Public Environment Report

Technical Appendix A: Flora and fauna

North East Link Project

Public Environment Report

Technical Appendix A – Flora and fauna technical report

Prepared for North East Link

September 2019

Executive summary

This technical report is an appendix to the North East Link Public Environment Report (PER) and has been prepared to inform the PER and meet the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* assessments required.

Overview

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The proponent for the North East Link project is the State of Victoria through the Major Transport Infrastructure Authority (MTIA). The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is the division within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

On 13 April 2018, a delegate of the Australian Government Minister for the Environment and Energy determined that North East Link is a controlled action due to likely significant impacts on the following matters protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (Sections 18 and 18A)
- Listed migratory species (Sections 20 and 20A)
- Environment on Commonwealth land (Sections 26 and 27A).

The delegate of the Minister also determined that North East Link requires assessment by a PER. The PER allows stakeholders to understand the likely impacts of North East Link on these Matters of National Environmental Significance (MNES) and on the environment on Commonwealth land and how they are proposed to be managed.

The PER was developed in parallel with the reference project development and preparation of the North East Link Environment Effects Statement (EES). The reference project has been assessed in the PER.

GHD was commissioned to undertake an ecological impact assessment for the purposes of the PER.

Ecological context

In accordance with the PER Guideline requirements, this ecological assessment considers the following matters of national environmental significance (MNES) that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (Sections 18 and 18A of the EPBC Act), including:
  - Matted Flax Lily (*Dianella amoena*) (endangered)
  - Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)

  - Swift Parrot (*Lathamus discolor*) (critically endangered)
  - Australian Painted Snipe (*Rostratula australis*) (endangered)
  - Australasian Bittern (*Botaurus poiciloptilus*) (endangered)
  - Macquarie Perch (*Macquaria australasica*) (endangered)
  - River Swamp Wallaby-grass (*Amphibromus fluitans*) (vulnerable)
  - Clover Glycine (*Glycine latrobeana*) (vulnerable)
  - Growling Grass Frog (*Litoria raniformis*) (vulnerable)
  - Australian Grayling (*Prototroctes maraena*) (vulnerable)
- Listed migratory species (Sections 20 and 20A), including:
  - Latham's Snipe (*Gallinago hardwickii*)
- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

An impact-based approach was applied to prioritise the key issues for assessment and inform measures to avoid and minimise potential effects. Characterisation of the existing ecological conditions within the project boundary was undertaken through:

- A desktop assessment to determine the likelihood of occurrence of threatened flora, fauna and ecological communities within the project boundary
- A general field assessment to collect information on vegetation and habitat characteristics, and to inform the need for targeted surveys
- Aquatic ecosystem assessment
- Targeted surveys at specific locations that were considered likely to support threatened species or communities.

In accordance with the PER Guideline requirements, the findings and conclusions in this ecological assessment are presented in two parts: content relating to matters of national environmental significance (MNES) across the entire project boundary, and content relating to Commonwealth land.

The significance of impacts on MNES and the environment on Commonwealth land were assessed using the EPBC Act Significant impact guidelines 1.1 *Matters of National Environmental Significance*, and 1.2 *Actions on, or impacting upon Commonwealth land, and actions by Commonwealth agencies* (DSEWPAC, 2013b).

Description of the environment and key findings – MNES within the entire project boundary

Threatened flora – species and communities

The flora component of this assessment is required to consider the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain
- Matted Flax-lily (*Dianella amoena*)
- Clover Glycine (*Glycine latrobeana*).

This assessment also considers potential impacts on the following additional threatened species and communities protected under Part 3 of the EPBC Act, which were deemed to have the potential to occur within the project boundary based on the EPBC Act Protected Matters Search Tool (PMST):

- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
- River Swamp Wallaby-grass (*Amphibromus fluitans*)
- Charming Spider-orchid (*Caladenia amoena*)
- Basalt Peppercress (*Lepidium hyssopifolium*)
- Green-striped Greenhood (*Pterostylis chlorogramma*)
- Swamp Fireweed (*Senecio psilocarpus*)
- Swamp Everlasting (*Xerochrysum palustre*).

The project boundary incorporates three bioregions, including the Gippsland Plain, Victorian Volcanic Plain and Highlands – Southern Fall. The majority of the project boundary falls within the Gippsland Plain bioregion. Landforms within the Gippsland Plain generally consist of low-lying floodplains including billabongs (oxbow lakes) associated with the Yarra River and flat to undulating plains. The northern part of the project boundary is characterised by undulating hills within the Highlands – Southern Fall bioregion, which drain to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection.

Native vegetation within the project boundary is generally in poor-moderate condition, with the ecological values present largely reflecting the long history of urban land use throughout the surrounding landscape. However, despite the highly urbanised landscape, the project boundary does contain substantial ecological values, particularly in the following areas:

- Simpson Barracks
- The Yarra River, its floodplains and parks (Warringal Parklands and Banyule Flats, Bolin Bolin Billabong, Kew Billabong and Willsmere Park)
- Koonung Creek
- Banyule Creek.

Substantial areas of the project boundary support native vegetation planted for amenity purposes along public roads and within recreation reserves.

Continuing pressure from weed invasion and regular anthropogenic disturbance has historically negatively impacted vegetation quality throughout much of the project boundary. However, there are pockets where significant effort in revegetation and management has resulted in higher quality patches.

The Matted Flax-lily was recorded at three locations within the project boundary, with a large population recorded at Simpson Barracks. A patch of Grassy Eucalypt Woodland of the Victorian Volcanic Plain was recorded immediately adjacent to the project boundary along the Metropolitan Ring Road between Enterprise Drive and the M80 Ring Road, and is designated as a no-go zone. No other flora species or communities listed as threatened under the EPBC Act were recorded within the project boundary.

Threatened terrestrial fauna – species and communities

The study area is considerably urbanised and fragmented as a result of historical land clearance for urbanisation and to enable the construction of the Eastern Freeway and major arterial roads between the Eastern Freeway and the Metropolitan Ring Road. That said, the study area still supports a range of habitats for terrestrial fauna, though these are typically highly disturbed. Areas of high ecological value remain in some sections, particularly near the Yarra River and its associated floodplain in the Alphington, Kew East, Bulleen and Banyule areas. Because this land is a floodplain within a large metropolitan area, it is characterised by expansive, well-treed, multi-use recreational parks (including golf courses), which retain important patches of high value habitat for terrestrial fauna.

The northern parts of the project boundary generally pass through areas that have been previously disturbed. The woodland and forest areas that remain or that have regenerated or been re-planted offer low to moderate value habitat for threatened and migratory fauna species. While some threatened species may use these habitats occasionally (such as Swift Parrot *Lathamus discolor*), these habitats tend to be used and visited by common and adaptable fauna that occur across much of the Melbourne area.

Further south, in the suburb of Yallambie, the corridor runs along the western fringe of Simpson Barracks, which contains a relatively large area of remnant woodland. The corridor then courses along Banyule Creek as tunnels, which is relatively degraded (weedy with non-native trees and shrubs) and generally of low to moderate value to fauna for most of its length. Banyule Creek flows into or alongside Banyule Swamp within a large area of recreational parks associated with the Yarra River floodplain where there are numerous records of threatened species. The corridor then continues along the eastern side of more high value Yarra River floodplain, including the Bolin Bolin Billabong.

Where the corridor meets the Eastern Freeway at Bulleen Road, the area has been considerably disturbed historically, mostly for the construction of the Eastern Freeway. Golf courses adjacent to the Eastern Freeway (north side, west of Bulleen Road) provide some limited habitats for native fauna, but are mostly dominated by common and aggressive bird species. Threatened species may use those habitats occasionally. Fauna habitats along Koonung Creek (mainly east of Bulleen Road) are mostly degraded and disturbed, and tend to be used mostly by common and adaptable fauna.

West of Bulleen Road, the Eastern Freeway crosses the Yarra River and Merri Creek (separate locations). The fauna habitats at both locations are degraded and disturbed. Where it crosses the Yarra River, the project boundary includes approximately 10 metres of the north side of a designated Management Area associated with the Grey-headed Flying-fox camp/colony at Yarra Bend Park, which is designated as a no-go zone.

Habitats for terrestrial fauna within the project boundary include: forests and woodlands (riparian), forests and woodland (non-riparian), scattered trees and planted roadside trees and shrubs, and waterways and wetlands. Non-native vegetation (including planted amenity trees) can also provide habitat for some fauna, and was considered in the assessment.

The terrestrial fauna component of this assessment is required to consider the following matters of national environmental significance (MNES) that are protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Swift Parrot (*Lathamus discolor*) (critically endangered)
  - Australian Painted Snipe (*Rostratula australis*) (endangered)
  - Australasian Bittern (*Botaurus poiciloptilus*) (endangered)
  - Growling Grass Frog (*Litoria raniformis*) (vulnerable).

This assessment also considers potential impacts on the following additional threatened species protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Grey-headed Flying-fox (*Pteropus poliocephalus*) (vulnerable).

The Grey-headed Flying-fox occurs across the Melbourne area, foraging in densely vegetated flowering and fruiting trees. Since 2003, there has been an established Grey-headed Flying-fox colony/camp along the Yarra River at Yarra Bend Park, downstream of the eastern Freeway. The Grey-headed Flying-fox was observed in small numbers flying overhead during nocturnal field assessments at several locations across the project boundary.

No other threatened terrestrial fauna species listed under the EPBC Act was detected in the project boundary. The Australasian Bittern and Swift Parrot have the potential to visit suitable habitat within the project boundary occasionally or rarely, but are unlikely to use any of those habitats to any great degree. The Growling Grass Frog is likely locally extinct (extirpated) from land within the project boundary at present, but may recolonise suitable sites in future.
The Australian Painted Snipe is a rare, nomadic bird species that may turn up at any suitable wetland when conditions are favourable, but that is generally unlikely to occur within the project boundary.

Threatened aquatic fauna

The study area is within the Yarra River catchment, and North East Link would intersect or is adjacent to sections of the Yarra River, Merri Creek, Plenty River, Koonung Creek and Banyule Creek. A number of permanent and ephemeral natural wetlands are also present, notably including Bolin Bolin Billabong, and Banyule Swamp.

The Yarra River provides very high value aquatic habitat, and supports an abundant and diverse assemblage of aquatic fauna, including native fish, turtles and platypus. The Yarra River supports this aquatic ecosystem, despite the cumulative pressures of heavily modified catchment landscape, including modified hydrology through river regulation, urban stormwater inputs containing chemical and litter pollution and modification of riparian zones. The floodplain wetlands of the Yarra River contain some high quality aquatic habitat, including the billabongs, although these are somewhat more degraded, with altered hydrological regime disrupting the ecological conditions of these dynamic systems.

The other waterways within the study area are generally more degraded, with heavy impacts of channel modification, urban stormwater and riparian zone modification affecting aquatic habitat condition and reduced aquatic biodiversity. Aquatic ecosystem assessment of these waterway revealed most sites fail to meet environmental condition objectives for aquatic ecosystems for urban waterways (EPA, 2003, DELWP, 2018).

The aquatic fauna component of this assessment is required to consider the following MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Macquarie Perch (*Macquaria australasica*) (endangered)
  - Australian Grayling (*Prototroctes maraena*) (vulnerable).

This assessment also considers potential impacts on the following additional threatened species protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Dwarf Galaxias (*Galaxiella pusilla*) (vulnerable)
  - Murray Hardyhead (*Craterocephalus fluviatilis*) (endangered)

– Murray Cod (*Maccullochella peelii*) (vulnerable)
– Yarra Pygmy Perch (*Nannoperca obscura*) (vulnerable).

The construction of a fishway at Dights Falls in the Yarra River has aided in the recovery of the Australian Grayling. They are known to occur in the Yarra River between Mullum Mullum Creek and Dights falls. The connectivity with the Yarra River means there is some potential for Australian Grayling to also exist in Merri Creek, although modelled distribution of the species suggesting a low probability they would exist in Merri Creek. The habitat assessment of Plenty River was found to potentially allow passage/migration corridors for the species from the Yarra River. The habitat assessment of all other waterways in the study area concluded the presence of Australian Grayling was unlikely, but is possible in waterways with direct connectivity to Yarra River and where suitable habitat was present. The habitat assessment of Banyule Creek identified significant barriers to fish passage that would prevent Australian Grayling from moving upstream from the Yarra River. Koonung Creek was also found to contain some significant covered sections and drop structures that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. However, other fish species that are more capable of traversing drop structures were located upstream of these covered sections, which indicates passage maybe possible for some species. Australian Grayling are not expected to inhabit the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

Macquarie Perch is now restricted to a small number of fragmented populations mostly in relatively undisturbed upland catchments in northern Victoria. However, a self-sustaining population exists in the Yarra River from fish translocated in the 1920s and possibly represents the most secure population in Australia. Due to connectivity with the Yarra River, there would be a high potential for the species to also occur in Merri Creek. The species is reported as living in Mullum Mullum Creek and the Plenty River. Substantial existing barriers to fish passage prevent fish passage upstream from the Yarra River into Banyule Creek and Koonung Creek.
The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

The Dwarf Galaxias is widely distributed, but populations are fragmented and patchy and their presence in the study area is considered unlikely. However small aquatic habitats in the protected environment of Simpson Barracks may contain a similarly translocated population, which may be isolated due to lack of connectivity. The absence of fish records from this site means the presence of Dwarf Galaxias at this site is unlikely but possible.

The Murray Hardyhead is unlikely to occur within the study area.

The Murray Cod has been successfully introduced in the Yarra River. Although the Murray Cod's EPBC Vulnerable status does not apply protection to the populations outside the natural range in the Murray-Darling basin, its status under Victoria's *Flora and Fauna Guarantee Act 1988* does apply to this species across the state, including the introduced Yarra River population. Given the territorial and sedentary nature of the species, and their preference to inhabit deeper areas of rivers, the Murray Cod is expected to occur within the project boundary in the Yarra River, and there is a high probability they also occur in Merri Creek and Plenty River. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp, nor in Banyule Creek or Koonung Creek due to the presence of barriers to movement and absence of suitable habitat.

The Yarra River population of Yarra Pygmy Perch reportedly disappeared in 1872. Although an original resident of the Yarra River, this species is unlikely to be present within the study area.

Migratory fauna

Twenty-six species (all birds) known or predicted to occur within the study area are listed as Migratory under the EPBC Act. While some of those species may use or visit habitats within the project boundary occasionally, field assessment of the potentially suitable habitats determined that most species are unlikely to use the project boundary in large numbers or frequently.
The terrestrial fauna component of this assessment is required to consider the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Listed migratory species (Sections 20 and 20A), including:
  - Latham's Snipe (*Gallinago hardwickii*).

Latham's Snipe appears to be a regular visitor to the study area, with most records from the Yarra River floodplain, between Kew and Warrandyte. In the Banyule Swamp and Banyule Flats area, there are numerous records, and this area appears to be the focus of Latham's Snipe habitat along this section of the Yarra River floodplain. Other locations within the project boundary where this species may occur are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. No Latham's Snipe were observed during this assessment, but their seasonal presence within the Banyule Swamp area is assumed.

Description of the ecology on Commonwealth land and key findings

In accordance with the PER Guideline requirements for Commonwealth land, this ecological assessment considers the following:

- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - War Services easement, to the rear of residential properties on Elder Street.

Flora – species and communities

Simpson Barracks has been extensively studied in recent decades, and much is known about the flora values it supports. It is situated on fertile soils that support Plains Grassy Woodland with a moderately species rich grassy and herbaceous ground layer (Jacobs, 2016 and HLA, 2007). The understory generally consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer (Jacobs, 2016).

Simpson Barracks contains a range of significant environmental values including Commonwealth and state-listed flora and several Ecological Vegetation Classes (EVCs).
A summary of several ecological assessments conducted across the *entire* Simpson Barracks site indicates:

- 52.5 hectares of remnant vegetation has been mapped
- 192 flora species have been recorded, including 92 indigenous and 100 exotic species. One nationally-listed species (Matted Flax-lily) and one state-listed species (Studley Park Gum) were observed on site.

Within the area to be directly impacted at Simpson Barracks, the current study mapped three patches of native vegetation (10.98 hectares; 6.290 habitat hectares), 34 Large Trees in patches and 17 scattered trees (five large, 12 small). The area within Simpson Barracks that intersects with the project boundary comprises Plains Grassy Woodland (EVC 55).

Of particular importance within the Barracks are:

- A significant population of Matted Flax lily *Dianella amoena* (Commonwealth and state-listed)

- A population of Arching Flax-lily *Dianella longifolia* var*. grandis* (DELWP, vulnerable)
- A significant population of the hybrid taxon, Studley Park Gum *Eucalyptus X studleyensis* (DELWP, endangered).

The War Services easement comprises slashed non-native grassland, with the western edge of the site crossed by a shared use path and timber wall. It contains four isolated trees on the boundary with the residential properties and some minor amenity planting near the timber wall.

Terrestrial fauna – species and communities

The Commonwealth land within the project boundary is within a locality that is considerably urbanised and fragmented as a result of historical land clearance. This provides important historical context for the fauna that continue to use the area.

The western section of Simpson Barracks where North East Link would traverse contains a relatively large area of remnant woodland, particularly large for this part of otherwise urbanised Melbourne. Most of the area is Plains Grassy Woodland (EVC 55), dominated by River Red Gum (*Eucalyptus camaldulensis*). While some of the trees observed during the site assessment were large, the trees generally tended to be relatively young and large hollows were not seen.

The eastern section of Simpson Barracks, outside the project boundary, was also found to be dominated by Plains Grassy Woodland (EVC 55), with small areas of Creekline Grassy Woodland (68), but that area differed in habitat characteristics from the western area. The eastern area typically consisted of a mixed-eucalypt overstorey, comprising Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx*, and Narrow-leaf Peppermint *E. radiata.* Understorey composition and density varied across the habitat zones.

Because Simpson Barracks currently contains relatively large areas of remnant woodland in an urbanised landscape, it is likely to attract and support a range of fauna. However, because it is surrounded by urbanisation and has been considerably disturbed historically, it is generally degraded and so is unlikely to support the full range of threatened and non-threatened fauna that would have occurred there historically.

Habitats within Simpson Barracks have moderate value for fauna, threatened and non-threatened. Patches of woodland (remnant, regrowth or planted) of this size within the Melbourne area tend to be characterised by bold, common and adaptable fauna, which can be aggressive and outcompete other native fauna. Occasionally or rarely, habitats within Simpson Barracks may attract threatened fauna such as Powerful Owl *N. strenua*, Swift Parrot *Lathamus discolor* and Grey-headed Flying-fox *Pteropus poliocephalus*; although this is likely to be for foraging only, and these species are not expected to breed or roost there frequently or regularly.

The woodland and grassland habitats within Simpson Barracks support a small population of Eastern Grey Kangaroos (*Macropus giganteus*). Approximately 52 hectares of the Barracks provides suitable habitat for kangaroos. The carrying capacity at the site is unknown, and whether or not the site (which is securely fenced) is 'closed' to kangaroo migration is uncertain.

Banyule Creek generally runs parallel to Greensborough Road through Simpson Barracks to an open reserve north of Drysdale Road. Where North East Link is proposed through the western part of Simpson Barracks, the waterway is small and intermittent and provides poor quality fauna habitat. A series of man-made, stream-side, densely vegetated ponds provide habitat for common frogs. Threatened wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus*, are unlikely to occur within this section of Banyule Creek.

The War Services easement does not contain any significant habitat for fauna.

Aquatic fauna

Simpson Barracks contains two natural drainage systems; the east side drains to Yallambie Drain which runs into the Plenty River and the west side includes the upper catchment of Banyule Creek which drains into the Yarra River. The project boundary is located on the western side of Simpson Barracks, within the headwater catchment of Banyule Creek.

Banyule Creek within the Barracks is an ephemeral waterway, which provides aquatic habitat only during and following periods of rainfall runoff. The riparian condition of the waterway is relatively good, due to the intact vegetation. However, considerable modification to the drainage in the Barracks includes a constructed drain that diverts much of the water away from the natural channel. The habitat in this drain is poor, and contains little instream structural diversity or microhabitats. The waterway habitats in the headwaters of Banyule Creek support very poor aquatic ecosystem condition, as indicated by very low diversity and pollution tolerance of macroinvertebrate community collected in Rapid Bioassessment. There is no suitable habitat for fish in Banyule Creek within Simpson Barracks.

Away from the main channel of Banyule Creek, a number of constructed wetlands are present, that receive runoff from catch drains and appear to contain permanent water. These wetlands may provide good habitat for small-bodied fish, but fish surveys revealed no fish were present.

Field assessment of Banyule Creek downstream of Simpson Barracks revealed a poor quality aquatic ecosystem, with degraded aquatic macroinvertebrate communities. The hydrological field assessment of Banyule Creek revealed that groundwater inputs to the creek occur downstream of Lower Plenty Road, beyond the extent that North East Link would impact groundwater. Fish surveys revealed the common native and non-native fish. The fish community was dominated by the exotic Oriental Weatherloach.

The field assessment of Banyule Swamp indicated a wetland that is impacted by stormwater inputs. The water level of the lake is maintained by a constructed levee. The macroinvertebrate community surveyed revealed a moderate diversity of wetland generalists, although the fish surveys indicted a community dominated by exotic Mosquito Fish.

The War Services easement does not contain any watercourses or drainage systems. It therefore does not support any aquatic flora or fauna.

Groundwater dependent ecosystems

Since the numerical groundwater modelling was undertaken for the preparation of the draft PER that was published under Section 98 of the EPBC Act, additional numerical groundwater modelling has been undertaken. The purpose of the further modelling was to incorporate additional groundwater data collected over a period of approximately 12 months to enable transient calibration to seasonal variations in groundwater levels and to assess whether or not the additional calibration efforts result in changes to the assessment of project-induced groundwater impacts.

It was determined that some large trees within Simpson Barracks and abutting Commonwealth land, but outside the project boundary, may be accessing groundwater on occasions (10<20 metres groundwater depth zone). Based on the additional numerical groundwater modelling undertaken, a total of eight large trees (five River Red Gum, three Studley Park Gum) have a moderate to high likelihood of being negatively impacted by groundwater drawdown over the long-term (2075 scenario) which could include a decline in health and/or premature death. Mitigation measures such as short-term watering may reduce the number of trees impacted by groundwater drawdown during construction. Any large trees predicted to be affected over the long-term would need to be offset in association with the offset strategy for North East Link,

based on the Guidelines (DELWP, 2017a). Areas outside the 10<20-metre groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

Summary of key impacts – MNES within the entire project boundary

The potential impact on MNES (terrestrial and aquatic flora and fauna listed as threatened or migratory under the EPBC Act) is assessed here using the criteria outlined in the *Significant impact guidelines 1.1 under the Commonwealth EPBC Act* (DSEWPAC, 2013a).

Threatened flora – species and communities

North East Link would impact on the Matted Flax-lily. Plants/patches within the project boundary are therefore proposed to be translocated to suitable alternative sites, some of which already support Matted Flax-lily, and some of which do not support the species but contain appropriate habitat. Translocation of Matted Flax-lily is listed as a specific objective of the National Recovery Plan for the species, and has been successfully completed for other major projects, with high success rates. With successful implementation of a salvage and translocation program, significant impacts on Matted Flax-lily are expected to be unlikely for seven or eight of the nine significant impact criteria, while significant impacts are possible for one criterion: 'Adversely affect habitat critical to the survival of a species', and possibly a second criterion, 'Reduce the area of occupancy of the species'. However, the residual post-translocation impact of North East Link on Matted Flax-lily is expected to be **non-significant** for the following reasons: a) evidence points to strong prospects of long-term survivorship of translocated individuals, b) translocation risk is proposed to be spread across a number of potential receptor sites in the local area, minimising the risk of failure, and c) multiple ramets would be harvested (and grown on) from each plant/patch to be salvaged; therefore, it is likely the overall population size in the local area would increase following implementation of the translocation program.

Impacts on other species and communities listed as threatened under the EPBC Act are not expected due to North East Link.

Threatened fauna – terrestrial

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential for North East Link to impact most terrestrial and aquatic fauna species across the eastern Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use the inner eastern Melbourne area. In areas where surface impacts could not be avoided, and particularly in locations where habitats are identified as being of high value, the smallest practicable project boundary has been adopted for North East Link to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

The residual impact of North East Link on fauna species listed as threatened under the EPBC Act is expected to be minor and non-significant.

Threatened fauna – aquatic

Threatened fish species located in the study area (Australian Grayling and Macquarie Perch) are limited to the Yarra River habitat, and are not present in other waterways that North East Link would affect. Tunnelling under the Yarra River would avoid impacts on habitat, connectivity or environmental conditions that are important for these vulnerable species. The likelihood of significant impacts to these fish species is low.

Migratory fauna

Latham's Snipe is recorded occasionally but regularly in the Melbourne area and within the project boundary, mainly in the Banyule Flats and Banyule Swamp area, which would be avoided by tunnelling. Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential for North East Link to impact on all areas that may be considered important habitat for Latham's Snipe under the EPBC Act. In areas where surface impacts could not be avoided, including waterway and wetland habitats that are potentially used occasionally by Latham's Snipe, the removal of vegetation and habitat would be minimised through detailed design, including by minimising the footprint of works.

The residual impact of North East Link on this species and all other migratory species is expected to be negligible and non-significant.

Summary of key impacts – the environment of Commonwealth land

The potential impacts on the environment on Commonwealth land were assessed using the EPBC Act Significant impact guidelines 1.2 *Actions on, or impacting upon Commonwealth land, and actions by Commonwealth agencies* (DSEWPAC, 2013b).

Plants

Removal of 10.976 hectares of Plains Grassy Woodland from Commonwealth land, and potential additional indirect loss of eight large trees through groundwater drawdown in and around the same area, is likely to be considered to be medium-scale vegetation removal, in the context of Simpson Barracks alone. The removal of this amount of native vegetation is therefore likely to constitute a **significant impact** on plants on Commonwealth land.

The clearance of native vegetation involving removal of two listed threatened plant species (Matted Flax-lily *Dianella amoena*, Arching Flax-lily *Dianella longifolia* var. *grandis*) is unlikely to result in a long-term decline in a population, or threaten the viability, or reduce the occupancy of Matted Flax-lily or Arching Flax-lily.

The direct clearance of 44 mature individuals of Studley Park Gum within the project boundary at Simpson Barracks, and the additional indirect impact on three large Studley Park Gum's outside the project boundary by groundwater drawdown over the long-term (2075 operational scenario based on further numerical groundwater modelling undertaken) is likely to result in a long-term decline in a population, or threaten the viability, or reduce the occupancy of Studley Park Gum.

To mitigate potential impacts of groundwater drawdown on Studley Park Gum trees at Simpson Barracks during construction, a Groundwater Dependent Ecosystem Monitoring and Mitigation Plan would be implemented (the proposed strategy which would form the basis of the plan is attached as Appendix H). However, as this mitigation would not avoid or mitigate the predicted loss of 47 Studley Park Gum individuals, it is expected that the residual impact on plants on Commonwealth land will be **significant**. In accordance with the *EPBC Act Environmental Offsets Policy*, this would trigger a requirement for offsets for impacts to Studley Park Gum on Commonwealth land.

Studley Park Gum itself is not a protected matter however the environment on Commonwealth land is a protected matter. NELP proposes to contribute to the conservation of Studley Park Gum by establishing new habitat through the implementation of the Studley Park Gum Management Framework (Appendix A). This approach is expected to result in a viable outcome noting that the creation of new habitat for a protected matter is a type of direct offset under the *EPBC Act Environmental Offsets Policy*. This framework would include collecting seed and establishing a new population of Studley Park Gum.

In addition to the above, at the State level native vegetation offsets would be provided based on the Victorian Guidelines (DELWP 2017a) to offset for the removal of native vegetation (which Studley Park Gum trees form part of) directly impacted by the project, and three Studley Park Gum trees expected to experience premature mortality due to long term groundwater drawdown.

Implementing the Studley Park Gum Management Framework (Appendix A) and State offsets is in line with the *EPBC Act Environmental Offsets Policy* and commensurate with the conservation status of the species.

North East Link would be unlikely to introduce a potentially invasive species to or from Commonwealth land.

A chemical that would substantially stunt the growth of native vegetation is not proposed for North East Link.

Controlled burning is not proposed for North East Link.

Animals – terrestrial

Loss of some animal habitat would be unavoidable, and it is possible that small numbers of common animals might be injured, killed, disturbed or displaced during construction. However, North East Link is expected to have no more than a minor impact on terrestrial animals on Commonwealth land overall. Animals that visit or reside at Simpson Barracks already tolerate various disturbances and dangers that are associated with the large city that surrounds the area. North East Link would not add any significant disturbance or threat to those animals that is not already present.

Habitat loss from Commonwealth land proposed for North East Link is expected to result in the loss or displacement of individuals of mostly common or abundant species, rather than entire populations or species, and rather than threatened species. North East Link is not expected to influence the long-term persistence or viability of any native terrestrial animal species.

Animals – aquatic

Impacts to aquatic fauna resulting from works on Commonwealth land are limited to the aquatic habitats of Banyule Creek. Loss of some aquatic habitat along Banyule Creek would be unavoidable. Due to the existing degraded ecological conditions of this waterway, the presence of several barriers to fish passage and ephemeral nature of the headwaters within Simpson Barracks, the ecological impacts from proposed modification to waterways on aquatic fauna is not expected to be significant.

With adequate management of materials and controls of discharges, spills and runoff from North East Link, its residual impact on aquatic animals in and around Commonwealth land is expected to be minor and non-significant.

Table of contents

Table index

Figure index

Appendices

Abbreviations

Abbreviation	Term in full
ALA	Atlas of Living Australia
BCS	Bioregional Conservation Significance
BLA	Birdlife Australia
BOM	Bureau of Meteorology
CaLP Act	*Catchment and Land Protection Act 1994*
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DBH	Diameter at breast height
DoEE	Department of Environment and Energy
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (now DELWP)
EAO	Environmental Audit Overlay
EGK	Eastern Grey Kangaroo
EnSym	Environmental Systems Modelling Platform
ESO	Environmental Significance Overlay
EES	Environment Effects Statement
EPA	Environment Protection Authority
EPT	Ephemeroptera, Plecoptera, Trichoptera
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988*
GDE	Groundwater Dependent Ecosystem
GDEMMP	Groundwater Dependent Ecosystem Monitoring and Mitigation Plan
GEWVVP	Grassy Eucalypt Woodland of the Victorian Volcanic Plain
Hha	Habitat hectares
HO	Heritage overlay
HZ	Habitat zone
JAMBA	Japan-Australia Migratory Bird Agreement
LGA	Local Government Authority
MNES	Matters of National Environmental Significance
NEL	North East Link
NELP	North East Link Project
NVIM	Native Vegetation Information Management

Abbreviation	Term in full
NVR report	Native Vegetation Removal report
OEMP	Operations Environmental Management Plan
OMP	Offset Management Plan
PAR	Photosynthetically Active Radiation
PMST	Protected Matters Search Tool
PPRZ	Public Park And Recreation Zone
RBA	Rapid Bioassessment
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEPP	State Environment Protection Policy
SIGNAL	Stream Invertebrate Grade Number – Average Level
SLO	Significant Landscape Overlay
SRZ	Structural Root Zone
TBM	Tunnel Boring Machine
TPZ	Tree Protection Zone
VPO	Vegetation Protection Overlay
VBA	The Victorian Biodiversity Atlas
VQA	Vegetation Quality Assessment
WEMP	Worksite Environmental Management Plan
WoNS	Weeds of national significance
WoV	Waters of Victoria
WSUD	Water Sensitive Urban Design

Glossary

Term	Definition
Biodiversity	The variety of all life forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part.
Bioregion	A landscape based approach to classifying the land surface using a range of environmental attributes such as climate, geomorphology, lithology and vegetation.
Bioregional conservation status (BCS)	An assessment of the conservation status of the native vegetation type (EVC) in the context of a particular bioregion, taking account of how commonly it originally occurred, the current level of depletion and the level of degradation of condition typical of remaining stands.
e-bird	A database of bird records (at www.ebird.org), administered by Audubon and Cornell Lab of Ornithology, USA
Ecological Vegetation Class (EVC)	A type of indigenous vegetation classification that is described through a combination of floristics, lifeforms and ecological characteristics and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.
Exotic fauna (= non-native fauna)	Any fauna that is not native to Australia or its states and territories.
Exotic vegetation	Any vegetation that is not native to Australia or its states and territories.
Extirpated	Locally extinct
Graminoid	A herbaceous plant with a grass-like morphology
Habitat hectare (Hha)	A site-based measure of quality and quantity of native vegetation that is assessed in the context of the relevant native vegetation type.
Habitat zone (HZ)	A discrete area of native vegetation consisting of a single vegetation type (EVC) with an assumed similar averaged quality. This is the base spatial unit for conducting a habitat hectare assessment.
Indigenous vegetation	Indigenous vegetation includes vegetation that is native to Australia as well as being native to a specific geographic region. In the case of North East Link, this includes vegetation that is native to the Port Phillip and Westernport Catchment Management Region.
Native trees	Native trees include all trees that are native to Australia, and its states and territories.
North East Link Project (NELP)	North East Link Project (NELP) is the division within MTIA that is responsible for developing and delivering North East Link. NELP was formerly known as the North East Link Authority prior to 1 January 2019. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

Term	Definition
Patch	A patch of native vegetation is either: a) an area of vegetation where at least 25% of the total perennial understorey plant cover[1] is native, or b) any area with three or more native canopy trees[2] where the drip line[3] of each tree touches the drip line of at least one other tree, forming a continuous canopy, or c) any mapped wetland included in the *Current wetlands map*, available in DELWP systems and tools (DELWP, 2017a).
Scattered tree	A scattered tree is a native canopy tree that does not form part of a patch (DELWP, 2017a).
Threatened species	For the purposes of this report, threatened species refers to species considered threatened in Victoria or Australia. This includes species that are vulnerable or endangered in Victoria as defined by DEPI (2014) listed under the Victorian *Flora and Fauna Guarantee (FFG) Act 1988* or listed as vulnerable, endangered or critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Species listed as rare, near-threatened, poorly known or data deficient are not considered threatened.
Victorian Biodiversity Atlas (VBA)	The VBA is administered by the Victorian Department of Environment, Land, Water and Planning and replaces several legacy systems, including the Flora Information System, the Atlas of Victorian Wildlife, and the Aquatic Fauna Database. The VBA encompasses vertebrate and invertebrate animals, fungi, vascular and non-vascular plants from terrestrial and aquatic environments, including marine waters to the three nautical mile statutory limit. It includes both native and naturalised exotic species (including weeds and pests) but is not intended to hold data on cultivated or domesticated species.

[1] Plant cover is the proportion of the ground that is shaded by vegetation foliage when lit from directly above. Areas that include non-vascular vegetation (such as mosses and lichens) but otherwise support no vascular vegetation are not considered to be a patch for the purposes of the Guidelines (DELWP 2017a), However, when non-vascular vegetation is present with vascular vegetation, it does contribute to cover when determining the percentage of perennial understorey plant cover.

[2] A native canopy tree is a mature tree (it is able to flower) that is greater than 3 metres in height and is normally found in the upper layer of the relevant vegetation type.

[3] The drip line is the outermost boundary of a tree canopy (leaves and/or branches) where the water drips on to the ground.

1. Introduction

1.1 Purpose of this report

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The proponent for the North East Link project is the State of Victoria through the Major Transport Infrastructure Authority (MTIA). The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is the division within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

North East Link was referred to the Australian Government's Department of the Environment and Energy on 17 January 2018. On 13 April 2018 North East Link was declared a 'controlled action', requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The decision notice requires North East Link to be assessed through a Public Environment Report (PER).

The purpose of this report is to assess the potential ecological impacts on Commonwealth land and Matters of National Environmental Significance (MNES) associated with North East Link to inform the preparation of the PER.

North East Link also requires assessment under Victoria's *Environment Effects Act 1978*. A separate report has been prepared for the purposes of the Environment Effects Statement (EES) required under the Environment Effects Act.

1.2 Why understanding ecology is important

The study of ecology in the context of this PER technical report is focused on identifying the MNES and other biodiversity values of areas that North East Link may impact. These values are recognised by the Australian and Victorian government in legislation, frameworks and policies designed to facilitate their conservation. The values include native vegetation, migratory species, threatened species or communities, and habitat for migratory and/or threatened species.

Impacts on MNES and other significant ecological values, and the application of the legislation, frameworks and policies that relate to their protection, are a key consideration of the PER process. Accordingly, an understanding of existing ecological values within the North East Link study area is critical to determining the likelihood and extent of project-related impacts on MNES and other significant ecological values.

2. PER Guidelines

2.1 Controlling provisions

The controlling provisions are the matters protected under Part 3 of the EPBC Act, which the proposed action may have a significant impact on. These are the focus of the PER assessment.

The controlling provisions relevant to ecology are:

- Listed threatened species and communities (Sections 18 and 18A of the EPBC Act)
- Listed migratory species (Sections 20 and 20A of the EPBC Act)
- Environment on Commonwealth land (Sections 26 and 27A).

2.2 PER Guideline requirements

The Commonwealth Department of Environment and Energy provided NELP with '*Guidelines for the content of a draft Public Environment Report'* (PER Guidelines) on 10 July 2018.

The content requirements from the PER Guidelines relevant to ecology are shown in Table 2-1, as well as the location where these items are addressed in this report or the PER.

Table 2-1 PER Guidelines content requirements relevant to flora and fauna

PER Guidelines section	Summary of PER Guidelines content requirements*	Application to this report
2.0 Specific content	Lists the matters to which the PER Guidelines apply.	The matters in this list that are relevant to this report are discussed in Sections 5 to 13.
2.2. Description of the action	Description of the construction and operational components of the action.	Chapter 3 of the PER describes the action. Section 3 of this report describes the specific components of the action relevant to ecology impacts.
2.3. Feasible alternatives	Description and comparison of feasible alternatives.	Chapter 4 of the PER describes the feasible alternatives.
2.4. Description of the environment	(a) A description of the abundance, distribution, and ecological relationships of threatened species and ecological communities in the study area (as defined in Section 5.2.1) including maps. A description of the known threats to, and assessment of quality and importance of, species or communities' habitats in the study area. A description of the scope, timing and methodology for studies or surveys including assessment of the adequacy of any surveys undertaken.	Chapter 5 of the PER provides a description of the environment. Section 5 of this report outlines the ecology assessment method used. Sections 6, 7 and 8 of this report provide a detailed description of MNES potentially affected by North East Link and ecological resources on and around Commonwealth land. Appendix E describes known threatening processes.

PER Guidelines section	Summary of PER Guidelines content requirements*	Application to this report
	(b) A description of the surface and groundwater resources relevant to the action and listed threatened species or communities; and migratory species.	This report draws on information relating to water resources presented in the PER Technical Appendix B – Groundwater and PER Technical Appendix C – Surface water.
	A description of the Commonwealth land environment to be affected by the proposal	Sections 6.3, 7.3 and 8.3 of this report describes the ecological features on and around Commonwealth land that North East Link would potentially impact.
2.5. Relevant impacts	(a) Requirements for the assessment of impacts on the Specific content listed in Section 2 of the guidelines. This includes assessment of: • Direct, indirect, cumulative and facilitated impacts • Long and short-term impacts and if they are reversible • Analysis of impact significance • If any impacts are unpredictable or unknown and any additional data that may be needed • Illustration of impacts using maps • Description of assessment methodology. (b) Requirement to address cumulative impacts. (c) Requirement to address 'facilitated' impacts at a local, regional, state and national scale.	Section 5 of this report summarises the scope of the assessment and describes the impact assessment methodology and limitations. Section 9 of this report details the relevant impacts identified including maps where applicable. Section 12 of this report details the relevant cumulative and facilitated impacts identified.
2.5.1. Listed threatened species and ecological communities; and migratory species	Specific requirements for assessment of the impacts on MNES (threatened species, ecological communities and migratory species). These include: • Number of individuals and area of occupancy affected • Impacts on population and community • Loss, alteration or fragmentation of habitat and breeding sites.	Section 9 of this report provides a detailed description of potential North East Link impacts on MNES.

PER Guidelines section	Summary of PER Guidelines content requirements*	Application to this report
2.5.3. Commonwealth –land – whole of the environment	Assessment of the whole of the environment on Commonwealth land. The requirements include a description of resources used for the assessment, description of the matters affected and assessment of: • Flora and fauna • People and communities (including the Defence estate as a distinct community) • Cultural and heritage values • Landscapes and soils • Water resources • Pollutants, chemicals and toxic substances.	Sections 6.3, 7.3 and 8.3 of this report describe the features on Commonwealth land that North East Link would potentially impact. Section 11 of this report details the predicted flora and fauna impacts on Commonwealth land. PER Technical Appendix D – Commonwealth land addresses all other requirements.
2.6. Proposed avoidance and mitigation measures	Description of safeguards and mitigation, including a consolidated list of measures, which include: • Details of the impacts to which measures relate • Maps showing the measures' location • The anticipated effectiveness of the measures and the expected environmental outcomes of their use • Baseline data and/or proposed monitoring to demonstrate achievement of outcomes • Description of habitat rehabilitation including management, methodology and timing • Statutory or policy basis and agency responsible for approval of measures • Cost of the mitigation measures • An overall framework for management, mitigation and monitoring including provision for independent auditing.	Section 13 of this report describes measures to avoid, mitigate and monitor ecological impacts, including description of the likely residual impacts and environmental outcomes following the implementation of the mitigation measures.
2.7. Residual impacts/ environmental offsets	(a) Description of likely residual impacts (the 'Relevant impacts' referred to in Section 2.5 of the PER Guidelines following the implementation of mitigation measures referred to in Section 2.6.	Sections 10 and 11 of this report describes the likely residual impacts and environmental outcomes following the implementation of the mitigation measures.

PER Guidelines section	Summary of PER Guidelines content requirements*	Application to this report
	(b) An offset strategy for residual impacts if relevant, consistent with the EPBC Environmental Offsets Policy (DSEWPAC 2012), including: • Details of size, location, boundaries, tenure, landscape and ecology of the proposed offset site • Justification of how the offset package will maintain or improve the viability of the affected matter, including detail of actions to be undertaken, their timing, the risk of damage or degradation of the offset site and legal mechanisms proposed to prevent this happening • Cost of the offsets package.	Chapter 11 of the PER describes the offset requirements for the action.
2.8. Environmental outcomes	Specific, measurable and achievable outcomes for MNES which should be based on the EPBC Outcomes-based conditions policy 2016 and guidelines and include: • The impacts to which the outcome relates • Performance measures for outcomes • Baseline data used to define the outcome • Risks of non-achievement • Demonstrated willingness and capability of achieving the outcome • The proposed management framework, performance indicators, milestones, independent audits, monitoring and adaptive management, record keeping, publication and reporting processes proposed to achieve the outcome.	Chapter 12 of the PER describes the environmental outcomes following the implementation of mitigation measures, which covers, amongst other things, MNES.
2.10. Consultation	Description of any consultation undertaken or proposed.	Section 5.6 of this report describes consultation that has informed the ecological assessment.
2.13. Information sources provided in the PER	Information on the source, currency, reliability and uncertainty of data provided in the PER.	Section 2.2 of this report describes limitations, uncertainties and assumptions including data sources and reliability.

*A full copy of the guidelines can be found in PER Attachment I.

3. Description of the action

3.1 Overview

The North East Link alignment and its key elements assessed in the PER include:

- **M80 Ring Road to the northern portal** – from the M80 Ring Road at Plenty Road, and the Greensborough Bypass at Plenty River Drive, North East Link would extend to the northern portal near Blamey Road utilising a mixture of above, below and at surface road sections. This would include new road interchanges at the M80 Ring Road and Grimshaw Street.
- **Northern portal to southern portal** – from the northern portal the road would transition into twin tunnels that would connect to Lower Plenty Road via a new interchange, before travelling under residential areas, Banyule Flats and the Yarra River to a new interchange at Manningham Road. The tunnels would then continue to the southern portal located south of the Veneto Club.
- **Eastern Freeway** – from around Hoddle Street in the west through to Springvale Road in the east, modifications to the Eastern Freeway would include widening to accommodate future traffic volumes and provision of new dedicated bus lanes for the Doncaster Busway. There would also be a new interchange at Bulleen Road to connect North East Link to the Eastern Freeway.

An overview of North East Link is shown in Figure 3-1.

North East Link would also improve existing bus services from Doncaster Road to Hoddle Street with the Doncaster Busway as well as pedestrian connections and the bicycle network with connected cycling and walking paths from the M80 Ring Road to the Eastern Freeway.

For a detailed description of North East Link and the design of the action on Commonwealth land, refer to PER Chapter 3 –Description of the action. Following the transfer of land from Commonwealth to State ownership, the construction and operation of North East Link would not take place on Commonwealth land.

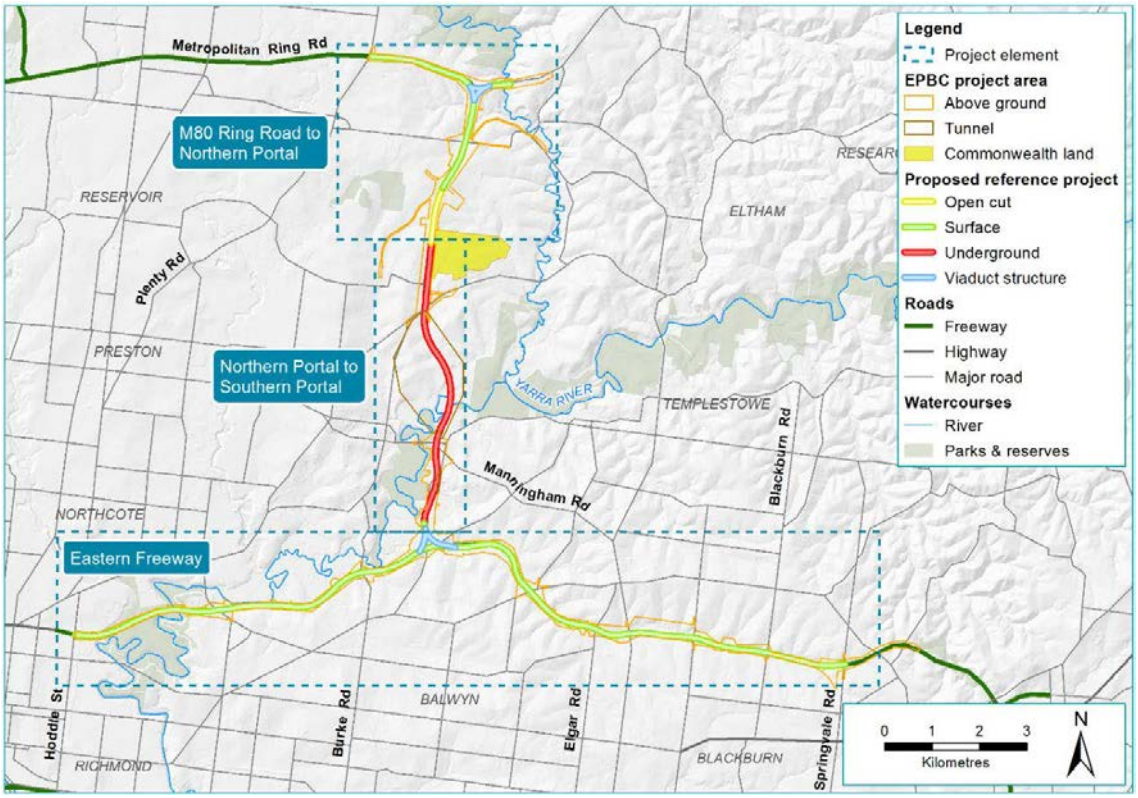


Figure 3-1 Overview of North East Link

3.2 Construction

Key construction activities for North East Link would include:

- General earthworks including topsoil removal, clearing and grubbing vegetation
- Relocation, adjustment or installation of new utility services
- Construction of retaining walls and diaphragm walls including piling
- Ground treatment to stabilise soils
- Tunnel portal and dive shaft construction
- Storage and removal of spoil
- Construction of cross passages, ventilation structures and access shafts
- Installation of drainage and water quality treatment facilities
- Installation of a Freeway Management System
- Tunnel construction using tunnel boring machines (TBMs), mining and cut and cover techniques
- Installation of noise walls
- Restoration of surface areas.

3.3 Operation

Following construction of North East Link, the key operation phase activities would include:

- Operation and maintenance of new road infrastructure
- Operation and maintenance of Freeway Management System
- Operation of North East Link motorway control centre
- Operation and maintenance of the tunnel ventilation system
- Operation and maintenance of water treatment facilities
- Operation and maintenance of the motorways power supply (substations)
- Maintenance of landscaping and Water Sensitive Urban Design (WSUD) features.

3.4 Activities on Commonwealth land

Commonwealth land that is potentially affected by the action includes:

- Simpson Barracks and adjoining publicly accessible area immediately south-west of the fence line of the Barracks. This area is used for informal outdoor recreation purposes. Throughout this report, all this land is referred to as 'Simpson Barracks'
- A strip of land located about one kilometre north of the Barracks, to the rear of residential properties on Elder Street. This strip of land is an easement for electricity transmission lines, and is referred to in this report as the 'War Services easement'.

Key activities on Simpson Barracks include:

- Construction of North East Link carriageways in a trench between Yallambie Road to just north of Blamey Road, then as a cut and cover tunnel section between Blamey Road and Lower Plenty Road
- Construction of ramps for the Lower Plenty Road interchange
- Construction of a northern portal tunnel ventilation structure
- Construction compounds and laydown areas during construction.

Key activities on the War Services easement include:

- Construction of surface road components of North East Link, including a local road connection (Greensborough Road), an upgraded shared use path, new noise wall and stormwater drainage bioretention water treatment pond
- Relocation of electricity transmission lines
- Construction laydown areas and temporary car parking during construction.

3.5 Activities and design considerations relevant to flora and fauna

Other activities that may require consideration from a flora and fauna standpoint include:

- Groundwater management following dewatering
- Surface water management
- Arboricultural assessments, mitigation and management.

4. Legislation, policy, guidelines and criteria

4.1 Legislation, policy and guidelines

Numerous legislative, policy and guidance documents were found to be relevant to this flora and fauna impact assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to the flora and fauna impact assessment for North East Link are summarised in Table 4-1.

Victorian legislation has been considered when assessing impacts on Commonwealth land and from works on Commonwealth land to provide a consistent approach to the assessment of impacts across North East Link.

Victorian Government and other legislation and guidance has also provided criteria for valuing receptors and assessing impact magnitude where none exists under the Commonwealth system, which is particularly the case for receptors that are not MNES.

Table 4-1 Key legislation and policy

Legislation/policy/ guideline	Key policies/strategies	Relevance to this impact assessment	Approvals required
Australian Government			
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Matters of National Environmental Significance – Significant impact guidelines 1.1: (DoE, 2013). Matters of National Environmental Significance – Significant impact guidelines 1.2: Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies.	*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).	Approval required for North East Link would be obtained from the Commonwealth Minister for the Environment or delegate following assessment by the PER.
Victorian Government			
Environment Effects Act 1978	EES referral criteria for ecological matters (from DSE, 2006).	Under the Environmental Effects Act, projects that could have a 'significant effect' on Victoria's environment may require an EES to be developed. North East Link was referred to Victoria's Minister for Planning who determined an EES was required.	EES being prepared. Proposed action to be assessed via the Victorian Government process of an EES.

Legislation/policy/ guideline	Key policies/strategies	Relevance to this impact assessment	Approvals required
Planning and Environment Act 1987	Guidelines for the removal, destruction or lopping of native vegetation (DELWP, 2017a).	The DELWP Guidelines are incorporated into the Victorian Planning Provisions and all planning schemes. They provide instruction on how an application for a permit to remove native vegetation is to be assessed under the Planning and Environment Act. Sets the offsetting requirements for removal of native vegetation patches and scattered trees.	Offsets for loss of native vegetation patches, large trees within patches and scattered trees would be required. Offsets outlined in an Offset Management Plan (OMP).
	Environmental Significance Overlays (ESOs).	Identification of areas where the development of land may be affected by environmental constraints, and to ensure that if development does happen, it is compatible with the values that are highlighted in any schedule to the identified ESOs.	Work with respective councils to determine the significance of the environment, vegetation or landscape to be impacted and consider mitigation measures via a condition in the incorporated document (a detailed list of applicable planning scheme zones and overlays is provided in Section 4.3.10). Permits are required in general for any removal, destruction or lopping of native vegetation, unless particular exemptions apply as outlined under Clause 52.17-7 of the Victoria Planning Provisions (VPPs). Any native vegetation loss would be offset in accordance with the DELWP *Guidelines for the removal,*
	Vegetation Protection Overlays (VPOs).	Specific to the removal of vegetation that has been deemed to be significant, and protects this vegetation against inappropriate development.	
	Significant Landscape Overlays (SLOs).	Specific to the identification, conservation and enhancement of a significant landscape, particularly its character, including the protection of vegetation against inappropriate development.	

Legislation/policy/ guideline	Key policies/strategies	Relevance to this impact assessment	Approvals required
	Heritage Overlays (HOs).	Protection of places of natural and cultural significance, with an aim to conserve and enhance the assets. This includes the protection of vegetation against inappropriate development.	*destruction or lopping of native vegetation* (2017a)). Additional permits or controls may exist for both native and non-native vegetation under various overlays such as an ESO, SLO or VPO.
	Environmental Audit Overlay (EAO).	To ensure that potentially contaminated land is suitable for use which could be significantly adversely affected by any contamination.	
Flora and Fauna Guarantee Act 1988 (FFG Act)	Flora and Fauna Guarantee Regulations 2011.	Provides a process for listing threatened native species and communities, protected flora and fauna, and processes and potentially threatening processes with respect to native flora and fauna. Protected flora controls.	Protected and threatened flora controls – permit to 'take' (kill, injure, disturb or collect) protected or listed flora required if said flora are impacted. Likewise, a permit is also required to 'take' protected fish.
Environment Protection Act 1970	State Environment Protection Policy (Waters) 2018.	Sets framework for protection and improvement of surface water environments, including protected beneficial uses and environmental quality objectives.	Licences to discharge to waterways are issued under this legislation.
Water Act 1989	Healthy Waterways Strategy.	Melbourne Water is responsible for development and delivery of the Healthy Waterway Strategy, including ecological values.	Works on Waterways.
Wildlife Act 1975	Wildlife Act Regulations 2013. Procedure statement for translocation of threatened native fauna in Victoria – 2016 (DELWP, 2016a).	Under the Wildlife Act it is an offence to take or destroy protected or threatened wildlife without authorisation. Under the Wildlife Act Regulations it is an offence to damage, disturb (including removal or relocation of wildlife) or destroy any wildlife habitat unless authorised to do so under any Act.	Management Authorisation is required from DELWP to undertake salvage, if salvage approved by DELWP.

Legislation/policy/ guideline	Key policies/strategies	Relevance to this impact assessment	Approvals required
Catchment and Land Protection Act 1994 (CaLP Act)	List of declared noxious weeds. List of established pest animals.	Establishes a framework for management and protection of catchments, including responsibilities in relation to the management of pest plants and animals in Victoria.	Responsibility to take all reasonable steps to eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and, where possible, eradicate established pest animals declared under the CaLP Act.
Fisheries Act 1995	List of declared noxious aquatic species.	Creates a framework for regulation, management, development and conservation of Victorian fisheries, aquatic habitats and ecosystems, aquaculture industries and associated aquatic biological resources. FFG-listed fish are also protected under the Fisheries Act and may not be 'taken' without authorisation under both Acts.	A permit may be required to 'take' fish for salvage during construction.
Threatened species advisory lists (Non-statutory)	Advisory lists of threatened species in Victoria are maintained by DELWP. Species are categorised into the following groupings: • Rare or Threatened Plants (DEPI, 2014) • Threatened Vertebrate Fauna (DEPI, 2013a) • Threatened invertebrate Fauna (DSE, 2009a).	There are no direct legal requirements or consequences that flow from inclusion of a species in advisory lists, although they are afforded some protection through the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017a). Species included in the list may also be formally listed as threatened under the EPBC Act or FFG Act.	No direct approvals required, however advisory list status is considered by DELWP when determining vegetation and species offsets in relation to the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017a).

5. Assessment method

This chapter describes how relevant impacts of MNES and the environment on Commonwealth land have been assessed. This chapter responds to Section 2.5 of the PER Guidelines.

5.1 Overview of method

Four technical reports were prepared to inform the PER and assessment of impacts. This flora and fauna technical report is one of those four reports. Impacts and their significance were assessed taking into account relevant EPBC Act Significant impact guidelines. Figure 5-1 provides an overview of this process.

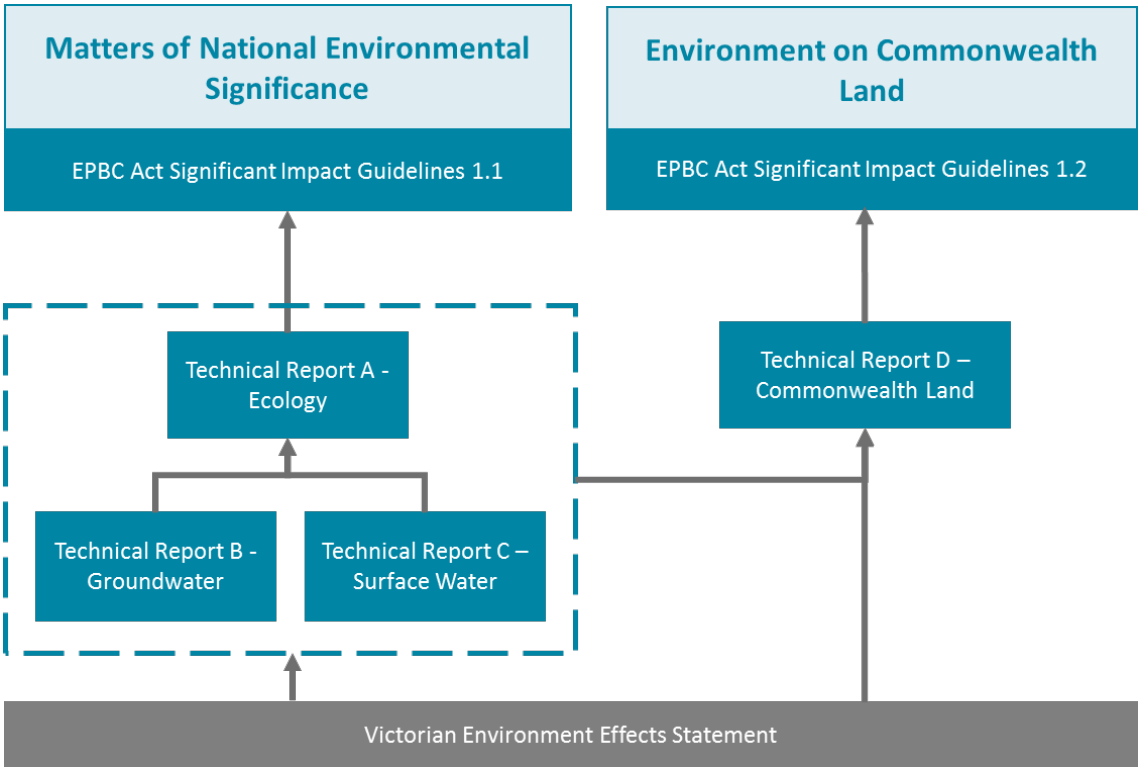


Figure 5-1 Assessment approach

In assessing ecology impacts in this technical report, the following steps were followed:

- The existing environment with respect to MNES and Commonwealth land was described
- Impacts, either direct or indirect, resulting from construction and operation of North East Link on MNES and Commonwealth land were identified
- Measures to avoid and mitigate impacts were considered iteratively with the impact assessment
- The need to offset any impacts following avoidance and mitigation measures was considered, as well as the likely availability of suitable offsets
- The significance of residual impacts were assessed.

The impact assessment process has informed and been informed by community and stakeholder engagement (refer Chapter 14 – Consultation) and development of the reference project (refer Chapter 3 – Description of the action). Figure 5-2 shows this process.

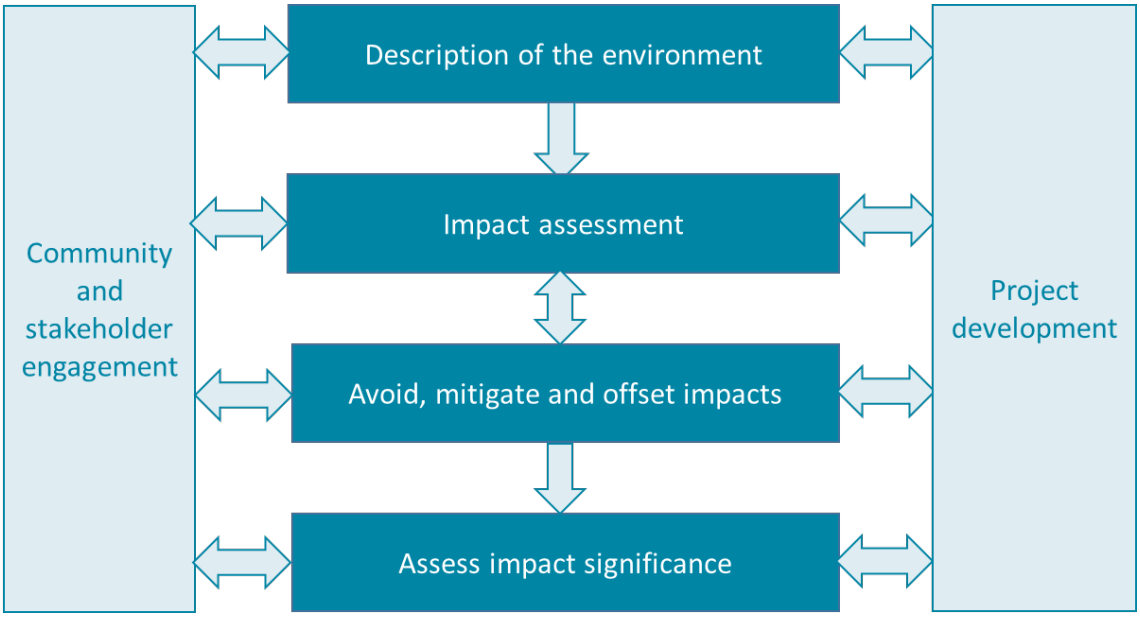


Figure 5-2 Impact assessment process

5.2 Study scope

5.2.1 Study area

Project boundary definition

The proposed **project boundary** established for North East Link defines the area in which the project elements and construction would be contained (Figure 5-3).

The project boundary encompasses all areas that would be used for permanent structures and temporary construction areas (above and below ground). It provides the basis for the ecological assessments undertaken for the PER. It should be noted that while fauna are to be assessed as part of the PER, these are not necessarily located within the project boundary and may move in or out of the project boundary over time.

A number of waterways are located within, or intersect, the project boundary, including the Yarra River, Plenty River, Merri Creek, Koonung Creek and Banyule Creek. There are also several natural floodplain wetlands, including Bolin Bolin Billabong and Banyule Swamp.

An assessment of MNES was completed for the entire area within the project boundary.

Study area – whole project

The term **study area** refers to a broader region surrounding the project boundary. The study area for this assessment includes all land within five kilometres of the project boundary, and aquatic habitats beyond this buffer with connection to waterways in the project boundary (the Yarra River catchment). This description covers a much broader area than the expected zone of impact (the project boundary), and the additional information captured has been used to provide context to determine the significance of ecological features identified within the project boundary, and to identify MNES that North East Link may impact. The broader study area

was only assessed at a desktop level, while the project boundary was assessed on the ground by ecologists.

This report has assessed potential impacts on MNES within the study area indicated in Figure 5-3, and the potential for those impacts to be significant in the context of the EPBC Act significant impact guidelines.

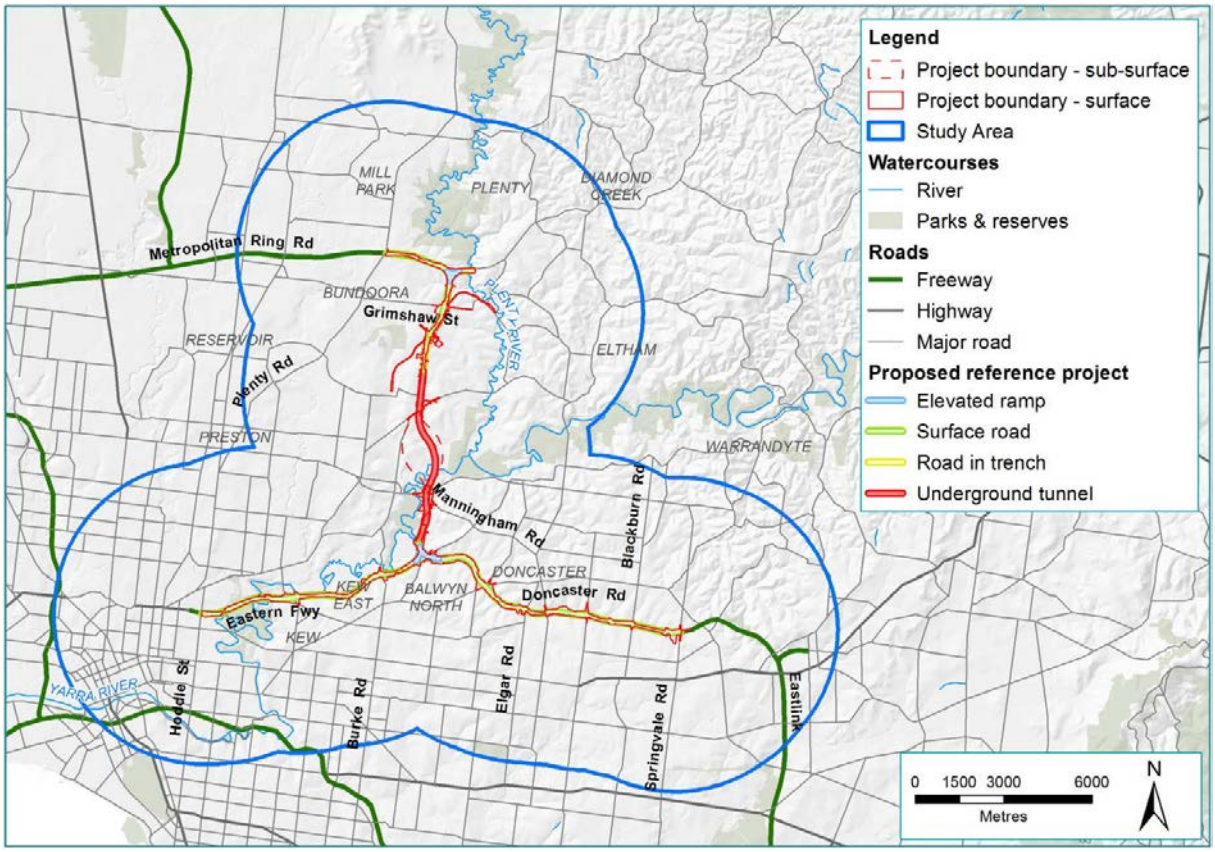


Figure 5-3 PER study area for whole project

Study area – Commonwealth land

The areas considered for the 'action on, or impacting upon, Commonwealth land' are:

- Simpson Barracks, as well as the small area along Greensborough Road immediately to the south
- The War Services easement located at the rear of properties on Elder Street, Watsonia.

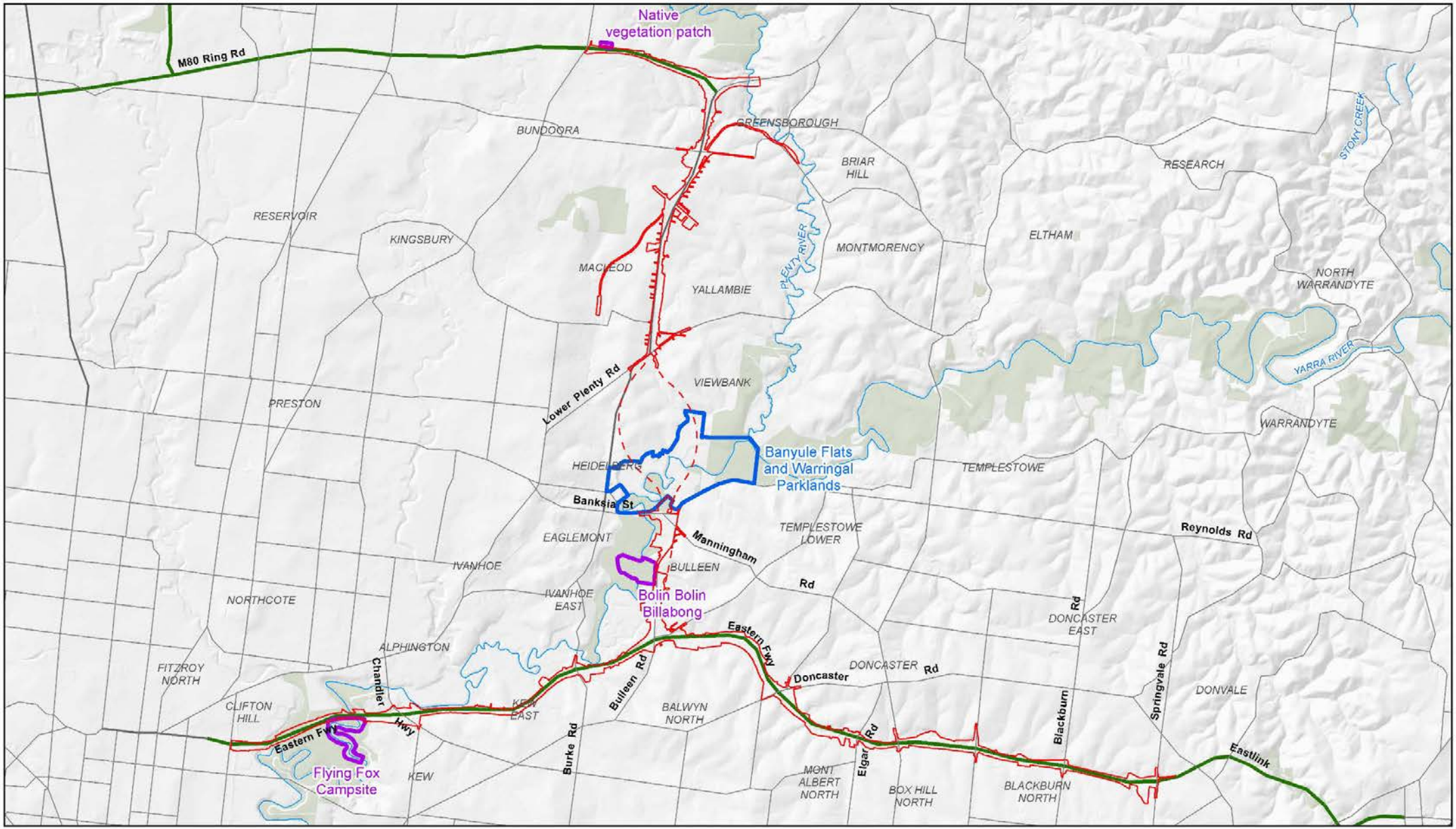
In these areas, the whole of environment is considered and assessed.

No-go zones (adjacent to the project boundary within the study area)

Direct impacts at a number of sensitive areas near North East Link would be avoided with the designation of no-go zones (adjacent to the project boundary), where surface works are not permitted for North East Link. No-go zones have been designated for the following sensitive areas (shown in Figure 5-4):

- A vegetated patch near the intersection of the M80 Ring Road and Plenty Road. This area contains Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP), an ecological community listed under the EPBC Act as critically endangered.
- Bolin Bolin Billabong, located between Bulleen Road and the Yarra River. This is a known site of cultural significance and ecological value (non-EPBC-related). Melbourne Water are actively managing the hydrological regime of the billabong.
- A 26-hectare portion of Yarra Bend Park, south of the Eastern Freeway. This area supports a large breeding colony of the Grey-headed Flying-fox Pteropus poliocephalus (EPBC Act-listed as vulnerable) and is protected under the Flying-Fox Campsite Management Plan (DSE, 2005a). The camp at Yarra Bend Park is identified in the Australian Government's interactive National Flying-fox Monitoring Viewer as a Nationally Important Flying-fox Camp (DoE, 2014). Tree lopping or removal would be required in the far north of this section (up to 10 metres from the southern edge of the Eastern Freeway bridge), to allow construction work to be undertaken safely. The no-go zone commences 10 metres south of the bridge.
- Twin tunnels are proposed beneath the Banyule Flats, Warringal Parklands and the Yarra River and its associated floodplain, as well as the Heide Museum of Modern Art and sculpture park, to avoid surface impacts at these locations. This area has been included within a designated 'conditional no-go area' where surface works would not be permitted for North East Link with the possible exception of activities relating to site investigations, relocation of minor utilities, and ground improvement.

It is noted that while direct impacts would not occur, the potential for indirect impacts on sensitive areas within the no-go zones are considered throughout this assessment.



Paper Size A4

0 550 1,100 2,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Conditional no go zone
- No go zone

Roads

- Freeway
- Highway
- Major road

Watercourses

- River
- Parks & reserves

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	F
Date	04/03/2019

No-go zones

Figure 5-4

\\ghdnet\ghd\AU\Melbourne\Projects\31\35006\GIS\Maps\Working\KBM\EES_PER_Technical_Report\EES_Technical_Reports_A4L.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: CIP Imagery - DELWP - 2018 | roads, watercourses, parks, rail, localities - Vicmap - 2019 | no go zone, project infrastructure - GHD, AECOM - 2019 Created by: trighetti

5.2.2 Scope

In accordance with the PER Guideline requirements, this ecological assessment considers the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (Sections 18 and 18A of the EPBC Act), including:
  - Matted Flax Lily (*Dianella amoena*) (endangered)
  - Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)
  - Swift Parrot (*Lathamus discolor*) (critically endangered)
  - Australian Painted Snipe (*Rostratula australis*) (endangered)
  - Australasian Bittern (*Botaurus poiciloptilus*) (endangered)
  - Macquarie Perch (*Macquaria australasica*) (endangered)
  - River Swamp Wallaby-grass (*Amphibromus fluitans*) (vulnerable)
  - Clover Glycine (*Glycine latrobeana*) (vulnerable)
  - Growling Grass Frog (*Litoria raniformis*) (vulnerable)
  - Australian Grayling (*Prototroctes maraena*) (vulnerable).
- Listed migratory species (Sections 20 and Section 20A), including:
  - Latham's Snipe (*Gallinago hardwickii*).
- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

5.3 Description of the environment

In describing the existing environment, the environmental assets, values and uses that may be affected by North East Link were characterised. This focused on the potential presence of or habitat for MNES and the environment on Commonwealth land.

This has considered:

- History, current use and condition of environmental assets, values and uses
- Significance of environmental assets, values and uses
- Sensitivity or vulnerability to impacts.

A comprehensive ecological assessment was undertaken to understand the existing conditions of the study area to inform the environmental impact assessment for the works.
This assessment incorporated:

- A desktop assessment and synthesis of Australian and Victorian government-curated biodiversity datasets
- A review of existing literature
- Consultation with specialists
- Flora and fauna field assessments
- Vegetation quality assessment (Habitat Hectare Assessment) of recorded native vegetation
- Aquatic ecosystem assessments

- Targeted survey for threatened species, where deemed necessary
- Determination of the likelihood of threatened species and threatened species' habitat presence.

The specific methods used are set out in the following sections.

5.3.1 Defining threatened species, migratory species and ecological communities

For most of this report, 'threatened species' refers to species listed as threatened under the EPBC Act, 'threatened communities' refers to ecological communities listed as threatened under the EPBC Act, and 'Migratory species' refers to species listed as Migratory under the EPBC Act.

For Commonwealth land where the whole of environment is considered, 'threatened species' refers to species listed as threatened under the EPBC Act, FFG Act, and/or the DELWP-administered Advisory Lists. 'Threatened communities' refers to communities listed as threatened under the EPBC Act or FFG Act. Species listed as rare under the DELWP Advisory list are included in the discussion of threatened species, even though they are technically not threatened species. Categories are identified in Table 5-1.

Table 5-1 Rare and threatened species, threatened communities and Migratory species listing categories by legislation

Legislation	Categories
EPBC Act	Vulnerable (VU)
	Endangered (EN)
	Critically Endangered (CR)
	Migratory (Mi)
FFG Act	Listed (L)
DELWP Advisory List	Vulnerable (v)
	Endangered (e)
	Critically Endangered (c)
	Rare (r)

The Marine status of fauna (as defined under the EPBC Act) was not considered, because the project boundary is not within or near a Commonwealth Marine Area, and impacts on a Commonwealth Marine Area are highly unlikely.

A number of species records were eliminated from the Victorian Biodiversity Atlas (VBA) list based on their listing status, a review of relevant literature and an understanding of their preferred habitats. Records of species not considered further in this report include:

- Records older than 30 years (pre-1987) for most species – older records for some fauna species are referred to for context in the likelihood of occurrence assessment
- Fauna species considered 'near threatened', 'conservation dependent' or 'data deficient' in the DELWP Advisory list (these species are not considered by DELWP to be threatened species), unless they are also listed under the EPBC Act and/or FFG Act
- Flora listed as 'Nominated' under the FFG Act

- Flora listed as ‘poorly known’ in the DELWP Advisory list as the current knowledge of their distribution and abundance is not sufficient to determine whether these species should be considered as rare or threatened in Victoria
- Some threatened flora species outside their natural range but commonly used for landscaping and amenity, including Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera* and Giant Honey-myrtle *Melaleuca armillaris*
- Threatened species in translocated populations outside their natural distribution, so not considered important populations in national recovery plan or referral guidelines, including Murray Cod *Maccullochella peelii peelii*
- Fauna reliant on marine environments, including albatross, petrel, cetaceans and marine turtles (which are in the database search results based on the proximity of the project boundary to the Port Phillip Bay marine environment) as no habitat for these species is present in the project boundary, or would likely be impacted by North East Link.

5.3.2 Nomenclature

Common and scientific names used for flora and fauna follow those used in the VBA (Version 3.2.0) unless otherwise stated.

The scientific and common names are generally presented for all species when first introduced, with one name provided thereafter in that section. This convention is overlooked in some sections to make it clear which species are being referred to.

5.3.3 Review of existing literature

An extensive literature review was completed of: environmental studies by public or private entities; public authority management plans, recovery plans and action plans; environmental investigations and environmental feature descriptions by councils or other administrative bodies. The aim of the literature review was to compile the findings of historical records, reports and information relevant to North East Link.

This section includes accounts of some areas outside the project footprint which are not expected to be directly impacted. However, for fauna in particular, these areas were considered to help build a picture of the broader ecology of the area and identify any values that may need to be protected from any indirect impacts. Table 5-2 summarises the reports reviewed during the literature review.

Table 5-2 Reports reviewed during the literature review

Report name	Reference
Banksia Park – Park Note	Parks Victoria (2011a)
Banyule Flats Reserve	Banyule City Council (2018)
Billabong Song, Bolin Bolin Billabong Walk	Manningham City Council (n.d.)
Biodiversity Assessments and Strategies for Simpson Barracks.	HLA-Envirosciences Pty Ltd (2007)
Biodiversity Monitoring in Melbourne's East – Bird Component.	Herman, K. (2016) (Birdlife Australia)
Birrarrung Park – Park Note	Parks Victoria (2011b)
Digging up the dirty past: evidence for stormwater's contribution to pollution of an urban floodplain lake	Lintern *et al.*(2015)
Ecological assessment and recommendations for Banyule Flats	Practical Ecology (2007a)
Ecological assessments of wetlands at the Trinity Grammar School Sporting Complex, Bulleen	Practical Ecology (2007b)
Fauna surveys at specified sites on the Yarra River	Practical Ecology (2010)
Flora, fauna and biodiversity assessment report: Bolin Bolin stormwater harvest project, Bulleen	James *et al.* (2014)
Flying-Fox Campsite Management Plan; Yarra Bend Park.	DSE (2005)
Healthy habitats: bushland management strategy for council managed land	Manningham City Council (2012)
Healthy Waterways Strategy	Melbourne Water (2018)
Identifying heavy metal levels in historical flood water deposits using sediment cores	Lintern *et al.* (2016)
Inventory and assessment of indigenous flora and fauna in Boroondara	Lorimer (2006)
Koonung Creek Reserve remnant bushland patch: vegetation action plan	Practical Ecology (2017a)
Mullum Mullum Park strategic management plan	Parks Victoria (2012)
Reassessment of botanical values on Streeton Views Estate Stage 11 Yallambie with particular reference to the significance of the natural hybrid *Eucalyptus X studleyensis* Studley Park Gum and the endangered species *Dianella amoena* Matted Flax-Lily.	Cameron *et al.* (1999)
Referral guideline for management actions in grey-headed and spectacled flying-fox camps	DoE (2015)
Report on Base Security Improvement Program – Base Infrastructure Works Project. Initial Environmental Review	GHD (2011)
Simpson Barracks Flora and Fauna Monitoring Program 2016-2021	Jacobs (2016)

Report name	Reference
Simpson Barracks. Kangaroo Monitoring Program 2015	AECOM (2015)
Simpson Barracks Kangaroo Population: Status Report	Wilson Environmental (2014)
Sites of (biological) significance review	Foreman *et al.* (2004)
Sites of faunal and habitat significance in North East Melbourne Volume 1 – introduction and overview	Nillumbik Shire Council (1997)
Species distribution models derived from citizen science data predict the fine scale movements of owls in an urbanizing landscape	Bradsworth *et al.* (2017)
Sugar Gliders (*Petaurus breviceps*) at key biodiversity sites along the Yarra River Corridor, Boroondara City Council	Van der Ree (2017).
Swift Parrots in Banyule and surrounds	Practical Ecology (2017c)
The Koonung Creek Linear Park management plan	Manningham City Council (2011)
The palaeolimnology and current status of Yarra River Billabongs	Leahy (2007)
Warringal Parklands and Banyule Flats: Cultural Heritage Assessment	Context (2014)
Warringal Parklands and Banyule Flats ecological and conservation values assessment	Practical Ecology (2017b)
Wildlife movement and habitat needs in Manningham	Lorimer *et al.* (2009)
Yarra Bend Park environmental action plan	Parks Victoria (2000)
Yarra Bend Park Flying-fox Campsite: Review of Scientific Research	DSE (2009b)
Yarra Flats Park – Park Note	Parks Victoria (2011c)
Yarra Valley Parklands management plan	Parks Victoria (2008)

5.3.4 Desktop assessment

Ecological databases

A desktop assessment of ecological databases was undertaken to provide an account of the ecological values previously recorded or modelled to occur within the project boundary. The databases are mostly curated by the Australian and Victorian Governments. Databases accessed were:

- Australian Government's EPBC Act Protected Matters Search Tool (PMST) to identify the potential occurrence of MNES
- VBA, administered by Victoria's Department of Environment, Land, Water and Planning (DELWP)
- Australian Government's Atlas of Living Australia (ALA) to capture any records not contained by the Victorian Biodiversity Atlas
- Birdata – The New Atlas database (1998 – present), administered by Birdlife Australia
- e-Bird data (<www.ebird.org>), administered by Audubon and Cornell Lab of Ornithology, USA
- NatureKit, administered by DELWP
- DELWP's Native Vegetation Information Management (NVIM) tool
- DELWP's Planning Schemes online
- DELWP's MapShare – Victorian Wetland Inventory available at <https://www.data.vic.gov.au/data/dataset/victorian-wetland-inventory-current>
- Groundwater Dependent Ecosystems (GDE) Atlas, maintained by the Bureau of Meteorology (BOM) (BOM, 2018)
- Potential Groundwater Dependent Ecosystem (GDE) Mapping for the Port Phillip and Westernport Catchment Management Authority (CMA) (DELWP, 2018)
- PlatypusSpot, administered by CESAR
- EPA Victoria's Rapid Bioassessment (RBA) of waterways monitoring
- Aerial photographs and topographic maps.

The reviews of the VBA database and PMST included a five-kilometre buffer around the North East Link project boundary. This approach was adopted to provide a clearer picture of species recorded within the project boundary and species found within the vicinity. The reviews also provided contextual information for describing the flora and fauna that do or might occur at Simpson Barracks. The buffer was used to account for the potential lack of historic survey effort in the project boundary. For the purposes of describing the whole of environment on Commonwealth land, a VBA search was also conducted for a 500-metre buffer from Simpson Barracks.

For aquatic species, the VBA database and PMST search was also conducted on the entire Yarra River catchment of waterways that intercept the North East Link project boundary, with a one-kilometre buffer from streams. This approach considers the requirement for diadromous fish species to migrate between freshwater and marine habitats for breeding. This process considers the possibility that records of occurrence may be outside the five-kilometre buffer, but the passage through the project boundary is a life cycle requirement. Records outside the five-kilometre buffer that are not diadromous species were not considered further.

The Birdlife Australia (BLA) database search was done for a polygon area that incorporates the project boundary, rather than for a five-kilometre buffer on the project boundary itself. This means that larger numbers of records of some bird species were obtained from BLA than from VBA, and that a portion of those records are relatively distant from the project boundary. The BLA database search included records of threatened and migratory species. For the purposes of describing the whole of environment on Commonwealth land, a Birdlife Australia Atlas search (threatened species only) was done also for a 500-metre buffer from Simpson Barracks.

Not all locations of records in the VBA are precise; the actual geo-positional accuracy of a record can range from ± 1 to ± 500 metres, and some records contain locational errors (that is, the location does not match the location's description). The validity of records accepted by the VBA has not been assessed as part of this report. Many records within the VBA are also attributed to the same coordinate. For instance, a botanist may have recorded several species of flora at the same location.

The VBA data were last accessed on 29 March 2018.

5.3.5 Likelihood of occurrence assessment

A likelihood of occurrence assessment was completed for each threatened or migratory species and each threatened community identified in the desktop assessment as either occurring, or having the potential to occur, within five kilometres of the project boundary.

For threatened and migratory species, the likelihood assessment was used to determine the likelihood of occurrence of each species within the project boundary based on the results of the habitat assessment, and the dates and number of previous records of each species. The complete likelihood assessment for species is presented in Appendix A (flora), Appendix B (fauna) and Appendix C (migratory fauna) of this report. The following likelihood categories were used to rate the likelihood of occurrence of each species:

- **Low** (= unlikely) – Preferred habitat absent from the project boundary, or if present, is limited in extent and quality. Generally, the species is unlikely to be present in the project boundary at any time or season. In the case of fauna, the species may infrequently visit for foraging but would not reside, roost or breed in, or otherwise depend on habitat in the project boundary for their survival.
- **Moderate** – Habitat is available in the project boundary, which partially meets the requirements of the species. In the case of fauna, the species may regularly visit the habitat.
- **High** – Species has been recorded in the project boundary (or within very close proximity) within the past 30 years. The project boundary contains habitat that meets the habitat requirements of the species and is likely to support a population of the species.
- **Present** – (limited to flora only). Species confirmed to be present within the project boundary through direct observation of the species or recent records in the VBA output or other reliable source. Species is likely to be present at appropriate times of the year.

This process was used to short-list species that have potential to be impacted by the proposed works.

5.3.6 Field assessment – overview

Extensive field assessments were conducted over nine periods in winter 2017, spring 2017, summer 2017/2018, autumn 2018, winter 2018, spring 2018, early summer 2018/2019, autumn 2019 and winter 2019 by up to four ecologists for flora, two ecologists for fauna, and two aquatic ecologists for the aquatic ecology assessment. Field assessments aimed to collect comprehensive information about the ecological values present or potentially present within the project boundary. Separate field surveys were undertaken for flora, terrestrial fauna, and aquatic fauna. Total field survey effort is outlined in Table 5-3. Survey methods and effort were appropriate and in accordance with the Department of Environment and Energy (DoEE) relevant scientific and policy guidance.

Targeted threatened flora surveys were undertaken in accordance with survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database for Matted Flax-lily, Clover Glycine and River Swamp Wallaby-grass. However, it should be noted that minimal guidance is provided for these species apart from survey timing requirements. Targeted survey for Green-striped Greenhood was largely based on the *Survey Guidelines for Australia's Threatened Orchids* (Commonwealth of Australia 2013).

Targeted threatened fauna surveys for EPBC Act-listed species were undertaken in accordance with species-specific survey guidelines, as identified in the DoEE Species Profile and Threats (SPRAT) Database, and as explained for relevant species in Section 5.3.11.

The aquatic fauna surveys undertaken were based on the Survey Guidelines for Australia's threatened fish (DSEWPAC, 2011). These include specific survey methods and habitats to be targeted for detecting fish listed as threatened under the EPBC Act. Specifically, the surveys applied methods suited for:

- Dwarf Galaxias – Group 1 Galaxiids – Dip netting and electrofishing undertaken in November 2017 and March 2018
- Australian Grayling – Group 3: Small south-eastern Australian freshwater fishes – fyke netting and backpack electrofishing undertaken in smaller creeks during November 2017 and March/April 2018 during lower flow conditions
- Macquarie Perch – Group 6 Large freshwater perches and lungfish – fyke netting and backpack electrofishing undertaken in smaller creeks during November 2017 and March/April 2018.

Table 5-3 Field survey effort

Survey period by discipline	Total survey effort	Notes
Flora		
Spring flora assessments 2017 (16 October – 7 December 2017)	34 person days	General mapping of native vegetation, scattered indigenous trees and threatened flora targeted survey (where appropriate).
Summer flora assessments 2018 (19 February – 27 February 2018)	19 person days	Additional mapping of native vegetation including large trees in patches and wetland mapping.
Autumn flora assessments 2018 (14 – 16 May 2018)	12 person days	Following access granted by Boroondara City Council.

Survey period by discipline	Total survey effort	Notes
Winter flora assessment 2018 (4 June – 28 August 2018)	26 person days	Mapping large trees in patches, mapping Studley Park Gum *Eucalyptus X studleyensis* at Simpson Barracks, mapping large trees at risk of groundwater drawdown, targeted survey for threatened Greenhood orchids, and survey of other minor areas with previous access constraints.
Spring flora assessment 2018 19 October – 20 November 2018)	14 person days	Vegetation mapping.
Summer flora assessment 2018 (3 – 7 December 2018)	6 person days	Targeted threatened species surveys.
Autumn flora assessment 2019 (1-3 May, 13-14 June 2019)	10 person days	Studley Park Gum targeted survey.
Winter flora assessment 2019 (4 June 2019)	1 person day	Matted Flax-lily recipient site assessments.
Terrestrial fauna		
High-level field assessment (Phase 1) (25 – 26 May 2017)	2 days; 1 person	Overview and habitat assessment.
Habitat assessments (Phases 2 and 3) (4, 17 – 18 July 2017)	3 days; 1 person	Habitat assessment.
Targeted surveys (spring/summer) (31 October – 15 November 2017)	8 days, 8 nights; 2 people	Surveys of wetland areas for Growling Grass Frog *Litoria raniformis* and other fauna active in warmer seasons.
Targeted surveys (autumn) (19 April – 17 May 2018)	5 days, 5 nights; 2 people	Surveys of wetland and forested areas for Brown Toadlet *Pseudophryne bibronii*, Southern Toadlet *Pseudophryne semimarmorata* and Powerful Owl *Ninox strenua.*
Aquatic ecology		
Preliminary habitat assessment (10 – 17 July 2017)	2 days (2 people)	Habitat Assessment to identify high level aquatic ecology values.
Spring waterway surveys 2017 (23 October – 10 November 2017)	7 survey days, 4 netting nights (2 people)	Fish surveys, including targeted surveys.
Autumn waterway and wetland surveys 2018 (20 March – 4 June 2018)	15 survey days, 7 netting nights (2 people)	Rapid Bioassessment of aquatic ecosystems and fish surveys, including targeted surveys.

5.3.7 Field assessment – flora and vegetation

The field assessments incorporated the following:

- Native vegetation mapping and Vegetation Quality Assessments (VQA) under the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017a)
- Habitat assessment to determine the likelihood of the project boundary to support threatened flora species
- Threatened ecological community assessments
- Mapping of incidental records of rare or threatened flora.

Further details of these assessments are provided in the sub-sections below.

Native vegetation mapping and quality assessment

Native vegetation was mapped throughout the project boundary according to the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017a). Under the DELWP Guidelines, native vegetation is considered to be either a patch or a scattered tree, where:

- A patch of native vegetation is defined as:
  'an area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native, or 'an area with three or more native canopy trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy' (DELWP, 2017a, p. 6).
- A scattered tree is defined as '*a native canopy tree that does not form part of a patch*' (DELWP, 2017a, p. 6).

The location of patches and scattered trees was mapped using ArcGIS Collector mobile app or handheld mapping units (tablet) which have a spatial accuracy of approximately five metres (dependent on access to satellites).

All patches of native vegetation were also subjected to a vegetation quality assessment using the Habitat Hectares (Hha) method as described by DSE (2004).

Determination of the Diameter at Breast Height (DBH) threshold for large scattered trees was conducted by overlaying the pre-1750 (pre-European settlement) EVC layer available from DELWP over the locations of scattered trees. The corresponding EVC benchmark was used to allocate DBH thresholds. As per the DELWP Guidelines (2017a), circumference should be provided when determining large trees; however, DBH was used in this instance as the available EVC benchmarks still list DBH thresholds. These values were later converted to circumference for submission to DELWP for the development of the Native Vegetation Removal (NVR) report.

Warringal Parklands and Banyule Flats

During the current assessment, only high level EVC ground-truthing and assessment of vegetation against the condition thresholds for the EPBC Act-listed ecological community, Seasonal Herbaceous Wetlands of the Temperate Lowland Plains (TSSC, 2012) was conducted for the Warringal Parklands and Banyule Flats. Practical Ecology (2017b) had already conducted a detailed investigation of the sites and surface impacts are not anticipated in this section of the project boundary. In this case, the current study relied upon the more comprehensive ecological investigation undertaken by Practical Ecology (2017b) to inform the values in this area.

Planted vegetation/Amenity plantings

Within the project boundary, there are numerous occurrences of revegetation or plantings on public land. These plantings comprise two main categories:

a. **Native vegetation.** Revegetation using a mix of locally indigenous species representative of an EVC that would have formerly occupied the site prior to clearing following European settlement. These areas are regarded as patches of native vegetation and are assessed in the same manner as patches of naturally occurring native vegetation elsewhere within the project boundary.

b. **Amenity plantings.** Plantings in patches or as isolated trees comprising species native to Victoria or Australia but planted in a manner/context that clearly indicates the primary purpose is for visual amenity purposes, rather than land protection or enhancing biodiversity. Examples include: a) isolated trees, b) evenly spaced rows of trees, c) roadside artificial embankment plantings, and d) parkland garden bed plantings with some structural diversity (for example, eucalypt species, over one to two shrub species, with a few robust groundcover species). While these plantings may have some biodiversity benefits, the main purpose of the planting was for amenity purposes, and they have been mapped accordingly.

Habitat assessment

The suitability of the project boundary to support threatened flora species was assessed, primarily through the consideration of habitats occurring within the project boundary, the condition of these habitats, and historic records of significant species. This information was used as part of the likelihood assessment of the presence of threatened species.

Recording of declared weeds

Declared weeds are those listed under Victoria's Catchment and Land Protection (CaLP) Act or Weeds of National Significance (WoNS[4]). All weed species that were observed during the vegetation assessments and targeted surveys were noted. Due to the extensive presence of these species across the site, locations were not collected.

5.3.8 Targeted surveys – flora – MNES

Following the general field assessment for all flora, targeted surveys were undertaken for certain threatened flora species in areas considered most likely to support those species. Species considered for targeted surveys across the entire project boundary were species listed as threatened under the EPBC Act. Species considered for targeted surveys at Simpson Barracks were species listed as threatened under the EPBC Act, threatened under the FFG Act, or rare or threatened under the DELWP Advisory List (DSE, 2014).

Through the desktop review and initial site investigations, targeted surveys were conducted for those EPBC Act-listed threatened species and communities deemed to have a moderate to high likelihood of occurrence within the project boundary. These included:

- Matted Flax-lily *Dianella amoena*
- Clover Glycine *Glycine latrobeana*
- Green-striped Greenhood *Pterostylis chlorogramma*
- River Swamp Wallaby-grass *Amphibromus fluitans*
- Grassy Eucalypt Woodland of the Victorian Volcanic Plain
- Seasonal Herbaceous Wetland of the Temperate Lowland Plains.

Further information on the assessment for each of the above-mentioned species/communities is presented below.

[4] http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

Matted Flax-lily *Dianella amoena* and Clover Glycine *Glycine latrobeana*

Flora surveys for Matted Flax-lily and Clover Glycine adhered to the following protocol:

- Surveys were undertaken when plants were known to be in flower where possible.
- Surveys commenced at Simpson Barracks on 26 October 2017 when Matted Flax-lily was initially identified. A follow-up survey was undertaken on 2 November 2017 near the end of the Clover Glycine flowering season and while Matted Flax-lily was in bud (prior to flowering) and a final survey was undertaken on 21 November 2017 after Matted Flax-lily had started flowering and so was more visible. Surveys were undertaken at the Hurstbridge rail line and the M80 Ring Road interchange on 24 October 2017 and again on 6 December 2017 to confirm presence and assess abundance.
- Where plants of either species were positively identified, sites were visited twice (Simpson Barracks, Hurstbridge rail line and M80 Ring Road interchange).
- Surveys for Matted Flax-lily were undertaken in accordance with the timing and survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database (November to February[5]). Surveys for Clover Glycine were undertaken in accordance with the flowering time of the species provided in VicFlora[6] (September to December) and the survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database.
- Targeted survey effort was directed at potential native grassland and grassy woodland habitat, particularly better quality patches with low to moderate weed cover.
- Survey teams were led by botanists/ecologists familiar with the target species.
- Teams of a minimum two ecologists slowly walked transects at five-metre intervals (as stipulated for Matted Flax-lily in the Melbourne Strategic Assessment (Carter, 2010), in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.
- Where individuals were observed, the species was recorded, along with number of individuals and/or patch size, and the location of the plant/patch was mapped. Additional searching effort then occurred in concentric circles out from the initially identified individual until no further individuals were observed within a 10-metre radius from the initially identified plant.
- It should be noted that it is almost impossible (except with molecular techniques) to accurately determine population size for Matted Flax-lily, owing to its mat-forming habit, which can comprise anything from dense patches to sparsely distributed tufts of leaves. Therefore, this report describes the occurrence of this species as discrete individual plants or patches separated by a gap of at least one metre between visible tufts of leaves. The use of this criterion implies that each plant/patch contains at least one plant but possibly more, and that where tufts are at least one metre apart, they are regarded as separate plants.

[5] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64886

[6] https://vicflora.rbg.vic.gov.au/flora/search?q=Glycine latrobeana

Green-striped Greenhood *Pterostylis chlorogramma*

Flora surveys for Green-striped Greenhood considered the *Survey Guidelines for Australia's Threatened Orchids* (Commonwealth of Australia, 2013) and adhered to the following protocol:

- The surveys were undertaken in the middle of the known flowering season for the species (July to September; Commonwealth of Australia, 2013) on 26 August 2018 but a flowering reference population was not visited
- Targeted survey effort was directed toward moist areas of heathy and shrubby forest habitat, in the northern portion of the project boundary (near where the species had previously been recorded in the local area)
- The survey team was led by a botanist familiar with the species
- A team of two ecologists slowly walked transects at five-metre intervals (as recommended by Commonwealth of Australia (2013)), in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

River Swamp Wallaby-grass *Amphibromus fluitans*

No specific survey guidelines are outlined for River Swamp Wallaby-grass in the DoEE Species Profile and Threats (SPRAT) Database[7]. Flora surveys for the species therefore adhered to the following protocol:

- The surveys were undertaken during the flowering/fruiting season for the species (November to March) when plants were known to be in flower in areas where the species had been previously recorded within or adjacent to the project boundary
- Surveys were undertaken in potentially suitable habitat at Trinity Grammar School Sporting Complex wetlands A, B, C and D (as defined by Australian Ecosystems 2007) on 3 December 2018 (wetlands A and B within the project boundary, wetlands C and D outside the project boundary). Surveys were also conducted in suitable habitat at Bolin Bolin Billabong, Banyule Swamp and Banyule Flats on 6 December 2018
- Targeted survey effort was directed at potential wetland and billabong habitat, including permanent and ephemeral wetlands, within and outside the project boundary. Wetlands outside the project boundary were selected to be surveyed based on the presence of historical records between 1995 and 2011, proximity to the boundary, and the potential for groundwater drawdown associated with tunnelling to adversely affect the species in these areas
- Survey teams were led by botanists familiar with the target species
- Teams of two botanists slowly walked transects at five-metre intervals, in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

[7] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=19215

Charming Spider-orchid *Caladenia amoena*

Targeted surveys were not undertaken for Charming Spider-orchid, as it was determined that field investigations were being conducted at a time when this species was observable. During field assessments, field teams were aware of the potential presence of this species on ridge tops and on sheltered slopes in dry sclerophyll forest, and any observations were mapped using a handheld GPS unit. Timing of surveys across the majority of the project boundary generally overlapped with the flowering period of this species (late August to late September; Commonwealth of Australia (2013)). However, since orchids undergo periods of dormancy over one or more years, or may appear as non-reproductive plants (in leaf only) in some years, it is possible the Charming Spider-orchid was undetectable when field work was conducted.

Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP)

Targeted survey for the threatened ecological community, Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP) was completed at sites within the Victorian Volcanic Plan bioregion that contained Plains Grassy Woodland. An assessment was also completed at Simpson Barracks, but it was determined not to occur at the site because the underlying geology is Silurian sediments, rather than cracking clays derived from basalt, as stipulated in DSEWPaC (2011).

Only one site was considered to support the listed community— a vegetated patch near the intersection of the M80 Ring Road and Plenty Road. As this site was designated as a no-go zone (shown in Figure 5-4) no further assessments were completed.

Seasonal Herbaceous Wetlands of the Temperate Lowland Plains

Surveys for Seasonal Herbaceous Wetlands were undertaken in accordance with *Approved Conservation Advice for the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* (TSSC, 2012), which generally followed the following protocol:

- Surveys were undertaken within the recommended period of spring to early summer, with one day completed on 19 December 2017 by two ecologists (one aquatic and one terrestrial)
- Vegetation assessed was an area within Banyule Flats and Warringal Parklands, but was not an extensive assessment of all vegetation in this area
- Surveys followed the key diagnostic criteria and description according to TSSC (2012)
- An overall assessment was undertaken of the wetland areas and surrounding landscape
- Where a patch was considered as having the potential to contain Seasonal Herbaceous Wetlands a detailed assessment was undertaken including identification of native vegetation.

The EVCs listed in Table 5-4 were identified as most likely to correspond to the Seasonal Herbaceous Wetland community and therefore were targeted during assessment where present.

Table 5-4 Victorian EVCs most likely to correspond to Seasonal Herbaceous Wetlands

EVC number and name	Notes
125 Plains Grassy Wetland + complexes	Complexes may include EVCs 755, 767, 959, 960
306 Aquatic Grassy Wetland	Not available
647 Plains Sedgy Wetland	Not available
678 Ephemeral Drainage-line Grassy Wetland	In gilgai systems along poorly defined drainage lines within natural temperate grassland
778 Gilgai Wetland	In gilgai systems along poorly defined drainage lines within natural temperate grassland
920 Sweet Grass Wetland	Not available
956 Herb-rich Gilgai Wetland	Not available

5.3.9 Targeted surveys – flora – Commonwealth land

It is also recognised that other threatened flora (that is, has a DELWP Advisory listing greater than 'rare') were assessed as having a moderate to high likelihood of occurrence within the Commonwealth land; and targeted surveys were conducted for these species.
These species include:

- Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* (Silurian)
- Studley Park Gum *Eucalyptus X studleyensis.*

Further rationale on the survey effort for these species is presented below:

Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* (Silurian)

Survey undertaken as per Green-striped Greenhood.

Studley Park Gum *Eucalyptus X studleyensis*

Studley Park Gum is notoriously difficult to identify, and consequently, is frequently misidentified, even by experienced botanists. The Flora of Victoria contains little descriptive information for Studley Park Gum, which is known to be morphologically variable, particularly with respect to bud, fruit, leaf and bark characteristics. To provide an overview of potential variation within the Studley Park Gum complex and to assist with identification of the species in the field, the following steps were undertaken prior to formally commencing the field survey:

- All curated specimens of Studley Park Gum held at the National Herbarium of Victoria, Royal Botanic Gardens (hereafter referred to as 'MEL') were examined on 30 April 2019
- A photographic reference set of characteristics was compiled from all curated specimens and from photographs taken during the earlier survey. Photographs included leaves, fertile material, location description and MEL reference number. This reference set was carried in the field by each team
- A total of five publicly accessible locations where Studley Park Gum was known to occur (based on herbarium records) were visited on 1 May 2019 prior to conducting the survey at Simpson Barracks. Photos and plant material of the species were collected at each location to confirm the species identification and to use as reference material during the

survey. The sites visited were in Viewbank, Macleod, Watsonia, Heidelberg and Eaglemont

- A review of Cameron *et al.* (1999) and a comparison of sites listed in this report with curated specimens held at MEL.

To locate all potential stands, treed areas in Simpson Barracks within the project boundary were systematically surveyed by following pre-determined parallel transects at 15 m intervals (ie line of sight of 7.5 m either side of the transect walked), guided by aerial imagery on mobile technology. The area of Commonwealth land south of the Simpson Barracks boundary, was also surveyed using the transect approach. The survey was undertaken on 1-3 May 2019 and aimed to cover the equivalent of a distance of 8 km within the 10.976 ha area of native vegetation (Plains Grassy Woodland) within the project boundary at Simpson Barracks.

It is also recognised that other threatened flora (EPBC Act, FFG Act listed, or DELWP Advisory listing greater than 'rare') were assessed as having a moderate to high likelihood of occurrence within the study area, including on Commonwealth land. However, specific targeted surveys were not conducted for these species as it was determined their habitat would unlikely be impacted by North East Link, that sufficient survey effort had previously been conducted, and the data were available and/or the species survey could be conducted as part of general vegetation assessments. These species include:

- Arching Flax-lily *Dianella longifolia* var. *grandis*
- Austral Crane's-bill *Geranium solanderi* var. *solanderi*
- Wine-lipped Spider-orchid *Caladenia oenochila.*

Further rationale on the survey effort for these species is presented below:

Arching Flax-lily *Dianella longifolia var. grandis*

Targeted surveys were not undertaken specifically for this species, as it was surveyed for as part of the general vegetation assessment. During field assessments, field teams were aware of the potential presence of this species and any observations were mapped using a handheld GPS unit.

Austral Crane's-bill *Geranium solanderi* var. *solanderi*

Targeted surveys were not undertaken specifically for this species, as it was surveyed for as part of the general vegetation assessment.

Wine-lipped Spider-orchid

Targeted surveys were not undertaken for Wine-lipped Spider-orchid, as it was determined that field investigations were being conducted at a time when this species was observable. During field assessments, field teams were aware of the potential presence of this species and any observations were mapped using a handheld GPS unit. Timing of surveys across the majority of the project boundary generally overlapped with the flowering period of this species. However, since orchids undergo periods of dormancy over one or more years, or may appear as non-reproductive plants (in leaf only) in some years, it is possible that Wine-lipped Spider-orchid may have been undetectable at the time field work was conducted. While it is recognised that surveys are not required for state-listed orchids, any species that are protected under the EPBC Act require consideration for survey.

5.3.10 Field assessment – fauna

For the fauna assessment, high priority locations to assess were identified prior to the site visit, using aerial imagery and locations of historical threatened fauna records (VBA and BLA). All areas assessed were visited during daylight hours, and some areas assessed for nocturnal fauna were also assessed at night.

The assessment was limited to publicly accessible land, and privately owned land (such as golf courses) where permission had been granted. Private land was not entered if no permission had been granted. At a few locations where the identified location (such as a dam or a habitat patch) was on private land but near to public access, 'over the fence' assessment was possible to some degree, but the limitations in this are acknowledged.

At most locations, assessment was made on foot by walking into the areas considered likely to support the highest-quality and representative habitat (judgement based on aerial imagery and prior field experience). Zoologists remained adaptable in the field, and opportunistically included other nearby areas in the investigation if those areas were thought to provide higher quality habitat or help provide information on fauna that might use the project boundary. Photographs were taken at locations as a record of the habitats encountered.

Observations of threatened species were recorded at locations if seen/heard, but observations of common fauna were not recorded because abundant information on those species exists for the project boundary already, and additional records are unlikely to alter the prevailing understanding of the distribution and habitat use by those species.

Given the mobility of fauna, and the low likelihood of encountering most rare and threatened species during any given site visit, the approach adopted was to assess the condition and landscape context (including patch size and connectivity) of habitat patches that were considered most likely to attract or support threatened and migratory fauna, rather than searching for the species themselves. That said, the list of potentially relevant threatened species for each location was evaluated prior to the site visit and the potential presence of those species was considered in particular at specific sites.

Woodland/forested habitats were assessed qualitatively for the following attributes:

- Canopy trees (present/absent; density; native/non-native; large, medium or small; remnant, planted or regrowth; hollows present/absent)
- Mid-storey/shrub layer (present/absent; native/non-native; remnant, planted or regrowth)
- Understorey (present/absent; native/non-native; weediness; density (with a view to providing cover for small fauna); whether subject to weed management or revegetation efforts), and presence of litter and coarse woody debris
- Landscape context (patch size; connectivity and proximity to other patches; land management regime).

Grassland habitats were assessed qualitatively for the following attributes:

- Whether derived/natural; native/non-native; structure (whether grassland provided cover for small native fauna); apparent disturbance levels; presence/absence of trees and shrubs, and if present, density; native/non-native; large, medium or small trees and shrubs; remnant, planted or regrowth
- Landscape context (grassland patch size; connectivity and proximity to other patches; land management regime).

Waterbody and waterway habitats (in the context of threatened terrestrial fauna such as waterbirds and frogs, not aquatic fauna such as fish or turtles) were assessed qualitatively for the following attributes relevant to terrestrial fauna:

- Whether margins were vegetated; whether there was open or flowing water; apparent disturbance levels; landscape context and setting (whether in recreational area, proximity to highly-frequented public area)
- Landscape context (connectivity and proximity to other waterways/waterbodies).

Visited locations were evaluated in terms of their potential value (high, moderate, low) to native fauna, particularly threatened or migratory fauna species.

The field surveys were conducted in accordance with the following permits and approvals:

- Wildlife Act Research Permit 10008401
- Animal Research Authority issued by the accredited GHD Animal Ethics Committee Scientific Procedures Fieldwork Licence GHD SPFL20067.

5.3.11 Targeted surveys – fauna

Following the general field assessment for all fauna, targeted surveys were undertaken for certain threatened fauna species in areas considered most likely to support those species. Species considered for targeted surveys across the entire project boundary were species listed as threatened or migratory under the EPBC Act. Species considered for targeted surveys at Simpson Barracks were species listed as threatened or migratory under the EPBC Act, or threatened under the FFG Act or DELWP Advisory Lists (DSE, 2009a, DSE, 2013).

Targeted searches for EPBC Act-listed species across the entire project boundary

Targeted surveys were undertaken where there was doubt about the occurrence of a species or where the results were considered most likely to change the conclusions drawn.

Targeted surveys were not undertaken for EPBC Act-listed threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn. For example, the Grey-headed Flying-fox *Pteropus poliocephalus* is well-known to have a large roosting and breeding colony at Yarra Bend Park along the Yarra River, downstream of the Eastern Freeway, and to disperse widely from the colony to forage in flowering and fruiting trees and shrubs (planted and remnant) throughout the majority of Melbourne's suburbs. Therefore, presence of this species throughout the project boundary is presumed, without the need for targeted surveys. Contrastingly, targeted surveys for regular but rare species (such as Swift Parrot *Lathamus discolor*) were not conducted, because the likelihood of detecting the species was considered low, yet drawing a subsequent conclusion of absence from non-detection would have been misleading. Therefore, assessment for these species was done by habitat assessment, with occasional presence presumed in all appropriate habitat.

Growling Grass Frog *Litoria raniformis*

Growling Grass Frog habitat assessments were conducted in the field at locations determined through a review of record data (VBA) of threatened species and considering the presence of potentially suitable habitat occurring within the project boundary, based on preliminary field surveys, aerial imagery and modelled information.

Each location was visited during daylight hours to determine the habitat suitability of the waterway or waterbody for the Growling Grass Frog. The assessment took into account the following attributes:

- Presence of surface water
- Presence of emergent and fringing vegetation
- Shading
- The known or likely presence of fish
- Water quality
- Bank suitability (such as steep, shallow)
- Potential for high flows
- Level of degradation
- Landscape context of waterbody (isolated or connected to other waterways/waterbodies).

Between 31 October and 15 November 2017, two zoologists completed between one and three rounds of targeted frog surveys at each site where habitat was deemed suitable, in accordance with EPBC Act survey guidelines for this species (DEWHA, 2010b). Sites deemed to not currently provide suitable habitat were not included further in the targeted surveys (some sites deemed to not currently provide suitable habitat were still surveyed at night on one occasion following the habitat assessment, simply because the ecologists were already at the site at the right time of day and under the right conditions).

The survey timing was chosen to target the peak activity period of the Growling Grass Frog (November-December), and to follow survey guidelines for the species (DEWHA, 2010b). While all habitat assessments were conducted during daylight hours, all monitoring for the frogs themselves was conducted at night, because frog activity is most likely to be detected at night.

Nocturnal frog surveys targeting suitable weather conditions were undertaken at six sites (Plenty River, Simpson Barracks, Bolin Bolin Billabong, Merri Creek, Kew Golf Course, Koonung Creek) with the following protocol done at each site:

- An initial quiet listening period (up to five minutes) was undertaken from the edge of the waterway/waterbody to detect calling of frogs
- Playback of pre-recorded advertisement calls of Growling Grass Frog was undertaken for two to three minutes, in an attempt to elicit responses from frogs that may be present but not calling spontaneously
- The number of frogs calling for each species was estimated using the following abundance categories 0, 1–5, 11–20, 21–50, 51+
- A visual inspection of part or all of the site (generally focused on the most suitable habitat, as determined during the daytime visit) was undertaken following playback, using strong head torches to scan the water's surface, aquatic and bank-side vegetation for resting/perching frogs. Searches at each site lasted for up to 40 minutes; duration was influenced by the size of the waterbody, frog activity at the site, and habitat suitability for Growling Grass Frog.

Frog surveys are best undertaken during warm, humid and windless conditions, and surveys were timed to encounter appropriate conditions and EPBC survey guidelines (DEWHA, 2010b) as much as possible. On some evenings, temperatures were below the threshold indicated in DEWHA (2010b)(night time air temperatures to be greater than 12 degrees Celsius), but this was not deemed to influence the results. The temperatures were not greatly cooler than

required, and other frogs were heard on those nights. At each site, weather conditions were recorded, including cloud cover (estimated %), wind speed and direction, rain at the time of survey, presence of moonlight, air temperature (°C) and relative humidity (%). Temperature, relative humidity, wind speed and direction were taken from nearest weather station to each site and accessed via Eldersweather.com.au.

Grey-headed Flying-fox *Pteropus poliocephalus*

Targeted surveys were not conducted for this species. This species is well-known to have a large roosting and breeding colony at Yarra Bend Park along the Yarra River, downstream of the Eastern Freeway, and to disperse widely from the colony to forage in flowering and fruiting trees and shrubs (planted and remnant) throughout the majority of Melbourne's suburbs. Presence of this species throughout the project boundary is therefore presumed.

On 16 November 2017, the Yarra Bend colony was visited by zoologists (accessed from Fairlea Reserve, Fairfield) to determine proximity of the project boundary to current roosting areas used by flying-foxes.

Swift Parrot *Lathamus discolor*

Targeted surveys were not conducted for this species. This species breeds in Tasmania only, and migrates to the mainland to forage during the winter months. Typically, small numbers of birds fly through the Melbourne area on their northerly and southerly migrations. Birds are reported sporadically in small numbers in Melbourne's northern and north-western suburbs in most years, where suitable eucalypts occur and flower at appropriate times of the year. Given that, the chance of detecting the species through targeted survey was considered low, yet drawing a subsequent conclusion of absence from non-detection would have been misleading. Therefore, assessment for this species was restricted to habitat assessment, with occasional presence presumed in appropriate habitat.

Australasian Bittern *Botaurus poiciloptilus*

Targeted surveys were not conducted for this species. This species is cryptic and difficult to detect. According to the desktop assessment (VBA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. These areas are proposed to be tunnelled, so would not be impacted directly by construction, and indirect impacts through groundwater changes are expected to be negligible. The location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Australasian Bittern. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA/e-Bird records, suggests those areas are very unlikely to support this species. Assessment for this species was restricted to habitat assessment and opportunistic observations.

Australian Painted Snipe *Rostratula australis*

Targeted surveys were not conducted for this species. According to the desktop assessment (VBA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is in and around Banyule Swamp. This area is proposed to be tunnelled, so would not be impacted directly by construction, and indirect impacts through groundwater changes are expected to be negligible. There is potentially suitable habitat also at Bolin Bolin Billabong, although there are no historical records of the species in the VBA, BLA or e-Bird at that location. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA/e-Bird records, suggests those areas are very unlikely to

support this species. Assessment for this species was restricted to habitat assessment and opportunistic observations.

Latham's Snipe *Gallinago hardwickii*

Targeted surveys were not conducted for this species. This species is migratory, and is present in southern Australia only during the warmer months (August to March). According to the desktop assessment (VBA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. This area satisfies the criteria to be considered as 'important habitat under the EPBC Act (Section 8.3.3). These areas are proposed to be tunnelled, so would not be impacted directly by construction, and indirect impacts through groundwater changes are expected to be negligible. The location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Latham's Snipe. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA/e-Bird records, suggests those areas are very unlikely to support large enough numbers of birds (18 or more) to be considered important habitat (Commonwealth of Australia, 2017). Assessment for this species was restricted to habitat assessment and opportunistic observations.

Targeted searches within Simpson Barracks

For Simpson Barracks, species considered for targeted surveys were EPBC Act-listed species, and species that are listed as threatened under the FFG Act and/or the DELWP Advisory Lists, to provide a more comprehensive understanding of the whole of environment, as required for DSEWPaC (2013).

Brown Toadlet *Pseudophryne bibroni* and Southern Toadlet *P. semimarmorata*

Toadlet habitat assessments were conducted within the western and eastern woodland sections within Simpson Barracks. Locations were visited during daylight hours to determine the habitat suitability of the location for toadlets. The assessment took into account the following attributes:

- Presence of surface water or dampness of gully/depression
- Presence of litter or equivalent ground cover suitable for toadlets
- Shading and tree cover
- Evidence of disturbance and/or degradation
- Landscape context of gully/waterbody (isolated or connected to other waterways/waterbodies).

In early June 2018, two zoologists completed a targeted toadlet survey at night. The survey timing was within the known toadlet calling period (March to June), and close to the peak activity period for toadlets (April to May). Monitoring for the toadlets was conducted at night, because frog activity is most likely to be detected at night.

The nocturnal survey was undertaken with the following protocol:

- An initial quiet listening period (up to five minutes) was undertaken from the edge of the waterway/waterbody to detect calling of toadlets
- Playback of pre-recorded advertisement calls of Brown Toadlet was undertaken for two to three minutes, in an attempt to elicit responses from toadlets that may be present but not calling spontaneously

- The number of frogs or toadlets calling for each species was estimated using the following abundance categories 0, 1–5, 11–20, 21–50, 51+
- Visual inspections of the site were undertaken briefly following playback, using strong head torches to search for resting/perching frogs/toadlets, acknowledging that toadlets are typically fossorial and unlikely to be detected visually.

The nocturnal survey targeted suitable weather conditions. Frog/toadlet surveys are best undertaken during warm, humid and windless conditions, and surveys were timed to encounter appropriate conditions as much as possible. At Simpson Barracks, weather conditions were recorded, including cloud cover (estimated %), wind speed and direction, rain at the time of survey, presence of moonlight, air temperature (°C) and relative humidity (%). Temperature, relative humidity, wind speed and direction were taken from nearest weather station (Viewbank) and accessed via Eldersweather.com.au.

Powerful Owl *Ninox strenua* and Barking Owl *N. connivens*

Two threatened species of owl are documented to occur within the Melbourne area: Powerful Owl and Barking Owl. Of these, records of the Powerful Owl are far more common than records of the Barking Owl, which appears to occur rarely in the area, and more in larger patches of woodland in outer suburbs, rather than in the project boundary itself. Both owl species were considered here, but the Powerful Owl in particular is known to occur in well-treed areas in the inner suburbs of Melbourne, so was the main focus of the owl surveys at Simpson Barracks.

During the 2017 surveys for Growling Grass Frog, and during the autumn 2018 surveys for toadlets, two zoologists searched for owls and signs of owls at Simpson Barracks. The Barracks was visited firstly during daylight hours to determine the habitat suitability for owls.
The assessment took into account the following attributes:

- General tree size, particularly noting very large trees
- Presence of hollows, particularly very large hollows
- Suitability for high density/abundance of prey species (possums)
- Patch size and connectivity to other forest/woodland
- Level of disturbance (such as roads, walkers, dogs, military activities).

Searches were made for white wash and owl pellets around large trees.

Habitat evaluation was conducted during daylight hours, and then spotlighting and call playback for owls was conducted at night, when owls are active.

Nocturnal surveys were undertaken with the following protocol:

- Upon first arriving at the location, an initial quiet listening period (up to five minutes) was undertaken from the within the habitat patch to detect spontaneous calling by owls
- Then a slow meander was undertaken on foot through the potential owl habitat, using strong head torches/spotlights to search trees for movement and eye shine. Searches were undertaken within the western and eastern parts of Simpson Barracks, and lasted for up to 60 minutes at each location. Paths were followed where available, to reduce the likelihood of the observers being injured while spotlighting (such as by tripping, slipping, or being spiked or scratched by vegetation)
- During the wanderings, pre-recorded owl calls (mainly using Powerful Owl calls, but also including Barking Owl calls) were played periodically through a smart phone and loud-speaker, in an attempt to elicit responses from owls that may be nearby.

Presence of all nocturnal fauna was noted during the nocturnal site visits (including owls, frogmouths, frogs, possums, wallabies, kangaroos, flying-foxes).

Glossy Grass Skink *Pseudemoia rawlinsonii*

Opportunistic searches for the Glossy Grass Skink were made at Simpson Barracks during the daytime assessment of habitat for Growling Grass Frogs. Surveys were done under appropriate conditions for the skink: warm, sunny and windless conditions. This location was chosen on the basis of potentially suitable habitat based on preliminary field surveys and aerial imagery.
The VBA and Atlas of Living Australia (ALA) both include only one record (the same record) of this species in the study area: 1991 Bolin Bolin Billabong.

5.3.12 Field assessment – aquatic ecology

Preliminary habitat assessment

For the aquatic ecology assessment, high priority waterway and wetland locations were identified prior to the site visit. These were based on the location of proposed construction works. These are represented in the schematic map in Figure 5-5 that is provided to indicate the stream network and relative location. All areas selected for assessment were visited to inspect instream habitat quality, to prioritise sites with aquatic ecosystems that could support aquatic MNES.

Given the mobility and cryptic nature of aquatic fauna, the approach adopted was to assess the condition and connectivity of aquatic habitat that were considered most likely to attract or support threatened fauna. Based on this preliminary assessment, the list of potentially relevant MNES for each location was evaluated prior to the site visit and the potential presence of those species was considered at each site visited.

The assessment was limited to publicly accessible waterways, and privately owned land where permission had been granted. Private land containing wetland habitat that was not assessed for aquatic ecology values in the field included Kew Golf Course, which contains two waterbodies (Simpsons Lake and adjacent billabong). Given the use of Simpsons Lake for irrigation, disconnection from waterways (except during overbank flooding events), a high level assessment of this site using aerial imagery and existing desktop information indicated low likelihood of aquatic MNES to be present.

Photographs were taken at locations as a record of the habitats encountered.

The field surveys were conducted in accordance with the following permits and approvals:

- *Wildlife Act 1975* Research Permit 10008401
- *Fisheries Act 1995* General Research Permit 1096
- *Flora and Fauna Act 1988* (FFG Act) Research Permit/Permit to Take/Keep Protected Fish Permit 10007730FFG
- Animal Research Authority issued by the accredited GHD Animal Ethics Committee Scientific Procedures Fieldwork Licence GHD SPFL20067.

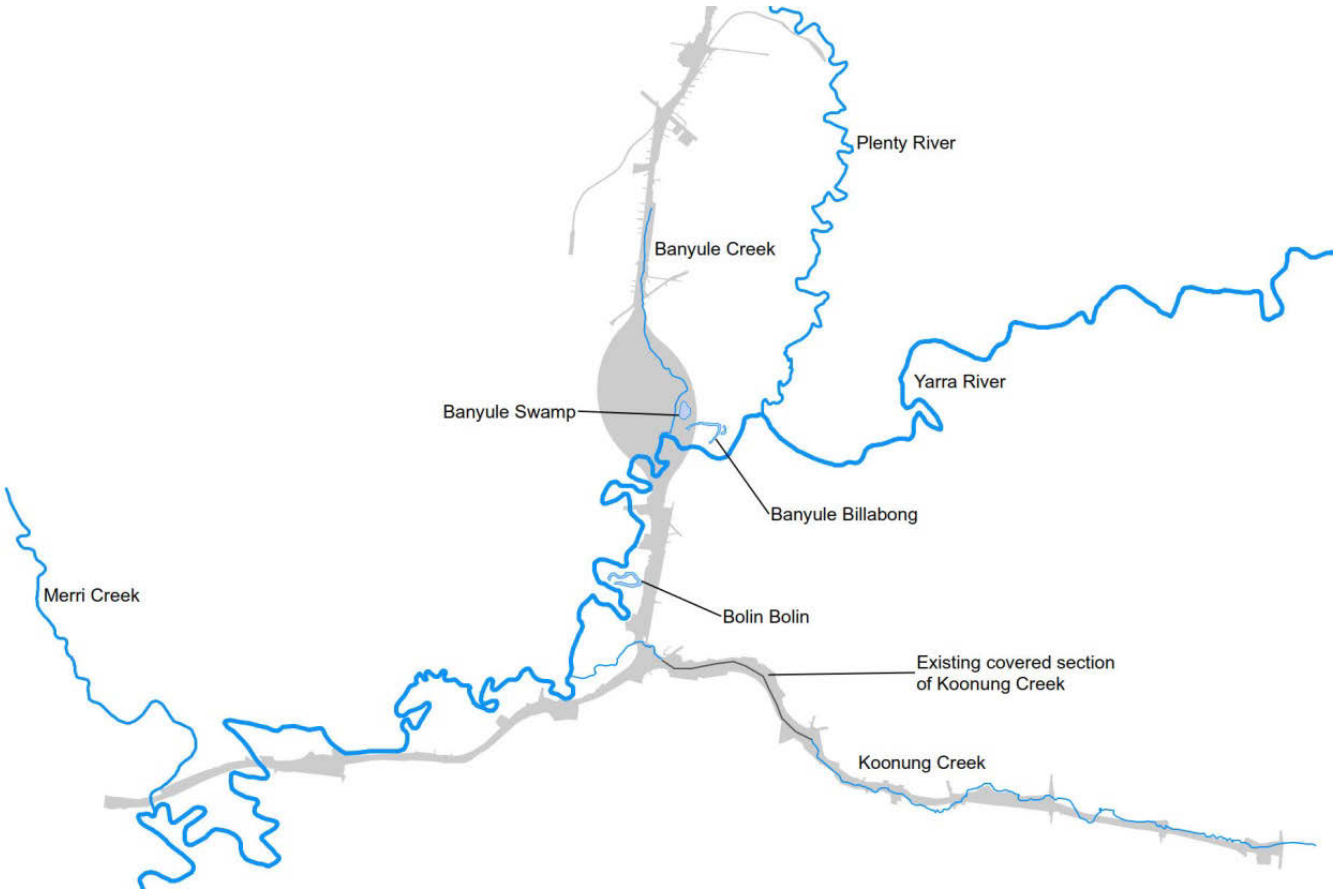


Figure 5-5 Schematic map of high priority waterways and wetlands considered in and adjacent to the project boundary

Rapid Bioassessment

The existing aquatic ecosystem condition was assessed using the EPA Victoria standard Rapid Bioassessment (RBA) method (EPA, 2003). This method uses aquatic macroinvertebrates as an indicator of aquatic ecosystem condition, integrating the impacts of multiple stressors over time. Biological indices calculated from the assemblage of macroinvertebrate families collected at a site provide insight to various aspects of waterway condition. EPA Victoria suggests that RBA data from a single season (autumn or spring) is sufficient for assessing aquatic ecosystem condition and objectives for ecosystem condition have been developed for urban waterways and are included in State Environment Protection Policy (SEPP) (Waters). Therefore, results of the RBA surveys were compared against the urban waterway aquatic ecosystem objectives (DELWP, 2018b) for the following biological indices:

- SIGNAL 2 – Stream Invertebrate Grade Number Average Level – indicates the average pollution tolerance/sensitivity of macroinvertebrates. A high score indicates better quality water quality conditions, whereas a lower score suggests macroinvertebrates tolerant of poor water quality (Chessman, 2003).
- EPT – the number of families from the Orders Ephemeroptera, Plecoptera and Trichoptera; insect orders that are known to be pollution sensitive. A high EPT score indicates more of these families, suggesting a better quality aquatic ecosystem (EPA, 2003).
- Number of Families – the diversity of a macroinvertebrates found at a site indicates the health of the waterway. A high score suggests good ecosystem, whereas low score suggests a degraded ecosystem (EPA, 2003).

RBA surveys were undertaken during autumn 2018 at the following locations that could potentially be impacted directly or indirectly by actions on Commonwealth land:

- Banyule Creek at Simpson Barracks
- Banyule Creek at McCrae Road, downstream of Lower Plenty Road
- Banyule Creek at Banyule Road.

Hydrology assessment of Banyule Creek

An assessment of the surface water hydrology of Banyule Creek was undertaken to understand the contribution of groundwater or rainfall runoff to the stream flow and aquatic habitat in the waterway. While this stream is known to be intermittent, and upstream reaches are anecdotally reported to dry out completely, it is not known how much of the waterway retains water during low-flow periods. The impact of groundwater manipulation within and adjacent to the Simpson Barracks area during construction and operation of North East Link was considered to be a risk to the surface water aquatic ecosystem, and this assessment was planned to consider the reliance of aquatic values in Banyule Creek on groundwater inflows. During an extended period of low rainfall, the full length of Banyule Creek was walked, from Simpson Barracks down to the Yarra River. The presence and salinity of water in the stream was recorded to assess which reaches support permanent aquatic ecosystems and which reaches are likely maintained by groundwater or runoff.

Environmental quality of Victorian Lakes

EPA Victoria has developed a monitoring program recommended for the assessment of overall environmental condition of Victorian Lakes (EPA, 2010). This includes a standardised assessment of aquatic ecosystem condition that has been included in the Draft SEPP (Waters) (DELWP, 2018b) as the standard method for lakes and wetlands. The assessment includes aquatic macroinvertebrates, water quality, habitat quality and catchment threats.

The assessment was undertaken in Banyule Swamp that has potential indirect impact from of hydrological impacts from North East Link.

5.3.13 Targeted fish surveys – aquatic ecology

Following the preliminary habitat assessment of waterways and wetlands, targeted surveys were undertaken in aquatic habitat considered most likely to contain certain threatened species. Targeted surveys were conducted for four native fish species (Australian Grayling *Prototroctes maraena*, Macquarie Perch *Macquaria australasica* and Dwarf Galaxias *Galaxiella pusilla*). As methods used for targeted surveys also survey other fish species, the targeted surveys also provided general fish survey that provided data on native and exotic fish species to inform the general aquatic ecosystem condition assessment in waterways affected by works on Commonwealth land.

Targeted surveys were not undertaken for some threatened species because the presence of these species is already known in certain waterways. For example, Australian Grayling and Macquarie Perch are known to occur in the Yarra River in the reaches in and near the project boundary. Therefore, presence of these species in the Yarra River is presumed, without the need for targeted surveys. However recent records indicating the presence of these species is not known from the tributaries of the Yarra River within the project boundary. Due to the hydrological connectivity and potential fish passage from the Yarra River to these waterways, targeted surveys for these species were undertaken in Koonung Creek and Plenty River.

See sections below for survey rationale for each species of highest concern in the project boundary.

Macquarie Perch and Australian Grayling

Habitat assessments for each fish species, fyke netting and electrofishing were conducted at sites where records of the species were not known, but where connectivity to the known Yarra River population could be possible. Targeted surveys for Macquarie Perch and Australian Grayling were undertaken at the sites listed in Table 5-5.

The recommended time to survey for Macquarie Perch is March through September (DSEWPAC, 2011). Surveys were undertaken in autumn 2018. The same methods were also used during spring 2017, during targeted surveys for other species, which may have also captured Macquarie Perch if present. Spring and summer surveys are not recommended for survey for this species due to concerns over impacts during spawning, however the timing and annual pattern of migration in not well understood in the Yarra River population (DoEE, 2017c).

The Australian Grayling is a migratory species that inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. The recommended time to survey for Australian Grayling is December through to April (DSEWPAC, 2011), to maximise survey effectiveness during periods of lower flow. Surveys were undertaken during autumn 2018, but also included surveys during spring 2017 when upstream migration of this species is most likely to occur. Australian Grayling are thought to disperse as juveniles in the marine environment, and ascend freshwater systems independent of their origin (DELWP, 2015). This leads to the potential for expansion of the distribution of Australian Grayling population in the Yarra River into other tributaries with suitable habitat.

Each site was visited during daylight hours to determine the presence of instream habitat, including the presence of pools, connectivity, substrate and degree of modification and urban stormwater runoff. The fyke netting was undertaken to target juvenile fish in these tributaries of the Yarra River. Double-wing four-millimetre mesh fyke nets were deployed overnight (12-hour soak time) in the best available habitat in the waterway reach. The wings were set to entirely cover the width of the stream; one net facing upstream and another net facing downstream. Nets were retrieved the following morning and all fish captured were identified. Fyke netting is considered to be most effective during period of rising water (DSEWPAC, 2011). However, due to workplace safety and low rainfall during the survey season, only the Plenty River was able to be surveyed during a rising flow event. Other survey sites were surveyed during stable flow conditions.

Electrofishing was undertaken using a Smith Root LR20B backpack operated by a pair of experienced aquatic ecologists, in accordance with the Australian Code of Electrofishing Practice (NSW Fisheries, 1997). Electrofishing was undertaken for between 600 and 1,000 seconds of pulse time at each site, typically extending along a length of waterway of 100 to 200 metres.

Table 5-5 Summary of fish survey methods

Site	Targeted round 1	Targeted round 2
Plenty River at Plenty River Drive	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Bulleen Road	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Doncaster Road	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Jocelyn Avenue, Balwyn	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting

Site	Targeted round 1	Targeted round 2
Koonung Creek at Valda Avenue, Box Hill North	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Frank Sedgman Reserve, Box Hill North	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Church Road, Doncaster	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Boronia Grove Reserve, Doncaster East	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting
Koonung Creek at Tunstall Road, Doncaster East	1 night x 2 Fyke nets, Backpack electrofish, Dip netting	1 night x 2 Fyke nets, Backpack electrofish, Dip netting

Dwarf Galaxias

Dwarf Galaxias are known to occur in ephemeral and intermittent waterbodies, but are typically associated with floodplain wetlands, dispersing during periods of overbank flow. This species is not known from the Yarra River catchment, although a translocated population is known from wetlands at La Trobe University (Saddlier *et al.,* 2010). While it was considered possible that a similar isolated population was present within the protected environment of Simpson Barracks, no historical fish survey data from waterways within Simpson Barracks is available. Targeted surveys for this species were only conducted for this species at Simpson Barracks.

A habitat assessment, dip net sampling and backpack electrofishing of any aquatic habitat was undertaken during spring 2017 and autumn 2018. The use of bait traps was not appropriate for the habitat in Simpson Barracks, as the water depth (typically <15 centimetres) was too low for trap to be effective. The use of electrofishing and dip netting in this small, shallow waterway was appropriate for this targeted Dwarf Galaxias survey, in accordance with the survey guidelines for threatened fish (DSEWPAC, 2011), as the aquatic habitat did not contain dense instream aquatic vegetation or high salinity that might otherwise limit the effectiveness of these methods.

5.3.14 Declared weeds and pathogens

An assessment was undertaken of the likelihood of declared weeds and pathogens to occur in the study area. For the purpose of the assessment, declared weeds are those listed by the CaLP Act (for Commonwealth land) or Weeds of National Significance (WoNS) identified by the PMST (for the entire project boundary).

This assessment was completed for species recorded on the VBA and/or predicted to occur by the PMST, within five kilometres of the project boundary. Likelihood definitions are as per Section 5.3.5.

There is no method for identifying pathogens with likelihood to occur in the study area. However, key pathogens (those identified as threatening processes under the EPBC Act and/or FFG Act) have been considered in this report. One pathogen considered most relevant to the ecological impact assessment of the project boundary is Cinnamon Fungus *Phytophthora cinnamomi.* Potential range and indicative threat mapping is provided in DSE (2008).

Another known pathogen that affects fauna is the Amphibian Chytrid Fungus, which causes the disease chytridiomycosis, which can result in high mortality of frogs. *Chytridiomycosis due to the amphibian chytrid fungus* is a listed Key Threatening Processes under the EPBC Act.
The Amphibian Chytrid Fungus is known to have been in Australia since 1978 and Victoria since 1998 (Murray *et al.,* 2010), and is likely to be widespread throughout frog habitats within the project boundary already (Brannelly *et al.,* 2018).

5.3.15 Threatening processes

An assessment was undertaken of the relevance and likelihood of occurrence of threatening processes listed under the FFG Act (DELWP, 2016b) (for Commonwealth land) and key threatening processes listed under the EPBC Act (DoEE, 2017a; DoEE, 2017b) (for the entire project boundary). Only those threatening processes deemed to be relevant to North East Link were assessed (refer to Appendix D of this report).

Likelihood category definitions are:

- **Low** – threatening process not recorded in the project boundary, or the project boundary supports conditions that could encourage or exacerbate threatening processes; however, the impact of these processes is considered limited by the location of the project boundary in an urban, fragmented environment
- **Moderate** – the project boundary supports suitable conditions that could encourage or exacerbate threatening process
- **High** – the project boundary supports suitable conditions that are likely to encourage and/or exacerbate threatening processes
- **Present** – threatening process directly observed or recently recorded within the project boundary.

5.3.16 Wetlands of international or national importance

Wetlands of International Importance (Ramsar) and Nationally Important Wetlands

A PMST report with a five-kilometre buffer was run on 6 March 2018 to determine whether North East Link would impact on Wetlands of International Importance (Ramsar) and/or Nationally Important Wetlands.

Mapped wetlands

Mapped wetlands were identified through DELWP's Current Wetlands Map (accessed 19 March 2018).

Assessment of presence of mapped wetlands was introduced through the recently updated DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017a) to overcome the difficulty in identifying and accurately assessing a landscape feature that responds quickly to changes in environmental conditions and may be ephemeral in nature. For the purposes of measuring removal of native vegetation by the proposed works, any extent of mapped wetland that is to be removed is considered to be a patch of native vegetation. Condition of the wetland and value in Habitat Hectares is determined by the modelled condition score unless a site assessment is carried out soon after inundation (DELWP, 2017a)

5.3.17 Groundwater dependent ecosystems

To assess the potential for impacts to MNES or impacts on Commonwealth land resulting from groundwater changes, groundwater dependent ecosystem (GDEs) have been considered using two modelled spatial databases.

National Atlas of Groundwater Dependent Ecosystems administered by the Australian Government Bureau of Meteorology (BOM). The GDE Atlas was developed as a national dataset of Australian GDEs to inform groundwater planning and management. The Atlas contains information about three types of ecosystems. Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs. Terrestrial ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems. The Atlas

also identifies subterranean GDEs in cave and aquifer ecosystems, which do not occur in the study area.

Potential Groundwater Dependent Ecosystem Mapping for the Port Phillip and Westernport Catchment Management Authority (PPWCMA) administered by DELWP. The DELWP mapping does not indicate the degree of groundwater dependence, only locations in the landscape that have the potential to be groundwater dependent ecosystems. The DELWP model is expected to over-estimate the extent of terrestrial GDEs. Validation of the model through field assessment has not been performed. This dataset does not directly support interpretation of the amount of dependence or the amount of groundwater used by the regions highlighted within the maps. Further analysis and more detailed field-based data collection are required to support this.

Types of GDEs

Multiple types of GDEs have been identified in Australia (Geosciences Australia, 2018), and these can be grouped into two categories as per Eamus (2009):

- GDEs that rely on surface expression of groundwater which include:
  - Wetland areas
  - Rivers where groundwater discharge provides a significant baseflow component to the system
- GDEs that rely on the availability of water beneath the surface (subsurface) which include:
  - Terrestrial vegetation that relies on groundwater close to the surface (within the root depth of the vegetation) which in turn supports animal communities
  - Aquifer and cave ecosystems
  - Estuarine systems that rely on submarine groundwater discharge.

GDEs that rely on the availability of water beneath the surface (terrestrial vegetation) are discussed in Section 6.3.3. GDEs that rely on surface expression of groundwater (wetland areas, rivers) are discussed in Section 8.4.

5.4 Impact assessment

5.4.1 Impact assessment approach and terminology

This study provides a detailed assessment of the potential presence and relevant impacts on ecological MNES, specifically, listed threatened species and communities and migratory species, and the environment on Commonwealth land.

The general description of impacts is presented in Section 9. These are then considered according to the significant impact criteria for MNES in Section 10, and for Commonwealth land in Section 11.

Impact assessment

The change that would result from the implementation of North East Link is called an impact. Impacts can be positive or negative. Impacts can be a direct result of an action, or can occur indirectly, such as impacts on habitat for MNES resulting from a change in groundwater conditions. The nature and extent of any impact is measured against the current environmental conditions, considering the differences between ‘with project’ and ‘no project’ scenarios.

The following factors were considered when assessing potential impacts:

- Severity including the intensity, duration, timing and frequency, and scale or geographic extent of impacts
- The relationship between different impacts on the environment
- The likely effectiveness of measures to avoid and mitigate adverse impacts
- The likelihood that any given environmental impact would occur
- Whether any impacts are likely to be unknown, unpredictable or irreversible
- Benchmarks and requirements set by statutory requirements, policies and guidelines
- Community expectations
- The principles of ecologically sustainable development, and objects and requirements of the EPBC Act.

Impacts can be positive or negative, and can be a direct result of an action, or can occur indirectly. For example, impacts to habitat for MNES resulting from a change in groundwater conditions. Sometimes these involve complex chains of events and often draw on the findings of other technical studies.

Sections 10 and 11 consider the potential impacts of the action on MNES and ecological values on Commonwealth land, during construction and operational of North East Link.

Losses of indigenous vegetation and scattered trees were determined by overlaying the project boundary, including temporary laydown and works areas, against the mapped existing conditions, and identifying any overlap. Within the project boundary, 100 per cent vegetation loss was assumed.

The impact assessment process has been separated into key themes to address the requirements of the PER Guidelines. With a focus on EPBC-listed taxa and communities across the entire project boundary, and all taxa and communities on Commonwealth land, these include:

- **Native vegetation** – including all remnant vegetation (patches of remnant vegetation, large trees within patches, and scattered indigenous trees) that occur in the terrestrial environment
- **Aquatic ecology** – the aquatic ecology considers plants and animals that occur in freshwater waterbodies; for this assessment, platypus and turtles are considered as aquatic fauna, while amphibians are considered as terrestrial fauna
- **Terrestrial fauna** – any fauna that occur in the terrestrial environment that largely reside in the terrestrial environment for all life stages; for this assessment, amphibians are considered as terrestrial fauna, while platypus and turtles are considered as aquatic fauna.

Avoid mitigate and offset impacts

Measures to avoid and mitigate impacts were developed in response to the impact assessment to reduce impacts on MNES and the environment on Commonwealth land.

These have included refinements to the reference project and specification of measures to avoid and mitigate environmental impacts during construction and operation of North East Link.

The final reference project is described in PER Chapter 3 – Description of the action.
A consolidated list of avoidance and mitigation measures and the framework for implementing these is provided in PER Chapter 10 – Proposed avoidance and mitigation measures.

Mitigation measures have been developed that are:

- Appropriate in terms of effort and expense in relation to the scale and nature of the impact
- Targeted to the protection and/or restoration of the systems or resources affected
- At the highest practicable level in the 'mitigation hierarchy' (Avoid >Minimise > Rehabilitate >Manage > Offset/Compensate)
- Practicable and effective
- Accord with the principles of ecologically sustainable development
- Accord, where possible, with community expectations.

Where impacts could not be reduced through avoidance and mitigation measures, environmental offsets have been considered in accordance with the EPBC Act Environmental Offsets Policy (DSEWPAC, 2012). For the Commonwealth whole of environment assessment, Victorian Government legislation has also been considered for determining offsets. These are described in PER Chapter 11 – Offsets.

Assessment of impact significance

The significance of impacts on MNES and the environment on Commonwealth land were assessed using the EPBC Act Significant impact guidelines 1.1 *Matters of National Environmental Significance*, and 1.2 *Actions on, or impacting upon Commonwealth land, and actions by Commonwealth agencies* (DSEWPAC, 2013b). These documents are intended to guide the referral and approval process. The principles set out in these guidelines are applicable for use in a more detailed assessment.

The significant impact criteria against which impacts in this report are assessed is presented in Sections 5.4.2, 5.4.3, 5.4.4 and 5.4.5 for threatened species, threatened communities, Migratory species, and the environment on Commonwealth land.

This assessment considers impacts that remain after mitigation. Significant residual impacts require offsetting under the EPBC Act (DSEWPaC, 2012).

Where impacts could not be reduced through avoidance and mitigation measures, environmental offsets have been proposed in accordance with the EPBC Act Environmental Offsets Policy (DSEWPAC, 2012).

5.4.2 Assessment of impact significance – threatened species

Significant impact criteria relevant to critically endangered and endangered species

EPBC significant impact criteria relevant to critically endangered and endangered species are presented in Table 5-6. Definitions for specific terms (population, invasive species, critical habitat), as they appear in the EPBC Significant impact guidelines 1.1 (DoE, 2013), are provided below the table.

Table 5-6 EPBC significant impact criteria relevant to critically endangered and endangered species

MNES or category	Criterion	Relevant to which project phase/s?
Critically endangered and endangered species	An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
	• Lead to a long-term decrease in the size of a population	Construction/Operation
	• Reduce the area of occupancy of the species	Construction
	• Fragment an existing population into two or more populations	Construction
	• Adversely affect habitat critical to the survival of a species	Construction/ Operation
	• Disrupt the breeding cycle of a population	Construction/ Operation
	• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Construction
	• Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Construction/ Operation
	• Introduce disease that may cause the species to decline, or	Construction/ Operation
	• Interfere with the recovery of the species.	Construction/ Operation

DoE (2013) provides the following definitions relevant to critically endangered and endangered species:

Population

"A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion".

Invasive species

"An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation".

Habitat critical to the survival of a species

"'Habitat critical to the survival of a species' refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species as habitat critical for that species; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act".

Significant impact criteria relevant to vulnerable species

EPBC Significant impact criteria relevant to vulnerable species are presented in Table 5-7. Definitions for specific terms (important population, invasive species, critical habitat), as they appear in the EPBC Significant impact guidelines 1.1 (DoE, 2013), are provided below the table.

Table 5-7 EPBC Significant impact criteria relevant to vulnerable species

MNES or category	Criterion	Relevant to which project phase/s?
Vulnerable species	An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
	• Lead to a long-term decrease in the size of an important population of a species	Construction/ Operation
	• Reduce the area of occupancy of an important population	Construction
	• Fragment an existing important population into two or more populations	Construction
	• Adversely affect habitat critical to the survival of a species	Construction/ Operation
	• Disrupt the breeding cycle of an important population	Construction/ Operation
	• Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Construction
	• Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Construction/ Operation
	• Introduce disease that may cause the species to decline, or	Construction/ Operation
	• Interfere substantially with the recovery of the species	Construction/ Operation

DoE (2013) provides the following definitions relevant to vulnerable species:

Important population

"An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity, and/or
- Populations that are near the limit of the species range".

Invasive species

As defined for critically endangered and endangered species above.

Habitat critical to the survival of a species

As defined for critically endangered and endangered species above.

5.4.3 Assessment of impact significance – threatened ecological communities

EPBC Significant impact criteria relevant to critically endangered and endangered ecological communities are presented in Table 5-8.

Table 5-8 EPBC Significant impact criteria relevant to critically endangered and endangered ecological communities

MNES or category	Criterion	Relevant to which project phase/s?
Critically endangered and endangered ecological communities	An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
	• Reduce the extent of an ecological community	Construction
	• Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Construction
	• Adversely affect habitat critical to the survival of an ecological community	Construction/ Operation
	• Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	Construction/ Operation
	• Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	Construction/ Operation
	• Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established, or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or	Construction/ Operation
	• Interfere with the recovery of an ecological community.	Construction/ Operation

DoE (2013) provides the following definitions relevant to critically endangered and endangered ecological communities:

Habitat critical to the survival of an ecological community

"'Habitat critical to the survival of an ecological community' refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the ecological community (including the maintenance of species essential to the survival of the ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or

- For the reintroduction of populations or recovery of the ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the ecological community as habitat critical for that ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act".

5.4.4 Assessment of impact significance – migratory species

This section presents the criteria for listed migratory species against which impacts in this report are assessed. Central to this are the EPBC Significant impact guidelines 1.1 (DoE, 2013) which list criteria for the assessment of impacts on MNES, including migratory species.

EPBC Significant impact criteria relevant to listed migratory species are presented in Table 5-9. Definitions for specific terms (important habitat, ecologically significant proportion), as they appear in the EPBC Significant impact guidelines 1.1 (DoE, 2013) are provided below the table.

Note that some migratory species are also listed under the EPBC Act as threatened species. The criteria below are relevant to migratory species that are not considered threatened under the EPBC Act.

Table 5-9 EPBC Significant impact criteria relevant to listed migratory species

MNES or category	Criterion	Relevant to which project phase/s?
Migratory species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
	• 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	Construction/ Operation
	• Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	Construction/ Operation
	• Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Construction/ Operation

DoE (2013) provides the following definitions relevant to migratory species:

Important habitat

"An area of 'important habitat' for a migratory species is:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species range, and/or
- Habitat within an area where the species is declining".

Ecologically significant proportion

"Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance would need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates)".

Population

"'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia".

5.4.5 Assessment of impact significance – Actions on Commonwealth land

This section presents the criteria for actions on or impacting upon Commonwealth land, against which impacts in this report are assessed. Central to this are the EPBC Significant impact guidelines 1.2 (DSEWPaC, 2013), which list criteria for the assessment of impacts on or from Commonwealth land. Table 5-10 records which of these criteria are assessed in this technical report.

Table 5-10 EPBC Significant impact criteria relevant to impacts on Commonwealth land

Category	Criteria *(Is there a real chance or possibility that the action will:)*	Coverage in report
Impacts on water resources	Measurably reduce the quantity, quality or availability of surface or ground water	Ecological impacts related to information presented in PER Technical Appendix C – Surface water and PER Technical Appendix B – Groundwater.
	Channelise, divert or impound rivers or creeks or substantially alter drainage patterns, or	Ecological impacts related to information presented in PER Technical Appendix C – Surface water and PER Technical Appendix B – Groundwater.
	Measurably alter water table levels?	Ecological impacts related to information presented in PER Technical Appendix C –Surface water and PER Technical Appendix B – Groundwater.
Impacts on plants	Involve medium or large-scale native vegetation clearance	Section 11
	Involve any clearance of any vegetation containing a listed threatened species which is likely to result in a long-term decline in a population or which threatens the viability of the species	Section 11
	Introduce potentially invasive species	Section 11

Category	Criteria *(Is there a real chance or possibility that the action will:)*	Coverage in report
	Involve the use of chemicals which substantially stunt the growth of native vegetation, or	Section 11
	Involve large-scale controlled burning or any controlled burning in sensitive areas, including areas which contain listed threatened species?	None anticipated
Impacts on animals	Cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals	Section 11
	Displace or substantially limit the movement or dispersal of native animal populations	Section 11
	Substantially reduce or fragment available habitat for native species;	Section 11
	Reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species	Section 11
	Introduce exotic species which will substantially reduce habitat or resources for native species, or	Section 11
	Undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species?	None anticipated

DSEWPaC (2013) provides the following definition relevant to actions on or impacting upon Commonwealth land:

Environment

'Environment' is defined in the EPBC Act as:

- Ecosystems and their constituent parts including people and communities ('ecosystem' is defined in the EPBC Act as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functioning unit')
- Natural and physical resources
- Qualities and characteristics of locations, places and areas
- Heritage values of places ('heritage value' is defined in the EPBC Act as including 'the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians'. 'Indigenous heritage value' is defined as meaning 'a heritage value of the place that is of significance to Indigenous persons in accordance with their practices, observances, customs, traditions, beliefs or history')
- The social, economic and cultural aspects of a thing mentioned in paragraphs a, b or c.

DSEWPaC (2013) provides the following guidance on what to consider in describing the water, vegetation and animal components of the environment on Commonwealth land:

Water

- What are the characteristics of the catchment area and what water bodies are present?
  - What water catchment area will the action be located in and what geographic area does the water catchment cover?
  - What water bodies are present (for example, rivers, creeks, lakes, groundwater, wetlands, estuaries and the ocean)?
- Is it likely that any water bodies will be directly or indirectly impacted by the action?
  - Does the action involve impoundment, diversion, or extraction of water?
  - Will the action alter drainage patterns?
  - Will the action create or increase pollutants, nutrients, or sediment?
- Will any sensitive, valuable or otherwise important water bodies be impacted?
  - For example, wetlands or other sensitive environments and drinking water supplies.
- What is the condition and current use of water bodies which may be impacted?
  - What is the water quality?
  - Are there competing uses?

Vegetation

- What general vegetation types and vegetation species are present?
  - Vegetation types: rainforest; forest; woodlands; grasslands; riparian (river side) vegetation; mallee vegetation; sub-alpine heath; coastal heath; mangroves.
  - Vegetation species: tree species; shrub species; grass species; marine plants.
  - Are any ecological communities present?
- Is it likely that vegetation will be directly or indirectly impacted by the action?
- Are there any vegetation types or associations that are rare, endemic or otherwise valuable?
  - For example, listed threatened plant species and ecological communities; habitat for listed threatened animal species or ecological communities.
- What is the condition and current use of the vegetation?
  - Is the vegetation remnant vegetation or regrowth?
  - Does the vegetation contain weed species? How many?

Animal species

- What animal species are present and what are their characteristics?
  - Terrestrial species/marine species/ecological communities?
  - Populations, movements, and breeding, feeding, and migration patterns/times
- Is the action likely to directly or indirectly impact upon animal species?
  - Will the action result directly or indirectly in animal deaths or injury?
  - Will the action impact upon habitat, water or other resources utilised by animals?
- Is the action likely to impact upon animal species that are rare, endemic or otherwise valuable?
  - For example, listed threatened species and listed migratory species
  - Feeding, nesting, breeding areas.

5.5 Assumptions

Generally, the level of risk posed by the limitations and assumptions described in this section is considered to be low to moderate since the ecological features of the Melbourne area (including the project boundary) have a long history of disturbance, degradation and urbanisation typical of a large city. The likelihood of this assessment missing species or communities of high ecological value in the project boundary is considered to be low, since the ecological features of the Melbourne area tend to be relatively well studied and well understood.

Ecological limitations and assumptions of this assessment are outlined below:

- Since a detailed design for North East Link is yet to be established, for the purpose of this report, it has been assumed that any area within the project boundary may be subject to land clearing and native vegetation removal. The exception to this is the area above the proposed tunnels that would be constructed by tunnel boring machine (TBM) which would not result in surface disturbance, and other locations where indicated (that is, the conditional no-go zone areas of the Banyule Flats, the no-go zone areas of the Yarra River floodplain). It is noted this assessment is based on a reference project and that the actual impacts realised by North East Link would be expected to affect a significantly smaller footprint within the project boundary.
- Mapping of native vegetation (patches and scattered trees) was conducted using hand-held Trimble PDA units, ArcGIS Collector app for iPhone, and aerial photo interpretation. The accuracy of the mapping is subject to the accuracy of the unit, access to satellite information (generally < 5 metres) and environmental conditions at the time of assessment (cloud cover).
- The need for targeted survey for listed threatened species was considered for those species identified by the investigation as having moderate or greater likelihood of occurrence in the study area, or for species potentially inhabiting areas with little to no previous survey data (such as fish at Simpson Barracks).
- For fauna, targeted surveys were not undertaken for some threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn (such as the Grey-headed Flying-fox *Pteropus poliocephalus*, Swift Parrot *Lathamus discolor*; as explained in Section 5.3.11).
- Monitoring of waterways (Rapid Bioassessment) and lakes (Vlakes) was conducted during a particularly dry period, which may influence the assessment of aquatic ecosystems. The results from this monitoring event may or may not be representative of conditions during wet periods. This should be considered in future management plans.
- Targeted fauna (terrestrial or aquatic) surveys that do not detect the subject species cannot provide conclusive evidence that threatened species do or will not occur, just that they have not been detected. The assessment of likelihood of occurrence is based on survey effort, background information and previous records compiled.
- The extent of field survey and information available from other sources were considered adequate for the purpose of identifying potential impacts of North East Link on ecological values.
- The literature review as it pertains to the project boundary was not intended to be an exhaustive synthesis of current knowledge, but rather provide a concise and consolidated account of the ecological values supported, or predicted to be supported, by these ecosystems.

- Identification of GDEs for consideration in the assessment is based on external source data (the Australian Government Bureau of Meteorology and the Department of Environment, Land, Water and Planning). The spatial extent of groundwater dependency was validated in the field for Banyule Creek as part of the aquatic ecology existing conditions assessment. However, this report does not seek to verify the accuracy of modelling or provide an indication of the level of groundwater dependence of a potential GDE.
- Other than aquatic ecosystem assessment undertaken in Banyule Creek and Banyule Swamp downstream of Simpson Barracks, surveys were not undertaken outside the project boundary and Commonwealth land.

5.6 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of the North East Link EES and PER, and to inform the development of the action and an understanding of potential impacts. Table 5-11 lists specific engagement activities that have occurred in relation to ecology, with more general engagement activities occurring at all stages of the action.

Table 5-11 Stakeholder engagement undertaken for ecology

Activity	When	Matters discussed	Outcome
Meeting with DELWP	19 February 2018	FFG-listed and DELWP-listed fauna – seeking DELWP endorsement to project approach for fauna surveys (including on Commonwealth land)	DELWP generally happy with project approach. DELWP had the following comments: • Powerful Owl known to breed in the area – Deakin University study • DELWP recommended NELP liaise with Deakin University on their Powerful Owl project • DELWP mentioned Practical Ecology report for Banyule, which discussed more Migratory species at Banyule Flats.
Meeting with the EPA	23 March 2018	Aquatic ecosystem assessments	• Confirmation of requirements under the draft SEPP (Waters) • Provision of references for background to billabongs.
Meeting with Deakin University (School of Life and Environmental Sciences)	2 May 2018	Powerful Owl mostly, also Barking Owl briefly	• Deakin University researchers provided overview of recent findings for Powerful Owl surveys across eastern suburbs of Melbourne, including parts of the project boundary and Simpson Barracks.
Meeting with Warringal Conservation Society (WCS)	17 May 2018	The ecology of Warringal Parklands and Banyule Flats in relation to North East Link	• Presented overview of ecology assessments • Opportunity to receive further information from local interest group • NELP to provide advice on timing for comment on when assessment documents are open for comment • WCS to be kept up updated, including when government requirements are released.

Activity	When	Matters discussed	Outcome
Meeting with Melbourne Water	21 May 2018	Groundwater and wetlands	• Melbourne Water to provide list of available reports and data approved for use • Contact established for access to data and models in future.
Meeting with City of Whittlesea	24 May 2018	Matted Flax-lily translocation	• Discussion of potential translocation sites within Whittlesea • Discussion of potential process.
Meeting with City of Banyule	4 July 2018	Matted Flax-lily translocation	• Discussion of potential translocation sites within Banyule.
Meeting with DELWP	18 July 2018	Native Vegetation Removal, offset strategy, technical matters associated with delineation of habitat zones (includes vegetation removal from Commonwealth land)	• DELWP suggested site visit with Port Phillip Region biodiversity officer • DELWP encouraged reduction of impacts to avoid/minimise requirements for species offsets.
Telephone call with Arthur Rylah Institute (DELWP) (Wayne Koster, Australian Grayling researcher)	4 September 2018	Australian Grayling migration timing and sensitivity to noise impacts	• Updated report with months of Australian Grayling seasonal migration • Confirmed this species is likely to avoid areas of good habitat to avoid noise.
Meeting with Department of Defence	12 November 2018	Loss of native vegetation, alteration to Banyule Creek	• Information provided on anticipated ecological impacts and mitigation measures, such as offsets, Matted Flax-lily Salvage and Translocation Plan (Appendix F), Tree Canopy Replacement Plan.

6. Description of the environment – flora

6.1 PER Guidelines scope relating to flora

This flora component of the ecological assessment considers the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species and communities (Sections 18 and 18A of the EPBC Act), including:
  - Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)
  - Matted Flax Lily (*Dianella amoena*) (endangered)
  - Clover Glycine (*Glycine latrobeana*) (vulnerable)
- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

6.2 MNES within project boundary

As outlined above, the flora component of this assessment is required to consider the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain
- Matted Flax-lily (*Dianella amoena*)
- Clover Glycine (*Glycine latrobeana*)
- River Swamp Wallaby-grass (*Amphibromus fluitans*).

From the information provided in the referral, DoEE considered these matters may be significantly impacted by the action.

This assessment has also considered potential impacts on the following additional threatened species and communities protected under Part 3 of the EPBC Act:

- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
- Charming Spider-orchid (*Caladenia amoena*)
- Green-striped Greenhood (*Pterostylis chlorogramma*).

6.2.1 Desktop assessment results

Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of MNES that may occur, or for which suitable habitat may occur within the five-kilometre buffer beyond the project boundary. A full assessment of the likelihood of occurrence of all threatened flora is provided in Appendix A.

Results of the PMST search are presented in Appendix D, and summarised in Table 6-1.

Table 6-1 Summary of ecology-related PMST results for the five-kilometre buffer, including aquatic fauna within the stream network

MNES	
Wetlands of International Importance (Ramsar Sites)	None
Commonwealth Marine Area	None
Listed threatened ecological communities	Five listed communities: • Grassy Eucalypt Woodland of the Victorian Volcanic Plain • Natural Damp Grassland of the Victorian Coastal Plains • Natural Temperate Grassland of the Victorian Volcanic Plain • Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains • White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.
Listed threatened species	Forty species consisting of: • 25 listed fauna species • 15 listed flora species.
Listed migratory species	15

All threatened flora predicted to occur by the PMST (Appendix D) are combined with the VBA data in a list of threatened species in Appendix A, along with an evaluation of the likelihood of those species occurring in the study area.

Victorian Biodiversity Atlas

The following section provides the results of the VBA search for records of flora listed as threatened under the EPBC Act.

Within the five-kilometre radius search area, eight flora listed under the EPBC Act are recorded and lodged on the VBA (excludes those only modelled to occur by the PMST). Those flora species listed under the EPBC Act and recorded within five kilometres of the project boundary are summarised in Table 6-2, shown in Figure 6-1, and the full list of threatened species is provided in Appendix A.

Species listed under the EPBC Act and modelled to occur in the local area by the PMST, but not recorded within five kilometres of the project boundary on the VBA are provided in Table 6-3.

Within the project boundary, only one threatened species has been historically recorded (excluding those only modelled to occur by the PMST):

- Matted Flax-lily *Dianella amoena* (EPBC – Endangered; FFG – Listed; DELWP Advisory List – Endangered).

Table 6-2 EPBC Act-listed species recorded within five kilometres of the project boundary

Scientific name	Common name	EPBC Act
Amphibromus fluitans	River Swamp Wallaby-grass	VU
Caladenia amoena	Charming Spider-orchid	EN
Dianella amoena	Matted Flax-lily	EN
Glycine latrobeana	Clover Glycine	VU
Lepidium hyssopifolium	Basalt Peppercress	EN
Pterostylis chlorogramma	Green-striped Greenhood	VU
Senecio psilocarpus	Swamp Fireweed	VU
Xerochrysum palustre	Swamp Everlasting	VU

VU – vulnerable; EN – endangered

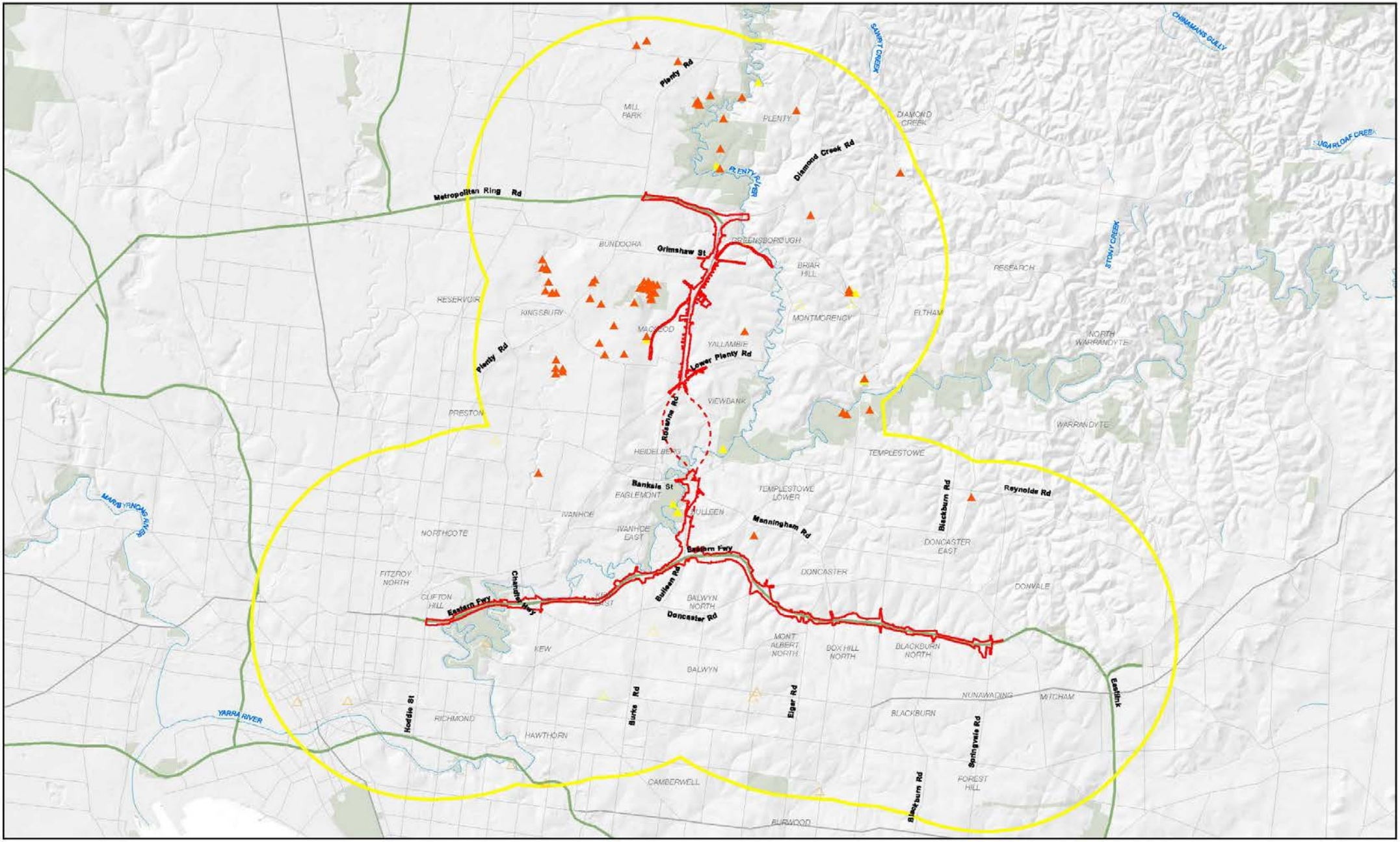
Table 6-3 Species only modelled to occur by the PMST

Scientific Name	Common Name	EPBC Act
Caladenia rosella	Little Pink Spider-orchid	EN
Diuris fragrantissima	Sunshine Diuris	EN
Lachnagrostis adamsonii	Adamson's Blown-grass	EN
Pimelea spinescens subsp. *spinescens*	Spiny Rice-flower	CR
Pomaderris vacciniifolia	Round-leaf Pomaderris	CR
Prasophyllum colemaniae	Lilac Leek-orchid	VU
Prasophyllum frenchii	Maroon Leek-orchid	EN
Pterostylis cucullata	Leafy Greenhood	VU
Rutidosis leptorrhynchoides	Button Wrinklewort	EN

VU – vulnerable; EN – endangered; CR – critically endangered

Literature

An assessment of VBA data found a high likelihood of the presence of River Swamp Wallaby-grass, with nine recent records within the five-kilometre search radius of the project boundary. Notable VBA records in close proximity to the project boundary were at the western end of Bolin Bolin Billabong (1994, 2011), Yarra Flats north of Bolin Bolin (1995) and Banyule Flats (1995). Australian Ecosystems (2007) also identified the species at two wetlands (B and D) within the Trinity Grammar School Sporting Complex, Bulleen. Wetland B is within the project boundary, while wetland D is immediately east of the project boundary.



Paper Size A4

0 970 1,940 2,910 3,880

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987+

- Endangered
- Vulnerable

VBA Threatened Flora < 1987

- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

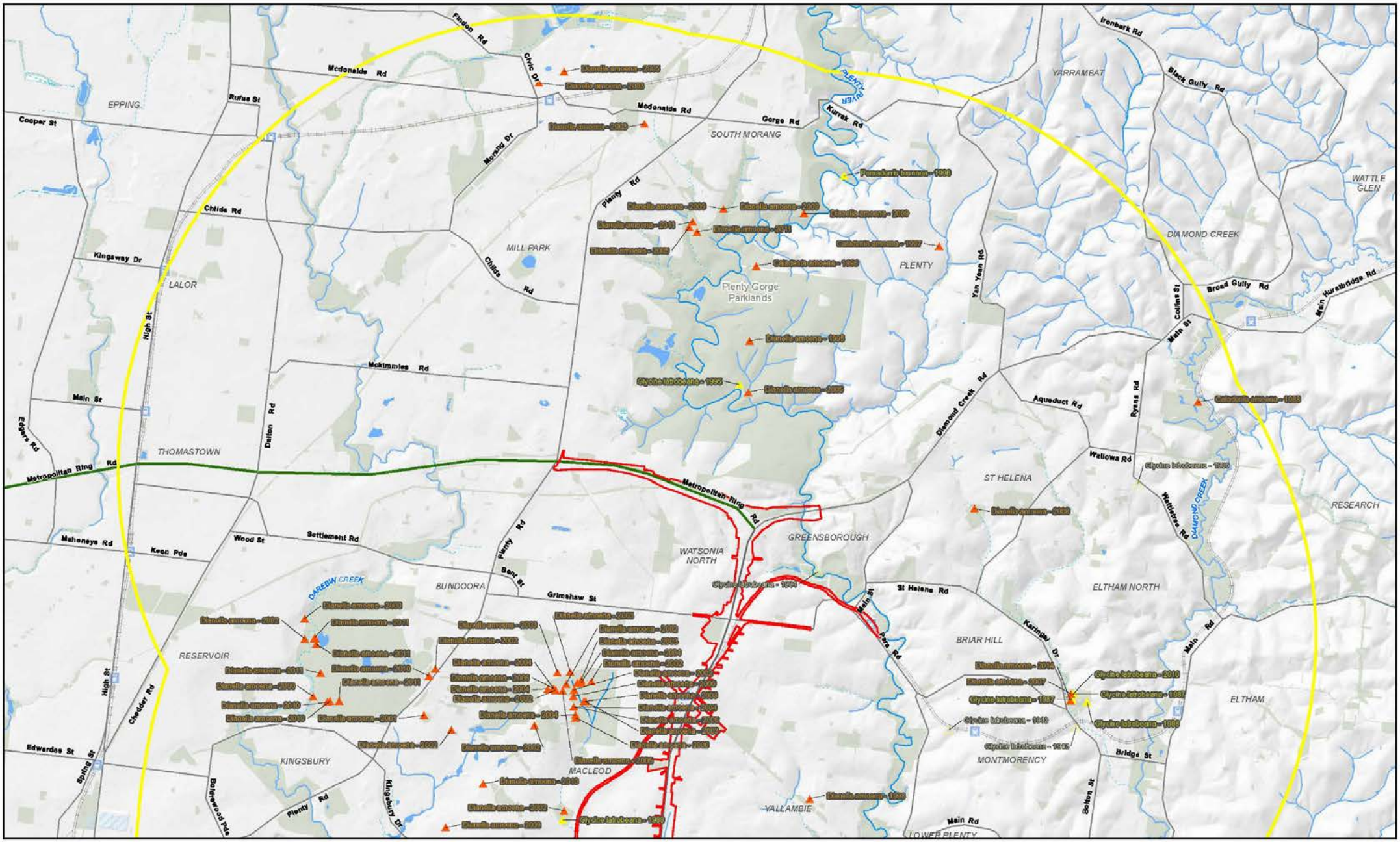
VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31\35006_PER_6_1_Flora_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:lnghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987+
- Endangered
- Vulnerable

VBA Threatened Flora < 1987
- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

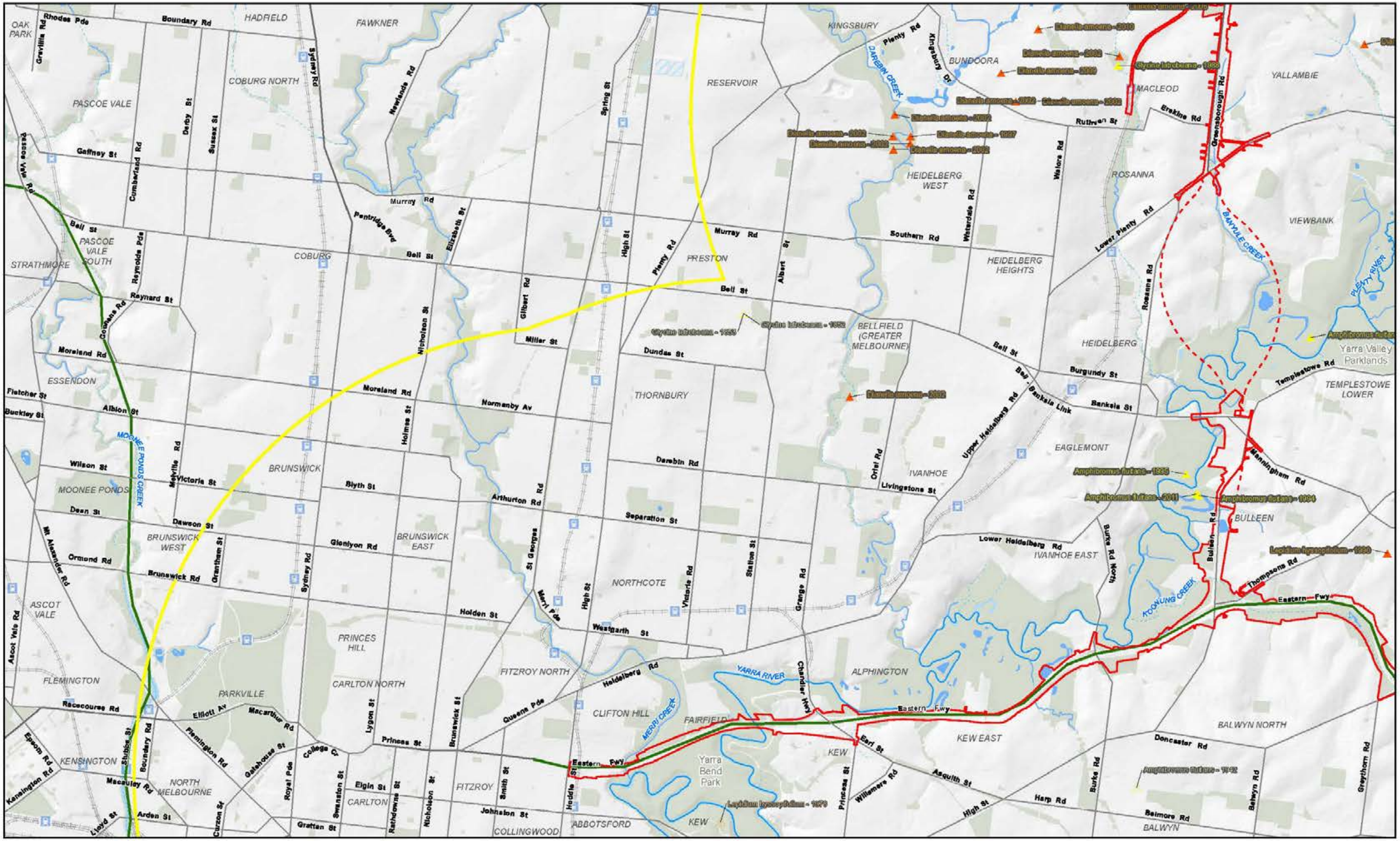
VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31350006_PER_6_1_Flora_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987+
- Endangered
- Vulnerable

VBA Threatened Flora < 1987
- Endangered
- Vulnerable

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

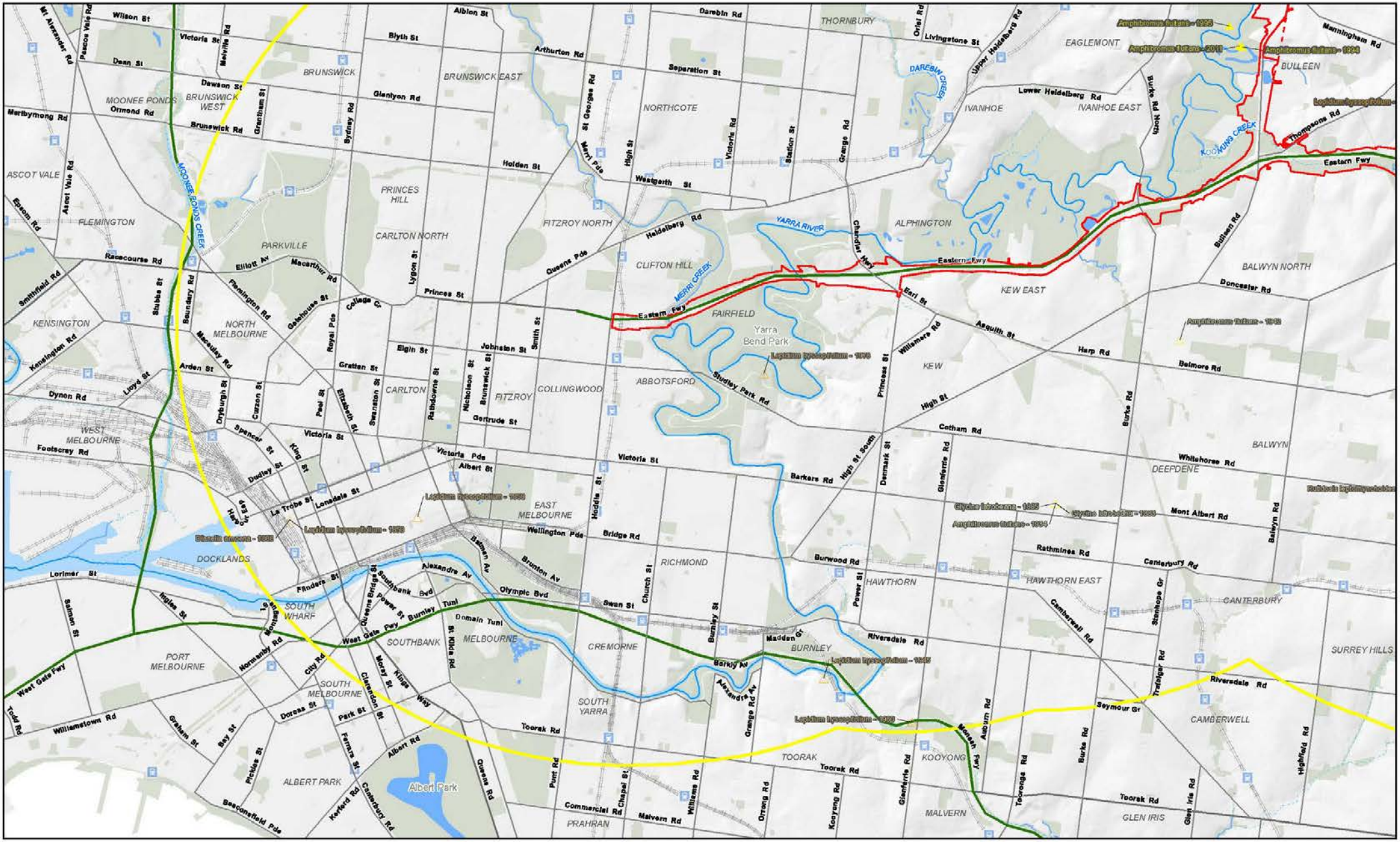
VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\3135006_PER_6_1_Flora_A3L_RevC.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:tnghetti



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987+
- Endangered
- Vulnerable

VBA Threatened Flora < 1987
- Endangered
- Vulnerable

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

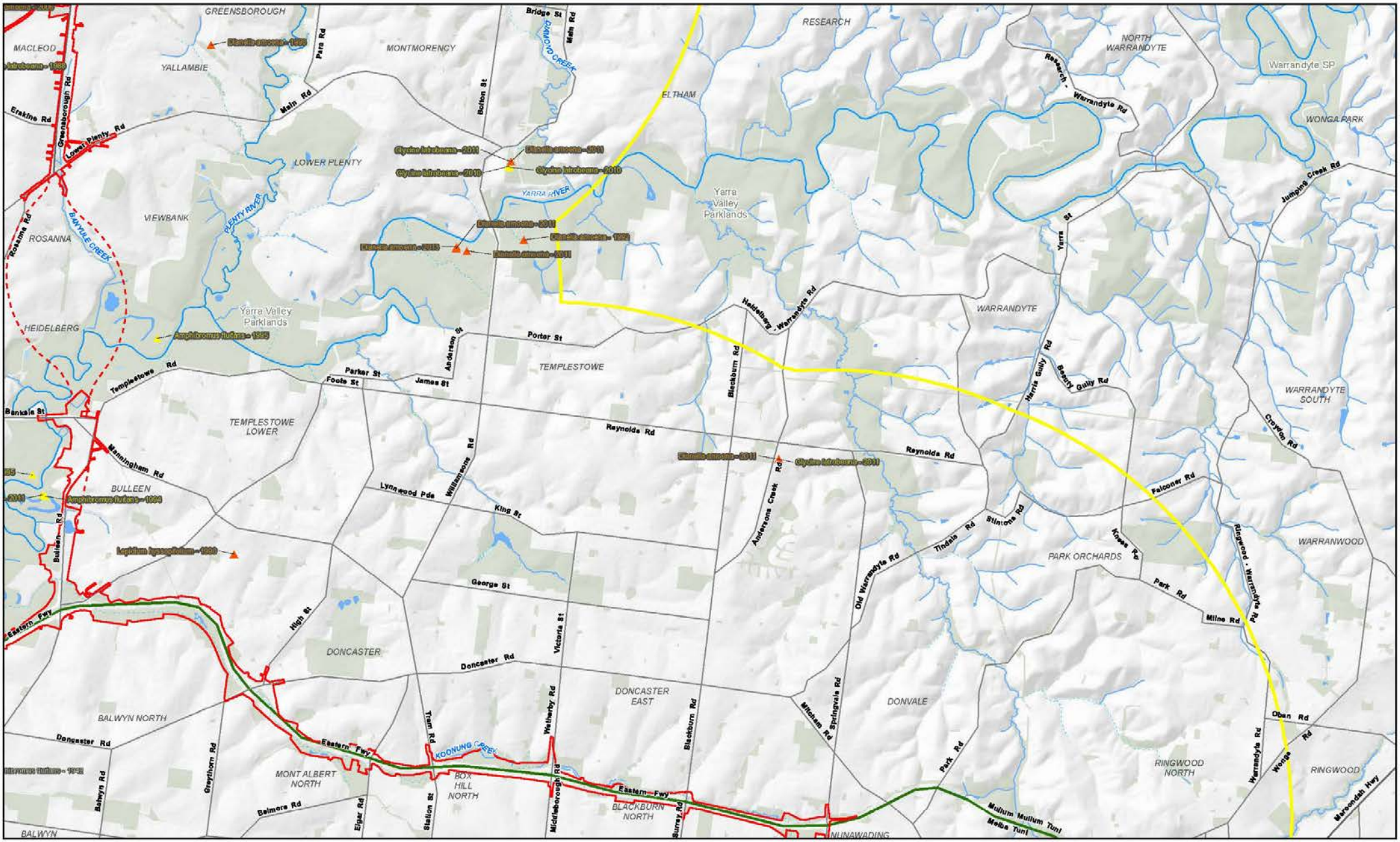
VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31s35006_PER_6_1_Flora_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987

- Endangered
- Vulnerable

VBA Threatened Flora < 1987

- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

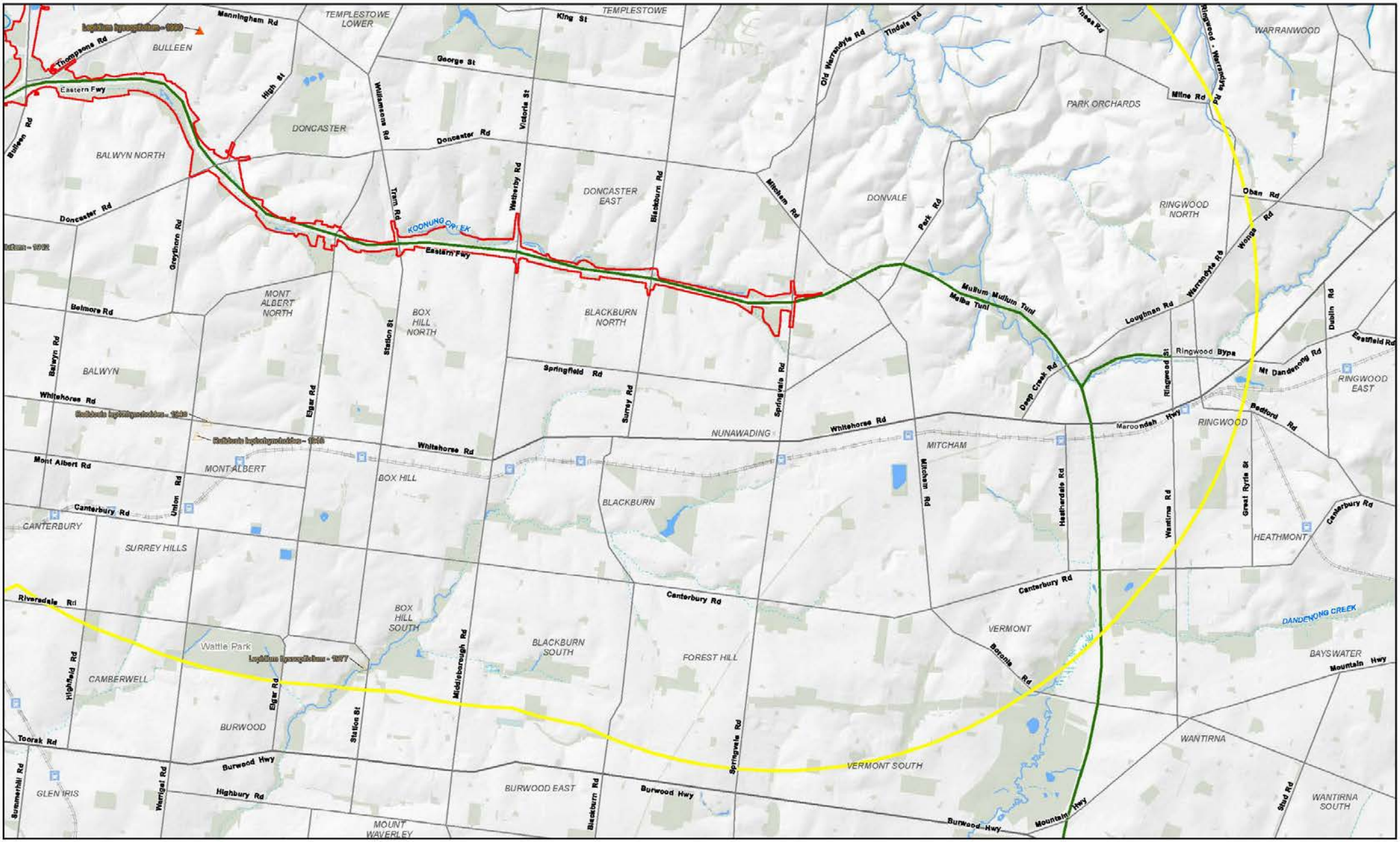
VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31t35006_PER_6_1_Flora_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Flora > 1987+

- Endangered
- Vulnerable

VBA Threatened Flora < 1987

- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

VBA records of Flora listed as threatened under the EPBC Act

Figure 6-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_PER_6_1_Flora_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

6.2.2 Site assessment results

Vegetation within the project boundary

The project boundary incorporates three bioregions: the Gippsland Plain, Victorian Volcanic Plain and Highlands – Southern Fall. Most of the project boundary falls within the Gippsland Plain bioregion. Landforms within the Gippsland Plain generally consist of low-lying floodplains including billabongs (oxbow lakes) associated with the Yarra River and flat to undulating plains. The northern part of the project boundary is characterised by undulating hills within the Highlands – Southern Fall bioregion, which drain to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection.

Native vegetation within the project boundary is generally in poor-moderate condition, with the ecological values present largely reflecting the long history of urban land use throughout the surrounding landscape. However, despite the highly urbanised landscape, the project boundary does contain substantial ecological values, particularly in the following areas:

- Simpson Barracks
- The Yarra River, its floodplains and parks (Warringal Parklands and Banyule Flats, Bolin Bolin Billabong, Kew Billabong and Willsmere Park)
- Koonung Creek
- Banyule Creek.

In addition, substantial areas of the project boundary support native vegetation planted for amenity purposes along public roads and within recreation reserves.

Continuing pressure from weed invasion and regular anthropogenic disturbance has historically negatively impacted vegetation quality throughout much of the project boundary. However, there are pockets where significant effort in revegetation and management has resulted in higher quality patches.

As mentioned above, key areas of remnant vegetation within the project boundary include Simpson Barracks and riparian and floodplain vegetation associated with the Yarra River and its tributaries. This includes Koonung Creek in the south, Banyule Creek and Yarra River in the centre and Plenty River in the northern parts of the project boundary.

While various EVCs are present, the majority of the native vegetation consists of Plains Grassy Woodland (EVC 55), Floodplain Riparian Woodland (EVC 56), Swampy Riparian Woodland (EVC 83) and Valley Grassy Forest (EVC 47). These EVCs are characterised by mature, mixed-eucalypt canopies consisting of species such as River Red Gum *Eucalyptus camaldulensis,* Swamp Gum *E. ovata*, and Manna Gum *E. viminalis*, which form remnant patches or occur as isolated scattered trees. Eucalypt trees within the project boundary range in size from saplings to very large trees with a diameter at breast height (DBH) up to 190 centimetres.

Consistent with the low-lying landforms of the Gippsland Plain bioregion, several swamps and billabongs including man-made wetlands are located within and adjacent to the project boundary. These areas including Bolin Bolin Billabong (designated no-go zone, see Figure 5-4, wetlands adjacent to the Eastern Freeway and wetlands associated with the Banyule Flats. These wetlands vary in quality and for the most part are man-made or have had a history of modification and rehabilitation.

In several locations, occurrences of the EPBC Act listed species, Matted Flax-lily, were observed and recorded. This includes areas within Simpson Barracks adjacent to Banyule Creek, the Hurstbridge rail corridor and areas adjacent to the Metropolitan Ring Road bike path at the northern end of the project boundary.

Threatened species

The likelihood of occurrence for all flora recorded within five kilometres of the project boundary (VBA) or predicted to occur within the project boundary (PMST) is outlined in Appendix A. In summary, of the 17 EPBC Act-listed species recorded or predicted to occur in the study area, five have a moderate or high likelihood of occurrence within the project boundary, including:

- Matted Flax-lily (present within the project boundary)
- River Swamp Wallaby-grass (high likelihood of occurrence within the project boundary)
- Clover Glycine (moderate likelihood of occurrence within the project boundary)
- Charming Spider-orchid (moderate likelihood of occurrence within the project boundary)
- Green-striped Greenhood (moderate likelihood of occurrence within the project boundary).

Matted Flax-lily *Dianella amoena* (EPBC, endangered; FFG, listed; DELWP, endangered)

Matted Flax-lily is listed as endangered under the EPBC Act and a listed species under the FFG Act. It is a small, perennial, tufted lily endemic to south-east Australia, occurring in grassland and grassy woodland habitats. Matted Flax-lily occurs in Victoria and Tasmania, and multiple populations are known from the northern suburbs of Melbourne, typically within remnant vegetation alongside road or rail corridors, conservation reserves and in translocation sites (Carter, 2010).

The National Recovery Plan for the Matted Flax-lily *Dianella amoena* (Carter, 2010) describes Matted Flax-lily as:

> *...in the family Hemerocallidaceae (formerly included in the family Liliaceae) is a tufted, mat–forming perennial lily. Plants are rhizomatous and can form loose clumps up to 5 m wide. Rhizomes are yellow and slender, with shoots arising every 10–30 cm. Leaves are grey-green, dull crimson at the base, narrow and tapering, to 45 cm long by 12 mm wide, and broadly V-shaped, with a prominent abaxial keel along the midrib and loose clasping leaf sheaths. Blades, sheaths and midribs usually have small, irregularly spaced teeth. Leaves are deciduous in summer if plants are water-stressed (Gray & Knight 2001). The inflorescence is erect, 20–90 cm long, with a slender, arching scape that bears several bluish, star-shaped, nodding, sweetly fragrant flowers. Perianth segments are pale to deep blue-violet, recurved, elliptic, to 10 mm long by 3 mm, the outer tepals with five veins, the inner tepals with three veins. There are six stamens, to 7 mm long, with pale yellow filaments, orange strumae and pale lime-yellow anthers, while the style is whitish-translucent, to 6 mm long. Fruits are ovoid purple berries to 7 mm long, and seeds are shiny black and smooth, to 3 mm long. Flowering occurs from October to April (description from Carr & Horsfall, 1995).*

Much of this habitat has been cleared, and remaining populations of Matted Flax-lily are mostly small and highly fragmented. The species rarely germinates from seed (Carter, 2010) but has occasionally been observed to colonise bare earth where it occurs in close proximity to existing plants (T Wills, pers. obs.). Current threats include ongoing clearing of habitat and weed invasion.

Previous studies within the project boundary

The population of Matted Flax-lily at Simpson Barracks is well documented, with the site listed as supporting a ‘significant population’ on the National Recovery Plan for the species, where it was recorded as possessing a population of 10 plants (Carter, 2010). A number of previous investigations into the populations of Matted Flax-lily present at Simpson Barracks have been undertaken, as summarised below:

- **Jacobs, May 2016, Simpson Barracks Flora and Fauna Monitoring Program 2016–2021**

  This report refers to a survey program undertaken in 2016, which identified Matted Flax-lily occurring at Simpson Barracks. Overall, a total of 65 locations were recorded with a total of 603 ramets counted. As such, this suggests the Barracks supports one of the larger subpopulations in the Melbourne metropolitan area. The Matted Flax-lily was identified on the eastern and western sides of the base, with the greatest portion of the population (87 per cent; 60 locations) occurring on the eastern side of the Barracks within the higher quality native vegetation areas identified. A smaller proportion (13 per cent; five locations) of the Matted Flax-lily population was recorded in the lower quality EVC 55 Plains Grassy Woodland vegetation.

- **HLA-Envirosciences, May 2007, Biodiversity Assessments and Strategies for Simpson Barracks**

  The HLA report refers to a report prepared by Kinhill in 2000 that identified two populations of Matted Flax-lily at Simpson Barracks. One population was assessed to contain approximately 50 individuals or clumps on the western section of the Barracks. The other site comprised of approximately 20 individuals, or clumps, in the eastern section of the Barracks.

  HLA-Envirosciences conducted field surveys on the site in 2006. They recorded two individuals or clumps in the western section of the Barracks, and 39 individuals or clumps in the eastern section. HLA-Envirosciences indicated the population had declined by 90 per cent in the western section of the Barracks, but noted the difference could be attributed to the different seasonal timings of the surveys. The Kinhill surveys (2000) occurred in November/January, while the 2006 survey occurring in September outside the flowering season of the species. Surveys of Matted Flax-lily should be conducted between November and February when flowers are present to increase plant visibility and detectability.

  HLA-Envirosciences also suggested the Matted Flax-lily had been out-competed by highly invasive perennial weeds that were observed dominating the ground layer.

  Given that the National Recovery Plan listed a population size of 10 plants at the site, it is assumed the Kinhill and HLA-Envirosciences reports were unavailable (or confidential and unable to be released) when the National Recovery Plan was being developed in 2010.

Results

During targeted surveys conducted between October and December 2017, and subsequent surveys of the Hurstbridge rail line reserve, a total of 95 individual Matted Flax-lily plants/patches were recorded and mapped within the project boundary as follows:

- 83 individuals/patches at Simpson Barracks (including within the publicly accessible section of Commonwealth land), with individuals ranging from a few leaf tufts to large patches up to 4 x 4 metres in size
- Four plants/patches near the M80 Ring Road interchange at an elevated point close to a telecommunications tower
- Eight plants/patches along the Hurstbridge rail line, including one large patch (2 x 15 metres) and seven individuals or smaller patches at three discrete locations.

To place these numbers in context, at least 188 additional plants/patches have been identified in the eastern part of Simpson Barracks (outside the project boundary), as identified by:

- Rapid surveys for North East Link undertaken in 2017/2018 identified approximately 123 plants/patches
- Jacobs identified approximately 18 additional plants/patches in 2016
- HLA identified approximately 9 additional plants/patches in 2006/7
- Department of Defence identified approximately 38 additional plants/patches in 2006.

It should be noted that since publication of the draft PER, the location of these records has been carefully checked, and no historical records from the Jacobs, HLA or Defence surveys were included if they were within 15 metres of the records identified during the current survey. This approach was undertaken to minimise the risk of double counting patches/individuals.

Most Matted Flax-lily plants/patches observed during targeted surveys were in a healthy condition (Plate 6.1 below). Plants showed evidence of recent flowering and leaf growth and several were observed being pollinated by the native Blue-banded Bee *Amegilla cingulata*. Matted Flax-lily occurred in a number of different habitats including at the base of River Red Gums, on rocky open areas or in shallow depressions. They often co-existed with other *Dianella* species within the project boundary, in particular Black-anther Flax-lily *Dianella revoluta* s.l. and Arching Flax-lily *Dianella longifolia* var. *grandis*.

a. Matted Flax-lily amongst Black-anther Flax-lily (D. revoluta s.l.) below River Red Gum

b. Matted Flax-lily at Simpson Barracks

c. Matted Flax-lily within a shallow depression at Simpson Barracks

Plate 6.1 Representative photos of Matted Flax-lily at Simpson Barracks

Clover Glycine *Glycine latrobeana* (EPBC, vulnerable; FFG, listed; DELWP, vulnerable)

Clover Glycine is listed as vulnerable under the EPBC Act and a listed species under the FFG Act. It is a small perennial herb with leaves that look similar to common pasture clover (DPI, 2003; DSE, 2005b). It is endemic to south-east Australia and concentrated largely around South Australia, Tasmania and Victoria where it occurs mainly in grasslands and grassy woodland habitats. Clover Glycine has been heavily impacted by land clearing, grazing, weed invasion and alteration of fire regimes leading to significant fragmentation of the population.

Results

Clover Glycine was not recorded in the project boundary despite a high likelihood of presence determined in the desktop assessment (there are 18 VBA records for Clover Glycine in the surrounding five kilometres). Much of the project boundary, including remnant patches, consisted of a modified understorey with varying levels of weediness. Generally, the most common weeds were grassy species (such as Veldt-grass Ehrharta spp., Brome Bromus spp., Oat Avena spp.), which compete in the ground layer, generally making the environment unsuitable for Clover Glycine due to the high biomass (Carter & Sutter, 2010). Nonetheless, targeted surveys were completed during the tail-end of the flowering season to confirm the presence or absence of the species.

Better quality remnant patches of Plains Grassy Woodland and Riparian Woodland such as Simpson Barracks, Banyule Reserve and some elevated flats along Koonung Creek were considered to have a higher potential to support the species because of their archetypal indigenous grassland structure, such as Kangaroo Grass, Wallaby Grass, Spear Grass *Austrostipa* spp. and Plume Grass *Dichelachne* spp. However, Clover Glycine was not observed despite extensive searching in these areas. In addition to weed cover, pressure from rabbit and kangaroo grazing is likely to be a barrier to the persistence of the species in the project boundary (Carter & Sutter, 2010) as well as the wider landscape. These areas are also subject to infrequent/altered fire regimes, thereby increasing competition and reducing recruitment opportunities for Clover Glycine.

Although no individuals were recorded, it is concluded that Clover Glycine has a moderate likelihood of occurring within the project boundary based on the presence of potentially suitable habitat.

Charming Spider-orchid *Caladenia amoena* (EPBC, endangered; FFG, listed; DELWP, endangered)

Charming Spider-orchid is listed as endangered under the EPBC Act and is a listed species under the FFG Act. It is also classified as endangered under the DELWP Advisory list. This species is endemic to Victoria and is located in the north-eastern suburbs of Melbourne in the Greensborough–Plenty–Hurstbridge area as well as south-central Victoria; typically in grassy dry forest. In Melbourne, it is known only from a few small remnant populations.

Results

No individuals were observed during field assessments, and while potential habitat may be affected, the closest of the sparse historical records is located approximately two to three kilometres from the project boundary.

Green-striped Greenhood *Pterostylis chlorogramma* (EPBC, vulnerable; FFG, listed; DELWP, vulnerable)

Green-striped Greenhood is listed as vulnerable under the EPBC Act and is a listed species under the FFG Act. It is also categorised as vulnerable under the DELWP Advisory list. The species generally prefers moist areas of heathy and shrubby forests and is often difficult to distinguish from Emerald-lip Greenhood *Pterostylis smaragdyna.*

Results

During targeted surveys conducted in August 2018, no individuals were observed and potentially suitable habitat is unlikely to be impacted by the proposed works.

River Swamp Wallaby-grass *Amphibromus fluitans* (EPBC, vulnerable)

River Swamp Wallaby-grass is listed as vulnerable under the EPBC Act and is an aquatic perennial with one-metre long decumbent culms (aerial stems growing horizontally with tips turned up at the end) and often only the inflorescence is above water. It occurs in natural as well as man-made low flow water-bodies, including swamps, lagoons, billabongs and dams. Within the study area, optimal habitat for this species occurs in wetlands associated with the floodplain of the Yarra River.

Results

River Swamp Wallaby-grass was not observed during field assessments or targeted surveys. An assessment of VBA data found a high likelihood of presence, with nine recent records within the five-kilometre buffer of the project boundary with the most recent record from 2011. Practical Ecology (2007b) also identified this species at the Trinity Grammar School Sporting Complex, Bulleen, within close proximity to the project boundary.

There are some suitable areas of habitat such as Banyule Swamp, Trinity Grammar School Sporting Complex wetlands and Bolin Bolin Billabong. As such, there is a high likelihood that River Swamp Wallaby-grass is located within the project boundary. Despite a high likelihood of occurrence within the project boundary, River Swamp Wallaby-grass is not expected to be significantly impacted as the majority of suitable habitat falls within areas not being directly impacted by surface works. However, minor hydrological (groundwater) changes as a result of tunnelling are likely in nearby wetlands where the species is known to occur (such as Bolin Bolin Billabong). However, based on detailed groundwater modelling, these impacts would likely be relatively minor in the context of natural seasonal and annual variation in water depth (drawdown of 0.1 to 0.5 metres at Bolin Bolin Billabong, and mounding of 0.1 to 0.5 metres at Trinity Grammar wetland D). Any removal of habitat at Trinity Grammar wetlands B would likely have a minor effect on the species, if indeed it still persists at this wetland.

Threatened ecological communities within the project boundary

EPBC Act-listed communities

Of the five EPBC Act-listed communities listed as potentially occurring within the project boundary, three were considered to not occur within the project boundary following site assessments:

- Natural Damp Grassland of the Victorian Coastal Plains
- Natural Temperate Grassland of the Victorian Volcanic Plain
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

For these communities, none of the EVCs associated with these EPBC Act-listed communities were recorded during field assessments of the project boundary and/or the project boundary did not support the biogeographical characteristics of these communities. These communities were therefore not considered further.

The remaining two communities, *Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* and *Grassy Eucalypt Woodland of the Victorian Volcanic Plain*, were considered further, owing to the presence of potentially suitable habitat within the project boundary. The presence or otherwise of these communities is discussed further below.

Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains

Seasonal Herbaceous Wetlands occur on the lowland plains of Victoria. The ecological community is limited to plains and lower slopes or stony rises at elevations below 500 metres above sea level. The soils on which the Seasonal Herbaceous Wetlands occur are generally fertile but poorly draining clays of various geologies (TSSC, 2012).

The community occurs on seasonally-filled drainage lines or depressions, sometimes poorly defined, that are variously categorised as isolated closed or endorheic systems.
Their inundation is typically seasonal. Inundation is not dependent on connections to riverine systems but is fed by local rainfall. There may be some groundwater influence that contributes to retention of the water in wetlands and persistence of wetland flora when climatic conditions are dry (TSSC, 2012).

The vegetation is generally treeless and dominated by an herbaceous ground layer, often with a considerable graminoid component. The herbaceous species present are characteristic of wetter sites and most of them are typically absent or uncommon in any adjoining dryland grasslands and woodlands. The type of wetland vegetation present is variable, but is often strongly represented by native species that are rooted in the soil and are emergent (shoots rising well above the water level) or have leaves floating on the water surface. The dominant plants present are subject to seasonal and site conditions, and the diversity of the flora may range from relatively species-poor to species-rich composition (TSSC, 2012).

In the vicinity of North East Link, two areas of Yarra River floodplain wetlands (Bolin Bolin Billabong and Banyule Swamp/Warringal Parklands) occur in landscapes potentially associated with Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Field surveys did not identify Seasonal Herbaceous Wetlands at either of the locations identified above.

Within the Banyule Flats and Warringal Parklands area exists an important remnant of relatively intact geomorphology, including the Banyule Swamp in the north-west and the Banyule Billabong, a large section of old river course, in the south-west; and various other apparently natural depressions. The Warringal Parklands has been significantly modified with the filling and levelling of the floodplain for sporting ovals, with the Warringal Swamp being retained.
As wetlands in this area are primarily influenced by riverine processes and overbank flooding, they cannot support the Seasonal Herbaceous Wetlands community (TSSC, 2012).

Bolin Bolin Billabong is a regionally significant floodplain wetland, with largely intact riparian vegetation, but with considerable weed infestation. The greatest threat to the ecological values of the billabong appears to be the lack of hydrological connectivity with the Yarra River, resulting from increasingly rare overbank flows. Habitat hectare assessments revealed the vegetation is primarily Floodplain Riparian Woodland of the Gippsland Plain that does not meet the Seasonal Herbaceous Wetlands criteria set out by TSSC (2012).

Grassy Eucalypt Woodland of the Victorian Volcanic Plain

Grassy Eucalypt Woodland of the Victorian Volcanic Plain (VVP) was identified to have some potential to occur in the study area. Although unlikely to occur within much of the study area, a patch of Grassy Eucalypt Woodland of the Victorian Volcanic Plain occurs along the Metropolitan Ring Road in a small patch (approximately 1.5 hectares) that occurs between Enterprise Drive and the M80 Ring Road as shown in Plate 6.2. The site is characterised by a large, open canopy of mature River Red Gum. While the understorey lacks much of the shrubby mid-layer described in the community description, there is a high cover of native graminoid species including Wallaby Grasses, Kangaroo Grass, and Mat Rush *Lomandra* spp. There is a relatively low cover of native forbs but the community description allows for considerable variance in understorey composition.

a. Patch north-west of project boundary

b. Patch north-west of project boundary.

Plate 6.2 Patch of Grassy Eucalypt Woodland of the Victorian Volcanic Plain

This site has been designated as a no-go zone for North East Link to avoid potential impacts on this community.

6.3 Whole of environment in and around Commonwealth land

6.3.1 Desktop assessment results

Protected Matters Search Tool

The results of the Protected Matters Search Tool (PMST) presented in Section 6.2.1 include all Commonwealth land considered for North East Link.

Victorian Biodiversity Atlas

Within a 500-metre buffer surrounding Commonwealth land, 203 flora species have been recorded (VBA), with all these except one recorded since 1987. Most of these species are introduced (110), while 91 native species are recorded.

Two species—Giant Honey-myrtle (*Melaleuca armillaris* subsp. *armillaris*) and Sallow Wattle (*Acacia longifolia* subsp. *longifolia*)—are recorded within the area and are native but are not considered remnant or natural in setting. Giant Honey-myrtle is listed as rare under the DELWP-administered Advisory List but is not indigenous to the Melbourne area, occurring naturally in Victoria in East Gippsland only.

Three species identified for the 500-metre buffer are classified as threatened, one of which is listed as Endangered under the EPBC Act, as listed in Table 6-4.

Table 6-4 Threatened flora recorded within 500 metres of Commonwealth land (VBA)

Common name	Scientific name	EPBC	FFG	DELWP
Matted Flax-lily	*Dianella amoena*	EN	L	en
Arching Flax-lily	*Dianella longifolia* var. *grandis*			vu
Studley Park Gum	*Eucalyptus X studleyensis*			en

Ecological Vegetation Classes (modelled and present)

Based on the DELWP NatureKit EVC modelling, there is potential for up to three EVCs to be present within the study area on Commonwealth land. These EVCs and their Bioregional Conservation Status (BCS) in the Gippsland Plain/Highlands – Southern Fall bioregion are listed in Table 6-5.

Table 6-5 EVCs modelled to occur on Commonwealth land

EVC	Bioregion	Bioregional Conservation Status
Grassy Dry Forest (22)	Highlands – Southern Fall	Least Concern
Plains Grassy Woodland (55)	Gippsland Plain	Endangered
Creekline Grassy Woodland (68)	Gippsland Plain	Endangered

FFG communities

None of the FFG communities listed as threatened under the FFG Act occur on Commonwealth land.

6.3.2 Site assessment results

The Commonwealth land within the project boundary (Simpson Barracks and the War Services easement) is located within the Gippsland Plain bioregion.

Simpson Barracks

Vegetation

Simpson Barracks is characterised by gently undulating terrain with a ridgeline through the centre of the site, and the headwaters of Banyule Creek in the west. The site supports Defence infrastructure such as administrative and accommodation facilities, training buildings and outdoor training areas, as well as areas of some relatively large patches (up to ~30 ha) of native vegetation (Jacobs, 2016). Land use immediately adjacent to the base is predominantly urban in nature.

Simpson Barracks is within a locality that is considerably urbanised and fragmented as a result of historical land clearance. Aerial imagery from 1945 (Figure 6-2) shows the entire area, including Simpson Barracks, Banyule Creek and Banyule Creek, was cleared of most large trees and habitats prior to 1945. This provides important historical context for the ecological assessment of the area.

The ecological values of Simpson Barracks have been extensively studied in recent decades, so much is known about the vegetation of the Barracks.

The Barracks is situated on fertile soils that support Plains Grassy Woodland with a moderately species rich grassy and herbaceous ground layer (Jacobs, 2016; HLA, 2007). In areas supporting native vegetation, the understory generally consists of a few sparse shrubs over a relatively species-rich grassy and herbaceous ground layer (Jacobs, 2016).

The western section of Simpson Barracks which North East would traverse contains a relatively large area of remnant woodland, particularly large for this part of otherwise urbanised Melbourne. Most of the area is Plains Grassy Woodland (EVC 55), with small areas of Creekline Grassy Woodland (68) along Banyule Creek south of Simpson Barracks (but north of Lower Plenty Road). According to aerial imagery, very few large trees were present in this area in 1945 (Figure 6-2). The trees were mostly small, which suggests the majority were regrowth then, although a number of large individuals were present in 1945 and remain today.

The Plains Grassy Woodland within the western part of Simpson Barracks is dominated by River Red Gum (*Eucalyptus camaldulensis*). Understorey composition and density varies across the site, generally containing a mid-storey shrubby layer including *Acacia* species, Tree Violet *Melicytus dentatus* and Common Cassinia *Cassinia aculeata*, and a grass cover typically including common species such as Kangaroo Grass *Themeda triandra*, Wallaby-grass species *Rytidosperma* spp. And Tussock Grass *Poa* spp. Weed cover varies greatly and includes high threat species such as African Box-thorn *Lycium ferocissimum*, Serrated Tussock *Nassella trichotoma* and Agapanthus *Agapanthus praecox* subsp. *Orientalis*. Litter and coarse woody debris are present, but not abundant.

The eastern section of Simpson Barracks, outside the project boundary, was also found to be dominated by Plains Grassy Woodland (EVC 55), with small areas of Creekline Grassy Woodland (68), but the area differs in habitat characteristics from the western area. The eastern area typically consists of a mixed-eucalypt overstorey, comprising Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx*, and Narrow-leaf Peppermint *E. radiata.* Understorey composition and density varies across the habitat zones. The shrubby mid-storey consists of species such as Acacia species *Acacia* spp., Victorian Christmas Bush *Prostanthera lasianthos* and Common Cassinia *Cassinia aculeata*. Historical aerial imagery of this eastern section shows a similar pattern to the western section, with very few large trees present in 1945 (Figure 6-2) and most trees being relatively small, and likely to be regrowth.

Overall, Simpson Barracks contains a range of significant environmental values including Commonwealth and Victorian listed flora and several Ecological Vegetation Classes.
A summary of several ecological assessments conducted across the entire Simpson Barracks site includes:

- 52.5 hectares of remnant vegetation mapped
- 192 flora species recorded, including 92 indigenous and 100 exotic species
- One nationally-listed species (Matted Flax-lily) and one state-listed species (Studley Park Gum) observed.

Within the area that North East Link would impact at Simpson Barracks, the current study mapped three patches of native vegetation (10.976 hectares; 6.29 habitat hectares), 34 large trees in patches and 17 scattered trees (five large, 12 small). The area within Simpson Barracks that intersects with the project boundary comprises Plains Grassy Woodland (EVC 55).

Of particular importance within the Barracks are:

- A significant population of Matted Flax lily *Dianella amoena* (Commonwealth and Victorian listed)

- A small population of Arching Flax-lily *Dianella longifolia* var. *grandis* (DELWP, vulnerable)
- A significant population of Studley Park Gum *Eucalyptus X studleyensis* (DELWP, endangered).

Ecological values mapped within Simpson Barracks are presented in Figure 6-3.

Figure 6-2 Aerial imagery of Simpson Barracks comparing landscape condition in 1945 and current period (1945 imagery from https://1945.melbourne)

Paper Size A4

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Project Boundary
- surface impact
- Simpson Barracks Boundary

Vegetation Assessed
- Creekline Grassy Woodland (66)
- Plains Grassy Woodland (55)
- Amenity planting

- Large trees in patches
- Large scattered trees
- Small scattered trees

- Matted Flax-lily (Defence 2006)
- Matted Flax-lily (HLA 2007)
- Matted Flax-lily (Jacobs 2016)

- Studley Park Gum (HLA 1998)
- Studley Park Gum (HLA 2007)
- Studley Park Gum (Jacobs 2016)

- Matted Flax-Lily Patch (AECOM/GHD 2017)

- Matted Flax-lily (AECOM/GHD 2019)
- Arching Flax-lily (AECOM/GHD 2017)

- Stream
- Drain/channel/ot...
- Lake
- Studley Park Gum tree (GHD 2019)

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	16 Aug 2019

Summary of vegetation assessments at Simpsons Barracks Figure 6-3

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_6_3_Summary_of_Vegetation_Assessment_Simpsons_Barracks_A4L_Rev5.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: CIP Imagery - DELWP - 2018, Roads, Watercourse - VicMap - 2018 (Threatened Flora - HLA, Defence, Jacobs - 1998-2018 (Trees, Matted Flax-lily, Arching Flax-lily, Project boundary - AECOM, GHD, 2018.

Threatened species

Matted Flax-lily Dianella amoena (EPBC, endangered; FFG, listed; DELWP, endangered)

A population of Matted Flax-lily occurs at Simpson Barracks and has been documented as a 'significant population' on the National Recovery Plan for the species (Carter, 2010).

Jacobs (2016) counted 603 ramets (an individual within a clonal colony) across Simpson Barracks during their survey. This result indicates that Simpson Barracks supports one of the larger sub-populations of Matted Flax-lily in the Melbourne metropolitan area.

Matted Flax-lily was identified on the eastern and western sides of the base, with the greatest proportion of the population (87 per cent or 60 locations) occurring on the eastern side of the base (Jacobs, 2016).

Previous field surveys undertaken by HLA and Kinhill have also identified Matted Flax-lily on-site. Kinhill (2000, in HLA, 2007) conducted surveys during the recommended spring survey period (between November 1998 and January 1999) and reported at least 72 individuals.

On the western side of Simpson Barracks, the current study identified 83 individuals within the project boundary. An additional 188 plants/patches have been observed east of the project boundary (and west of the 'long green') and in the large remnant on the eastern side of Simpson Barracks.

The survey results for Matted Flax-lily within the whole project boundary have been described above in Section 6.2.2.

Studley Park Gum Eucalyptus X studleyensis (DELWP, endangered)

Studley Park Gum is classified as endangered under the DELWP Advisory list and is a hybrid between River Red Gum *Eucalyptus camaldulensis* and Swamp Gum *E. ovata.* It is morphologically variable and is distributed in the lower Yarra River corridor in Melbourne, primarily in the suburbs of Kew, Ivanhoe, Viewbank, Rosanna, Macleod, Watsonia, Yallambie, Plenty and Templestowe. Almost all records are concentrated within the metropolitan area to the north and north-east of Melbourne; however, two reliably determined specimens are also known from Nar Nar Goon south-east of Melbourne (VBA) and Connewarre on the Bellarine Peninsula (VBA). Site records in the Victorian Biodiversity Atlas, herbarium records and field observations (K. Rule, pers. comm.; D. Cameron, DELWP, pers. comm.) indicate the taxon also occurs near Clayton North, at Lysterfield Park and between Carrum Downs, Hampton Park and Lyndhurst to the south-east of Melbourne, and at Riddells Creek to the north-west of Melbourne. The sites within the Yallambie-Macleod-Rosanna area are thought to be the fragmented remnants of larger pre-settlement populations (Cameron *et al.,* 1999). Individuals are generally intermediate between the two eucalypt species, with leaf, bud and fruit characters often showing a greater affinity to either parent in one or more of those characters (Maiden, 1922).

The taxon is one of eight described *Eucalyptus* hybrids formally accepted by the National Herbarium of Victoria. It is also one of two named intersectional Victorian hybrids in the genus, the other being *Eucalyptus X oxypoma*. Hybrids between distantly related parents are highly significant for their potential contribution to evolutionary novelty and speciation if they are also fertile and form hybrid swarms in the wild. When they are also observed to display niche differentiation in relation to the parent populations, they are at lower risk of introgression by either parent and therefore have the greatest potential to become incipient hybridogenous taxa and eventually stabilise to become distinct new species. *Eucalyptus X studleyensis* is

the only Victorian eucalypt hybrid which has been demonstrated to combine all these qualifying characteristics[8].

An analysis of the VBA indicates that 26 discrete records of Studley Park Gum are present across the greater Melbourne area, with some of these records likely to be re-sampling of the one population at different times. It should also be noted the accuracy, reliability, currency and population size of these records is likely to be variable.

Previous studies within the project boundary

A report by Cameron *et al*., (1999) detailing the ecological values of the Streeton Views Estate, which lies immediately east of Simpson Barracks, provides important supplementary information regarding the distribution and status of known locations for this taxon.

Although the report is 20 years old, it provides the best available information regarding the taxonomic status and distribution of Studley Park Gum. Since the draft PER was published, NELP has undertaken further field surveys to better understand the prevalence of the species at Simpson Barracks. The result of these field surveys is presented in the 'results' section below.

At part of the Streeton Views report, Cameron *et al.* (1999) investigated the 28 reported sites of Studley Park Gum that were known at the time. As a result of the Cameron *et al.* (1999) investigation, the following information is worth noting with respect to *E. Xstudleyensis*:

- Simpson Barracks site east of Greensborough Road was reported to support the most extensive hybrid swarm of *Eucalyptus Xstudleyensis*, including at least 53 established trees and numerous juveniles
- A population located immediately east of Simpson Barracks at Stage 11 of the Streeton Views Estate (117 hybrid individuals), and including the adjacent Commonwealth reserve and transmission line easement south-west of Streeton Views Estate Stage 11, is also ecologically important (note: this is regarded as two sites in the 1999 report)
- A population at the Plenty Hospital site in Macleod supports a modest population of highly introgressed hybrids
- A further 11 sites support one or more confirmed occurrences of the taxon; however, recruitment opportunities are either greatly impaired or lost
- Investigation at a further 11 sites indicated the taxon was previously misidentified and does not occur at these sites
- The status of the taxon at a further two sites was unable to be confirmed.

Studley Park Gum has been historically recorded within the project boundary at Banyule Flats (Practical Ecology, 2017b) and at Simpson Barracks (Jacobs, 2016; HLA, 2007). It has also been recorded adjacent to the eastern boundary of Simpson Barracks as part of the Streeton Views Estate planning approvals process (Cameron *et al.,* 1999).

Surveys by Jacobs (2016) identified two sub-populations: a Red Gum-biased sub-population and a Swamp Gum-biased sub-population. Both sub-populations were reported to support one pure stand of individuals of varying size classes as well as scattered individuals, indicating reproductive success has occurred in the recent and distant past. The River Red Gum-biased sub-population was located on the western portion of the site, on a slight rise to the north of the Greensborough Highway pass office and adjacent to Greensborough Highway. The Swamp Gum-biased sub-population was located on the flatter areas south of the River Red Gum sub-population. The population occurred in woodland vegetation dominated by a Yellow Box canopy with occasional Swamp Gums present (Jacobs, 2016).

[8] Text extracted from RAMAS treatment of taxon (under IUCN Red List criteria) by David Cameron (DELWP), 26 February 2019.

Results

After the publication of the draft PER, NELP undertook further field surveys within Simpson Barracks for the Studley Park Gum. Further investigation found that in Simpson Barracks, Studley Park Gum was sub-dominant to *E. camaldulensis* on low relief mid to lower slopes in Plains Grassy Woodland east of Greensborough Road. Relatively low numbers of *E. ovata* were observed during the survey but in most cases a single individual or a small number of mature individuals were in reasonably close proximity to Studley Park Gum trees.

During surveys conducted as part of the North East Link project, a total of 46 individuals of Studley Park Gum were recorded and mapped within the project boundary as follows:

- 44 trees at Simpson Barracks directly impacted:
  - *Identification reliability* – 71% of these trees were identified with a moderate to high level of confidence, while 29% had low confidence due to the unavailability of fertile material (ie fruits, buds)
  - *Condition* – 89% of these trees were in good condition
  - *Size* – 21% (5<25 cm DBH); 60% (25<80 cm DBH); 19% (80+ cm DBH, ie defined as a large tree according to DELWP Plains Grassy Woodland EVC benchmark for the Gippsland Plain bioregion)
- Two trees at Watsonia Station directly impacted (identification reliability, condition, size were not assessed)
- It should be noted that the total of 46 trees does not include juveniles, owing to the inherent difficulty in positively identifying juvenile individuals of Studley Park Gum.

In addition, the survey of Studley Park Gum was extended outside of the project boundary, and identified a further 83 trees at Simpson Barracks. The following Studley Park Gum trees outside the project boundary may be indirectly impacted by groundwater drawdown associated with tunnel construction (based on further groundwater modelling, see Section 9 for further information):

- Nine trees at Simpson Barracks indirectly impacted by groundwater drawdown temporarily in the short-term (2024 construction scenario); however, it should be noted that mitigation measures such as watering would be implemented to avoid premature mortality or condition decline due to tunnel construction.
- Three of these trees at Simpson Barracks may be indirectly impacted by groundwater drawdown in the long-term (2075 operational scenario).

It should be noted that due to the complexities in accurately identifying the taxon, all previous records within the project boundary at Simpson Barracks have been disregarded.

Arching Flax-lily Dianella longifolia var. grandis (DELWP, vulnerable)

Arching Flax-lily is classified as vulnerable under the DELWP Advisory list. This species is a perennial graminoid, to 1.3-metre tall growing in solitary tufts or loose patches. Following urban expansion, many of the remaining populations of this species are very small and fragmented in Victoria, where it is mainly concentrated in the Volcanic Plains and Riverina.

Two individuals were observed in moderate to good quality Plains Grassy Woodland on the western side of the site during field assessments at Simpson Barracks.

Ecological Vegetation Classes

During field surveys, one EVC was recorded on Commonwealth land:

- Plains Grassy Woodland (EVC 55).

Plains Grassy Woodland (EVC 55)

Simpson Barracks contains approximately 10.976 hectares of Plains Grassy Woodland within the project boundary. The dominant overstorey species of this EVC was River Red Gum. Understorey composition, diversity and condition varied across the site. Generally, the EVC contained a mid-storey shrub layer including Wattle *Acacia* species, Tree Violet *Melicytus dentatus*, Common Cassinia *Cassinia aculeata* and eucalypt saplings. Native grass cover varied across the site but generally ranged from 15–40 per cent. The grassy assemblage typically included common species such as Kangaroo Grass *Themeda triandra*, Wallaby-grass *Rytidosperma* spp., Weeping Grass *Microlaena stipoides*, Common Wheat-grass *Anthsachne scabra* and Common Tussock-grass *Poa sieberiana*.

The eastern section of the Plains Grassy Woodland is dominated by Yellow Box *Eucalyptus melliodora* with sub-dominant canopy species including Studley Park Gum and Long-leaf Box *E. goniocalyx*. The understorey is sparse and open, with a species-rich grassy and herbaceous ground layer, including Weeping Grass and Kangaroo Grass as the dominant cover. Several herbaceous and woody indigenous species occur at ground level, including Wattle Mat-rush *Lomandra filiformis*, Common Rice-flower *Pimelea humilis*, Chocolate Lily *Arthropodium strictum*, Matted Flax-lily, Creeping Bossiaea *Bossiaea prostrata* and Sheep's Burr *Acaena echinata* (HLA, 2007).

Vegetation within this EVC at Simpson Barracks has the potential to support Clover Glycine (though none was identified during field surveys) and is known to support Matted Flax-lily, Arching Flax-lily and Studley Park Gum, as discussed above.

Threatened ecological communities

The Plains Grassy Woodland (EVC 55) that exists within Simpson Barracks was investigated for its potential to be considered Grassy Eucalypt Woodland of the Victorian Volcanic Plain. While the vegetation present on site comprised open woodland with a grassy understorey, which resembles some of the structural characteristics of Grassy Eucalypt Woodland, the geology of the site was sandstone and not volcanic in origin. Therefore, since Grassy Eucalypt Woodland is 'specifically limited to the extensive Quaternary basalt plain of south-western Victoria' (as per the listing advice), it was concluded the woodland at Simpson Barracks is not Grassy Eucalypt Woodland of the Victorian Volcanic Plain.

Weeds

Species presented in Table 6-6 are weeds observed in the field that are either Weeds of National Significance (WoNS) or declared under Victoria's *Catchment and Land Protection Act 1994* (CaLP).

Table 6-6 Declared weeds present at Simpson Barracks

Scientific name	Common name	CaLP	WoNS
Allium triquetrum	Angled Onion	Restricted	No
Asparagus asparagoides	Bridal Creeper	Restricted	Yes
Chrysanthemoides monolifera subsp. *monolifera*	Bonseed	Regionally controlled	Yes
Cirsium vulgare	Spear Thistle	Regionally controlled	No
Echium plantagineum	Paterson's Curse	Regionally controlled	No
Foeniculum vulgare	Fennel	Restricted	No

Scientific name	Common name	CaLP	WoNS
Hypericum perforatum subsp. *veronense*	St John's Wort	Regionally controlled	No
Nassella neesiana	Chilean Needle-grass	Restricted	Yes
Nassella trichotoma	Serrated Tussock	Regionally controlled	Yes
Oxalis pes-caprae	Soursob	Restricted	No
Rosa rubiginosa	Sweet Briar	Regionally controlled	No
Rubus fruticosus spp. agg.	Blackberry	Regionally controlled	Yes
Ulex europaeus	Gorse	Regionally controlled	Yes

War Services easement

The War Services easement comprises slashed non-native grassland, with the western edge of the site crossed by a shared use path and timber wall. It contains four isolated trees on the boundary with the residential properties and some minor amenity planting near the timber wall.

6.3.3 Groundwater dependent ecosystems

A full overview of the hydrogeology within the project boundary and immediate environs within the study area is outlined in PER Technical Appendix B – Groundwater. Of greatest importance to GDEs in the study area and their reliance upon groundwater is the modelled depth to groundwater. Modelled depth to groundwater is the water level that has been generated through a numerical model (that is, applying rainfall to the model and checking against a number of points from the North East Link groundwater monitoring network). In addition, modelled groundwater drawdown provides an indication of the extent of groundwater drawdown across the study area, using construction methods (such as tanking scenario) as outlined in PER Technical Appendix B – Groundwater.

Further numerical groundwater modelling was undertaken following the publication of the draft PER. The purpose of further modelling was to incorporate additional groundwater data collected over a period of approximately 12 months to enable transient calibration to seasonal variations in groundwater levels and to assess whether or not the additional calibration efforts result in changes to the assessment of project-induced groundwater impacts. The further groundwater modelling is detailed in the *Report on Additional Groundwater Modelling, July 2019* which is an appendix to PER Technical Appendix B – Groundwater.

The surface of the water table simulated by the further modelling is informed by a larger number of data points (greater spatial spread of data), with recalibration resulting in a higher estimate of recharge and modifications to the distribution of hydraulic conductivity in the bedrock (where data were previously absent). The net effect is a slightly broader area of drawdown predicted temporarily during construction (2024 scenario) over the northern portion of the alignment when the aquifer is depressurised, eg broader extent of one to two metre drawdown contour where the recalibrated model indicates slightly higher hydraulic conductivity. Over the long term (2075 scenario), once the cut and cover excavations are sealed and made water tight, the piezometric heads begin recovery. The further groundwater modelling predicts that long term drawndown will be less compared to the initital predictions, primarily due to higher calibrated recharge.

It is noted that the revised groundwater modelling is conservative since it assumes that the base slabs for the trench through Simpson Barracks are not placed until the end of construction. In reality, base slabs would typically be placed more gradually, allowing for some partial recovery of groundwater levels earlier on during construction.

Terrestrial woodland interaction with groundwater

Access to, and demand for, groundwater in terrestrial woodlands varies between species and temporal scales and is shaped by rainfall patterns, temperature, the frequency and duration of flooding events, soil type, and species position in the landscape (Zencich *et al.*, 2002; Senior, 2018). Groundwater is usually accessed directly through a tap root, via the capillary fringe or vadose zone, located just above the water table (Eamus *et al.*, 2006b), but can also be accessed directly from the saturated zone below the water table. Expansion of rooting depth has the potential to draw on the water table indirectly via the capillary effect and from the moist soil directly above the water table, to either sustain transpiration and/or growth through a dry season (Eamus *et al.*, 2015; Hatton & Evans, 1998) but scant information exists regarding rooting depth of eucalypts.

Certain species have the ability to actively manage their groundwater dependency, such as deep-rooted perennials found within terrestrial woodlands (such as River Red Gum).
The available evidence suggests that River Red Gum roots can penetrate to 10 metres (Davies, 1953) and potentially deeper but this evidence comes from floodplain forests rather than non-floodplain trees (such as on slopes). Kath *et al.* (2014) determined that River Red Gum condition on floodplains deteriorated significantly when a groundwater depth threshold was reached (12 to 22 metres depending on the model used). This conclusion supported earlier work that proposed groundwater depth thresholds for River Red Gum of 12 to 15 metres on Murray River floodplain forests (Horner *et al.,* 2009) and 13 to 16 metres for the upper Condamine floodplain (Reardon-Smith, 2011), whereby trees dependent on groundwater would suffer significant declines in condition or premature mortality when groundwater levels moved below these ranges. It should be noted the evidence presented by Kath *et al.* (2014) strongly suggests that decline in tree health was threshold related, rather than displaying a linear trend of decreasing condition with decreasing groundwater level.

River Red Gums have the ability to rapidly increase root depth and establish extensive root systems (Bacon *et al.*, 1993) following a decline in water table depth during dry periods (summer), and contract their root system in wetter periods (winter) in response to increased water availability (Canham *et al.*, 2012). However, if a groundwater depth threshold is reached, whereby tree roots are no longer able to access available soil moisture, tree condition is likely to deteriorate and trees may suffer premature death. Flow-on effects of population failure in a dominant tree species may then result in altered community composition and structure, and potential cascading effects in avifauna communities (Kath *et al.,* 2014).

It should be noted that most studies on groundwater-tree condition relationships are undertaken in riparian and floodplain environments. However, River Red Gum is a widely distributed species that frequently occurs in floodplain and foothills landscapes, where depth to groundwater can differ by more than an order of magnitude. While the threshold response principle is likely to remain between both environments, the depth to groundwater and degree of dependency (if any) is likely to differ between River Red Gums occurring in the floodplain and the non-floodplain (slopes) environments of the study area. Also, in the absence of studies on other species, for the purpose of this assessment it is assumed that Studley Park Gum behaves in a similar manner to River Red Gum, especially given it is a hybrid between River Red Gum and Swamp Gum.

Simpson Barracks

At Simpson Barracks, the headwaters of Banyule Creek are mapped as a GDE relying on the surface expression of groundwater. In addition, parts of the Plains Grassy Woodland mapped at Simpson Barracks are mapped as a GDE.

Type of GDE

‘GDE – subsurface expression’ (BOM) and ‘GDE’ (PPWCMA) is mapped partly in areas supporting Plains Grassy Woodland at Simpson Barracks. The dominant tree species are River Red Gum in the lower western section closest to the project boundary, in association with Yellow Box and Studley Park Gum. These trees generally reach mature heights greater than 20 metres at Simpson Barracks.

Groundwater dependency

To determine level of groundwater dependency and potential risk to native vegetation and terrestrial GDEs at Simpson Barracks, a spatio-temporal model was developed based on: a) current groundwater depth, b) mapped GDEs and native vegetation including large trees, c) known rooting depth of eucalypts based on literature, and d) modelled groundwater drawdown under 2024 (post-construction) and 2075 (operation) scenarios.

The first step in the process was to develop a baseline vegetation layer, derived from EVC mapping undertaken during project fieldwork, DELWP EVC mapping and vegetation mapping at Simpson Barracks (HLA, 2007). This was then overlaid with mapped Bureau of Meteorology (BoM) and PPWCMA GDE layers. Current modelled groundwater levels using five-metre contour intervals (and one-metre contour levels where depth to groundwater was less than five metres) were then overlaid on top of the vegetation and GDE mapping. Fourth, a polygon was created, capturing any mapped EVCs or GDEs within the 10<20 metres groundwater depth band; this denotes the area most at risk of groundwater drawdown. Next, the modelled groundwater drawdown layer was overlaid in the following increments: 0.1<0.5 metres, 0.5<1.0 metres, 1.0<2.0 metres and 2.0<3.0 metres (there is no modelled groundwater drawdown >3.0 metres at Simpson Barracks). It should be noted that multiple scenarios were run and the 95th percentile of scenarios was used to determine drawdown levels, thus factoring conservativity into the model. Finally, level of risk of native canopy trees declining in condition or suffering premature mortality was determined according to the rationale provided in Table 6-7.

It should be noted the size threshold for determining potential impacts on trees within terrestrial GDEs was set at the EVC large tree benchmark, which for EVCs in this area (Plains Grassy Woodland EVC 55, Creekline Grassy Woodland EVC 68) is 80 centimetres DBH. Large trees were used as the threshold for two primary reasons: a) they are the trees most at risk of impact associated with groundwater drawdown, and b) removal of large trees within patches of native vegetation is an impact that needs to be offset, in accordance with the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP, 2017a). All large trees within the modelled 10<20 metres groundwater depth zone were thoroughly ground-truthed and mapped in the field.

Table 6-7 Rationale for determining risk of premature tree mortality or tree condition decline due to groundwater drawdown associated with construction of the northern tunnel portal at Simpson Barracks

Risk	Current modelled groundwater depth (m)	Modelled groundwater drawdown (m)	Rationale
Very high	15<20	2.0<3.0	• Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater • Likely that a 2.0<3.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
High	10<15	2.0<3.0	• Roots of mature trees likely to be accessing groundwater periodically • Possible to likely that a 2.0<3.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
High	15<20	1.0<2.0	• Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater • Possible that a 1.0<2.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
Moderate	10<15	1.0<2.0	• Roots of mature trees likely to be accessing groundwater periodically • Possible that a 1.0<2.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
Moderate	15<20	0.5<1.0	• Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater • Possible to unlikely that a 0.5<1.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
Low	10<15	0.5<1.0	• Roots of mature trees likely to be accessing groundwater periodically • Unlikely that a 0.5<1.0 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
Negligible	10<20	<0.5	• Highly unlikely that a 0.1<0.5 m drawdown would decrease the water table to a depth unable to be accessed by tree roots
Negligible	<10	NA	• Roots of mature trees likely to be accessing groundwater due to proximity to surface and any drawdown is unlikely to be beyond the depth able to be reached by tree roots
Negligible	>20	NA	• Roots of mature trees unlikely to be accessing groundwater

Lower slopes – depth to groundwater <10 metres

On the lower slopes of Simpson Barracks where depth to groundwater is modelled to be 10 metres or less (based on groundwater depth contours), it is assumed that River Red Gums/Studley Park Gums are accessing subsurface groundwater for at least part of the year (during summer) or during drought conditions. Groundwater drawdown in these areas is unlikely to negatively affect tree health or cause premature tree death, as the 0.1 to 3-metre modelled drawdown in 2024 and 2075 respectively respectively (both models have drawdowns within this range) is unlikely to decrease the water table to a level below that which River Red Gum/Studley Park Gum roots are able to access. Negligible impacts are therefore anticipated in these areas.

Upper slopes – depth to groundwater >20 metres

On the upper slopes of Simpson Barracks where depth to groundwater is greater than 20 metres (based on groundwater depth contours), it is assumed that River Red Gum, Studley Park Gum and Yellow Box do not access subsurface groundwater, and so trees in this zone would unlikely be impacted by any potential groundwater drawdown.

Lower to mid slopes – depth to groundwater 10<20 metres

On the lower to mid slopes of Simpson Barracks (east of the project boundary) where depth to groundwater is 10 to 20 metres (based on groundwater depth contours), it is assumed that River Red Gums/Studley Park Gums may be accessing subsurface groundwater for at least part of the year (during summer) or during drought conditions. Drawdown in these areas has a moderate to high likelihood of negatively affecting tree health or causing premature tree death at some stage between construction and 50 years post-construction. The modelled drawdown in 2024 and 2075 (up to three metres depending on scenario) may be enough to tip the groundwater depth beyond a threshold by which River Red Gum/Studley Park Gum roots are unable to access groundwater. Refer to Table 6-7 for a more detailed outline of risk of impact.

Scarred trees

Two of the large trees at Simpson Barracks are registered as scarred trees (Tree no. 7922-0584 & 7922-0585). An assessment of these trees has been undertaken in consultation with Wurundjeri Woi Wurrung Cultural Heritage Aboriginal and it has been determined the apparent scarring is not cultural in origin. A process has been initiated to have these trees removed the Victorian Aboriginal Heritage Register.

Groundwater salinity

In all areas around the northern portal, groundwater salinity is not expected to influence the impact of groundwater changes. The models predict drawdown rather than mounding, which would result in decreasing (if any) rather than increasing groundwater salinity for the trees which have facultative groundwater dependency.

Furthermore, the approach developed to ascertain numbers of trees potentially indirectly impacted by groundwater drawdown has been inherently conservative, in the sense that salinity has been disregarded in our model of potential indirect impacts to native trees. In other words, it is assumed that the trees are physiologically adapted to high levels of salinity (generally over 5000 mg/L and upwards of 9000 mg/L TDS in the barracks) and can access and utilise the groundwater when required.

War Services easement

No GDEs were identified in the War Services easement.

7. Description of the environment – fauna

This section describes the ecological environment for terrestrial fauna, as relevant to MNES and actions on Commonwealth land.

Terrestrial fauna are defined as any fauna that occur in the terrestrial environment that largely reside in the terrestrial environment for all life stages. For this assessment, amphibians are considered as terrestrial fauna, while platypus and turtles are considered as aquatic fauna (see Section 8).

7.1 PER Guidelines scope relating to terrestrial fauna

This terrestrial fauna component of the ecological assessment considers the following matters of MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Swift Parrot (*Lathamus discolor*) (critically endangered)
  - Australian Painted Snipe (*Rostratula australis*) (endangered)
  - Australasian Bittern (*Botaurus poiciloptilus*) (endangered)
  - Growling Grass Frog (*Litoria raniformis*) (vulnerable)
- Listed migratory species (Sections 20 and 20A), including:
  - Latham's Snipe (*Gallinago hardwickii*)
- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

7.2 MNES within project boundary

Sections 7.2.1 and 7.3.1 provide a summary of the results of the ecological database searches relating to terrestrial fauna. A full assessment of the likelihood of occurrence of all threatened and migratory fauna within the project boundary is provided in Appendix B and Appendix C.

7.2.1 Desktop assessment results

Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of MNES that may occur, or for which suitable habitat may occur within the associated five-kilometre buffer. Results of the PMST search are presented in Appendix D and summarised for terrestrial fauna in Table 7-1 and Table 7-2.

Table 7-1 Counts of threatened and migratory terrestrial fauna species identified by the PMST for the project boundary

Group	Threatened species	Migratory species	Total
Mammals	7	-	7
Birds	13	15	22
Reptiles	1	-	1
Amphibians	1	-	1
Invertebrates	2	-	2
Total	**24**	**15**	**33**

Table 7-2 Threatened and migratory terrestrial fauna species identified by the PMST for the project boundary

Common name	Scientific Name	EPBC	Migratory
Mammals			
Spot-tailed Quoll	*Dasyurus maculatus maculatus*	EN	
Swamp Antechinus	*Antechinus minimus maritimus*	VU	
Southern Brown Bandicoot	*Isoodon obesulus obesulus*	EN	
Greater Glider	*Petauroides volans*	VU	
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU	
Broad-toothed Rat	*Mastacomys fuscus*	VU	
Smoky Mouse	*Pseudomys fumeus*	EN	
Birds			
Plains-wanderer	*Pedionomus torquatus*	CR	
Eastern Curlew	*Numenius madagascariensis*	CR	Mi
Common Sandpiper	*Actitis hypoleucos*		Mi
Common Greenshank	*Tringa nebularia*		Mi
Curlew Sandpiper	*Calidris ferruginea*	CR	Mi
Sharp-tailed Sandpiper	*Calidris acuminata*		Mi
Red Knot	*Calidris canutus*	EN	Mi
Pectoral Sandpiper	*Calidris melanotos*		Mi
Latham's Snipe	*Gallinago hardwickii*		Mi
Australian Painted Snipe	*Rostratula australis*	EN	
Australasian Bittern	*Botaurus poiciloptilus*	EN	
Osprey	*Pandion haliaetus*		Mi
Orange-bellied Parrot	*Neophema chrysogaster*	CR	

Common name	Scientific Name	EPBC	Migratory
Swift Parrot	*Lathamus discolor*	CR	
White-throated Needletail	*Hirundapus caudacutus*		Mi
Fork-tailed Swift	*Apus pacificus*		Mi
Rufous Fantail	*Rhipidura rufifrons*		Mi
Satin Flycatcher	*Myiagra cyanoleuca*		Mi
Black-faced Monarch	*Monarcha melanopsis*		Mi
Painted Honeyeater	*Grantiella picta*	VU	
Regent Honeyeater	*Anthochaera phrygia*	CR	
Yellow Wagtail	*Motacilla flava*		Mi
Reptiles			
Striped Legless Lizard	*Delma impar*	VU	
Frogs			
Growling Grass Frog	*Litoria raniformis*	VU	
Invertebrates			
Eltham Copper	*Paralucia pyrodiscus lucida*	EN	
Golden Sun Moth	*Synemon plana*	CR	

CR – Critically endangered; EN – Endangered; VU – Vulnerable; Mi – Migratory

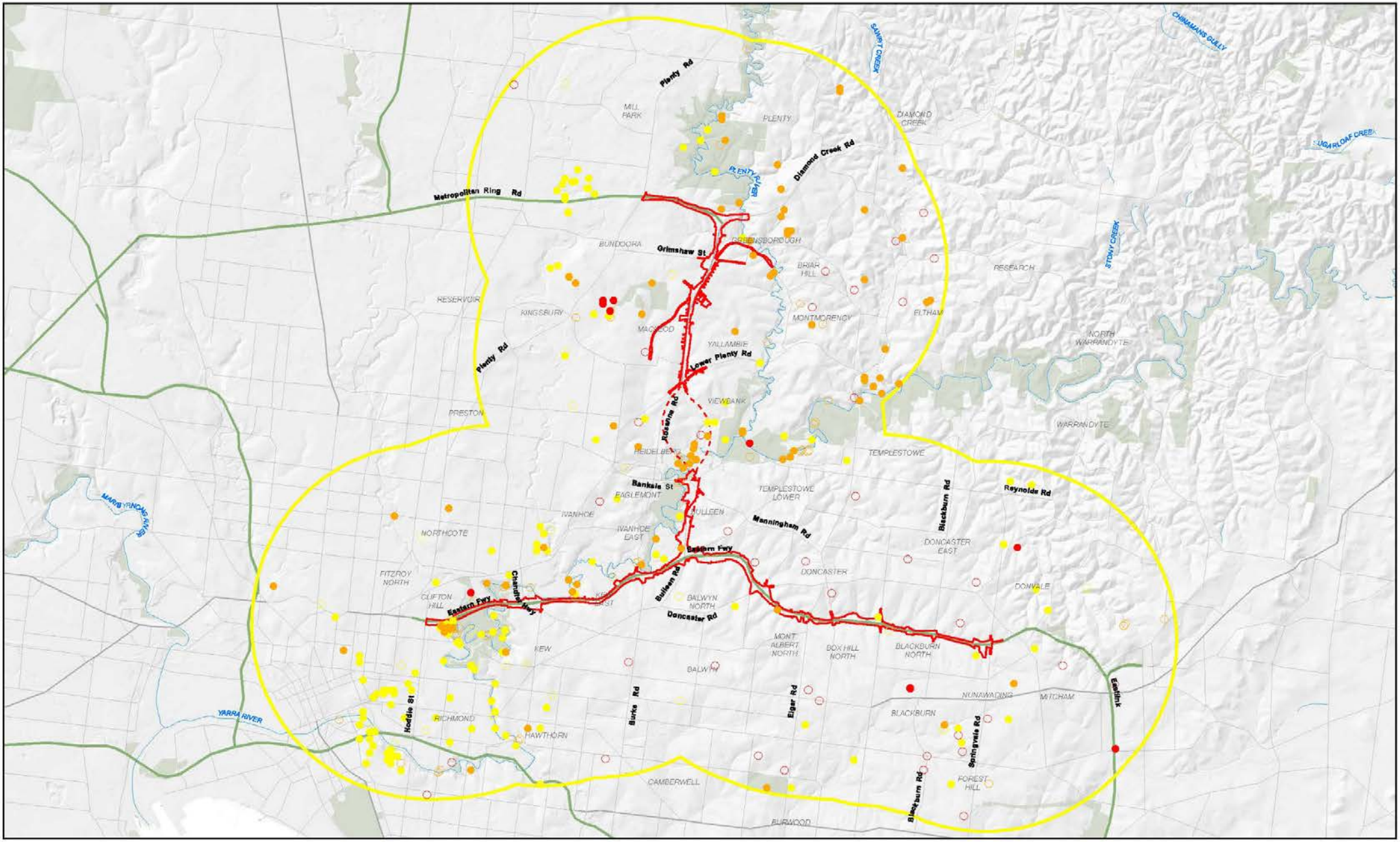
All EPBC Act-listed threatened and/or migratory fauna predicted to occur by the PMST (Appendix D) are combined with the VBA and BLA data in lists of threatened and migratory species in Appendix B and Appendix C, along with an evaluation of the likelihood of those species occurring within the project boundary.

Victorian Biodiversity Atlas and Birdlife Australia Atlas

The VBA contains records of six additional terrestrial fauna species (two mammals and four birds) listed as threatened and 10 additional species listed as migratory under the EPBC Act that were not identified by the PMST. The BLA contains no records of additional terrestrial fauna species listed as threatened under the EPBC Act, but contains records of three additional migratory species that were not identified by the PMST. All three were identified by the VBA search. All EPBC Act-listed species identified by the VBA and BLA searches, but not by the PMST search, are shown in Table 7-3. For VBA mapping for listed fauna and migratory species, see Figure 7-1 and Figure 7-2.

Of the six species listed as threatened under the EPBC Act, four have not been recorded in the five-kilometre search area since 1950, and one was last (and only once) recorded in 1976. One species (Superb Parrot) has been recorded in the Melbourne area since 1987, but that species is not considered to occur naturally within the Melbourne area – the records are likely to be of aviary escapees.

Of the 11 migratory species, five have been recorded in the five-kilometre search area since 1987, but there are no more than three records for any species.



Paper Size A4

0 970 1,940 2,910 3,880

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)

- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)

- Critically Endangered
- Endangered
- Vulnerable

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

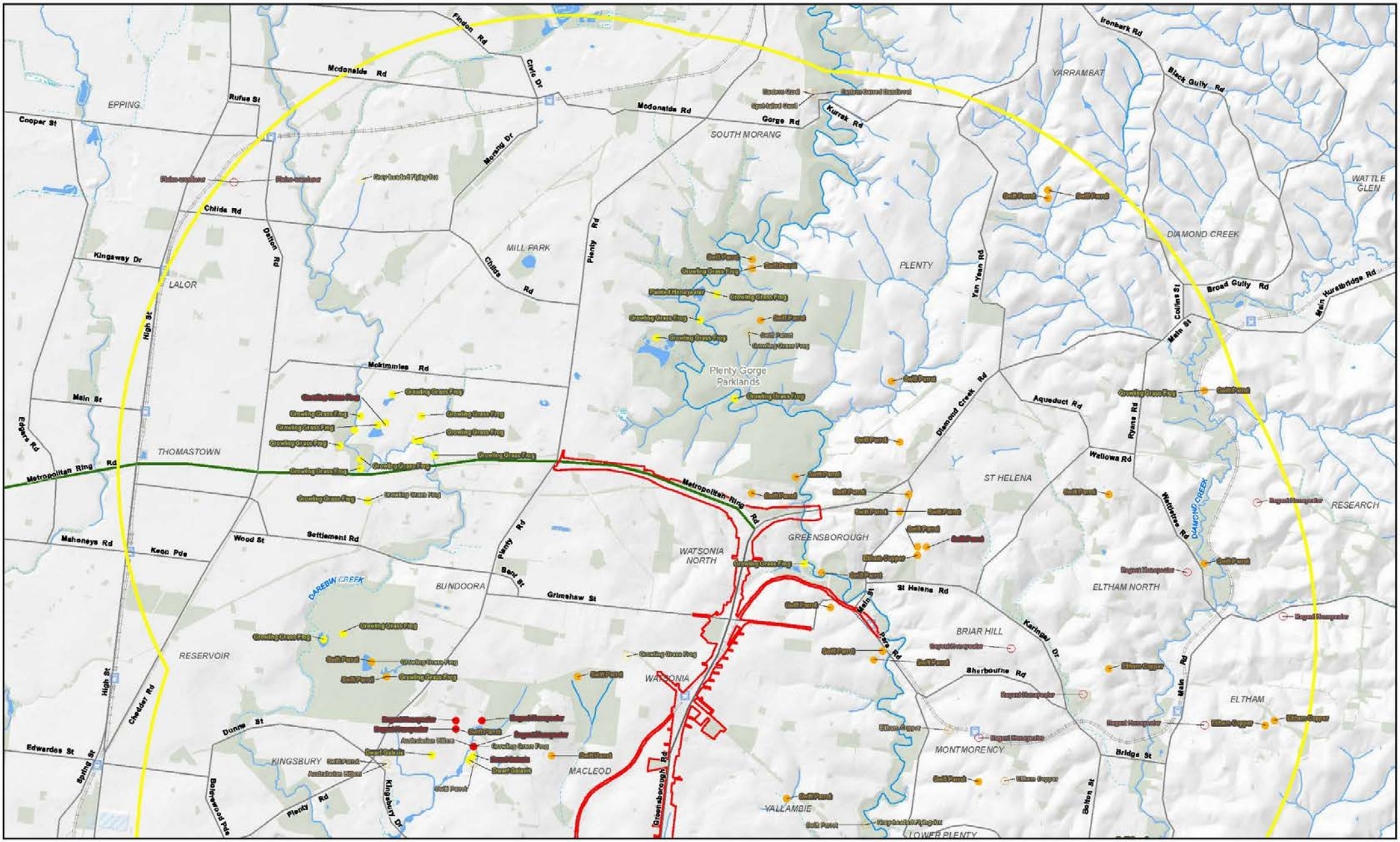
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31-35006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:bghelli

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)

- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)

- Critically Endangered
- Endangered
- Vulnerable

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

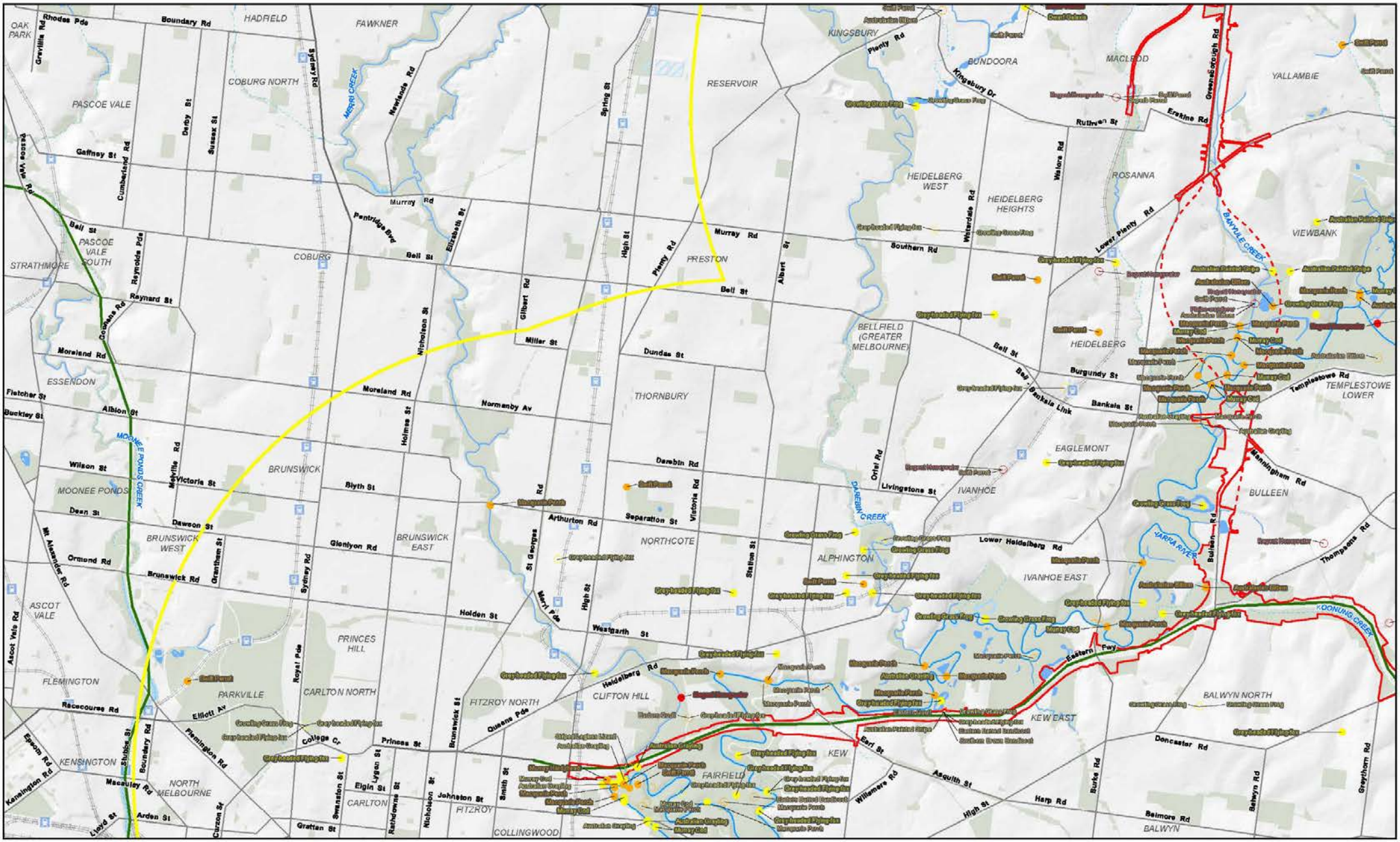
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31-35006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)

- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)

- Critically Endangered
- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

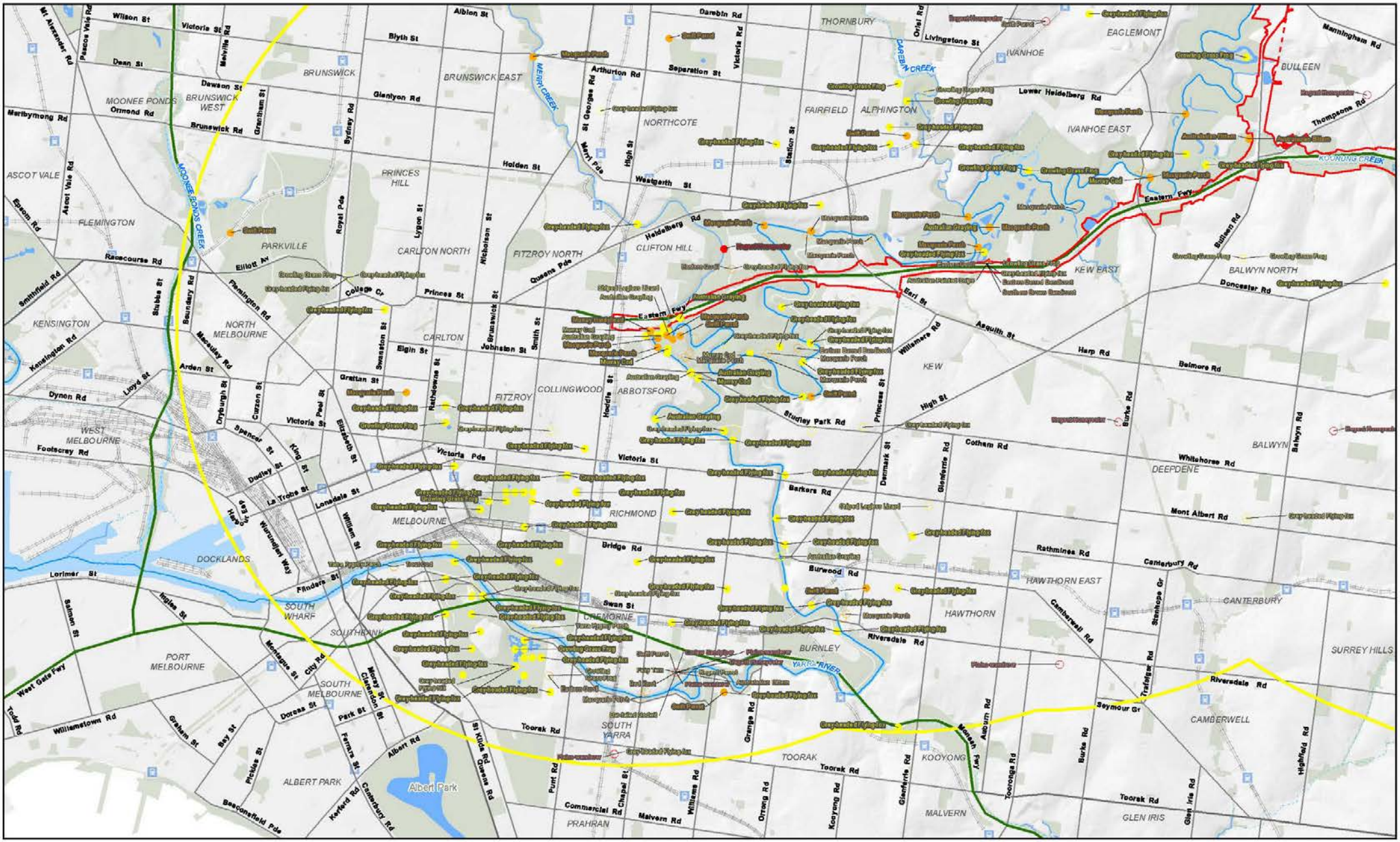
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)

- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)

- Critically Endangered
- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

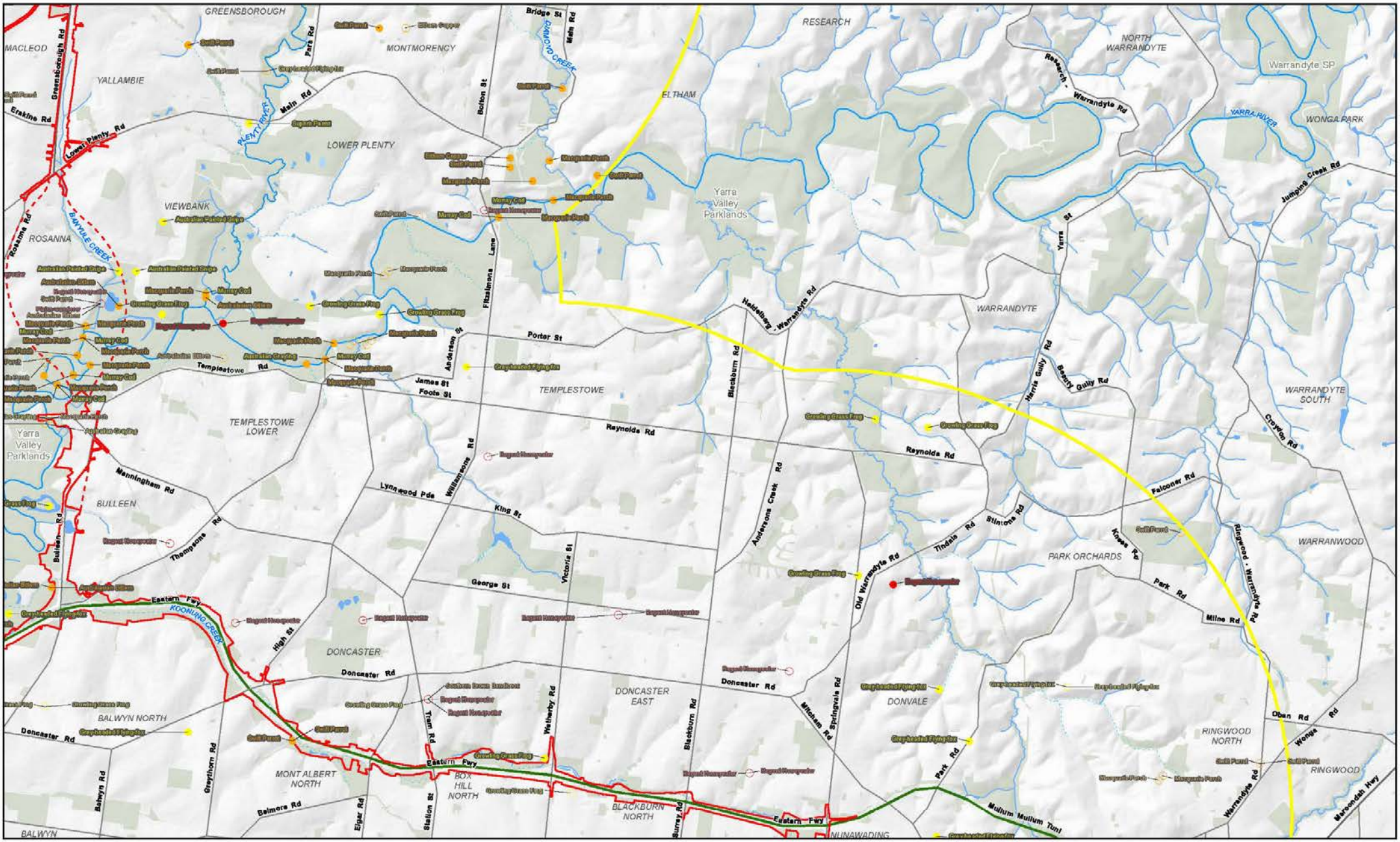
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31-35006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)

- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)

- Critically Endangered
- Endangered
- Vulnerable

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

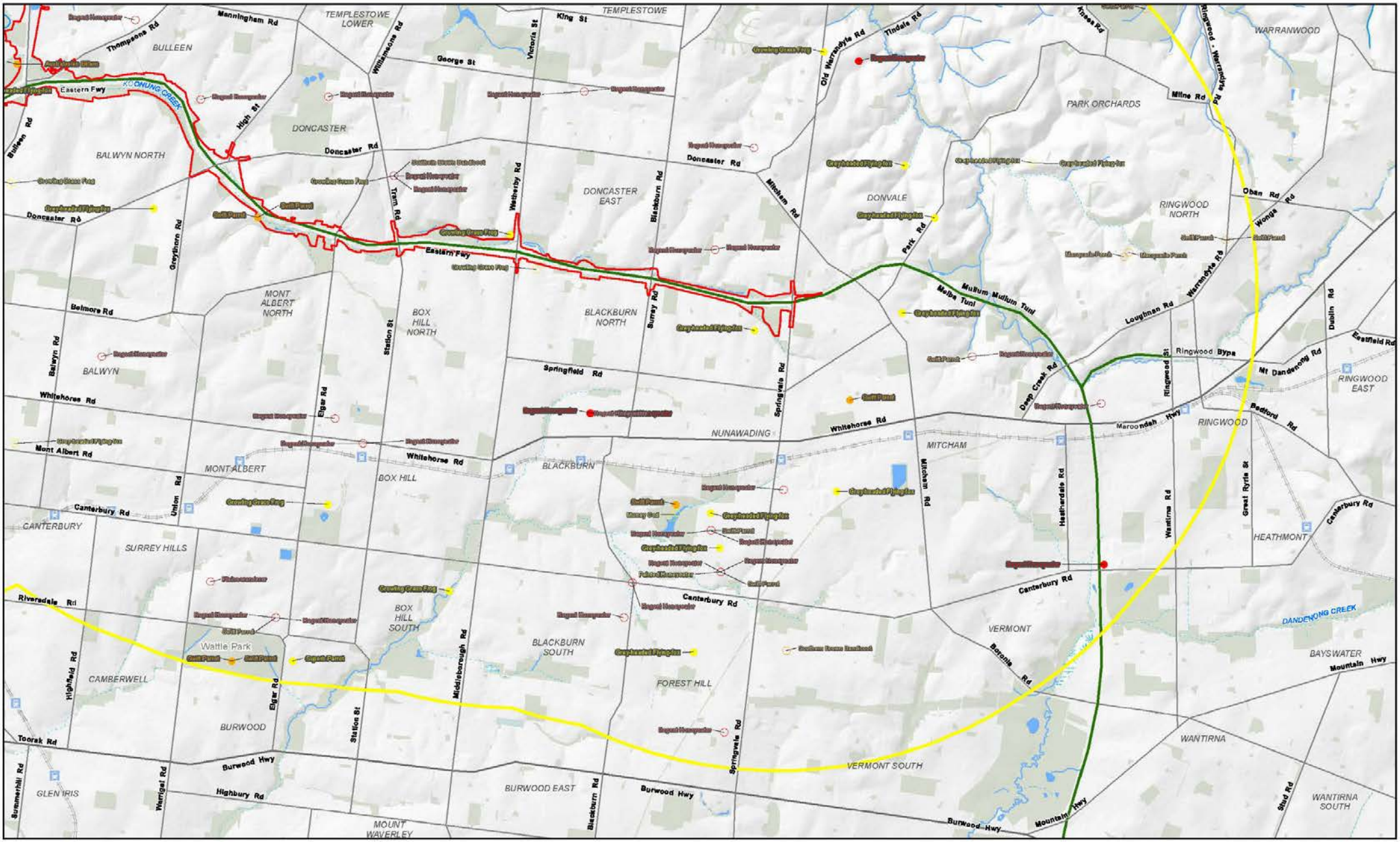
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31t35006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Threatened Species (1987+)
- Critically Endangered
- Endangered
- Vulnerable

VBA Threatened Species (<1987)
- Critically Endangered
- Endangered
- Vulnerable

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	C
Date	15 Jan 2019

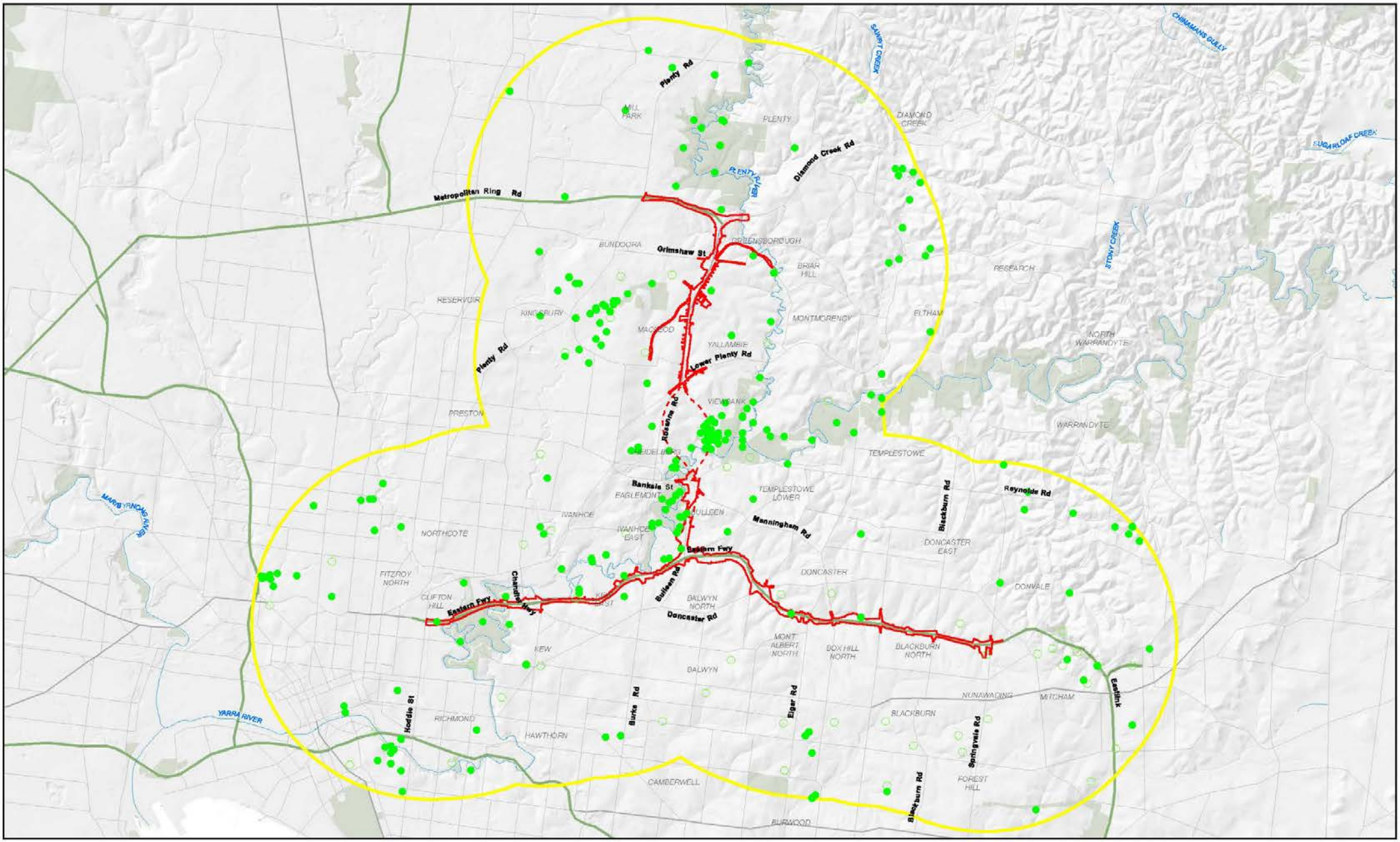
VBA records of Fauna listed as threatened under the EPBC Act

Figure 7-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31t35006_PER_7_1_Fauna_A3L_RevC.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 970 1,940 2,910 3,880

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

- VBA Migratory Species (1987+)
- VBA Migratory Species (<1987)

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

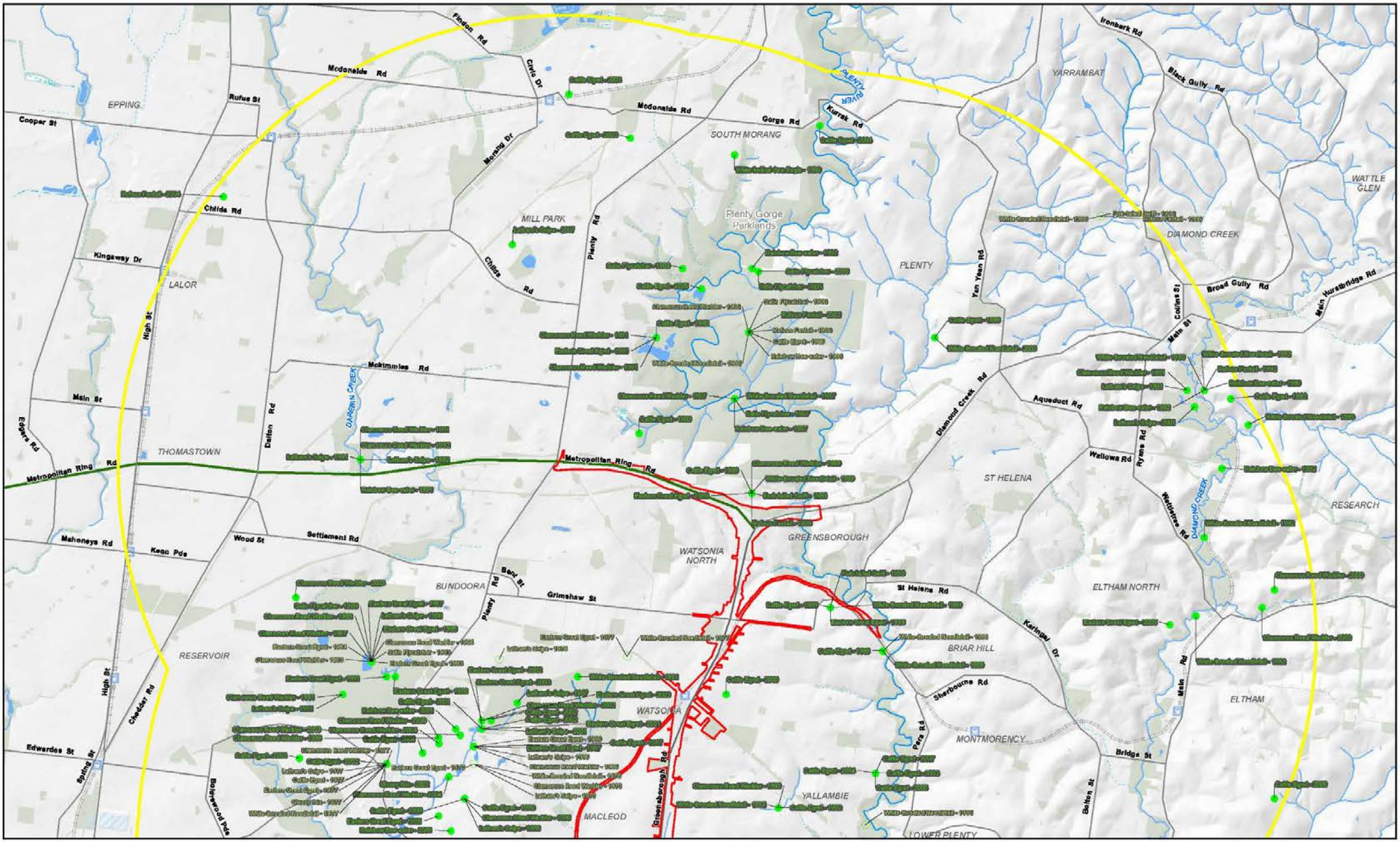
VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31-35006_PER_7_2_Migratory_A3L_RevB.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer

VBA Migratory Species (1987+)
VBA Migratory Species (<1987)

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

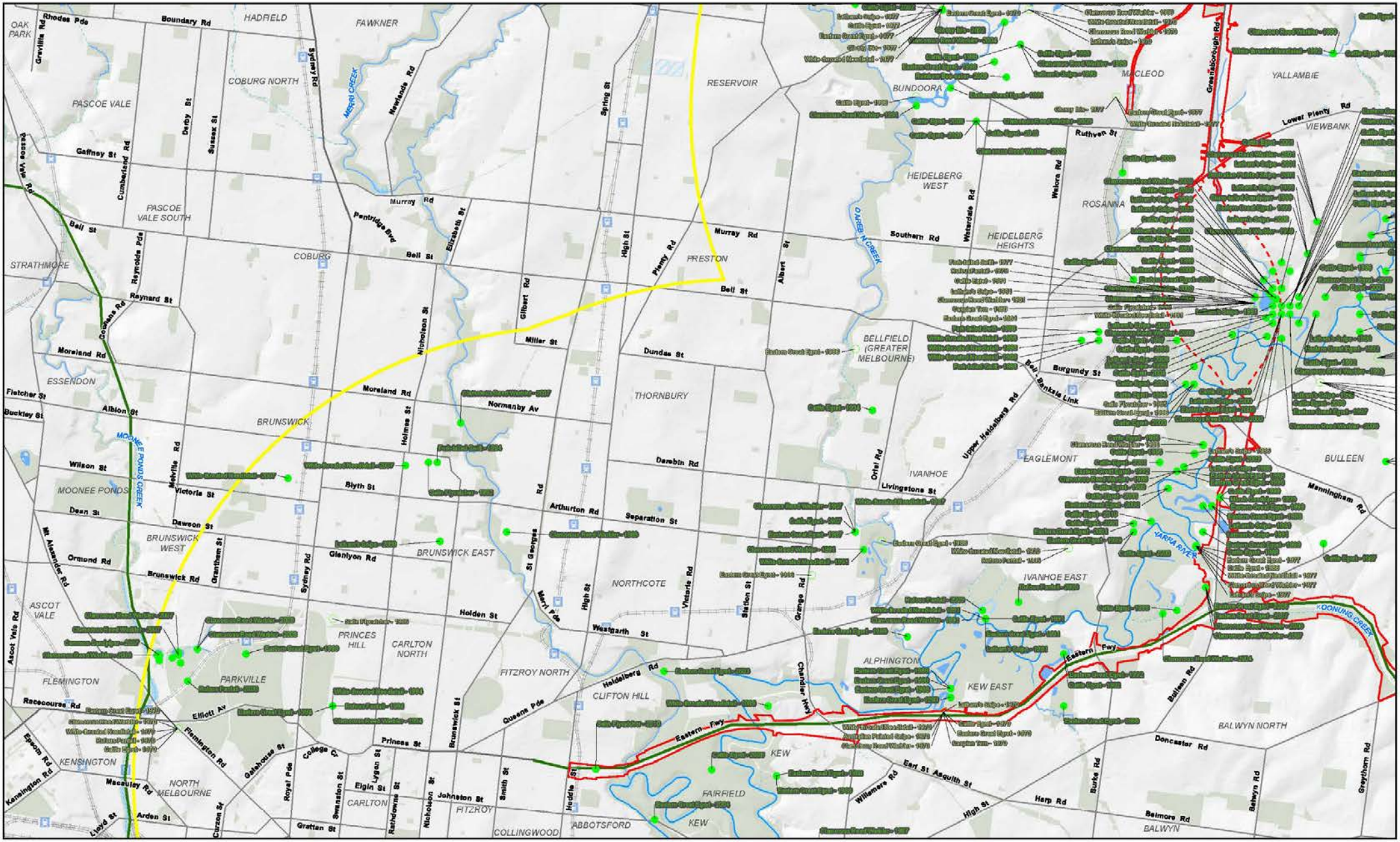
VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31\35006_PER_7_2_Migratory_A3L_RevB.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer
- VBA Migratory Species (1987+)
- VBA Migratory Species (<1987)

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

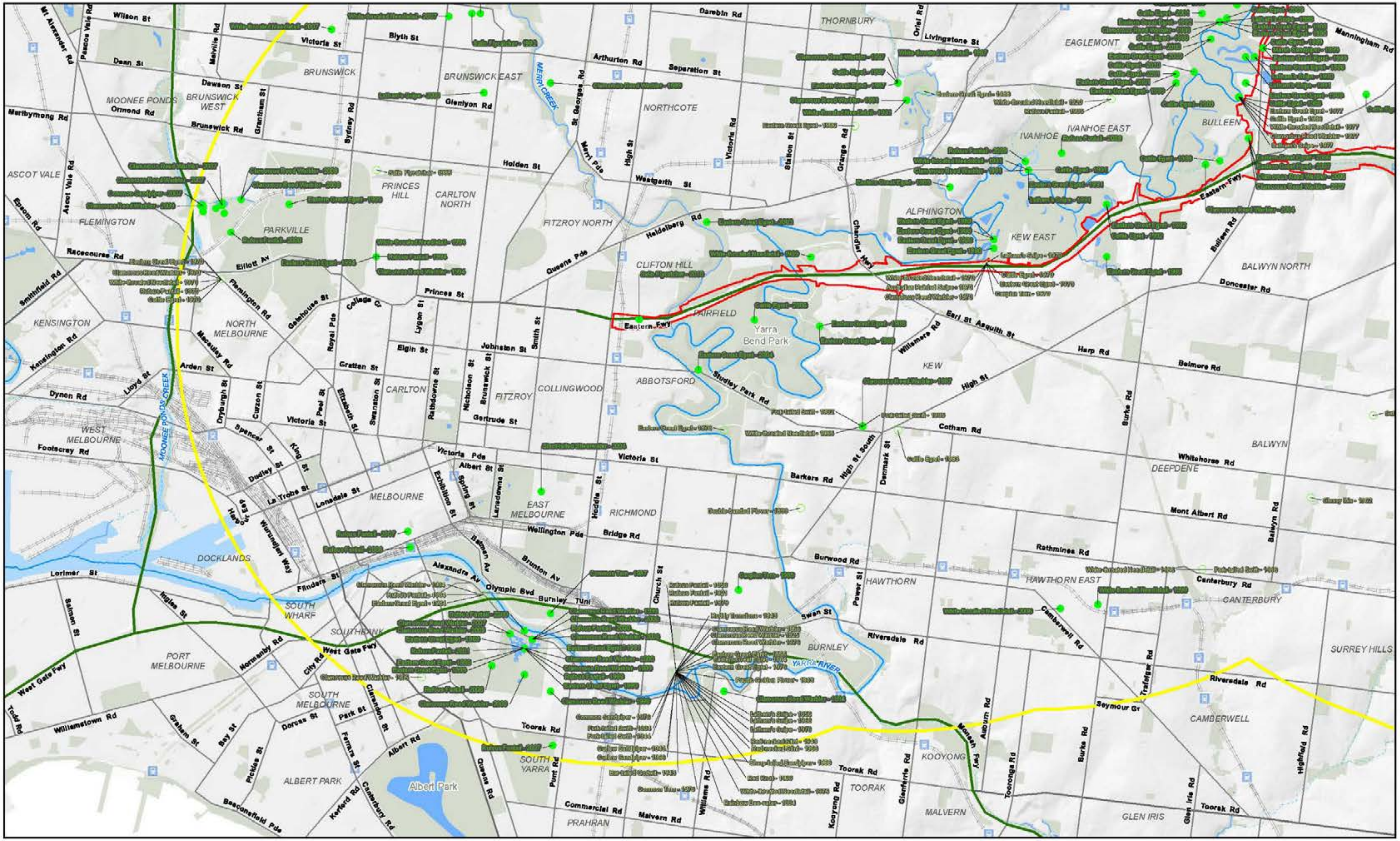
VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_PER_7_2_Migratory_A3L_RevB.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:bghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

Project boundary

Project boundary - sub-surface

Project Boundary - surface

5km Buffer

VBA Migratory Species (1987+)

VBA Migratory Species (<1987)

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

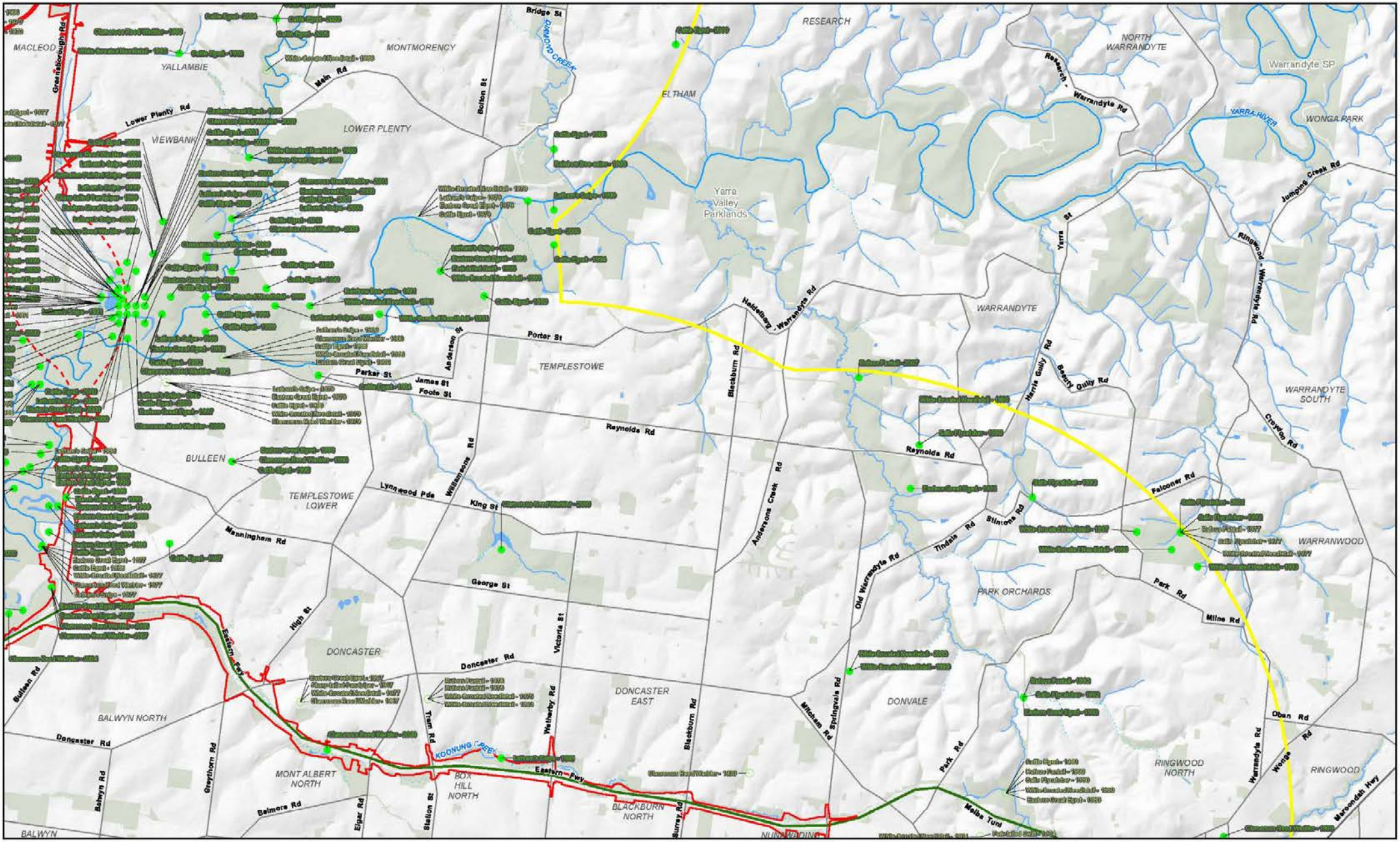
VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\3135006_PER_7_2_Migratory_A3L_RevB.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:bghetti



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer
- VBA Migratory Species (1987+)
- VBA Migratory Species (<1987)

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

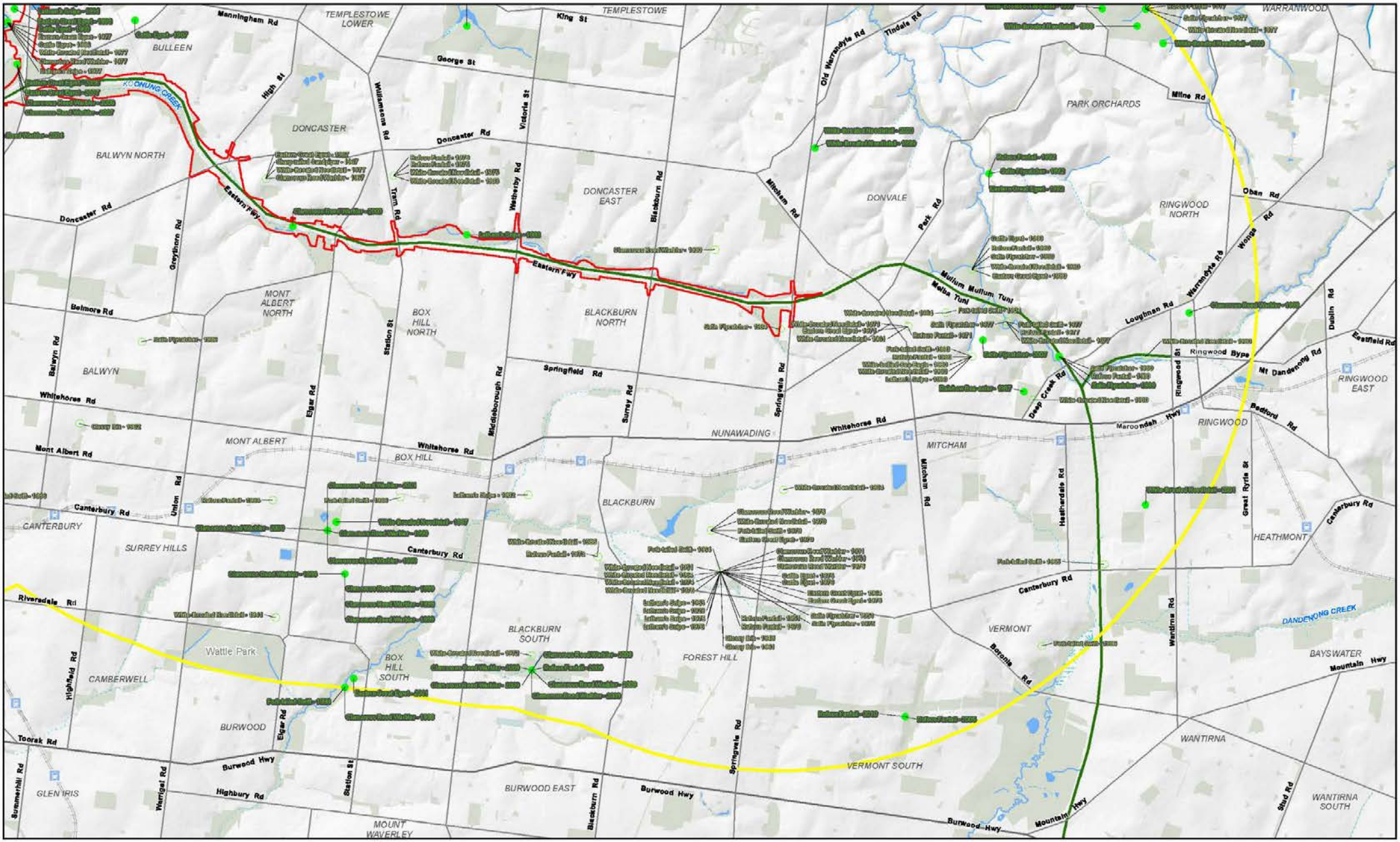
VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31s35006_PER_7_2_Migratory_A3L_RevB.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:brghetti

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 380 760 1,140 1,520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary
- Project boundary - sub-surface
- Project Boundary - surface
- 5km Buffer
- VBA Migratory Species (1987+)
- VBA Migratory Species (<1987)

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Job Number	31-35006
Revision	B
Date	15 Jan 2019

VBA records of species listed as migratory under the EPBC Act

Figure 7-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31t35006_PER_7_2_Migratory_A3L_RevB.mxd

Data source: Roads, Watercourses, Parks, Hillshade, Localities - Vicmap - 2018. Created by:bghelli

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Table 7-3 Threatened and migratory terrestrial fauna species (not fish) identified by the VBA or BLA (but not PMST) for the project boundary

Common name	Scientific name	EPBC	Source	VBA records (last recorded)
Mammals				
Eastern Quoll	*Dasyurus viverrinus*	EN	VBA	12 (1948)
Eastern Barred Bandicoot	*Perameles gunnii*	EN	VBA	3 (1930)
Birds				
Fairy Tern	*Sternula nereis*	VU	VBA	1 (1976)
Bar-tailed Godwit	*Limosa lapponica*	VU/CR (subsp); Mi	VBA	1 (1943)
Superb Parrot	*Polytelis swainsonii*	VU	VBA	3 (1999)
Regent Parrot	*Polytelis anthopeplus*	VU	VBA	1 (1897)
Short-tailed Shearwater	*Puffinus tenuirostris*	Mi	VBA	1 (2004)
Caspian Tern	*Sterna caspia*	Mi	VBA	3 (1988)
Crested Tern	*Sterna bergii*	Mi	VBA, BLA	1 (1994)
Common Tern	*Sterna hirundo*	Mi	VBA	1 (1976)
Ruddy Turnstone	*Arenaria interpres*	Mi	VBA	1 (1943)
Pacific Golden Plover	*Pluvialis fulva*	Mi	VBA	1 (1943)
Double-banded Plover	*Charadrius bicinctus*	Mi	VBA	1 (1899)
Marsh Sandpiper	*Tringa stagnatilis*	Mi	VBA, BLA	3 (2004)
Red-necked Stint	*Calidris ruficollis*	Mi	VBA	2 (1966)
Glossy Ibis	*Plegadis falcinellus*	Mi	VBA, BLA	2 (2002)

7.2.2 Site assessment results

Fauna habitats for EPBC Act-listed fauna

The study area is considerably urbanised and fragmented as a result of historical land clearance for urbanisation and to enable the construction of the Eastern Freeway and major arterial roads between the Eastern Freeway and the Metropolitan Ring Road. That said, the study area still supports a range of habitats for terrestrial fauna, though these are typically highly disturbed. Areas of high ecological value remain in some sections, particularly near the Yarra River and its associated floodplain in the Alphington, Kew East, Bulleen and Banyule areas. Because this land is a floodplain within a large metropolitan area, it is characterised by expansive, well-treed, multi-use recreational parks (including golf courses), which retain important patches of high value habitat for terrestrial fauna. Representative photos of higher quality fauna habitats within the study area are shown in Plate 7.1.

The northern parts of the project boundary generally pass through areas that have been previously disturbed. The woodland and forest areas that remain or that have regenerated or been re-planted offer low to moderate value habitat for threatened and migratory fauna species. While some threatened species may use these habitats occasionally (such as Swift Parrot *Lathamus discolor*), these habitats tend to be used and visited by common and adaptable fauna that occur across much of the Melbourne area.

Further south, in the suburb of Yallambie, the corridor runs along the western fringe of Simpson Barracks, which contains a relatively large area of remnant woodland, as described in Section 7.3.2.

The corridor then courses along Banyule Creek as tunnels, which is relatively degraded (weedy with non-native trees and shrubs) and generally of low to moderate value to fauna for most of its length. Banyule Creek flows into or alongside Banyule Swamp within a large area of recreational parks associated with the Yarra River floodplain where there are numerous records of threatened species. The corridor then continues along the eastern side of more high value Yarra River floodplain, including the Bolin Bolin Billabong.

Where the corridor meets the Eastern Freeway at Bulleen Road, the area has been considerably disturbed historically, mostly for the construction of the Eastern Freeway. Golf courses adjacent to the Eastern Freeway (north side, west of Bulleen Road) provide some limited habitats for native fauna, but are mostly dominated by common and aggressive bird species such as Noisy Miner *Manorina melanocephala*, Red Wattlebird *Anthochaera carunculata* and Rainbow Lorikeet *Trichoglossus haemotodus*. Threatened species may use those habitats occasionally. Fauna habitats along Koonung Creek (mainly east of Bulleen Road) are mostly degraded and disturbed, and tend to be used mostly by common and adaptable fauna.

West of Bulleen Road, the Eastern Freeway crosses the Yarra River and Merri Creek (separate locations). The fauna habitats at both locations are degraded and disturbed. Where it crosses the Yarra River, the project boundary abuts the north side of the Flying-fox Management Area (DSE, 2005) associated with the Grey-headed Flying-fox camp/colony at Yarra Bend Park. The project boundary has been designed to avoid the Flying-fox Management Area (a no-go zone) as far as possible.

a. High value woodland/forest – Simpson Barracks

b. Low value scattered trees – Greensborough Road

c. Degraded waterway – Banyule Creek upper

d. Degraded waterway – Banyule Creek lower

e. Banyule Flats

f. Banyule Swamp

g. Yarra Flats

h. Bolin Bolin Billabong

i. Yarra River – Yarra Flats

j. Yarra River – Kew

k. Golf course habitat, Kew

l. Yarra Bend at Eastern Freeway

m. Koonung Creek Linear Reserve, west of Elgar Road

n. Koonung Creek, Boronia Grove Reserve, Doncaster

Plate 7.1 Representative photos of fauna habitats within the study area

Forests and woodlands (non-riparian)

Associated EVC: Grassy Dry Forest (22), Valley Grassy Forest (47), Plains Grassy Woodland (55) and Grassy Woodland (175).

This habitat type mainly occurs at Simpson Barracks (described in Section 7.3.2) but there are also small areas beside the M80 Ring Road at the far north of the project boundary. This habitat type has moderate-value due to the small and fragmented nature of the remaining patches. These patches tend to be characterised by common and adaptable fauna (such as Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Common Ringtail Possum *Pseudocheirus peregrinus*, Common Brushtail Possum *Trichosurus vulpecula*) which can be aggressive and outcompete other native fauna. Occasionally or rarely, the larger of these patches (such as Simpson Barracks) may attract threatened fauna such as Powerful Owl *Ninox strenua*, Swift Parrot, and Grey-headed Flying-fox, although this is expected to comprise foraging habitat only and so species are not expected to breed or roost here.

Riparian forests and woodland

Associated EVC: Valley Grassy Forest (47), Floodplain Riparian Woodland (56), Creekline Grassy Woodland (68) Swampy Riparian Woodland (83) and Riparian Woodland (641).

The forests and woodlands that line the waterways within the project boundary are the most extensive areas of vegetation that remain. These areas generally contain high-value habitat that is likely to attract and support a range of common, uncommon and rare fauna, including threatened species.

While these areas are often a narrow strip of habitat, they tend to be subject to fewer ongoing disturbances so often have several habitat features the other habitat types have now lost such as leaf-litter, coarse woody debris, hollow-bearing trees and large trees. Some of the vegetation in this habitat type is remnant (such as on banks of the Yarra River), but other areas comprise planted native vegetation in linear reserves along parts of Koonung Creek. These plantings were aimed at replicating natural EVCs and have been established long enough to be considered a ‘patch’ of native vegetation.

The main value of these patches is as wildlife corridors which facilitate landscape-scale movement of fauna between two or more areas of habitat. Corridors play an important role in linking otherwise isolated areas of habitat. Typically, wildlife corridors are linear strips of habitat that connect two larger patches of habitat, but corridors vary substantially in terms of width, length and habitat features, and their success depends upon the biology of the fauna species involved. Wildlife corridors often comprise valuable fauna habitat themselves, regardless of their connectivity.

Common fauna can be abundant in these habitats, especially the larger and more connected patches such as along the Yarra River, Bolin Bolin Billabong, Banyule Swamp and along Koonung Creek. Larger fauna such as Macropods (Eastern Grey Kangaroo (*Macropus giganteus*) and Black Wallaby (*Wallabia bicolor*), Common Wombat (*Vombatus ursinus)*, Short-beaked Echidna (*Tachyglossus aculeatus*) and Sugar Glider (*Petaurus breviceps)* are able to persist here compared with the smaller more fragmented patches. These patches also tend to have a greater diversity of bird fauna (beyond the common, adaptable and often aggressive parrots and honeyeaters), such as thornbills (Brown Thornbill *Acanthiza pusilla*, Yellow-rumped Thornbill *Acanthiza chrysorrhoa*), kingfishers (Azure Kingfisher *Alcedo azurea*, Sacred Kingfisher *Todiramphus sanctus*), Superb-fairy Wren *Malurus cyaneus*, smaller honeyeaters (including Scarlet Honeyeater *Myzomela sanguinolenta*, White-plumed Honeyeater *Lichenostomus penicillatus*) and waterbirds such as crakes, rails and waterfowl. Frogs (such as Common Froglet *Crinia signifera*, Southern Brown Tree Frog *Litoria ewingi* and Spotted Marsh Frog *Limnodynastes tasmaniensis*) and reptiles (Tiger Snake *Notechis scutatus*) are also most likely to be found in these areas.

Scattered trees and planted roadside trees and shrubs

This habitat generally has low value for native fauna. Scattered trees and planted roadside trees and shrubs is the main habitat type most likely to be affected by North East Link as it makes up a large proportion of what remains within the project boundary, and impacts on larger more intact vegetation are being avoided by tunnelling or the establishment of no-go zones. The main value of this habitat is likely as a corridor for the movement of fauna within and through the project boundary and between the larger patches of vegetation outside the project boundary.

The value of this habitat is likely to vary, depending on the size of the roadside reserve, park or garden, its quality (for example, the presence of hollow-bearing trees, vegetation layers, leaf litter, fallen limbs and logs) and connectivity to other patches of habitat. However, many of these habitat features were often absent from this habitat type.

This habitat type tended to be characterised by common and adaptable mobile fauna (such as Red Wattlebird, Rainbow Lorikeet, Noisy Miner). Occasionally or rarely, less disturbed patches of this habitat may attract foraging threatened fauna such as Swift Parrot and Grey-headed Flying-fox.

Waterways and Wetlands

The main ecological values within the study area are centred on the numerous waterways and wetlands, the most notable of which include:

- Banyule Creek
- Koonung Creek
- Yarra River
- Plenty River
- Merri Creek
- Yarra River billabongs, including Bolin Bolin Billabong, Kew Billabong, Simpson's Lake, and other wetlands within Kew Golf Course and Freeway Public Golf Course
- Banyule Swamp.

The aquatic value of these areas is discussed within Section 8 but it is worth noting these areas tend to provide the most significant wildlife corridors within the study area.

Banyule Creek, Koonung Creek and the Yarra River are intercepted significantly by the project boundary and are described below (and see relevant sections of Section 6).

Banyule Creek

Banyule Creek originates within Simpson Barracks. From Simpson Barracks, Banyule Creek flows south to its outfall into the Yarra River. The creek is approximately four kilometres long.

From Blamey Road, Banyule Creek generally runs parallel to Greensborough Road through Simpson Barracks to an open reserve north of Drysdale Road. At Drysdale Road, the creek crosses under the road in a 0.6-metre diameter circular culvert and continues downstream through an open reserve to Lower Plenty Road. At Lower Plenty Road, the creek crosses under the road in two 1.575-metre diameter circular culverts. South of Lower Plenty Road, the creek continues through an open reserve near residential properties until it meets the Yarra River.

Where North East Link is proposed through the western part of Simpson Barracks, the waterway is small and intermittent and forms a naturally incised channel providing poor quality fauna habitat, but a series of man-made, stream-side, densely vegetated ponds provide habitat for common frogs, including Common Froglet and Southern Brown Tree Frog. Threatened and migratory wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus*, are unlikely to occur within this section of Banyule Creek.

Koonung Creek

Koonung Creek is a tributary of the Yarra River. Koonung Creek is approximately 12 kilometres long and begins near Springvale Road, in Blackburn North, and flows west before out falling into the Yarra River just north of the Freeway Public Golf Course. The creek meanders back and forth either side of the Eastern Freeway for much of its length before it outfalls into the Yarra River. Overall, the catchment is heavily urbanised. Flows into Koonung Creek enter from local catchment drainage connections including the following Melbourne Water Drains (Blackburn Road Drain, Leeds Road Drain, Elms Grove Drain, Gardenia Road Drain, Ayr Street Drain and Minerva Avenue Drain) and creeks (Brushy Creek). Threatened and migratory wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus* have the potential to occur along Koonung Creek rarely, but are unlikely to depend on habitats along Koonung Creek or its tributaries.

Yarra River and billabongs

The Yarra River catchment lies north and east of Melbourne, beginning on the southern slopes of the Great Dividing Range in the forested Yarra Ranges National Park. The upper reaches of the Yarra River and its major tributaries flow through forested, mountainous areas. Most of the land along rivers and creeks in the middle and lower sections has been cleared for agriculture or urban development.

At the location of North East Link, the Yarra River consists of an extensive floodplain that comprises a number of land uses including but not limited to public recreation, conservation and special use zones such as golf courses. Between Banksia Street and Chandler Highway, the floodplain is generally well vegetated.

The Yarra River and its associated floodplain in the Banyule/Bulleen area retain high ecological value. This waterway provides the most significant wildlife corridor within the study area and within the eastern suburbs of Melbourne. Threatened and migratory wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus* have the potential to occur in wetland/waterway habitats associated with the Yarra River and billabongs. However, the historical record suggests that if these species occur there, they would most likely be uncommon visitors.

EPBC Act-listed threatened ecological communities (fauna) within the project boundary

No fauna communities listed as threatened under the EPBC Act were recorded or are expected to occur within the project boundary.

Threatened terrestrial fauna (EPBC)

All threatened fauna identified for the study area are shown in Appendix B. Most of those species are considered unlikely to occur within the project boundary, as explained in Appendix B.

Habitat assessments were undertaken to determine the likely presence of species, and targeted surveys for selected species were completed where it was considered likely the results would change our understanding of that species at a particular site based on existing information.

Species listed as threatened under the EPBC Act and shown in Appendix B as having a moderate or high likelihood of occurrence within the project boundary are discussed in more detail below. These tend to be the species known to visit or reside in parts of the project boundary, or considered to be of high ecological significance for some other reason (such as those considered to be nationally threatened under the EPBC Act).

Results of the habitat assessment and targeted surveys for species listed under the EPBC Act are shown in Table 7-4. None of the targeted species were detected.

Grey-headed Flying-fox, *Pteropus poliocephalus* (EPBC, vulnerable)

The Grey-headed Flying-fox uses a wide range of habitats in Victoria, from lowland rainforest and coastal Stringybark forests to agricultural land and suburban gardens. It occurs across the Melbourne area, foraging in densely vegetated flowering and fruiting trees. The VBA contains a large number of records of this species.

According to the DELWP website (DELWP, 2018b), Grey-headed Flying-foxes have been coming to Melbourne for more than 100 years. Numbers have been increasing due to a loss of habitat in New South Wales and Queensland and the creation of a reliable food supply here. In 1986, a colony of Grey-headed Flying-foxes took up permanent residence in the Royal Botanic Gardens, Melbourne. Up to 6,000 individuals roosted in the gardens year-round, increasing to 20,000 during the breeding season. By 2002, the colony was out-growing its available habitat and was killing trees and damaging heritage-listed vegetation in the Botanic Gardens. In 2003, a large-scale dispersal program successfully relocated the colony to Yarra Bend Park, Kew, in the vicinity of Bellbird Park. The Management Plan for the Yarra Bend flying-fox colony (DSE, 2005) shows the Flying-Fox Management Area to extend upstream from about Bellbird Park to the Eastern Freeway. The camp at Yarra Bend Park is identified in DoEE's interactive National Flying-fox Monitoring Viewer as a Nationally Important Flying-fox Camp (DoE, 2014).

Colony size fluctuates with breeding season. Mating occurs in early autumn, with females giving birth in October after a six-month gestation. Dependent young suckle for three to four months, and during spring and early summer they are left at the colony overnight while the adults forage. Juvenile flying-foxes are usually independent after 12 weeks. This means that over summer the Yarra Bend colony can increase to more than 30,000 individuals, including young, but during winter, the population falls to around 6,000 individuals (DELWP, 2018b).

The northern limit of the flying-fox camp was visited on 16 November 2017 to ascertain current habitat use by roosting flying-foxes. Roosting flying-foxes were observed approximately 70 metres from the Eastern Freeway (but note that, given the river's meanders, this location is approximately 400 metres from the nearest freeway bridge across the river). No estimate of population size was made during the visit, but flying-foxes were observed to be roosting at high densities across a large area. Numerous individuals were seen carrying dependent young.

Aside from flying-foxes observed within the camp, the Grey-headed Flying-fox was observed in small numbers flying overhead during nocturnal field assessments at several locations across the project boundary. Targeted surveys for this species were not undertaken. Individuals are expected to forage across the entire study area, so its presence was assumed.

Australasian Bittern, *Botaurus poiciloptilus* (EPBC, endangered)

This cryptic species is a rarely seen or reported nocturnal heron. It prefers dense tall vegetation in permanent freshwater swamps and wetlands, particularly when dominated by sedges, rushes and reeds. There are records of Australasian Bittern along the Yarra River floodplain, but there are no records along Koonung Creek or Banyule Creek.

Within the study area, suitable habitat for this species occurs mainly along the Yarra River, particularly in the expansive Banyule Swamp area, where there are small numbers of historical records. The suitable habitat in this area is extensive and in good condition, and parts of it are relatively removed from disturbance sources (walking tracks, bike paths). The potential habitat along the smaller waterways (Koonung Creek, Banyule Creek) is degraded, highly disturbed, and only in relatively small and isolated patches, so is unlikely to support this species.

The Yarra River provides the most suitable habitat for this species in the project boundary, and the species may occur along or visit the Yarra River floodplain occasionally in small numbers. Direct impacts on this area are being avoided by tunnelling. Targeted surveys for this species were not undertaken and the species was not detected during the assessment.

Australian Painted Snipe, *Rostratula australis* (EPBC, endangered)

The Australian Painted Snipe is a rare, nomadic bird species that may turn up at any suitable wetland across Australia, when conditions are favourable. This species is widespread but rare throughout most of eastern Australia.

According to the desktop assessment (VBA, BLA and e-Bird records), the most suitable habitat for this species is in and around Banyule Swamp. This area is currently proposed to be tunnelled, so would not be impacted directly. There is potentially suitable habitat also at Bolin Bolin Billabong, although there are no historical records of the species in the VBA, BLA or e-Bird at that location. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA/e-Bird records, suggests those areas are very unlikely to support this species. There is one exceptional and potentially erroneous 2012 BLA record of 80 birds in Darebin parklands ~two kilometres north of the Eastern Freeway alignment near Chandler Highway. While the location is considered valid, this count of birds far exceeds any other VBA or BLA record for this species (the next highest count is two individuals) and is not consistent with prevailing reports from reliable sources (for example, ‘usually in pairs or small parties’; Marchant and Higgins 1993).

There is a cluster of 16 BLA records of this species at and around Banyule Swamp. All these are from October/November 2001, with a maximum number of two birds being observed at any one time. Therefore, most of these 16 records are likely to be of the same two individuals. The VBA also contains two of those records. This species has not been recorded in the study area since then, and there is only one record before then, from 1970.

A targeted survey for this species was not undertaken due to the very low likelihood of finding the species.

Swift Parrot, *Lathamus discolor* (EPBC, critically endangered)

The Swift Parrot is a winter migrant to Victoria (and other parts of SE Australia) from breeding areas in Tasmania. In Victoria, it prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Occasionally, this species is recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs. Typically, small numbers of birds fly through the Melbourne area on their northerly and southerly migrations, mostly *en route* to or from central or western Victoria and further north. Birds are reported sporadically in small numbers across Melbourne (mainly in the northern and north-western suburbs) in most years, where suitable eucalypts occur and flower at appropriate times of the year.

The VBA results identified a total of 87 Swift Parrot records within five kilometres of the project boundary, the most recent of which dates from 2009. The BLA has 90 records, most recently in April 2018.

The majority of the records relevant to the study area are from north of the Yarra River. West of Watsonia Station, Gresswell Forest Nature Conservation Reserve and the grounds of La Trobe University are both likely to be categorised as priority habitat for Swift Parrot in the Melbourne area. Swift Parrots (generally no more than 20) have been regularly observed at or near those locations in recent years (2005, 2009, 2011, 2014, 2015, 2016), and up to 50 Swift Parrots were observed at La Trobe University in April and May 2018 (observations sourced from BLA database and eBird).

The trees in and around Macleod Station may also be categorised as priority habitat in the Melbourne area. Up to 40 Swift Parrots were observed between May and July 2015 in the trees surrounding Macleod Station (BLA, e-Bird). In 2017, small numbers of Swift Parrots were observed in a few locations around Greensborough and Plenty (eBird), north-east of the northern part of the project boundary.

Within the project boundary where impacts are expected, the habitat that was considered most likely to attract Swift Parrots was thought to be within Simpson Barracks. There is one older (1992) VBA record of five birds in the eastern section of the Barracks. A site assessment at the Barracks determined the western margin (within the project boundary) largely consists of non-favoured eucalypt species (mainly River Red Gum *Eucalyptus camaldulensis*), which was dominated by aggressive nectar feeders such as Noisy Miners, Red Wattlebirds and Rainbow Lorikeets which are reported to disturb or out-compete Swift Parrots. The woodland on the eastern side of Simpson Barracks, which North East Link would not impact, supports superior habitat that is dominated more by Yellow Box *E. melliodora*, a favoured eucalypt species for Swift Parrot foraging.

Overall, for the Banyule city and surrounding areas, Practical Ecology (2017c) found the Yarra River floodplain (from Yarra Bend Park through to Banyule Flats), Plenty Gorge, and La Trobe University/Gresswell area support habitats considered to be of highest rank for the Swift Parrot, while habitats in other areas, including Simpson Barracks, were determined to be of lower rank.

This species was not detected during the assessment, and targeted surveys for this species in the project boundary were not done, due to: i) the low likelihood of detecting the species, and ii) the fact that not detecting the species would not lead to a conclusion that the species is absent. Through desktop investigations and field habitat assessments, it was determined the Swift Parrot has at least some potential to visit almost any flowering trees within the project boundary occasionally, but is unlikely to use any of those habitats to any great degree. Given the dominant types of eucalypt across the project boundary, Swift Parrot visits are considered more likely towards the northern parts of the project boundary than the south-western or south-eastern extents. While Swift Parrots may forage in trees in the project boundary occasionally

and opportunistically, there is little evidence to suggest that any part of the study area is favoured or visited regularly by this species.

Growling Grass Frog, *Litoria raniformis* (EPBC, vulnerable)

The Growing Grass Frog is a member of the 'Bell Frog' species complex (*Anura: Hylidae*) and is distributed across a large portion of south-east Australia. In Victoria, it was previously widespread and common, absent only from the driest and highest parts of the state. In the last few decades, the species suffered widespread population declines, and has now disappeared from most of its former range. Causes of this decline are likely to be multifactorial and include invasion by the novel disease Chytridiomycosis, caused by the Amphibian Chytrid Fungus. On-going loss of habitat and habitat connectivity may have increased the severity and consequence of the disease, by limiting genetic resilience in the frogs.

The species is found mostly amongst non-shaded emergent vegetation, including rushes, reeds and sedges, in or at the edge of still or slow-flowing water bodies such as lagoons, swamps, lakes, ponds and farm dams. Growling Grass Frogs may utilise permanent or semi-permanent waterbodies. Persistence of the species now appears to depend on access to a matrix of connected wetlands/waterbodies/waterways, rather than one wetland alone (Heard, 2013). Typical habitats include lowland grasslands, open vegetated wetlands, flooded paddocks and drains. Floodplains tend to provide suitable habitat for this species, in that they are predominantly wet, and contain a range of waterbody types.

There are large numbers of VBA records of this species across the Melbourne area and the study area, mainly along the Yarra River floodplain, but also along small and large tributaries. None of the records in the study area is more recent than 1991, which is likely to have been during or pre-population declines. Records most relevant to the study area include Chelsworth Park in Ivanhoe East (1788 and 1988), Bolin Bolin Billabong (1991), Banyule Swamp two records in 1991, and along Koonung Creek (1788, 1977 and 1989). Australian Ecosystems (2007) reports a record of Growling Grass Frog from a small wetland at far eastern end at Trinity Grammar School Sporting Complex (not impacted by North East Link), with no date or source. It is unknown if this is an actual record (it's not in the VBA), or speculation that the species is likely to occur there on the basis of habitat characteristics and the nearby record at Bolin Bolin Billabong. Lorimer (2006) indicates this species is believed to be extinct within Boroondara, having disappeared well over a decade ago from its last known habitat.

All VBA records in the eastern part of the Melbourne area since 2010 are beyond the study area. One record comes from Corhanwarrabul Creek in Scoresby (2012; more than 12 kilometres south-east of the Eastern Freeway at Springvale Road), numerous records from the upper reaches of Merri Creek between Campbellfield and Craigieburn (up to 2013; more than 10 kilometres west of the Greensborough Road and M80 Ring Road intersection), and a handful of records from the upper reaches of Darebin Creek in Bundoora and Thomastown (up to 2014; within four kilometres west of the Greensborough Road and M80 Ring Road intersection).

No Growling Grass Frogs were detected during targeted surveys. Weather conditions are important to frog surveys, as they influence the likelihood of success. Weather conditions experienced during the targeted surveys are shown in Table 7-5.

At present, the Growling Grass Frog is not expected to significantly utilise or rely on the habitats/resources within the project boundary. However, on the basis of historical records, the Yarra floodplain clearly provides potentially suitable habitat, and some individuals may still use the waterways/waterbodies if they disperse across the landscape.

Migratory species

Twenty-six species (all birds) known or predicted to occur within the study area are listed as Migratory under the EPBC Act. These species are listed in Appendix C. The Migratory listing of some Australian fauna under the EPBC Act is intended to protect and conserve habitat within Australia for species that depend on habitats within and outside Australia. While some of those species may use or visit habitats within the project boundary occasionally, field assessment of the potentially suitable habitats determined that most species are unlikely to use the project boundary in large numbers or frequently.

Five of the species are predominantly coastal or marine species (shearwater, terns, Osprey *Pandion haliaetus*) that are not likely to use habitats within the project boundary. Thirteen are shorebird species (such as plovers, sandpipers, curlews) that are also not likely to use the project boundary. One species (Glossy Ibis *Plegadis falcinellus*) uses open wetlands and flooded grasslands, but is an occasional or rare visitor to the Melbourne area. Two of the species are aerial species (White-throated Needletail *Hirundapus caudacutus* and Fork-tailed Swift *Apus pacificus*) that may forage in the airspace above North East Link, but that are unlikely to have any substantial association with terrestrial habitats within the project boundary. Three species are bushbirds (Rufous Fantail *Rhipidura rufifrons*, Satin Flycatcher *Myiagra cyanoleuca*, Black-faced Monarch *Monarcha melanopsis*), and small numbers of birds are likely to visit the habitats with dense mid-storey along the Yarra River floodplain. These three species are relatively common species that occur along a range of wet, damp and dry forest types in the east of Australia, and their habitat strongholds are outside the urbanised areas of Melbourne.

One species (Latham's Snipe, *Gallinago hardwickii*) may use parts of the study area regularly, as discussed below.

Latham's Snipe, *Gallinago hardwickii*

Latham's Snipe is listed as Migratory under the EPBC Act. Latham's Snipe is a summer migrant/visitor to south-eastern Australia, returning each year to Japan and eastern Russia to breed during the northern summer. This species is present in southern Australia only during the warmer months (August to March).

Latham's Snipe is a highly mobile species that forages in wet and flooded grasslands that are subjected to little disturbance. Preference of habitat does not appear to be determined by the diversity of native or introduced plants, but more related to the availability of suitably damp/wet habitat, food resources and level of disturbance (particularly people on foot, and presence of dogs). The species is omnivorous and feeds predominately on seeds, plant material, and invertebrates.

The BLA database has 187 sightings of Latham's Snipe in the search area, until as recently as 2015. The VBA has 104 records up to 2013. This suggests that Latham's Snipe is a regular visitor to the study area. Many of the records are from the Yarra River floodplain, between Kew and Warrandyte. There is another notable cluster of records from La Trobe University, west of the study area, and from Dandenong Creek, well south-east of the study area.

Of the records along the Yarra River floodplain, two are within the Kew golf course area north of the Eastern Freeway (1970 and 1991). The record from 1970 is reported as 'roughly two kilometres SW of Ivanhoe', so may contain locational error and may not actually be with the study area. Further upstream, there is a handful of pre-1991 records from the Bolin Bolin Billabong area, with a maximum count of five birds. Then, in the Banyule Swamp and Banyule Flats area, there are numerous records, including records of 20 birds as recently as 2013. This area appears to be the focus of Latham's Snipe habitat along this section of the Yarra River floodplain.

Other locations within the project boundary where this species may occur are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. There is one record from Tram Road Reserve along Koonung Creek (1989), and none from Banyule Creek.

No Latham's Snipe were observed during this assessment.

Table 7-4 Summary of results of habitat assessment and targeted surveys for fauna listed as threatened or migratory under the EPBC Act

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted round 1	Targeted round 2	Target species detected?	Other species recorded
Bolin Bolin Billabong	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	31/10/2017	31/10/2017	8/11/2017	No	Southern Brown Tree Frog (*Litoria ewingii)* Peron's Tree Frog *(Litoria peroni)* Striped Marsh Frog *(Limnodynastes peroni)* Spotted Marsh Frog (*Limnodynastes tasmaniensis*) Southern Bullfrog (*Limnodynastes dumerili*)
Kew Billabong (Willesmere Park)	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	17/05/2018	N	N	No	Victorian Smooth Froglet *(Geocrinia victoriana)*
Kew Golf Course	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	6/11/2017	6/11/2017	13/11/2017	No	Southern Brown Tree Frog (*Litoria ewingii)* Peron's Tree Frog *(Litoria peroni)* Eastern Dwarf Tree Frog *(Litoria fallax)* Striped Marsh Frog *(Limnodynastes peroni)*

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted round 1	Targeted round 2	Target species detected?	Other species recorded
Koonung Creek	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	1/11/2017	1/11/2017	9/11/2017	No	Common Froglet (*Crinia signifera)* Southern Brown Tree Frog (*Litoria ewingii)* Striped Marsh Frog *(Limnodynastes peroni)* Spotted Marsh Frog (*Limnodynastes tasmaniensis*) Southern Bullfrog (*Limnodynastes dumerili*)
Merri Creek	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	15/11/2017	15/11/2017	N	No	None
Plenty River Crossing	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	1/11/2017	N	N	No	None
Simpson Barracks	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	2/11/2017	2/11/2017	N	No	Common Froglet (*Crinia signifera)*
	Latham's Snipe	*Gallinago hardwickii*	Mi			2/11/2017	N	N	No	None
	Swift Parrot	*Lathamus discolor*	CR	L	EN	2/11/2017	N	N	No	None

Table 7-5 Weather conditions during targeted surveys for the Growling Grass Frog, Litoria raniformis

Target species	Date	Time start	Time finish	Temperature range (°C)	Relative humidity range (%)	Wind speed range (km/h)	Cloud cover (%)	Rain at time of survey	Rain on date from BoM (mm)	Weather stations
Growling Grass Frog	31/10/2017	2030	2332	10.6–12.9	65–93	2–15	100	None-light	10.6	Viewbank
	1/11/2017	2033	2325	13–13.9	76–85	4–13	80–100	None	0.6	Viewbank
	2/11/2017	2115	2210	12.1	68	7	30	None	1.2	Viewbank
	6/11/2017	2055	2127	13	54	17	30	None	0	Melbourne
	8/11/2017	2036	2222	12.1–14.1	74–81	7–9	0	None	0.2	Viewbank
	9/11/2017	2030	2328	13.5–16.9	65–88	6–15	0–25	None	0	Viewbank
	15/11/2017	2300	0010	19.5	97	<2	100	Light	0	Melbourne

7.3 Whole of environment in and around Commonwealth land

7.3.1 Desktop assessment results

Protected Matters Search Tool

The results of the Protected Matters Search Tool (PMST) presented in Section 7.2.1 include all Commonwealth land considered for North East Link.

Victorian Biodiversity Atlas and Birdlife Australia Atlas

Within a 500-metre buffer area surrounding Commonwealth land, 100 species of terrestrial fauna have been recorded (VBA), and two of those are also recorded on the threatened species records of the Birdlife Atlas (BLA). All 100 species have been recorded in the area since 1987. Most of these species are birds (79), with smaller numbers of mammals (nine), reptiles (seven) and amphibians (five). The VBA contains no records of invertebrates within 500 metres of Commonwealth land.

Eleven of the 100 species are non-native species (three mammals and eight birds).

Two species (both birds) identified are classified as threatened terrestrial fauna, and one of those species is also classified as Migratory under the EPBC Act (see Table 7-6). All migratory fauna identified for the search area by the PMST or recorded in the area (VBA/BLA) are shown in Appendix C.

The Marine status of fauna (as defined under the EPBC Act) is not considered in this PER, because North East Link is not within a Commonwealth Marine Area, nor expected to impact a Commonwealth Marine Area.

Table 7-6 Threatened and migratory terrestrial fauna recorded within 500 metres of Commonwealth land (VBA and BLA data)

Common name	Scientific name	EPBC	FFG	DELWP
Birds				
Swift Parrot	*Lathamus discolor*	CR	L	en
White-throated Needletail	*Hirundapus caudacutus*	Mi	L	vu

CR – Critically endangered; L – listed as threatened; en – Endangered
vu – Vulnerable; Mi – Migratory

EPBC Act-listed threatened ecological communities (fauna)

No fauna communities listed as threatened under the EPBC Act were recorded or are expected to occur within a 500-metre buffer area surrounding Commonwealth land.

FFG communities

One fauna community listed as threatened under the FFG Act is identified for Commonwealth land at Simpson Barracks: *Victorian temperate-woodland bird community*. The description of this community identifies 25 *key indicator bird species* (the presence of which confirm the presence of the community) and 21 *associated bird species* (the presence of which indicate the *potential* presence of the community). Three key indicator species and four associated bird species are identified by the desktop assessment as having been recorded (VBA/BLA) within a 500-metre buffer area. There are two records of Little Lorikeet (*Glossopsitta pusilla*) (key) and Restless Flycatcher (*Myiagra inquieta*) (associated), and one record of Swift Parrot (*Lathamus discolor*) (key), Jacky Winter (*Microeca fascinans*) (key), Rufous Whistler (*Pachycephala rufiventris*) (associated), Crested Shrike-tit (*Falcunculus frontatus*) (associated) and Dusky Woodswallow (*Artamus cyanopterus*) (associated).

7.3.2 Site assessment results

Simpson Barracks

Fauna habitats and likely species

As outlined in Section 6.3.2, Simpson Barracks is within a locality that is considerably urbanised and fragmented as a result of historical land clearance. Aerial imagery from 1945 (Figure 6-2) shows that the entire area, including Simpson Barracks, Banyule Creek and Watsonia Drain (on the eastern side of the Barracks), was cleared of most of its large trees and habitats prior to 1945. This provides important historical context for the flora and fauna assessment of the area.

Despite its history of habitat disturbance, Simpson Barracks currently supports a range of habitats for terrestrial fauna, which have regenerated since 1945.

While some of the trees observed during the site assessment were large, the trees generally tended to be relatively young and large hollows were not seen. However, there may be hollows high up in some of the larger trees, and those hollows may provide habitat for fauna such as microchiropteran bats and small parrots (such as Red-rumped Parrot, Rainbow Lorikeet).

Because Simpson Barracks currently contains relatively large areas of remnant woodland in an urbanised landscape, it is likely to attract and support a range of fauna. However, because it is surrounded by urbanisation and has been considerably disturbed historically, it is generally degraded and so is unlikely to support the full range of threatened and non-threatened fauna that would have occurred there historically.

Habitats within Simpson Barracks have moderate value for fauna. Patches of woodland (remnant, regrowth or planted) of this size within the Melbourne area tend to be characterised by bold, common and adaptable fauna (such as Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Common Ringtail Possum *Pseudocheirus peregrinus*, Common Brushtail Possum *Trichosurus vulpecula*), which can be aggressive and outcompete other native fauna. Other non-threatened species that are reasonably common but more notable in the Melbourne area are also likely to visit Simpson Barracks (such as Common Bronzewing *Phaps chalcoptera*, Gang-gang Cockatoo *Callocephalon fimbriatum*, Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*, and Olive-backed Oriole *Oriolus sagittatus*). Occasionally or rarely, habitats at Simpson Barracks may attract threatened fauna such as Powerful Owl *N. strenua*, Swift Parrot *Lathamus discolor* and Grey-headed Flying-fox *Pteropus poliocephalus*; although this is likely to be for foraging only, and these species are not expected to breed or roost there frequently or regularly.

Species that are unusual/rare in the Melbourne area, such as Grey Goshawk *Accipiter novaehollandiae*, Black Falcon *Falco subniger*, Barking Owl *Ninox connivens*, White-throated Needletail *Hirundapus caudacutus*, may visit the Barracks occasionally, but are unlikely to be there regularly, or to depend on habitat within the site. Due to historical ground disturbance and vegetation clearance, native small mammals are not expected to persist within Simpson Barracks, a conclusion also reached by HLA (2007). Dense grassy habitats within Simpson Barracks are still likely to be used by common species of reptiles (such as Tiger Snake *Notechis scutatus*; Common and Blotched Blue-tongued Lizards *Tiliqua scincoides* and *T. nigrolutea*).

The woodland and grassland habitats at Simpson Barracks support a small population of Eastern Grey Kangaroos (*Macropus giganteus*) and are used by other notable fauna such as Swamp Wallaby (*Wallabia bicolor*), Short-beaked Echidna (*Tachyglossus aculeatus*), and the Common Wombat (*Vombatus ursinus*).

With the exception of the unfenced strip of land to the south, the Barracks site is considered 'closed', being entirely fenced by security mesh fencing. This restricts movement of large mammals such as Eastern Grey Kangaroo, so space and resources are critical to the population's viability. Smaller animals or more mobile fauna are able to move along the waterways into and out of the site or fly over the fences (Jacobs, 2016).

As a 'closed' site, there have been numerous studies of the kangaroo population at Simpson Barracks, to estimate kangaroo abundance and density, the degree of migration into and out of the site or whether they are resident within Simpson Barracks boundaries (Defence, 2007 (as cited in Aecom, 2011); Aecom 2011; Wilson 2014; Aecom 2015). The origins of the kangaroo population at the Barracks are unknown.

AECOM (2015) reported that approximately 52 hectares of the Barracks is grassy woodland vegetation that provides suitable habitat for kangaroos. In addition to the woodland areas, the Barracks contains numerous areas around buildings where the grass is mowed, two large grassed sports fields and one large grassed parade ground (Long Green) that is watered during the summer (Wilson, 2014). The carrying capacity at the site is unknown, and whether or not the site is truly 'closed' to kangaroo migration is uncertain (AECOM, 2015).

Banyule Creek originates within Simpson Barracks. From Simpson Barracks, Banyule Creek flows south to its outfall into the Yarra River. The creek is approximately four kilometres long.

From Blamey Road, Banyule Creek generally runs parallel to Greensborough Road through Simpson Barracks to an open reserve north of Drysdale Road. Aerial imagery shows the creekline to be almost entirely cleared of its habitat in 1945 (Figure 6-2). Where North East Link is proposed through the western part of Simpson Barracks, the waterway currently is small and intermittent and forms a naturally incised channel providing poor quality fauna habitat. A series of man-made, stream-side, densely vegetated ponds provide habitat for common frogs (such as Common Froglet *Crinia signifera*, Southern Brown Tree Frog *Litoria ewingi* and Spotted Marsh Frog *Limnodynastes tasmaniensis*). Threatened wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus*, are unlikely to occur within this section of Banyule Creek.

Overall, Banyule Creek is relatively degraded and generally of low to moderate value to fauna for most of its length, particularly towards the north. Further south, and well outside Commonwealth land, Banyule Creek flows into or alongside Banyule Swamp within a large area of recreational parks associated with the Yarra River floodplain in Heidelberg and Bulleen where there are numerous records of threatened species.

Previous assessment of Simpson Barracks identified potential habitat for three threatened fauna: Swift Parrot *Lathamus discolor*, Grey-headed Flying-fox *Pteropus poliocephalus* and Brown Toadlet *Pseudophryne bibroni* (Jacobs, 2016). HLA-Envirosciences Pty Ltd (2007) assessed flora and fauna at the site in September 2006, including Elliot and pitfall trapping for fauna. During that assessment, no Swift Parrots, Grey-headed Flying-foxes, or Brown Toadlets were seen or heard, no small mammals were captured, and no threatened reptiles were detected. Though Jacobs (2016) undertook baseline surveys for threatened communities and threatened species of fauna, the survey involved daytime observations of habitat only; no threatened fauna species were observed opportunistically, and no targeted surveys were conducted.

As found during this assessment, and reported by HLA-Envirosciences Pty Ltd (2007), there is typically lower than expected fauna diversity in the western part of Simpson Barracks, perhaps due to the 'prevalence of aggressive bird species such as Noisy Miner, Rainbow Lorikeet, Australian Magpie and Common Myna', and to 'the modified nature of much of the Barracks as well as the isolated nature of the remnant habitat'.

There is one older (1992) VBA record of five Swift Parrots in the eastern section of Simpson Barracks. Practical Ecology (2017c) undertook an assessment of Swift Parrot for a broader area centred on the City of Banyule. Using historical records of the species, habitat assessments at 104 sites across the broader Banyule area (including one site on the north side of the eastern habitat patch at Simpson Barracks (outside the project boundary) and also habitat modelling, the study aimed to determine where Swift Parrots were most likely to occur and which areas were of greatest importance to the species. That assessment found that Simpson Barracks provided Swift Parrots with canopy opportunities that were of intermediate quality (middle of five categories) and tree basal area (an overall index of tree size) to be low (second lowest of five categories). However, the tree canopy health at Simpson Barracks was judged to be relatively good (fourth highest of five categories), and better than other notable areas of potential habitat included in the study (La Trobe University and Gresswell, Plenty Gorge area, and Yarra Bend Park) (Practical Ecology, 2017c). Overall, the Practical Ecology (2017c) assessment found that across the City of Banyule and surrounding areas, Simpson Barracks provided habitat opportunities that were of 'Secondary' rank for the Swift Parrot, compared with areas of highest (Principal) rank, which included the Yarra River floodplain (from Yarra Bend Park through to Banyule Flats), Plenty Gorge, and the La Trobe University/Gresswell area.

Representative photos of higher quality fauna habitats at Simpson Barracks are shown in Plate 3.

a. High value woodland/forest along Greensborough Road – Simpson Barracks

b. Degraded waterway – Banyule Creek upper, south of Simpson Barracks

Plate 7.2 Representative photos of fauna habitats within land

EPBC Act-listed threatened ecological communities (fauna)

No fauna communities listed as threatened under the EPBC Act were recorded or are expected to occur within a 500-metre buffer around Simpson Barracks.

FFG communities

One fauna community listed as threatened under the FFG Act is identified for the study area: *Victorian temperate-woodland bird community*. This community is defined in part by habitats (box-ironbark, yellow box, cypress pine and other woodlands) and in part by geographical area, which is broadly defined as: 'the country that lies in the south-east along the slopes and plains of the Great Dividing Range' (FFG, 2000). This description does not match the habitats within the project boundary on Commonwealth land, nor the geographical location of North East Link. Therefore, the VTWBC is considered to not occur within the area, despite some of the community's members possibly occurring in the area occasionally.

Threatened species

All threatened fauna identified for Simpson Barracks are shown in Appendix B. Most of those species are considered unlikely to occur within or around Simpson Barracks, as explained in Appendix B.

Habitat assessments were undertaken to determine the likely presence of species and targeted surveys for selected species were completed where it was considered likely the results would change our understanding of that species at a particular site based on existing information.

Species shown in Appendix B as having a moderate or high likelihood of occurrence within or near to Commonwealth land are discussed in more detail below. These tend to be the species known or considered likely to visit or reside in or around Simpson Barracks, or considered to be of high ecological significance for some other reason (such as considered to be threatened under the EPBC Act, FFG Act or DELWP Advisory List).

Results of the habitat assessment and targeted surveys undertaken at Simpson Barracks and upper reaches of Banyule Creek are shown in Table 7-7. Weather conditions are important to frog surveys, as they influence the likelihood of success. Weather conditions experienced during the targeted surveys at Simpson Barracks are shown in Table 7-8.

Table 7-7 Summary of results of habitat assessment and targeted fauna surveys undertaken in Simpson Barracks and upper reaches of Banyule Creek

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted round 1	Targeted round 2	Other species recorded
Simpson Barracks (includes upper reach of Banyule Creek)	Brown Toadlet and Southern Toadlet	*Pseudophryne bibroni/P. semimarmorata*		L	EN	4/06/2018	4/06/2018*	N	Common Froglet (*Crinia signifera)*
	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	2/11/2017	2/11/2017*	N	Common Froglet (*Crinia signifera)*
	Latham's Snipe	*Gallinago hardwickii*	Mi			2/11/2017	N	N	No other wetland birds
	Powerful Owl	*Ninox strenua*		L	EN	2/11/2017	2/11/2017*	N	No other nocturnal birds
	Swift Parrot	*Lathamus discolor*	CR	L	EN	2/11/2017	N	N	No threatened species

CR – Critically endangered; EN – endangered; VU – vulnerable; L – listed as threatened; Mi – Migratory; N – not undertaken (site deemed not suitable for species).
* One nocturnal survey undertaken anyway (despite habitat considered unsuitable) because survey was planned well in advance and ecologists were present.

Table 7-8 Weather conditions during threatened species targeted surveys

Date	Time start	Time finish	Temperature range (°C)	Relative humidity range (%)	Wind speed range (km/h)	Cloud cover (%)	Rain at time of survey	Rain on date from BoM (mm)	Weather station (BoM)
2/11/2017	2115	2210	12.1	68	7	30	None	1.2	Viewbank
4/06/2018	1705	1915	10.6–12.5	79–92	0–9	0	None	0	Viewbank

Grey-headed Flying-fox, *Pteropus poliocephalus* (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

Background information for the Grey-headed Flying-fox in the Melbourne area is provided in Section 7.2.2.

Targeted surveys for this species were not undertaken. Individuals are expected to forage across the entire study area, including within Simpson Barracks. The Grey-headed Flying-fox was observed in small numbers flying overhead during nocturnal field assessments at Simpson Barracks (2 November 2017 and 4 June 2018). It is likely to be a regular and frequent foraging visitor to the large River Red Gums within the entire Simpson Barracks area, including the western section where North East Link would traverse.

Common Bent-wing Bat (eastern ssp.), *Miniopterus schreibersii oceanensis* (FFG, Listed; DELWP, vulnerable)

The Common Bent-wing Bat is a cave-roosting and cave-breeding species, but also uses artificial structures such as abandoned mines and road culverts (Churchill, 2008). Populations are centred on maternity caves, and individuals disperse to other caves during the non-breeding season. It is considered to be a mostly uncommon bat, particularly in the inner suburban Melbourne area.

This species forages above the canopy, and may forage occasionally in the airspace of Simpson Barracks, even though the core foraging habitat within the Melbourne area is likely to be associated with the riparian forests of the Yarra River floodplain. Targeted surveys for this species were not undertaken. This species was not detected during the assessment.

Lewin's Rail, *Rallus pectoralis* (FFG, Listed; DELWP, vulnerable)***;*** **and**
Baillon's Crake, *Porzana pusilla* (FFG, Listed; DELWP, vulnerable)

These two species are secretive species that prefer densely vegetated wetlands, and are rarely seen or reported. Simpson Barracks does not contain suitable habitat for these species, although there is suitable habitat further down Banyule Creek along the Yarra River watercourse in the Banyule and Bulleen areas. Historical records of both species exist in these areas, particularly near Banyule Swamp. There are notably more records of Baillon's Crake than Lewin's Rail.

The habitat opportunities for these species along Banyule Creek are of low value, due to the small and narrow extent of habitat, their generally degraded condition, and their proximity to disturbance by humans and dogs. Either species may visit Banyule Creek, but there are no historical records of either species from that waterway, or from Simpson Barracks.
Targeted surveys for this species were not undertaken. Neither species was detected during the assessment.

Little Egret, *Egretta garzetta* (FFG, Listed; DELWP, endangered)**; and**
Intermediate Egret, *Ardea intermedia* (FFG, Listed; DELWP, endangered)**; and**
Eastern Great Egret, *Ardea modesta* (=alba) (FFG, Listed; DELWP, vulnerable)

These three species of white egret forage across a wide range of habitats, including saltwater and freshwater wetlands, mudflats, estuaries, lakes, dams, river margins, small waterways and wet grassland areas. They breed in flooded or fringing trees alongside larger wetlands.

Simpson Barracks does not contain suitable habitat for these species. The habitat opportunities along Banyule Creek are of low value, due to the small and narrow extent of habitat, their generally degraded condition, and their proximity to disturbance by humans and dogs.

The Eastern Great Egret is the most common of these three species in the Melbourne area, and is likely to visit wetlands associated with the Yarra River to forage regularly. An Eastern Great Egret was seen at Banyule Swamp during this assessment. It may occasionally visit Banyule Creek, but is not expected to visit Simpson Barracks, particularly the western section where North East Link would traverse.

Targeted surveys for these species were not undertaken.

Little Bittern, *Ixobrychus minutus* (FFG, Listed; DELWP, endangered)**; and**
Australasian Bittern, *Botaurus poiciloptilus* (EPBC, endangered; FFG, Listed; DELWP, endangered)

Background information for the Australasian Bittern in the Melbourne area is provided in Section 7.2.2.

These two species are cryptic species that are rarely seen or reported. They prefer dense tall vegetation in permanent freshwater swamps and wetlands, particularly when dominated by sedges, rushes and reeds. There are no records of either species along Banyule Creek or within Simpson Barracks. The potential habitat along Banyule Creek is degraded, highly disturbed, and only in relatively small and isolated patches, so is unlikely to support either species.

Targeted surveys for this species were not undertaken. Neither species was detected during the assessment.

Australian Painted Snipe, *Rostratula australis* (EPBC, endangered; FFG, Listed; DELWP, critically endangered)

Background information for the Australian Painted Snipe in the Melbourne area is provided in Section 7.2.2.

This species is unlikely to occur in or visit Simpson Barracks. A targeted survey for this species was not undertaken due to the very low likelihood of finding the species.

Australasian Shoveler, *Anas rhynchotis* (DELWP, vulnerable)**; and**
Hardhead, *Aythya australis* (DELWP, vulnerable)**; and**
Blue-billed Duck, *Oxyura australis* (FFG, Listed; DELWP, endangered)**; and**
Musk Duck, *Biziura lobata* (DELWP, vulnerable)

These four duck species use a wide range of habitats. The Shoveler is a filter-feeding duck, and uses well vegetated larger wetlands, dams and lakes. The Blue-billed and Musk Ducks are diving ducks that tend to prefer deep open water in wetlands, dams, lakes and slow-flowing rivers. The Hardhead is also a diving duck, but has the least habitat specificity of these species. It uses deep permanent wetlands, dams, lakes, slow-flowing rivers, as well as brackish wetlands and water storage ponds, and occasionally estuarine and littoral habitats such as saltpans, coastal lagoons and sheltered inshore waters.

Simpson Barracks does not contain suitable habitat for these species. Any of these species may be seen in appropriate habitats along the Yarra River floodplain, but none is likely to occur at Simpson Barracks. Targeted surveys for these species were not undertaken.

Grey Goshawk, *Accipiter novaehollandiae* (FFG, Listed; DELWP, vulnerable)

The Grey Goshawk is a generally uncommon but regular visitor to the Melbourne area. It favours woodlands, forests and riparian habitats in wetter areas, and in Melbourne, tends to be recorded along the Yarra floodplain and in other well-treed areas surrounding or near a wetland (such as La Trobe University). There are numerous records of Grey Goshawk in the

Banyule Flats area, as recently as 2018. NatureKit identifies no breeding records of this species in the Yarra River floodplain, with the nearest record from Dandenong Ranges National Park in 2005. It appears to be a foraging visitor to suitable habitat in the study area.

Targeted surveys for this species were not undertaken and the species was not detected during the assessment. The woodlands of Simpson Barracks provide potentially suitable habitat for this species, but the species would be expected to be a rare visitor at most.

Powerful Owl, *Ninox strenua* (FFG, Listed; DELWP, vulnerable)

The Powerful Owl is the largest owl in Australia. It is a forest owl that preys predominantly on arboreal mammals, and occurs in south-east Australia from South Australia to south-east Queensland. In Victoria, the Powerful Owl favours tall wet eucalypt forests in the ranges, but also uses drier forest types that have many live large hollow-bearing eucalypt trees in association with Blackwood Wattles, diverse habitats and extensive mature forest within two to five kilometres (Webster *et al.*, 2004). Powerful Owls form breeding pairs and reportedly pair for life.

The VBA results show numerous records of this species across Melbourne. These are mostly in the well-treed outer-eastern suburbs, along with a notable cluster of records of birds in parks and gardens in the inner parts of Melbourne (such as Royal Botanical Gardens, Flagstaff Gardens, Fitzroy Gardens). The records show that this species favours well-treed areas; there are few records in very urbanised areas. The VBA and BLA database results show a pattern of distribution for this species in the broader area – records tend to be centred on well-treed habitats along the Yarra River floodplain.

There are no VBA records of this species at Simpson Barracks. The nearest records are near La Trobe University (1.8 kilometres north-west) and Banyule Flats (2.2 kilometres south).

Researchers at Deakin University (Burwood campus) have been studying the Powerful Owl in the Melbourne area since the mid-1990s. Their data (published and unpublished) show that the VBA and BLA database records greatly underestimate the presence of this species across the eastern suburbs of Melbourne and across the study area (Bradsworth *et al.,* 2017). Modelling of potential habitat across Melbourne using BLA and VBA atlas records, followed by subsequent validation against GPS tracking data, suggests considerable important habitat along the entire length of the Yarra River and other major river systems around Melbourne (Bradsworth *et al.,* 2017). Their current and ongoing research uses GPS tracking of individual birds, and provides information on home range size and boundaries as well as movement paths through the landscape (Bradsworth *et al.,* 2017; and unpublished data). The research has found there are many pairs of resident Powerful Owls along the Yarra River floodplain.

The home range for a Powerful Owl pair appears to vary from 400 to 1,500 hectares across its range in Victoria (Webster *et al.*, 2004). Home range is likely to be determined by availability of food, which in Melbourne is almost entirely possums (ringtail and brushtail). The lower the abundance and density of possums, the larger the home range needs to be to support a resident pair of owls. An area that supports a sufficient abundance and density of possums is likely to form part of a home range, and be visited by foraging Powerful Owls.

Home ranges are typically centred on densely vegetated gullies, where nesting and most roosting occurs. Nesting by Powerful Owls tends to be within large hollows (mostly trunk hollows, but also in spout hollows) in tall and large old (350+ years old; Higgins, 1999) trees along permanent watercourses. The hollow is usually sheltered by the canopy. Breeding pairs may use multiple nest trees over time. If they do, those trees are always within the defined home range.

While most roosting occurs within densely vegetated gullies and strips along creeks and rivers, Powerful Owls use multiple roost sites, and choose their site partly on the basis of temperature (Cooke *et al.,* 2002). Roosts favoured in warm conditions may differ from those favoured in cool conditions. Powerful Owls will roost in suitably dense non-native trees, particularly pines and willows (Cooke *et al.,* 2002). Powerful Owls in urban areas may be susceptible to repeated disturbance, and tend to nest and roost in locations that are less disturbed. They show a reluctance to cross large roads (Bradsworth *et al.,* 2017).

The expansive well-treed parts of the Yarra River floodplain in the Kew, Bulleen and Banyule areas provide suitable habitat for the Powerful Owl (Bradsworth *et al.,* 2017). This is supported by the database and research observations. Powerful Owls are regularly reported in the Banyule Flats area, and fledging chicks have been reported there in multiple years (e-Bird.org, and confirmed by Deakin University researchers). From their home range observations, atlas records and personal observations, Deakin researchers are confident that at least two other breeding pairs reside along the Yarra River downstream of the Banyule area. Those areas are all characterised by the presence of large eucalypts in relatively dense and undisturbed forests along a permanent watercourse.

The Banyule Flats and Yarra River floodplain areas appear to be the focal home range habitats of Powerful Owls that occur within the study area. However, foraging habitat for those birds is likely to extend along the smaller tributaries. Banyule Creek supports foraging and possibly occasional roosting habitat, and Deakin University research shows that owls forage and possibly roost in the southern reach of Banyule Creek.

While owls visit the southern part of Banyule Creek from the Yarra River floodplain, there does not appear to be evidence that they follow it all the way along the northern part to Simpson Barracks. However, because the Deakin University tracking data only covered 34 nights of activity, it remains possible that birds use the area during the year. Deakin GPS results show that at least one of the Banyule Flats Powerful Owls ventures as far as Simpson Barracks (one owl spent six hours there on one night in April 2016; Cooke/White, unpubl. Data), but may get there using other well-treed patches, rather than the upper reaches of Banyule Creek. It must be noted, however, that GPS tracking data across nine breeding territories in the Melbourne area indicates a strong preference for creek lines and rivers for moving through the landscape (Carter 2017, unpublished data, Deakin Honours thesis).

At Simpson Barracks, owls are known to forage among the large eucalypt trees at the western end of the site. This area was included in a targeted survey at night in November 2017 and April 2018, but no owls of any type were detected.

Banyule Creek currently does not appear to have the habitat characteristics that support breeding/nesting. This may be due to inadequate tree size, absence of sufficiently large hollows, narrower patches (linear reserves) with higher disturbance levels, or inadequate density of prey to support owls over an extended period.

No Powerful Owls, or trees with apparently suitable hollows, were detected at Simpson Barracks during the targeted surveys.

Swift Parrot, *Lathamus discolor* (EPBC, critically endangered; FFG, Listed; DELWP, endangered)

Background information for the Swift Parrot in the Melbourne area is provided in Section 7.2.2.

The majority of Swift Parrot records relevant to North East Link are from areas north and west of Simpson Barracks (west of Watsonia Station, Gresswell Forest Nature Conservation Reserve, the grounds of La Trobe University, Macleod Station, and a few locations around Greensborough and Plenty).

There is one older (1992) VBA record of five birds in the eastern section of Simpson Barracks. A site assessment at the Barracks determined that the western margin (within the project boundary) largely consists of non-favoured eucalypt species (mainly River Red Gum *Eucalyptus camaldulensis*), which was dominated by aggressive nectar feeders such as Noisy Miners, Red Wattlebirds and Rainbow Lorikeets which are reported to disturb or out-compete Swift Parrots. The woodland on the eastern side of Simpson Barracks, which North East Link would not impact, supports superior habitat that is dominated more by Yellow Box *E. melliodora*, a favoured eucalypt species for Swift Parrot foraging.

This species was not detected during the assessment, and targeted surveys for this species were not done, due to: i) the low likelihood of detecting the species, and ii) the fact that not detecting the species would not lead to a conclusion the species is absent. Through desktop investigations and field habitat assessments, it was determined the Swift Parrot has at least some potential to visit almost any flowering trees within the project boundary (including Simpson Barracks) occasionally, but is unlikely to use any of those habitats to any great degree.

White-throated Needletail, *Hirundapus caudacutus* (FFG, Listed; DELWP, vulnerable)

This species is reported to be almost exclusively aerial within Australia, although birds do roost in trees at least occasionally (Corben *et al.,* 1982, Day 1993, Quested 1982, Tarburton 1993; in DoE 2018f). This species occurs over most types of habitat, particularly wooded areas, including forest and rainforest and less commonly above woodland.

Needletails are likely to forage occasionally in the airspace above Simpson Barracks, but unlikely to have a substantial association with the terrestrial habitats. Impacts on this species are not expected.

The White-throated Needletail was not detected during the assessment.

Glossy Grass Skink, *Pseudemoia rawlinsoni* (DELWP, vulnerable)

The Glossy Grass Skink is a poorly known and rarely recorded species, with only two VBA records in the study area. Both records are along the Yarra River: one from Bolin Bolin Billabong (1991), and the other along the Plenty River (1988). The Plenty River record is potentially mis-located (labelled as 'Barber Creek: 1 km. S. of Yan Yean').

This species prefers swamp and lake edges, saltmarshes and boggy creeks with dense vegetation. Simpson Barracks was thought to contain potentially suitable habitat along Banyule Creek. However, the long history of disturbance across the Melbourne area, including Simpson Barracks itself (Figure 6-2), along with introduced predators such as cats, rats and foxes, may mean this species is less abundant than the habitat presence suggests. The ability of the species to cope with disturbance is unknown.

Opportunistic searches for this species and all reptiles were undertaken at Simpson Barracks at the time of surveys for the Growling Grass Frog. No Glossy Grass Skinks were detected.

Banyule Creek is considered unlikely to support this species due to its narrow habitat extent and history of disturbance and degradation.

Growling Grass Frog, *Litoria raniformis* (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

Background information for the Growling Grass Frog in the Melbourne area is provided in Section 7.2.2.

Prior to visiting the site, Simpson Barracks was thought to have the potential to contain suitable habitat for the Growling Grass Frog in some of the vegetated man-made ponds at the head of Banyule Creek, despite there being no VBA records within Simpson Barracks or along Banyule

Creek. However, on-site habitat assessments determined that habitats present are unsuitable and the species is highly unlikely to occur there. No Growling Grass Frogs were detected during targeted surveys, in Simpson Barracks or anywhere.

Banyule Creek is considered unlikely to support this species due to its narrow habitat extent and history of disturbance and degradation.

Brown Toadlet, *Pseudophryne bibroni* (FFG, Listed; DELWP, endangered); **and Southern Toadlet, *Pseudophryne semimarmorata*** (DELWP, vulnerable)

Toadlets are small (<30 millimetres), short-limbed, ground-dwelling frogs in the Family Myobatrachidae (Southern Frogs) that tend to walk rather than jump. Most species have coarse black/brown and white marbling on the belly, and orange or yellow in the groin and/or armpits.

These two species (Brown Toadlet and Southern Toadlet) overlap in their distribution, and have very similar ecological characteristics. Both species are known from moist soaks, depressions, dams and watercourses in woodland and open forest, where there is sufficient litter or other ground cover. The Southern Toadlet is also known from heathlands. For both species, adults shelter beneath leaf litter and other debris in damp areas. Males call to attract females in autumn, and eggs are laid on land in damp depressions. Eggs and tadpoles develop in those depressions that flood following autumn rains.

Toadlets appear to be most threatened by habitat loss and habitat degradation. Their status with respect to the Amphibian Chytrid Fungus is unknown.

There is a handful of VBA records of both species across the Melbourne area, but a larger number of records occur towards the less-urbanised outer suburbs and beyond. Most records near to the project boundary are old (pre-1980) and are of Brown Toadlet. One 2005 record from Alphington Park/Wetlands (north side of the Yarra River) suggests that toadlets may persist in small areas of suitable habitat. Lorimer (2006) indicates these species are believed to be extinct within Boroondara (south of Simpson Barracks), having disappeared well over a decade ago from their last known habitat.

There are no VBA records of toadlets within Simpson Barracks or along Banyule Creek. Simpson Barracks had the potential to contain suitable habitat, along the Banyule Creek watercourse in the west, and the Banyule Creek in the east. However, targeted surveys were undertaken in both areas in 2018, and determined that both habitat locations were mostly disturbed and degraded. Neither toadlet species was detected during targeted surveys.

Migratory species

Migratory species relevant to Simpson Barracks were discussed in Section 7.2.2.

No Migratory species are expected to use habitats within Simpson Barracks any more than very occasionally. There is an old (1992) VBA record of 10 White-throated Needletails (*Hirundapus caudacutus*) from Elder Street Reserve, approximately 500 metres north of Simpson Barracks. This species is an aerial species that may forage occasionally in the airspace above Simpson Barracks, but that is unlikely to have any substantial association with terrestrial habitats within Simpson Barracks.

Non-threatened native fauna

Non-threatened native fauna that occur within and characterise the habitats within Simpson Barracks are described within the fauna habitat section above in Section 7.3.2.

Non-native, invasive and pest animals

There are records of 32 non-native terrestrial fauna species in the vicinity of Simpson Barracks, including 22 birds and 10 mammals (Table 7-9). These species vary in their abundance and in their environmental impact. Not all are considered pest species. Species considered to be most detrimental to the natural ecology of Simpson Barracks (and the broader Melbourne area) are identified as having a high level of impact (current).

Table 7-9 Non-native fauna species identified at Simpson Barracks, with an evaluation of their status as environmental pests

Common name	Scientific name	Level of impact in study area (current)	Likelihood of impact increasing from project
Mammals			
Dog	*Canis familiaris*	High	Low
Black Rat	*Rattus rattus*	High	Low
Brown Rat	*Rattus norvegicus*	Low	Low
House Mouse	*Mus musculus*	Low	Low
Eastern Grey Squirrel	*Sciurus carolinensis*	Low	Low
European Rabbit	*Oryctolagus cuniculus*	Low	Low
European Hare	*Lepus capensis*	Low	Low
Red Fox	*Canis vulpes*	High	Low
Cat	*Felis catus*	High	Low
Ferret	*Mustela furo*	Low	Low
Birds			
Indian Ringneck Parrot	*Psittacula krameri*	Low	Low
Pale-headed Rosella	*Platycercus adscitus*	Low	Low
Chestnut-breasted Mannikin	*Lonchura castaneothorax*	Low	Low
European Skylark	*Alauda arvensis*	Low	Low
Domestic Goose	*Anser anser (domestic)*	Low	Low
Domestic Duck	*Anas sp.*	Low	Low
Northern Mallard	*Anas platyrhynchos*	Low	Low
Rock Dove	*Columba livia*	High	Low
Spotted Turtle-dove	*Streptopelia chinensis*	Low	Low
European Goldfinch	*Carduelis carduelis*	Low	Low
European Greenfinch	*Carduelis chloris*	Low	Low
Common Blackbird	*Turdus merula*	Low	Low
Song Thrush	*Turdus philomelos*	Low	Low
Nutmeg Mannikin	*Lonchura punctulata*	Low	Low
Eurasian Tree Sparrow	*Passer montanus*	Low	Low
House Sparrow	*Passer domesticus*	Low	Low
California Quail	*Lophortyx californicus*	Low	Low
Indian Peafowl	*Pavo cristatus*	Low	Low
Red-vented Bulbul	*Pycnonotus cafer*	Low	Low

Common name	Scientific name	Level of impact in study area (current)	Likelihood of impact increasing from project
Red-whiskered Bulbul	*Pycnonotus jocosus*	Low	Low
Common Myna	*Acridotheres tristis*	High	Low
Common Starling	*Sturnus vulgaris*	High	Low

Simpson Barracks supports one native species of bird that is recognised as a pest species: Noisy Miner. In May 2014, '*Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (Manorina melanocephala)*' was formally added to the list of Key Threatening Processes under the EPBC Act. The Noisy Miner is abundant at Simpson Barracks and across the entire study area, and is likely to be having a strong influence on the ecology of the area, by competitively and aggressively restricting the distribution and habitat use of other species.

War Services easement

The War Services easement does not contain any significant habitat for fauna.

8. Description of the environment – aquatic ecology

This section describes the aquatic fauna and aquatic ecosystems as relevant to MNES and actions on Commonwealth land.

Aquatic fauna are defined as any fauna that occur in aquatic environment (such as waterways or wetlands) that are dependant on the aquatic environment for all life stages. For North East Link, fish, platypus and turtles are considered as aquatic fauna, whereas amphibians are considered as terrestrial fauna (Section 7). Aquatic ecosystems are defined as the communities of organisms that are dependant on each other and the aquatic environment. For this report, the aquatic ecosystems considered are freshwater ecosystems of streams, rivers and wetlands.

8.1 PER Guidelines scope relating to aquatic fauna and ecosystems

This aquatic ecology component of the ecological assessment considers the MNES that are protected under Part 3 of the EPBC Act:

- Listed threatened species (Sections 18 and 18A of the EPBC Act), including:
  - Macquarie Perch (*Macquaria australasica*) (endangered)
  - Australian Grayling (*Prototroctes maraena*) (vulnerable)
- The environment of Commonwealth land (Sections 26 and 27A), namely:
  - Simpson Barracks and an unfenced strip of land immediately to the south
  - A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

8.2 MNES within project boundary

Section 8.2.1 provides a summary of the results of the ecological database searches relating to aquatic fauna. A full assessment of the likelihood of occurrence of all threatened fauna is provided in Appendix B.

8.2.1 Desktop assessment results

Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of MNES that may occur, or for which suitable habitat may occur within the associated five kilometre buffer. Results of the PMST search are presented in Appendix D and summarised in Table 8-1.

Table 8-1 Threatened aquatic fauna species identified by the PMST for the study area

Common name	Scientific name	EPBC
Australian Grayling	*Prototroctes maraena*	VU
Eastern Dwarf Galaxias	*Galaxiella pusilla*	VU
Murray Cod	*Maccullochella peelii*	VU
Yarra Pygmy Perch	*Nannoperca obscura*	VU

VU – Vulnerable

Victorian Biodiversity Atlas

The VBA contains records of one additional aquatic fauna species listed as threatened under the EPBC Act that were not identified by the PMST, as listed in Table 8-2.

Table 8-2 Threatened aquatic fauna species identified by the VBA (but not PMST) for the study area

Common name	Scientific name	EPBC	VBA records (last recorded)
Macquarie Perch	*Macquaria australasica*	EN	56 (2015)

EN – Endangered

8.2.2 Site assessment results

The study area is within the Yarra River catchment, and North East Link intersects or is adjacent to sections of the Yarra River, Merri Creek, Plenty River, Koonung Creek and Banyule Creek. A number of permanent and ephemeral natural wetlands are also present, notably including Bolin Bolin Billabong, and Banyule Swamp.

The Yarra River provides very high value aquatic habitat, and supports an abundant and diverse assemblage of aquatic fauna, including native fish, turtles and platypus. The Yarra River supports this aquatic ecosystem, despite the cumulative pressures of heavily modified catchment landscape, including modified hydrology through river regulation, urban stormwater inputs containing chemical and litter pollution and modification of riparian zones. The floodplain wetlands of the Yarra River contain some high quality aquatic habitat, including the billabongs, although these are somewhat more degraded, with altered hydrological regime disrupting the ecological conditions of these dynamic systems.

The other waterways within the study area are generally more degraded, with heavy impacts of channel modification, urban stormwater and riparian zone modification affecting aquatic habitat condition and reduced aquatic biodiversity. Aquatic ecosystem assessment of these waterway revealed most sites fail to meet environmental condition objectives for aquatic ecosystems for urban waterways (EPA 2003, DELWP, 2018).

Threatened aquatic fauna (EPBC)

All threatened aquatic fauna identified for the study area are shown in Appendix B. Most of those species are considered unlikely to occur within the project boundary, as explained in Appendix B.

Species listed as threatened under the EPBC Act and shown in Appendix B as having a moderate or high likelihood of occurrence within the project boundary are discussed in more detail below. These tend to be the species known in the Yarra River, either as resident population in or near the project boundary, or considered to require passage through North East Link. In addition, due to the absence of historical fish survey data from Simpson Barracks, threatened fish species that may inhabit this habitat are also discussed in detail below.

Australian Grayling *Protroctes maraena* (EPBC, vulnerable)

Australian Grayling are the largest native salmoniform fish in Australia and the last surviving member of the family Prototroctidae (Ingram *et al.*, 1990; DoE, 2018a). The species occur in coastal rivers and streams in south-eastern Australia from the Shoalhaven River in NSW through to the Hopkins River in Victoria (Backhouse *et al.*, 2008). They usually prefer cool, clear waters with a gravel substrate and alternating pool and riffle habitats (Bishop & Bell, 1978; Berra, 1982) but can also occur in turbid water (Jackson & Keohn, 1988). They may form large schools, especially before spawning periods (Gomon & Bray, 2011). Adults prefer moderate to fast-flowing water, usually below altitudes of 200 metres, although in Victoria they have also been recorded above 1,000 metres (Gomon & Bray, 2011).

During autumn (March – June) Australian Grayling undertake large migrations to spawn in lower reaches of rivers (Wayne Koster, pers. Comm. 2018, Allen, 1989; Gomon & Bray, 2011). Larvae hatch after around 10 to 20 days and drift out to sea where the spend approximately six months as juveniles before migrating back into freshwater during spring where the remain for the rest of their life (DPI, 2015; Gomon & Bray, 2011). They are known to travel inland well over 100 kilometres (Jackson & Keohn, 1988). The environmental flows recommendations for the Yarra River include provision of high flows from December to May and from October to November facilitate the downstream and upstream migration of Australian Grayling respectively (Sinclair Knight Merz, 2012). Koster *et al. (*2013) found that Australian Grayling migrated between 15 and 30 kilometres downstream from upper reaches of the Bunyip River to reaches immediately upstream of the estuary in response to high flows in late March to late April. In late May many of the individuals tracked moved back upstream to the upper reaches where their migration began (Koster *et al.,* 2013). This is important given they have a relatively short life span and most individuals spawn only once before they die (Backhouse *et al.,* 2008).

As early as the 1990s Australian Grayling were reported to be impacted by competition with introduced trout, barriers to migration, and loss of habitat and on the mainland were restricted to isolated populations from the Grose River (NSW) to the Otway River in Victoria (Ingram *et al.*, 1990).

Although there are no reliable population estimates, Australian Grayling are reported to be relatively uncommon and often only caught in small numbers, and research suggest there can be large, annual fluctuations in abundance depending on prevailing conditions (DoE, 2018c). It is also not known if the species ascend their own natal streams, or whether there is mingling in coastal areas and ascension (swimming upstream) into any convenient river (Berra, 1982).

In the Yarra River, the construction of a fishway at Dights Falls has aided in the recovery of the species with increased recolonisation of upstream reaches (Backhouse *et al.*, 2008). They are known to occur in the Yarra River between Mullum Mullum Creek and Dights Falls (Sinclair Knight Merz, 2012) and eggs and larvae have been retrieved at Fairfield (Koster *et. al.,* 2017).The connectivity with the Yarra River means there is some potential for Australian Grayling to also exist in Merri Creek, although modelled distribution of the species suggesting a low probability they would exist in Merri Creek (Walsh *et. al.,* 2013). The habitat assessment of the Plenty River was found to potentially allow passage/migration corridors for the species from the Yarra River and this is also suggested by (Lieschke *et al.*, 2000).

The habitat assessment of all other waterways in the study area concluded the presence of Australian Grayling was unlikely, but is possible in waterways with direct connectivity to Yarra River and where suitable habitat was present. The habitat assessment of Banyule Creek identified significant barriers to fish passage that would prevent Australian Grayling from moving upstream from the Yarra River. Koonung Creek was also found to contain some significant covered sections that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. However, other fish species more capable of traversing drop structures (such as Shortfinend Eels, Common Galxias, Climbing Galaxias) were located upstream of these covered sections, which indicates passage maybe possible for some species. Australian Grayling are not expected to inhabit the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

Macquarie Perch *Macquaria australasica* (EPBC, endangered)

Macquarie Perch are a native fish freshwater species whose populations have declined in Victoria (DoE, 2018). They are now restricted to a small number of fragmented populations mostly in relatively undisturbed upland catchments, such as King Parrot Creek in the Goulburn Broken Catchment in northern Victoria (Bray & Thompson, 2018a). However, a self-sustaining population exists in the Yarra River from fish translocated in the 1920s (Bray & Thompson, 2018a) and possibly represents the most secure population in Australia (Douglas, 2002 cited in Ryan *et al.*, 2003). The species inhabits cool and clear freshwater reaches of rivers with deep holes and shallow riffles, as well as lakes and reservoirs (Bray & Thompson, 2018a). In rivers they prefer cool areas with aquatic vegetation, large boulders, woody debris and overhanging banks (Cadwallader & Eden, 1979; Bray & Thompson, 2018).

In a study of fish movement in the Yarra River, Macquarie Perch were found to typically occupy restricted reaches (<450 metres) although movements up to 1,000 metres in response to large flow variations during the spawning season where observed (Koster *et al.*, 2013). However, there was no evidence of synchronised migration or movement of multiple fish to specific locations (Koster *et. al.,* 2013). In rivers and streams they spawn in shallow, fast-flowing areas in the lower reaches from October to December, usually when water temperatures rise above 16°C (Bray & Thompson, 2018a) although the DoE (2018e) suggests the breeding season can extend into mid-January.

In the 1990s, the distribution of the species was reported as fragmented with only small, discrete populations remaining in the upper reaches of the Mitta Mitta, Broken, Campaspe and Goulburn Rivers in northern Victoria, and the upper reaches of the Lachlan and Murrumbidgee Rivers in southern NSW (Ingram *et al.*, 1990). However, the Yarra River is now reported to have an abundant and healthy Macquarie Perch population and they are distributed throughout the majority of the river (Commonwealth of Australia, 2017; Ecosure, 2011). Finns Reserve in Templestowe is considered an important habitat and the flow requirements of the species have been incorporated into environmental flow recommendations to maintain suitable habitat throughout the Yarra River (Sinclair Knight Merz, 2012).

Due to connectivity with the Yarra River, there would be a high potential for the species to also occur in Merri Creek. The species is reported as living in Mullum Mullum Creek and the Plenty River Melbourne Water (2012). As previously stated, substantial barriers to fish passage prevent fish passage upstream from the Yarra River into Banyule Creek. Koonung Creek was also found to contain some significant covered sections and drop structures that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. Given that the movements of Macquarie Perch are generally limited (Koster *et al.*, 2013), it is unlikely this species inhabits Banyule and Koonung Creeks. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

Dwarf Galaxias *Galaxiella pusilla* (EPBC, vulnerable)

Dwarf Galaxias are a mid-water, free swimming species with its entire life spent in freshwater (Saddlier *et al.*, 2010). Typically they occur in slow flowing and still, shallow, permanent and temporary, freshwater habitats including swamps, drains and backwaters that often contain dense stands of aquatic macrophytes and emergent plants (Cadwallader & Backhouse, 1983). However, they can also occur in creeks and streams (Bray, 2016) and in larger pools individuals are usually found amongst marginal vegetation (Saddlier *et al.*, 2010). Temporary wetland habitats rely on seasonal flooding and connectivity to other sites where the species occur for habitat and population replenishment (Saddlier *et al.*, 2010). They are also known to live in association with burrowing crayfish (*Engaeus* spp.) with the burrows providing refuge from predators and dry conditions (Beck, 1985; McDowell, 1996). It is not clear if they are capable of aestivation during dry conditions or if they rely on refuges such as crayfish burrows (Saddlier *et al.*, 2010) or wet vegetation (Coleman *et. al.,* 2016).

Dwarf Galaxias are a short-lived species that probably has poor dispersal abilities (Saddlier *et al.*, 2010), reach sexual maturity in their first year, and likely die soon after spawning (Bray, 2016). Spawning occurs in late winter-spring with eggs usually attached on the underside of aquatic vegetation or on hard surfaces such as rock or timber (Saddlier *et al.*, 2010). However, Bray (2016) suggests they can spawn all year round in suitable conditions. Larvae hatch after about two to three weeks and are around 4.5 millimetres long (Saddlier *et al.*, 2010).

Across most of the range of the Dwarf Galaxias, there are large numbers of and expansive stretches of waterways that are either unsurveyed or have been surveyed using methods not particularly suited to the species (such as electrofishing). DoE (2018b) suggests the very small body size of the species limits the use of electrofishing and their preferred habitat (swamps, drains and the backwaters of streams and creeks) are less commonly surveyed than main channel habitats. Off-stream habitats are also difficult to survey due to abundant aquatic vegetation, often higher electrical conductivities and soft sediments (DoE, 2018d). These habitat factors, combined with their short life span, leads to populations fluctuating annually reflecting variability in habitat desiccation and connectivity, spawning and recruitment success, dispersal and colonisation/recolonisation (DoE, 2018d).

Although the Dwarf Galaxias is still widely distributed, populations are fragmented and patchy. In the Yarra River catchment, only translocated populations are known to exist in the La Trobe University wetlands (Saddlier *et al.*, 2010). Their presence in the study area is considered unlikely. However small aquatic habitats in the protected environment of Simpson Barracks may contain a similarly translocated population, which may be isolated due to lack of connectivity. The absence of fish records from this site means the presence of Dwarf Galaxias at this site is unlikely but possible.

Murray Hardyhead *Craterocephalus fluviatilis* (EPBC, endangered)

The native Murray Hardyhead is endemic to the lower Murray-Darling River system in South Australia, Victoria and New South Wales (Backhouse, Lyon, & Cant, 2008). It was once considered widespread and common throughout its range but there has been an extensive decline in distribution and abundance and it is now one of the most threatened vertebrate species in Australia (Backhouse *et al.*, 2008). It now exists in only a few isolated areas in Victoria (Backhouse *et al.*, 2008). The species prefers relatively salty fringing wetlands in floodplains and lakes (Lintermans, 2007; Bray & Thompson, 2011). They can survive in isolated and salty ephemeral wetlands on the fringes of floodplain during dry seasons before dispersing out over the floodplain during wet seasons (Lintermans, 2007; Bray & Thompson, 2011).

The exact distribution of the Murray Hardyhead is unclear due to confusion in identification with other Hardyheads that appear similar (Backhouse *et al.*, 2008). A review of distribution in Victoria suggests that it has been recorded and restricted to lakes near Mildura and several in the Swan Hill-Kerang district (Backhouse *et al.*, 2008). It is likely the records in the VBA database are of species other than Murray Hardyhead. This species is unlikely to occur within the study area.

Murray Cod *Maccullochella peelii* (EPBC, vulnerable)

The iconic Murray Cod is the largest freshwater fish in Australia but populations have reduced markedly throughout their natural range, and the species is now rare in some areas (National Murray Cod Recovery Team, 2010; Bray & Thompson, 2018b). They live in a variety of habitats including rivers, lakes and billabongs but are very territorial and in rivers prefer deep holes with boulders, fallen trees and other woody debris and banks with overhanging vegetation (Doe, 2018a; Bray & Thompson, 2018b). Although they prefer the main channel of rivers they can be found in inundated floodplain channels during high flows although this is reported as limited (DoE, 2018a; Bray & Thompson, 2018b). Tracking studies in the Murray River found the species was strongly associated with structural woody habitat, deep (>2.4 metres), slow flowing water (<0.2 metres s-1) close river banks (Koehn & Nicol, 2014).

Murray Cod undertake a spawning migration each year and in rivers have been found to travel several hundred kilometres upstream (Koehn *et al.*, 2009). In Southern areas spawning tends to occur from early October to mid-December (Humphries, 2005; DoE, 2018b). They form breeding pairs prior to spawning and select a site or nest that is usually a sunken log in lowland rivers, or a submerged rock in upland streams (DoE, 2018b). Females lay demersal eggs that are guarded and fanned by her male partner until they hatch into pelagic larvae after about 25 days (Humphries, 2005; Bray & Thompson, 2018b). After spawning, adults move back downstream and return to the same territory occupied before upstream (Koehn *et al.*, 2009).

The species is endemic to river systems of the Murray–Darling Basin in south-eastern Australia. However the species has been successfully introduced in the Yarra River (National Murray Cod Recovery Team, 2010; DoE, 2018b). The Murray Cod's EPBC Vulnerable status does not apply protection to the populations outside the natural range in the Murray-Darling basin. Therefore the introduced Murray Cod population in the Yarra River catchment is not considered vulnerable under the EPBC Act. FFG status does apply to this species across the state, including the Yarra River population.

There is no overall Murray Cod population monitoring program within Victoria (National Murray Cod Recovery Team, 2010) which makes estimation of population sizes problematic. Recreational catches of Murray Cod measuring over one metre long have been reported in the Yarra River at Eltham, Wonga Park and Templestowe. The presence of Murray Cod in these areas, including the Plenty River catchment, is also reported by Melbourne Water (2012). Environmental flow recommendations have been made to support Murray Cod in the Yarra River between Yering Gorge and Dights Falls (Sinclair Knight Merz, 2012). Given the territorial and sedentary nature of the species, and their preference to inhabit deeper areas of rivers, the Murray Cod is expected to occur within the project boundary in the Yarra River. However, there is a high probability that it also occurs in Merri Creek and Plenty River and due to connectivity with the Yarra River and available habitat. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp, nor in Banyule and Koonung Creeks due to the presence of barriers to movement and absence of suitable habitat.

Yarra Pygmy Perch *Nannoperca obscura* (EPBC, vulnerable)

The Yarra Pygmy Perch is a small freshwater fish endemic to south-eastern Australia and is found in South Australia and Victoria (Saddlier & Hammer, 2010; Bray & Thompson, 2018c). Although still widely distributed, populations are fragmented and patchy across the landscape due to habitat changes to rivers, creeks and shallow freshwater wetlands (Saddlier & Hammer, 2010). They are a free-swimming species and their entire life cycle is completed in freshwater (Cadwallader & Backhouse, 1983; DoE, 2018a). They typically occur in slow-flowing or still waters with large amounts of aquatic vegetation such as lakes, ponds and slow-flowing rivers (Saddlier & Hammer, 2010; Bray & Thompson, 2018c).

Yarra Pygmy Perch spawn during spring (September to October) and although little is known of the breeding biology, it is assumed that breeding behaviour is similar to the closely related Southern Pygmy Perch (*N. australis*), which lays demersal, non-adhesive eggs on aquatic vegetation and the substrate (Kuiter, 2013). It is believed to be a short-lived species with poor dispersal ability (Saddlier & Hammer, 2010).

The species is distributed from the Bunyip River basin in West Gippsland through to South Australia near the mouth of the Murray River (Saddlier & Hammer, 2010). Some populations are very small and located in extremely limited ephemeral habitat, while others are quite large and extensive and occur in permanent waterways (Saddlier & Hammer, 2010). The DoE (2018a) suggests that small, isolated populations exist between Melbourne and the Hopkins River system in south-west Victoria, but the major Victorian populations are located between the Barwon River and the South Australia border. Since European settlement it has been reported that the Yarra River population disappeared in 1872 but a small population remains in Deep Creek on private land in Lancefield (Saddlier & Hammer, 2010; Bray & Thompson, 2018c). The fragmented and patchy nature of its remaining habitat across the landscape, and variability of this habitat between seasons and years, makes the species extremely vulnerable to local extinctions (Saddlier & Hammer, 2010). Although an original resident of the Yarra River Basin, it is unlikely to be present within the study area.

8.3 Whole of environment in and around Commonwealth land

8.3.1 Desktop assessment results

Protected Matters Search Tool

The results of the Protected Matters Search Tool (PMST) presented in Section 7.2.1 include all Commonwealth land considered for North East Link.

Victorian Biodiversity Atlas

Within a 500-metre buffer area surrounding Commonwealth land, no fish are recorded in the VBA, and a single record of the Eastern Snake-necked Turtle (*Chelodnia* longicollis) is recorded from the east side of Simpson Barracks near Yallambie Drain.

In the downstream connected waterways of Banyule Creek and Banyule Swamp, two aquatic fauna species have been recorded from Banyule Swamp: the Eastern Snake-necked Turtle and Water Rat (*Hydromys* chrysogaster).

There are no records of fish from Simpson Barracks, Banyule Creek or Banyule Swamp in the VBA.

8.3.2 Site assessment results

Simpson Barracks

Simpson Barracks contains two natural drainage systems: the east side drains to Yallambie Drain which runs into the Plenty River, and the west side includes the upper catchment of Banyule Creek which drains into the Yarra River (Jacobs, 2016). The project boundary is located on the western side of Simpson Barracks, within the headwater catchment of Banyule Creek.

Although flora and fauna studies have been undertaken within the Barracks, little historical information is available about the aquatic ecosystem values within Banyule Creek, or other aquatic habitats of small wetlands. Substantial erosion of the drainage lines are indicative of high flows that occasionally occur and there is also evidence of undercut banks and accumulation of organic debris (Jacobs, 2016).

Aquatic fauna habitats

Simpson Barracks contains the headwater of Banyule Creek. The waterway within the Barracks is an ephemeral waterway, which provides aquatic habitat only during and following periods of rainfall runoff. The riparian condition of the waterway is relatively good, due to the intact vegetation. However, considerable modification to the drainage in the Barracks includes a constructed drain that diverts much of the water away from the natural channel. The habitat in this drain is poor, and contains little instream structural diversity or microhabitats. The waterway habitats in the headwaters of Banyule Creek support very poor aquatic ecosystem conditions, as indicated by very low diversity and pollution tolerance of macroinvertebrate community collected in Rapid Bioassessment. There is no suitable habitat for fish in Banyule Creek at Simpson Barracks.

Away from the main channel of Banyule Creek, a number of constructed wetlands are present that receive runoff from catch drains and appear to contain permanent water. These wetlands may provide good habitat for small bodied fish, but fish surveys revealed no fish were present.

Field assessment of Banyule Creek downstream of Simpson Barracks revealed a poor quality aquatic ecosystem, with degraded aquatic macroinvertebrate communities. The hydrological field assessment of Banyule Creek revealed that groundwater inputs to the creek occur downstream of Lower Plenty Road, beyond the extent that North East Link would impact groundwater. Fish surveys revealed the native Common Galaxias (*Galaxias maculatus*) was present in the downstream reaches near Banyule Road, in reaches that are maintained by groundwater inputs of water. However, the fish community of Banyule Creek was dominated by the exotic Oriental Weatherloach (*Misgurnus anguillicaudatus*) which was found in all reaches on Banyule Creek containing water. Habitat quality in Banyule Creek was generally poor, with evidence of scouring and bank erosion, likely caused by high flows from existing urban stormwater. Beds of fringing aquatic macrophytes are widespread.

The field assessment of Banyule Swamp indicated a wetland impacted by stormwater inputs. The water level of the lake is maintained by a constructed levee. The macroinvertebrate community surveyed revealed a moderate diversity of wetland generalists, although the fish surveys indicted a community dominated by exotic Mosquito Fish (*Gambusia holbrooki*). The native Short-finned Eels (*Anguilla australis*) was also abundant in the swamp. In addition, Eastern Snake-necked Turtles were observed. The swamp contains abundant fringing aquatic macrophytes, which provide good habitat diversity for aquatic fauna.

Threatened species

Targeted surveys were undertaken in Banyule Creek and wetlands within Simpson Barracks for Dwarf Galaxias, based on the possibility that an isolated population may occur in this protected habitat. No Dwarf Galaxias, or any other fish, were detected within Simpson Barracks. No EPBC Act-listed fish species are expected to occur at Simpson Barracks.

War Services easement

The War Services easement does not contain any watercourses or drainage systems. It therefore does not support any aquatic flora or fauna.

8.4 Groundwater dependent ecosystems

A full overview of the hydrogeology within the project boundary and immediate environs within the study area is outlined in PER Technical Appendix B – Groundwater. Of greatest importance to GDEs in the study area and their reliance upon groundwater is the modelled depth to groundwater. Modelled depth to groundwater is the water level that has been generated through a numerical model (applying rainfall to the model and checking against a number of points from the North East Link groundwater monitoring network). In addition, modelled groundwater drawdown provides an indication of the extent of groundwater drawdown across the study area, using construction methods (such as tanking scenario) as outlined in PER Technical Appendix B – Groundwater.

Terrestrial wetland interaction with groundwater

The water within most terrestrial wetland systems is sourced from groundwater and rainfall (Hatton and Evans, 1998), including inflows from shallow groundwater systems (Harrington & Cook, 2014) or irrigation and run off, which is particularly common in urban areas. Yet for many wetland communities, the reliance on water sources and the degree of groundwater dependency is largely unknown (Hatton & Evans, 1998; Kuginis *et al.*, 2012).

Dependency may shift over climatic conditions, as the constituent species of some wetlands may be completely dependent on groundwater discharge under all climatic conditions (that is, obligate dependency) while others may have dependence only under dry conditions or at certain times of the year (for example, facultative dependency) (Thorburn *et al.*, 1994).

Many of the species common in terrestrial wetlands have shallow root systems that are relatively intolerant of drying out (Kuginis *et al.*, 2012).

Terrestrial waterway interaction with groundwater

Waterways or wetlands where groundwater discharge provides a contribution to the hydrology of the system can contain aquatic ecosystems that are dependent on the contribution of groundwater. These may include streams with a baseflow that is maintained by groundwater inputs (that is, a gaining system) or wetlands where a pool maintained by groundwater inputs provides aquatic habitat. The ecological significance of groundwater dependent aquatic ecosystems is the ability for these systems to provide aquatic habitat during periods of low rainfall runoff, which can act as drought refugia for aquatic species. In some systems, these drought refugia can support isolated populations of species that can then disperse or recolonise other habitats following rainfall events and reconnection with other aquatic habitats.

Southern portal – Yarra Flats

At the southern portal, the majority of the Yarra River floodplain (characterised mainly by Floodplain Riparian Woodland) adjacent to the project boundary is mapped as GDEs relying on the surface or subsurface expression of groundwater. The GDEs in this area are thought to be accessing an alluvial aquifer, which is understood to be strongly interconnected with Yarra River surface water levels, though local groundwater levels and flux pathways are affected by local geology and topography.

Type of GDE

'GDE – subsurface expression' (BOM), 'GDE – surface expression' (BOM) and 'GDE' (PPWCMA) is mapped across much of the area on the Yarra River floodplain. In addition, Floodplain Wetland Aggregate (EVC 172) is mapped by DELWP within Bolin Bolin Billabong as 'GDE – surface expression' (BOM).

Groundwater dependency

Billabongs associated with the Yarra River

In billabongs associated with the Yarra River floodplain, where depth to groundwater is modelled to be 0 to five metres (based on groundwater depth and modelled drawdown), it is assumed these wetlands are largely filled by overland flow during floods or local runoff from natural or stormwater catchment, and so do not have obligate dependency. Connection to groundwater is expected to occur during and immediately following flooding or inundation events, as the water collected in the billabong seeps into the groundwater. Drawdown in these areas is unlikely to affect billabong condition as they are ephemeral systems in a constant state of flux depending on flooding of the Yarra River and seasonal rainfall.

Bolin Bolin Billabong

Bolin Bolin Billabong is a high value ox-bow lake on the floodplain of the Yarra River west of Bulleen Road (Jacobs, 2017). The eastern end of Bolin Bolin Billabong contains a deep pool, with an area of permanent surface water, which dries out rarely (approximately once per decade) (Jacobs Group, 2017). This deep pool spanning an area of approximately 0.2 hectares is recognised by Melbourne Water as groundwater dependent (Jacobs Group, 2017) and at typical base-flow water levels is approximately 1.8 metres deep. The pool is located in the deepest section of the billabong. The permanency of surface water in this pool is largely due to the depth of the scour pool in this excised palaeo channel, which allows the pool to intersect the quaternary alluvial groundwater, which maintains the pool hydrology.

Bolin Bolin Billabong has highly variable hydrology that can be characterised in two distinct phases. During the flooded phase the majority of the billabong is inundated with water from the Yarra River, either due to flooding overbank flows, or managed watering events. During this phase, the water in the billabong gradually seeps into the groundwater and the water level declines until it reaches an equilibrium with the alluvial groundwater. During the dry phase, water is present only in a deep pool, located at the eastern end of the billabong. It is recognised by Melbourne Water this pool is a surface expression of the alluvial groundwater, and is often referred to as permanent water maintained by groundwater. The projected drawdown of 0.1 to 0.5 metres in this area has a moderate to high likelihood of lowering the water level in the pool by a similar difference. However, under Melbourne Water's intended managed hydrological regime of mostly annual flood and dry phases, this change in water level would only affect the billabong during the dry phase, and this change in the pool depth is considered minor compared with the annual hydrological variability in the billabong. Under the 2024 (post-construction) and 2075 (operation) scenarios, the ecological consequence of this change to water level is some shrinking of the extent of wetland permanently inundated and potentially altering water quality.

However, the significance of this consequence is minor, as the species and ecosystem that inhabit the deep pool during the dry phase and which would be impacted by this change are dominated by tolerant generalists, common colonisers, and weed/pest species. Nevertheless, the cultural and amenity significance of the permanent pool and associated ecosystem may be greater than the ecological significance of the pool itself. Native vegetation is not expected to be affected, due to the small change relative to the depth to groundwater. Melbourne Water are actively managing the hydrological regime of the billabong.

Groundwater salinity

In all areas around the southern portal, groundwater salinity is not expected to influence the impact of groundwater changes. The models predict a slight drawdown rather than mounding in areas supporting native vegetation along the Yarra River floodplain, which would result in decreasing (if any) rather than increasing groundwater salinity for the trees which have obligate groundwater dependency.

Tunnels – Banyule Flats

Groundwater dependent ecosystems are modelled extensively across the Banyule Flats area. However, as short-term and long-term groundwater drawdown resulting from the project's construction is modelled to be less than 0.1 metres throughout the main tunnelled section of the project boundary that includes ecological values, including the Banyule Flats this area is not considered further. Any impacts on ecological values in this area are expected to be negligible. Areas predicted for more significant drawdown are limited to the suburban areas along and beyond the escarpment along Buckingham Drive, west of the Banyule Flats area.

9. Expected and potential impacts and mitigation

This section describes the ecological impacts that are expected to, or that may, result from the construction and operation of North East Link, and mitigation measures that would be applied to potential impacts to reduce or eliminate the extent, severity or duration of residual impacts.

Table 9-1 summarises the potential impacts for the construction and operation of North East Link.

The significance of impacts have been evaluated specifically with respect to MNES and whole of environment on Commonwealth land, in accordance with criteria outlined in the EPBC Act Guidelines 1.1 and 1.2, in subsequent sections of the report, as follows:

- Section 10 – Matters of National Environmental Significance – Significant impact guidelines 1.1 (Department of Environment, 2013)
- Section 11 – Step 4 of the *Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies – Significant impact guidelines 1.2* (DSEWPAC, 2013).

Table 9-1 Direct and indirect impacts that would or might result from construction and operation of North East Link

Potential impact	Section of this report
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Death or injury of fauna during construction	9.1.6
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of terrestrial wildlife corridors creating barriers to terrestrial fauna movement	9.1.8
Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement	9.1.9
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3

Potential impact	Section of this report
Degradation of aquatic habitat through contaminated runoff	9.2.4
Death or injury of fauna during road operation	9.2.5
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

9.1 Construction impacts and mitigation

This section describes the potential ecological impacts that North East Link would or may have during construction, and the mitigation and management efforts that would reduce or eliminate the impacts.

9.1.1 Removal of vegetation and habitat

Impact description

Construction of new roads and tunnels, widening of existing roads, and ancillary infrastructure would require land to be cleared of its vegetation and fauna habitat. Where habitat is replaced by new road surface, loss is permanent. Where habitat is lost to create space for the construction process (such as access, laydown, spoil storage, parking, offices), the loss would be shorter-term (two to eight years).

This assessment has conservatively assumed that any flora or communities located within the project boundary would be lost. Flora are discussed more specifically in Sections 10.1.2 to 10.1.4.

The vegetation cleared may or may not be threatened at a Commonwealth or state level, and may provide habitat for terrestrial or aquatic fauna that may or may not be threatened at a Commonwealth or state level.

Loss of habitat reduces foraging, nesting and dispersal opportunities for fauna in the local area, and confines fauna to the extent of suitable habitat that remains, often increasing con-specific and inter-specific competition. Loss of too much habitat, relative to the original contiguous habitat patch, can threaten the viability of some populations that currently rely on the extent of habitat present. Small proportional losses are less detrimental than large proportional losses. Animals that are unable to seek and obtain resources from alternative sources (closed population) are more disadvantaged by habitat loss than those that can freely move to and use other areas (open population).

Loss of habitat affects species differently. Some species are mobile and adaptable (such as Red Wattlebird) and are able to use remaining habitats or even a degraded form of the same habitat. Others are more sensitive to habitat extent and condition, and may decline or disappear as habitat patches get too small or too degraded (such as Eastern Yellow Robin). Most of the fauna that persist in the Melbourne area are adaptable fauna, already coping with a fragmented and degraded habitat landscape. This applies to common non-threatened fauna as well as rarer threatened fauna.

Land clearing during construction of North East Link may also result in indirect loss or degradation of adjacent habitat that is not cleared, but which becomes exposed to new detrimental influences (edge effects).

Proposed avoidance and mitigation measures

The reference project for North East Link has avoided direct impacts to a significant area of (non-threatened) vegetation throughout the Banyule Flats and Warringal Parklands by tunnelling underneath this area. It is anticipated that with further refinement in the detailed design stage, the actual project boundary would be reduced, which would further minimise the removal of native vegetation and/or mature trees.

Where the removal of native vegetation (also fauna habitat) is unavoidable, North East Link would meet the assessment and offset requirements of the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (2017a). A revised Native Vegetation Removal (NVR) report (dated 24 June 2019) has been completed that identifies general offset units and species offset units required to compensate for the vegetation removal. In addition to meeting Victorian offset obligations, substantial areas disturbed during construction would be revegetated using locally indigenous species (utilising seed collected from species within the project boundary where possible) that are suited to the landscape profile and setting being revegetated.

While offsetting is required for removal of vegetation, it would not reduce the loss of listed flora species from within the project boundary. For detail regarding mitigation measures for listed species such as Matted Flax-lily, see Section 10.1.2. Where possible, impact to threatened and protected flora species would be minimised through reduction of the project boundary. To avoid inadvertent impacts to threatened or protected species during construction, a Construction Environmental Management Plan (CEMP) and Tree Protection Plan would be developed that clearly identify measures to guard against vegetation loss and, protect areas such as no-go zones and tree protection zones. Maximum possible tree retention would increase the likelihood of retaining all valuable habitat linkages and wildlife corridors, and minimise the removal of trees and vegetation that provide fauna habitat.

Tree Removal Plans would also be developed that clearly identify trees to be retained and removed and the protocol for tree removal. The Tree Protection Plans would identify and establish Tree Protection Zones[9] (TPZs) to protect retained trees from construction or related activities. Where TPZs would be encroached upon, the Tree Protection Plan would clearly indicate where works can and cannot occur so that no more than 10 per cent of the TPZ would be impacted. In addition, where Structural Root Zones[10] (SRZs) are to be impacted, trees would be regarded as a loss.

While the Australian Standards provide clear guidance regarding TPZs and SRZs, they are generally silent on the depth of protection required for subsurface works. While maximum rooting depths for River Red Gum are unknown, the available evidence suggests that roots can penetrate down to 10 metres (Davies, 1953) and potentially deeper. The Melbourne Metro Arboriculture Impact Assessment (AJM JV, 2016) produced for the Melbourne Metro Rail Authority, indicates the depth of tunnelling (3.1 metres at its shallowest point) is below the zone of anticipated growth. The assessment indicates that impact may occur through ground

[9] TPZ: A specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development. *TPZ = DBH × 12*. A TPZ should not be less than two metres nor greater than 15 metres (except where crown protection is required) (AS4970-2009).

[10] SRZ: The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres. This zone considers a tree's structural stability only, not the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area. The SRZ is determined following the formula provided in AS 4970-2009 (Council of Australian Standards, 2009) where: $SRZ\ radius = (D \times 50)^{0.42} X\ 0.64$, where D = trunk diameter, in m, measured above the root buttress.

stabilisation practices associated with tunnelling such as grouting and soil mixing to limit the impact of ground setline and potential for major settlement.

Given uncertainties around rooting depths of trees, it is difficult to present a precise discussion on the levels of protection required for individual trees. However, from an impact assessment perspective the following approach has been applied when considering whether a large tree is considered lost for offsetting purposes:

- Any tree that has >10 per cent encroachment within the TPZ is considered lost
- Any tree that has any encroachment within the SRZ is considered lost
- Where tunnelling impacts only the sub-surface area, a minimum depth of two times the depth of the SRZ must be avoided for the tree to be considered not impacted.

Any trees that have

- Greater than 10 per cent encroachment within the TPZ would be assessed by a qualified arborist to verify the acceptable level of encroachment
- Encroachment (tunnelling) at a depth greater than the depth of the SRZ but less than two times the depth of the SRZ would be assessed by a qualified arborist to verify the acceptable level of encroachment.

Impacts to individual trees are likely to vary based on the tree species, age, magnitude of settlement and/or volume of altered soil conditions in contact with the root zone of trees. Given this uncertainty, it is proposed the area and number of trees and other vegetation actually removed is confirmed through a post-construction assessment. Trees designated ‘at risk’ could be included in the Tree Protection Plan.

During construction, impacts on remnant vegetation to be retained must be avoided to prevent loss of vegetation not earmarked for loss.

As for loss of vegetation, loss of some fauna habitat would be unavoidable, but would be minimised as far as possible through design, and minimised within each site during construction. Environmental Management Plans (including a Construction Environmental Management Plan (CEMP), Worksite Environmental Management Plans (WEMPs), and an Operations Environmental Management Plan (OEMP)) would be prepared and implemented in consultation with relevant councils, VicRoads, Melbourne Water, EPA Victoria and other authorities as required by NELP or under any statutory approvals. Prescribed fauna management measures, in compliance with Victoria’s *Wildlife Act 1975*, would enable appropriate management of fauna that may be displaced due to habitat removal.

9.1.2 Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination

Impact description

Some project activities, such as the removal, handling and transport of soil and rock, dumping, crushing and processing of material, and increased traffic along existing, newly constructed roads and access tracks (mainly during construction), have the potential to increase dust and sediment levels. Erosion, sedimentation, dust and contamination represent key risk factors in potential negative impacts to native vegetation and terrestrial habitats. If construction activities, such as access road upgrades and excavation, are not properly managed, this can lead to the mobilisation of airborne or waterborne sediments and/or contaminants, which can have detrimental impacts on native vegetation.

Effects on vegetation may include higher levels of plant stress (Shah *et al.*, 2017; Liang *et al.*, 2016), such as decreased photosynthesis rates, transpiration and respiration capacities, in turn leading to reduced growth and productivity (Shah *et al.*, 2017). In cases where dust comprises specific chemical compositions (highly alkaline cement production dust, or other calcareous dusts) it can induce changes in soil chemistry and microbial decomposition (Müllerová, *et al.*, 2011), potentially leading to impacts ranging from an alteration of the vegetation habitat structure (Paal *et al.*, 2012) to general species effects, including chlorosis, diminished leaf thickness, cellular collapse, obstructed stomata and senescence (Siqueira-Silva *et al.*, 2016).

For fauna, erosion, sedimentation, contamination or dust that results in substantial changes to vegetation may result in loss or degradation of habitat, and contamination may cause death or ill health of animals directly.

Proposed avoidance and mitigation measures

To minimise the risk of sedimentation, contamination, erosion and dust, a Construction Environmental Management Plan (CEMP) would be prepared including requirements for best-practice erosion protection, sedimentation and discharge controls, and management of chemicals, fuels and hazardous materials to reduce negative impacts on non-threatened vegetation.

Prior to construction, discharges, runoff pathways and stockpiles would be designed in a way to reduce the risk of contaminated flows, sediment, and discharges entering local waterways and surrounding areas of vegetation.

In the case of an accidental spill, a best-practice spill contamination procedure would be detailed in the CEMP and spill kits would be present on all construction sites.

Dust control measures would be put in place in accordance with the Dust and Air Quality Management and Monitoring Plan. When implementing measures the following implications need to be considered:

- Inadequate dust suppression measures may result in a wider geographical spread of dust contamination
- Excessive dust suppression may result in excess runoff of sediment and/or contaminants.

Additionally, construction activities that lead to the generation of excessive dust levels could be avoided where practicable during very windy conditions and/or appropriate dust suppression techniques employed. Measures to control dust would be specified in the CEMP and Dust and Air Quality Management Plan. Implementation of the Dust and Air Quality Management Plan, as well as a Spoil Management Plan, would reduce the likelihood of dust being generated to the point that it impacts on ecological values.

Waste management measures in accordance with Victoria's *Environment Protection Act 1970* would enable waste minimisation during construction. Waste excludes soils, but includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

9.1.3 Degradation of vegetation and terrestrial habitat through soil compaction

Impact description

Where construction activity occurs, movement of heavy vehicles, plant and equipment would likely result in compaction of soil. Uncontrolled, this could have a significant impact on adjacent threatened and non-threatened vegetation (including tree protection zones) and fauna habitat to be retained.

Proposed avoidance and mitigation measures

During construction, clear access routes would be specified for heavy vehicle traffic as well as no-go zones for sensitive environmental areas. As a result, the risk of soil compaction in sensitive environmental areas is expected to be negligible.

Before construction starts, a Spoil Management Plan would also be developed and implemented, with requirements for the location and management of appropriate stockpiling and spoil storage sites. This would also assist to avoid movement of heavy traffic and storage of construction materials and spoil in sensitive environmental areas.

9.1.4 Degradation of aquatic habitat through sedimentation or contamination

Impact description

Aquatic habitats across the study area are directly connected to the stormwater network and runoff drainage, which places habitat for aquatic fauna in the direct path of sediments and contaminants that are mobilised and enter the drainage network. Aquatic habitats are the sink for most mobilised contamination, which is generally only removed by transport further downstream to another aquatic habitat.

Wetlands and waterways in the project boundary are, or may be, used by a range of threatened and non-threatened aquatic and terrestrial fauna ((fish, turtles, macroinvertebrates, mammals, frogs, ducks, egrets, other waterbirds). The impacts of pollutant runoff on fauna can be significant, with both water and sediment contamination potentially causing toxicity, physical stress and behavioural effects. The impacts on aquatic fauna habitat can have greater severity than semi-aquatic or terrestrial fauna, as these species are restricted in capacity to relocate to more suitable habitat in the event of degradation from runoff from construction activities. Through appropriate construction environmental management and monitoring of waterways, the likelihood and extent of such an event is reduced.

Wetland and waterway habitats in the project boundary already receive stormwater from urbanised catchments, so tend to be degraded to some degree already. Due to the high degree of urbanisation of the catchments, waterways and wetlands in the project boundary support aquatic fauna that have some tolerance for degraded, polluted and contaminated aquatic habitats. Construction of North East Link may result in unplanned sedimentation and/or erosion that contribute to degradation of wetland habitats. Effective controls of site and monitoring of aquatic environmental conditions, particularly during high risk period (rainfall events) would be critical to minimise impacts to aquatic habitat quality.

Proposed avoidance and mitigation measures

The most important method for preventing aquatic habitat degradation is through the design of North East Link to minimise the impacts from discharges and runoff, and to manage construction to protect aquatic habitat. Tunnelling under the Yarra River is a good example of this approach, which avoids the need to undertake works in the waterway that would cause direct impacts to the habitat. In other waterways, the avoidance of works within or adjacent to waterways is also important to minimise the risk of indirect impacts. Short-term and long-term impacts on riparian, riverbed and aquatic habitat would be minimised through detailed design and construction, to the extent practicable. The CEMP would contain and require implementation of measures to minimise adverse impacts from construction activities on riparian, riverbed and aquatic habitat and aquatic fauna connectivity.

To further reduce the risk of sedimentation, contamination, erosion and dust, a CEMP would be prepared containing requirements for best-practice erosion protection, sedimentation and discharge controls, and management of chemicals, fuels and hazardous materials to reduce ecological impacts.

Minimising the design footprint to the extent practicable would assist to avoid and minimise short-term and permanent impacts on ecological values, including parks and reserves, and significant landscapes around the Yarra River. Riparian vegetation provides some protection of waterways and wetlands through the prevention of pollutants entering the waterways through overland runoff. Degradation or removal of riparian vegetation may lead to increased pollution of waterways and would be minimised.

Design of surface water facilities that cope with discharges and runoff would enable management of discharge and run-off from North East Link to meet legislated standards for environmental protection. A Surface Water Management Plan would be developed and implemented, setting out the requirements and methods for best-practice erosion protection, sediment and erosion control and monitoring, in accordance with EPA Victoria requirements.

A surface water monitoring program would be developed and implemented before construction starts to assess background water quality in all receiving waters. The monitoring and management of surface water quality and flow would consider changed risks due to changes in rainfall and riverflow during wet periods with greater rainfall runoff.

Modifications to all waterways would be designed and undertaken in a way that mitigates the effects of changes to flow, and minimises the potential for erosion, sediment plumes and exposure of contaminated material during construction.

Appropriate measures would be developed and implemented to maintain bank stability of waterways to the satisfaction of Melbourne Water and in consultation with relevant local councils.

Waste management measures in accordance with Victoria's *Environment Protection Act 1970* would enable waste minimisation during construction. Waste includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

The CEMP would include requirements for management of chemicals, fuels and hazardous materials, and would enable minimisation of chemical and fuel storage on site and storage of hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements. This would include development and implementation of management measures for dangerous substances, including appropriate disposing of hazardous materials, installation of bunds and precautions to reduce the risk of spills, and developing contingency and emergency response plans to handle fuel and chemical spills. In the case of an accidental spill, a best-practice spill contamination procedure would be detailed in the CEMP and spill kits would be present on all construction sites.

9.1.5 Degradation of aquatic habitat through waterway modification or construction activities in and around waterways

Impact description

Waterways would be substantially modified in two areas. For the Eastern Freeway upgrade, a number of sections of Koonung Creek would be enclosed and covered (five sections totalling approximately one kilometre, with covered sections ranging from 100 to 500 metres). In addition, three sections of the creek (100, 400 and 100 metres long) would be diverted to a constructed naturalised channel.

Within the Metropolitan Ring Road to Lower Plenty Road section, the upper reaches of Banyule Creek (approximately 1,400 metres of channel extending within Simpson Barracks and extending downstream to Lower Plenty Road) would be replaced by two pipes.

Converting sections of a waterway to an enclosed pipe would directly remove structural habitat for aquatic and terrestrial fauna. In addition, there is potential for degradation of habitat due to increased sedimentation, groundwater drawdown, and downstream water quality impacts during construction.

Diversion of sections of creek to naturalised channel is expected to replace some aquatic habitat, but the time for naturalisation and colonisation by aquatic and terrestrial fauna may be years.

The aquatic habitat that would be directly impacted by North East Link supports non-threatened aquatic fauna that are adapted to a highly modified urban environment. Impacts to these waterways could result in changes to their environmental condition which may have impacts downstream from the points of direct impact. No threatened aquatic species inhabit the waterways that would likely be directly impacted and as so no impact to threatened species is likely.

The headwaters of Banyule Creek are ephemeral and support temporary aquatic ecosystems able to tolerate drying phase or colonise during wetted periods. The loss of natural waterway in this reach of Banyule Creek has a very low risk of impacting the viability of aquatic or terrestrial fauna populations outside the area of direct waterway modification.

The enclosure and covering of sections of Koonung Creek would severely degrade the aquatic habitat in these affected sections, although this waterway is not likely to contain aquatic MNES.

Existing wetlands that are within the project boundary and identified as possible locations for water sensitive urban design (WSUD) features (such as the southernmost pond at the Freeway Public Golf Course) may attract threatened terrestrial fauna, such as Baillon's Crake, which is listed as threatened under Victoria's *Flora and Fauna Guarantee Act 1988* (FFG Act) and vulnerable under the DELWP advisory list. Construction in those wetlands would impact those species if they are using the habitat at the time. The wetland changes as a result of WSUD would be temporary, given the purpose of WSUD is to create wetlands that function hydrologically and ecologically. Those wetlands are relatively small and in an area (the Yarra River floodplain) that supports numerous similar ponds/wetlands. Therefore, mobile wetland species would likely adapt to the temporary loss of small areas of habitat. The resulting impact is expected to be minor.

Proposed avoidance and mitigation measures

Threatened aquatic and terrestrial species are more likely to be present in the Yarra River than in the smaller tributaries in the project boundary. Tunnelling under the Yarra River to avoid this major waterway is central to preventing impacts to aquatic and terrestrial threatened species by avoiding and minimising works in waterways.

The management of surface water runoff and bank stability during construction is essential to protect environmental conditions in waterways. As pollutants and other threats to aquatic habitats can be transported through the drainage network to waterways, the Surface Water Management Plan would include measures to minimise erosion, and pollutants and sediments entering waterways. A surface water monitoring program would be required to confirm the effectiveness of waterway protection measures according to SEPP (Waters) objectives, and identify any environmental degradation that could require remediation. The monitoring and management of surface water quality and flow would consider changed risks due to changes in rainfall and riverflow during wet periods with greater rainfall runoff.

Fauna habitat values in existing waterbodies that are modified for WSUD features, would be protected as far as practicable (such as trees left standing in Simpson's Lake).

9.1.6 Death or injury of fauna during construction

Impact description

North East Link would be located in a busy urban landscape. Construction may result in the injuring or killing of fauna, mainly through land clearing (habitat removal) or fauna straying into a construction area. Fauna most at risk are fauna that reside in the habitats to be removed and that have limited mobility (such as frogs, small reptiles, possums), and/or dependent young (young birds in a nest), or fauna that stray into a construction area during a quiet time (overnight). Fauna straying into a noisy active construction site during the day is considered unlikely.

In the north-eastern suburbs of Melbourne, fauna most likely to be encountered in a construction site are common species. Presence of uncommon or threatened species is expected to be rare, and death or injury of those species is expected to be extremely rare.

Death or injury of some fauna may occur, but is expected to be infrequent and localised, and most likely to affect individuals rather than populations or species. While killing an individual animal would be permanent, the impact on the population of that species (particularly if that species is common and adaptable) may be only short-term. Its population would be expected to recover relatively quickly (within 2 years). Therefore, death or injury of common species is not expected to have a long-lasting effect on any of the populations of fauna in the project boundary.

Proposed avoidance and mitigation measures

Measures to avoid harming fauna during construction, and to deal with injured fauna if found, would be specified in the CEMP. This would enable management of fauna displaced or harmed due to habitat removal in compliance with Victoria's *Wildlife Act 1975*, undertaking pre-clearing surveys and inspections to confirm the on-site location of fauna immediately prior to habitat removal, and assisting fauna to safety as necessary. The CEMP would include requirements for reporting of incidental threatened fauna finds, with any clearing works in the vicinity stopped until an evaluation and approval response can be established.

Fauna straying into an active construction site would be managed by the site environmental officer (via a CEMP).

9.1.7 Disturbance of fauna through noise, vibration or lighting

The construction process would involve a range of demolition and construction work in numerous locations along the corridor simultaneously (such as pile driving, tunnel-boring machine, road widening). Work at some locations would be during daylight hours only, while at other locations it would be at night only or as well. Construction noise has the potential to disturb fauna (terrestrial and aquatic) day or night, while lighting would disturb fauna only at night.

The potential severity of disturbance varies with species and location. Disturbing a threatened species to the point that it abandoned its breeding habitat (such as the Grey-headed Flying-fox camp at Yarra Bend) would be a severe impact, while localised and temporary disturbance of small numbers of individuals of common species (such as Red Wattlebird, Noisy Miner) from marginal foraging habitat would be relatively inconsequential ecologically.

The impacts of North East Link on non-threatened terrestrial fauna are expected to be minimal but more widespread than those on threatened fauna, due to the ubiquitous distribution of non-threatened fauna and the localised distribution of threatened fauna along the corridor.

Disturbance from noise, vibrations and light are not expected to impact on fauna (threatened or non-threatened) through the tunnelled section of the corridor.

Impact description – Lighting

Project construction at night would require adequate lighting, which may result in the disturbance or displacement of native or non-native fauna. Lighting during construction would be temporary, moving with the work front. Depending on the nature of the construction changes proposed, some sites would require lighting over a shorter period (weeks or months) than others (months or years).

Artificial light can reduce the success of some nocturnal predators, by giving the potential prey an advantage or favour more tolerant nocturnal predators, potentially changing the composition of predator and prey species. Artificial light at night can disrupt the typical nocturnal behaviour of fauna (diurnal birds may not roost, nocturnal frogs may not call, insects may be fatally attracted to lights). The effects of lighting may result in some fauna no longer occurring in habitats nearest to the lit areas.

Disturbance of some fauna by light would be unavoidable, but is expected to be minor and localised. Disturbance of fauna is most likely to affect individuals rather than populations or species, and is not expected to have a long-lasting effect on the populations of fauna in any particular suburb or across Melbourne. Fauna in the urbanised Melbourne area already cope with an environment that is awash with artificial light at night. It is likely, therefore, the fauna that still occur within the area, or visit the area, have coping mechanisms for persisting in well-lit environments.

Impact description – Noise and vibration

Persistent noise (such as loud traffic noise near a busy road) has the potential to disrupt acoustic communication by some fauna (frogs, birds). The noise may jam frequencies used by some fauna, so that those fauna are no longer audible to their conspecifics. There is evidence that some fauna have changed their acoustic signals in response to loud urban noises (Parris *et al.,* 2009, Parris, 2013, Parris, 2015). For species that call at a certain time of year, or at a certain time of day (such as frogs that call mainly at dusk during their preferred season; birds that call in spring), this may be only an occasional problem, but it may reduce their success to the extent that those fauna no longer occur in the habitats nearest to the disturbance source.

Project construction would involve increased noise, and this assessment has investigated the potential for that to result in the disturbance or displacement of native or non-native fauna. Displacement of fauna into sub-optimal habitats could increase their susceptibility to predation and competition, or other source of harm in the urban environment. Noisy environments may make it harder for fauna to hear each other and to hear predators moving around.

Noises that disturb fauna tend to be loud, sudden and unexpected noises (such as explosions, pile driving), rather than predictable constant noises (such as loud machinery in continual use). Fauna can become habituated to predictable noises, even if those noises are very loud (such as birds that use airfields as habitat). Noises generated by North East Link are expected to vary in intensity and may or may not be accompanied by vibrations that affect terrestrial and aquatic fauna.

During daylight hours, construction noise has the potential to impact on terrestrial fauna in a few ways. It could result in temporary displacement of active diurnal birds – individual birds may choose to forage and roost further from the corridor than they normally do, for the period of disturbance. It could also result in displacement of roosting nocturnal fauna – birds or mammals (such as possums) when disturbed may flee from the corridor and seek a quieter location. Because this would be during daylight hours, it could make the nocturnal fauna more susceptible to predators, competitors and/or temporary harassment (such as mobbing of owls by birds such as noisy miners).

At night, construction noise has the potential to impact terrestrial fauna through temporary displacement of nocturnal birds and mammals – owls and possums that might forage or roost occasionally near the corridor may abandon a disturbed area for a period of time. It could also displace roosting diurnal fauna – birds when disturbed may flee from the corridor and seek a quieter location. Because this would be at night, it could make them more susceptible to predators.

Construction noise at night could result in temporary silencing of frogs – frogs may not call during the period of disturbance, or may call but have lower reproductive success due to not being heard. If the construction period lasts longer than the frogs' breeding/calling season, there is a risk of losing an entire breeding cohort from that location.

Reptiles are not expected to be disturbed greatly by construction noise or vibration, although there may be rare occurrences of localised displacements of individuals (such as a Tiger Snake moves away from noise or vibration in the area where pile driving occurs).

Fish use sound in a number of ways, including communication, hunting and predator avoidance. Human-induced noise may impact fish by generating high intensity (acute) or low intensity (chronic) noise (Popper and Hastings, 2009). High intensity noise may kill or damage hearing of fish or lead to a startle response, whereas low intensity noise may pervade the environment and lead to behaviour changes over a long-term period.

Most of the fauna habitats nearest the North East Link corridor are not known to support threatened species, other than occasionally. One main exception to this is the Grey-headed Flying-fox colony at Yarra Bend, near the Eastern Freeway where it crosses the Yarra River. Very large numbers of flying-foxes use the colony for daily roosting and for annual breeding.

At this location, impacts from noise are considered unlikely to result in a significant impact on individual flying-foxes or on the colony. This section of the Eastern Freeway is already very noisy (daily noise from commuting and base-flow traffic) and well-lit at night. Construction is not expected to result in significantly increased noise or light levels that would result in disturbance of the camp. Construction near this location would include bridge strengthening works, road surfacing works and construction of a new bridge for a shared-user path. From information provided by specialists preparing Section 13 – Surface noise and vibration of PER Technical

Appendix D – Commonwealth land, the linear noise level is modelled to be 133 dB (119 dB(A)) at the construction site. Modelling is highly conservative and assumes the continuous and simultaneous operation (which is highly improbable) of the following equipment: Excavator (35T), Concrete Saw, Crane – wheeled (100T), Crane – Franna (20T), Piling Rig (Driven), Concrete Agitator, Truck – Low Loader, and Concrete Pump. On the basis of this, noise levels are predicted to be 65 dB 700 metres downstream of the site (the location where the nearest flying-foxes were observed in November 2017), and 61 dB at a central point of the colony as it currently is. According to a range of online sources (such as <http://www.industrialnoisecontrol.com/comparative-noise-examples.htm>), these levels are slightly more than the level of a conversation in a restaurant, office, or background music, air conditioning unit at 100 feet (~33 metres).

If work at this location is done at night, construction lighting is not expected to disturb the flying-fox camp because there is no line of sight between the works area and the current colony.

Noise during construction of North East Link would be temporary and short-term (actual duration depends on the site and the construction activities required).

Vibrations are considered less likely than noise to disturb terrestrial fauna. Vibrations that result from high-impact ground disturbance (tunnelling, pile driving) tend to be localised and relatively minor in effect to terrestrial fauna. The tunnelling process would generate a constant, quiet, low-pitched hum at surface level, rather than loud noises and ground trembling or quaking (Section 14 – Tunnel vibration of PER Technical Appendix D – Commonwealth land).
For terrestrial fauna at or near these locations, it is expected to be the noise that disturbs, rather than vibrations.

The sensitive receptors potentially affected by noise or vibration in aquatic ecosystems include resident and migratory aquatic fauna. Vibrations, including sound waves, travel faster and more effectively through liquids than through air, and even more effectively through solids.
The vibration generated through construction activities there needs to consider construction activity in and around waterways, as well as construction at distance from the waterways where enhanced noise/vibration transmission through the substrate has potential to impact aquatic ecosystems away from the construction site.

For aquatic MNES fauna such as the Australian Grayling, the key area of sensitivity is around the Yarra River in relation to bridge strengthening works and the construction of a new shared use path crossing of the river. The two key activities with the potential to cause impact are:

- Bored piles – use of bored piling techniques would reduce impact compared with driven piles and this would be beneficial
- Jack hammering – use of low energy jack-hammers or alternative means (such as saw cutting) would be the preferential construction method. Low energy jackhammering does not transmit high levels of vibration into a major structure such as a bridge, so impacts in the river would likely be low.

General low-level noise due to plant movement and other activities, including tunnel boring, would also occur during construction.

The published literature contains little directly relevant information about the impact of the expected construction activities on freshwater fish in rivers as most studies are from marine or laboratory conditions. The biology of freshwater and marine fish are similar enough to consider the response to anthropogenic noises would be similar (Vega & Wiens, 2012, in; Cox *et al.* 2016). However, it is not clear what, if any, differences in the physical form and structure of the riverine environment affect the fish species differently compared with marine habitats or laboratory conditions. The acoustic landscape of marine versus freshwater environments differs quite markedly (Mickle and Higgs, 2017). Sound transmission in the open ocean can be

effectively modelled as an unbounded medium, but, especially for shallow freshwater environments, such as the Yarra River, acoustic modelling is much more difficult when depth is often very shallow and substrates poorly defined (Kuperman and Ingenito, 1998; Rogers and Cox, 1988, in Mickle & Higgs, 2016).

One experimental study indicated that loud, sudden noise can affect individual and group fish swimming behaviour in laboratory conditions, but continuous loud noise has less effect (Neo *et al.,* 2015). The effects of noise in the natural environment on fish is less clear. The literature refers to increased alarm responses or movement from fishing areas in studies of sudden loud noise from seismic air guns (Fewtrell & McCauley, 2012, Skalski *et al.,* 1992; Engås *et al.,* 1996; Engås and Løkkeborg, 2002: in Wardle *et al.,* 2001). But there is some uncertainty about pile driving, with one study on a coral reef showing little or no effect on overall behaviour and movement patterns of fish (Wardle, 2001). Given the behavioural impacts of loud intermittent noise have been demonstrated experimentally, it is a reasonable precaution to avoid loud, intermittent noise generating activities during periods when changes to fish swimming behaviour could affect important breeding events for the Yarra River Australian Grayling population. Given the Yarra River is located within an environment of considerable human activity (including land based construction, traffic, motorised vessels), the aquatic environment is expected to already have a relatively high background noise level. The impacts of loud constant noise resulting from general construction activities (such as TBM, pile boring, heavy truck traffic) is not expected to cause behavioural changes that would impact the viability of native fish populations.

The impacts of intense impact generated noise (such as from pile-driving or jackhammering) on fish in the Yarra River are largely unknown (Popper & Hastings, 2009). However, fish are more likely to elicit an avoidance response before physical damage occurs if they are not constrained (McCauley *et al.,* 2000). In the context of North East Link, generation of high intensity noise is not expected as the planned construction methods include bored piles, not driven piles. If pile driving or jack hammering was employed during construction, these would most likely lead to short-term behavioural impacts in fish during these activities.

Behavioural avoidance of an area that is a key migration corridor during a migratory or spawning period for fish may result in significant impacts on the breeding success of that species. This is the case for the important population of Australian Grayling in the Yarra River. High intensity noise/vibration generation during construction that is transmitted to the Yarra River has the potential to deter spawning fish from descending the river to spawning areas in the estuary, or deter juvenile fish from ascending the river into upstream reaches. Any effects on migration are not expected to persist during periods without noise. Therefore, the best time to undertake construction activities in the vicinity of the Yarra River that involve high intensity noise generation (driven piles) is outside the Australian Grayling spawning or upstream migration period. Similar impacts to other fish species are also expected, although the significance of this impact is considerably less for other species with more flexible and/or multiple breeding cycles (such as Macquarie Perch, Common Galaxias) or for species where the Yarra River is not considered an important breeding habitat or contain an important population (such as Australian Mudfish).

North East Link would be located in an already disturbed and urbanised area. Threatened and non-threatened fauna that live in or visit habitats within the project boundary already tolerate substantial disturbance from noise, vibrations and lighting. Construction work similar in nature to that proposed (such as roadworks or bridge works with associated noise and lighting) already occurs within the project boundary on a daily basis, albeit at a smaller scale than North East Link. It is therefore likely the fauna that still occur within the area, or visit the area, have coping mechanisms for persisting in noisy environments. However, the impact of construction noise may have a disproportionate impact on non-resident or migratory species that have little exposure or are already impacted by the existing acoustic environment. This is notably the case

for Australian Grayling, which has a national recovery plan that aims to protect and enhance important life cycle stages (Backhouse *et al.,* 2008a).

Disturbance of some terrestrial and aquatic fauna would be unavoidable, but is expected to be minor, localised and short-term (in that fauna would most likely return to the habitat when the noise disturbance subsides). Disturbance of fauna would most likely affect individuals rather than populations or species, and is not expected to have a long-lasting effect on the populations of fauna in any particular suburb or across Melbourne. The impacts of noise and vibration on threatened fish is limited to intermittent impact generated intense vibration transmitted from construction sites to the Yarra River, which is the only waterway in the project boundary likely to support threatened fish.

Proposed avoidance and mitigation measures

Lighting would be designed to minimise spill and disturbance to sensitive fauna sites (such as Grey-headed Flying-fox colony at Yarra Bend, wetlands and waterways immediately adjacent to roadways). Measures to reduce the effects of light would be specified in the CEMP. To minimise the escape of light during construction, this could include measures such as design lights to be directed downwards rather than outwards as far as practicable, and use of light screens between roadways and potentially sensitive habitats (such as wetlands). Measures to reduce the effects of light would be specified in the CEMP. Contractors would be required to design lighting used during the operation of permanent structures in accordance with relevant standards, including but not limited to AS 4282 – 1997 Control of the obtrusive effects of outdoor lighting.

The implementation of a Construction Noise and Vibration Management Plan (CNVMP) would identify:

- Noise and vibration sensitive receptors along the project alignment
- Construction noise and vibration targets
- Key noise and/or vibration generating construction activities that have the potential to generate airborne noise and/or surface vibration impacts on surrounding sensitive receivers
- Management actions and notification, and mitigation measures to be implemented to minimise noise and vibration associated with construction.

The CNVMP would also document how construction noise must be minimised, and notification and mitigation measures that would be implemented if noise levels exceed targets. The CNVMP would identify an effective monitoring protocol for noise associated with construction.

Activities generating intense noise such as pile driving or jack hammering would be avoided in or near the Yarra River as far as practicable, and if required, these activities would be scheduled to minimise impacts on the Australian Grayling.

To minimise the likelihood of impacting the breeding cycles of threatened fish species, significant noise generating construction activities would be undertaken, where practicable, during December, January and February or July and August as summarised in Table 9-2. This requirement should be included in a CNVMP.

Table 9-2 Typical lifecycle and movement patterns of threatened migratory fish – indicating high noise/vibration avoidance periods

Common name	Life stage	Timing											
		J	F	M	A	M	J	J	A	S	O	N	D
Australian Grayling	Spawning			↓	↓	↓	↓						
	Larvae					↓	↓	↓					
	Juvenile									↑	↑	↑	
	Adult				↓	↓↑	↓↑	↑					
Avoid high intensity noise generation													

Note: arrows indicate upstream or downstream movement

The CNVMP would be prepared in consultation with EPA Victoria Construction noise and vibration impacts at sensitive receptors would be managed in accordance with EPA Victoria Guidelines and as specified in the CNVMP. This could include use of measure such as sound barriers to reduce the effects locally on particularly sensitive fauna (such as near wetlands that support frogs).

9.1.8 Fragmentation of terrestrial wildlife corridors creating barriers to terrestrial fauna movement

Impact description

Construction of North East Link would involve removal of vegetation (habitat) and/or modification of waterways in some areas, which may result in localised fragmentation of some fauna habitats. Loss of a patch of habitat may disrupt or sever habitat connectivity, particularly along waterways and other narrow sections of habitat.

The operation of North East Link is not expected to result in further habitat fragmentation.

Fragmentation of habitat and isolation of habitat patches reduces the ability of some fauna to disperse across the landscape, and may threaten the viability of some populations that rely on habitat connectivity. Generally, the worst ecological consequences for habitat fragmentation or isolation result when disruption to connectivity is large (such as a broad area of habitat clearing across a wildlife corridor), and/or the habitat fragmented is highly functioning ecologically (such as the Yarra River floodplain).

Habitat fragmentation can affect common non-threatened fauna and rarer threatened fauna alike. Common, mobile and adaptable species (such as the Red Wattlebird, Rainbow Lorikeet) tend to be least affected by fragmentation, as habitat gaps tend not to create barriers to their movement. These species tend to be the ones that persist in the Melbourne area currently. Some mobile threatened species also are able to cope with Melbourne's already fragmented landscape (such as the Swift Parrot, Grey-headed Flying-fox), as determined by their continued use of trees in metropolitan areas. Some common but less mobile fauna appear less inclined or able to bridge habitat gaps (such as the Superb Fairy-wren, White-browed Scrubwren, Sugar Glider), and some of the threatened species tend to be restricted by large habitat barriers to some extent in the Melbourne area (such as the Powerful Owl).

Losing habitat connectivity tends to be long-term or permanent. Permanent loss of connectivity can be at least partially offset by creating or encouraging adjacent habitat patches that can serve the purpose of connecting habitats.

The additional fragmentation that could result from North East Link is not expected to be extensive enough to alter the ecological effectiveness of existing habitat or wildlife corridors, or to create new barriers to fauna movement. North East Link would be constructed in an already fragmented urban landscape. Species that use habitat patches as movement corridors in the project boundary tend to be highly mobile species already coping with a fragmented and degraded habitat landscape.

The most important habitat and wildlife corridor within the study area is the riparian forests and wetlands associated with the Yarra River floodplain, particularly around the Kew, Bulleen and Banyule area. Threatened wetland and forest fauna, including Powerful Owl, are known or likely to use this area for movement across the landscape. Tunnelling would avoid this area and so North East Link is not expected to disrupt this area as fauna habitat and as a wildlife corridor.

The fauna movement corridor offered by Koonung Creek is narrow, degraded and already fragmented. While revegetation efforts and wetland creation (mostly for stormwater treatment) in recent decades have improved the condition, amenity and ecological function in some areas along Koonung Creek (such as Koonung Creek Linear Reserve), habitats along the corridor are used predominantly by common and adaptable non-threatened native and non-native fauna. Construction of the Eastern Freeway in earlier decades resulted in an almost unrecoverable loss of ecological function of the corridor along Koonung Creek. North East Link could result in minor additional corridor disruption along Koonung Creek, particularly where new parts of the creek are proposed to be covered and the surface riparian habitat connection would be lost. The impact of this is expected to be minor and not result in further loss of ecological function from Koonung Creek.

North East Link would impact on the upper reaches of Banyule Creek within Simpson Barracks and south to Lower Plenty Road. This upper section of Banyule Creek offers a very small fauna movement corridor between Simpson Barracks and the Yarra River floodplain. Through this section, the habitat corridor is narrow, degraded, and likely to be used mainly by common and adaptable mobile fauna for local movements only, rather than landscape-scale movements. The absence of mid-storey and under-storey vegetation along the section of Banyule Creek north of Lower Plenty Road, the major barrier to ground-based fauna created by Lower Plenty Road itself, and the busy and urbanised landscape that surrounds Banyule Creek in this local area, means this wildlife corridor is highly compromised in its current form. North East Link is not expected to result in further loss of ecological function from corridor habitats along Banyule Creek.

Proposed avoidance and mitigation measures

The most important habitat and wildlife corridor within the study area is the riparian forests and wetlands associated with the Yarra River floodplain, particularly around the Kew, Bulleen and Banyule area. This area would be avoided through tunnelling.

Habitat fragmentation would be minimised through project design. Measures to avoid accidental loss of habitat that further disrupts habitat connectivity would be specified in the CEMP and further minimised through the implementation of other measures, such as a Tree Protection Plan to protect trees to be retained. Reinstatement of vegetation along potential corridors beside the completed roads (such as Koonung Creek Linear Reserve) would allow continued passage of fauna and help to reduce the long-term effect of additional habitat fragmentation that does occur. Additional planting of canopy trees (exceeding replacement, resulting in a net gain of tree canopy cover) along potential corridors may even improve the long-term condition and effectiveness of corridors.

9.1.9 Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement

Impact description

Restrictions to movement of native fish have the potential to occur in Koonung Creek and Banyule Creek during construction due to works in waterways that restrict passage (such as cofferdam placement). These works would not affect aquatic MNES, as there are no EPBC Act-listed threatened species of aquatic fauna present in Koonung Creek or Banyule Creek. The native aquatic species that are found in these waterways are common, widespread and abundant fish species that are not obligate migratory species. The impacts of temporary lack of connectivity would be minor and not jeopardize population viability. Construction to divert or cover the waterways would have a severe impact on the habitat within the waterways, but this would not have major impacts on the connectivity to important habitat for these species.

The Yarra River contains numerous species of native aquatic fauna, including EPBC Act-listed threatened fish species. The waterway provides passage to large areas of important habitat for many species. To avoid impacts to the aquatic fauna of the Yarra River, works in the Yarra River are not proposed. The construction works in the waterway are therefore not applicable to habitat for threatened species. However, impeded passage in the Yarra River may be caused by noise/vibration near the river (as described in Section 9.1.7).

Proposed avoidance and mitigation measures

The protection of aquatic habitat through design and avoidance of construction works in and around waterways is the key measure to protect aquatic fauna, through minimising the construction of physical barriers to passage. The management of construction activities that can cause behavioural changes in fish are required to minimise the impacts of avoidance. These could include noise and vibration controls, design of drainage structures that could impact habitat quality and prevent spills entering waterways, management of runoff from construction areas and monitoring for any water quality pollution, modelling and planning to avoiding flow velocities that could prevent fish movement. Implementation of these across all waterways could minimise the risk to aquatic fauna within the Yarra River catchment, including threatened aquatic species.

9.1.10 Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values

Impact description

The seeds of weed species and other pathogens can become lodged in plant and equipment (particularly in the mud of tyre treads) when driven through infested areas. The seeds and/or pathogens may then be carried some distance before being unintentionally deposited in areas free from previous infestations of the species or pathogens. Plant and/or equipment moving from the project boundary could result in off-site infestations of those species present within the project boundary, while the importation of soil into the project boundary also presents a risk of importing weed propagules onto site, which may have a negative impact on any native vegetation retained within the project boundary.

Weeds

Construction may spread Weeds of National Significance (WoNS) or weeds listed under the *Catchment and Land Protection Act 1994* (CALP), resulting in the decline in quality of native vegetation within the project boundary and adjacent areas.

CaLP Act-listed weed species identified within the project boundary are listed in Table 6-6 along with their status within the Port Phillip and Westernport Catchment Management Authority (PPWCMA) area.

Cinnamon Fungus

Cinnamon Fungus (*Phytophthora cinnamomi*) is a microscopic, soil-borne pathogen that attacks and destroys plant root systems causing plants to die through lack of water and nutrients. Despite the common name, *Phytophthora cinnamomi* is not a true fungus, but actually a soil-borne water mould, more closely related to brown algae. The disease is also known as die back, root rot, PC or Phytophthora. It is listed in the top 100 of the world's most invasive species and is Victoria's most significant plant pathogen affecting both native ecosystems and the horticultural industry. There is no known cure. The presence of Cinnamon Fungus threatens not only vegetation communities – it can alter the ecology of entire ecosystems.

Heathlands, coastal woodlands and dry eucalypt forests are most at risk. Patches of dead or dying vegetation can indicate the presence of infected vegetation, and infected plants appear drought affected and develop signs of 'dieback'. Within Victoria, the pathogen has had serious impacts in the Brisbane Ranges, Grampians, Great Otway, Lower Glenelg, Point Nepean, Kinglake, Croajingalong and Wilsons Promontory National Parks, in addition to Lerderderg State Park, Lake Tyers, Anglesea Heathlands and the coastal forests of east and south Gippsland.

While the pathogen can spread locally through soil or water via tiny swimming spores, it is more commonly spread through the movement of contaminated soil and gravel carried by vehicle or foot traffic. It can also be spread through infected plant material and potting mix. Without proper soil testing, this microscopic pathogen is difficult to detect. It is more actively spread in moist soils during warm weather and can survive drought. It can be present even if vegetation appears healthy as not all plants are susceptible.

Pest fauna species

Some non-native terrestrial and aquatic fauna species in the study area are considered pest species, and are likely to be having a detrimental impact on the natural ecology of the Melbourne area. Given the study area is already highly urbanised, North East Link is considered unlikely to exacerbate the impact of any pest animal or fish species.

One native species of bird (Noisy Miner, *Manorina melanocephala*) is implicated in ecological deterioration, and is integral to a Key Threatening Process under the EPBC Act.

Amphibian Chytrid Fungus

One known pathogen that affects fauna is the Amphibian Chytrid Fungus, which causes the disease chytridiomycosis, which can result in high mortality of frogs. Worldwide, the impact of this fungus has been catastrophic – in numerous locations (including Australia), many species have become extinct or endangered as a result of its inadvertent introduction (such as Schloegel *et al.,* 2006, Skerratt *et al.,* 2007), and it is likely the decline of the Growling Grass Frog across its range is linked to introduction of the fungus into new areas.

Chytridiomycosis due to the amphibian chytrid fungus was included on the List of Key Threatening Processes under the EPBC Act on 23 July 2002.

The fungus appears to have been spread worldwide by various means from Africa (Weldon *et al.,* 2004). It is highly infectious, and can be spread via zoospores on frogs and tadpoles, and potentially in water, on wet equipment and within moist soils (such as on boots, tyres vehicles, equipment) (Murray *et al.,* 2011). There is evidence that different strains of the fungus vary in their impact; some strains are more lethal to frogs than others (Berger *et al.,* 2005).

The typical response pattern of chytrid introduction into a previously uninfected area is for there to be a rapid mass die-off of frogs (epidemic chytrid infection); common and abundant species tend to become rare, while uncommon or rare species may decline to such small population sizes that they become undetectable, extirpated or even extinct (Lips *et al.,* 2006). In the years following the epidemic, the species that persist may build their populations again, now with endemic chytrid infection (Retallick *et al.,* 2004, McDonald *et al.,* 2005). During this phase, there may be a continual or episodic mortality of smaller numbers of frogs, but the mass population-scale die-offs tend not to occur.

Locations where the fungus has had the most catastrophic impacts have been mostly remote locations (such as rugged mountainous areas) where humans rarely visit, rather than urbanised areas that have sustained a high level of human and other disturbance historically.

While little is known of the status or distribution of the fungus in the Melbourne area and across most of Victoria, the Amphibian Chytrid Fungus is known to have been in Australia since 1978 and in Victoria since 1998 (Murray *et al.,* 2010). Recent research has identified the abundant and ubiquitous Common Froglet (*Crinia signifera*) as a likely reservoir host, spreading chytrid spores among frog populations without succumbing greatly to the disease itself (Brannelly *et al.,* 2018).

Given the highly infectious nature of the fungus, the long history of disturbance to waterways and landforms in the Melbourne area, the enormous volume of animal and human movements (foot and vehicular) across the area, and the ubiquity of *Crinia signifera* in Melbourne's waterbodies, it is highly unlikely that any wetlands or waterways (habitats for frogs) in the Melbourne area have remained free of chytrid infection to this point. It is likely to be widespread throughout frog habitats within the project boundary already. Therefore, the likelihood of introducing the fungus to the project boundary (such as through transport of soil, wet or muddy equipment) is low, as is the likelihood of a catastrophic epidemic occurring within the project boundary due to North East Link. However, different strains of the fungus may vary in how lethal they are to frogs, so avoiding continued spread of the fungus is critical to management of this pathogen. If a new strain of the chytrid fungus is introduced to the project boundary, a larger impact is possible. If infected materials (such as soil, equipment, vehicles) are brought in from elsewhere, there is a chance of a novel and more pathogenic strain becoming established.

Frog species detected in the project boundary are common species (mainly Common Froglet, Southern Brown Treefrog). No threatened species (such as Growling Grass Frog, Brown Toadlet, or Southern Toadlet) were detected.

The risk to North East Link from the Amphibian Chytrid Fungus is expected to be low.

Epizootic Haemtopoietic Necrosis Virus (EHNV)

Epizootic Haematopoietic Necrosis Virus (EHNV) is an Australian virus with the potential to negatively impact several native fish species. The EHN Virus enters fish through the body surface or gastrointestinal tract, multiplies in the blood forming organs such as the spleen and kidney and destroys them in the process. The liver is also affected by the virus. Most infected fish are believed to quickly succumb and die.

Native fish species that may be affected by EHNV include Macquarie Perch, Murray Cod, plus exotic fish species, Eastern Gambusia, Rainbow Trout and Redfin Perch. At present, Australian field studies have only detected EHNV infection in Redfin Perch and farmed Rainbow Trout. It is

suspected that illegal movements of Redfin Perch by anglers may have played a part in the distribution of EHNV in the past

Activities that can increase the risk of diseases between waterways include movement of boating, fishing, aquaculture gear and equipment from one waterway to another.

Proposed avoidance and mitigation measures

Weeds

Management requirements for Weeds of National Significance (WoNS) and declared noxious weed species listed under Victoria's *Catchment and Land Protection (CaLP) Act 1994* and would be incorporated into the CEMP during construction activities, to account for the potential transportation of declared noxious weeds and environmental weeds into and out of the project boundary. Additionally, a Spoil Management Plan would be developed in conjunction with the CEMP so that potentially contaminated construction spoil is managed to reduce the risk of spreading weeds and pathogens to other sites.

Cinnamon Fungus

Management measures to reduce the risk of spreading Cinnamon Fungus would be employed by the implementation of a CEMP, which would detail and raise awareness of and compliance with pathogen management, as well as a Spoil Management Plan to regulate the movement of spoil and reduce the risk of infected soil leaving or entering the site.

Pest fauna species

Management measures to reduce the risk of exacerbating the impact of terrestrial pest animals would be employed by the implementation of a CEMP and Waste Management to enable management measures for waste (including litter, which may attract pest animals) minimisation during construction and operation in accordance with Victoria's *Environment Protection Act 1970.*

Project measures to minimise loss of vegetation and fragmentation of terrestrial habitats would reduce the potential for the Noisy Miner to increase in abundance or area. Tunnelling under the Yarra River is a critical mitigation for this.

Amphibian Chytrid Fungus

Management measures to reduce the risk of spreading the Amphibian Chytrid Fungus into, out of or within the project boundary would be employed by the implementation of a CEMP which would detail and raise awareness of, and compliance with, pathogen management. A Spoil Management Plan would regulate the movement of spoil and could reduce the risk of chytrid-infected soil or water leaving or entering the site.

Epizootic Haematopoietic Necrosis Virus (EHNV)

Spread of EHNV would be managed through hygiene of equipment used for instream works (such as barges, floating work platforms).

9.1.11 Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction

Impact description

The construction of tunnels has the potential to cause minor levels of ground settlement. There is predicted settlement of 10 millimetres in a small area of Floodplain Riparian Woodland between Bolin Bolin Billabong and Bulleen Road, 10 to 14 millimetres in a small area of Floodplain Riparian Woodland west of the southern tunnel portal, two to 45 millimetres through the Banyule Swamp area, and two to six millimetres in Plains Grassy Woodland within Simpson Barracks. Modelled settlement of this magnitude is regarded as a negligible impact and is unlikely to cause premature death of native trees, or cause degradation of vegetation quality.

Some changes to ground surface levels resulting from ground movement caused by construction of the tunnels are indicated in the ground movement section (Section 22) of PER Technical Appendix D – Commonwealth land. Based on this report, the modelled changes to surface levels at Bolin Bolin Billabong are less than two millimetres, which is a negligible change for aquatic or terrestrial ecosystems. There are no ecological impacts expected due to these small ground movements.

Section 22 of PER Technical Appendix D – Commonwealth land indicates ground movement modelled at Banyule Swamp could experience minor ground settlement along the alignment of the tunnels. This may change the level of the shallow constructed levee bank and water level control offtake pipe that drains overflow water to Banyule Creek. Ground movement that affects these structures could cause some change to the hydrology of the swamp, as the water level of this wetland is maintained by the offtake pipe and levee bank. This constructed water level control has created a wetland with relatively stable hydrology, and strongly defined boundary of surface water extent and fringing vegetation controlled by the maximum water levels. However, there is some natural variation below this high water mark; during periods of low rainfall the water levels drops, resulting in natural recession of the wetland's aquatic habitat area.

There is the potential that localised settlement resulting from construction of the tunnels may lower the height of the levee bank or overflow structure. If this is the case, less water may be retained in the wetland basin, lowering the high water mark, and reducing the potential area of aquatic habitat present. Ground movement analysis suggests that approximately 45 millimetres of settlement could occur at the location of the pipe with a corresponding ground slope of around 1/750. Based on this scenario, it is not expected to be any structural damage to the pipe. The topography of the area shows that Banyule Swamp drains into Banyule Creek through a narrow swale that serves as the bypass or spillway. Ground movement settlement contours indicate that a localised depression may occur in the vicinity of this swale, which could modify the effective height of the spillway. A comparable level change is not expected across the remainder of the Banyule Swamp banks or other hydraulic control structures affecting water level. A localised height reduction of the spillway would lower the maximum water level – assuming the observed swale is serving to regulate the maximum lake level. Although the predicted drop in ground level is not large in the landscape context, the bathymetry of the wetland is extremely shallow, with considerable areas of very shallow water. A small lowering of the hydraulic control structures and corresponding drop in water level (<50 millimetres) would result in a significant change in wetland surface area, including the shallow habitat suitable for wading birds. This range of variation is considered well within the natural range experienced by the swamp on a seasonal or annual basis, but the impact of the lowered high water mark would result in a more permanent recession of aquatic habitat area.

Proposed avoidance and mitigation measures

To protect the functionality of the Banyule Swamp lake, the level of the water level control structures (the overflow pipe and levee bank) should be modelled to inform of likely ground movement. Geological and groundwater models would be developed to inform design and development of a ground movement plan to address potential ground movement impacts. Sensitive receptors would be identified and ground movement impact acceptability criteria set as part of this process. Pre and post condition surveys would be carried out of potentially impacted assets, with any damage caused by North East Link rectified. Through this process, any observed changes to water level control structures could then be identified for repair works, if required. A mitigation strategy could be to increase the height of embankment surrounding the outfall to the swale to offset the settlement.

9.1.12 Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems

Terrestrial and aquatic GDEs are reliant on the availability of water beneath the surface. Relationships between groundwater and GDEs are described in Sections 6.3.3 and 8.4. Construction works are likely to impact on groundwater conditions within the study area, particularly around the tunnel portals. The extent and magnitude of potential groundwater depressurisation (drawdown) following construction of North East Link has been determined through groundwater modelling undertaken as part of PER Technical Appendix B – Groundwater.

Further numerical groundwater modelling has also been undertaken for the project following the publication of the draft PER. The purpose of further modelling was to incorporate additional groundwater data collected over a period of approximately 12 months to enable transient calibration to seasonal variations in groundwater levels and to assess whether or not the additional calibration efforts result in changes to the assessment of project-induced groundwater impacts.

Impacts to GDEs have been reassessed based on the further groundwater modelling. The impacts to GDEs from both the inital and further groundwater modelling are presented in the discussion below.

Impact description – terrestrial ecosystems

Areas outside the project boundary have the potential to be impacted by groundwater changes as a result of North East Link. There are three main geographic areas of focus in relation to GDEs where indirect effects may occur and have the potential to impact terrestrial ecology:

- Vicinity of the northern portal, including Simpson Barracks and Banyule Creek
- Vicinity of the southern portal, including the Yarra River Flats
- Tunnel section, including Banyule Flats.

An area of Plains Grassy Woodland (dominated by River Red Gum) within Simpson Barracks but outside the project boundary is likely to be accessing groundwater on occasions (10<20 metres groundwater depth zone). Based on the initial groundwater modelling, it was found that approximately seven large trees were assessed as having a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction, which could include suffering a decline in health and/or premature death (Figure 9-1). A further nine large trees would likely be impacted *outside* Simpson Barracks by drawdown associated with construction of the northern tunnel portal. These trees, as they are outside Commonwealth land, are not discussed further for the purpose of the PER. Areas outside this groundwater depth zone would unlikely be negatively impacted by groundwater changes.

The potential impacts to large trees and GDEs was reassessed based on the further groundwater modelling. This modelling showed approximately 45 large trees (36 River Red Gum; nine Studley Park Gum) within Simpson Barracks as having a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction (Figure 9-2). A further eight large trees (six River Red Gum; two Studley Park Gum) would likely be impacted *outside* Simpson Barracks by drawdown associated with construction of the northern tunnel portal. These trees, as they are outside Commonwealth land, are not discussed further for the purposes of the PER.

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary, which are likely to be accessing groundwater, would unlikely be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain would also unlikely be negatively impacted, nor the terrestrial vegetation surrounding Bolin Bolin Billabong since drawdown levels are very low. However, the deep pool at the eastern end of Bolin Bolin Billabong is an aquatic GDE and the potential for it to be impacted by drawdown is discussed in the subsequent section.

For the tunnelled section beneath Banyule Flats and the Warringal Parklands (where terrestrial and aquatic habitats occur that are likely to support threatened and migratory fauna), there is negligible predicted change to groundwater levels and flow during and at the end of construction. A numerical modelling scenario was undertaken to predict mounding beneath the floodplain as a result of boring of the TBM tunnel (Section 7.3.2 of the PER Technical Appendix B – Groundwater). The results do not predict mounding beneath the floodplain (groundwater is predicted to flow above and below the tunnels within the bedrock aquifer, without resulting in an increase in water levels in the overlying alluvial sediments). Some mounding of up to 0.2 metres was noted on the eastern side of the TBM between the floodplain and the northern portal, but within the bedrock aquifer.

It is particularly important to understand the potential impacts to the Yarra River floodplain environments, and relatively good condition vegetation at Simpson Barracks and nearby reserves. Where vegetation may be significantly impacted by groundwater drawdown, it may be considered lost and would need to be offset according to the DELWP Guidelines (2017a).

It should be noted that in terms of MNES, Matted Flax-lily (*Dianella amoena*) would unlikely be impacted by groundwater drawdown at Simpson Barracks, as roots are unlikely to penetrate deeper than one metre, and so are unlikely to be groundwater dependent. Any potential decrease in canopy cover caused by tree dieback in the 10<20-metre groundwater depth zone would unlikely negatively impact the Matted Flax-lily population, as the dieback would likely be minimal in the context of shade provided by non-impacted trees, and the species is known to persist in grasslands with no tree cover.

Impact description – aquatic ecosystems

Changes to groundwater levels during construction have the potential to alter the hydrology of waterways and wetlands that have significant groundwater contribution. Any changes to the hydrology of aquatic habitat has the potential to change the aquatic ecosystem. Aquatic habitat that intersects the areas of groundwater impacts during construction include Banyule Creek, and Bolin Bolin Billabong.

The hydrological assessment of Banyule Creek (Section 8.3.2) revealed that aquatic habitat is not maintained by groundwater inputs within the area of groundwater drawdown. The source of water in the upper reaches of Banyule Creek is rainfall runoff from overland flow and through the stormwater drainage network. Therefore, dewatering of groundwater during construction is not expected to result in any change to the aquatic ecosystems of Banyule Creek.

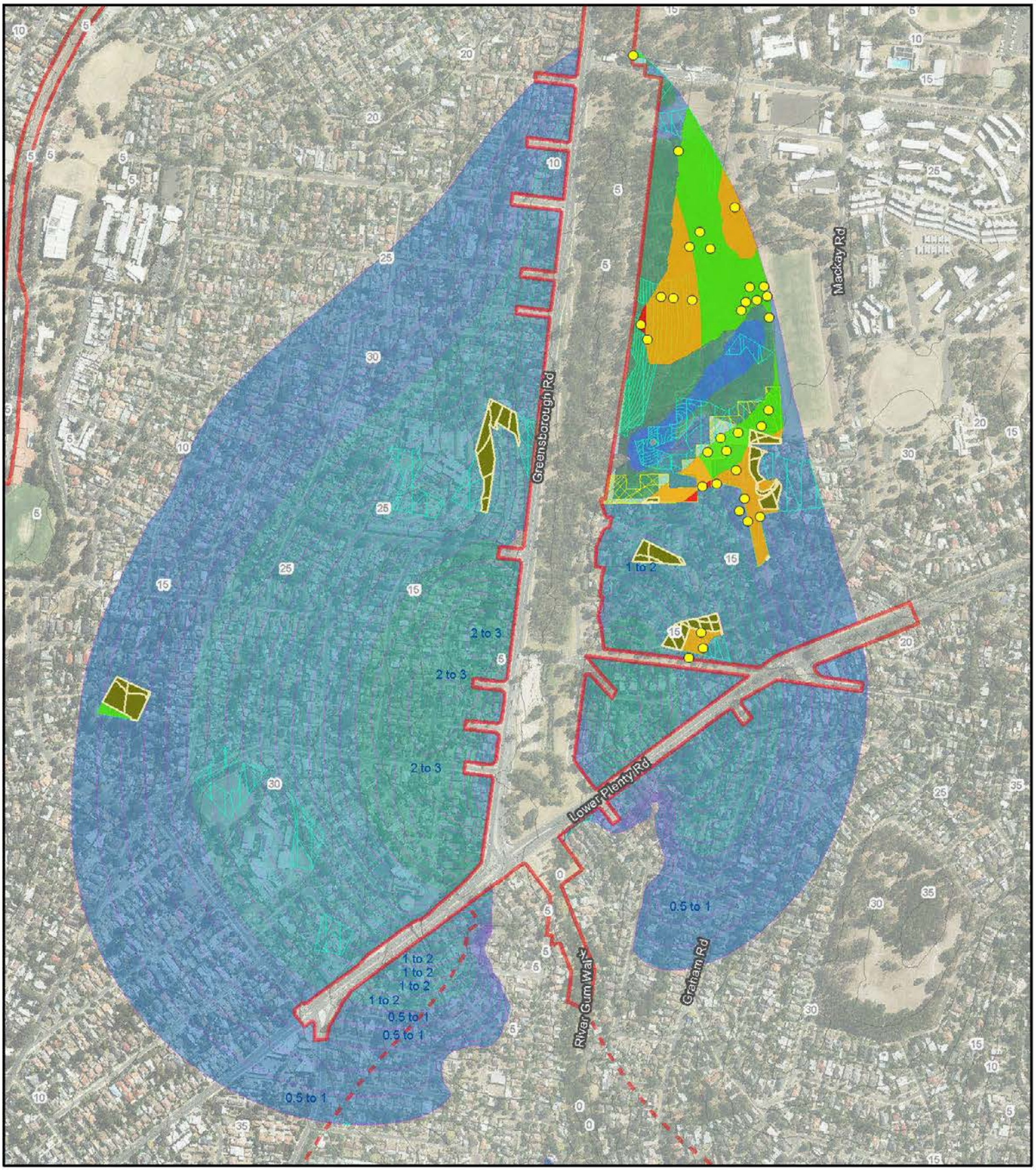
Bolin Bolin Billabong is located on the Yarra floodplain, and has no direct connectivity with the waterway or works on Commonwealth land. Desktop and field assessments revealed no aquatic MNES at the billabong, and therefore impacts to groundwater dependant aquatic habitat is not expected to have impacts on MNES.

Proposed avoidance and mitigation measures

Mitigation measures are available to minimise the risk of adverse impacts on LTs at Simpson Barracks, particularly in the short-term during construction. Measures to maintain the health of trees, such as supplementary short-term watering could reduce the number of trees impacted in the short-term. However, where trees are predicted to have a moderate to high likelihood of suffering premature mortality due to groundwater drawdown, and long-term watering (that is, beyond construction and extending to the 2075 scenario) is not a feasible and realistic mitigation option, these trees would be regarded as a loss in accordance with the *Guidelines* (DELWP, 2017a). Based on the inital groundwater modelling results, it was previously expected that offsets would need to be sourced for the loss of 19 scattered large trees from Simpson Barracks over the long term (2075).

However, the further modelling indicates that offsets would only need to be sourced for the loss of eight scattered large trees (five River Red Gum; three Studley Park Gum) over the long term (2075). Trees with a low risk of suffering condition decline or premature mortality are not regarded as requiring to be offset in accordance with the *Guidelines*. In addition, areas outside the 10<20-metre groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

Given the aquatic ecosystems in and around Simpson Barracks are not groundwater dependant, the impacts of groundwater modification are not expected to affect aquatic ecosystems on Commonwealth land. Similarly, the groundwater changes predicted in and around Bolin Bolin Billabong would not impact aquatic MNES.



Legend

GDE Risk Rating Late 2024
- Very High Risk
- High Risk
- Moderate Risk
- Low Risk

- Negligible Risk - Residential, Industrial or Oval Area
- Project boundary - sub-surface
- Project boundary - surface

- Groundwater Dependent Ecosystems - surface expression (BOM)
- Groundwater Dependent Ecosystems - sub-surface expression (BOM)
- Groundwater Dependent Ecosystems (PPCMA)

- Large tree

Native Vegetation (EVC)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2005 (DELWP)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2007 (HLA)
- Riparian Area with Seasonal Grassy Wetland
- River Red Gum Woodland

- Depth to Groundwater Contours (5m)

Paper Size A4

0 60 120 240

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Risk to native vegetation and GDEs from groundwater drawdown in vicinity of northern portal - Late 2024 (95th percentile, initial modelling)

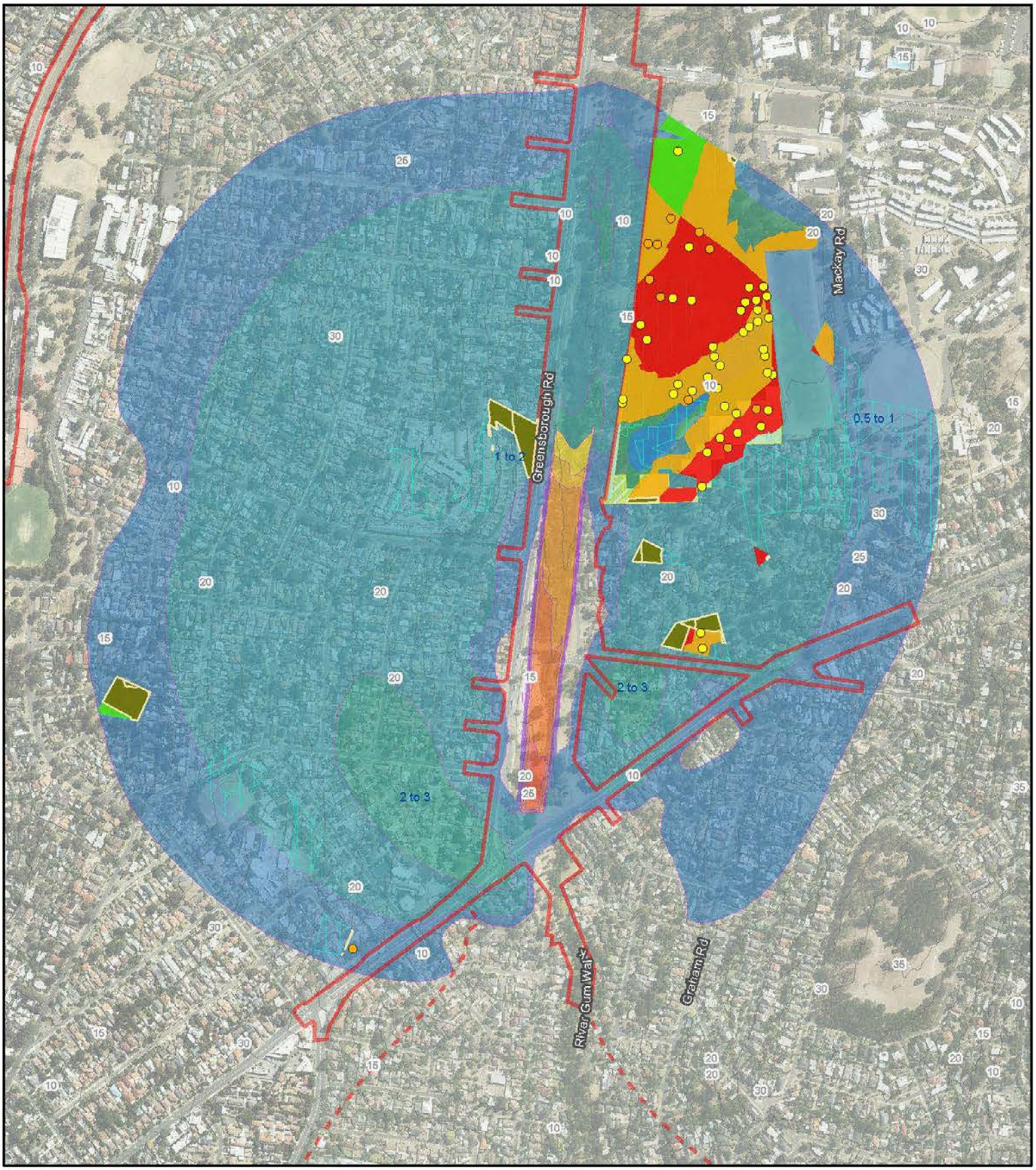
Job Number	31-35006
Revision	C
Date	16 Aug 2019

Figure 9-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31350006_9_1_GDEs_95th_Late_2024_A3L_RevC.mxd

GHD | 180 Lonsdale Street Melbourne VIC 3000 Australia | T 61 3 8687 8000 | F 61 3 8687 8111 | E melmail@ghd.com | W www.ghd.com

Data Sources: CIP Imagery, EVC 2005 - DELWP - 2018 | Road Names - Vicmap - 2018 | Groundwater Dependant Ecosystems - PPCMA, BOM - 2018 | Construction Footprint, Scattered Trees, Matted Flax-lily, Groundwater Drawdown - GHD/AECOM - 2018



Legend

GDE Risk Rating Late 2024
- Very High Risk
- High Risk
- Moderate Risk
- Low Risk
- Negligible Risk - Residential, Industrial or Oval Area
- Project boundary - sub-surface
- Project boundary - surface
- Groundwater Dependent Ecosystems (PPCMA)
- Groundwater Dependent Ecosystems - surface expression (BOM)
- Groundwater Dependent Ecosystems - sub-surface expression (BOM)

Groundwater Drawdown (m)
- -0.5 to -0.1
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 10
- 10 to 15
- 15 to 20
- Large tree
- Large Studley Park Gum

Native Vegetation (EVC)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2005 (DELWP)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2007 (HLA)
- Riparian Area with Seasonal Grassy Wetland
- River Red Gum Woodland

- Depth to Groundwater Contours (5m)

Paper Size A4

0 60 120 240

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Risk to native vegetation and GDEs from groundwater drawdown in vicinity of northern portal - Late 2024 (further modelling)

Job Number 31-35006
Revision C
Date 16 Aug 2019

Figure 9-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_9_2_GDEs_95th_Late_2024_Post_EES_A3L_RevC.mxd

180 Lonsdale Street Melbourne VIC 3000 Aus. T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

9.2 Operation impacts and mitigation

This section describes the potential ecological impacts North East Link would or may have during operation, and the mitigation and management efforts that would reduce or eliminate the impacts.

9.2.1 Loss or degradation of terrestrial or aquatic habitat through shading

Impact description – terrestrial ecosystems

The effects of reduced lighting and increased shading on vegetation, ultimately representing a reduction in photosynthetically active radiation (PAR) are manifolding, both growth promoting and limiting. In general, effects are dependent on the percentage of PAR reduction and the species affected.

At the basic level, a reduction of PAR can lead to a reduction in photosynthesis, which in turn reduces available energy, plant growth and vigour. As such, there is a range of adverse and avoidance effects observed in plants, which occur and relate to the PAR levels and a plant's physiological limit for leaf survival. Each species has different tolerance levels and thus whole plant vegetative growth, and the level of flowering (as an indication of reproduction) are dependent on respective PAR levels (Tan & Ismail, 2014).

In general, adverse effects include:

- Decline in plant growth
- Decline in reproductive growth
- Decline in flowering
- Shade avoidance response (excessive growth).

Research indicates that a decreasing ability of plants to utilise carbon, through less utilisable PAR, can reduce root mass; shoot mass, and leaf production, decreasing overall biomass production (Mikola *et al.*, 2000). In general, non-tolerant or adaptive plants experiencing significant PAR reductions show decreasing seedling biomass and growth (Mikola *et al.*, 2000), as well as reduced flowering (Tan & Ismail, 2014). This means that, even though many plants can tolerate low PAR conditions, not all plants can effectively reproduce under these conditions (Valladares & Niinemets, 2008).

One of the most common plant avoidance reactions to low PAR is excessive shoot growth. This is reflected through above average stem height/DBH size (Tan & Ismail, 2014). These avoidance reactions themselves represent a potential cause for further flow-on effects to the surrounding flora through changes in competition between species, such as fast-growing taller species suppressing slower growing shorter species (Norton & Young, 2016).

This means that significant shading can be harmful to terrestrial and aquatic ecosystems, as it can result in streams that are barren of aquatic flora. Similarly, growth of canopy vegetation declines as a function of shade, as well as crowding (Poulson & Platt, 1989). Given this, there is the potential of shading from structures to cause decline of some canopy species of trees. However, in some circumstances shading can be beneficial, such as where some species benefit from partial shading (50 per cent shade) (Sari, Triadiati & Ratnadewi, 2017).

Shading is also known to affect the physical and chemical properties of small and moderate sized watercourses by reducing incident radiation and temperature. Shading has therefore been found to be an effective tool in improving water quality and reducing the risk of eutrophication (Ghermandi *et al.*, 2009).

In unaltered ecosystems, this shading function would normally be provided by riparian canopy trees. However, in a disturbed waterway; artificial shading may play a similar functional role to those pre-existing riparian canopy trees and therefore improve water and habitat quality.

Literature suggests the ecological impact of shading is varied and unclear and it is likely to depend on the pre-existing conditions of the ecosystem. Within the context of North East Link, shading may have a negative impact on retained native and planted vegetation. While it may have a negative impact on the growth of canopy vegetation, it may also improve soil conditions. Nevertheless, within this impact assessment it is assumed that where >50 per cent average annual shading occurs as a result of new structures, loss to vegetation (remnant or amenity) would be assumed.

For terrestrial fauna, shading that results in substantial changes to vegetation may result in localised loss or degradation of habitat (see Sections 9.1.1 and 9.1.2).

Areas of native vegetation on Commonwealth land potentially affected by shading would include those located immediate east of noise walls at Simpson Barracks and the Commonwealth land immediately south of the Barracks (particularly on the south side) and those under elevated structures. Shading is not expected to have a negative impact on flora MNES, in particular, Matted Flax-lily.

Shade modelling has not been completed for elevated structures and noise walls, as total native vegetation loss is currently assumed for vegetation within the project boundary. For the purpose of this assessment it is assumed that 100 per cent of native vegetation that exists below proposed elevated structures would be considered lost and so is therefore included in offset calculations.

Impact description – aquatic ecosystems

Vegetation in waterways provides important ecosystem functions that contribute to the quality of aquatic habitat. Vegetation provides habitat for aquatic fauna, and epiphytic microbiome, stabilises sediments, provides food source for aquatic and terrestrial fauna and contributes to nutrient processing and organic cycling. The ecosystem services provided by instream vegetation can be substantial, and are often replicated in WSUD features for the management of nutrient, sediment and other contaminant transport in waterways. Changes to aquatic vegetation from shading can therefore impact aquatic habitat quality and reduce the ecosystem services provided by the waterway. This assessment has considered the potential for shading from North East Link structures to impact aquatic habitat and ecosystems.

The impact of shading from new or modified bridges on light availability for aquatic vegetation is not considered significant, as the width and elevation of these structures would allow for ample light penetration to the waterway beneath. Any increase in shading of the Yarra River at these locations is negligible, compared with the natural shading from riparian vegetation and channel topography.

Areas of waterways where shading from North East Link would be significant are the reaches of Koonung Creek, where the waterway would be modified to a covered channel (complete shading), or where the existing channel is located to the south of proposed sound walls (partial shading) along the southern edge of the Eastern Freeway. This is not expected to impact aquatic MNES, as listed threatened species are not likely to be present in this waterway.

Proposed avoidance and mitigation measures

To minimise impacts of shading, overhead structures and noise walls would be designed to minimise overshadowing and shading. Examples of how this could be achieved include use of transparent materials where practicable. Irrespective of this mitigation measure, all native vegetation within the project boundary (vegetation directly removed and indirectly impacted by shading) would be offset in accordance with the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (DELWP, 2017a).

The modifications to waterways, including the containment and covering of waterways would be minimised as far as practicable, with diversions of waterways designed to be open and naturalised wherever possible. The placement and design of sound walls would consider the shading footprint over waterways, and aim to minimise the impacts to aquatic vegetation. Opportunities to expand the use of WSUD to offset any loss of specific ecosystem services resulting from changes to aquatic habitat, specifically nutrient and sediment management, could be explored where practicable during detailed design.

With implementation of mitigation in the detailed design, the impact of shading on native flora is expected to be low. The impact on threatened flora or communities would be low, but is unlikely to occur.

9.2.2 Degradation of aquatic habitat through waterway modification

Impact description

This impact addresses the localised effects of enclosing a waterway on the existing fauna that inhabit the modified segment of waterway. This impact also addresses the effects that impeded passage can have on aquatic species across the stream network, beyond the extent of physical modifications to the waterway. The impact is wider in extent than the immediate effects of shading or enclosing. For background information see Section 9.1.5.

The aquatic fauna likely to be present in waterways impacted by habitat modification are either dominated by exotic species (as in Koonung Creek) or there is very little available habitat or passage under existing conditions to support native fish (as in Banyule Creek). Covering of waterways indefinitely is likely to impact native aquatic species that inhabit Koonung Creek and Banyule Creek. However, neither waterway affected by these modifications contain aquatic MNES.

In terms of impacts of works on Commonwealth land, the effects of converting open channel to piped waterway would result in a loss of connectivity in Banyule Creek The headwaters affected by channel modification do not currently provide important aquatic habitat, and the loss of connectivity at this site is not significant for aquatic species.

Proposed avoidance and mitigation measures

Where channel modification occurs, channels would be naturalised where practical, which is likely to support the return of some aquatic ecosystem values and improve waterway health by re-creating suitable habitat for native aquatic fauna at these locations. Design of waterways could include the removal of existing drop structures or other physical barriers to fish passage.

The impacts of North East Link on fish passage could be minimised by reducing design impacts on aquatic habitats, including flow and water velocities. For the piped waterway sections, this might include managing surface water from North East Link to minimise scouring and include measures to avoid the creation of new barriers downstream.

9.2.3 Degradation of aquatic habitat through modification of stormwater catchment

Impact description

An increase in paved surface is planned as part of the new roads, with consequential increase in stormwater drainage that needs to be discharged to urban waterways in and around the project boundary. The implementation of water sensitive urban and road drainage design would need to include the prevention of stormwater surges that could degrade aquatic ecosystems. Input of urban stormwater is regarded as one of the two most threatening processes to aquatic ecosystems in the urban environment (Walsh & Webb, 2016), with the major mechanisms of impact from flow velocity and scouring of aquatic habitats. Stormwater drainage features should be designed to not only prevent flooding and water quality impacts, but also to maintain or improve the hydrology of waterways to reduce the impacts of stormwater surges from new directly connected impervious surfaces.

Proposed avoidance and mitigation measures

Drainage would be designed to minimise impact to aquatic habitats. Modelling of flow velocity in waterways would be undertaken. Where drainage inputs to waterways are likely to result in ecologically significant changes to the magnitude or duration of peak flows, waterway channel modifications may be used to ameliorate the hydrological impacts. This might include bank stabilisation works at drainage outfalls, channel and/or floodplain storage capacity and engagement modifications to minimise the impacts of high flows on aquatic habitat, and provision of refuges for aquatic fauna. WSUD features would be operated and maintained to manage potential hydrological and pollutant impacts.

9.2.4 Degradation of aquatic habitat through contaminated runoff

Impact description

Operation of the roads, and the resultant increase in traffic volume, is expected to lead to increased generation of road borne pollution, such as hydrocarbons and metals. The transport of these to aquatic ecosystems by stormwater runoff has the potential to lead to a degradation of water and sediment quality in receiving aquatic environments. This process would result in an accumulation of pollutants over the longer term and a degradation of aquatic ecosystems due to increased toxicity in sediments and water.

Proposed avoidance and mitigation measures

The use of WSUD features would mitigate this impact by capturing the additional run-off from the new road/ramp surfaces before it reaches waterways within the study area. WSUD features would be required to manage the pollutant load from North East Link's new road/ramp surfaces to prevent transport of pollutants to waterways or natural wetlands.

The design of the road and drainage network should avoid impacts to aquatic habitats, through placement of drainage inputs to waterways at locations that avoid input of pollutants to aquatic ecosystems. Any works on the drainage network and waterways should include elements that enhance the ecosystem services to build resilience to degradation from pollutants.

WSUD would be operated and maintained to manage potential hydrological and pollutant impacts.

9.2.5 Death or injury of fauna during road operation

Impact description

Fauna may be injured or killed when attempting to cross new roads with large volumes of fast-moving traffic. Fauna most at risk of roadkill are mobile fauna that readily cross substantial barriers such as main roads to get to other habitat patches (including possums, birds, foxes, rabbits and kangaroos). In the eastern suburbs of Melbourne, these tend to be common species, and the injury or death of uncommon or threatened species is expected to be rare.

North East Link would be located in an already busy urban landscape. Injury of some fauna may occur, but is expected to be infrequent and localised, and most likely to affect individuals rather than populations or species. Fencing along the roadways would be required for safety and security purposes and would deter most fauna, greatly reducing the risk of injury and harm. Birds would still be able to fly across the roads at low elevation, and those birds would be at greatest risk of collisions. These include Sulphur-crested Cockatoos, Galahs, Long-billed Corellas and ravens, all of which are common to abundant in the Melbourne area.

Proposed avoidance and mitigation measures

The design and scale of the roadways would discourage most fauna from using or crossing the roads, which would reduce the incidence of fauna collisions with vehicles. Birds would still be able to access and cross the roads with ease.

Fauna-attracting habitat would not be reinstated in the median strips of the roads, so fauna would not be encouraged to cross roadways to access that habitat.

9.2.6 Disturbance of fauna through noise, vibration or lighting

Impact description

Operation and use of the roads would generate noise (engines, engine braking, tyres, horns) and require lighting at night (overhead lights to enable better visibility for motorists) that may result in the disturbance or displacement of native or non-native fauna. Disturbance from noise and light are not expected to impact on fauna through the tunnelled section of the corridor.

Vibrations from the operation of North East Link are not expected to impact threatened fauna.

Section 9.1.7 for background information on this impact and applicable mitigation measures. Construction-related noise and vibration mitigation is not relevant to operational noise and vibration, but the lighting mitigation measures are relevant.

Along sections of road that abut fauna habitat (along parts of Koonung Creek, the Yarra River and at Simpson Barracks) and in the absence of sound barriers, operational noise may establish a ‘noise impact zone’ adjacent to the roads, particularly during noisy periods. In this zone, fauna may not be able to hear each other (or potential predators) due to the noise, which could result in a number of responses. Vocal fauna that cannot hear each other may alter their vocal behaviour – they may abandon calling in that zone and focus on other aspects of life (such as foraging), and over time some species may alter the characteristics of their calls to be more audible to others with the background noise (Parris *et al.,* 2009, Parris, 2013, Parris, 2015). Alternatively, they may abandon the area and seek a habitat patch where they can call and hear each other. Other fauna (such as Eastern Grey Kangaroo at Simpson Barracks) may move away from the roadway during noise periods, to better hear their surroundings (such as potential predators).

The width of this zone is likely to vary with location and time, depending on the prevailing noise levels. At times of less noise, fauna would be expected to re-enter the impacts zone and use them as normal habitat.

Noise impacts on individuals or on species (such as impacts on social structure) in already noisy environments is poorly known. For common and adaptable species that reside in or regularly visit urbanised areas, the impact is expected to be minor. It may lead to gradual changes in fauna composition (in noisy areas, bolder species less susceptible to noise may dominate over species more sensitive to noise), but that type of change is likely to have occurred already across much of the Melbourne area, including the project boundary.

Additional lighting from North East Link would increase light levels in some areas, but because the area is already well-lit with street lights, broad-scale increases are not expected across the entire project corridor. Fauna in the urbanised Melbourne area already live with and cope with an artificially lit environment at night. Nocturnal and diurnal fauna that occur within or visit the area are likely to have coping mechanisms for light. Lighting across the area is not even, and fauna are likely to seek the light conditions that best suit their requirements and tolerances.

Impacts on non-threatened terrestrial fauna are expected to be minimal but more widespread than those on threatened fauna, due to the ubiquitous distribution of non-threatened fauna and the localised distribution of threatened fauna along the corridor.

With mitigation and careful design, impacts from operational noise and light on the Grey-headed Flying-fox colony at Yarra Bend are expected to be minimal. This section of the Eastern Freeway is already very noisy (daily noise from commuting and base-flow traffic) and well-lit at night. Given the distance from the road to the colony, and sound/distance relationship (sound level decreases by 6 dB per doubling the distance), the level of additional noise reaching the colony is expected to be relatively low. Given the already restricted line of sight between the roadway and the current colony, operational lighting is not expected to greatly increase existing levels of road lighting. Because habitat for threatened species is localised along the corridor (such as Yarra Bend Park), disturbance impacts of noise and lighting on threatened species would be localised.

Proposed avoidance and mitigation measures

Design features would help to reduce the escape of light during North East Link's operation (such as lights could be directed downwards rather than outwards, and light screens and planted vegetation could be used between roadways and potentially sensitive habitats, such as wetlands). Lighting used during operation of permanent structures would be designed in accordance with council requirements and relevant standards.

Sound barriers (comprising screens and vegetation) alongside the roads for social and amenity purposes are expected to effectively reduce noise impacts on local fauna. North East Link would be designed to achieve set traffic noise objectives at properties adjacent to the alignment. This would assist with mitigating noise impacts on fauna habitat.

Traffic noise would be measured prior to and upon opening, and during the operation of North East Link, in accordance with VicRoads requirements. Remedial action would be taken if measured traffic noise levels exceed the noise performance requirements.

9.2.7 Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems

Further numerical groundwater modelling was undertaken for the project following the publication of the draft PER. The purpose of further modelling was to incorporate additional groundwater data collected over a period of approximately 12 months to enable transient calibration to seasonal variations in groundwater levels and to assess whether or not the additional calibration efforts result in changes to the assessment of project-induced groundwater impacts.

Using the results of the further groundwater modelling, impacts to GDEs have been reassessed. The impacts to GDEs from both the inital and further groundwater modelling are presented in the discussion below.

Impact description – terrestrial ecosystems

Terrestrial GDEs are reliant on the availability of water beneath the surface. Relationships between groundwater and GDEs are described in Sections 6.3.3 and 8.4. Groundwater extraction would occur during construction around the portal areas but cease once construction is complete. Groundwater levels would then gradually re-adjust to new levels (increasing or decreasing) during the operation of North East Link, flowing around the tunnels and portals. In some areas, depth to water is predicted to remain below the original level. In other areas, it is predicted to mound (a rise in water table depth) over an extended period. Mounding is expected to stabilise after 50 years (2075) (refer to PER Technical Appendix B – Groundwater).

The extent and magnitude of potential groundwater depressurisation (drawdown) after 50 years of North East Link's operation (year 2075) has been determined through groundwater modelling.

Areas outside the project boundary have the potential to be impacted by groundwater changes due to North East Link. There are three main geographic areas of focus where indirect (outside the project boundary) impacts on terrestrial GDEs may occur:

- In the vicinity of the northern portal, including Simpson Barracks and Banyule Creek
- In the vicinity of the southern portal, including the Yarra River Flats
- Tunnel section, including Banyule Flats.

In the vicinity of the northern portal, there is an area of Plains Grassy Woodland (dominated by River Red Gum) within Simpson Barracks but outside the project boundary, which is likely to be accessing groundwater on occasions (10<20 metres groundwater depth zone).

Using the inital groundwater modelling, it was found that approximately 19 large trees were assessed as having a moderate to highlikelihood of being negatively impacted by groundwater drawdown during operation within Simpson Barracks. This may include a decline in health and/or premature death. A further 13 large trees were also likely to be impacted *outside* Simpson Barracks by drawdown associated with operation of the northern tunnel portal. These trees, as they are outside Commonwealth land, are not discussed further for the purpose of the PER. Areas outside this groundwater depth zone would unlikely be negatively impacted by groundwater changes, as shown in Figure 9-3.

The potential impacts to large trees and this GDE was reassessed based on the further groundwater modelling. This modelling indicates approximately eight large trees (five River Red Gum; three Studley Park Gum) as having a moderate to high likelihood of being negatively impacted by drawdown during operation (2075) within Simpson Barracks. A further three large trees (all River Red Gum) were also likely to be impacted *outside* Simpson Barracks by drawdown associated with operation of the northern tunnel portal (Figure 9-4).

Although a number of large trees within Simpson Barracks have the potential (moderate to high likelihood) to suffer premature mortality over the long term, there are currently thousands of other younger trees approximately 10 to 20 metres high (with diameter at breast height [DBH] ranging from 20 to 70 centimetres) within the moderate to high risk zones at Simpson Barracks. From 2024 to 2075, these trees are expected to grow and self-thin (due to density-dependent mortality), with many trees likely to move through the ranks into the large tree category by 2075. While groundwater levels may be slightly lower over the long-term, most of these trees are likely to have never accessed groundwater during their development, owing to their relatively smaller size (and shallower root systems) at the time of the construction of North East Link, and subsequently, are unlikely to be affected by the projected drawdown as they are unlikely to be dependent on groundwater.

It should be noted that it is possible, even likely, that any large tree losses due to groundwater drawdown may be countered by other trees growing and moving into the large tree cohort over time. For example, it is estimated that more than 200 trees ranging in size from 50 to 79 centimetres DBH occur in the moderate to high risk zones at Simpson Barracks. While some of these trees may suffer premature mortality due to groundwater drawdown, many are likely to have root systems that do not penetrate deep enough to access groundwater, and by inference, drawdown would not impact these individuals. Over the 50-year timespan from 2024 to 2075, many of these trees would likely become large trees, conservatively adding girth of *c.* 0.5 centimetres per year (Bennetts and Jolly 2017 reported 0.44 centimetres $year^{-1}$ growth in River Red Gum in floodplain forests). This would make it quite probable there would be no net loss of large trees from Simpson Barracks over time.

In the vicinity of the southern portal, areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary, which are likely to be accessing groundwater, would unlikely be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain would also unlikely be negatively impacted.

GDEs are modelled extensively across the Banyule Flats area. The tunnels have the potential to modify the movement of groundwater in their immediate location, and across a wider area. These changes may raise or lower the groundwater level at various locations. Lowering of the groundwater could impact terrestrial or aquatic GDEs, whereas raising of the groundwater could impact ecosystems not previously reliant on groundwater, but sensitive to greater levels of inundation, saturation or salinity.

For the tunnelled section between the portals (where terrestrial and aquatic habitats occur that are likely to support threatened and migratory fauna), there is negligible predicted change to groundwater levels and flow at the end of construction and by 2075. A numerical modelling scenario was undertaken to predict mounding beneath the floodplain as a result of the TBM tunnels (refer to Section 7.4.2 of PER Technical Appendix B – Groundwater). The results do not predict mounding beneath the floodplain; groundwater is predicted to flow above and below the tunnel within the bedrock aquifer, without increasing water levels in the overlying alluvial sediments. Some mounding of up to 0.2 metres was noted on the eastern side of the TBM tunnels between the floodplain and the northern portal, but within the bedrock aquifer.

It should be noted that in terms of MNES, Matted Flax-lily (*Dianella amoena*) would unlikely be impacted by groundwater drawdown at Simpson Barracks, as roots are unlikely to penetrate deeper than one metre, and so are unlikely to be groundwater dependent. Any potential decrease in canopy cover caused by tree dieback in the 10<20-metre groundwater depth zone is unlikely to negatively impact the Matted Flax-lily population, as dieback is likely to be minimal in the context of shade provided by non-impacted trees, and the species is known to persist in grasslands with no tree cover.

Impact description – aquatic ecosystems

The key aquatic habitat likely impacted by changes to groundwater levels are the groundwater dependent deep pool wetland of Bolin Bolin Billabong. The aquatic ecosystem does not support MNES.

Waterways with larger catchments and more permanent baseflow (the Yarra River and Koonung Creek) or intermittent streams that are not impacted by groundwater changes (Banyule Creek) are not expected to have significant groundwater impacts on hydrology or aquatic habitat quality. MNES inhabiting or reliant on these aquatic ecosystems would therefore not be impacted by changes to groundwater due to North East Link.

The modelled groundwater drawdown in the northern portal indicates the impacts on groundwater levels are not expected to affect reaches of Banyule Creek that are maintained by groundwater-fed baseflows. The field assessment of Banyule Creek identified that groundwater supplemented baseflows in Banyule Creek occur more than one kilometre south of Lower Plenty Road, which is well outside the drawdown area within and around Simpson Barracks. The groundwater changes would therefore not impact aquatic ecosystems on Commonwealth land.

Proposed avoidance and mitigation measures

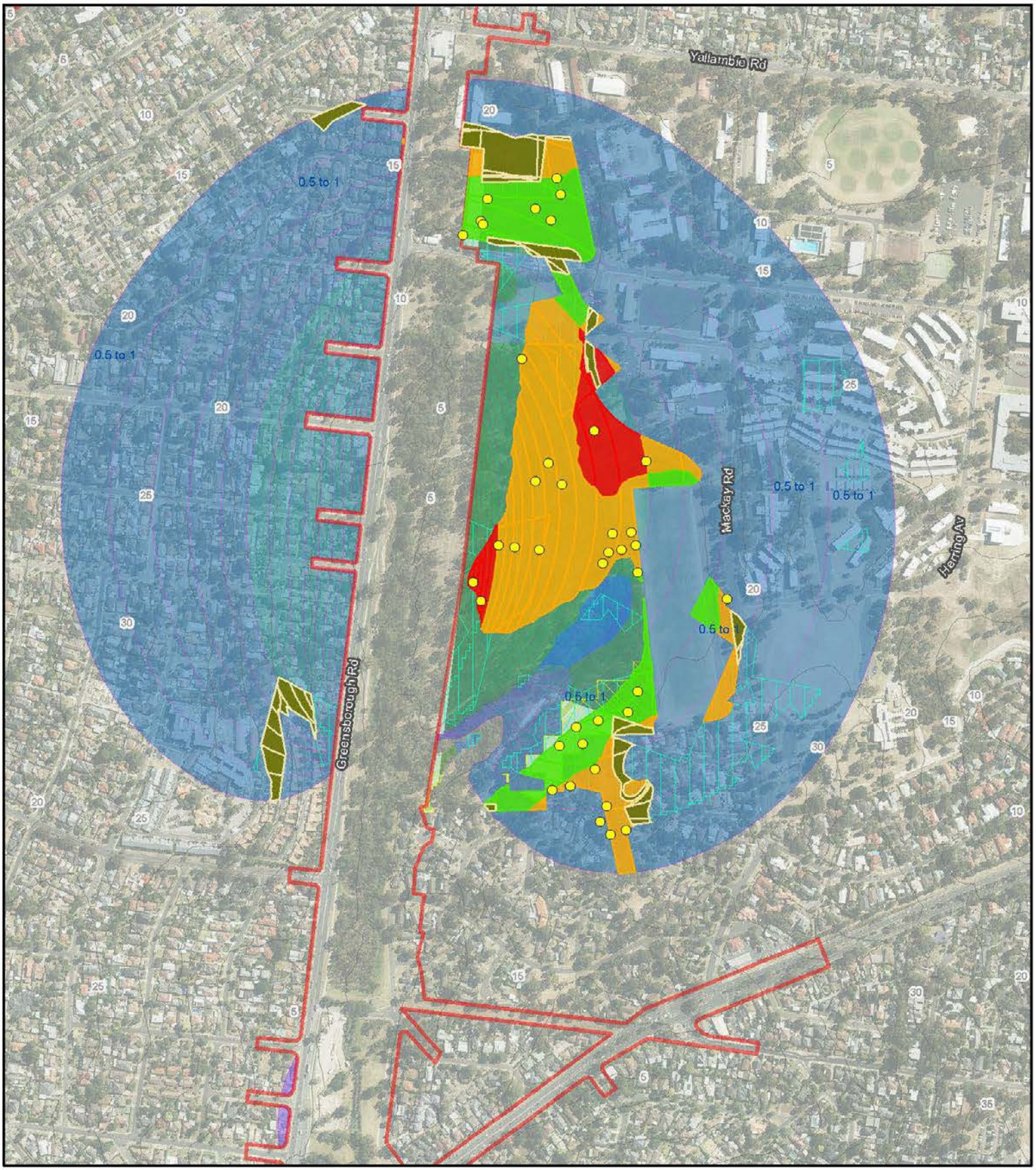
Given the variability and uncertainty in dependency of GDEs within the study area, potential impacts would be monitored and managed through:

- Implementation of groundwater monitoring
- Implementation of a GDE monitoring and mitigation plan.

The design of the tunnels would consider the location of these ecological values to minimise impacts on aquatic ecosystems. The tunnels would be designed and constructed to avoid and minimise groundwater changes that could impact ecological values. During the operation of North East Link, groundwater and GDEs would require monitoring, with protection measures implemented to avoid impacts on ecological values.

It is particularly important to understand the potential impacts on the Yarra River and relatively good condition vegetation at Simpson Barracks and nearby reserves. Where vegetation has a moderate to high likelihood of being impacted by groundwater drawdown, it would be considered lost and would be offset according to the DELWP Guidelines (2017a).

Monitoring of relevant ground and surface water levels should be conducted in areas of vegetation and wetlands potentially impacted by groundwater changes (Banyule Flats and Banyule Swamp). Monitoring could assess changes to hydrology and habitat types suitable for threatened species (such as snipe, bitterns, owls, ducks and egrets) that use those habitats. A mitigation plan for any impacts to GDEs detected in the monitoring is also required.



Legend

GDE Risk Rating 2075
- Very High Risk
- High Risk
- Moderate Risk
- Low Risk
- Negligible Risk - Residential, Industrial or Oval Area
- Project boundary - sub-surface
- Project boundary - surface
- Groundwater Dependent Ecosystems - surface expression (BOM)
- Groundwater Dependent Ecosystems - sub-surface expression (BOM)
- Groundwater Dependent Ecosystems (PPCMA)
- Large tree

Native Vegetation (EVC)
- Plains Grassy Woodland (55)

EVC 2005 (DELWP)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2007 (HLA)
- Riparian Area with Seasonal Grassy Wetland
- River Red Gum Woodland
- Depth to Groundwater Contours (5m)

Groundwater Drawdown (m)
- -0.5 to -0.1
- 0.5 to 1
- 1 to 2
- 2 to 3

Paper Size A4

0 45 90 180

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

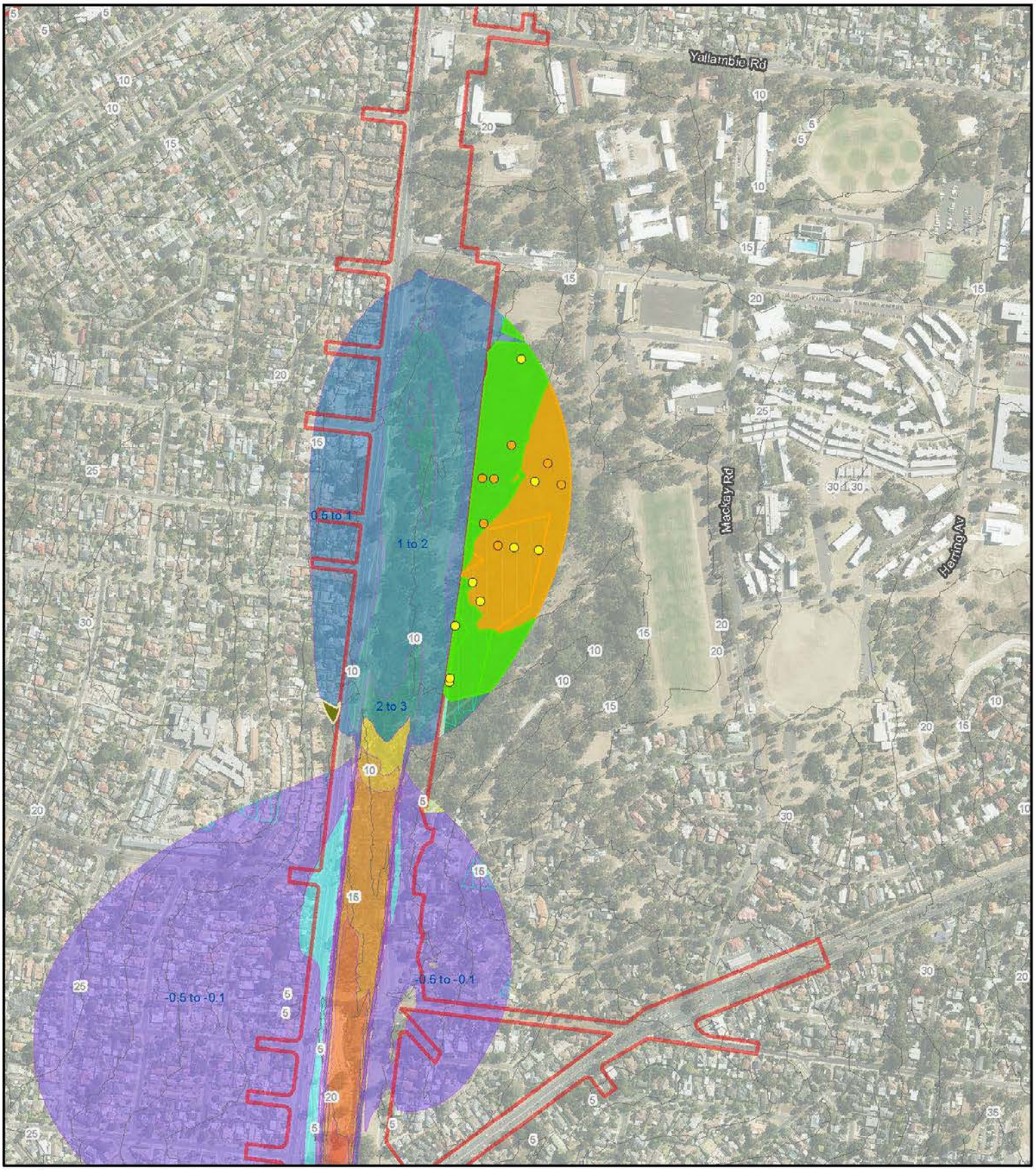
North East Link Project
Public Environment Report

Risk to native vegetation and GDEs from groundwater drawdown in vicinity of northern portal - 2075 (95th percentile, initial modelling)

Job Number 31-35006
Revision C
Date 16 Aug 2019

Figure 9-3

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_9_3_GDEs_95th_2075_A3L_RevC.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com
Data Sources: CIP Imagery, EVC 2005 - DELWP - 2018 | Road Names - Vicmap - 2018 | Groundwater Dependant Ecosystems - PPCMA, BOM - 2018 | Construction Footprint, Scattered Trees, Matted Flax-lily, Groundwater Drawdown - GHD/AECOM - 2018



Legend

GDE Risk Rating 2075
- Very High Risk
- High Risk
- Moderate Risk
- Low Risk

- Negligible Risk - Residential, Industrial or Oval Area
- Project boundary - sub-surface
- Project boundary - surface

- Groundwater Dependent Ecosystems - surface expression (BOM)
- Groundwater Dependent Ecosystems - sub-surface expression (BOM)
- Groundwater Dependent Ecosystems (PPCMA)

Groundwater Drawdown (m)
- -2 to -0.5
- -0.5 to -0.1
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 10
- 10 to 15
- 15 to 20

- Large tree
- Large Studley Park Gum

Native Vegetation (EVC)
- Plains Grassy Woodland (55)

EVC 2005 (DELWP)
- Creekline Grassy Woodland (68)
- Plains Grassy Woodland (55)

EVC 2007 (HLA)
- Riparian Area with Seasonal Grassy Wetland
- River Red Gum Woodland
- Depth to Groundwater Contours (5m)

Paper Size A4

0 45 90 180

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link Project
Public Environment Report

Risk to native vegetation and GDEs from groundwater drawdown in vicinity of northern portal - 2075 (further modelling)

Job Number 31-35006
Revision C
Date 16 Aug 2019

Figure 9-4

G:\31\35006\GIS\Maps\Working\Specialist Submission\PER\Ecology\31135006_9_4_GDEs_2075_Post_EES_A3P_RevC.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data Sources: CIP Imagery, EVC 2005 - DELWP - 2018 | Road Names - Vicmap - 2018 | Groundwater Dependant Ecosystems - PPCMA, BOM - 2018 | Construction Footprint, Scattered Trees, Matted Flax-lily, Groundwater Drawdown - GHD/AECOM - 2018

10. Relevant impacts on MNES

This section describes the potential for the construction and operation of North East Link to impact ecological assets, values and uses. Section 9 describes the potential direct and indirect impact pathways.

The impact assessment has considered the potential for significant impacts on the environment to occur as described by the criteria outlined in the EPBC Act Guidelines:

- Matters of National Environmental Significance – Significant impact guidelines 1.1 (Department of Environment, 2013)
- Step 4 of the *Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies – Significant impact guidelines 1.2* (DSEWPAC, 2013a).

10.1 Flora and vegetation

Individual assessments of the potential for North East Link to impact the following flora species and threatened ecological communities listed as threatened under the EPBC Act are provided below:

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)
- Matted Flax Lily (*Dianella amoena*) (endangered)
- River Swamp Wallaby-grass (*Amphibromus fluitans*) (vulnerable)
- Clover Glycine (*Glycine latrobeana*) (vulnerable).

10.1.1 Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)

No Grassy Eucalypt Woodland of the Victorian Volcanic Plan (GEWVVP) occurs within the project boundary. One patch of GEWVVP between the M80 Ring Road and Enterprise Drive, Bundoora is immediately adjacent to the project boundary and would be avoided (it is a designated ‘no-go’ zone). No significant changes to surface water regimes or groundwater systems are expected in this area.

Table 10-1 identifies the construction and operation impacts that could affect GEWVVP. These impact pathways are discussed in detail in Section 9. Table 10-2 provides an assessment of potential impacts against the EPBC Act Significant impact criteria that relate to a critically endangered community.

Table 10-1 Impacts that would or might affect Grassy Eucalypt Woodland of the Victorian Volcanic Plain

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11

Potential impact	Section
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-2 Assessment of project against significant impact criteria for Grassy Eucalypt Woodland of the Victorian Volcanic Plain

Criterion	Response
• Reduce the extent of an ecological community	**Unlikely.** As outlined in Section 6.2.2, GEWVVP does not occur within the project boundary. However, it does occur immediately adjacent to the project boundary at a site near Enterprise Drive, north of the M80 Ring Road in Bundoora. This site is a designated 'no-go' zone for North East Link and would not be impacted. The construction of North East Link would not therefore reduce the extent of this ecological community.
• Fragment or increase fragmentation of an ecological community, such as by clearing vegetation for roads or transmission lines	**Unlikely.** Rationale as per criterion above (reduce the extent of an ecological community).
• Adversely affect habitat critical to the survival of an ecological community	**Unlikely.** Rationale as per criterion above (reduce the extent of an ecological community).
• Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**Unlikely.** Construction of North East Link adjacent to the GEWVVP at the Enterprise Drive native vegetation site north of the M80 Ring Road in Bundoora would unlikely influence groundwater levels or alter surface water drainage patterns. The M80 Ring Road currently sits approximately 5 –10 m below the remnant GEWVVP and so North East Link would unlikely result in further lowering of the road surface leading to alteration of groundwater levels.
• Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**Unlikely.** Construction of North East Link adjacent to the GEWVVP at the Enterprise Drive native vegetation site north of the M80 Ring Road in Bundoora would unlikely result in a substantial change in species composition of the ecological community. While nearby construction activities have the potential to facilitate weed encroachment onto the GEWVVP 'no-go' zone, this community would unlikely be negatively affected, as the understorey composition of the remnant woodland is already almost totally dominated by introduced species.

Criterion	Response
• Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: – Assisting invasive species, that are harmful to the listed ecological community, to become established, or – Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or	**Unlikely.** Rationale as per criterion above (cause a substantial reduction in the quality or integrity of an occurrence of an ecological community).
• Interfere with the recovery of an ecological community.	**Unlikely.** Rationale as per criterion above (reduce the extent of an ecological community AND cause a substantial reduction in the quality or integrity of an occurrence of an ecological community).

10.1.2 Matted Flax Lily (*Dianella amoena*) (endangered)

Table 10-3 identifies the construction and operation impacts that could affect Matted Flax Lily. These impact pathways are discussed in detail in Section 9. Table 10-4 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to an endangered species.

Table 10-3 Impacts that would or might affect Matted Flax Lily

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1

Table 10-4 Assessment of project against significant impact criteria for Matted Flax-lily

Criterion	Response
Lead to a long-term decrease in the size of a population	**Likely (without translocation)** **Unlikely (with translocation)** – for context, see discussion after table on 'proposed mitigation measures', 'translocation' and 'residual impact'. Works would require removal of up to 95 Matted Flax-lily plants/patches from five sites across the study area (83 plants/patches at Simpson Barracks Reserve, four plants/patches at the M80 Ring Road interchange, and eight plants/patches across three distinct sites within the Hurstbridge rail line). It should be noted this is the total number recorded within the project boundary and the actual impact on plants in significant sites (such as at Simpson Barracks) may be reduced following detailed design. To place this impact in context, at the very least, an additional 188 plants/patches occur nearby at Simpson Barracks outside the project boundary, which suggests that approximately 31% (83 out of 271 plants/patches) of Simpson Barracks population would likely be impacted. Based on this level of impact to the Simpson Barracks population, in the absence of mitigation or translocation, it is likely that North East Link would result in a long-term decrease in the size of the population at Simpson Barracks in particular. However, with implementation of the mitigation measures and Salvage and Translocation Plan discussed below and attached at Attachment F, it is considered unlikely that North East Link would result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	**Likely** **Possible (with translocation)** – for context, see discussion after table on 'proposed mitigation measures', 'translocation' and 'residual impact'. North East Link would likely result in the loss of Matted Flax-lily at five discrete sites, totalling up to 95 discrete patches/individuals separated by at least 1 m. In the absence of mitigation measures, North East Link would reduce the area of occupancy of the species through the direct removal of: a) 83 plants/patches of Matted Flax-lily in Plains Grassy Woodland at Simpson Barracks, and b) four plants/patches in Grassy Dry Forest at the M80 Ring Road interchange. In addition, three small locations in a patch of Grassy Dry Forest along the Hurstbridge rail line would potentially be impacted. While the area of occupancy of the species would be reduced (in the absence of mitigation), the total geographical range of the species would not be impacted. However, with implementation of the translocation measures proposed below, it is considered unlikely the overall area of occupancy of the species would be reduced, as occupancy would be reduced in the impacted areas but increased in others via translocation.
Fragment an existing population into two or more populations	**Unlikely** While plants are expected to be removed, it is unlikely that works would fragment existing populations at any of the identified sites into two or more populations. For example, while impacts in terms of total numbers at Simpson Barracks are expected to be significant, the population would not be fragmented, as plants to be removed are from the edge of the population.

Criterion	Response
Adversely affect habitat critical to the survival of a species	**Possible (with translocation)** No habitats within the study area are identified on the Register of Critical Habitat (however, it should be noted the Register of Critical Habitat currently does not include any listing for the Matted Flax-lily). In addition, information regarding habitat critical to the survival of the species is not available in the National Recovery Plan for the species (Carter, 2010). While Simpson Barracks is listed as a 'significant population' in the Recovery Plan (10 plants recorded at the time of the Recovery Plan, suggesting that it was the 16th largest population listed in the Plan), the surveys associated with North East Link, and other historical surveys by HLA (2007) and Jacobs (2016), indicate the total population size at Simpson Barracks is at least 271 plants/patches (83 of which fall within the project boundary). The total population size at the site suggests that it is likely to be one of the largest known populations of Matted Flax-lily. Although habitat critical to the survival of the species has not been formally recognised or documented, given the significance of the population, it is possible that North East Link may adversely affect habitat critical to the survival of the species, even with the implementation of mitigation or translocation measures.
Disrupt the breeding cycle of a population	**Unlikely** Native bees are the natural pollinator of Matted Flax-lily, with translocated plants observed to have been successfully pollinated (Ecology Australia, 2014). However, little evidence exists to indicate whether pollinated flowers translate to successful seed germination and recruitment. Matted Flax-lily apparently does not readily regenerate from seed *in situ*, and no seedlings have been seen at any site, indicating that at least some processes upon which the species relies have probably been disrupted (Carter, 2010). However, we have noted at other sites that Matted Flax-lily can occasionally colonise disturbed substrates such as embankments via clonal growth (T. Wills, pers. obs.). Measures would be implemented as part of the CEMP to minimise impacts on native vegetation and Matted Flax-lily to be retained, including minimising the areas of vegetation to be disturbed, no-go zones, weed management and hygiene measures. While North East Link would impact individuals, works would unlikely disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Likely** **Unlikely (with translocation)** – for context, see discussion after table on 'proposed mitigation measures', 'translocation' and 'residual impact'. In the absence of mitigation and translocation measures, habitat for Matted Flax-lily would be removed to the extent the species would likely decline. Reasons are outlined above under the criteria, *Lead to a long-term decrease in the size of a population* and *Reduce the area of occupancy of the species*. While there would be a decrease in available habitat due to North East Link, the translocation plan would mitigate the potential for a decline in the species due to measures discussed below including producing multiple clones for each plant, maintaining plants in an approved nursery, implementing a 10-year monitoring plan and replacing any plants that suffer premature mortality.

Criterion	Response
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**Possible** **Unlikely (with mitigation)** – for context, see discussion after table on 'proposed mitigation measures', 'translocation' and 'residual impact'. In the absence of mitigation measures, it is possible that invasive species may become established in the retained habitat for Matted Flax-lily (east of the project boundary) at Simpson Barracks, owing to ground disturbance in the immediately adjacent construction area facilitating weed invasion or encroachment. However, with implementation of the mitigation measures proposed below, specifically pertaining to weed control, it is considered unlikely that North East Link would result in invasive species becoming established and negatively impacting habitat for the species.
Introduce disease that may cause the species to decline	**Unlikely** No diseases known to affect Matted Flax-lily would likely be activated or exacerbated by construction of North East Link. It is therefore unlikely that any disease would be introduced to the retained Matted Flax-lily habitat at Simpson Barracks.
Interfere substantially with the recovery of the species	**Likely** **Unlikely (with translocation)** – for context, see discussion after table on 'proposed mitigation measures'. 'translocation' and 'residual impact'. Threats to the survival of the Matted Flax-lily as identified in *the National Recovery Plan for the Matted Flax-lily Dianella amoena* include weed invasion/competition, habitat destruction and disturbance, and population fragmentation (Carter, 2010). In the absence of mitigation and translocation measures, North East Link would reduce the area of occupancy for the species and exacerbate identified threatening processes such as weed invasion. Vegetation clearance would also result in the loss of up to 95 plants/patches, which in the absence of mitigation and translocation measures, is likely to interfere with the recovery of the species. However, with implementation of the mitigation and translocation measures proposed below, it is considered unlikely that North East Link would interfere substantially with the recovery of the species.

Proposed mitigation measures

To avoid inadvertent impacts on retained Matted Flax-lily, weed control measures would be developed and outlined in the CEMP, to control weeds within Simpson Barracks adjacent to the eastern edge of the project boundary in the area where Matted Flax-lily would be retained. For general mitigation regarding habitat removal, refer to Section 9.

Translocation

In the National Recovery Plan for Matted Flax-lily (Carter, 2010), translocation to bolster existing populations or establish new populations, is listed as one of eight specific objectives for the recovery of Matted Flax-lily. The EPBC Act Policy Statement Translocation of Listed Threatened Species (DSEWPAC 2013) notes that a key issue when considering translocation is the probability of long-term success.

Translocation of Matted Flax-lily has been successfully completed before for other major projects, with Carter (2010) indicating a success rate of 80 to 90 per cent (over a period of five years) for salvage undertaken in 2004 from grasslands in Craigieburn and translocated into reserves in Craigieburn, Fawkner, Somerton and Whittlesea. In recent years, a number of large-scale Matted Flax-lily translocation projects have been approved and undertaken in the greater Melbourne area, including the Sugarloaf Pipeline Project (Yarra Glen), South Morang Rail Extension[11] and the Level Crossing Removal Project (Mernda). As an example of the success of previous translocation efforts, the Sugarloaf Pipeline Project established a post-translocation five-year monitoring program (Ecology Australia, 2014), with the results summarised below:

- *Dianella amoena* was easily translocated and as a robust, rhizomatous herb it readily established and soon became reproductive
- Survivorship amongst the cohorts was high over the five-year monitoring period, ranging from 70 to 100 per cent at each translocation subplot/site
- Positive trends in vegetative performance (growth) were evident in the number of shoots per plant, basal diameter of plants and leaf length, which confirmed the ease of establishment and excellent growth under good conditions
- Weed invasion presented a severe problem, with weed control the only significant management issue.

Careful attention must be paid to every component of the salvage and translocation program to maximise the chance of successful translocation.

To minimise unavoidable residual impacts on the Matted Flax-lily, plants/patches within the project boundary are proposed to be salvaged and translocated to suitable alternative sites, some of which already support Matted Flax-lily, and some of which do not support the species but contain appropriate habitat. NELP is investigating potential recipient sites within the City of Whittlesea, City of Darebin and City of Banyule, as well as in the eastern section of Simpson Barracks. A Salvage and Translocation Plan has been developed (Appendix F), which includes methods to maximise the success of the translocations including:

- Multiple clones would be taken for each plant removed from the ground to safeguard the persistence of the plants
- Stock would be maintained in an approved nursery with experience in the management and handling of Matted Flax-lily
- Recipient sites would be selected based on an approved process, with key elements being suitability of habitat, and commitment to ongoing maintenance required for the species to establish successfully
- Implementation of a detailed 10-year monitoring plan to determine progress over time. The plan would incorporate thresholds of plant condition and survivorship for which additional management action would be required.

[11] https://floravictoria.com.au/endangered-species/

Residual impact

With the implementation of a successful salvage and translocation program, significant impacts on Matted Flax-lily are expected to be unlikely for seven or eight of the nine significant impact criteria, while significant impacts are possible for one criterion: 'Adversely affect habitat critical to the survival of a species', and possibly a second criterion, 'Reduce the area of occupancy of the species'. However, the residual impact of North East Link on Matted Flax-lily is expected to be **non-significant** for the following reasons:

- Salvage and translocation is a specific action identified under the National Recovery Plan for Matted Flax-lily (Carter, 2010)
- There is a documented successful track record of Matted Flax-lily salvage and translocation in the greater Melbourne area over the past decade (such as Carter, 2010; Ecology Australia, 2014)
- The evidence suggests there are strong prospects of long-term survivorship of translocated individuals
- The translocation risk is proposed to be spread across a number of potential receptor sites in the local area, minimising the risk of failure
- Multiple ramets would be harvested (and grown on) from each plant/patch to be salvaged; therefore, it is likely the overall population size in the local area would increase following implementation of the translocation program.

Noting that the residual impacts on Matted Flax-lily are expected to be non-significant, no offsetting for the removal and translocation of Matted Flax-lily is proposed. Any loss of the native vegetation that provides habitat would be offset in accordance with the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (2017a).

10.1.3 River Swamp Wallaby-grass (*Amphibromus fluitans*) (vulnerable)

Table 10-5 identifies the construction and operation impacts that could affect River Swamp Wallaby-grass. These impact pathways are discussed in detail in Section 9. Table 10-6 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a vulnerable species.

Table 10-5 Impacts that would or might affect River Swamp Wallaby-grass

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12

Potential impact	Section
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-6 Assessment of project against significant impact criteria for River Swamp Wallaby-grass

Criterion	Response
Lead to a long-term decrease in the size of an important population of a species	**Unlikely** River Swamp Wallaby-grass has been historically recorded within the project boundary at Trinity Grammar School Sporting Complex wetland B (Australian Ecosystems, 2007). Despite targeted survey during the flowering season of this species, it was unable to be located at this wetland. In addition, it has been recorded in close proximity to the project boundary at four locations: a) Bolin Bolin Billabong in 1994 and 2011 (VBA), b) Yarra Flats north of Bolin Bolin (1995), c) Banyule Flats (1995) and d) Trinity Grammar wetland D (Australian Ecosystems, 2007). The Conservation Advice for the species does not outline the location of any important populations in Australia. In the absence of this information, it is unlikely the Trinity Grammar population (if still present), constitutes an important population, given its man-made status, small size, poor quality surrounding habitat and susceptibility to weed invasion. It is therefore unlikely that North East Link would lead to a long-term decrease in the size of an important population of River Swamp Wallaby-grass.
Reduce the area of occupancy of an important population	**Unlikely** Given the logic outlined above, which indicated the project boundary was unlikely to support an important population of the species, it is considered unlikely that North East Link would reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	**Unlikely** Given the logic outlined above, which indicated the project boundary was unlikely to support an important population of the species, it is considered unlikely that North East Link would fragment an existing important population into two or more populations.

Criterion	Response
Adversely affect habitat critical to the survival of a species	**Unlikely** No habitats within the project boundary are identified on the Register of Critical Habitat (although it should be noted the Register of Critical Habitat currently does not include any listing for River Swamp Wallaby-grass). The quality of the potential habitat within the project boundary is relatively poor, while known records occur nearby in better quality habitat on the Yarra Flats, Banyule Flats and Bolin Bolin Billabong outside the project boundary. These areas outside the project boundary are more likely to be considered as habitat critical to the survival of the species due to their size, number of records and management regime. In summary, although habitat critical to the survival of the species has not been formally recognised or documented, it is considered unlikely that North East Link would adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	**Unlikely** Given the logic outlined above, which indicated the project boundary was unlikely to support an important population of the species, it is considered unlikely that North East Link would disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** Trinity Grammar wetland B is the only historical location within the project boundary where River Swamp Wallaby-grass has been recorded (Australian Ecosystems, 2007). Despite this record, a targeted search for the species during its flowering time in December 2018 failed to locate any individuals. If still present at this wetland, the potential direct removal of habitat is unlikely to be of an extent that would cause the species to decline. North East Link also has the potential to indirectly modify available habitat through groundwater drawdown associated with tunnel construction. However, the extent of drawdown at sensitive receptor sites outside the project boundary where the species has been previously recorded (Bolin Bolin Billabong, Yarra Flats, Banyule Flats, Trinity Grammar wetland B) is modelled to be relatively minor, particularly in the context of natural seasonal and year-to-year variation in water levels. Therefore, the quality or availability of habitat for the species would unlikely be modified or removed to the extent the species would likely decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely** In the absence of mitigation measures, it is possible that invasive species would become established in the retained habitat for River Swamp Wallaby-grass immediately adjacent to the project boundary (east of the project boundary at Trinity Grammar wetland D and west of the project boundary at Bolin Bolin Billabong), owing to ground disturbance associated with North East Link in the immediately adjacent construction area. It should be noted these nearby areas are already subject to a range of urban pressures including weed invasion and are already managed for conservation purposes. It is therefore considered unlikely that North East Link would result in invasive species that are harmful to a vulnerable species becoming established in their habitat. Nevertheless, construction methods would be implemented through the CEMP so it would be unlikely that invasive species would be introduced.

Criterion	Response
Introduce disease that may cause the species to decline	**Unlikely** No diseases known to affect River Swamp Wallaby-grass are likely to be activated or exacerbated by construction of North East Link. It is therefore unlikely that any disease would be introduced to the retained River Swamp Wallaby-grass habitat in floodplain areas near to the project boundary.
Interfere substantially with the recovery of the species	**Unlikely** Threats to the survival of River Swamp Wallaby-grass as identified in the *Conservation Advice* for the species include grazing and trampling by livestock, hydrological changes, and invasion of remnant habitats by exotic grasses and weeds. As outlined above, minor hydrological (groundwater) changes as a result of tunnelling are likely in nearby wetlands where the species is known to occur (Bolin Bolin Billabong). However, based on detailed groundwater modelling, these impacts would likely be relatively minor in the context of natural seasonal and annual variation in water depth (drawdown of 0.1–0.5 m at Bolin Bolin Billabong, and mounding of 0.1 to 0.5 m at Trinity Grammar wetland D). Any removal of habitat at Trinity Grammar wetland B would likely have a minor effect on the species, if indeed it still persists at this wetland (note – targeted surveys failed to locate the species). On the available evidence, it is therefore unlikely that construction of North East Link would interfere substantially with the recovery of the species.

Proposed avoidance and mitigation measures

Given the relatively minor ecological impact of changes to surface water levels, and the uncertainty of the degree of change expected, the recommended method for protecting the aquatic ecosystem of Bolin Bolin, and by inference, River Swamp Wallaby-grass, would be to undertake water level monitoring in the deep pool to confirm the actual changes to surface water. Water level monitoring would be recommended as part of a groundwater dependant ecosystem monitoring and mitigation plan, which would include the surface expression of groundwater at Bolin Bolin Billabong. This monitoring would inform the need for mitigation measures to maintain water depth in the deep pool. Therefore, a groundwater and surface water monitoring program would be required to determine the level of change in this ecosystem during construction.

To avoid ecosystem changes in the groundwater dependent deep pool in Bolin Bolin Billabong, groundwater levels in this area would be maintained to the extent practicable. This would also serve to avoid the potential for activation of acid sulfate soils. If monitoring of groundwater and surface water levels indicates changes to water levels that may impact ecosystem conditions at Bolin Bolin billabong, a Groundwater Management Plan could include measures to mitigate the impact of these changes. Measures to maintain supply to identified groundwater users and protect groundwater quality recharged to the environment would be developed and implemented. In particular, the protection of groundwater quality could consider any use or recharge activities used to maintain water levels in GDEs that support listed species such as River Swamp Wallaby-grass (Bolin Bolin Billabong) to prevent impacts to groundwater or surface water quality and protect environmental conditions of the GDEs.

Prior to construction, a final targeted survey would be undertaken at the Trinity Grammar wetlands to ascertain whether the species was present within the project boundary. If present, it is proposed that the stolons (the creeping root system) and and aerial parts (eg stems/leaves) would be salvaged and translocated to suitable nearby habitat.

Finally, weed control measures would be outlined in the CEMP to control weeds, and could include the area immediately adjacent to the project boundary at the Trinity Grammar School wetlands.

Residual impact and offsetting

Following implementation of mitigation measures, the residual impacts on River Swamp Wallaby-grass are anticipated to be low and non-significant. Any direct loss of the native vegetation that provides habitat would be offset in accordance with the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (2017a).

10.1.4 Clover Glycine (*Glycine latrobeana*) (vulnerable)

Table 10-7 identifies the construction and operation impacts that could affect Clover Glycine. These impact pathways are discussed in detail in Section 9. Table 10-8 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a vulnerable species.

Table 10-7 Impacts that would or might affect Clover Glycine

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1

Table 10-8 Assessment of project against significant impact criteria for Clover Glycine

Criterion	Response
Lead to a long-term decrease in the size of an important population of a species	**Unlikely** While populations important to the survival of Clover Glycine have not been identified within the project boundary, significant populations based on size, geographic spread and land tenure have been identified in the National Recovery Plan (Carter and Sutter, 2010). None of these populations occur within the project boundary. Targeted surveys during the flowering season in areas of potential habitat identified no plants within the project boundary, although eight sites have been documented on the VBA within a five-km radius of the project boundary. This means there remains a possibility, albeit low, that the species may occur within the project boundary. Given the available evidence, it is unlikely that North East Link would lead to a long-term decrease in the size of an important population of the species.

Criterion	Response
Reduce the area of occupancy of an important population	**Unlikely** While North East Link has the potential to impact habitat suitable for Clover Glycine, the species was not recorded within the project boundary during targeted surveys for the species. As outlined above, it is unlikely that an important population occurs within the project boundary. While it is possible the area of occupancy of the species may be reduced through clearance of the Plains Grassy Woodland habitat that supports the species (if it actually occurs within the project boundary), it is unlikely to reduce the area of occupancy for an important population.
Fragment an existing important population into two or more populations	**Unlikely** As outlined above, an important population is unlikely to be present within the project boundary, and so fragmentation of an important population is regarded as unlikely.
Adversely affect habitat critical to the survival of a species	**Unlikely** No habitats within the study area are identified on the Register of Critical Habitat (although it should be noted the Register of Critical Habitat currently does not include any listing for Clover Glycine). In addition, information regarding habitat critical to the survival of the species is not available in the National Recovery Plan for the species (Carter and Sutter, 2010). Given the above, and that the species was not recorded within the project boundary during targeted surveys, it is unlikely that habitat critical to the survival of the species would be adversely affected.
Disrupt the breeding cycle of an important population	**Unlikely** As outlined above, an important population is unlikely to be present within the study area, and so the breeding cycle of an important population is unlikely to be disrupted.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** The availability or quality of habitat would be impacted by North East Link, although it is unlikely the species would decline as a result, as the species was not recorded following targeted surveys in suitable habitat during the flowering time for this species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely** Construction methods would be implemented through the CEMP so it is unlikely that invasive species would be introduced.
Introduce disease that may cause the species to decline	**Unlikely** No diseases known to affect Clover Glycine would likely be activated or exacerbated by construction of North East Link. It is therefore unlikely that any disease would be introduced to the retained Clover Glycine habitat in grassy woodland areas near the project boundary.
Interfere substantially with the recovery of the species	**Unlikely** Threats to the survival of Clover Glycine as identified in *the National Recovery Plan* include weed invasion/competition, inappropriate fire regimes, grazing and human disturbance (Carter and Sutter, 2010). Given the species has not been recorded historically within the project boundary, and following targeted surveys in suitable habitat during the flowering time for this species, North East Link would unlikely interfere substantially with the recovery of the species.

Proposed avoidance and mitigation measures

While no individuals of Clover Glycine are known from within the project boundary, attempts would be made to minimise loss of native vegetation including potential Plains Grassy Woodland habitat, particularly at Simpson Barracks, which contains the most likely habitat for the species within the project boundary.

Residual impact and offsetting

Following implementation of mitigation measures, the residual impacts on Clover Glycine are anticipated to be minimal. Any direct loss of potential habitat would be offset in accordance with the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (2017a).

10.2 Terrestrial fauna

Individual assessments for the potential for North East Link to impact the following terrestrial fauna species listed as threatened under the EPBC Act are provided below:

- Swift Parrot (Table 10-10)
- Australian Painted Snipe (Table 10-12)
- Australasian Bittern (Table 10-14)
- Growling Grass Frog (Table 10-16)
- Grey-headed Flying-fox (Table 10-18).

10.2.1 Swift Parrot (*Lathamus discolor*) (critically endangered)

Table 10-9 identifies the construction and operation impacts that could affect the Swift Parrot. These impact pathways are discussed in detail in Section 9. Table 10-10 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a critically endangered species.

Table 10-9 Impacts that would or might affect the Swift Parrot

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Death or injury of fauna during construction	9.1.6
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of terrestrial wildlife corridors creating barriers to terrestrial fauna movement	9.1.8
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12

Potential impact	Section
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Death or injury of fauna during road operation	9.2.5
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-10 Assessment of project against significant impact criteria for the Swift Parrot

Criterion	Response
Lead to a long-term decrease in the size of a population	**Unlikely** North East Link would unlikely lead to a long-term decrease in the size of the Swift Parrot population. While Swift Parrots may forage in trees along the alignment occasionally and opportunistically, there is little evidence to suggest they rely on those trees, or use them regularly or frequently to the point that birds would be displaced by removal of those trees. The trees at Macleod Station may be an exception to this – up to 40 Swift Parrots were observed between May and July 2015 in the trees surrounding the railway station (BLA, e-Bird), and those trees may be categorised as priority habitat. Most of the trees the Swift Parrots used are located outside the project boundary, but some trees within the project boundary do or may form part of the habitat patch. Every effort would be made to avoid all impacts on the trees within the project boundary at this location, by confining works to the base of the rail trench, or designing works around these trees. Minor impacts (such as pruning) may be necessary to allow safe access to signal boxes, but the impact is considered unlikely to discourage Swift Parrots from foraging in those trees in future. The total area of priority habitat to be removed may be further reduced during the detailed design. By adhering to mitigation measures, it is considered unlikely that North East Link would lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	**Unlikely** North East Link would not reduce the area of occupancy of the Swift Parrot. Each year, small numbers of Swift Parrots are reported sporadically across a wide area of the Melbourne metropolitan area as the birds migrate north and south. Removal of potentially suitable trees from the alignment would not stop Swift Parrots from foraging in trees across the Melbourne area, and the parrots would continue to select trees that are suitable at the time of migration. No trees or patches of trees along the alignment appear to be regularly visited by this species, and all tree species within the area are well represented outside the alignment. However, the total area of priority habitat to be removed may be reduced during detailed design.
Fragment an existing population into two or more populations	**Unlikely** North East Link would not fragment the existing Swift Parrot population into two or more populations. Rationale as for criterion above (Reducing area of occupancy).

Criterion	Response
Adversely affect habitat critical to the survival of a species	**Unlikely** North East Link would unlikely adversely affect habitat critical to the survival of the Swift Parrot. No habitats within the study area are identified on the Register of Critical Habitat (note the Register of Critical Habitat currently does not include any listing for the Swift Parrot). In terms of priority Swift Parrot habitats in Victoria, as identified by the Swift Parrot Recovery Plan (Saunders and Tzaros, 2011), the trees at Macleod Station may be categorised as priority habitat. Every effort would be made to avoid these trees by confining works to the base of the rail trench, or designing works around these trees. Swift Parrots may visit trees in and around the study area occasionally and opportunistically, but the alignment does not appear to offer Swift Parrots a particular foraging resource that is not also present and widely available in the suburbs surrounding the sites.
Disrupt the breeding cycle of a population	**Unlikely** North East Link would not disrupt the breeding cycle of the Swift Parrot population. The species breeds entirely in Tasmania, and only uses trees in Victoria for foraging during the non-breeding season.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** North East Link would unlikely modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the Swift Parrot would likely decline. Swift Parrots may visit trees in and around the alignment to forage, but their use of those trees appears to be very occasional and opportunistic. Given the relatively wide range of eucalypt species that Swift Parrots are known to visit in Victoria, and the relative commonness of those trees in areas surrounding the alignment, impacts on trees in the study area is not expected to result in any change to the numbers of Swift Parrot.
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat	**Unlikely** North East Link would unlikely result in invasive species that are harmful to the Swift Parrot becoming established in their habitat. Known species that are potentially harmful or detrimental to the Swift Parrot (aggressive bird species such as the Noisy Miner and Rainbow Lorikeet, which may harass or out-compete foraging Swift Parrots) are already abundant along the alignment.
Introduce disease that may cause the species to decline	**Unlikely** North East Link would unlikely introduce disease that may cause the Swift Parrot to decline.

Criterion	Response
Interfere substantially with the recovery of the species	**Unlikely** North East Link would unlikely impact the Swift Parrot, so is unlikely to interfere with the recovery of the species. Threats to the species recovery as identified in the *National Recovery Plan for the Swift Parrot Lathamus discolor* include habitat loss, alteration and fragmentation, climate change, collision mortality, disease, invasion/competition from other species and predation from cats *Felis catus* (Saunders & Tzaros, 2011). Habitat within the study area is only likely to be utilised by the species for foraging occasionally and opportunistically. Other than the trees at Macleod Station, there is no evidence to suggest that Swift Parrots rely on other particular trees, or use them regularly or frequently. However, the total area of priority habitat to be removed may be reduced during detailed design. North East Link would increase traffic volumes in some areas, but these are already areas of high traffic. Traffic would not be introduced into regional areas or areas of low traffic volumes. It is therefore unlikely that North East Link would increase collision mortality. By adhering to mitigation measures, North East Link is considered unlikely to interfere with the recovery of the species.

Proposed avoidance and mitigation measures

The main potential impact of North East Link on the Swift Parrot is localised loss of occasional foraging habitat. Other potential impacts such as disturbance or death of individuals are expected to be very rare, if they occur at all. Swift Parrots that visit Melbourne already tolerate various disturbances and dangers associated with a large city. North East Link would not add any significant disturbance or threat to the Swift Parrot that is not already present.

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential of North East Link to impact most terrestrial and aquatic fauna species across the Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use the inner eastern Melbourne area. In areas where surface impacts could not be avoided, particularly in locations where habitats are identified as being of high value, the smallest practicable project boundary for North East Link has been adopted to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

One location within the project boundary (Macleod Station) supports trees suitable for foraging that are considered of high value for the Swift Parrot. Every effort would be made to avoid these trees by confining works to the base of the rail trench, or designing works around these trees.

Residual impact and offsetting

With implementation of mitigation measures, the residual impact of North East Link of the Swift Parrot is expected to be minor and non-significant. Swift Parrots regularly move through the Melbourne area to forage on flowering eucalypts, but they do not show strong fidelity for any locations within the project boundary. Tree that North East Link would impact may be used occasionally or rarely for foraging by small numbers of Swift Parrots, but do not provide a particular resource not readily available in alternative locations nearby.

With a non-significant residual impact, offsets would not be required for the Swift Parrot.

10.2.2 Australian Painted Snipe (*Rostratula australis*) (endangered)

Table 10-11 identifies the construction and operation impacts that could impact the Australian Painted Snipe. These impact pathways are discussed in detail in Section 9. Table 10-12 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to an endangered species.

Table 10-11 Impacts that would or might affect the Australian Painted Snipe

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, or contamination	9.1.2
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of terrestrial wildlife corridors creating barriers to terrestrial fauna movement	9.1.8
Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement	9.1.9
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6

Table 10-12 Assessment of project against significant impact criteria for Australian Painted Snipe

Criterion	Response
Lead to a long-term decrease in the size of a population	**Unlikely** North East Link would unlikely lead to a long-term decrease in the size of the Australian Painted Snipe population. According to the desktop assessment (VBA and e-Bird records) and assessment of habitat, the most suitable habitat for this species is in and around Banyule Swamp. North East Link is proposed to be in tunnels in this area, which would avoid impacts. Other locations where this species may occur (Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. This, combined with the few VBA/e-Bird records, suggests those areas are very unlikely to support this species. There is a cluster of 16 BLA records of this species (maximum two birds) at and around Banyule Swamp, all recorded in October/November 2001. The VBA also contains two of those records. The species has not been recorded in the area since then, and there is only one record before this (1970).

Criterion	Response
Reduce the area of occupancy of the species	**Unlikely** North East Link would not reduce the area of occupancy of the Australian Painted Snipe. This species is widespread but rare throughout most of eastern Australia. The most suitable habitat for this species in the study area is in and around Banyule Swamp, where North East Link would be in tunnels, avoiding direct impacts. Even this area is not used frequently: the species has not been recorded in the project boundary since 2001, and there is only one record before this (1970). No other parts of the study area are considered likely to attract the Australian Painted Snipe, so North East Link is not expected to influence the snipe's area of occupancy.
Fragment an existing population into two or more populations	**Unlikely** North East Link would not fragment the existing Australian Painted Snipe population into two or more populations. Rationale as for criterion above (Reducing area of occupancy).
Adversely affect habitat critical to the survival of a species	**Unlikely** North East Link would unlikely adversely affect habitat critical to the survival of the Australian Painted Snipe. The most suitable habitat for this species in the study area is in and around Banyule Swamp, where North East Link would be in tunnels, avoiding direct impacts. Even this area is not used frequently: the species has not been recorded in the project boundary since 2001, and there is only one record before this (1970).
Disrupt the breeding cycle of a population	**Unlikely** North East Link would unlikely disrupt the breeding cycle of the Australian Painted Snipe. The most suitable habitat for this species in the study area is in and around Banyule Swamp, where North East Link would be in tunnels, avoiding direct impacts. Even this area is not used frequently: the species has not been recorded in the project boundary since 2001, and there is only one record before this (1970). This area is not known to be breeding habitat.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** North East Link would unlikely modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the Australian Painted Snipe would likely decline. The most suitable habitat for this species in the study area is in and around Banyule Swamp, where North East Link would be in tunnels, avoiding direct impacts. Even this area is not used frequently: the species has not been recorded in the project boundary since 2001, and there is only one record before this (1970).
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat	**Unlikely** North East Link would unlikely result in invasive species that are harmful to the Australian Painted Snipe becoming established in its habitat. Known terrestrial species that are potentially harmful or detrimental to the species (Red Fox, Cat, Black Rat) are already present along the alignment.
Introduce disease that may cause the species to decline	**Unlikely** North East Link would unlikely introduce disease that may cause the Australian Painted Snipe to decline.

Criterion	Response
Interfere substantially with the recovery of the species	**Unlikely** There is no adopted Recovery Plan for this species. Identified threats are loss and degradation of habitat, and predation by non-native predators (Red Foxes and Cats). North East Link would unlikely impact on the Australian Painted Snipe, so is unlikely to interfere with the recovery of the species. The most suitable habitat for this species in the study area is in and around Banyule Swamp, where North East Link would be in tunnels, avoiding direct impacts. Even this area is not used frequently: the species has not been recorded in the project boundary since 2001, and there is only one record before this (1970).

Proposed avoidance and mitigation measures

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential of North East Link to impact most terrestrial and aquatic fauna species across the Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use the inner eastern Melbourne area, including the Australian Painted Snipe. In areas where surface impacts could not be avoided, including waterway and wetland habitats that are potentially used, albeit very rarely, by the Australian Painted Snipe, the smallest practicable project boundary has been adopted for North East Link to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

Best-practice surface water and site management would reduce the potential for deleterious impacts on wetlands and waterways that may be visited by the Australian Painted Snipe.

In the long term, the addition of WSUD features around wetlands may increase habitat opportunities for species such as the Australian Painted Snipe, by creating higher quality wetland habitats in the urban environment using stormwater run-off.

Residual impact and offsetting

The residual impact of North East Link on the Australian Painted Snipe is expected to be negligible and non-significant. The Australian Painted Snipe is very rarely recorded in the Melbourne area, and impacts on areas where it has the greatest potential to turn up would be avoided by tunnelling.

With a non-significant residual impact, offsets would not be required for the Australian Painted Snipe.

10.2.3 Australasian Bittern (*Botaurus poiciloptilus*) (endangered)

Table 10-13 identifies the construction and operation impacts that could affect the Australasian Bittern. These impact pathways are discussed in detail in Section 9. Table 10-14 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to an endangered species.

Table 10-13 Impacts that would or might affect the Australasian Bittern

Potential impact	Section
Construction	
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Disturbance of fauna through noise, vibration or lighting	9.1.7
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-14 Assessment of project against significant impact criteria for the Australasian Bittern

Criterion	Response
Lead to a long-term decrease in the size of a population	**Unlikely.** North East Link would unlikely lead to a long-term decrease in the size of the Australasian Bittern population. This species is widespread in small numbers throughout south-western and south-eastern Australia, including Tasmania. According to the desktop assessment (VBA and e-Bird records), the most suitable habitat for this species within the study area is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. North East Link would be in tunnels in these areas, avoiding impacts. Field assessment determined the location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Australasian Bittern. Other locations where this species may occur (Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. Those areas are very unlikely to support this species.
Reduce the area of occupancy of the species	**Unlikely.** North East Link would not reduce the area of occupancy of the Australasian Bittern. This species is widespread in small numbers throughout south-western and south-eastern Australia, including Tasmania. North East Link would be in tunnels in this area so would not impact suitable habitat for this species. Other locations where this species may occur (such as Koonung Creek) are degraded and disturbed, and unlikely to support this species. North East Link would be extremely unlikely to change the area of occupancy of this species.

Criterion	Response
Fragment an existing population into two or more populations	**Unlikely.** North East Link would not fragment the existing Australasian Bittern population into two or more populations. Rationale as for criterion above (Reducing area of occupancy).
Adversely affect habitat critical to the survival of a species	**Unlikely** North East Link would unlikely adversely affect habitat critical to the survival of the Australasian Bittern. This species is widespread in small numbers throughout south-western and south-eastern Australia, including Tasmania, and North East Link would be in tunnels in this area so would not impact suitable habitat for this species. Other locations where this species may occur (such as Koonung Creek) are degraded and disturbed, and unlikely to support this species.
Disrupt the breeding cycle of a population	**Unlikely** North East Link would not disrupt the breeding cycle of the Australasian Bittern population. North East Link would be in tunnels in this area and would not impact the most suitable habitat (which may or may not be breeding habitat). Other locations where this species may occur (such as Koonung Creek) are degraded and disturbed, and unlikely to support breeding by this species.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** North East Link would unlikely modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Australasian Bittern is likely to decline. North East Link would be in tunnels in this area so would not impact the most suitable habitat for this species. Other locations where this species may occur (such as Koonung Creek) are degraded and disturbed, and unlikely to support this species.
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat	**Unlikely** North East Link would unlikely result in invasive species that are harmful to the Australasian Bittern becoming established in the bittern's habitat. Known terrestrial species that are potentially harmful or detrimental to the species (such as Red Fox, Cat, Black Rat) are already present along the alignment.
Introduce disease that may cause the species to decline	**Unlikely** North East Link would unlikely introduce disease that may cause the Australasian Bittern to decline.
Interfere substantially with the recovery of the species	**Unlikely** There is no adopted Recovery Plan for the Australasian Bittern. Identified threats are loss and degradation of habitat. North East Link would unlikely impact the Australasian Bittern, so is unlikely to interfere with the recovery of the species. North East Link would be in tunnels in this area, so the most suitable habitat for this species would not be impacted. Other locations where this species may occur (such as Koonung Creek) are degraded and disturbed, and unlikely to support this species.

Proposed avoidance and mitigation measures

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential of North East Link to impact most terrestrial and aquatic fauna species across the Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use the inner eastern Melbourne area, including the Australasian Bittern. In areas where surface impacts could not be avoided, including waterway and wetland habitats that are potentially used by the Australasian Bittern, the smallest practicable project boundary has been adopted for North East Link to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

Best-practice surface water and site management would reduce the potential for deleterious impacts on wetlands and waterways that may be used by the Australasian Bittern.

In the long term, the addition of WSUD features around wetlands may increase habitat opportunities for species such as the Australasian Bittern, by creating higher quality wetland habitats in the urban environment using stormwater run-off.

Residual impact and offsetting

The residual impact of North East Link on the Australasian Bittern is expected to be negligible and non-significant. The Australasian Bittern is rarely recorded in the Melbourne area, and the areas where it has the greatest potential to turn up would be avoided by tunnelling.

With a non-significant residual impact, offsets would not be required for the Australasian Bittern.

10.2.4 Growling Grass Frog (*Litoria raniformis*) (vulnerable)

Table 10-15 identifies the construction and operation impacts that could affect the Growling Grass Frog. These impact pathways are discussed in detail in Section 9. Table 10-16 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a vulnerable species.

Table 10-15 Impacts that would or might affect the Growling Grass Frog

Potential impact	Section
Construction	
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Death or injury of fauna during construction	9.1.6
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of terrestrial wildlife corridors creating barriers to terrestrial fauna movement	9.1.8
Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement	9.1.9
Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values	9.1.10
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12

Potential impact	Section
Operation	
Loss or degradation of terrestrial or aquatic habitat through shading	9.2.1
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-16 Assessment of project against significant impact criteria for the Growling Grass Frog

Criterion	Response
Lead to a long-term decrease in the size of an important population of a species	**Unlikely**. No individuals were detected during targeted surveys, which were done in accordance with survey guidelines for Australia's threatened Frogs (DEWHA, 2010b). Important populations are not expected to occur within the study area.
Reduce the area of occupancy of an important population	**Unlikely**. No individuals were detected during targeted surveys. Important populations are not expected to occur within the study area.
Fragment an existing important population into two or more populations	**Unlikely**. No individuals were detected during targeted surveys. No populations were observed. An important population is not expected to be fragmented.
Adversely affect habitat critical to the survival of a species	**Unlikely**. No habitat that is expected to be critical to the survival of the species was observed during habitat assessments. No populations or individuals of the species were detected within the study area. No habitats within the study area are identified on the Register of Critical Habitat (note the Register of Critical Habitat currently does not include any listing for the Growling Grass Frog). The floodplain areas provide the largest and highest quality areas of habitat for Growling Grass Frog within the study area. With the implementation of the mitigation measures outlined below, it is considered unlikely that North East Link would adversely affect habitat critical to the survival of this species.
Disrupt the breeding cycle of an important population	**Unlikely**. No individuals were detected during targeted surveys. Important populations are not expected to occur within the study area.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely.** Potentially suitable habitat within the study area is minimal. No populations or individuals were detected during targeted surveys. The species is considered to be currently absent from the project boundary, and North East Link is not expected to result in the decline of the species.

Criterion	Response
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely.** Most of the waterways in the study area already support invasive fish species. North East Link is not expected to result in the spread or increase in invasive fish species within the study area. North East Link would unlikely result in other invasive species that are harmful to the Growling Grass Frog becoming established in the frog's habitat. Known terrestrial species that are potentially harmful or detrimental to the frog (such as the Red Fox) are present along the alignment already.
Introduce disease that may cause the species to decline	**Unlikely.** No individuals or populations were detected within the study area. Regardless, appropriate mitigation would be employed to minimise the risk of North East Link works introducing or spreading Chytrid Fungus within the study area. The existing presence of the Common Froglet (*Crinia signifera*) at most if not all sites of potential habitat for Growling Grass Frog suggest that chytrid fungus is likely to be widespread across the region already (the Common Froglet is a likely reservoir host; Brannelly *et al.,* 2018).
Interfere substantially with the recovery of the species	**Unlikely**. North East Link is not expected to interfere with the recovery of the species. There is a low likelihood the species is present in small numbers within the study area and proposed impacts would not hinder movement/dispersal of the species across the landscape, if present. As identified in the *National Recovery Plan for the Southern Bell Frog Litoria raniformis,* primary threats facing the species include loss and degradation of habitat, barriers to movement, disease, predation, biocides and ultra-violet B radiation. It is not anticipated that North East Link would exacerbate these threats and substantially interfere with the recovery of the species.

Proposed avoidance and mitigation measures

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential of North East Link to impact most terrestrial and aquatic fauna species across the Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use, or might use, the inner eastern Melbourne area, including the Growling Grass Frog. The Growling Grass Frog was once widespread across the Melbourne area, but populations declined greatly in the 1990s, probably as a result of a chytrid fungus epidemic. The species is now thought not to occur within the project boundary, but it has the potential to re-colonise areas where it once occurred. In areas where surface impacts could not be avoided, including waterway, billabong and wetland habitats that provide potential habitat for the Growling Grass Frog, the smallest practicable project boundary for North East Link has been adopted to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

Best-practice surface water and site management would reduce the potential for deleterious impacts on wetlands, billabong and waterways that provide potential habitat for the Growling Grass Frog.

In the long term, the addition of WSUD features around wetlands may increase habitat opportunities for species such as the Growling Grass Frog, by creating higher quality wetland habitats in the urban environment using stormwater run-off.

Residual impact and offsetting

The residual impact of North East Link on this species is expected to be negligible and non-significant. Once widespread across the Melbourne area, the Growling Grass Frog is now thought not to occur within the project boundary, but has the potential to re-colonise areas where it once occurred. The Yarra River Floodplain area, where it has the greatest potential to turn up, would be avoided by tunnelling.

With a non-significant residual impact, offsets would not be required for the Growling Grass Frog.

10.2.5 Grey-headed Flying-fox (*Pteropus poliocephalus*) (vulnerable)

Table 10-17 identifies the construction and operation impacts that could affect the Grey-headed Flying-fox. These impact pathways are discussed in detail in Section 9. Table 10-18 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a vulnerable species.

Table 10-17 Impacts that would or might affect the Grey-headed Flying-fox

Potential impact	Section
Construction	
Removal of vegetation and habitat	9.1.1
Degradation of vegetation and terrestrial habitat through soil compaction	9.1.3
Disturbance of fauna through noise, vibration or lighting	9.1.7
Operation	
Death or injury of fauna during road operation	9.2.5
Disturbance of fauna through noise, vibration or lighting	9.2.6

Table 10-18 Assessment of project against significant impact criteria for the Grey-headed Flying-fox

Criterion	Response
Lead to a long-term decrease in the size of an important population of a species	**Unlikely.** The Grey-headed Flying-fox is considered to occur in one continuous population across south-east Australia, which must be considered an important population. A Nationally Important Flying-fox Camp is present at Yarra Bend, Fairfield. North East Link works along the Eastern Freeway in the vicinity of the camp are expected to be restricted to within 10 m of the existing road and entirely avoid the camp. The flying-fox management area has been designated a no-go zone beyond that 10 m section. This section of the Eastern Freeway is already very noisy and well-lit and construction is not expected to markedly increase noise or light levels that would disturb the camp. North East Link is not expected to decrease the size of this colony.

Criterion	Response
Reduce the area of occupancy of an important population	**Unlikely.** The Grey-headed Flying-fox is considered to occur in one continuous population across south-east Australia. This species forages widely across a broad area and its area of occupancy is unlikely to change with changes to the vegetation present along the proposed alignment. Works along the Eastern Freeway in the vicinity of the Nationally Important Flying-fox Camp are expected to be restricted to a 10 m section beside the existing road and the camp itself is not expected to be impacted. The detailed design of North East Link would attempt to minimise the removal of native vegetation and fauna habitat and minimise the footprint of works and disturbance of populations of EPBC Act-listed threatened species, including the potential foraging habitat for the Grey-headed Flying-fox.
Fragment an existing important population into two or more populations	**Unlikely.** The Grey-headed Flying-fox is considered to occur in one continuous population across south-east Australia. North East Link is not expected to result in the fragmentation of the population. The alignment for the most part follows existing roads and the Grey-headed Flying-fox is fully capable of crossing large roads including the existing Eastern Freeway.
Adversely affect habitat critical to the survival of a species	**Unlikely.** Habitat critical to the survival of the Grey-headed Flying-fox is present within the Yarra Bend flying-fox Camp. A small section of habitat within the management area (approximately 10 m into the management area) is within the project boundary and would be removed. A decrease in the area of occupancy of this important population is therefore expected, but the removal of native vegetation and fauna habitat would be minimised in the detailed design, including minimising the footprint of works and disturbance of populations of EPBC Act-listed threatened species, including potential foraging habitat for the Grey-headed Flying-fox. This impact is only expected to be temporary during construction. No habitats within the study area are identified on the Register of Critical Habitat (note the Register of Critical Habitat currently does not include any listing for the Grey-headed Flying-fox).
Disrupt the breeding cycle of an important population	**Unlikely.** The Grey-headed Flying-fox is considered to occur in one continuous population across south-east Australia. This species has a large breeding colony at Yarra Bend, Fairfield. A small section of habitat within the management area (approximately 10 m into the management area) is within the project boundary and would be removed. However, this area is only used for foraging, and not expected to be important breeding habitat for the species. This impact is also expected to be temporary.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely.** This species forages widely across the Melbourne suburbs. North East Link is expected to result in the loss of small amounts of foraging resources (flowering/fruiting trees and shrubs). However, vegetation of similar quality is present in the surrounding area and the decrease in available foraging resources is expected to have a negligible impact on the species and not result in its decline. At the Yarra River crossing (Eastern Freeway), habitat lost would comprise occasional foraging habitat rather than roosting or breeding habitat for the Grey-headed Flying-fox, and extend no more than 10 m south of the existing freeway bridges (towards the existing flying-fox camp). Impacts of habitat loss at the location would be negligible for the Grey-headed Flying-fox.

Criterion	Response
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely.** North East Link is not expected to result in the introduction of invasive species that would be harmful to the Grey-headed Flying-fox. A CEMP would be implemented to minimise the likelihood of the introduction and establishment of invasive species.
Introduce disease that may cause the species to decline	**Unlikely.** North East Link is not expected to result in the introduction of disease that causes decline in this species.
Interfere substantially with the recovery of the species	**Unlikely.** The Draft National Recovery Plan for the Grey-headed Flying-fox (*Pteropus poliocephalus*) was released in 2017. Loss of foraging habitat has been identified as the primary threat to the species. Small areas of foraging habitat are expected to be impacted by North East Link. However, similar quality habitat is abundant in the surrounding areas and the proposed vegetation losses are not expected to interfere with the recovery of the species (DoEE, 2017d). Other threats identified include camp disturbance, mortality in commercial fruit crops, heat stress, electrocution on power lines, climate change and disease. These threats would unlikely be exacerbated by North East Link. According to historical reports of colony size, the Grey-headed Flying-fox population in Melbourne does not appear to be declining (DSE, 2005a; DSE, 2009b). Avoiding impacts on the roosting/breeding camp would ensure that North East Link would not interfere with the recovery of the species.

Proposed avoidance and mitigation measures

The main potential impact of North East Link on the Grey-headed Flying-fox is localised loss of occasional foraging habitat. Other potential impacts such as disturbance or death of individuals are expected to be rare, if they occur at all. Grey-headed Flying-foxes that visit or reside in Melbourne already tolerate various disturbances and dangers associated with a large city. North East Link would not add any significant disturbance or threat to the Grey-headed Flying-fox that is not already present.

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential for North East Link to impact most terrestrial and aquatic fauna species across the Melbourne area. The Yarra River floodplain areas provide the largest and highest quality areas of habitat for many of the species that use the inner eastern Melbourne area. In areas where surface impacts could not be avoided, particularly in locations where habitats are identified as being of high value, the smallest practicable project boundary has been adopted North East Link to avoid unnecessary loss of habitat, as far as possible utilising areas that are already disturbed or have been previously disturbed.

Residual impact and offsetting

The residual impact of North East Link on the Grey-headed Flying-fox is expected to be minor and non-significant. Grey-headed Flying-foxes reside in the Melbourne area and forage widely and variably on flowering eucalypts in parks, gardens and along waterways. Trees that North East Link would impact are likely used occasionally for foraging by the Grey-headed Flying-fox, but do not provide a particular resource not readily available in alternative locations nearby.

With a non-significant residual impact, specific offsets would not be required for the Grey-headed Flying-fox. However, any loss of native vegetation that Grey-headed Flying-fox depend on would be offset as per the requirements of the DELWP Guidelines (2017a).

10.3 Aquatic ecology

Individual assessments of the potential for North East Link to impact matters of MNES in relation to the Macquarie Perch (Table 10-20) and Australian Grayling (Table 10-22) are provided below.

10.3.1 Macquarie Perch (*Macquaria australasica*) (endangered)

Table 10-19 identifies the construction and operation impacts that could affect the Macquarie Perch. These impact pathways are discussed in detail in Section 9. Table 10-20 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to an endangered species.

Table 10-19 Impacts that would or might affect the Macquarie Perch

Potential impact	Section
Construction	
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement	9.1.9
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-20 Assessment of project against significant impact criteria for the Macquarie Perch

Criterion	Response
Lead to a long-term decrease in the size of a population	**Unlikely.** North East Link would unlikely impact the important population in the Yarra River as the study area is close to the most downstream extent of the population distribution, and there are no works planned within the Yarra River. There is potential that North East Link may result in some drawdown of groundwater. However, modelled groundwater contributions to the hydrology of the Yarra River in the areas of potential impact are insignificant. Groundwater drawdown would not result in hydrological impacts that could affect habitat or passage in the Yarra River. Therefore, North East Link is not anticipated to lead to a long-term decrease in the size of the Macquarie Perch population.
Reduce the area of occupancy of an important population	**Unlikely.** The proposed tunnel avoids works that would affect the Yarra River. North East Link is not expected to impact the area of the Yarra River, which is the only aquatic habitat within the study containing this species. There is potential that North East Link may result in some drawdown of groundwater, but this is not anticipated to change conditions in the Yarra River, or reduce the area of occupancy for the Macquarie Perch.
Fragment an existing important population into two or more populations	**Unlikely.** The study area is close to the most downstream extent of the isolated population in the Yarra River. There are no works planned within the Yarra River, or impacts that would fragment aquatic habitat for this population. Any impacts are not expected to fragment this population.
Adversely affect habitat critical to the survival of a species	**Unlikely.** It is unlikely the species relies on waterways that North East Link would impact. The Yarra River population is an important population, but North East Link does not occupy aquatic habitat occupied by this species. Tunnelling under the Yarra River avoids this habitat. There is potential that North East Link may result in some drawdown of groundwater, but this would have negligible impact on the Yarra River. This is not anticipated to adversely affect the habitat of the Macquarie Perch.
Disrupt the breeding cycle of an important population	**Unlikely.** The spawning of this species is unlikely to occur in waterway locations so it is not expected that North East Link would impact on cues for spawning. The potential for groundwater levels to decrease is not expected to impact the flows in the Yarra River, and so it would unlikely disrupt the breeding cycle of the population of Macquarie Perch.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely.** North East Link does not involve works within the Yarra River, which is the only waterway that supports Macquarie Perch within the study area. There is potential that North East Link may result in some drawdown of groundwater. However, modelled groundwater contributions to the hydrology of the Yarra River in the areas of potential impact are insignificant. Groundwater drawdown would not result in hydrological impacts that could affect habitat or passage in the Yarra River. North East Link is not expected to change the aquatic habitat in the Yarra River and so it is unlikely the action would impact availability or quality of habitat that would impact the Yarra River population of this species.

Criterion	Response
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely.** North East Link would unlikely result in invasive species becoming established or expanding in range throughout the Yarra River. North East Link would not provide connections between waterways that could enable invasive aquatic species to colonise Macquarie Perch habitat. Tunnelling would avoid impacts to the Yarra River and avoidance of works in waterways where possible would minimise impacts to other waterways in the river's catchment. With the implementation of mitigation measures outlined above and further in Chapter 10 Proposed avoidance and mitigation measures, North East Link would unlikely to result in invasive species becoming established in the habitat of vulnerable species.
Introduce disease that may cause the species to decline	**Unlikely.** Tunnelling would avoid impacts to the Yarra River and avoidance of works in waterways where possible would minimise impacts to other waterways in the river's catchment. Where possible, the inclusion of WSUD features would prevent runoff impacts to urban streams. With the implementation of mitigation measures outlined above and further in Chapter 10 Proposed avoidance and mitigation measures, it is unlikely that North East Link would result in new disease introduction.
Interfere substantially with the recovery of the species	**Unlikely.** It is unlikely that recovery of the species is reliant on aquatic habitat in this location. The study area is located at the most downstream extent of the Yarra River population, with greatest opportunity for recovery of this species in upstream reaches of the Yarra River beyond the study area.

Proposed avoidance and mitigation measures

North East Link would avoid impacts to Macquarie Perch habitat by tunnelling under the Yarra River, which is the only waterway in the region that supports this species. The reference project minimises impacts to other waterways in the Yarra River catchment by avoiding works in waterways where possible, and including WSUD features to prevent runoff impacts from the new road/ramps surfaces to urban streams.

A Construction Environmental Management Plan (CEMP) would mitigate potential indirect impacts of construction that could affect aquatic habitat quality for this species, through measures to prevent sedimentation, contamination and runoff from entering the drainage network.

Residual impact and offsetting

The residual impact of North East Link on Macquarie Perch is expected to be negligible and non-significant. The Macquarie Perch is known from the Yarra River but not other waterways that North East Link would affect. The important aquatic habitat would be avoided by tunnelling.

With a non-significant residual impact, offsets would not be required for Macquarie Perch.

10.3.2 Australian Grayling (*Prototroctes maraena*) (vulnerable)

Table 10-21 identifies the construction and operation impacts that could affect the Australian Grayling. These impact pathways are discussed in detail in Section 9. Table 10-22 provides an assessment of potential impacts against the EPBC Act significant impact criteria that relate to a vulnerable species.

Table 10-21 Impacts that would or might affect the Australian Grayling

Potential impact	Section
Construction	
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Disturbance of fauna through noise, vibration or lighting	9.1.7
Fragmentation of aquatic wildlife corridors creating barriers to aquatic fauna movement	9.1.9
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-22 Assessment of project against significant impact criteria for the Australian Grayling

Criterion	Response
Lead to a long-term decrease in the size of an important population of a species	**Unlikely.** North East Link would unlikely impact the important Australian Grayling population in the Yarra River by tunnelling under the Yarra River and avoiding works that would increase the threatening processes for this species. Specifically, North East Link would not involve works that would create barriers to fish migration, or lead to degradation of habitat or water quality.
Reduce the area of occupancy of an important population	**Unlikely.** Tunnelling would avoid works that would impact the Yarra River. North East Link is not expected to impact the area available for this species. There is potential that North East Link may result in some drawdown of groundwater, which would have negligible impact on the habitat in the Yarra River.
Fragment an existing important population into two or more populations	**Unlikely.** The Yarra River population is likely to remain connected to adjacent populations during the marine phase of the Australian Grayling's lifecycle. As no impacts to upstream or downstream migration are expected, any impacts are not expected to fragment this population.
Adversely affect habitat critical to the survival of a species	**Unlikely.** It is unlikely that would affect fish passage, which is the primary habitat attribute the species relies on waterways in this location. The proposed tunnel avoids works that would affect fish passage in the Yarra River.

Criterion	Response
Disrupt the breeding cycle of an important population	**Unlikely.** It is unlikely that North East Link would impact fish passage, which is critical for breeding in this diadromous species. The spawning of this species is likely to occur downstream of the study area. Tunnelling would avoid works that would affect fish passage and it is expected that cues for spawning would be avoided. Potential vibration disturbance during migratory periods would be avoided with low impact construction methods and by avoiding high intensity vibration-generating construction methods during critical migratory periods.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely.** It is unlikely that North East Link would impact availability or quality of habitat that would impact the Yarra River population of this species. Tunnelling would avoid works that would affect habitat within the Yarra River.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely.** Introduced fish are listed as a threat to the recovery of Australian Grayling. The Yarra River already contains several species that pose threats through predation on juvenile fish or eggs. North East Link would not provide connections between waterways that could enable invasive aquatic species to colonise habitat. Tunnelling would avoid impacts to the Yarra River, and avoiding works in waterways where possible would minimise impacts to other waterways in the Yarra River catchment. With the implementation of mitigation measures outlined above and further in Chapter 10 Proposed avoidance and mitigation measures, North East Link would unlikely result in the introduction or expansion in range of invasive species.
Introduce disease that may cause the species to decline	**Unlikely.** Tunnelling would avoid impacts to the Yarra River, and avoiding works in waterways where possible would minimise impacts to other waterways in the Yarra River catchment. With the implementation of mitigation measures outlined above and further in Chapter 10 Proposed avoidance and mitigation measures, it is unlikely that North East Link would result in new disease introduction
Interfere substantially with the recovery of the species	**Unlikely.** The National Recovery Plan for the Australian Grayling (Backhouse *et al.* 2008a) lists the following threats to the Australian Grayling population: barriers to movements, river regulation, poor water quality, siltation, introduced fish, climate change, disease and fishing: angling and whitebaiting. North East Link would increase the area of paved surface with new roads, with a consequential increase in stormwater drainage that would need to be discharged to urban waterways in and around the project boundary. Urban stormwater is regarded as one of the two most threatening processes to aquatic ecosystems in the urban environment (Walsh & Webb, 2016), with the major mechanisms of impact due to flow velocity and scouring of aquatic habitats. The reference project minimises impacts to waterways in the Yarra River catchment by avoiding works in waterways where possible, and including WSUD features to prevent additional runoff impacts from new roads/ramps to urban streams. It is unlikely that North East Link would introduce or increase threatening processes listed for this species.

Proposed avoidance and mitigation measures

North East Link would avoid impacts to Australian Grayling habitat and migration passage route by tunnelling under the Yarra River, which is the only waterway in the region that supports this species. The reference project minimises impacts to other waterways in the Yarra River catchment by avoiding works in waterways where possible and including WSUD features to prevent additional runoff impacts from new road/ramp surfaces to urban streams. Works that have planned waterway modifications affecting aquatic habitat do not provide habitat or migratory passage for this species.

A Construction Environmental Management Plan (CEMP) would mitigate potential indirect impacts of construction that could affect aquatic habitat quality for Australian Grayling, through measures to prevent sedimentation, contamination and runoff from entering the drainage network. Avoiding works in the Yarra River would minimise the potential impacts to migratory passage required for the breeding cycle of the species. Disturbance from intense noise or vibration during impact-generating construction activities (such as pile driving) would be avoided to the extent practicable with construction methods that minimise noise and vibration (such as bored piles) and by avoiding intense vibration-generating construction activities during critical periods of migration as defined within the National Recovery Plan (Backhouse *et al.*, 2008a). Noise and vibration would be monitored and managed as part of the Construction Noise and Vibration Management Plan.

Residual impact and offsetting

The residual impact of North East Link on the Australian Grayling is expected to be negligible and non-significant. The Australian Grayling is known from the Yarra River, but not other waterways that North East Link would affect. Tunnelling would avoid important aquatic habitat for this species.

With a non-significant residual impact, offsets would not be required for Australian Grayling.

However, any loss of native vegetation that Australian Grayling depend on would be offset as per the requirements of the DELWP Guidelines (2017a)

10.4 Migratory species

The potential impact of loss of important habitat for an EPBC Migratory species is assessed here using the criteria outlined for Migratory species in the Impact Significance Guidelines 1.1 under the EPBC Act.

The loss of important habitat for a Migratory species would be significant, because it could jeopardise the success or recovery of a species internationally. And, unless comparable habitat were replaced nearby, the duration would be long-term, because the habitat would be lost permanently. However, these impacts are not expected to occur during construction, because important habitat is not expected to be lost due to the construction of North East Link.

Twenty-six bird species known or predicted to occur within the study area are listed as Migratory under the EPBC Act (Appendix C). Some may use or visit habitats within the project boundary occasionally (such as White-throated Needletail, Rufous Fantail), but most are seabirds or coastal shorebirds and are unlikely to use the project boundary in large numbers or frequently. One species—Latham's Snipe, *Gallinago hardwickii*)—may use habitats within the project boundary regularly enough, and in sufficient numbers, that could constitute 'important habitat' for that species (in accordance with Commonwealth of Australia 2017). Assessment of the potential for Latham's Snipe to occur within the project boundary is described in Section 7.2.2, and impacts on this species are assessed in more detail below.

Many of the Latham's Snipe records in the area are from the Yarra River floodplain, but only the Banyule Swamp and Banyule Flats area has sufficient historical records to be considered important habitat. There is no indication that any other site along the corridor supports or attracts an ecologically significant proportion of the Latham's Snipe (or other Migratory species) population, or would be considered important habitat.

The Yarra River floodplain area would be avoided by tunnelling, so direct impacts on important habitat would be avoided during construction. Long-term changes to groundwater flow due to construction or the presence of the tunnels are considered highly unlikely to lead to changes in the habitat of Migratory species.

Direct and indirect impacts on Migratory species and their terrestrial and wetland habitats during construction would be managed and minimised through mitigation. The removal of native vegetation and fauna habitat would be minimised in the detailed design. Short- and long-term impacts on riparian, riverbed and aquatic habitat would be minimised in the detailed design and construction phases to the extent practicable.

Groundwater and ground movement management would reduce the risk of aquatic habitat degradation or loss. Geotechnical and groundwater modelling and assessment, including a predictive and numerical groundwater model would be used to predict changes in groundwater levels, flow and quality, and mitigation strategies would be developed. Through groundwater monitoring, a pre-construction, construction and post-construction groundwater monitoring program would be developed and implemented to calibrate the predictive model before construction starts, to manage construction activities, to verify the model predictions post-construction, and to monitor during operation.

The tunnel would be designed and constructed to minimise changes to groundwater levels during construction and operation, and minimise potential impacts on waterways and GDEs, including terrestrial ecosystems. Contingency measures and/or controls would also be introduced to maintain base flows to prevent a reduction or loss of groundwater discharge or loss of water availability for terrestrial ecosystems.

The design footprint would be minimised so that temporary and permanent impacts on ecological values, including parks and reserves, and significant landscapes around the Yarra River are minimised.

Surface water discharge and run-off from North East Link would be monitored and managed, and a management plan developed that sets out the surface water management requirements and methods for best practice sediment and erosion control and monitoring, in accordance with EPA Victoria requirements.

Modifications to all waterways would be designed and undertaken in a way that mitigates the effects of changes to flow, and minimises the potential for erosion, sediment plumes and exposure of contaminated material during construction.

Latham's Snipe, *Gallinago hardwickii*

Latham's Snipe is listed as Migratory under the EPBC Act. In terms of the EPBC Act, an action is likely to have a significant impact on a Migratory species if there is a real chance or possibility it will:

- 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

- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

For most migratory species, important habitat is defined as an area that regularly supports 0.1 per cent of the 'flyway population' (Commonwealth of Australia 2017). Latham's Snipe, because of its 'cryptic lifestyle', is treated differently: if the habitat regularly supports 18 or more individuals, it should be considered important habitat (Commonwealth of Australia 2017).

The desktop assessment suggests that Latham's Snipe is a regular visitor to the study area. The Banyule Swamp and Banyule Flats area in particular has numerous records, including records of 20 birds as recently as 2013. This area appears to be the focus of Latham's Snipe habitat along this section of the Yarra River floodplain, and is likely to be considered important habitat under the EPBC Act.

Tunnelling would avoid direct impacts on this area, and indirect impacts (such as through changes to groundwater levels) are expected to be negligible.

There is no indication that any other site along the alignment supports or attracts an ecologically significant proportion of the Latham's Snipe population. Other locations within the project boundary where this species may occur are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas, and have very few historical records, if any. Those sites are not likely to be considered important habitat for Latham's Snipe.

Table 10-23 identifies the construction and operation impacts that could affect Latham's Snipe. An assessment of the potential for North East Link to impact on matters of MNES in relation to Latham's Snipe is provided in Table 10-24.

Table 10-23 Impacts that would or might affect Latham's Snipe

Potential impact	Section
Construction	
Degradation of aquatic habitat through sedimentation or contamination	9.1.4
Degradation of aquatic habitat through waterway modification or construction activities in and around waterways	9.1.5
Disturbance of fauna through noise, vibration or lighting	9.1.7
Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction	9.1.11
Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems	9.1.12
Operation	
Degradation of aquatic habitat through waterway modification	9.2.2
Degradation of aquatic habitat through modification of stormwater catchment	9.2.3
Degradation of aquatic habitat through contaminated runoff	9.2.4
Disturbance of fauna through noise, vibration or lighting	9.2.6
Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems	9.2.7

Table 10-24 Assessment of project against significant impact criteria for Latham's Snipe

Criterion	Response
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	**Unlikely.** While important habitat for Latham's Snipe is thought to exist within the project boundary, North East Link would not impact this habitat. The most suitable habitat for Latham's Snipe occurs in the vicinity of the Yarra River and associated floodplain in the Banyule/Bulleen area. The history of VBA records suggest this area may constitute *important habitat* for this species. Tunnelling in this area would avoid impacts. Other areas that may provide suitable habitat within the project boundary are generally degraded and disturbed and have no historical record of this species that would suggest they constitute important habitat.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unlikely.** North East Link would unlikely result in the introduction of a novel invasive species. Known terrestrial species that are potentially harmful or detrimental to Latham's Snipe (such as Red Fox, Cat) are present along the alignment already. Impacted areas are unlikely to constitute *important habitat* for this species
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Unlikely.** Very few VBA records of Latham's Snipe occur in habitats within the project boundary (excluding the tunnelled section) – a handful of pre-1991 records are from the Bolin Bolin Wetland area in Bulleen, and another record from 1970 appears to be within the study area but is reported as 'roughly 2 km SW of Ivanhoe', so may contain locational error and may not actually be within the study area. There is no indication that any site along the alignment (excluding the tunnelled section) supports or attracts an ecologically significant proportion of the Latham's Snipe population. Latham's Snipe does not breed in Australia, so North East Link would not disrupt the breeding cycle.

Proposed avoidance and mitigation measures

Tunnelling under the Yarra River and its associated floodplain habitats greatly reduces the potential of North East Link to impact what is considered important habitat for Latham's Snipe under the EPBC Act. In areas where surface impacts could not be avoided, including waterway and wetland habitats that are potentially used occasionally by Latham's Snipe, the removal of vegetation and habitat would be minimised through detailed design including by minimising the footprint of works.

Best-practice surface water and site management would reduce the potential for deleterious impacts on wetlands and waterways that Latham's Snipe may visit.

Residual impact and offsetting

The residual impact of North East Link on Latham's Snipe is expected to be negligible and non-significant. Latham's Snipe is recorded occasionally but regularly in the Melbourne area and within the project boundary, mainly in the Banyule Flats and Banyule Swamp area, which is tunnelling would avoid.

With a non-significant residual impact, offsets would not be required for Latham's Snipe.

11. Relevant impacts on Commonwealth land

This section discusses the general environment of Commonwealth land in accordance with Sections 26 and Section 27A of the EPBC Act. The Commonwealth land that is located within the project boundary includes:

- Simpson Barracks and an unfenced strip of land immediately to the south
- A strip of land about one kilometre north of the Barracks, to the rear of residential properties on Elder Street, Watsonia, which is referred to as the 'War Services easement'.

Simpson Barracks is located within an urban area in the suburb of Yallambie, approximately 18 kilometres north-east of the Melbourne CBD. Surrounding land use is well established residential on all sides. Simpson Barracks occupies approximately 112 hectares of land comprising a mixture of developed land and significant natural areas. Simpson Barracks contains relatively large areas of remnant woodland, particularly for this part of otherwise urbanised Melbourne. This includes the western margin of Simpson Barracks, which largely consists of Plains Grassy Woodland (EVC 55) dominated by River Red Gum *Eucalyptus camaldulensis*, in association with Studley Park Gum *E. X studleyensis* and Yellow Box *E. melliodora* in the headwaters of Banyule Creek.

At Simpson Barracks, North East Link is expected to run in a north-south alignment through the western portion of the Barracks, adjacent and parallel to Greensborough Road.

Impacts that would or may result from North East Link are described in Section 9. The following sections evaluate those impacts on the 'whole of environment' on Commonwealth land, using specific criteria for ecological components as presented in the EPBC Significant impact guidelines 1.2 (DSEWPaC, 2013a) (see Table 5-10 in Section 5.4.5).

As noted in Section 9, since the intial groundwater modelling was undertaken for the preparation of the draft PER, further numerical groundwater modelling was undertaken for the project. The purpose of the further modelling was to incorporate additional groundwater data collected over a period of approximately 12 months to enable transient calibration to seasonal variations in groundwater levels and to assess whether or not the additional calibration efforts result in changes to the assessment of project-induced groundwater impacts. The results of the further groundwater modelling and associated predicted indirect ecological impacts have been discussed in Section 9. The discussion of impacts and mitigation in the sections below have been updated based on the predicted ecological outcomes based on the further groundwater modelling undertaken for the project.

11.1 Impacts on plants

According to the EPBC Act Significant impact guidelines 1.2 (DSEWPaC, 2013a), an impact on plants on Commonwealth land would be considered significant (see Table 5-10 in Section 5.4.5) if there is a real chance or possibility the action will:

- Involve medium or large-scale native vegetation clearance
- Involve any clearance of any vegetation containing a listed threatened species which is likely to result in a long-term decline in a population or which threatens the viability of the species
- Introduce potentially invasive species

- Involve the use of chemicals which substantially stunt the growth of native vegetation
- Involve large-scale controlled burning or any controlled burning in sensitive areas, including areas which contain listed threatened species.

This section discusses the expected and potential impacts of North East Link (as presented and discussed in Section 9) with respect to these criteria, for the whole of environment (plants) on Commonwealth land, as described in Section 6.3. Components considered part of 'plants on Commonwealth land' include threatened species, non-threatened species, threatened vegetation communities, and non-native pest species (weeds).

Each criterion is addressed separately in Sections 11.1.1 to 11.1.5 below.

11.1.1 Involve medium or large-scale native vegetation clearance

Direct loss of native vegetation

Construction at Simpson Barracks would require land to be cleared of its vegetation. This assessment conservatively assumes that all plants within the project boundary would be lost due to construction.

Simpson Barracks has been extensively studied and much is known about the flora values it supports. The site is situated on fertile soils that support Plains Grassy Woodland with a few sparse shrubs and a species-rich grassy and herbaceous ground layer (Jacobs, 2016; HLA, 2007).

Simpson Barracks contains significant flora values including:

- 52.5 hectares of remnant vegetation
- 192 recorded flora species, including 92 indigenous and 100 exotic species.

The area within Simpson Barracks that intersects with the project boundary largely comprises Plains Grassy Woodland (EVC 55), dominated by River Red Gum. The Plains Grassy Woodland (EVC 55) that exists within Simpson Barracks was investigated for its potential to be considered Grassy Eucalypt Woodland of the Victorian Volcanic Plain. Because the geology of the site is sandstone and not volcanic in origin, the woodland within Simpson Barracks does not support Grassy Eucalypt Woodland as defined in DSEWPaC (2011).

Approximately 10.976 hectares of Plains Grassy Woodland would be directly removed for North East Link, which is approximately 21 per cent of the native vegetation at Simpson Barracks. Contained within the 10.976 hectares is 34 large trees (trees with a diameter at breast height >80 centimetres, according to the Plains Grassy Woodland EVC benchmark determined by DELWP). A further five scattered large trees and 12 scattered small trees occurring outside patches of native vegetation would also be removed.

Conclusion – direct loss of native vegetation

While the EPBC Act Significant impact guidelines 1.2 do not define medium-scale vegetation clearance, in the context of vegetation removal proposals across Victoria and Australia, it is our considered opinion the removal of 10.976 hectares of native vegetation, including 39 Large Trees, at Simpson Barracks would constitute medium-scale native vegetation clearance.

Shading is not expected to result in vegetation loss on Commonwealth land.

Indirect loss of native vegetation

Changes to groundwater levels due to North East Link would not lead to direct vegetation clearance. However, based on the further groundwater modelling, groundwater drawdown is modelled to result in a moderate to high risk of death or decline in health of an additional eight large trees (>80 centimetres DBH) at Simpson Barracks over the long term (2075 scenario). While some individual trees may die due to groundwater drawdown, all smaller trees, shrubs and understorey species would be expected to remain unaffected.

Large Tree mapping

All large trees (>80 centimetres DBH) within the modelled 10<20 metres groundwater depth zone (as outlined in Section 6.3.3) were mapped in the field, with tree numbers likely to be impacted based on risk zones. A total of 45 large trees at Simpson Barracks would have a moderate to high chance of being negatively impacted by 2024 at the end of construction, and one further large tree would have a low chance of being impacted in the absence of any mitigation measures. Under the 2075 long-term scenario, eight large trees within Simpson Barracks would have a moderate to high chance of being negatively impacted, while a further eight large trees would have a low chance of being impacted in the absence of any mitigation measures. All trees predicted to be impacted are River Red Gums, apart from nine (five high, four moderate) Studley Park Gum under the 2024 scenario and seven (three moderate, four low risk) Studley Park Gum under the 2075 scenario.

Table 11-1 Number of large trees expected to suffer premature mortality or condition decline due to groundwater drawdown associated with construction of the northern tunnel portal at Simpson Barracks

Risk	2024	2075
Very high	0	0
High	21 (5 Studley Park Gum)	0 (0 Studley Park Gum)
Moderate	24 (4 Studley Park Gum)	8 (3 Studley Park Gum)
Low	1 (0 Studley Park Gum)	8 (4 Studley Park Gum)
TOTAL	46 (9 Studley Park Gum)	16 (7 Studley Park Gum)

Other points to note

Although eight large trees at Simpson Barracks have the potential (moderate to high likelihood) to suffer premature mortality over the long term, there are currently thousands of other younger trees approximately 10 to 20 metres in height (with diameter at breast height (DBH) ranging from 20 to 70 centimetres) within the moderate to high risk zones at Simpson Barracks. From 2024 to 2075, these trees are expected to grow and self-thin (due to density-dependent mortality), with many trees likely to move through the ranks into the large tree category by 2075. While groundwater levels may be slightly lower over the long term, these trees are likely to have never accessed groundwater during their development, owing to their relatively smaller size at the time of the construction of North East Link, and so would unlikely be affected by the projected drawdown as they are not dependent on groundwater.

It should be noted that it is quite possible, even likely, that any large tree losses due to groundwater drawdown may be countered by other trees growing and moving into the large tree cohort over time. For example, it is estimated that more than 200 trees ranging in size from 50 to 79 centimetres DBH occur in the moderate to high risk zones at Simpson Barracks. While some of these trees may suffer premature mortality due to groundwater drawdown, many are likely to have root systems that do not penetrate deep enough to access groundwater, and

by inference, drawdown would not impact these individuals. Over the 50-year timespan from 2024 to 2075, many of these trees are likely to become large trees (conservatively adding girth of *c.* 0.5 centimetres per year (Bennetts and Jolly 2017 reported 0.44 centimetres year^{-1} growth in River Red Gum in floodplain forests). This would make it quite probable there would be no net loss of large trees from Simpson Barracks.

Conclusion – indirect loss of native vegetation

A total of eight large trees (five River Red Gum, three Studley Park Gum) at Simpson Barracks, but outside the project boundary, are likely accessing groundwater on occasions (10<20 metres groundwater depth zone) and have a moderate to high likelihood of being negatively impacted by groundwater drawdown over the long term (2075 scenario). This implies that in this groundwater depth zone, large trees have a reasonable likelihood of suffering a decline in health and/or premature death. Watering during construction is a potential mitigation measure that is likely to reduce the number of trees impacted in the short-term. Any large trees predicted to be affected over the long-term would need to be offset in association with the offset strategy for North East Link. Consistent with other sections of this report, offsetting would be undertaken in accordance with DELWP requirements. Areas outside the 10<20 metres groundwater depth zone would unlikely be negatively impacted by groundwater changes.

11.1.2 Involve any clearance of any vegetation containing a listed threatened species which is likely to result in a long-term decline in a population or which threatens the viability of the species

Clearance of vegetation at Simpson Barracks would involve the removal of three listed threatened plant species:

- Matted Flax-lily (*Dianella amoena*), Endangered under the EPBC Act, listed under FFG Act, endangered on DELWP Advisory List
- Arching Flax-lily (*Dianella longifolia* var. *grandis*), vulnerable on the DELWP Advisory List
- Studley Park Gum (*Eucalyptus* X *studleyensis*), endangered on the DELWP Advisory List.

Matted Flax-lily

During targeted surveys on Commonwealth land conducted between October and December 2017 and December 2018, a total of 83 individual Matted Flax-lily plants/patches were recorded and mapped at Simpson Barracks (including within the publicly accessible section of Commonwealth land), with individuals ranging from a few leaf tufts to large patches up to 4 x 4 metres in size.

Most Matted Flax-lily plants/patches observed during targeted surveys were in a healthy condition. Plants showed evidence of recent flowering and leaf growth and several were observed being pollinated by the native Blue-banded Bee *Amegilla cingulata*. Matted Flax-lily occurred in a number of different habitats at the Barracks, including at the base of River Red Gums, on rocky open areas or in shallow depressions. They often co-existed with other *Dianella* species within the project boundary, in particular Black-anther Flax-lily *Dianella revoluta* s.l. and Arching Flax-lily *Dianella longifolia* var*. grandis*.

To place the proposed Matted Flax-lily impact in context, an additional 188 plants/patches (at least) are known to occur at Simpson Barracks outside the project boundary, based on additional surveys undertaken for North East Link, and from surveys undertaken by HLA (2007) and Jacobs (2016), indicating the total population size at Simpson Barracks is at least 271 plants/patches. This suggests that approximately 31 per cent (83 out of 271 plants/patches) of Simpson Barracks population would likely be impacted. There are also parts of the Barracks

outside the project boundary that contain suitable grassy woodland habitat that are yet to be surveyed. Consequently, the total population size at the site is likely to be over 300 individuals/patches. While Simpson Barracks is listed as a 'significant population' in the Recovery Plan (10 plants recorded at the time of the Recovery Plan, suggesting it was the 16th largest population listed in the Plan), based on the current information, it is now likely to support one of the largest known populations of Matted Flax-lily.

Based on this level of impact to the Simpson Barracks population, *in the absence of mitigation*, it is likely that North East Link would result in a long-term decline in the size of the population on Commonwealth land and reduce the area of occupancy of the species. However, translocation of Matted Flax-lily has been successfully completed before for other large infrastructure projects, with Carter (2010) indicating a success rate of 80 to 90 per cent up to 2009. With the implementation of a successful salvage and translocation program, and the translocation risk spread across a number of suitable and approved potential receptor sites in the local area, the residual impact of North East Link on Matted Flax-lily on Commonwealth land is expected to be non-significant, and is unlikely to result in a long-term decline in the population, or threaten the viability of the species. The Matted Flax-lily population affected would be translocated to suitable recipient sites in accordance with an approved Salvage and Translocation Plan (Appendix F) to minimise impacts.

Studley Park Gum

In Simpson Barracks, Studley Park Gum was sub-dominant to *E. camaldulensis* on low relief mid to lower slopes in Plains Grassy Woodland east of Greensborough Road. During the surveys conducted as part of North East Link, a total of 44 individuals of Studley Park Gum were recorded and mapped within the project boundary at Simpson Barracks as follows:

- 44 trees at Simpson Barracks directly impacted:
  - *Identification reliability* – 71% of these trees were identified with a moderate to high level of confidence, while 29% had low confidence due to the unavailability of fertile material required for a positive identification (ie fruits, buds)
  - *Condition* – 89% of these trees were in good condition
  - *Size* – 21% (5<25 cm DBH); 60% (25<80 cm DBH); 19% (80+ cm DBH, ie defined as a large tree according to DELWP Plains Grassy Woodland EVC benchmark for the Gippsland Plain bioregion)
- It should be noted that the total of 44 trees does not include juveniles, owing to the inherent difficulty in positively identifying juvenile individuals of Studley Park Gum.

In addition, the following Studley Park Gum trees outside the project boundary may be indirectly impacted by groundwater drawdown associated with tunnel construction:

- Nine trees at Simpson Barracks indirectly impacted by groundwater drawdown temporarily in the short-term (2024 construction scenario based on further groundwater modelling); however, it should be noted that mitigation measures such as watering would be implemented in accordance with a Groundwater Dependent Ecosystem Monitoring and Mitigation Plan to avoid premature mortality or condition decline to these trees due to construction activities. The proposed strategy which would form the basis of the plan is attached as Appendix H.
- Three of these trees at Simpson Barracks indirectly impacted by groundwater drawdown in the long-term (2075 operational scenario based on further groundwater modelling).

The unavoidable loss of large trees within patches and scattered small trees of Studley Park Gum is regarded as a **significant** impact.

Arching Flax-lily

The Arching Flax-lily is classified as vulnerable under the DELWP Advisory list. Two individuals were observed during field assessments at Simpson Barracks.

The residual impact of North East Link on this species is not considered significant. The removal of two individuals would be unlikely to cause the long-term decline in a population, or threaten the viability of the species. The Arching Flax-lily individuals affected would be translocated to a suitable recipient site in accordance with the approved Matted Flax-lily Salvage and Translocation Plan (Appendix F) to minimise impacts.

11.1.3 Introduce potentially invasive species

Without mitigation, construction could result in the spread of weeds, pathogens or pest species, but the introduction of new invasive species to or from Commonwealth land is considered unlikely. Given the history of urbanisation across the entire Melbourne area, weeds and non-native pest species (such as rats, foxes, rabbits, mynas) are already widespread and well-established throughout Melbourne, including at Simpson Barracks.

11.1.4 Involve the use of chemicals which substantially stunt the growth of native vegetation

Chemical use that would substantially stunt the growth of native vegetation to be retained is not proposed for North East Link.

11.1.5 Involve large-scale controlled burning or any controlled burning in sensitive areas, including areas which contain listed threatened species

Controlled burning is not proposed for North East Link.

11.1.6 Proposed avoidance and mitigation measures

General

In consideration of the requirements for North East Link (traffic flow, TBM launching, safety, air quality, amenity and social requirements, within and beyond Commonwealth land), the smallest practicable project boundary within Commonwealth land has been adopted to avoid unnecessary loss of native vegetation. Refinement of the project boundary in the detailed design stage has the potential to further minimise removal of native vegetation on Commonwealth land.

Native vegetation

Based on the reference project design, there are no further opportunities to minimise the loss of 10.976 ha of native vegetation and 39 large trees within Simpson Barracks. An impact of this magnitude is likely to be regarded as significant, and consequently, offsets are required. During detailed design, the opportunity to minimise the impact would be further explored.

Where vegetation would be replaced by new road surface or infrastructure, the loss is permanent. Where vegetation would be lost to create space for construction (including for access, laydown, spoil storage, parking, offices), the loss would be shorter-term (two to eight years).

Given that there is no formal mechanism for offsetting the removal of non-threatened native vegetation from Commonwealth land, based on advice from the Commonwealth, NELP has committed to meeting the assessment and offset requirements of the DELWP *Guidelines for the removal destruction and lopping of native vegetation* (2017). A Native Vegetation Removal

(NVR) report (dated 24 June 2019) has been generated from DELWP, which identifies general offset units required for the vegetation removal on Commonwealth land. Enquiries have been made with DELWP-accredited offset brokers and NELP has received written assurance that sites are currently available on the market to offset the removal of 10.976 hectares of Plains Grassy Woodland and 39 large trees. As a general principle, NELP would seek to utilise one larger offset site in the bioregion where possible, rather than a number of small sites. The proposed offset strategy for North East Link aligns with the principles of the EPBC Act Offsets Policy.

Listed threatened species

Matted Flax-lily* and *Arching Flax-lily

Mitigation measures for Matted Flax-lily and Arching Flax-lily on Commonwealth land are outlined in Section 10.1.2. Offsets are not proposed, as it is considered that the impacts to these species are not significant when mitigation, salvage and translocation measures are taken into consideration.

Studley Park Gum

Nine of the large Studley Park Gums at Simpson Barracks are modelled to be impacted due to groundwater drawdown during construction, three of which may also be impacted during operation. The project proposes to implement a Groundwater Dependent Ecosystem Monitoring and Mitigation Plan to monitor the health of those trees and implement mitigation measures (such as watering) throughout the construction phase of the project to maintain their health, thus avoiding and mitigating impacts. The proposed strategy which would form the basis of the plan with respect to the Studley Park Gum at Simpson Barracks is attached as Appendix H. It is anticipated that those trees experiencing groundwater drawdown during operation would be impacted permanently.

Construction Environmental Management Plan

To avoid inadvertent impacts to threatened or protected species of plants during construction, a CEMP and Tree Protection Plan would be developed that clearly identifies measures to protect areas such as no-go zones and could include tree protection zones. To avoid further loss of vegetation through soil compaction, clear access routes would be specified for all heavy vehicle traffic, as well as no-go zones for sensitive environmental areas. This would reduce the risk of soil compaction in sensitive environmental areas.

Best-practice hygiene measures during construction would help to reduce the potential for transmission of weeds, pathogens and pest animals into adjacent areas of native vegetation within the barracks. Management requirements for declared noxious weed species and known pathogens (such as Cinnamon Fungus, Amphibian Chytrid Fungus) would be incorporated into the CEMP during construction activities. A Spoil Management Plan would be developed in conjunction with the CEMP to manage potentially contaminated construction spoil is a way to reduce the risk of spreading weeds and pathogens into or out of construction sites. To reduce the risk of exacerbating the impact of terrestrial pest animals, management measures would be implemented via a CEMP and appropriate management and minimisation of waste (including litter, which may attract pest animals) during construction and operation would be done in accordance with the *Environment Protection Act 1970*.

Tree Protection Plan

Tree Removal Plans would also be developed that clearly identify trees to be retained and those to be removed and the protocol for tree removal The Tree Protection plans would identify and establish Tree Protection Zones[12] (TPZs) to protect retained trees immediately outside the impact area from construction or related activities. Where TPZs would be encroached upon, it would clearly indicate where works can and cannot occur such that not more than 10 per cent of the TPZ would be impacted. In addition, where Structural Root Zones[13] (SRZs) are to be impacted, trees would be regarded as a loss.

11.1.7 Residual impact – plants

Medium or large-scale native vegetation clearance

Removal of 10.976 hectares of Plains Grassy Woodland, including 39 large trees, from Commonwealth land is likely to be considered to be medium-scale vegetation removal, and in the context of Simpson Barracks alone the removal constitutes approximately 21 per cent of the native vegetation on site. The removal of this amount of native vegetation is therefore likely to constitute a **significant impact** on plants on Commonwealth land.

Clearance of vegetation containing a listed threatened species

The clearance of native vegetation involving removal of two listed threatened plant species (Matted Flax-lily *Dianella amoena*, Arching Flax-lily *Dianella longifolia* var. *grandis*) is unlikely to result in a long-term decline in a population, or threaten the viability of Matted Flax-lily or Arching Flax-lily in the context of impacts on Commonwealth land.

As described in Section 11.1.2, the project is expected to have a **significant residual impact** on Studley Park Gum *Eucalyputs X studleyensis* as an element of the environment on Commonwealth land (noting that Studley Park Gum is not listed under the EPBC Act). In accordance with the *EPBC Act Environmental Offsets Policy*, this would trigger a requirement for offsets for impacts to Studley Park Gum on Commonwealth land.

Under the *EPBC Act Environmental Offsets Policy*, offsets are defined as measures that compensate for the residual impacts of an action. Offsets can comprise a combination of direct offsets and other compensatory measures. An offset may include:

- Improving existing habitat for the protected matter
- Creating new habitat for the protected matter
- Reducing threats to the protected matter
- Averting the loss of a protected matter or its habitat that is under threat.

By its very nature, the known population of Studley Park Gum is small both in distribution and numbers of individuals, given it is a rare fertile hybrid of two commonly occurring species (the River Red Gum and Swamp Gum).

[12] TPZ: A specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development. *TPZ = DBH × 12*. A TPZ should not be less than two metres nor greater than 15 metres (except where crown protection is required) (AS4970-2009).

[13] SRZ: The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres. This zone considers a tree's structural stability only, not the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area. The SRZ is determined following the formula provided in AS 4970-2009 (Council of Australian Standards, 2009) where: $SRZ\ radius = (D \times 50)^{0.42} X\ 0.64$, where D = trunk diameter, in m, measured above the root buttress.

Because of its inherently small population, determining a direct offset that improves and secures an existing population which accounts for at least 90 per cent of the offset requirements is not possible. There is also a lack of existing known habitat. According to the offsets policy, deviation from the 90 per cent direct offset requirement is able to be considered where scientific uncertainty is so high that it isn't possible to determine a direct offset that is likely to benefit the protected matter.

Studley Park Gum itself is not a protected matter however the environment on Commonwealth land is a protected matter. Therefore, instead of delivering direct offsets that secures and manages an existing population or habitat for the Studley Park Gum, NELP proposes to contribute to the conservation of Studley Park Gum by establishing new habitat through the implementation of the Studley Park Gum Management Framework (the Framework) (Appendix A). This approach is expected to result in a viable outcome noting that the creation of new habitat for a protected matter is a type of direct offset under the *EPBC Act Environmental Offsets Policy*.

The Framework has been developed as the proposed offset measure for the impacts to Studley Park Gum on Commonwealth land. The Framework commits to the following measures:

- Developing and implementing a 'seed collection and propagation plan', which provides detailed methods for the collection, storage and propagation of Studley Park Gum seeds
- Identifying a recipient site with appropriate conditions to enable establishment of a self-sustaining Studley Park Gum population
- Planting 288 Studley Park Gum saplings at the recipient site to achieve the establishment goal of a minimum of 98 Studley Park Gum plants after three years
- Developing and implementing a management plan for the recipient site, which includes detailed site-specific actions.

It is acknowledged that this approach has not previously been proposed for the taxon. Given this, uncertainties exist around the potential success (risk of failure) of the Framework. These uncertainties have been considered in the development of the Framework and the responses documented below:

- There is the potential that an insufficient volume of Studley Park Gum seed is collected.

  In response the Seed Collection and Propagation Plan (see Appendix A for more detail) identifies five 'collections' of Studley Park Gum seed. At each collection numerous individual trees would be targeted and fruit and seed taken (two collections have been completed as at August 2019).

- There is the potential that the collected seed is not viable.

  The Royal Botanic Gardens of Victoria have been engaged to store and test seed viability through germination testing.

- The potential that saplings display morphological characteristics more closely aligned with one parent species.

  As part of the propagation process the horticulturalist would observe the morphology being expressed by the seedlings. Those plants that are clearly showing a strong tendency to the morphological characteristics of either River Red Gum or Swamp Gum would be excluded from the numbers of trees considered to be Studley Park Gum.

- Failure to reach the 2:1 target.

  The Framework has been conservative and assumes annual death of up to 30 per cent (year on year) of planted Studley Park Gums over the three years of the Framework. In reality, with appropriate planting, maintenance and management it is reasonable to assume that mortality would not be so high and that overall at least 50 per cent (144) of planted Studley Park Gums survive past three years.

- Contingency planning.

  There is still the potential that the Framework fails to meet its goal of the establishment of 98 Studley Park Gums displaying strong morphological affinities with other Studley Park Gums at Simpson Barracks. The Framework documents evaluation and contingency measures to be implemented if the Framework looks likely to fail.

It is proposed that once a recipient site(s) is selected, a more detailed Studley Park Gum Management Plan would be prepared and approved by DELWP.

In addition to the above, at the State level native vegetation offsets would be provided based on the Victorian Guidelines (DELWP 2017a) to offset for the removal of native vegetation (which Studley Park Gum trees form part of) directly impacted by the project, and three Studley Park Gum trees expected to experience premature mortality due to long term groundwater drawdown.

Implementing the Studley Park Gum Management Framework (Appendix A) and State offsets is in line with the EPBC Act Environmental Offsets Policy and commensurate with the conservation status of the species.

Introduce potentially invasive species

With appropriate mitigation measures implemented through a CEMP, North East Link would unlikely result in the introduction of a potentially invasive species to or from Commonwealth land. No significant impact on plants on Commonwealth land is therefore foreseeable under this impact criterion

Use of chemicals which stunt growth of native vegetation

North East Link would unlikely result in the use of chemicals that would substantially stunt the growth of native vegetation to be retained within the project boundary, or immediately adjacent to the project boundary. No significant impact on plants on Commonwealth land are therefore foreseeable under this impact criterion.

Involve use of controlled burning

Controlled burning is not proposed for North East Link. No significant impact on plants on Commonwealth land are therefore foreseeable under this impact criterion

Overall residual impact

The removal of 10.976 hectares of Plains Grassy Woodland from Commonwealth land is likely to be considered to be medium-scale vegetation removal, and so the removal of this vegetation is likely to constitute a significant impact on plants on Commonwealth land.

In addition, the direct removal of 44 individauls of Studley Park Gum, and indirect removal of three individuals of Studley Park Gum via groundwater drawdown, is likely to constitute a significant impact on plants on Commonwealth land.

As per the PER Guidelines for state-listed matters on Commonwealth land, offsets for these residual impacts would be undertaken in accordance with state requirements, and supplemented by other measures as outlined above. See Chapter 11 of the PER for further details.

11.2 Impacts on animals (terrestrial)

According to the EPBC Significant impact guidelines 1.2 (DSEWPaC, 2013a), an impact on terrestrial animals on Commonwealth land would be considered significant (see Table 5-10 in 5.4.5) if there is a real chance or possibility that the action will:

- Cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals
- Displace or substantially limit the movement or dispersal of native animal populations
- Substantially reduce or fragment available habitat for native species
- Reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species
- Introduce exotic species which will substantially reduce habitat or resources for native species; or
- Undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species.

This section discusses the expected and potential impacts of North East Link (as presented and discussed in Section 9) with respect to these criteria, for the whole of environment (terrestrial animals) in and around Commonwealth land (500-metre buffer), as described in Section 7.3. Components considered part of 'terrestrial animals on Commonwealth land' include threatened species, non-threatened species, migratory species, fauna communities, and non-native and native pest species.

Each criterion is addressed separately in sections below.

11.2.1 Cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals

Construction on Commonwealth land would include removal of vegetation that provides habitat for animals, which may result in the injuring or killing of animals. Animals most at risk are those that reside in the habitats to be removed and that have limited mobility (such as frogs, small reptiles, possums, flightless invertebrates), and/or dependent or immobile young (young animals in a nest or den). Also at risk are animals that may stray into the construction area during a quiet time (overnight). Animals straying into a noisy active construction site during the day is considered unlikely.

Simpson Barracks is in the north-eastern suburbs of Melbourne, where animals most likely to be encountered in a construction site are common and even abundant species. Death or injury of some animals may occur during vegetation clearance, but is expected to involve small numbers of common animals only, and is most likely to affect individuals rather than populations or species. While killing an individual animal would be permanent, the population of a common species is unlikely to have any more than a negligible impact

The presence of uncommon or threatened species on Commonwealth land relevant to North East Link may occur, but is expected to be rare. Death, injury or other harm to those threatened animals (which would be expected to have a longer-lasting and more significant ecological impact) due to North East Link is expected to be extremely rare and highly unlikely.

The operation of North East Link would unlikely change existing levels of death, injury or harm to animals on or around Commonwealth land. Collisions between animals and vehicles (roadkill) is the most likely operational-phase threat to animals, and that threat is not expected to

increase. The Commonwealth land is already fenced (thereby preventing larger non-flying animals from leaving the Commonwealth land) and surrounded by roads and urbanised areas. That would not change.

Death, injury or other harm of common species impacted on Commonwealth land due to North East Link is not expected to cause a long-term decrease in, or threaten the viability of, a native animal population or populations. This includes the small population of Eastern Grey Kangaroo – individuals are not expected to be killed or harmed, and recent counts and density estimates suggest the population size would increase rather than decrease.

11.2.2 Displace or substantially limit the movement or dispersal of native animal populations

The construction process would involve a range of demolition and construction work, potentially day and night. Construction activities have the potential to disturb and displace animals locally. The potential severity and ecological consequence of disturbance varies with species and location. Disturbing a threatened species to the point that it abandoned its breeding habitat would be a severe impact, while localised and temporary disturbance of small numbers of individuals of common species (such as the Red Wattlebird, Noisy Miner) from marginal foraging habitat would be relatively inconsequential ecologically. The potential effects of disturbance of animals is discussed in Sections 9.1.7 and 9.2.6.

Because the western section of Simpson Barracks is already adjacent to an extremely busy, four-lane road (also a recognised truck route), North East Link is not expected to exacerbate existing levels of disturbance or displacement of animals. Disturbance and displacement of some animals on Commonwealth land would be unavoidable, but is expected to be minor. Disturbance would most likely affect individuals rather than entire populations or species, and is not expected to have a long-lasting effect on any population of animals that live in or visit the vicinity of the Commonwealth land. Animals in this area already cope with an urban environment that is disturbed. It is therefore likely the fauna that still occur within the area, or visit the area, have coping mechanisms for persisting in urbanised environments.

Some animals (such as Eastern Grey Kangaroo at Simpson Barracks) may move away from construction sites (and from busy roadways during the operational phase) during noisy periods, to better hear their surroundings (for potential predators). The extent of displacement is likely to vary, depending on the prevailing noise levels. At times of less noise, animals would be expected to re-enter the disturbed area and use it as normal habitat. Animals can become habituated to predictable disturbances (such as birds that use airfields as habitat).

Loss of habitat reduces foraging, nesting and dispersal opportunities for animals in the local area, and confines animals to the extent of suitable habitat that remains. Small proportional losses are less detrimental than large proportional losses. Animals that are unable to seek and obtain resources from alternative sources (closed population) are more disadvantaged by habitat loss than those that can freely move to and use other areas (open population).

Loss of habitat affects species differently. Some species are mobile and adaptable (such as the Red Wattlebird), and are able to use remaining habitats or even a degraded form of the same habitat. Others are more sensitive to habitat extent and condition, and may decline or disappear as habitat patches get too small or too degraded (such as for the Eastern Yellow Robin). Most of the native animals that persist at Simpson Barracks are adaptable and common species, already coping with a fragmented and degraded habitat landscape.

As a defence facility, Simpson Barracks is fenced all around, and the fence for the most part is substantial enough to prevent free movement of large fauna (such as Eastern Grey Kangaroos). This effectively makes Simpson Barracks a closed site for some animal populations already. Other animal species that use Simpson Barracks (such as possums, birds) are not as

constrained as the kangaroos in this way, because they are able to move more freely into and out of Simpson Barracks. North East Link would not change the ability of native animals to move into or out of the Commonwealth land.

North East Link would impact on the upper reaches of Banyule Creek, within Simpson Barracks and south to Lower Plenty Road. This upper section of Banyule Creek offers a very small fauna movement corridor between Simpson Barracks and the Yarra River floodplain. Through this section, the habitat corridor is narrow, degraded, and likely to be used mainly by common and adaptable mobile fauna for local movements only, rather than landscape-scale movements. The absence of mid-storey and under-storey vegetation along the section of Banyule Creek north of Lower Plenty Road, the major barrier to ground-based fauna created by Lower Plenty Road itself, and the busy and urbanised landscape that surrounds Banyule Creek in this local area, means that this wildlife corridor is highly compromised in its current form. North East Link is not expected to result in further loss of ecological function from corridor habitats along Banyule Creek.

North East Link would unlikely displace or substantially limit the movement or dispersal of native animal populations on Commonwealth land that has any ecological consequence.

11.2.3 Substantially reduce or fragment available habitat for native species

Loss of habitat reduces foraging, nesting and dispersal opportunities for fauna in the local area, and confines fauna to the extent of suitable habitat that remains. Loss of habitat affects species differently. Some species are mobile and adaptable (such as the Red Wattlebird), and are able to use remaining habitats or even a degraded form of the same habitat. Others are more sensitive to habitat extent and condition, and may decline or disappear as habitat patches get too small or too degraded (such as the Hooded Robin).

All habitats within and surrounding Simpson Barracks support non-threatened terrestrial animals, and clearing vegetation from that land would impact on those species. Most of the non-threatened native animals that persist at Simpson Barracks and in the Melbourne area (such as the Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Crested Pigeon, Common Brushtail Possum, Common Ringtail Possum) are generally mobile and/or adaptable, and are persisting within a fragmented and degraded habitat landscape. These species are able to use remaining habitats or even a degraded form of the same habitat.

North East Link would be constructed in an already fragmented urban landscape. Species that use habitat patches as movement corridors in the project boundary tend to be highly mobile species already coping with a fragmented and degraded habitat landscape.

For the most part, habitat loss on Commonwealth land due to North East Link would be unlikely to result in significant ecological impacts on fauna populations that use that habitat. Mobile fauna that use the patches are able to move into and use adjacent patches also. One species warrants more detailed discussion: the Eastern Grey Kangaroo.

Simpson Barracks contains a relatively large area of remnant eucalypt woodland in an otherwise urbanised part of Melbourne. This habitat is not accessible to the public and only used occasionally for Defence activities. Simpson Barracks supports a healthy population of the Eastern Grey Kangaroo. As a defence facility, the site is fenced all around, and the fence for the most part is substantial enough to be kangaroo proof. This effectively makes the kangaroo population at the Barracks a closed population, where space and resources are critical to the population's viability. Other animals that use the Barracks (such as possums, birds) are not as constrained as the kangaroos in this way, because they are able to move more freely into and out of the Barracks.

The kangaroo population at Simpson Barracks has been assessed numerous times in recent years (Defence 2007 (as cited in Aecom 2011); Aecom 2011; Wilson 2014; Aecom 2015). Aecom (2015) reported that approximately 52 hectares of the Barracks is grassy woodland vegetation that provides suitable habitat for kangaroos. In addition to the woodland areas, Simpson Barracks contains numerous areas around buildings where the grass is mowed, two large grassed sports fields and one large grassed parade ground (Long Green) that is watered during the summer (Wilson, 2014).

North East Link would require the permanent removal of eight hectares of woodland habitat from Simpson Barracks. If this equates to loss of 8 of the 52 ha, then this would increase the kangaroo density estimates by 15.4 per cent. Grazing habitat would be lost due to the project, but given the presence of well-watered grassy areas (outside the project boundary), the habitat lost may not be the vital habitat that sustains the population within the Barracks. Wilson (2014) reported that 80 per cent of kangaroo observations were on the Long Green.

The carrying capacity for EGK at the site is unknown, and whether or not the site is truly 'closed' to EGK migration is uncertain (AECOM, 2015). However, with its reliable water sources and copious and well-watered lawns, the carrying capacity of Simpson Barracks for EGK is likely to be much higher than the current population size. Further, the density of EGK at Simpson Barracks is likely to be far lower than density estimates for other kangaroo populations (for example, of five counts of Eastern Grey Kangaroos in the ACT between 1995 – 1997, the lowest density reported was 2.33 kangaroos/hectare (reported as 233/km^2; for Tidbinbilla Nature Reserve, ACT; ACT Parks & Conservation Service (1997)). The proposed habitat loss is therefore expected to be ecologically inconsequential for the Eastern Grey Kangaroo population, and would be highly unlikely to jeopardize the viability of the current Eastern Grey Kangaroo population in Simpson Barracks.

Density estimates for the Barracks assume that the Barracks provide the only habitat available to the kangaroo population, and that the population is a closed population. However, there are anecdotal reports of kangaroos being killed by vehicles on nearby roads occasionally. These may be kangaroos from surrounding suburban areas, or they may be kangaroos that get through the fence occasionally, which would suggest that the population is not entirely closed. If it occurs, the most likely direction for immigration and emigration of kangaroos is to the east, as there is a seemingly safe route that offers continuous suitable habitat and few road crossings between the Barracks and the Plenty River at Yallambie.

By removing native vegetation, North East Link would reduce available habitat for native species on Commonwealth land, but this reduction is not considered substantial and would not be to the extent that it has ecological consequences.

Loss of habitat from Commonwealth land for North East Link is not expected to cause further fragmentation of available habitat for native species.

11.2.4 Reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species

Loss of habitat reduces foraging, nesting and dispersal opportunities for fauna in the local area, and confines fauna to the extent of suitable habitat that remains, often increasing con-specific and inter-specific competition. Loss of too much habitat, relative to the original contiguous habitat patch, can threaten the viability of some populations that currently rely on the extent of habitat present. Small proportional losses are less detrimental than large proportional losses. Animals that are unable to seek and obtain resources from alternative sources (closed population) are more disadvantaged by habitat loss than those that can freely move to and use other areas (open population).

Because Simpson Barracks currently contains relatively large areas of remnant woodland in an urbanised landscape, it is likely to attract and support a range of fauna. However, because it is surrounded by urbanisation and has been considerably disturbed historically, it is generally degraded and so is unlikely to support the full range of threatened and non-threatened fauna that would have occurred there historically.

Occasionally or rarely, habitats within Simpson Barracks are known to attract threatened fauna such as Powerful Owl *Ninox strenua*, Swift Parrot *Lathamus discolor* and Grey-headed Flying-fox *Pteropus poliocephalus*; although this is likely to be for foraging only, and such species are not expected to breed or roost there frequently or regularly.

The Grey-headed Flying-fox is likely to use habitats within Simpson Barracks relatively frequently – it was seen there during the surveys for North East Link, and it is well known in the entire Melbourne area as a common visitor to flowering trees, in parks, gardens and reserves.

The Powerful Owls in this part of Melbourne appear to spend most of their time within Yarra River floodplain habitats (particularly Banyule Flats). However, Deakin University research results showed that at least one of the Banyule Flats Powerful Owls ventured as far as Simpson Barracks on one occasion. Because the Deakin University tracking data only covered 34 nights of activity, it remains possible or even likely that owls also use other parts of Simpson Barracks (outside the project boundary).

For Swift Parrots, there is one older (1992) VBA record of five birds in the eastern section of Simpson Barracks. A site assessment at the Barracks determined that the western margin (within the project boundary) largely consists of non-favoured eucalypt species (mainly River Red Gum *Eucalyptus camaldulensis*), which was dominated by aggressive nectar feeders such as Noisy Miners, Red Wattlebirds and Rainbow Lorikeets which are reported to disturb or out-compete Swift Parrots. The woodland on the eastern side of Simpson Barracks, which North East Link would not impact, supports superior habitat that is dominated more by Yellow Box *E. melliodora*, a favoured eucalypt species for Swift Parrot foraging.

The White-throated Needletail has been recorded at Simpson Barracks historically. Needletails may forage occasionally in the airspace above Simpson Barracks, but because this species is reported to be almost exclusively aerial within Australia, they are unlikely to have a substantial association with the terrestrial habitats.

Species that are unusual/rare in the Melbourne area, such as Grey Goshawk *Accipiter novaehollandiae*, Black Falcon *Falco subniger* and Barking Owl *Ninox connivens* may visit Simpson Barracks occasionally, but are unlikely to be there regularly, or to depend on habitat within the site.

Loss of habitat from Commonwealth land for North East Link is not expected to reduce or fragment available habitat for a listed threatened species to the extent that it displaces a population, results in a long-term decline in a population, or threatens the viability of the threatened species.

11.2.5 Introduce exotic species which will substantially reduce habitat or resources for native species

Without mitigation, construction could result in the spread of weeds, pathogens or pest species. However, this is unlikely to result in the decline in habitat or resources for native species.

Weeds and non-native pest species (such as rats, foxes, rabbits, mynas) are already widespread and well-established throughout Melbourne, including Simpson Barracks. One native species of bird (Noisy Miner, *Manorina melanocephala*) is implicated in ecological deterioration, and is integral to a Key Threatening Process under the EPBC Act. This species is already common and well-established at Simpson Barracks.

Pathogens include Cinnamon Fungus and Amphibian Chytrid Fungus, which can have devastating effects if introduced to novel areas. Neither pathogen is expected to increase in prevalence or impact due to North East Link. Transmission pathways for those pathogens are already numerous across the urbanised landscape of Melbourne, and North East Link would not increase the potential for transmission. Best-practice hygiene measures during construction would help to reduce the potential for transmission of pathogens.

North East Link would unlikely introduce exotic species that substantially reduce habitat or resources for native species.

11.2.6 Undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species

Controlled burning is not proposed for North East Link.

11.2.7 Proposed avoidance and mitigation measures

In consideration of the requirements of North East Link (traffic flow, TBM launching, safety, air quality, amenity and social requirements, within and beyond Commonwealth land), the smallest practicable project boundary on Commonwealth land has been adopted for North East Link to avoid unnecessary loss of habitat. Refinement of the project boundary in the detailed design stage has the potential to further minimise removal of native vegetation and animal habitat.

Loss of some animal habitat would be unavoidable. Measures to avoid harming fauna during construction and to deal with injured fauna if found, would be specified in Environmental management plans, including a Construction Environmental Management Plan (CEMP), Worksite Environmental Management Plans (WEMPs), and an Operations Environmental Management Plan (OEMP). Environmental management plans would be prepared and implemented in consultation with relevant councils, VicRoads, Melbourne Water, EPA Victoria and other authorities as required by NELP or under any statutory approvals. Prescribed fauna management measures, in compliance with Victoria's *Wildlife Act 1975*, would enable appropriate management of fauna that may be displaced due to habitat removal.

To minimise impacts on animals during removal of vegetation, appropriate controls would be implemented prior to vegetation clearance.

Prior to removing vegetation, pre-clearance surveys would be undertaken to confirm the on-site location of fauna immediately before tree removal or, where relevant, works on waterways, and to assist fauna to safety as necessary. The CEMP could include requirements to relocate animals to appropriate locations outside the construction area.

If threatened fauna are found within the area proposed for vegetation removal and are at risk of harm, the CEMP could require clearing works in the vicinity to be stopped until an appropriate solution could be achieved to remove that animal from harm's way.

Fauna that stray into or are found within an active construction site would be managed by a suitably qualified site environmental officer via the CEMP. Measures to avoid harming fauna, and to deal with injured fauna if found, would be specified in the CEMP and OEMP.

Existing fencing around Simpson Barracks would be maintained (or relocated if removed for construction activities) as required, to keep Simpson Barracks secure and to keep larger fauna (such as Eastern Grey Kangaroo, Swamp Wallaby, Common Wombat) from straying onto nearby roads. The design and scale of the adjacent roadways would discourage most fauna from using or crossing the roads to reduce the incidence of them colliding with vehicles. However, birds would still be able to access and cross the roads with ease. Fauna-attracting habitat would not be reinstated in median strips of the roads so they would not be encouraged to cross roadways to access that habitat.

To minimise disturbance on animals during construction, lighting would be designed to minimise impacts. For example, lights could be directed downwards rather than outwards as far as practicable, and screens could be used between construction sites and adjacent animal habitat. Measures to reduce lighting disturbance would be specified in the CEMP.

Best-practice hygiene measures during construction would help to reduce the potential for transmission of weeds, pathogens and pest animals. Management requirements for declared noxious weed species and known pathogens (such as Cinnamon Fungus, Amphibian Chytrid Fungus) would be incorporated into the CEMP during construction activities. A Spoil Management Plan would be developed in conjunction with the CEMP to ensure that potentially contaminated construction spoil is managed to reduce the risk of spreading weeds and pathogens into or out of construction sites. To reduce the risk of exacerbating the impact of terrestrial pest animals, management measures would be implemented via a CEMP and appropriate management and minimisation of waste (including litter, which may attract pest animals) during construction and operation would be done in accordance with Victoria's *Environment Protection Act 1970*.

11.2.8 Residual impact – terrestrial animals

North East Link is expected to have no more than a minor impact on terrestrial animals on Commonwealth land. Animals that visit or reside at Simpson Barracks already tolerate various disturbances and dangers associated with the large city that surrounds the area. North East Link would not add any significant disturbance or threat to those animals that is not already present.

Habitat loss from Commonwealth land for North East Link is expected to result in the loss or displacement of individuals of mostly common or abundant species, rather than entire populations or species, and rather than threatened species. North East Link is not expected to influence the long-term persistence or viability of any native terrestrial animal species.

11.3 Impacts on animals (aquatic)

According to the EPBC Significant impact guidelines 1.2 (DSEWPaC, 2013a), an impact on aquatic animals on Commonwealth land would be considered significant (see Table 5-10 in Section 5.4.5) if there is a real chance or possibility the action will:

- Cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals
- Displace or substantially limit the movement or dispersal of native animal populations
- Substantially reduce or fragment available habitat for native species
- Reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species
- Introduce exotic species which will substantially reduce habitat or resources for native species
- Undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species.

This section discusses the expected and potential impacts of North East Link (as presented and discussed in Section 9) with respect to these criteria, for the whole of environment (aquatic animals) on Commonwealth land, as described in Section 8.3. Components considered part of 'aquatic animals on Commonwealth land' include aquatic ecosystems broadly, as well as specific threatened species, non-threatened species, and non-native aquatic pest species.

Each criterion is addressed separately in sections below.

11.3.1 Cause a long-term decrease in, or threaten the viability of, a native animal population or populations, through death, injury or other harm to individuals

Banyule Creek is the only waterway that would be impacted by construction activities on Commonwealth land. Banyule Creek has intermittent flow, and only provides habitat for aquatic animals during periods of flow (during or following rain). Construction activities during a dry period would not cause the death, injury or other harm of aquatic animals in Banyule Creek at Simpson Barracks.

There is a handful of small constructed waterbodies at Simpson Barracks that provide permanent aquatic habitat. These waterbodies result from historical catchment drainage modifications to the headwaters and catchment of Banyule Creek at Simpson Barracks. These waterbodies do not support fish, and support only a subset of aquatic macroinvertebrates that could be found in Melbourne‘s waterways. Invertebrates present are common species that tolerate degraded aquatic habitats. Removal of those waterbodies would result in the death of common aquatic macroinvertebrates, but death of aquatic vertebrate animals (fish) would not occur.

The death, injury or other harm to aquatic animals on Commonwealth land due to North East Link would not cause a long-term decrease in, or threaten the viability of, a native aquatic animal population or populations.

11.3.2 Displace or substantially limit the movement or dispersal of native animal populations

Banyule Creek is the only waterway that would be impacted by construction activities on Commonwealth land. At Simpson Barracks, Banyule Creek has intermittent flow, and only provides aquatic habitat during periods of flow (during or following rain). Simpson Barracks contains the very headwaters of the waterway, and when flowing, does not provide a link to further aquatic habitat upstream.

Downstream of Simpson Barracks, Banyule Creek is a poor quality aquatic ecosystem, with degraded aquatic macroinvertebrate communities. Fish surveys revealed the fish community of Banyule Creek was dominated by the exotic Oriental Weatherloach (*Misgurnus anguillicaudatus*) which was found in all reaches on Banyule Creek containing water. The native Common Galaxias (*Galaxias maculatus*) was present in the downstream reaches of Bayule Creek, approximately 1.7 kilometres downstream of Simpson Barracks. These native fish were only found downstream of Lower Plenty Road, which contains major culverts and drop structures that provide a significant barrier to upstream fish passage. This existing barrier prevents the native fish present downstream in Banyule Creek from colonising upstream waters on Commonwealth land. Movement or dispersal of native aquatic animals is therefore already limited by existing infrastructure immediately downstream from Commonwealth land.

Construction on Commonwealth land would not displace or substantially limit the movement or dispersal of native aquatic animal populations.

11.3.3 Substantially reduce or fragment available habitat for native species

Aquatic habitats may be reduced or fragmented in either of two ways:

- Sections may be removed entirely
- They may be degraded to the point that they no longer provide suitable habitat for aquatic animals.

Banyule Creek is the only waterway that would be impacted by construction activities on Commonwealth land. The upper section of Banyule Creek would be considerably modified by North East Link – approximately 1,400 metres of channel extending within Simpson Barracks and downstream to Lower Plenty Road would be replaced by two pipes. Converting sections of a waterway to enclosed pipes would directly remove structural habitat for aquatic animals.

Banyule Creek has intermittent flow, and only provides habitat for aquatic animals during periods of flow (during or following rain). There is a handful of small constructed waterbodies at Simpson Barracks that provide permanent aquatic habitat. These waterbodies result from historical catchment drainage modifications to the headwaters of Banyule Creek at Simpson Barracks. The aquatic habitat that would be directly impacted by North East Link supports only a subset of aquatic animals that could be found in Melbourne‘s waterways. Aquatic animals present are limited to common and opportunistic invertebrate species that are adapted to a highly modified urban environment, that can disperse to any available aquatic habitats and tolerate degraded aquatic habitats. No native fish or threatened aquatic species inhabit Banyule Creek at Simpson Barracks.

Removal of those waterbodies would reduce available habitat for aquatic native species on a very local scale, but would not have ecological consequences for broader populations of any of the native species.

The section of Banyule Creek on Commonwealth land to be piped are the headwaters of the waterway, and so there is no upstream habitat this section provides a link to. While enclosing the waterway would have a severe impact on that section of the waterway, the impacted sections of the creek are the small ephemeral waterway at the very top of the stream.
This would not impact waterway connectivity to habitat for native aquatic species that inhabit Banyule Creek downstream of the barrier at Lower Plenty Road

The headwaters of Banyule Creek are ephemeral and support temporary aquatic ecosystems able to tolerate drying phase or colonise during wetted periods. The loss of natural waterway in this reach of Banyule Creek has a very low risk of substantially reducing or fragmenting available habitat for native aquatic species.

11.3.4 Reduce or fragment available habitat for listed threatened species which is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species

The Yarra River is the only waterway in the project boundary likely to support threatened aquatic animals (fish). Banyule Creek, within and downstream of Simpson Barracks, does not support threatened aquatic animal species.

The headwaters of Banyule Creek are ecologically fragmented from downstream reaches by several major road crossings, which prevent the ability for upstream colonisation by aquatic fauna, including threatened species.

North East Link would not likely reduce or fragment available habitat for listed threatened species which displaces a population, results in a long-term decline in a population, or threatens the viability of an aquatic animal species.

11.3.5 Introduce exotic species which will substantially reduce habitat or resources for native species

There are two mechanisms by which exotic species could reduce habitat or resources for native aquatic animals:

- Exotic aquatic plants could reduce habitat or resources for native aquatic animals
- Exotic aquatic animals could reduce habitat or resources for native aquatic animals.

Banyule Creek is the only waterway that would be impacted by construction activities on Commonwealth land. Banyule Creek has intermittent flow, and only provides habitat for aquatic animals or plants during periods of flow (during or following rain). There is a handful of small constructed waterbodies at Simpson Barracks that provide permanent aquatic habitat, and which support aquatic plants and common macroinvertebrates.

Banyule Creek is within an urbanised landscape and directly connected to an urbanised stormwater network and runoff drainage, so is already degraded to some degree. This means that Banyule Creek supports aquatic fauna that have some tolerance for degraded, polluted and contaminated aquatic habitats, including exotic species that have established themselves in Melbourne's waterways. Surveys revealed the fish community of Banyule Creek (downstream of Simpson Barracks) was dominated by the exotic Oriental Weatherloach (*Misgurnus anguillicaudatus*) which was found in all reaches of Banyule Creek containing water.

While not technically a species, Epizootic Haematopoietic Necrosis Virus (EHNV) is an Australian virus that has the potential to negatively impact several native fish species. The spread or introduction of this virus to Banyule Creek due to North East Link is considered highly unlikely.

Given the study area is already highly urbanised, and that Banyule Creek is already dominated by exotic aquatic species, North East Link is not expected to introduce an exotic species which would substantially reduce habitat or resources for native aquatic animals.

11.3.6 Undertake large-scale controlled burning or any controlled burning in areas containing listed threatened species

Controlled burning is not proposed for North East Link.

11.3.7 Proposed avoidance and mitigation measures

In consideration of requirements for North East Link (traffic flow, TBM launching, safety, air quality, amenity and social requirements, within and beyond Commonwealth land), the smallest practicable project boundary on Commonwealth land has been adopted for North East Link to avoid unnecessary loss of habitat, terrestrial and aquatic. However, loss of some aquatic habitat along Banyule Creek would be unavoidable. The modification of Banyule Creek within Simpson Barracks and downstream to Lower Plenty Road through replacement with two pipes would effectively remove this reach of ephemeral aquatic habitat. Mitigation measures for aquatic habitat protection described in this section relate to aquatic habitat protection measures implemented on Commonwealth land. These are not expected to restore the loss of aquatic habitat due to channel modification, but are more intended to protect aquatic ecosystems downstream in Banyule Creek from impacts on Commonwealth land.

The most important method for preventing aquatic habitat degradation is through the design of North East Link to minimise the impacts from discharges and runoff, and to manage construction to protect aquatic habitat. Prior to construction, discharges, runoff pathways and stockpiles would be designed in a way to reduce the risk of contaminated flows, sediment and discharges from entering waterways and surrounding areas of vegetation. Modifications to all waterways would be designed and undertaken to mitigate the effects of changes to flow, and minimise the potential for erosion, sediment plumes and exposure of contaminated material during construction. Surface water facilities would be designed to manage discharge and run-off from North East Link to meet legislated standards for environmental protection, and a Surface Water Management Plan would be developed and implemented (Refer to PER Technical Appendix C – Surface water), setting out the requirements and methods for best-practice erosion protection, sediment and erosion control and monitoring, in accordance with EPA Victoria requirements.

Modelling of flow velocity should be undertaken. Where drainage inputs to the natural waterway would likely result in ecologically significant changes to the magnitude or duration of peak flows, waterway channel modifications could be used to ameliorate the hydrological impacts. This may include bank stabilisation works at drainage outfalls, channel and/or floodplain storage capacity and engagement modifications to minimise the impacts of high flows on aquatic habitat, and provision of refuges for aquatic fauna.

The use of water sensitive urban design (WSUD) features would help mitigate this impact by capturing the additional run-off from the new road/ramp surfaces before it reached natural aquatic habitats. WSUD features would be required to manage the pollutant load from North East Link's new road/ramp surfaces to prevent transport of pollutants to waterways or natural wetlands.

To further reduce the risk of sedimentation, contamination and erosion, a Construction Environmental Management Plan (CEMP) would be prepared to outline best-practice erosion protection, sedimentation and discharge controls, and management of chemicals, fuels and hazardous materials methods to reduce the risk of ecological impacts to negligible. Appropriate management of chemicals, fuels and hazardous materials would enable minimisation of chemical and fuel storage on site and storage of hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements. This would include development and implementation of management measures for dangerous substances, including appropriate disposing of hazardous materials, installation of bunds and precautions to reduce the risk of spills, and developing contingency and emergency response plans to handle fuel and chemical spills. In the case of an accidental spill, a best-practice spill contamination procedure would be detailed in the CEMP and spill kits would be present on all construction sites.

Waste management measures would be implemented including waste minimisation during construction and operation in accordance with the Victoria's *Environment Protection Act 1970*. Waste excludes soils, but includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

Water quality monitoring would include a baseline surface water monitoring program developed and implemented before construction started to assess background water quality in all receiving waters (Refer to PER Technical Appendix C – Surface water). The monitoring and management of surface water quality and flow should include consideration of changed risks due to changes in rainfall and riverflow during wet periods with greater rainfall runoff.

Best-practice hygiene measures during construction would help reduce the potential for transmission of weeds, pathogens and pest animals. A Spoil Management Plan would be developed in conjunction with the CEMP so that potentially contaminated construction spoil is managed to reduce the risk of spreading weeds and pathogens into or out of construction sites.

11.3.8 Residual impact – aquatic animals

Banyule Creek at Simpson Barracks is an ephemeral stream, which flows intermittently after rainfall, but is dry for the majority of the time. There are no in-stream permanent pools, and from field assessment of the stream during low rainfall periods, no indication of groundwater supplemented baseflow in these headwaters. The headwaters of Banyule Creek have been modified and include several catch drains and constructed artificial wetlands at Simpson Barracks that are not directly connected to the Banyule Creek. The headwaters of Banyule Creek are ecologically fragmented from downstream reaches by several major road crossings, which prevent the ability for upstream colonisation by aquatic fauna.

North East Link would permanently modify the natural headwater channel of Banyule Creek, and replace this ephemeral stream with constructed drainage channel. This would remove entirely the aquatic ecosystem of the creek. However, the ephemeral nature, lack of connectivity, and poor condition of the aquatic ecosystem of this reach of Banyule Creek would result in little loss of aquatic ecosystem. The impacts of this modification to Banyule Creek could change the hydrology of the creek, with greater runoff from larger areas of impervious surfaces. Changes to hydrology of the creek could impact Banyule Creek downstream of the Barracks, including scouring and the erosion of aquatic habitat. This impact of operation could be mitigated with appropriate WSUD features applied to this modification to the natural drainage.

With adequate management of materials and controls of discharges, spills and runoff from North East Link, its residual impact on aquatic animals in and around Commonwealth land is expected to be minor and non-significant.

12. Facilitated impacts and cumulative impacts

North East Link would involve constructing freeway-grade roads and connections within an area that is already entirely urbanised. Existing roads and intersections that would be part of the action would be upgraded, rather than created on previously undisturbed land. Because the basic plan of the roads is existing, North East Link is not expected to lead to facilitated ecological impacts at either end of the road system, or *en route*.

Cumulative ecological impacts are exceedingly difficult to measure, particularly for an area that has been continually disturbed and urbanised over the past 100+ years. Aerial imagery of the project boundary from 1945, compared with current imagery, suggests that most if not all the ecological features that would be impacted by North East Link have been impacted to a greater degree in the past, and that superficially at least, those impacts can be erased with time and appropriate land management (such as revegetation). Much of the ecological value of the study area has withstood the long-term impacts of urbanisation, or returned to the area following habitat reinstatement. Given the history of disturbance and land clearing across the project boundary, the ecological impacts of North East Link would likely be far less than similar-scale impacts in the past, when ecological systems were more intact. Ecologically, repeated impacts on an urbanised landscape with a history of continual or repeated disturbance and degradation may not have a consequential cumulative effect.

North East Link would include tunnels under the Yarra River and surrounding suburbs. These would be the only tunnels in the project boundary (nearby tunnels include the Burnley/Domain tunnels >10 kilometres south-west, and the Mullum Mullum tunnels >10 kilometres south-east). While changes are predicted to groundwater from the tunnelling, the tunnels are not considered likely to lead to cumulative impacts on groundwater.

13. Summary of avoidance and mitigation measures

This section presents a consolidated list of the avoidance and mitigation measures proposed to address relevant impacts on MNES and Commonwealth land ecology values. These include measures to mitigate impacts specifically on ecology values, as well as other measures to avoid and mitigate construction and operation impacts more generally. Sections 9, 10 and 11 describe the measures in more detail for each relevant impact.

A range of environmental management plans would be developed and implemented for the construction and operation of North East Link. These would support implementation of the measures described in this section. Plans would include Construction Environmental Management Plans (CEMPs) including sub plans for specific issues, Worksite Environmental Management Plans (WEMPs), and an Operation Environmental Management Plan (OEMP).

An independent environmental auditor would review the environmental management plans and proposed management measures prior to construction or operation works that are the subject of the plans commencing. The independent environmental auditor would carry out regular audits of compliance with the environmental management plans.

13.1 Ecology-specific measures

Key measures to mitigate impacts on ecology values would include:

- Design and construction of North East Link as twin tunnels under the Yarra River, Banyule Flats and associated floodplains to avoid surface impacts
- Minimising North East Link's footprint during detailed design to minimise removal of native vegetation and fauna habitat and impacts on habitat connectivity and listed threatened species
- Developing and implementing a Salvage and Translocation Plan (Appendix F) for Matted Flax-lily to minimise impacts on plants/patches within the project boundary
- Developing and implementing a Studley Park Gum Management Framework (Appendix A) and subsequent management plan to offset impacts on Studley Park Gum within the project boundary
- Developing and implementing a Tree Protection Plan for trees to be retained in accordance with AS4970-2009 Protection of Trees on Development Sites
- Design and selection of construction methods for any works on or modifications to waterways or wetlands (including billabongs) to minimise impacts on aquatic habitat values, including those resulting from changes in flows or bank stability
- Developing and implementing detailed measures as part of CEMPs to avoid and mitigate construction impacts including for:
  - Protecting native vegetation and habitat to be retained, including through no-go zones, which would include the Grey headed Flying-Fox Campsite within Yarra Bend Park, Bolin Bolin Billabong, the Plains Grassy Woodland Community between Enterprise Drive and the M80 Ring Road in Bundoora, and surface impacts in the Banyule Flats and Warringal Parklands
  - Pre-clearance surveys for fauna and measures to manage fauna encountered in accordance with Victoria's *Wildlife Act 1975* and *Fisheries Act 1995*

  - Reporting and management of incidental finds of threatened flora and fauna species
  - Measures to avoid the spread or introduction of weeds and pathogens, including vehicle and equipment hygiene
  - Measures to avoid and minimise impacts on riparian, riverbed and aquatic habitat and fauna connectivity
  - Avoiding or minimising intense noise and vibration impacts (such as from pile driving and similar activities) in or near the Yarra River, and if these works are required, to the extent practicable, avoiding carrying these out during critical migration or breeding periods for the Australian Grayling as defined within the National Recovery Plan
  - Protecting fauna habitat values in waterbodies that are modified for drainage purposes, including retaining dead and alive standing trees and to the extent practicable, avoiding works during the typical nesting period for waterbirds (typically September to January)
- Developing and implementing a GDE Monitoring and Mitigation Plan, based on the Studley Park Gum Groundwater Dependent Ecosystem Monitoring and Mitigation Strategy (Appendix H) that includes but isn't limited to:
  - Identification of GDEs predicted to be impacted
  - Details of monitoring for each relevant GDE, incuding specific procedures to monitor groundwater and surface water levels and waulity as relevant
  - Measures to mitigate monitored changes in water levels and quality
  - Measures to maintain the health of large trees predicted to be affected by groundwater drawdown
- Offsetting native vegetation removed in accordance with the DELWP *Guidelines for the removal, destruction or lopping of native vegetation* (2017)
- Tree replacement and landscaping using locally indigenous species (utilising seed collected from species within the project boundary where possible) which are suited to the landscape profile and setting being revegetated, and which maximise habitat value and connectivity, where appropriate for the landscape and location.

13.2 Other measures

Other measures that would be developed and implemented to mitigate impacts, including on ecology values, would include:

- A Dust and Air Quality Management Plan to minimise dust and air quality impacts during construction
- A Ground Movement Plan to manage and mitigate ground movement impacts during construction:
  - Ground movement and groundwater modelling would inform this plan
  - Condition surveys would be carried out for property and infrastructure predicted to be affected by ground movement from North East Link, with repair works or other appropriate action taken to address any damage caused by ground movement due to North East Link
- A Spoil Management Plan to guide storage, handling, transport and disposal of spoil during construction
- A Construction Noise and Vibration Management Plan, including guideline targets, to minimise noise and vibration impacts during construction

- Design of lighting during construction and operation to minimise light spillage into significant fauna habitat
- Design of elevated structures and noise walls to minimise overshadowing and shading impacts
- Measures to minimise impacts on surface water quality and flood-related risks including:
  - A Surface Water Management Plan to set out requirements to protect surface water quality and minimising flood-related risks during construction, which would include requirements for best practice sediment and erosion control and management of wastewater
  - Management of discharges and runoff to meet the State Environment Protection Policy (SEPP) (Waters)
  - Surface water quality monitoring during construction
  - Water sensitive urban and road design in the stormwater treatment design
- A Transport Management Plan including designation of routes for construction haulage and construction vehicles travelling to and from construction sites
- Other measures as part of the CEMPs to:
  - Manage chemicals, fuels and hazardous substances, including incident and emergency response procedures and provision of spill kits on construction sites
  - Minimise and appropriate manage waste in accordance with Victoria's *Environment Protection Act 1970.*

14. References

ABEZCO (2004) Flora, Fauna and Biodiversity Assessment Report: Bolin Bolin Stormwater Harvest Project, Bulleen, A report prepared for Manningham City Council

ACT Parks & Conservation Service (1997) Living with Eastern Grey Kangaroos in the ACT – Public Land, Third Report to the Minister for the Environment, Land & Planning ACT Parks & Conservation Service

AECOM (2015) Simpson Barracks, Kangaroo Monitoring Program 2015. A report for the Department of Defence, prepared by AECOM

AJM JV (2016) Arboriculture Impact Assessment, prepared for Melbourne Metro Rail Authority Available at:

Allen, G R (1989) Freshwater Fishes of Australia, Brookvale, NSW, TFH Publications

Andrews, A P (1991) Observations on the Tasmanian mudfish, Galaxias cleaveri (Pisces: Galaxiidae), Papers and Proceedings of the Royal Society of Tasmania, vol 125, pp 55–59. Retrieved from

Atlas of Living Australia (2018), Available from. Viewed 30 April, 2018

Australian Ecosystems (2007), Ecological assessment of wetlands at the Trinity Grammar School sporting complex, Bulleen, Report prepared for Manningham City Council, August 2007

Backhouse, G, Jackson, J, & O'Connor, J (2008a) National Recovery Plan for the Australian Grayling Prototroctes maraena, Melbourne

Backhouse, G, Lyon, J, & Cant, B (2008b) National Recovery Plan for the Murray Hardyhead Craterocephalus fluviatilis

Bacon, P E, Stone, C, Binns, DL, Leslie, DJ & Edwards, DW (1993) Relationships between water availability and Eucalyptus camaldulensis growth in a riparian forest, Journal of Hydrology, vol 150, pp 541 – 561

Banyule City Council (2018) Banyule Flats Reserve, available at: https://www.banyule.vic.gov.au/Services/Parks-and-Facilities/Banyule-Flats-Reserve

Banyule City Council (2018) https://www.banyule.vic.gov.au/Council/Environment-and-Sustainability/Wildlife?BestBetMatch=native-fauna|6b191bab-c16b-49a3-afee-bee15664f127|414cb327-82b9-4708-a52c-a14d01244ce4|en-AU. Viewed 17 June 2018

Beardsell, C (1997) Sites of Faunal and Habitat Significance in North East Melbourne, Nillumbik Shire Council and the North East Regional Organisation of Councils (NEROC)

Beardsell C M (2003) The Vegetation of Yarra Bend Park, Report prepared for Parks Victoria, pp 75

Beck, R G (1985) Field observations upon the dwarf galaxiid Galaxiella pusilla (Mack) (Pisces:Galaxiidae) in the South-east of South Australia, Australia, South Australian Naturalist, vol 60(1), pp 12–22

Bennetts, K & Jolly, K (2017) Gunbower Forest Tree Assessment 2005 – 2017: A review of demographic and condition data for Red Gum, Black Box and Grey Box populations. Unpublished report for the North Central Catchment Management Authority. Holocene Environmental Science, Mentone East, Victoria.

Berger L, Marantelli G, Skerratt L, Speare R (2005) Virulence of the amphibian chytrid fungus Batrachochytrium dendrobatidis varies with the strain, Dis Aquat Org 68: 47–50

Berra, T M (1982) Life history of the Australian grayling, Prototroctes mareana (Salmoniformes: Prototroctidae) in the Tambo River, Victoria, Copeia, pp 795–805

Bishop, K A, & Bell, J D (1978) Aspects of the biology of the Australian grayling Prototroctes mareana Gunther (Pisces: Prototroctidae), Australian Journal of Marine and Freshwater Research, vol 29, pp 743–761

BoM (2018) Bureau of Meteorology – http://www.bom.gov.au/water/groundwater/gde/

Boulton, AJ, (2005) Chances and challenges in the conservation of groundwaters and their dependent ecosystems, Aquatic Conservation: Marine Freshwater Ecosystem, vol 15, pp 319–323

Bradsworth N, White JG, Isaac B, Cook R (2017) Species distribution models derived from citizen science data predict the fine scale movements of owls in an urbanizing landscape. Biological Conservation vol 213, pp 27–35

Brannelly L. A., R. J. Webb, D. A. Hunter, N. Clemann, K. Howard, L. F. Skerratt, L. Berger & B. C. Scheele. 2018. Non-declining amphibians can be important reservoir hosts for amphibian chytrid fungus. Animal Conservation 21: 91–101. https://zslpublications.onlinelibrary.wiley.com/doi/full/10.1111/acv.12380

Bray, D J (2016) Eastern Dwarf Galaxias, Galaxias pusilla (Mack 1936), Retrieved October 19, 2016, from http://fishesofaustralia.net.au/home/species/3393

Bray, D J, & Thompson, V (2011) Murray Hardyhead, Craterocephalus fluviatilis McCulloch 1912, Retrieved from http://fishesofaustralia.net.au/home/species/1384

Bray, D J, & Thompson, V J (2018a) Macquarie Perch, Macquaria australasica, Retrieved July 1, 2018, from http://fishesofaustralia.net.au/home/species/1594

Bray, D J, & Thompson, V J (2018b) Murray Cod, Maccullochella peelii. Retrieved July 2, 2018, from http://fishesofaustralia.net.au/home/species/4655

Bray, D J, & Thompson, V J (2018c) Yarra Pygmy Perch, Retrieved July 2, 2018, from http://fishesofaustralia.net.au/home/species/4459

Brown, R (2003) Banyule Wildlife Corridor Program, Banyule City Council, Greensborough, Victoria

Bunn, SE, Davies, PM, Kellaway, DM, Prosser, I P (1998) Influence of invasive macrophytes on channel morphology and hydrology in an open tropical lowland stream, and potential control by riparian shading, Freshwater Biology, vol 30, pp 171–178

Bush Heritage Australia (2017) Land clearing, (Online). Last viewed 31 May 2018, Available at: https://www.bushheritage.org.au/who-we-are/about/our-challenge/land-clearing

Cadwallader, P L, & Backhouse, G N (1983) A Guide to Freshwater Fish of Victoria, Melbourne Vic, Australia: Victorian Government Printing Office, on behalf of the Fisheries and Wildlife Division, Ministry for Conservation

Cadwallader, P L, & Eden, A K (1979) Observations of the food of the Macquarie Perch Macquaria australasica (Pisces: Percichthyidae), in Victoria, Australian Journal of Marine and Freshwater Research, vol 30, pp 401–409

Cameron, D., Rule, K. and Robinson, R. (1999). Reassessment of botanical values on Streeton Views Estate Stage 11 Yallambie with particular reference to the significance of the natural hybrid Eucalyptus Xstudleyensis Studley Park Gum and the endangered species Dianella amoena Matted Flax-Lily. Report for Banyule City Council.

Canham, C A, Froend, R H, Stock, W D, and Davies, M (2012) Dynamics of phreatophyte root growth relative to a seasonally fluctuating water table in a Mediterranean-type environment, Oecologia, vol 170, pp 909–916

Carbon, B A, Bartle, G A, Murray, A M, Macpherson, D K (1980) The distribution of root length, and the limits to flow of soil-water to roots in a dry sclerophyll forest. Forest Science, vol 26, pp 656–664

Carr, G W & Horsfall, P F (1995) Studies in the Phormiaceae (liliaceae) 1: New Species and combinations in Dianella Lam. Ex. Juss, in Muelleria 8; (3):365–378. Carter, O (2010) National Recovery Plan for the Matted Flax-lily Dianella amoena, East Melbourne, Department of Sustainability and Environment

Carter, O, & Sutter, G (2010) National Recovery Plan for the Clover Glycine, Melbourne, Victorian Government Department of Sustainability and Environment.

Chessman, B C (1988) Habitat Preferences of Fresh-Water Turtles in the Murray Valley, Victoria and New-South-Wales, Wildlife Research, vol 15, pp 485–491

Chessman, B C (1995) Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification, and a biotic index, Australian Journal of Ecology vol 20, pp 122–129

Chessman, B C (2003) New sensitivity grades for Australian river macroinvertebrates, Marine and Freshwater Research, vol 54, pp 96–103

Churchill, S (2008) Australian Bats, 2nd Ed, Jacana Books, Allen and Unwin

City of Melbourne (2018) Tree protection fact sheet, City of Melbourne, Available at: http://www.melbourne.vic.gov.au/community/parks-open-spaces/tree-protection-management/Pages/tree-protection.aspx

Clunie, P, & Koehn, J D (2001) Freshwater Catfish: A Recovery Plan (Final repo), Heidelberg, Victoria, Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, https://doi.org/10.13140/RG.2.1.4824.8407

COAG Standing Council on Environment and Water (2012), Australia's Native Vegetation Framework, Australian Government, Department of Sustainability, Environment, Water, Population and Communities, Canberra

Coleman, R A, Raadik, T A, Pettigrove, V, & Hoffmann, A A (2016) Taking advantage of adaptations when managing threatened species within variable environments: the case of the dwarf galaxias, Galaxiella pusilla (Teleostei, Galaxiidae), Marine and Freshwater Research – Http://Dx.Doi.Org/10.1071/MF15332

Colvin, C, D Le Maitre, S Hughes, & CSIR Environmental (2003) *Assessing terrestrial groundwater dependent ecosystems in South Africa,* WRC Report 1090–2/2/03

Commonwealth of Australia (2013) Survey Guidelines for Australia's Threatened Orchids: Guidelines for detecting orchids listed as 'threatened' under the Environment Protection and Biodiversity Conservation Act 1999, Australian Government, Canberra.

Commonwealth of Australia (2017) EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species. Australian Government, Canberra.

Context (2014) Warringal Parklands & Banyule Flats, Cultural Heritage Assessment, available at: https://www.banyule.vic.gov.au/files/945a4dd0-bb3e-4f5d-9dba-a3da00c1548a/Banyule-Flats-Warringal-Parklands-Heritage-Assessment-20140223.pdf

Cooke, R, R Wallis and J White (2002) Use of vegetative structure by Powerful Owls in outer urban Melbourne, Victoria, Australia – implications for management. J. Raptor Res. 36(4):294–299.

Corben, C., G. Roberts & A. Smyth (1982). Roosting of a White-throated Needletail. Sunbird. 12:47–48.

Council of Australian Standards (2009) The Australian Standard for the protection of trees on development sites 4970–2009, Published by Standards Australia

Cox, K.D, LP. Brennan, SE. Dudas, and F Juanes (2016) Assessing the effect of aquatic noise on fish behaviour and physiology: a meta-analysis approach. Proc. Mtgs. Acoust. **27**, 010024 doi: 10.1121/2.0000291

Davies, N (1953) Investigations on the Soil and Water Relations of the River Red Gum Forests, Final Report by Murray Management Survey, Resources Branch Report No. R. 124

Day, N. (1993). Tree perching and presumed roosting of White-throated Needletails Hirundapus caudacutus. Australian Bird Watcher. 15:43–44.

Dell, B, Bartle, J R, Tacey, W H (1983) Root Occupation and Root Channels of Jarrah Forest Subsoils, In Australian Journal of Botany 31(6) 615 – 627

DELWP (2015) Action Statement No 257 Australian Grayling Prototroctes maraena FFG Act 1988, State Government of Victoria

DELWP (2016a) Procedure statement for translocating of threatened native fauna in Victoria, Victorian Department of Environment, Land, Water and Planning, Melbourne, April 2016

DELWP (2016b) Flora and Fauna Guarantee Act 1988, Processes List – December 2016, Victorian Department of Environment, Land, Water and Planning, Melbourne, Available at: https://www.environment.vic.gov.au/__data/assets/pdf_file/0012/50241/201612-FFG-Processes-list.pdf

DELWP (2017a) Guidelines for the removal, destruction or lopping of native vegetation. Victorian Department of Environment, Land, Water and Planning, Melbourne, December 2017

DELWP (2017b) Exemptions from requiring a planning permit to remove, destroy or lop native vegetation: Guidance. Victorian Department of Environment, Land, Water and Planning, Melbourne.

DELWP (2017c) Translocation of non-threatened native wildlife (Online). Available at: https://www.wildlife.vic.gov.au/managing-wildlife/translocation-of-wildlife [Viewed 26 April 2018]

DELWP (2017d) Flora and Fauna Guarantee Act 1988 Threatened List – March 2017. Updated to include the most recent amendments contained in the Victorian Government Gazette published on 9 March 2017. Victorian Department of Environment, Land, Water and Planning, Melbourne. Available at: https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species-advisory-lists

DELWP (2017e) Flora and Fauna Guarantee Act 1988 Protected Flora List – June 2017. Updated to include the most recent amendments contained in the Victorian Government Gazette published on 9 March 2017. Victorian Department of Environment, Land, Water and Planning, Melbourne. Available at: https://www.environment.vic.gov.au/__data/assets/pdf_file/0011/50420/201706-FFG-protected-flora-list.pdf

DELWP (2017f) Protecting Victoria's Environment – Biodiversity 2037. Victorian Department of Environment, Land, Water and Planning, Melbourne. Available at: https://www.environment.vic.gov.au/__data/assets/pdf_file/0022/51259/Protecting-Victorias-Environment-Biodiversity-2037.pdf

DELWP (2018a) Potential Groundwater Dependent Ecosystem (GDE) Mapping for the Port Phillip and Westernport CMA. Department of Environment, Land, Water and Planning. Retrieved from https://www.data.vic.gov.au/data/dataset/potential-groundwater-dependent-ecosystem-gde-mapping-for-the-port-phillip-and-westernport-cma

DELWP (2018b) Draft State Environment Protection Policy (Waters) – Released for comment

DELWP (2018c) Victoria's flying fox colonies. Victorian Department of Environment, Land, Water and Planning, Melbourne. Available at: https://www.wildlife.vic.gov.au/our-wildlife/flying-foxes/victorias-flying-fox-colonies

DEPI (2013a) Advisory List of Threatened Vertebrate Fauna in Victoria – 2013, Victorian Government Department of Environment and Primary Industries, Melbourne

DEPI (2013b) Permitted clearing of native vegetation – Biodiversity assessment guidelines, Department of Environment and Primary Industries, September 2013

DEPI (2013c) Index of Wetland Condition Assessment Procedure, Victorian Government Department of Environment and Primary Industries, Melbourne, September 2013

DEPI (2014) Advisory List of Rare or Threatened Plants in Victoria – 2014, Victorian Government Department of Environment and Primary Industries, Melbourne

DEWHA (2010) Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies. Significant impact guidelines 1.2. Commonwealth of Australia, Canberra. Available at: http://www.environment.gov.au/system/files/resources/a0af2153-29dc-453c-8f04-3de35bca5264/files/commonwealth-guidelines_1.pdf [Viewed 30 May 2018]

DEWHA (2010b) *Survey Guidelines for Australia's Threatened Frogs. EPBC Act survey guidelines 6.3* (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2010)

Dexter, B D (1967) Flooding and regeneration of river red gum, Eucalyptus camaldulensis, Melbourne, Forests Commission, Victoria

DNRE (2000) Directory of Important Wetlands, Directory of Important Wetlands in Australia – Information Sheet, Yarra River – VIC156, Department of Natural Resources and Environment, Canberra. Accessed 11/07/18. Available from http://environment.gov.au/cgi-bin/wetlands/report.pl

DoE (2013a) Matters of National Environmental Significance: Significant impact guidelines 1.1., Environment Protection and Biodiversity Conservation Act 1999. Department of Environment, Australian Government. Available at: https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf

DoE (2014) National Flying-fox Monitoring Viewer, Commonwealth Department of the Environment. Available at: http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf

DoE (2015) Referral guideline for management actions in grey-headed and spectacled flying-fox camps, EPBC Act Policy Statement, Department of the Environment, Australian Government

DoE (2016a). Outcomes-based conditions policy. Department of Environment, Commonwealth of Australia, March 2016.

DoE (2016b). Outcomes-based conditions guidance Department of Environment, Commonwealth of Australia, March 2016.

DoE (2018) National Recovery Plan for the Macquarie Perch (Macquaria australasica). Canberra: Commonwealth of Australia. Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/macquaria-australasica-2018.

DoE (2018a) Nannoperca obscura — Yarra Pygmy Perch. Department of the Environment, Australian Government. Retrieved July 2, 2018, from http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=26177

DoE (2018b) Species Profile and Threats Database Murray Cod – Maccullochella peelii. Department of the Environment, Australian Government. Retrieved July 2, 2018, from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66633

DoE (2018c) Species Profile and Threats Database Australian Grayling – Prototroctes maraena. Department of the Environment, Australian Government. Retrieved June 30, 2018, from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26179

DoE (2018d) Species Profile and Threats Database Galaxiella pusilla — Eastern Dwarf Galaxias, Dwarf Galaxias. Department of the Environment, Australian Government. Retrieved July 2, 2018, from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=56790

DoE (2018e) Species Profile and Threats Database Macquaria australasica – Macquarie Perch. Department of the Environment, Australian Government Retrieved July 1, 2018, from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66632

DoE (2018f). Hirundapus caudacutus in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoEE (2017a) Frequently asked questions – key threatening processes Australian Government Department of the Environment and Energy, Canberra. Available at http://www.environment.gov.au/system/files/pages/10a10e3d-e677-4c5a-ba9a-00bfd70d8db2/files/faq-ktp-tap.pdf [Viewed 26 April 2018]

DoEE (2017b) EPBC Act Listed Key Threatening Processes, Australian Government Department of the Environment and Energy, Canberra, Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl [Viewed 26 April 2018]

DoEE (2017c) 'Draft National Recovery Plan for Macquarie Perch (Macquaria australasica), Commonwealth of Australia 2017'

DoEE (2017d) 'Draft National Recovery Plan for the Grey-headed Flying-fox (Pteropus poliocephalus), Commonwealth of Australia 2017'. Available from: http://www.environment.gov.au/system/files/resources/78d5e396-7475-4fc0-8a64-48c86a1cb2b6/files/draft-recovery-plan-grey-headed-flying-fox.pdf

DoEEH (2001) A Directory of Important Wetlands in Australia 3rd Ed. Department of the Environment and Energy and Heritage, Canberra

DoEW (2017) Soil Protection from erosion, Department of Environment and Water, retrieved 30 May 2018, < https://www.environment.sa.gov.au/Knowledge_Bank/Science_research/land-condition-sustainable-management/soil-protection-from-erosion>

DoNRE (2002) Victoria's Native Vegetation Management – A framework for action, Victoria Department of Natural Resources & Environment, Melbourne

DoPI (2012) Risk assessment guidelines for groundwater dependant ecosystems, New South Wales, Department of Primary Industries

DoPI (2003) The Nut State Reserve Management Plan 2003, Department of Primary Industries, Tasmania, Retrieved October 25, 2017, from http://www.parks.tas.gov.au/publications/tech/the_nut/the_nut.pdf

DoTMR (2010) Fauna Sensitive Road Design Manual, Department of Transport and Main Roads, vol 2: Preferred Practices, Chapter 6, Queensland (Online), Available at: https://www.tmr.qld.gov.au/-/media/busind/techstdpubs/Environment-management/Fauna-Sensitive-Road-Design-Volume-2/Chapter6.pdf?la=en

Docker, B B, Hubble, TCT (2009) Modelling the distribution of enhanced soil shear strength beneath riparian trees of south-eastern Australia, Ecological Engineering, vol **35**, pp 921–934

Doody, T M, Barron, OV, Dowsley, K, Emelyanova, I Fawcett, J, Overton, IC, Pritchard, J L, Van Dijk, A I J M & Warren, G (2017) Continental mapping of groundwater dependent ecosystems: A methodological framework to integrate diverse data and expert opinion, Journal of Hydrology: Regional Studies, vol **10**, pp 61–81

Dowling, H M (2010) Sedimentation affecting wetland soils and vegetation within the Dog River watershed, Department of Earth Sciences, University of South Alabama, Available at: http://www.usouthal.edu/geography/fearn/480page/2010/10Dowling.pdf

DPI (2003) Tasmanian Department of Primary Industries, Water and Environment (Tas DPI) (2003). Threatened Flora of Tasmania: Glycine latrobeana. Available from: http://www.dpiw.tas.gov.au/inter.nsf/Attachments/LJEM-7532XG/$FILE/Glycine%20latrobeana.pdf.

DPI (2012) Groundwater Dependent ecosystems section – mapping, Section 9.6

DPI (2015) Australian Grayling – Prototroctes maraena

Dresel, P E, Clark, R Cheng, X, Fawcett, J, and Cochraine, D (2010) Mapping Terrestrial Groundwater Dependent Ecosystems: Method Development and Example output. Department of Primary Industries, Victoria

DSE (2003) Flora and Fauna Guarantee Action Statement No 115: Australian Mudfish neocchanna cleaver. State of Victoria

DSE (2004) Vegetation Quality Assessment Manual–Guidelines for applying the habitat hectares scoring method, Version 1.3, Department Sustainability and Environment, Victoria

DSE (2005a) Melbourne: Flying-Fox Campsite Management Plan – Yarra Bend Park, Department of Sustainability and Environment, Victoria. Retrieved from https://www.wildlife.vic.gov.au/__data/assets/pdf_file/0031/27679/Flying_Fox_Management_Plan.pdf

DSE (2005b) Clover Glycine Gylcine latrobeana; a Nationally Threatened species of the Grassland and Grassy Woodland Communities, Department of Sustainability and Environment, Victoria. Retrieved Oct 30, 2017, from https://victorianvolcanicplainscmn.files.wordpress.com/2014/03/glycine_latrobeana.pdf

DSE (2005c) Action Statement FFG Act – Freshwater Catfish Tandanus tandanus. East Melbourne, VIC, Australia

DSE (2008) Victoria's public land Phytophthora cinnamomi management strategy. Department of Sustainability and Environment, Victoria. Retrieved from: http://lakeshub.com/wp-content/uploads/2013/04/Phytophthora_cinnamomi_Strategy-1.pdf

DSE (2009a) Advisory List of Threatened Invertebrate Fauna in Victoria – 2009, Victorian Government Department of Sustainability and Environment, Melbourne

DSE (2009b) Yarra Bend Park Flying-fox Campsite: Review of Scientific Research, Victorian Department of Sustainability and Environment

DSEWPaC (2011) Nationally threatened ecological communities of the Victorian Volcanic Plain: Natural Temperate Grassland and Grassy Eucalypt Woodland. Available at: http://www.environment.gov.au/system/files/resources/e97c2d51-08f2-45e0-9d2f-f0d277c836fa/files/grasslands-victoria.pdf

DSEWPAC (2011) Survey guidelines for Australia's threatened fish – Guidelines for detecting fish listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 Commonwealth of Australia

DSEWPaC (2012). Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPAC (2013) EPBC Act Policy Statement Translocation of Listed Threatened Species. Department of Environment and Energy, Australian Government. Available at http://www.environment.gov.au/resource/epbc-act-policy-statement-translocation-listed-threatened-species-assessment-under-chapter

DSEWPaC (2013a) Matters of National Environmental Significance: Significant impact guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999, Department of Environment, Australian Government. Available at: https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf

DSEWPAC (2013b) Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies: Significant impact guidelines 1.2., Environment Protection and Biodiversity Conservation Act 1999. Australian Government. Available at: http://www.environment.gov.au/system/files/resources/a0af2153-29dc-453c-8f04-3de35bca5264/files/commonwealth-guidelines_1.pdf

Eamus, D (2009) Identifying groundwater dependent ecosystems: a guide for land and water managers. Research Report. Published by Australian Government, Land and Water Australia, ACT

Eamus, D & Froend, R H (2006) Groundwater dependent ecosystems: the where, what and why of GDEs, Australian Journal of Botany, vol **54**, pp 91–96

Eamus, D, R Froend, R Loomes, G Hose and B Murray (2006a) A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation, Australian Journal of Botany vol **54**, pp 97–114

Eamus, D, Hatton, T, Cook, P, & Colvin, C (2006b) Ecohydrology – Vegetation function, water and resource management (p. 348). Collingwood, VIC: CSIRO Publishing, Australia

Eamus, D, Zolfaghar, S, Villalobos-Vega, R, Cleverly, J & Huete, A (2015) Groundwater-dependent ecosystems: recent insights form satellite and field-based studies, Hydrological Earth Systems Science, vol **19**, pp 4229–4256

Ecology Australia (2014) Sugarloaf Pipeline Matted Flax-lily (Dianella amoena) Translocation Monitoring: Spring 2014. Report prepared for Melbourne Water Corporation by Ecology Australia Pty Ltd, Fairfield

Ecosure (2011) Eastern Golf Club Development Planning Report: Aquatic Values Impact Assessment. Report prepared for Robert Luxmoore Project Management

Environment Australia (2001) A Directory of Important Wetlands in Australia, Third Edition. Environment Australia, Canberra

EPA Victoria (2000) Environmental health of streams in the Yarra River catchment. Publication 682, February 2000

EPA Victoria (2003) Guideline for Environmental Management: Rapid bioassessment methodology for rivers and streams, EPA Victoria, Melbourne, Australia (EPA publication 604)

EPA Victoria (2010) Environmental Quality Guidelines for Victorian Lakes (Publication 1302)

European Union Institute for Environment and Sustainability (EU-IES) (2014) Managing nitrogen and phosphorus loads to water bodies, Characterisation and solutions towards macro-regional integrated nutrient management: under enlargement and integration action – Study, retrieved 31 May 2018 <https://publications.europa.eu/en/publication-detail/-/publication/9fd02693-103f-4c0e-9496-1464d1feb2e4>

Ewen, A and Stephens, A (2017) Warringal Parklands and Banyule Flats Ecological and Conservation Values Assessment. Report prepared for Banyule City Council by Practical Ecology, Preston VIC

Feikema & Baker (2011) Effect of soil salinity on growth of irrigated plantation Eucalyptus in south-eastern Australia, Agricultural Water Management 98(7): 1180–1188

Fewtrell,J.L & R.D. McCauley (2012) Impact of airgun noise on the behaviour of marine fish and squid Marine Pollution Bulletin 64: 984–993

FFG (2000) Flora and Fauna Guarantee, Scientific Advising Committee; Final recommendation on a nomination for listing: Victorian temperate-woodland bird community, 5 Sept and 7 Dec 2000; File No: FF/54/0088

FHA (2004) Synthesis of Noise Effects on Wildlife Populations. Publication No. FHWA-HEP-06-016 September 2004; available at: https://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/

Fleming (2003) Warringal Conservation Society at Banyule Flats, Unpublished Report

Flora of Victoria (2018) Eucalyptus camaldulensis, River Red-gum, Available at: https://vicflora.rbg.vic.gov.au/flora/taxon/b81ef7c6-89a0-45d7-9b2b-cebb16c7033a [Accessed 30 April 2018]

Foreman, P, Meagher, D, Yen, A, and Wainer, J (2004) Sites of (biological) significance review, Report prepared for Manningham City Council, November 2004

Froend, R and Sommer, B (2010) Phreatophytic vegetation response to climatic and abstraction-induced groundwater drawdown: Examples of long-term spatial and temporal variability in community response. Centre for Ecosystem Management, Edith Cowan University, 270 Joondalup Drv, Joondalup 6027, WA, Australia Ecological Engineering, vol **36**, pp 1191–1200

Frood, D & Papas, P (2016) A guide to water regime, salinity ranges and bioregional conservation status of Victorian wetland Ecological Vegetation Classes, Arthur Rylah Institute for Environmental Research. Technical Report Series No. 266. Department of Environment, Land, Water and Planning, Heidelberg, Victoria

Furlan, E, Griffiths, J, Gust, N, Armisteaed, R, Mitrovski, P, Handasyde, K. A., … Weeks, A. R. (2011) Is body size variation in the platypus, Ornithorhynchus anatinus, associated with environmental variables ? Is body size variation in the platypus (Ornithorhynchus anatinus) associated with environmental variables ? Australian Journal of Zoology, vol **59**, pp 210–215, https://doi.org/10.1071/ZO11056

Geosciences Australia (2018) Groundwater Dependent Ecosystems, Australian Government Geosciences Australia, Available from: http://www.ga.gov.au/scientific-topics/water/groundwater/understanding-groundwater-resources/groundwater-dependant-ecosystems [Accessed 30 April 2018]

Ghermandi, A, Vandenberghe, A, Bendetti, L, Bauwens, W & Vanrolleghem, P A (2009) Model-based assessment of shading effect by riparian vegetation on river water quality. Ecological Engineering vol **1,** pp 92–104

GHD (2011) Report on Base Security Improvement Program – Base Infrastructure Works Project, A report for the Department of Defence

GHD (2011) Report for North East Link, Desktop Ecological Assessment of Alignment Options. A report by GHD to VicRoads

GHD (2015) Simpson Barracks Watsonia Offset Plan. A report for the Department of Defence

Gomon, M F, & Bray, D J (2011) Australian Grayling, Prototroctes maraena. Retrieved from http://www.fishesofaustralia.net.au/home/species/3634

Gomon, M F, & Bray, D J (2018a) Freshwater Catfish Tandanus tandanus. Retrieved July 2, 2018, from http://fishesofaustralia.net.au/home/species/2769

Gomon, M F, & Bray, D J (2018b) Tasmanian Mudfish Neochanna cleaveri. Retrieved July 2, 2018, from http://fishesofaustralia.net.au/home/species/4311

Grant, T R, & Temple-Smith, P D (1998) Field biology of the platypus (Ornithorhynchus anatinus): historical and current perspectives. Philosophical Transactions of the Royal Society London, vol **353**, pp 1081–1091

Groom, B P, Froend, R H, and Mattiske, E M (2000) Impact of groundwater abstraction on Banksia woodland, Swan Coastal Plain, Western Australia, Ecological Management and Restoration, vol **1**, pp 117–124

Halse, S A, Ruprecht, J K, Pinder, A M (2003) Salinisation and prospects for biodiversity in rivers and wetlands of south-west Western Australia, Australian Journal of Botany, vol **51**, pp 673–688

Harrington, N and Cook, P, (2014) Groundwater in Australia, National Centre for Groundwater Research and Training, Australia

Hatton T J and Evans R (1998) Dependence of Ecosystems on Groundwater and its Significance to Australia. Sinclair Knight Merz, Armadale and CSIRO Division of Land and Water, ACT

Herman, K (2016) Biodiversity Monitoring in Melbourne's East – Bird Component. Technical report prepared for The Eastern Alliance for Greenhouse Action. BirdLife Australia

Higgins, PJ (1999) Handbook of Australian, New Zealand and Antarctic Birds (HANZAB). Vol 4: Parrots to Dollarbird. Oxford University Press

HLA-Envirosciences PTY Ltd (2007) Biodiversity Assessments and Strategies for Simpson Barracks (Section 7 of Biodiversity Assessments and Strategies for Dutson Range, HMAS CERBERUS, West Head Gunnery, Monegeetta Proving Ground, RAAF Base East Sale, Simpson Barracks and Swan Island Report). Department of Defence. Prepared for: Spotless P&F Pty Ltd

Holloway, D Biggs, A., Marshall, J C and McGregor, G B (2013) Watering requirements of floodplain vegetation asset species of the Lower Balonne River Floodplain: Review of scientific understanding and identification of knowledge gaps for asset species of the northern Murray−Darling Basin. Department of Science, Information Technology, Innovation and the Arts, Brisbane

Horner, GJ, Baker, PJ, Mac Nally, R, Cunningham, SC, Thomson, JR and Hamilton, F (2009) Mortality of developing floodplain forests subjected to a drying climate and water extraction, Global Change Biology**,** vol **15**, pp 2176–2186

Hubble, T C T, Docker, B B & Rutherfurd, I D (2010) The role of riparian trees in maintaining riverbank stability: A review of Australia experience and practice, Ecological Engineering, vol **36**, pp 292 – 304

Humphries, P (2005) Spawning time and early life history of Murray cod, Maccullochella peelii peelii (Mitchell) in an Australian river. Environmental Biology of Fishes, vol **72**, pp 393–407, https://doi.org/10.1007/s10641-004-2596-z

Ingram, B A, Barlow, C G, Burchmore, J J, Gooley, G J, Rowland, S J, & Sanger, A C (1990) Threatened native freshwater fishes in Australia – some case histories. Journal of Fish Biology, 37(Supplement A), pp 175–182

Jackson, S.D. (1996) Underpass systems for amphibians. In G.L.Evink, P. Garret, D. Zeigler, & J.Berry (Eds), Trends in addressing transportation related wildlife mortality, proceedings of the transportation related wildlife mortality seminar. Department of Transportation. Tallahassee, FL.

Jackson, P D, & Keohn, J D (1988) A review of biological information, distribution and status of the Australian grayling (Prototroctes maraena) Gunther in Victoria, Melbourne

Jacobs Group (Australia) Pty Limited (2016) Simpson Barracks Flora and Fauna Monitoring Program 2016 – 2021

Jacobs Group (Australia) Pty Ltd (2017) Bolin Bolin Billabong Conceptual Model. Produced for Melbourne Water

James, G, Whittaker, K & Francis, R (2014) Flora, Fauna and Biodiversity Assessment Report: Bolin Bolin Stormwater Harvest Project, Bulleen. Report prepared by ABZECO for Manningham City Council, November 2014

Jones MJ, Baumgartner LJ, Zampatti BP, Beyer K. Low light inhibits native fish movement through a vertical-slot fishway: Implications for engineering design. Fish Manag Ecol. 2017;24:177–185.

Kaseloo PA (2005) Synthesis of noise effects on wildlife populations. IN: Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp 33–35

Kashem, M D & Singh, B R (1998) Heavy metal contamination of soil and vegetation in the vicinity of industries in Bangladesh, Water, Air, and Soil Pollution, vol **115**, pp 347–361

Kath, J, Reardon-Smith, K, Le Brocque, A F, Dyer, F J, Dafny, E, Fritz, L & Batterham, M. (2014) Groundwater decline and tree change in floodplain landscapes: Identifying non-linear threshold responses in canopy condition, Global Ecology and Conservation, vol **2**, pp 148–160

Kennard, M J (2005) A quantitative basis for the use of fish as indicators of river health in eastern Australia

Knight, A, Blott, K, Portelli, M & Hignett, C (2002) Use of tree and shrub belts to control leakage in three dryland cropping environments, Australian Journal of Agricultural Research, vol **53**, pp 571 – 586

Koehn, J D, McKenzie, J A, O'Mahony, D J, Nicol, S J, O'Connor, J P, & O'Connor, W G (2009) Movements of Murray cod (Maccullochella peelii peelii) in a large Australian lowland river. Ecology of Freshwater Fish, vol **18**, pp 594–602. https://doi.org/10.1111/j.1600-0633.2009.00375.x

Koehn, J D, & Nicol, S J (2014) Comparative habitat use by large riverine fishes. Marine and Freshwater Research, vol **65**, pp 194–174

Koehn, J D, & Raadik, T A (1991) The Tasmanian Mudfish, Galaxias ceaveri Scott, 1934, in Victoria. Proceedings of the Royal Society of Victoria, vol 103(2), pp 77–86

Koster, W M, Amtstaetter, F, Dawson, D R, Reich, P, & Morrongiello, J R (2017) Provision of environmental flows promotes spawning of a nationally threatened diadromous fish. Marine and Freshwater Research, vol **68**, pp 159–166. https://doi.org/10.1071/MF15398

Koster, W M, Dawson, D R, & Crook, D A (2013) Downstream spawning migration by the amphidromous Australian grayling (Prototroctes maraena) in a coastal river in south-eastern Australia. Marine and Freshwater Research, vol 64(1), pp 31–41. https://doi.org/10.1071/MF12196

Koster, W M, Dawson, J R, Morrongiello, J R, & Crook, D A (2013) Spawning season movements of Macquarie perch (Macquaria australasica) in the Yarra River, Victoria. Australian Journal of Ecology, vol **61**, pp 386–394

Kuginis, L, Byrne, G, Serov, P & Williams, J P (2012) Risk assessment guidelines for groundwater dependent ecosystems: Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value. Office of Water Department of Primary Industries, Sydney

Krupa, S V (2003) Effects of atmospheric ammonia (NH3) on terrestrial vegetation: a review, Environmental Pollution, vol **124**, pp 179–221

Kuginis, L, Byrne, G, Serov, P & Williams, J P (2012) Risk assessment guidelines for groundwater dependent ecosystems: Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value. Office of Water Department of Primary Industries, Sydney

Kuiter, R H (2013) Pictorial Guide to Victoria's Freshwater Fishes. Seaford, VIC, Australia: Aquatic Photographics

Kuperman, W.A., and Ingenito, F. 1998. Attenuation of the coherent component of sound propagating in shallow water with rough boundaries. J. Acoust. Soc.Am. 61(5): 1178–1187. doi:10.1121/1.381417.

Laclau, JP, da Silva EA, Lambais GR, Bernoux M, le Maire G, Stape JL, Bouillet JP, de Moraes Gonçalves JP, Jourdan C & Nouvellon Y (2013) Dynamics of soil exploration by fine roots down to a depth of 10 m throughout the entire rotation in Eucalyptus grandis plantations. Frontiers in Plant Science, vol **4**, pp 243

Landform-Australia (1986) Willsmere Park Conservation Study. Prepared for Kew City Council by Landform Australia Pty Ltd, Melbourne

Le Maitre and Versfeld, (1997) Forest evaporation models: relationships between stand growth and evaporation, Journal of Hydrology, vol **193,** pp 240 – 257

Leahy, Tibby, Kershaw, Heijnis Kershaw (2005) The impact of European settlement on Bolin Bolin Billabong, A Yarra River floodplain Lake, Melbourne Australia. River Research and Applications, vol **21,** pp 131–149

Liang, L, Luo, X, Sun, Q, Rui, S, Jialing, L, Jingmin, L, Lin, H (2016) Diagnosis the Dust Stress of Wheat Leaves with Hyperspectral Indices and Random Forest Algorithm, Geoscience and Remote Sensing Symposium (IGARSS), 2016 IEEE International, Bejing

Lieschke, J, Grgat, L and Zampatti, B (2000) An Assessment of Environmental Flow Requirements for the Plenty River Catchment. Natural Resources and Environment, Freshwater Ecology, Flora and Fauna

Lintermans, M (2007) Fishes of the Murray-Darling Basin – An Introductory Guide. Canberra ACT, Australia: Murray-darling Basin Authority

Lips, K R, F Brem, R Brenes, J D Reeve, R A Alford, J Voyles, C Carey, A Pessier, L Livo, J P Collins, (2006) Infectious disease and global biodiversity loss: pathogens and enigmatic amphibian extinctions. Proceedings of the National Academy of Science 103(9): 3165–3170

Lorimer, GS (2006) Inventory and assessment of indigenous flora and fauna in Boroondara (1st ed). Prepared for the City of Boroondara, February 2006

Lorimer, G S, Baker, S, & Lockwood, D (2009) Wildlife movement and habitat needs in Manningham. Manningham City Council, Melbourne June 2009

Maiden, J H (1922) A critical revision of the genus Eucalyptus. vol 6. Parts 51–60. University of Sydney Library, Sydney

Manningham City Council (n.d). Billabong Song, Bolin Bolin Billabong Walk, available at: www.victoriawalks.org.au/Assets/Files/15%20-%20Billabong%20song.pdf

Manningham City Council (2011) The Koonung Creek Linear Park Management Plan, Available at: https://www.manningham.vic.gov.au/file/4536/download

Manningham City Council (2012) Healthy Habitats: Bushland Management Strategy for Council Managed Land, Manningham City Council, August 2012

Martin, E H, Walsh, C J, Serena, M, & Webb, A J (2014) Urban stormwater runoff limits distribution of platypus. Austral Ecology, vol **39**, pp 337–345. https://doi.org/10.1111/aec.12083

Marchant S and P J Higgins (1993) Handbook of Australian, New Zealand and Antarctic Birds; Volume 2 – Raptors to Lapwings. Oxford University Press, Melbourne.

McCauley R D, J Fewtrell, A J Duncan, C Jenner, M-N Jenner, J D Penrose, R I T Prince, A Adhitya, J Murdoch and K McCabe (2000) Marine seismic surveys – A study of environmental implications APPEA Journal 692

McDonald, K, D Mendez, R Muller, A Freeman, and R Speare (2005) Decline in the prevalence of chytridiomycosis in frog populations in North Queensland, Australia. Pacific Conservation Biology 11:114–120

McDowell, R M (1996) Freshwater Fishes of South-Eastern Australia. Sydney: Reed Books

Melbourne Water (2007) Port Phillip and Westernport Regional River Health Strategy. East Melbourne

Melbourne Water (2009) Know Your River – Maribyrnong River. Retrieved from melbournewater.com.au

Melbourne Water (2012) Healthy Waterways Strategy Executive summary (October)

Melbourne Water (2007) Plenty river Water Supply Protection Area Streamflow Management Plan 2007. Melbourne Water, Docklands, VIC

Melbourne Water (2013) Healthy Waterways Strategy – A Melbourne Water strategy for Managing Rivers, Estuaries and Wetlands. Docklands, VIC

Melbourne Water (2018) Healthy Waterways Strategy – Yarra Catchment Preliminary Targets

Mickle, M.F. & D.M. Higgs (2016) Integrating techniques: a review of the effects of anthropogenic noise on freshwater fish. Can.J. Fish. Aq. Sc. https://doi.org/10.1139/cjfas-2017-0245

Mikola, J, Barker, G M & Wardle, D A (2000) Linking Above-Ground and Below-Ground Effects in Autotrophic Microcosms: Effects of Shading and Defoliation on Plant and Soil Properties, Oikos, vol **89**:3. pp 577–587

Müllerová, J, Vítková, M, Vítek, O, (2011) The impacts of road and walking trails upon adjacent vegetation: Effects of road building materials on species composition in a nutrient poor environment, Science of the Total Environment, vol **409**, pp 3839–3849

Murray K, Retallick R, McDonald K, Mendez D, Aplin K, Kirkpatrick P, Berger L, Hunter D, Hines H, Campbell R, Pauza M, Driessen M, Speare R, Richards S, Mahony M, Freeman A, Phillott A, Hero J-M, Kriger K, Driscoll D, Felton A, Puschendorf R, and Skerratt L. (2010) The distribution and host range of the pandemic disease chytridiomycosis in Australia, spanning surveys from 1956–2007. Ecology 91:1557

Murray, K, Skerratt, L, Marantelli, G, Berger, L, Hunter, D, Mahony, M and Hines, H (2011) Hygiene protocols for the control of diseases in Australian frogs. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities

National Institute of Water and Atmospheric Research (NIWA)(2016). Loss of riparian vegetation, (Online). Last viewed: 31 May 2018, Available at: https://www.niwa.co.nz/our-science/freshwater/tools/kaitiaki_tools/impacts/loss-of-riparian-vegetation>

Nasim, M, Qureshi, R H, Azzi, T, Saquib, M, Nawaz, S, Sagi, S T & Pervaiz, S (20&) Screening trees for salinity tolerance: A case study with ten Eucalyptus species, Pakistan Journal of Agricultural Science, vol **44**:3, pp 385–396

National Murray Cod Recovery Team (2010) National Recovery Plan for the Murray Cod Maccullochella peelii peelii. Melbourne Vic, Australia: Department of Sustainability and Environment

Neo, Y. Y., Parie, L., Bakker, F., Snelderwaard, P., Tudorache, C., Schaaf, M., & Slabbekoorn, H. (2015). Behavioural changes in response to sound exposure and no spatial avoidance of noisy conditions in captive zebrafish. Frontiers in Behavioural Neuroscience, 9, 28. http://doi.org/10.3389/fnbeh.2015.00028

Nillumbik Shire Council (1997) Sites of Faunal and Habitat Significance in North East Melbourne Volume 1—Introduction and Overview, available at: https://www.banyule.vic.gov.au/files/a39f7a13-a04d-4096-b9f3-a1db0114d8e8/Sites-of-Faunal-Habitat-Significance-In-North-East-Melbourne-Nillumbik-Shire-Council-1997.pdf

Norton, D.A. and Young, L. M. (2016) Effect of artificial shade and grazing removal degraded grasslands: Implications of woody restoration for herbaceous vegetation, Ecological Management & Restoration, 17: 2

NSW Fisheries 1997 Australian Electrofishing code of practice. State Government of NSW

Office of Environment and Heritage (OEH) (2011). Clearing of native vegetation – key threatening process listing NSW Scientific Committee – final determination, New South Wales. retrieved 31 May 2018, http://www.environment.nsw.gov.au/determinations/ClearingNativeVegKTPListing.htm

Odiyi, B. O. and Eniola, A. O., (2014). The Effect of Simulated Acid Rain on Plant Growth Component of Cowpea (Vigna unguiculata) L. Walps, Jordan Journal of Biological Sciences, **8**:1, 51 – 54

Olser, D. and Cook, D. (2007). Ecological Assessment and Management Recommendations for Banyule Flats Reserve. A report to the Banyule City Council by Australian Ecosystems, Patterson lakes, VIC

Olser, D., Frood, D. and Cook, D. (2007). Ecological Assessment of Westlands at the Trinity Grammar School Sporting Complex. Bulleen. A report to Manningham City Council by Australian Ecosystems, Patterson Lakes, VIC

Orellana, F, Verma, P, Loheide, S.P, and Daly, E (2011) Monitoring and modelling water-vegetation interactions in groundwater dependant ecosystems. Review of Geophysics **50**,1–24

Overton, I.C, Jolly, I. D. Slavich, P. G, Lewis, M. M. & Walker, G. R. (2006). Modelling vegetation health from the interaction of saline groundwater and flooding on the Chowilla floodplain, South Australia. Australian Journal of Botany, **54**:2, 207–220

Paal, J., Degtjarenko, P., Suija, A., and Liira, J. (2013). Vegetation responses to long-term alkaline cement dust pollution in Pinus sylvestris-dominated boreal forests –niche breadth along the soil pH gradient, Applied Vegetation Science **16**, 248–259

Parks Victoria (2000). Yarra Bend Park Environmental Action Plan, available at: http://parkweb.vic.gov.au/__data/assets/pdf_file/0019/313462/Yarra-Bend-Park-Environmental-Action-Plan-2001.pdf

Parks Victoria (2006). Bolin Bolin Billabong – Park Note. Parks Victoria, Melbourne, March 2006

Parks Victoria (2008). Yarra Valley Parklands Management Plan, Available at: http://parkweb.vic.gov.au/__data/assets/.../Yarra-Valley-Parklands-Management-Plan.pdf

Parks Victoria (2011a). Banksia Park – Park Note, available at: http://parkweb.vic.gov.au/__data/assets/pdf_file/0020/315830/Park-note-Yarra-Flats-Park.pdf

Parks Victoria (2011b). Birrarrung Park – Park Note, available at: https://parkweb.vic.gov.au/__data/assets/pdf_file/0005/314483/Park-note-Birarrung-Park.pdf

Parks Victoria (2011c). Yarra flats Park – Park Note, available at: http://parkweb.vic.gov.au/__data/assets/pdf_file/0003/315831/PArk-note-Banksia-Park.pdf

Parks Victoria (2012). Mullum Mullum Park Strategic Management Plan February 2012, available at: http://parkweb.vic.gov.au/__data/assets/pdf_file/0005/522716/Mullum-Mullum-Park-Strategic-Management-Plan.pdf

Popper A.N. and Hastings M.C. (2009) The effects of human-generated sound on fish. Integrative Zoology **4**, 43–52

Parris, K. M. (2015). Ecological impacts of road noise and options for mitigation. Pp. 151–158 in R. van der Ree, C. Grilo and D. Smith (eds), Ecology of Roads: A practitioners Guide to Impacts and Mitigation. Wiley-Blackwell, Oxford.

Parris, K. M. (2013). Anthropogenic noise constrains acoustic communication in urban-dwelling frogs. Proceedings of Meetings on Acoustics 19: 010055.

Parris, K.M., Velik-Lord, M. and North, J. M. A. (2009) Frogs call at a higher pitch in traffic noise. Ecology and Society 14(1): 25.

Poulson, P.L. & Platt, W.J. (1989). Gap light regimes influence canopy tree diversity. Ecology. **70**:3, 553 – 555

Practical Ecology (2007a). Ecological assessment and management recommendations for Banyule Flats Reserve. Australian Ecosystems, Patterson Lakes, Victoria

Practical Ecology (2007b). Ecological assessment of wetlands at the Trinity Grammar School sporting complex, Bulleen. Report prepared by Australian Ecosystems for Manningham City Council, August 2007

Practical Ecology (2010). Fauna surveys at specified sites on the Yarra River. Prepared for the City of Boroondara, June 2010.

Practical Ecology (2017a). Koonung Creek Reserve Remnant Bushland Patch: Vegetation Action Plan. Prepared for the City of Whitehorse, June 2017

Practical Ecology (2017b). Warringal Parklands and Banyule Flats Ecological and Conservation Values Assessment; available at: https://www.banyule.vic.gov.au/files/assets/public/files-forms-and-attachments/2-council/advocacy/warringal-parklands-banyule-flats-ecological-and-conservation-values-assessment-2017-final.pdf

Practical Ecology (2017c). Swift Parrots in Banyule and surrounds. Prepared for the City of Banyule, April 2017.

Quested, T. (1982). Spine-tailed Swift landing in tree. Australian Birds. 16:64.

Reardon-Smith, K.M. (2011). Disturbance and resilience in riparian woodlands on the highly-modified Upper Condamine floodplain, Unpublished PhD thesis, University of Southern Queensland, Toowoomba, Australia

Retallick, R. W. R., H. McCallum, and R. Speare. 2004. Endemic infection of the amphibian chytrid fungus in a frog community post-decline. Public Library of Science Biology 2:1965–1971

Richardson, S., Ervine, E., Froend, R., Boon, P., Barber, S., Bonneville, B. (2011). Australian Groundwater-dependent Ecosystem Toolbox Part 1: Assessment Framework, Waterlines Report. National Water Commission, Canberra http://nwc.gov.au/data/assets/pdf file/0006/19905/GDE-toolbox-part-1.pdf

Robinson, N., Harper, R.J. & Smettem, K.R.J. (2006). Soil water depletion by Eucalyptus spp. integrated into dryland agricultural systems. Plant and Soil, **286,** 141–151

Rogers, P., and Cox, M. 1988. Underwater sound as a biological stimulus. In Sensory biology of aquatic animals. Edited by J. Atema, R.R. Fay, A.N. Popper and W.N. Tavolga. Springer, New York.

Ryan, T., O'Connor, J., Lyon, J., Lennie, R., & Lieschke, J. (2003). Fish Fauna and Aquatic Habitat in the Yarra River and Potential Impact of the Henley Folg Course Development.

Saddlier, S., & Hammer, M. (2010). National recovery plan for the Yarra pygmy perch Nannoperca obscura. Retrieved from http://www.environment.sa.gov.au/files/f5f94121-afe4-46ba-af8f-9e8400ccaaff/pa-rec-YarraPygmyPerch.pdf

Saddlier, S., Jackson, J., & Hammer, M. (2010). National Recovery Plan for the Dwarf Galaxias Galaxiella pusilla. Melbourne Vic, Australia.

Sari, AP, Triadiati, T & Ratnadewi, D (2017). Effects of Shading and Fertiliser on the Growth and Antioxidant Content of Olives (Olea europaea L.), Pertanika Journal of Tropical Agricultural Science. **40**:2. 269 – 278

Saunders, D.L., & Tzaros C.L., (2011). National Recovery Plan for the Swift Parrot (Lathamus discolor). Birds Australia, Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-swift-parrot-lathamus-discolor.

Schloegel, LM, Hero, JM, Berger, L, Speare, R, McDonald, K & Daszak, P (2006). "The decline of the sharp-snouted day frog (Taudactylus acutiostris): the first documented case of extinction by infection in a free-ranging wildlife species?". EcoHealth. 3: 35–40. doi:10.1007/s10393-005-0012-6

Senior, B (2018). Do floodplain trees need floods?, Commonwealth Environmental Water Office (Online). Available at: http://ewkr.com.au/do-floodplain-trees-need-floods/. Accessed 1st May 2018

Serena, M., & Pettigrove, V. (2005). Relationship of sediment toxicants and water quality to the distribution of platypus populations in urban streams. J. North Am. Benthol. Soc., 24, 679–689.

Serov P, Kuginis L, Williams J.P., (2012). Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 – The conceptual framework, NSW Department of Primary Industries, Office of Water, Sydney

Shah, K., Ul Amin, N., Ahmad, I., Shah, S. and Hussain, K. (2017). Dust particles induce stress, reduce various photosynthetic pigments and their derivatives in Ficus benjamina. A landscape plant. International Journal of Agriculture & Biology **19**, 1469–1474

Shatfroth PB, Stromberg JC, Patten DT (2000) Woody riparian vegetation response to different alluvial water table regimes. Western North American Naturalist **60**, 66–76

Sinclair Knight Merz (2001). Environmental water requirements to maintain groundwater dependent ecosystems. Natural Heritage Trust, Department of Environment and Heritage, Canberra, p 140

Sinclair Knight Merz. (2005). Determination of the minimum environmental water requirement for the Yarra River: flow and non-flow related environmental and social issues associated with the Yarra River.

Sinclair Knight Merz. (2012). Yarra River Environmental Flow Study Review – Flow Recommendations Report. Melbourne Vic, Australia.

Siqueira-Silva, A. I., Pereira, E., G., Modolo, L., V., Lemos-Filho, J. P. & Paiva, E.A. S. (2016). Impact of cement dust pollution on Cedrela fissilis Vell. (Meliaceae): A potential bioindicator species, Chemosphere **158**, 56–65

Skerratt, L. F., L. Berger, R. Speare, S. Cashins, K. R. McDonald, A. D. Phillott, H. B. Hines, and N. Kenyon. 2007. Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs. EcoHealth 4:125–134

Song, X & Li. H (2016). Effects of building shade on photosynthesis and chlorophyll fluorescence of Euonymus fortune, Acta Ecologica Sinica **36**, 350–355

Stone, E.L. & Kalisz, P.J. (1991). On the maximum extent of tree roots. Forest Ecology and Management, **46**, 59–102

Van der Ree, R. (2017). Sugar Gliders (Petaurus breviceps) at key biodiversity sites along the Yarra River Corridor, Boroondara City Council. Report for Boroondara City Council by Ecology and Infrastructure International Pty Ltd

Tan, P. Y. & Ismail, M. R. B (2014). Building shade affects light environment and urban greenery in high-density residential estates in Singapore, Urban Forestry & Urban Greening, **13**, 771–784

Tarburton, M.K. (1993). Radiotracking a White-throated Needletail to roost. Emu. 93:121–124.

Thompson, M., & Spencer, R.-J. (2006). Murray River Turtle Information Package. Retrieved from http://turtlesat.org.au/docs/turtleinformationpack_v3.pdf

Thorburn, P.J., Mensforth L.J., Walker G.R. (1994). Reliance of creek-side river red gums on creekwater. Australian Journal of Marine and Freshwater Research, **45**,1439–1443

Threatened Species Scientific Committee (TSSC) (2012). Approved Conservation Advice for the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Canberra: Department of Sustainability, Environment, Water, Population and Communities

Tomlinson, M & Boulton, A.J 2010, Ecology and management of subsurface groundwater dependent ecosystems in Australia – a review, Marine and Freshwater Research, **61**, 936–949

Valladares, F. and Niinemets, Ü., 2008. Shade tolerance, a key plant feature of complex nature and consequences. Annual Review of Ecology, Evolution, and Systematics, 237–257

Valladares, F. & Niinemets, Ü. (2008). Shade tolerance, a key plant feature of complex nature and consequences. Annual Review of Ecology, Evolution, and Systematics, 237–257

Vega, G.C., Wiens, J.J. (2012). Why are there so few fish in the sea? Proceedings: Biological Sciences. 279, 2323–2329

VicRoads 2012, Fauna sensitive road design guidelines, VicRoads, August 2012. Available at: https://www.vicroads.vic.gov.au/~/media/files/documents/planning-and-projects/vicroads_n1571864_vicroads_fauna_sensitive_road_deisgn_guidelines_final.pdf?la=en

Victorian Government (2015). Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems. Issued by the Hon Lis Neville MP, Minister for Environment, Climate Change and Water on 8 June 2018. Available at: https://waterregister.vic.gov.au/images/documents/Guidelines%20for%20Groundwater%20Licensing%20and%20the%20Protection%20of%20High%20Value%20Groundwater%20Dependent%20Ecosystems.pdf

Walsh, C. J., Bond, N., & Fletcher, T. D. (2013). Possible ecological futures for Merri and Darebin creeks, (September), 1–18.

Walsh, C.J. and Webb, J.A. (2016) Interactive effects of urban stormwater drainage, land clearance and flow regime on stream macroinvertebrate assemblages across a large metropolitan region. Freshwater Science, 35:324–339.

Wardle, C. S., Carter, T. J., Urquhart, G. G., Johnstone, A. D. F., Ziolkowski, A. M., Hampson, G., and Mackie, D. (2001). "Effects of seismic air guns on marine fish". Continental Shelf Res. 21, 1005–1027.

Wassens, S., Ning, N., Hardwick, L., Bino, G. & Maguire, J. (2017). Long-term changes in freshwater aquatic plant communities following extreme drought, Hydrobiologia, 799:233–247

Webb, J. A., Martin, E. H., Walsh, C. J., Serena, M., & Webb, J. A. (2014). Urban stormwater runoff limits distribution of platypus. Austral E, 39, 337–345. https://doi.org/10.1111/aec.12083

Webster, A., Humphries, R., Lowe, K.W., 2004. Powerful Owl Ninox strenua Flora and Fauna Guarantee Act 1988 Action Statement No. 92. Department of Sustainability and Environment, The State of Victoria

Weldon C, du Preez LH, Hyatt AD, Muller R, Spears R (December 2004). "Origin of the amphibian chytrid fungus". Emerging Infect. Dis. 10 (12): 2100–5. doi:10.3201/eid1012.030804. PMID 15663845

Williams, G. & Serena, M. (2018) Distribution of the Australian Water-rat Hydromys chrysogaster in Victoria: findings from community-based sightings and live-trapping surveys. Victorian Naturalist 135(3):71–83

Wilson Environmental (2014). Simpson Barracks Kangaroo Population: Status Report. A report for Transfield Services

Zencich SJ, Froend RH, Turner JT, Gailitis V (2002). Influence of groundwater depth on the seasonal sources of water accessed by Banksia tree species on a shallow, sandy coastal aquifer. Oecologia 131, 8–19

Appendices

Appendix A Threatened flora – likelihood of occurrence assessment

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Acacia boormanii	Snowy River Wattle			r	2 (1996)		Mostly open-forest on rocky slopes and along banks of the Snowy River and tributaries.	Low – outside species' range, records most likely to be planted specimens.
Acacia cupularis	Cup Wattle			r	1 (2002)		Grows in sand, sometimes on dunes, or in loam or sandy clay in mallee communities. Known in Victoria only from Wyperfeld and Little Desert National Parks.	Low – outside species' range, records most likely to be planted specimens.
Acacia howittii	Sticky Wattle			r	5 (2014)		Confined to eastern Victoria from the upper Macalister River near Mt Howitt south to near Yarram and east to near Tabberabbera. Grows in moist forest.	Low – outside species' range, records most likely to be planted specimens.
Acacia stictophylla	Dandenong Wattle			r	3 (2013)		Naturally restricted to Dandenong Ranges but has isolated records as far west as Doncaster, Wonga Park in the riparian zone of hillsides in tall forest and open woodland.	Low – project boundary generally west of species range or where it may overlap (Koonung Creek) there is not appropriate habitat.
Adiantum capillus-veneris	Venus-hair Fern		L	e	3 (1999)		Grows on calcareous soils. Three isolated localities in Victoria: near Cape Schanck, just outside Bendigo and in the Plenty River Gorge near Greensborough.	Low – outside species' range, records most likely to be garden escapes.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Amphibromus fluitans	River Swamp Wallaby-grass	VU			4 (2011), PMST	Yes	Inhabits both natural and man-made water-bodies, including swamps, lagoons, billabongs and dams. Known from Trinity Grammar School wetlands.	Present
Austrostipa rudis subsp. *australis*	Veined Spear-grass			r	5 (2011)		Uncommon, mostly found in cool areas of moderate altitude in open-forest on sandy or sandstone-derived soils.	High
Billardiera scandens s.s.	Velvet Apple-berry			r	17 (2015)		Common in woodland and dry open forests from near sea-level to the sub-alps. Numerous records on the Atlas of Living Australia.	High
Caladenia amoena	Charming Spider-orchid	EN	L	e	3 (1997), PMST		Endemic to south-central Victoria where known from a few sites on ridges and sheltered slopes in open forests on shallow clay loams (for example, Plenty Gorge Parklands.	Moderate
Caladenia oenochila	Wine-lipped Spider-orchid			v	1 (2005)		Confined in Victoria to southern foothills of the Great Dividing Range between west Gippsland and the Grampians. Relatively common on moist, often grassy forest or woodland, often in shaded habitats.	Moderate

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Caladenia patersonii s.s.	Cream Spider-orchid			e	1 (2005)		Grows in coastal heathland and heathy woodlands east of Wilsons Promontory on well-drained sandy soils.	Low – project boundary unlikely to support suitable habitat.
Caladenia rosella	Little Pink Spider-orchid	EN	L	e	PMST		Known from only a few sites in the north-eastern outer suburbs of Melbourne and near the Grampians. Grows in woodland on skeletal soils.	Low – modelled data only, no records in local area.
Callitriche brachycarpa	Short Water-starwort		L	v	1 (2013)		In Victoria currently known only from the Otway Ranges and adjacent plains, and northern outskirts of Melbourne on sites subject to inundation.	High – previously recorded by Practical Ecology (2007 and 2017a) in close proximity to the project boundary.
Callitriche umbonata	Winged Water-starwort			r	Practical Ecology (2017a)		Damp and swampy areas	High – previously recorded by Practical Ecology (2017a) in close proximity to the project boundary.
Corybas fimbriatus	Fringed Helmet-orchid			r	2 (1996)		Occurs on moist, shaded sandy soil near the coast and generally east of Western Port, but with isolated occurrences near Melbourne at Gembrook, Warrandyte and Greensborough.	Moderate
Cymbonotus lawsonianus	Bear's ears			r	1 (1995)		Scattered in woodland communities across Victoria. A few eastern collections from dry-ish areas south of the Great Dividing Range	Moderate

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Dianella amoena	Matted Flax-lily	EN	L	e	66 (2014), PMST	Yes	Associated with drier grasslands and grassy woodlands south of the Dividing Range.	Present
Dianella longifolia var. *grandis*	Arching Flax-lily			v	2 (2011)	Yes	Occurs in lowland plains grassland and grassy woodlands (such as Volcanic Plain and Riverina) as well as around rocky outcrops at higher altitudes.	Present
Diuris fragrantissima	Sunshine Diuris	EN	L	e	PMST		Grassland plains immediately west of Melbourne. The sole remaining natural population occurs at Sunshine, where about 30 plants remain.	Low – modelled data only, no records in local area.
Echinopogon caespitosus var. *caespitosus*	Bushy Hedgehog-grass			e	1 (1995)		Recorded only from the Heyfield-Bairnsdale area, and in the vicinity of Mallacoota. Probably more widespread and likely to occur in other dryish lowland forest sites in the east.	Low – outside species' range.
Eucalyptus aff. *cinerea* (Beechworth)	Beechworth Silver Stringybark			v	1 (1989)		Confined to a few sites north of Beechworth. Commonly planted ornamental.	Low – outside species' range, records most likely to be planted specimens.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Eucalyptus fulgens	Green Scentbark			r	6 (1991)	Yes	Occurs east from Healesville and Woori Yallock to the La Trobe Valley near Driffield.	Moderate – historical 1989 VBA record within the project boundary, although likely to have been cleared for Eastern Fwy construction and not observed during field assessments.
Eucalyptus leucoxylon subsp. *connata*	Melbourne Yellow Gum			v	15 (2014)		Grows on skeletal soils at Long Forest between Bacchus Marsh and Melton, and at Studley Park (Kew) where it grows on soil derived from Silurian sandstone.	High – records known close to project boundary near the Eastern Freeway at Yarra Bend.
Eucalyptus X *studleyensis*	Studley Park Gum			e	17 (2006)	Yes	A morphologically variable hybrid between *E. camaldulensis* subsp. *camaldulensis* and *E. ovata* subsp. *ovata* from the lower Yarra River north-east of Melbourne (Kew, Viewbank, Watsonia). Plants are intermediate between the two parent taxa in leaf, bud and fruit characters, often showing a closer affinity to either parent in one or more of these features.	Present

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Eucalyptus yarraensis	Yarra Gum			r	2 (2006)		Disjunct distribution primarily in heavier soils of gullies and streams. Endemic to Victoria, extending from Glengarry (near Traralgon) north-west to Ararat and Daylesford.	Moderate – no individuals observed within the project boundary by ecology or arboricultural teams.
Fimbristylis velata	Veiled Fringe-sedge			r	3 (2011)		Occasional on drying mud beside lakes and rivers and in seasonally wet depressions; mostly in northern Victoria, but recent collections in the south	Moderate
Geijera parviflora	Wilga		L	e	1 (1989)		Found on calcareous red clays or sands soils in open woodland throughout inland eastern Australia. Victorian records confined to the north-west of the State in dry woodland.	Low – outside species' range, records most likely to be planted specimens.
Geranium solanderi var. *solanderi s.s.*	Austral Crane's-bill			v	2 (2011)		Occurs in damp to dryish, usually sheltered sites in grassy woodlands, often along drainage lines or seepage areas.	High
Geranium sp. 1	Large-flower Crane's-bill		L	e	3 (2010)		Generally associated with EVC 132_61: Heavier-soils Plains Grassland on basalt around Glenroy-Broadmeadows, Riddells Creek and Malmsbury.	Low – outside species' range.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Geranium sp. 3	Pale-flower Crane's-bill			r	13 (2011)		Currently known only from Stawell, Yan Yean, Eltham, and Bonegilla areas. Occurs in open grassy areas of dry woodland to forest.	Moderate – nearby records in Westerfolds Park
Glycine latrobeana	Clover Glycine	VU	L	v	8 (2011), PMST		Sporadically dispersed in grasslands and grassy woodlands.	Moderate – nearby records in Plenty Gorge Parklands, Kalparrin Gardens and Harry Pottage Reserve.
Goodia medicaginea	Western Golden-tip			r	1 (2002)		Found sporadically in the south-west, at Long Forest west of Melbourne, in central Victoria near Eaglehawk and Killawarra Forest. Favours dry, inland sites.	Low – project boundary unlikely to support suitable habitat.
Grevillea rosmarinifolia subsp. *rosmarinifolia*	Rosemary Grevillea			r	1 (2006)		Grows in open eucalypt forest or woodland, or in riparian shrub associations, on rocky slopes or near creeks. Patchy distribution and widely planted on road verges and in gardens.	Moderate
Hakea decurrens subsp. *platytaenia*	Coast Needlewood			r	1 (1995)		Currently recorded only from windswept coastal heaths on Wilsons Prom and in the Mallacoota area.	Low – outside species' range, records most likely to be planted specimens.
Lachnagrostis adamsonii	Adamson's Blown-grass	EN	L	v	PMST		Occurs in slightly saline, seasonally wet areas within the volcanic plains.	Low – modelled data only, no records in local area.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Lepidium hyssopifolium	Basalt Peppercress	EN	L	e	1 (1990), PMST		Scattered sites on the volcanic plain, most recent collections from disturbed, weedy sites.	Low – outside species' range.
Levenhookia sonderi	Slender Stylewort			r	2 (2011)		Found in seasonally damp ground and drying swamps in lowland areas, mostly in the south-west, but extending eastward to Rushworth in the north and Beaconsfield in the south.	Moderate
Limonium australe	Yellow Sea-lavender			r	1 (1991)		Confined to mangrove and saltmarsh communities near Point Lonsdale, Western Port, Shallow Inlet and Corner Inlet.	Low – outside species' range.
Microtis orbicularis	Swamp Onion-orchid			v	1 (1992)		Semi-aquatic species occurring in shallow water around the margins of swamps. Occurs in south-west Victoria, and east of Melbourne on French Island, Wonthaggi area and Wilsons Prom.	Low – outside species' range.
Nicotiana suaveolens	Austral Tobacco			r	3 (2008)		Widespread distribution but found particularly in drier inland areas, often in rocky or gravelled areas around rivers and streams from west of Melbourne to Mount Mercer.	Moderate

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Oreomyrrhis brevipes	Branched Caraway			v	1 (2001)		Known only from basalt outcrops on the Bogong High Plains and on granite outcrops of the Cobberas.	Low – outside species' range.
Pimelea spinescens subsp. *spinescens*	Spiny Rice-flower	CR	L	e	PMST		Grows in grassland, open shrubland and occasionally woodland, usually on basalt-derived soils. Mostly west of Melbourne (to near Horsham), but extending as far north as Echuca.	Low – modelled data only, no records in local area.
Pomaderris vacciniifolia	Round-leaf Pomaderris	CR	L	e	PMST		Endemic in moist forest and scrubs in the upper catchment of the Yarra, Plenty and Yea Rivers in an area bounded by Healesville, Marysville and Whittlesea.	Low – modelled data only, no records in local area.
Prasophyllum colemaniae	Lilac Leek-orchid	VU		x	PMST		Last recorded in 1922 from grassy woodland near Bayswater; probably extinct.	Low – modelled data only, no records in local area.
Prasophyllum frenchii	Maroon Leek-orchid	EN	L	e	PMST		Occurs in grassland, heathland and open forest on well-drained or water-retentive sand or clay loams. Predominantly occurs in or near coastal swamps and rarely occupies sites more than 10 km inland.	Low – modelled data only, no records in local area.
Prostanthera nivea var. *nivea*	Snowy Mint-bush			r	2 (2010)		Largely confined to shrubland and open woodland associated with granite outcrops.	Low – unlikely to be suitable habitat.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Pterostylis chlorogramma	Green-striped Greenhood	VU	L	v	7 (1995), PMST		Grows in moist areas of heathy and shrubby forest, on well-drained soils.	Moderate – records in Plenty Gorge Parklands and Kalparrin Gardens.
Pterostylis clivosa	Red-tip Greenhood			r	1 (2014)		Widespread across southern Victoria on slopes and ridges in drier open forests and woodlands on well-drained soils.	Moderate
Pterostylis cucullata	Leafy Greenhood	VU	L	v	PMST		Widely distributed but disjunct, mostly occurring in coastal areas, rarely inland. Recent records from volcanic soils. Coastal populations occur on stabilised sand dunes under open to closed scrub of Coast Tea-tree or Moonah.	Low – modelled data only, no records in local area.
Pterostylis smaragdyna	Emerald-lip Greenhood			r	12 (2016)		Occurs in outer north-eastern suburbs of Melbourne, Brisbane Ranges and Ararat. Grows in drier forests and woodlands on well-drained shallow clay loam.	Moderate – records in Plenty Gorge Parklands and Kalparrin Gardens
Pterostylis sp. aff. *striata* (Silurian)	Silurian Striped Greenhood			e	1 (2001)		This species is known from a few sites around Nilumbik. Grows in eucalypt woodland.	Moderate
Rhagodia parabolica	Fragrant Saltbush			r	7 (2010)		Confined to steep rocky slopes and broad ridges west of Melbourne.	Low – outside species' range.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Rutidosis leptorrhynchoides	Button Wrinklewort	EN	L	e	PMST		Confined to basaltic grasslands. In Victoria, known distribution is between Rokewood and Melbourne.	Low – modelled data only, no records in local area.
Senecio campylocarpus	Floodplain Fireweed			r	4 (2014)		Moist to wet clay soils in winter wet areas of forests and woodlands in central Victoria between Melbourne and the Murray River.	Moderate
Senecio glomeratus subsp. *longifructus*	Annual Fireweed			r	2 (2011)		Grows adjacent to streams and swamps throughout the south and north-east of the state	Moderate
Senecio psilocarpus	Swamp Fireweed	VU		v	2 (2014)		Occurs in winter-wet swamps on volcanic clays or peaty soils.	Low – unlikely to be suitable habitat.
Tragus australianus	Small Burr-grass			r	1 (1992)		Occurs on sandy soils and is known to colonise disturbed sites (for example, a 1992 record from Kensington). Found throughout north-central and north-western Victoria.	Low – outside species' range.
Tripogonella loliiformis	Rye Beetle-grass			r	2 (2009)		Dry and mostly rocky grasslands and plains. Usually occurring on shallow soils overlying rock.	Low – unlikely to be suitable habitat.

Scientific Name	Common Name	EPBC	FFG	VROT (DELWP)	Record	Present within project boundary?	Habitat Preference	Likelihood of occurrence within project boundary
Utricularia gibba	Floating Bladderwort			v	2 (2005)		Freshwater swamps and wetlands at low elevations. Collections from urban areas around Melbourne are probably introduced.	Low – outside species' natural range.
Xerochrysum palustre	Swamp Everlasting	VU	L	v	1 (2014), PMST		Sedge-rich lowland swamps and wetlands, usually on black cracking clay soils. Scattered from near South Australian border north-west of Portland to Bairnsdale.	Low – unlikely to be suitable habitat.

Legend:

EPBC Act
CR – Critically Endangered
EN – Endangered
VU – Vulnerable

FFG Act
L – Listed

VROTS
c – Critically Endangered
e – Endangered
v – Vulnerable
r – Rare

Records
(####) – VBA results: number of records (year of last record)
PMST – Protected Matters Search Tool

Note: The descriptions of preferred habitat for threatened flora species have been generated based on published species accounts – particularly from the Species Profile and Threats Database (SPRAT) database of DoEE (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl) and Flora of Victoria available online via the VicFlora website (https://vicflora.rbg.vic.gov.au/) – and reference books including, but not limited to, Flora of Melbourne: A Guide to the Indigenous Plants of the Greater Melbourne Area (Bull and Stolfo, 2014).

Records column represents the number of records of a species within the VBA output rather than a count of individuals recorded. This approach was taken for consistency as not all records include count data.

Appendix B Threatened fauna – likelihood of occurrence assessment

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Mammals							
Spot-tailed Quoll	*Dasyurus maculatus*	EN	L	e	1(1930), PMST	Woodlands and forests	Low. Extinct from the Melbourne area
Brush-tailed Phascogale	*Phascogale tapoatafa*		L	VU	1(2010)	Drier woodlands and forests, particularly where trees form small hollows suitable for denning	Low. No suitable habitat remaining in the project boundary. Numerous VBA records east of the project boundary, but only one within 5 km of the project boundary (4.95 km east of Plenty River).
Swamp Antechinus	*Antechinus minimus maritimus*	VU	L	nt	PMST	Swampy areas with dense grassy cover	Low. Potentially suitable habitats likely to be too degraded and disturbed to support this species. No VBA records in the Melbourne area.
Common Dunnart	*Sminthopsis murina*			VU	1(1991)	Heathy dry forest and mallee heath	Low. Potentially suitable habitats likely to be too degraded and disturbed to support this species. VBA records north of the study area, on the outskirts of suburban Melbourne.
Southern Brown Bandicoot	*Isoodon obesulus*	EN	L	nt	3(1955), PMST	Typically occurs in heathland, shrubland, heathy forest and woodland, and coastal scrub habitat across southern Victoria.	Low. Extinct from the study area.
Greater Glider	*Petauroides volans*	VU		vu	PMST	Eucalypt-dominated low open forests on coast to tall forests in the ranges and low woodland W of Great Dividing Range; not in rainforests.	Low. Easily detectable species, but no historical records within or near the study area.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU	L	vu	444(2013), PMST	Densely vegetated flowering and fruiting trees, mainly east of Melbourne. Roosts in dense gullies. Uses a wide range of habitats in Victoria, from lowland rainforest and coastal Stringybark forests to agricultural land and suburban gardens. Established colonies known in Melbourne, Geelong and Mallacoota.	High. Known camp/colony at Yarra Bend Park near Eastern Freeway upgrade. Species forages on flowering and fruiting trees across the study area.
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		L	DD	1(1990)	Most environments from deserts to wet forests. Reported to roost singly or in small groups, mostly in tree hollows and buildings.	Low. Wide-ranging species across northern and eastern Australia, but a rare summer/autumn visitor to the southerly part of its range in Victoria.
Common Bent-wing Bat (eastern ssp.)	*Miniopterus schreibersii oceanensis*		L	VU	6(2004)	Cave-roosting and cave-breeding species. May occur anywhere within flying distance of suitable caves. Forages above canopy.	Moderate. A mostly uncommon bat, particularly in the inner suburban Melbourne area. Likely to forage occasionally in the airspace of the project boundary, particularly along the waterways and in larger patches of vegetation.
Broad-toothed Rat	*Mastacomys fuscus*	VU	L	e	PMST	Wet sedges and grasslands in forested areas, from alpine areas to sea level	Low. No historical records within or near the study area.
Smoky Mouse	*Pseudomys fumeus*	EN	L	nt	PMST	Dry heathy forest on ridges. Coastal and sub-alpine heath.	Low. No historical records within or near the study area.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Birds							
Plains-wanderer	*Pedionomus torquatus*	CR	L	cr	V:8(1980), B:1(2000), PMST	Grasslands	Low. No suitable habitat in the study area.
Diamond Dove	*Geopelia cuneata*		L	NT	V:3(2001)	Woodland and shrubland in dry areas	Low. Abundant species in northern parts of Australia. Study area is at the southern limit of species' normal range, and birds here are occasional to rare.
Lewin's Rail	*Rallus pectoralis*		L	VU	V:6(1999), B:1(1999)	Densely vegetated wetlands	Moderate. Secretive species; may be under-reported. A handful of historical records exist along the Yarra watercourse, including one near Banyule Swamp. May be resident along Yarra River, and may occur occasionally along Banyule Creek and Koonung Creek. The largest area of suitable habitat would be avoided by tunnelling.
Baillon's Crake	*Porzana pusilla*		L	VU	V:30(2007), B:33(2017)	Densely vegetated wetlands	High. Secretive species; may be under-reported. Historical records exist along the Yarra watercourse, including some near Banyule Swamp and one along Koonung Creek, west of Elgar Road. May be resident along Yarra River, and may occur along Banyule Creek and Koonung Creek. The largest area of suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Caspian Tern	*Sterna caspia*		L	NT	V:3(1988)	Coastal areas and large inland wetlands and rivers. Exposed ocean beaches, sheltered coastal bays, harbours, lagoons, inlets, estuaries, usually with sandy or muddy margins. Breeds in a variety of coastal habitats including banks, ridges and beaches of sand and shell, often in open or among low or sparse vegetation.	Low. No suitable habitat within the project boundary.
Eastern Curlew	*Numenius madagascariensis*	CR	L	vu	PMST	Non-breeding migrant to Australia during the austral summer. Coastal. Sheltered coastal habitats, usually with large sand flats or intertidal mudflats with seagrass, estuaries, open sandy beaches. Occasionally on coastal rock platforms.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.
Common Sandpiper	*Actitis hypoleucos*			vu	V:4(1976), PMST	Migrates to Australia for austral summer. In Australia, inhabits a wide variety of coastal and inland wetlands with muddy margins, including lakes, rivers, sewage ponds.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.
Common Greenshank	*Tringa nebularia*			vu	PMST	Non-breeding migrant to Australia during the austral summer. Coastal mudflats, estuaries, salt marshes, mangroves, lakes and swamps.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.
Marsh Sandpiper	*Tringa stagnatilis*			vu	V:2(1991), B:3(2004)	Non-breeding migrant to Australia during the austral summer. Estuaries, and coastal and inland shallow wetlands.	Low. Habitats in the project boundary are marginally suitable at best. A small number of VBA and BLA records, including one from Bolin Bolin Billabong in 1999.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Curlew Sandpiper	*Calidris ferruginea*	CR	L	e	V:2(1966), PMST	Regular summer migrant to Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.
Red Knot	*Calidris canutus*	EN		e	V:1(1966), PMST	Non-breeding migrant to Australia during the austral summer. Coastal. Typically occurs on intertidal mudflats, sandflats and sandy beaches of sheltered coasts, and a range of other coastal and near-coastal environments such as lakes, lagoons, pools and pans, sewage ponds and saltworks. Inland lakes and swamps less commonly used.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.
Australian Painted Snipe	*Rostratula australis*	EN	L	cr	V:4(2001), B:17(2012), PMST	Generally in shallow, terrestrial freshwater wetlands with rank, emergent tussocks of grass, sedges and rushes. Occurs in well vegetated lakes, swamps, inundated pasture, saltmarsh and dams. Fresh to saline water. May use riverine forest.	Low. There is a cluster of 16 BLA records of this species (maximum two birds) at and around Banyule Swamp. All from October/November 2001. The VBA also contains two of those records. Species not recorded in the study area since then, and only one record before then (1970). There is one exceptional and possibly erroneous BLA record of 80 birds in 2012, in Darebin parklands ~2 km north of the Eastern Freeway alignment near Chandler Highway. There is potentially suitable habitat also at Bolin Bolin Billabong, although there are no historical records of the species at that location. The largest area of suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Bush Stone-curlew	*Burhinus grallarius*		L	EN	V:3(2001)	Open woodlands with coarse woody debris. In Victoria, occurs mostly north of the Great Divide.	Low. Species greatly threatened by introduced predators (cats and foxes), and now all but absent from the Melbourne area. Most suitable habitat in the project boundary is at Simpson Barracks, where species has not been recorded.
Brolga	*Grus rubicunda*		L	VU	V:1(1991)	Wetlands, dams, flooded fields	Low. Wide-ranging species which tends to occur west and north of Melbourne. There is one VBA record in the study area.
Little Egret	*Egretta garzetta*		L	EN	V:15(2000), B:20(2018)	Uses wide range of wetlands, mudflats, estuaries. Typically prefers shallows of wetlands for foraging. Occasionally in small waterways or wet grassland areas.	Moderate. Likely to visit wetlands associated with the Yarra watercourse to forage occasionally. The largest area of suitable habitat would be avoided by tunnelling.
Intermediate Egret	*Ardea intermedia*		L	EN	V:8(2008), B:5(2011)	Wetlands, river margins, mudflats, estuaries. Breeds in flooded or fringing trees alongside wetlands. Forages more widely.	Moderate. Likely to visit wetlands associated with the Yarra River watercourse to forage occasionally. The largest area of suitable habitat would be avoided by tunnelling.
Eastern Great Egret	*Ardea modesta (=alba)*		L	VU	V:260(2013), B:271(2017)	Saltwater and freshwater wetlands, lakes, dams, river margins, estuaries, mudflats	High. The most commonly reported egret in southern Victoria. Likely to visit wetlands associated with the Yarra River watercourse to forage. May occasionally visit Banyule and Koonung creeks. The largest area of suitable habitat would be avoided by tunnelling.
Little Bittern	*Ixobrychus minutus*		L	EN	V:12(2003), B:7(2003)	Dense tall vegetation in swamps and wetlands	Moderate. Secretive species and rarely reported. May occur along the Yarra River watercourse in small numbers. The largest area of suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Australasian Bittern	*Botaurus poiciloptilus*	EN	L	EN	V:10(2007), B:1(1999), PMST	Wetlands with tall, dense vegetation in permanent freshwater habitats, particularly when dominated by sedges, rushes and reeds.	Moderate. Cryptic species, difficult to detect. Few records in or around the study area, but notable records of no more than one bird (up to 2007) around the Banyule Swamp. A VBA record shown at the Freeway Public Golf Course is mis-located and actually from Dandenong. May visit the Yarra River watercourse occasionally. The largest area suitable habitat would be avoided by tunnelling.
Magpie Goose	*Anseranas semipalmata*		L	NT	V:5(2008), B:1(2007)	Seasonal wetlands, flooded fields. Aquatic and terrestrial habitat, mostly in wetlands on flood plains. Historically occurred in SE Australia, but extinct in Victoria by early 1900s. Re-introduction attempts have had mixed results.	Low. Rarely reported in Melbourne. May visit larger wetlands along the Yarra River watercourse occasionally, perhaps as a vagrant. The largest area of suitable habitat would be avoided by tunnelling.
Australasian Shoveler	*Anas rhynchotis*			VU	V:16(2007)	Well vegetated larger wetlands, dams, lakes	Moderate. Records at Banyule Swamp. Likely to be an occasional visitor to larger wetlands along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.
Freckled Duck	*Stictonetta naevosa*		L	EN	V:1(2001), B:11(2014)	Well vegetated shallow wetlands	Low. Occasional records at Banyule Swamp and along the Yarra River watercourse. Reports never of more than one bird. Likely to be a rare visitor to larger wetlands along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Hardhead	*Aythya australis*			VU	V:84(2013)	Deep permanent wetlands, dams, lakes, slow-flowing rivers. Also occurs in brackish wetlands and water storage ponds. Occasionally in estuarine and littoral habitats such as saltpans, coastal lagoons and sheltered inshore waters.	High. Numerous records at Banyule Swamp. Likely to be a regular visitor to larger wetlands along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.
Blue-billed Duck	*Oxyura australis*		L	EN	V:17(2003), B:73(2015)	Deep open water in wetlands, dams, lakes, slow-flowing rivers	Moderate. Occasional records at Banyule Swamp and Yarra Flats. Likely to be an occasional visitor to larger wetlands along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.
Musk Duck	*Biziura lobata*			VU	V:13(2011)	Deep open water in wetlands, dams, lakes, slow-flowing rivers	Moderate. Records at Banyule Swamp and Bolin Bolin Billabong. Likely to be an occasional visitor to larger wetlands along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.
Grey Goshawk	*Accipiter novaehollandiae*		L	VU	V:33(2008), B:10(2018)	Woodlands, forests and riparian habitats, mainly in wetter areas	Moderate. Records from Banyule Flats up to 2017. Likely to be an occasional visitor to well-treed patches along the Yarra River watercourse. The largest area of suitable habitat would be avoided by tunnelling.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		L	VU	V:2(1998), B:3(2009)	Coastal, marine and inland. Estuaries, beaches, large wetlands, including deep freshwater swamps, lakes, reservoirs, billabongs and rivers. Uses tall trees in or near water for breeding.	Low. No records in the project boundary. May be a rare visitor along the Yarra River watercourse. The largest area of potentially suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Square-tailed Kite	*Lophoictinia isura*		L	VU	V:2(1987), B:1(2014)	Woodland and open forest in drier areas	Low. No suitable habitat in project boundary.
Black Falcon	*Falco subniger*		L	VU	V:16(2008)	Grassy woodlands	Low. Occasional records across the Melbourne area, but rarely in the project boundary. May be an occasional visitor to larger patches of open grassy woodland in the northern part of the project boundary (such as Simpson Barracks).
Barking Owl	*Ninox connivens*		L	EN	V:26(2001), B:5(2011)	Woodland and dry open forest	Low. Occasional records across the Melbourne area, particularly Gresswell Reserve in Bundoora. Rarely in the project boundary. May be a rare visitor to larger patches of woodland in the northern part of the project boundary (such as Simpson Barracks).
Powerful Owl	*Ninox strenua*		L	VU	V:61(2013), B:167(2017)	Forests and woodland. Dense gullies.	High. Numerous records within the study area, including recent records and breeding records. Most likely in well-treed habitats along the Yarra River watercourse, but also possible along Koonung Creek and Banyule Creek.
Masked Owl	*Tyto novaehollandiae*		L	EN	V:3(2001)	Tall eucalypt forest	Low. Rarely recorded in the Melbourne area. Most recently recorded at La Trobe University (2001), west of the project boundary.
Sooty Owl	*Tyto tenebricosa*		L	VU	V:1(2008)	Rainforest and wet forests.	Low. Occurs mostly in the ranges east of Melbourne. Nearest record is 3 km from the project, near Springvale Road, south of the Eastern Freeway.
Major Mitchell's Cockatoo	*Cacatua leadbeateri*		L	VU	V:9(2008)	to be added	Low. Study area is outside species' normal distribution.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Superb Parrot	*Polytelis swainsonii*	VU	L	EN	V:3(1999)	Open woodland and riverine forest. Nests in eucalypt hollows.	Low. Study area is outside species' normal distribution.
Turquoise Parrot	*Neophema pulchella*		L	NT	V:1(1999)	to be added	Low. Study area is outside species' normal distribution.
Orange-bellied Parrot	*Neophema chrysogaster*	CR	L	cr	PMST	Winter migrant to coastal Victoria and South Australia from breeding areas in south-west Tasmania. Forages in coastal or near-coastal areas such as saltmarshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches.	Low. No suitable habitat within the study area.
Swift Parrot	*Lathamus discolor*	CR	L	en	V:87(2009), B:90(2018), PMST	Winter migrant to Victoria (and other parts of SE Australia) from breeding areas in Tasmania. In Victoria, prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Occasionally recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs.	Moderate. Numerous records in or near the study area, including recent records west of Greensborough Road (Macleod Station and La Trobe University). May visit any flowering tree (mostly eucalypts) within the project boundary occasionally. More likely towards the northern and south-western parts than the south-eastern extent.
White-throated Needletail	*Hirundapus caudacutus*		L	vu	V:148(2006), B:43(2017), PMST	Almost exclusively aerial within Australia, occurring over most types of habitat, particularly wooded areas. Less often seen over open farm paddocks but has been recorded in vineyards flying between the rows of trees.	Moderate. Likely to forage occasionally in the airspace of the project boundary, but association with the terrestrial habitats is minimal.
Hooded Robin	*Melanodryas cucullata*		L	NT	V:4(1992)	Woodlands, generally in drier areas.	Low. Very occasional reports of this species in the study area, mainly around Banyule Flats. May be rare visitor to larger patches of woodland.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Speckled Warbler	*Chthonicola sagittata*		L	VU	V:11(1990)	Woodlands. Generally absent from very wet and very dry areas.	Low. Rarely recorded in the study area; most VBA records are north and east of the action. May be rare visitor to larger patches of less-disturbed woodland (such as Simpson Barracks).
Painted Honeyeater	*Grantiella picta*	VU	L	vu	V:2(1990), B:1(2013), PMST	Forest, woodland, dry scrub, often with abundant mistletoe. Nomadic or migratory; uncommon.	Low. Rarely recorded in the Melbourne area. One BLA record (2013) from Banyule Flats area. May be rare visitor to any well-treed area.
Regent Honeyeater	*Anthochaera phrygia*	CR	L	cr	V:78(2001), B:1(1998), PMST	Open forests and woodlands. Generally, absent from very wet and very dry areas. Dry woodlands and forests dominated by Box Ironbark eucalypts. May be restricted to the Chiltern-Mt Pilot National Park (north-east Victoria) following population decline and range contraction.	Low. Rarely recorded in the Melbourne area. Scattered records occur across the entire Melbourne area, but there are no records since 2001. Closest to the project boundary, there is a 1977 record west of Macleod Station, one 1993 record along Merri Creek north of the Eastern Freeway, and one 1986 record immediately north of the Eastern Freeway in Bulleen. Within the project boundary, there is one VBA record (1998) from Banyule Swamp/Flats area. May be very rare visitor.
Diamond Firetail	*Stagonopleura guttata*		L	NT	V:6(2001)	Grasslands and open woodlands. Generally absent from very wet and very dry areas	Low. Some old records across the Melbourne area, most recently in Bundoora (2001). May be a rare visitor to larger patches of woodland in the northern part of the project boundary (such as Simpson Barracks).

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Reptiles							
Striped Legless Lizard	*Delma impar*	VU	L	vu	2(1975), PMST	Native and some non-native grasslands and grassy woodlands, where soil is little disturbed	Low. No suitable habitat within the project boundary. One very old record (1975) at the junction of the Yarra River and Merri Creek. No others in the study area.
Lace Monitor	*Varanus varius*			EN	1(2005)	Partly arboreal. Occurs in well-timbered areas, from dry woodland to southern temperate forests.	Low. May no longer occur within the study area. One 2005 record from Plenty River gorge, north of the study area.
Glossy Grass Skink	*Pseudemoia rawlinsoni*			VU	2(1991)	Swamp and lake edges, saltmarshes, boggy creeks with dense vegetation.	Moderate. Poorly known species, with only two VBA records in the study area, both along the Yarra River watercourse – one record at Bolin Bolin Billabong (1991) and another along the Plenty River (1988), which is potentially mis-located (labelled as 'Barber Creek: 1 km. S. of Yan Yean').
Broad-Shelled Turtle	*Chelodina expansa*		L	En	2007	Permanent deep water in large, slow moving or still bodies of water. Murray-Darling Basin	Moderate. Records known from upstream in the Yarra River
Murray River Turtle	*Emydura macquarii*			vu	2011	Permanent deep water in large, slow moving or still bodies of water. Murray-Darling Basin	Moderate. Records known from upstream in the Yarra River and Koonung Creek

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Frogs							
Brown Toadlet	*Pseudophryne bibronii*		L	EN	13(2005)	Dams and watercourses in woodland and open forest, where sufficient litter occurs	Low. Potentially suitable habitat present, but most nearby VBA records are old (pre-1980). One 2005 record from Alphington Park/Wetlands suggests species may persist in small areas of suitable habitat. Old records (1956) along Koonung Creek. Species not detected during targeted surveys in April-May 2018. If present, species likely to be in small numbers. The largest area that provides potentially suitable habitat is would be avoided by tunnelling.
Southern Toadlet	*Pseudophryne semimarmorata*			VU	23(2012)	Moist soaks, depressions, dams and watercourses in woodland and open forest and heathlands, with sufficient litter or other ground cover. Adults shelter beneath leaf litter and other debris. Eggs and tadpoles develop in depressions that flood following autumn rains.	Low. Potentially suitable habitat present. Species may persist in small areas of suitable habitat. Species not detected during targeted surveys in April 2018. If present, species likely to be in small numbers. The largest area that provides potentially suitable habitat would be avoided by tunnelling.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Growling Grass Frog	*Litoria raniformis*	VU	L	vu	69(2014), PMST	Permanent and semi-permanent waterbodies, generally containing abundant submerged and emergent vegetation. Within lowland grasslands, woodlands and open forests. Open vegetated wetlands, flooded paddocks, drains, farm dams, river pools.	Moderate. Potentially suitable habitat present. Numerous records across the Melbourne area, but mostly not within the project boundary. A handful of records along the Yarra River watercourse near the alignment (such as Willesmere Park) have unknown dates (1788). Species not detected during targeted surveys. If present, species likely to be in small numbers. The largest area that provides potentially suitable habitat would be avoided by tunnelling.
Invertebrates							
Eltham Copper Butterfly	*Paralucia pyrodiscus lucida*	EN	L	e	V:20(1988), PMST	Around Melbourne occurs exclusively in the Eltham to Greensborough area. Found in dry open woodlands. Its occurrence is dependent upon an obligatory association between a dwarfed form of the Sweet Bursaria *spinosa* and colonies of *Notoncus* sp. of ants.	Low. Numerous recent records identified for the study area, but all are from suitable habitat east of North East Link. No suitable habitat within the project boundary.
Golden Sun Moth	*Synemon plana*	CR	L	cr	PMST	Native grasslands and grassy woodlands, particularly where Austrodanthonia (Rytidosperma) dominant. Now recognised to occur also in exotic grasslands dominated by Chilean Needle Grass.	Low. No suitable habitat within the study area. No historical records identified for the study area.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Fish							
Murray Hardyhead	*Craterocephalus fluviatilis*	EN	L	cr	1989	Ephemeral lakes and billabongs.	Low. Historical records considered misidentification. Present isolated populations known from Murray Darling Basin.
Dwarf Galaxias	*Galaxiella pusilla*	VU	L	e	2010, PMST	Amongst marginal vegetation in still or gently flowing water of roadside ditches, swamps and backwaters of creeks. Occupies ephemeral and permanent habitats.	Low. Suitable habitat present but species not recorded in Yarra River catchment except for isolated translocated populations.
Murray Cod	*Maccullochella peelii*	VU	L	vu	2015, PMST	Slowly flowing, turbid Rivers and streams at low elevations, and also fast moving, clear rocky upland streams.	High. Suitable habitat in the Yarra River and potentially tributaries. Known population in the Yarra River outside natural range.
Macquarie Perch	*Macquaria australasica*	EN	L	e	2015	Cool, clear water of rivers and lakes and reservoirs. Prefers slow-flowing, deep rocky pools.	High. Suitable habitat in the Yarra River and potentially tributaries. Known population in the Yarra River.
Yarra Pygmy Perch	*Nannoperca obscura*	VU	L	vu	PMST	Prefers still or slow flowing waters, with abundant aquatic vegetation and woody debris.	Low. Known populations from fragmented distribution, but Yarra River catchment not considered likely population habitat.
Australian Grayling	*Prototroctes maraena*	VU	L	vu	2015, PMST	Clear, moderate to fast flowing streams in the upper reaches of rivers. Typically found in gravel bottom pools. Often forming aggregations below barriers to upstream movement. Known in the Yarra River catchment.	High. Suitable habitat in the Yarra River and potentially tributaries. Species known from the Yarra River.

Common name	Scientific name	EPBC Act	FFG Act	DELWP	Source	Habitat preference	Likelihood of occurrence within the project boundary
Australian Mudfish	*Neochanna cleaver*		L	Cr	1991	Coastal waterways with dense aquatic or inundated terrestrial vegetation and mud or silt substrate, up to 35 m elevation	High. Seldom recorded in surveys, but records from Yarra River and low elevation of waterways indicate suitable habitat may be present.
Freshwater Catfish	*Tandanus tandanus*		I	en	2010	Lakes, wetlands and rivers with abundant submerged and emergent aquatic plants.	Low, records from the Yarra River, although outside natural range

Legend

EPBC Act
CR – Critically Endangered
EN – Endangered
VU – Vulnerable

DELWP
cr – Critically Endangered
e – Endangered
vu – Vulnerable
nt – Near Threatened
dd – Data Deficient

FFG Act
L – Listed

Record
V:##(####) – VBA results: number of records (year of last record)
B:##(####) – BLA results: number of records (year of last record)
PMST – Protected Matters Search Tool

Note: The descriptions of preferred habitat for threatened, migratory and/or marine species have been generated based on published species accounts – particularly from the Species Profile and Threats Database (SPRAT) database of DoEE (*http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl*) and the Viridans Atlas and Field Guide to Plants and Animals of Melbourne Area (*https://viridans.com/wtajammel/*) – and reference books including, but not limited to, the Handbook of Australian and New Zealand and Antarctic Birds (HANZAB) Volumes 1 to 7 (1990-2006) and field guides to the mammals of Australia (Menkhorst and Knight, 2010), birds of Australia (Morcombe, 2004; Pizzey and Knight, 2012), frogs of Victoria (Hero et al, 1991) and Australia (Tyler and Knight, 2009), reptiles of Australia (Cogger, 2014; Wilson and Swan, 2013) and fish of Australia (Wager and Jackson, 1993; Allen et al, 2002).

Records column presents the number of records of a species within the VBA output rather than a count of individuals recorded. This approach was taken for consistency as not all records include count data.

Records are limited to those recorded since 1987, unless the species was identified by the PMST also.

Appendix C Migratory species – likelihood of occurrence assessment

Common name	Scientific name	Source	Habitat preference	Likelihood of occurrence within the project boundary	Likelihood of important habitat occurring within project boundary
Short-tailed Shearwater	*Puffinus tenuirostris*	V:1(2004)	Breeds at Phillip Island. Likely to forage across Victorian oceans and coasts.	Low. No suitable habitat in the project boundary.	Low
Caspian Tern	*Sterna caspia*	V:3(1988)	Coastal areas and large inland wetlands and rivers. Exposed ocean beaches, sheltered coastal bays, harbours, lagoons, inlets, estuaries, usually with sandy or muddy margins. Breeds in a variety of coastal habitats including banks, ridges and beaches of sand and shell, often in open or among low or sparse vegetation.	Low. No suitable habitat in the project boundary.	Low
Crested Tern	*Sterna bergii*	V:14(1994), B:1(1994)	Coastal and marine species.	Low. No suitable habitat in the project boundary.	Low
Common Tern	*Sterna hirundo*	V:1(1976)	Coastal and marine species.	Low. No suitable habitat in the project boundary.	Low
Ruddy Turnstone	*Arenaria interpres*	V:1(1943)	Non-breeding migrant, regular to Victoria. Typically coastal, on intertidal mudflats, sandflats and sandy beaches, rocky shores and intertidal reefs.	Low. No suitable habitat in the project boundary.	Low
Pacific Golden Plover	*Pluvialis fulva*	V:1(1943)	Non-breeding migrant to Australia during the austral summer. Usually in coastal habitats including mudflats, sandflats rocky shores and saltmarsh. Also sub-coastal wetlands and sewage ponds.	Low. No suitable habitat in the project boundary.	Low
Double-banded Plover	*Charadrius bicinctus*	V:1(1899)	Breeds in New Zealand. Regular winter migrant to Victoria. Occurs in a variety of habitats including bays, mudflats, saltmarshes.	Low. No suitable habitat in the project boundary.	Low
Eastern Curlew	*Numenius madagascariensis*	PMST	Non-breeding migrant to Australia during the austral summer. Coastal. Sheltered coastal habitats, usually with large sand flats or intertidal mudflats with seagrass, estuaries, open sandy beaches. Occasionally on coastal rock platforms.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.	Low

Common name	Scientific name	Source	Habitat preference	Likelihood of occurrence within the project boundary	Likelihood of important habitat occurring within project boundary
Bar-tailed Godwit	*Limosa lapponica*	V:1(1943)	Mudflats, sandflats, estuaries, large wetlands. Coastal, but occasionally inland.	Low. No suitable habitat in the project boundary.	Low
Common Sandpiper	*Actitis hypoleucos*	V:4(1976), PMST	Migrates to Australia for austral summer. In Australia, inhabits a wide variety of coastal and inland wetlands with muddy margins, including lakes, rivers, sewage ponds.	Low. No suitable habitat in the project boundary.	Low
Common Greenshank	*Tringa nebularia*	PMST	Non-breeding migrant to Australia during the austral summer. Coastal mudflats, estuaries, salt marshes, mangroves, lakes and swamps.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.	Low
Marsh Sandpiper	*Tringa stagnatilis*	V:2(1991), B:3(2004)	Non-breeding migrant to Australia during the austral summer. Estuaries and coastal and inland shallow wetlands.	Low. Habitats in the study area are marginally suitable at best. A small number of VBA and BLA records, including one from Bolin Bolin Billabong in 1999.	Low
Curlew Sandpiper	*Calidris ferruginea*	V:2(1966), PMST	Regular summer migrant to Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.	Low
Red-necked Stint	*Calidris ruficollis*	V:2(1966)	Regular summer migrant to Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.	Low

Common name	Scientific name	Source	Habitat preference	Likelihood of occurrence within the project boundary	Likelihood of important habitat occurring within project boundary
Sharp-tailed Sandpiper	*Calidris acuminata*	V:4(1999), B:3(1999), PMST	Non-breeding migrant to Australia during the austral summer. Prefers muddy edges of shallow fresh or brackish wetlands with inundated or emergent low vegetation.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.	Low
Red Knot	*Calidris canutus*	V:1(1966), PMST	Non-breeding migrant to Australia during the austral summer. Coastal. Typically occurs on intertidal mudflats, sandflats and sandy beaches of sheltered coasts, and a range of other coastal and near-coastal environments such as lakes, lagoons, pools and pans, sewage ponds and saltworks. Inland lakes and swamps less commonly used.	Low. Habitats in the project boundary are marginally suitable at best. Only a small number of old VBA records.	Low
Pectoral Sandpiper	*Calidris melanotos*	PMST	Non-breeding migrant to Australia during the austral summer. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands. Mostly recorded from Port Phillip Bay and Murray River Valley region.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.	Low
Latham's Snipe	*Gallinago hardwickii*	V:104(2013), B:187(2015), PMST	Non-breeding migrant to Australia during the austral summer. Uses a wide variety of permanent and ephemeral wetlands, generally freshwater wetlands with cover. Also recorded along creeks, rivers and floodplains. Forages in soft mud at edge of wetlands and roosts in a variety of vegetation around wetlands including tussock grasslands, reeds and rushes, tea-tree scrub, woodlands and forests.	High – Numerous and regular reports along the Yarra River in the Banyule Flats area. The species has also been recorded in small numbers within the Bolin Bolin Billabong area, a no-go zone for North East Link.	High. More than 18 individuals have been reported at least once from the Banyule Swamp area, which makes that area potentially considered as important habitat for this species. This area would be tunnelled to avoid impacts

Common name	Scientific name	Source	Habitat preference	Likelihood of occurrence within the project boundary	Likelihood of important habitat occurring within project boundary
Glossy Ibis	*Plegadis falcinellus*	V:6(2002), B:2(2002)	Wetlands, dams, flooded fields, mudflats, mangroves	Low. Very few records of this species across the Melbourne area. Species may be an occasional visitor to larger wetlands.	Low
Osprey	*Pandion haliaetus*	PMST	Primarily a coastal bird of prey around most of Australia. Least common along, and perhaps absent from, central Victorian coast.	Low. No suitable habitat in the project boundary, and no historical records on VBA or BLA.	Low
White-throated Needletail	*Hirundapus caudacutus*	V:148(2006), B:43(2017), PMST	Almost exclusively aerial within Australia, occurring over most types of habitat, particularly wooded areas. Less often seen over open farm paddocks but has been recorded in vineyards flying between the rows of trees.	Moderate. Likely to forage occasionally in the airspace of the project boundary. Unlikely to have a strong association with the terrestrial habitats.	Low
Fork-tailed Swift	*Apus pacificus*	V:22(1995), B:2(2013), PMST	Aerial species, occurring over a wide range of environments, predominately over open countryside but sometimes over forests and urban landscapes.	Moderate. Likely to forage occasionally in the airspace of the project boundary. Unlikely to have a strong association with the terrestrial habitats.	Low
Rufous Fantail	*Rhipidura rufifrons*	V:42(2010), B:27(2010), PMST	Uncommon summer visitor to forests, particularly densely vegetated gullies.	High. Numerous reports along the Yarra River habitats.	Low. Widespread species that is unlikely to depend on habitats within the project boundary.

Common name	Scientific name	Source	Habitat preference	Likelihood of occurrence within the project boundary	Likelihood of important habitat occurring within project boundary
Satin Flycatcher	*Myiagra cyanoleuca*	V:25(2010), B:12(2010), PMST	Uncommon summer migrant in forests, particularly densely vegetated gullies.	High. Numerous records along the Yarra River habitats.	Low. Widespread species that is unlikely to depend on habitats within the project boundary.
Black-faced Monarch	*Monarcha melanopsis*	PMST	Summer migrant to rainforests, forests, denser woodlands and densely vegetated gullies.	Low. No records in the project boundary. Species may be rare visitor.	Low
Yellow Wagtail	*Motacilla flava*	PMST	Primarily a rare coastal visitor. Prefers open country, such as those near airfields, swamps, sewage ponds.	Low. No records in the project boundary. Species may be rare visitor or vagrant.	Low

Legend

Record
V:##(####) – VBA results: number of records (year of last record)
B:##(####) – BLA results: number of records (year of last record)
PMST – Protected Matters Search Tool

Note: The descriptions of preferred habitat for threatened, migratory and/or marine species have been generated based on published species accounts – particularly from the Species Profile and Threats Database (SPRAT) database of DoEE (*http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl*) and the Viridans Atlas and Field Guide to Plants and Animals of Melbourne Area (*https://viridans.com/wtajammel/*) – and reference books including, but not limited to, the Handbook of Australian and New Zealand and Antarctic Birds (HANZAB) Volumes 1 to 7 (1990–2006) and field guides to the mammals of Australia (Menkhorst and Knight, 2010), birds of Australia (Morcombe, 2004; Pizzey and Knight, 2012), frogs of Victoria (Hero et al, 1991) and Australia (Tyler and Knight, 2009), reptiles of Australia (Cogger, 2014; Wilson and Swan, 2013) and fish of Australia (Wager and Jackson, 1993; Allen et al, 2002).

Records column presents the number of records of a species within the VBA output rather than a count of individuals recorded. This approach was taken for consistency as not all records include count data.

Appendix D PMST results

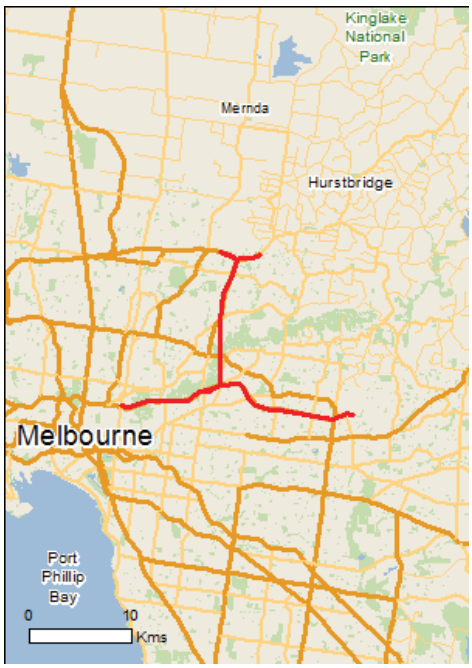
EPBC Act Protected Matters Report

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

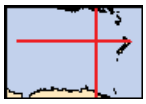
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 06/03/18 13:32:00



Coordinates
Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	1
National Heritage Places:	8
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	45
Listed Migratory Species:	16

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	15
Commonwealth Heritage Places:	11
Listed Marine Species:	24
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	4
Regional Forest Agreements:	1
Invasive Species:	56
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Royal Exhibition Building and Carlton Gardens	VIC	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Historic		
Abbotsford Convent	VIC	Listed place
High Court of Australia (former)	VIC	Listed place
ICI Building (former)	VIC	Listed place
Melbourne Cricket Ground	VIC	Listed place
Melbourne's Domain Parkland and Memorial Precinct	VIC	Listed place
Newman College	VIC	Listed place
Royal Exhibition Building National Historic Place	VIC	Listed place
Sidney Myer Music Bowl	VIC	Listed place

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community known to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community may occur within area
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Breeding known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat known to occur within area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Vulnerable	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Frogs		
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog [1828]	Vulnerable	Species or species habitat known to occur within area
Insects		
Paralucia pyrodiscus lucida Eltham Copper Butterfly [66766]	Endangered	Species or species habitat known to occur within area
Synemon plana Golden Sun Moth [25234]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat known to occur within area
Caladenia amoena Charming Spider-orchid [64502]	Endangered	Species or species habitat likely to occur within area
Caladenia rosella Rosella Spider-orchid, Little Pink Spider-orchid [5086]	Endangered	Species or species habitat likely to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat known to occur within area
Diuris fragrantissima Sunshine Diuris, Fragrant Doubletail, White Diuris [21243]	Endangered	Species or species habitat may occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to occur within area
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat likely to occur within area
Pomaderris vacciniifolia Round-leaf Pomaderris [4256]	Critically Endangered	Species or species habitat likely to occur within area
Prasophyllum colemaniae Lilac Leek-orchid [41647]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704]	Endangered	Species or species habitat likely to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat may occur within area
Rutidosis leptorrhynchoides Button Wrinklewort [7384]	Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Delma impar Striped Legless Lizard [1649]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Limosa lapponica		
Bar-tailed Godwit [844]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Defence - BOUGAINVILLE BARRACKS
Defence - CARLTON TRAINING DEPOT (Watsonia)
Defence - Cordel House
Defence - DEFENCE PLAZA MELBOURNE
Defence - Defence Depot
Defence - English Electric House
Defence - HAWTHORN TRAINING DEPOT
Defence - IVANHOE TRAINING DEPOT
Defence - Office Accomodation
Defence - SIMPSON BARRACKS - WATSONIA
Defence - SOUTH MELBOURNE TRAINING DEPOT
Defence - SURREY HILLS TRAINING DEPOT
Defence - Sands & Mcdougall Bldg
Defence - VICTORIA BARRACKS - MELBOURNE

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Canterbury Post Office	VIC	Listed place
Commonwealth Offices Building	VIC	Listed place
Melbourne General Post Office	VIC	Listed place
Victoria Barracks A Block	VIC	Listed place
Victoria Barracks C Block	VIC	Listed place
Victoria Barracks F Block	VIC	Listed place
Victoria Barracks G Block	VIC	Listed place
Victoria Barracks Guardhouse (former)	VIC	Listed place
Victoria Barracks J Block	VIC	Listed place
Victoria Barracks Precinct	VIC	Listed place
Victoria Barracks, The Keep	VIC	Listed place

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Gresswell Forest (part a) N.C.R.	VIC
Gresswell Forest (part b) N.C.R.	VIC
Gresswell Hill N.C.R.	VIC
Ironbark Road N.C.R.	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Central Highlands RFA	Victoria

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos Song Thrush [597]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-37.689808 145.113119,-37.691811 145.106939,-37.69266 145.096768,-37.693713 145.093421,-37.690895 145.088743,-37.687634 145.078186,-37.691064 145.088572,-37.693815 145.092906,-37.700844 145.090674,-37.706413 145.088486,-37.710996 145.085095,-37.717039 145.081491,-37.734893 145.078572,-37.780019 145.07883,-37.784157 145.069045,-37.785175 145.060247,-37.790839 145.051064,-37.791042 145.015444,-37.79562 144.998578,-37.794773 144.991497,-37.795722 144.999994,-37.791076 145.0148,-37.79111 145.049647,-37.784632 145.061749,-37.78392 145.068959,-37.78046 145.078744,-37.779714 145.094494,-37.78063 145.097755,-37.788872 145.102519,-37.793891 145.109428,-37.797214 145.12256,-37.797011 145.129899,-37.804369 145.177106,-37.800164 145.190238,-37.8003 145.192727,-37.800741 145.195173

Acknowledgements

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

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

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

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

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix E Key threatening processes (EPBC Act) and potentially threatening processes (FFG Act)

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)	EPBC Act	High. Process occurs within entire study area, project boundary and at Simpson Barracks.	No Land clearing associated with urbanisation has resulted in this process taking hold across the area already.
Competition and land degradation by rabbits	EPBC Act	Low. Rabbits occur within the project boundary and at Simpson Barracks, but generally in low densities and not to the point of causing land degradation.	No The influence of rabbits would unlikely change due to North East Link.
Predation by European red fox	EPBC Act	High. Process occurs within entire study area, project boundary and at Simpson Barracks.	No Predation of native fauna by foxes would unlikely change due to North East Link.
Predation by feral cats	EPBC Act	High. Process occurs within entire study area, project boundary and at Simpson Barracks.	No Predation of native fauna by feral cats would unlikely change due to North East Link.
Dieback caused by the root-rot fungus *Phytophthora cinnamomi*	EPBC Act	Low No signs of dieback were observed in the project boundary. Little documented evidence of Cinnamon Fungus in fragmented, urban landscapes. Few higher risk plants such as Banksia and Xanthorrhoea.	Given the amount of soil movements that will occur during construction, there is the potential, if inappropriately managed. However, if the CEMP has a specific section addressing *Phytophthora*, the risk can be managed so that North East Link would unlikely exacerbate the threatening process.
Land clearance	EPBC Act	Present Land would be cleared to facilitate North East Link.	Yes Clearing of up to 53 hectares of patches native vegetation, 74 large trees in patches and 284 scattered trees. None of the patches constitutes a threatened community under the EPBC Act or the FFG Act.

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act	Moderate Project located in urban area already invaded with garden species.	No Much of the native vegetation and indigenous planted vegetation recorded within the project boundary would be removed to facilitate North East Link, reducing the risk.
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	EPBC Act/FFG Act	Unlikely Project boundary occurs within highly urbanised area and large existing transport corridor (Greensborough Road, the Metropolitan Ring Road and the Eastern Freeway).	No
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	EPBC Act/FFG Act	Moderate – High. The Amphibian Chytrid Fungus is likely to be widespread throughout frog populations and habitats within the project boundary already, and additional local movements of chytrid fungus (such as through transport of soil, wet or muddy equipment) are unlikely to cause ecologically significant impacts on frog populations in the area.	No, through site-specific hygiene measures that will limit the movements of soil and water between sites. North East Link would not involve activities that would likely introduce or increase the spread of chytrid fungus.
Novel biota and their impact on biodiversity	EPBC Act	Unlikely North East Link would be constructed in an already disturbed and urbanised landscape where indigenous and non-indigenous biota already occur.	No
Alteration to the natural flow regimes of rivers and streams.	FFG Act	Moderate Existing flow regimes of waterways in the study area are currently impacted by river regulation and increased stormwater connectivity.	No (with mitigation)

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Alteration to the natural temperature regimes of rivers and streams.	FFG Act	Low Existing streams are modified channels including covered or tunnelled reaches, but no thermal impacts from impoundments.	No Thermal impacts of planned channel modification would be minimal.
Degradation of native riparian vegetation along Victorian rivers and streams.	FFG Act	High All riparian vegetation within the project boundary has already been degraded historically to some degree through urbanisation associated with development of Melbourne. North East Link would result in further degradation of riparian vegetation at some locations.	Yes North East Link would impact native riparian vegetation along Koonung and Banyule Creeks. Additional impacts are not expected to alter the ecological effectiveness of the waterways, given the extent of existing degradation.
Habitat fragmentation as a threatening process for fauna in Victoria	FFG Act	Unlikely North East Link would be constructed in an already fragmented urban landscape.	No Any additional fragmentation is not expected to be extensive enough to alter the ecological effectiveness of existing habitat or wildlife corridors, or to create new barriers to fauna movement.
Increase in sediment input into Victorian rivers and streams due to human activities.	FFG Act	High North East Link would be constructed in an urbanised area where sediment input into rivers and streams is already occurring from human activities. Project boundary occurs within close proximity of waterways (such as Koonung Creek, Banyule Creek, Plenty River and Yarra River).	No A CEMP would be developed for the construction phase detailing best-practice measures to prevent sediment runoff and discharges during construction. Discharge and spillways would also be designed to prevent movement of sediment into local rivers and waterways from built infrastructure.

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Input of toxic substances into Victorian rivers and streams.	FFG Act	High North East Link would be constructed in an urbanised area where input of toxic substances into rivers and streams already occurs occasionally from human activities. Project boundary occurs within close proximity of waterways (such as Koonung Creek, Banyule Creek, Plenty River and Yarra River).	No A CEMP would be developed for the construction phase detailing best-practice measures to prevent discharges of toxic substances into waterways during construction. Discharge and spillways would also be designed to prevent discharges of toxic substances into local rivers and waterways from built infrastructure.
Invasion of native vegetation by Blackberry *Rubus fruticosus* spp. agg.	FFG Act	High Blackberry recorded from within the project boundary.	No Native vegetation within the project boundary is already heavily invaded by Blackberry and North East Link would unlikely exacerbate this threatening process.
Invasion of native vegetation by 'environmental weeds'.	FFG Act	High. Declared weed species recorded within project boundary.	No Native vegetation within the project boundary is already heavily invaded by 'environmental weeds' and North East Link would unlikely exacerbate this threatening process.
Invasion of native vegetation communities by Tall Wheat-grass *Lophopyrum ponticum*.	FFG Act	Unlikely. Species not recorded or identified by VBA as occurring within 5 km of the project boundary.	No

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Loss of biodiversity as a result of the spread of Coast Wattle (*Acacia longifolia* subsp. *sophorae*) and Sallow Wattle (*Acacia longifolia* subsp. *longifolia*) into areas outside its natural range.	FFG Act	High Sallow Wattle present within project boundary.	Possible Clearance of native vegetation may create opportunities for Sallow Wattle to invade further into the project boundary. Ongoing monitoring and mitigation would be required to reduce the likelihood of this threatening process being exacerbated by North East Link.
Loss of coarse woody debris from Victorian native forests and woodlands	FFG Act	High Coarse woody debris has been lost from many of the patches of native vegetation across the study area.	No. Direct impacts on native forests and woodlands would comprise removal of vegetation and habitat rather than removal of coarse woody debris alone.
Loss of hollow-bearing trees from Victorian native forests	FFG Act	Moderate. All occurrence of loss of moderate and large trees from across the study area is likely to involve loss of hollows (even if small) that may be used by fauna. Few hollows were observed within the project boundary, but small hollows are likely to be present in some locations (such as Yarra Flats, Banyule Flats).	No. Most vegetation loss associated with North East Link is from areas where trees are relatively young and unlikely to have hollows. Some areas (such as Simpson Barracks) support larger trees that may have small hollows. Extent of hollow loss is not expected to be extensive enough to exacerbate the threatening process.

Threatening process	Source	Likelihood of occurrence within study area	Project likely to exacerbate threatening processes?
Spread of *Pittosporum undulatum* in areas outside its natural distribution.	FFG Act	High. Sweet Pittosporum present within project boundary.	Possible. Clearance of native vegetation may create opportunities for Sweet Pittosporum to invade further into the project boundary. Ongoing monitoring and mitigation would be required to reduce the likelihood of this threatening process being exacerbated by North East Link.
The spread of *Phytophthora cinnamomi* from infected sites into parks and reserves, including roadsides, under the control of a state or local government authority.	FFG Act	Low No signs of dieback were observed in the project boundary. Little documented evidence of Cinnamon Fungus in fragmented, urban landscapes.	No (with mitigation)
Use of Phytophthora-infected gravel in construction of roads, bridges and reservoirs.	FFG Act	Low No signs of dieback were observed in the project boundary. Little documented evidence of Cinnamon Fungus in fragmented, urban landscapes.	No (with mitigation).
Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing	FFG Act	High Most of the wetlands and waterways in the study area are highly modified and degraded due to human intervention.	Possible. Groundwater changes as a result of tunnelling may cause further loss or degradation of wetlands and waterways. Groundwater changes are discussed in Section 10 on groundwater dependent ecosystems and Section 12 (impact assessment).

Appendix F Salvage and Translocation Plan

North East Link Project

Salvage and Translocation Plan

July 2019

This report is prepared to inform the Inquiry and Advisory Committee and the public about the North East Link. This report may be of assistance to you but the North East Link Project (a division of the Major Transport Infrastructure Authority) and its employees, contractors or consultants (including the issuer of this document) do not guarantee that the report is without any defect, error or omission of any kind or is appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this report.

Table of contents

Table index

Figure index

Summary of this Plan

The following table summarises this Salvage and Translocation Plan.

Project title	North East Link
Taxon to be translocated	Matted Flax-lily *Dianella amoena* Arching Flax-lily *Dianella longifolia* var. *grandis*
Number of plants to be translocated	Approximately 95 plants/patches, including one large patch (15 x 2 m) of Matted Flax-lily may be subject to removal. However, it should be recognised that the final figure is likely to vary (+/-) depending on the prevailing conditions at the time of salvage. Five individuals of Arching Flax-lily were observed within the project boundary and are likely to be subject to removal.
Proposed dates of translocation	The proposed timing of translocation depends on when project planning and environmental approvals are received and on project procurement. Works are likely to start in 2020. Timing of salvage and translocation is to be determined, although the intent is to translocate plants either directly or within a year of salvage (and no later than two years after salvage). Alteration to this program may be considered if suitable conditions are prevalent or if early human intervention is likely to lead to higher salvage success rates. Translocation is proposed to be undertaken within two years of salvage; subject to both the conditions of the plants at the time of salvage, and the conditions of the recipient site(s).
Source location or propagation facility	North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include upgrade works at the Eastern Freeway. Within the project area (see Figure 1-1), Matted Flax-lily has been identified within the: • M80 Ring Road reserve • Hurstbridge line rail corridor • Commonwealth land (Simpson Barracks site). Arching Flax-lily has been identified within: • Commonwealth land (Simpson Barracks site) • Colleen Reserve • Crown land north of the Eastern Freeway between Yarra Boulevard and the Yarra River.
Recipient sites	The plan outlines the process for identifying a recipient site and presents a number of potential sites.
Summary of the Translocation	North East Link Project (NELP) is proposing to salvage and translocate approximately 95 individual plants/patches of Matted Flax-lily and five plants of Arching Flax-lily. This plan documents: • A protocol for salvage and translocation • Nomination and selection criteria to determine a recipient site(s) • Pre-clearance surveys • Post translocation management • Monitoring and reporting • Contingency planning and adaptive management

1. Introduction

1.1 Objectives

GHD Pty Ltd (GHD) and Emerge Environmental Services Pty Ltd (Emerge Associates) were engaged by the North East Link Project (NELP) to prepare a Salvage and Translocation Plan for Matted Flax-lily *Dianella amoena* and Arching Flax-lily *Dianella longifolia* var. *grandis* to support the Environment Effects Statement (EES) and Public Environment Report (PER) required to inform approvals for the North East Link project.

The objectives of this plan are to:

- Provide background on the project, Matted Flax-lily and Arching Flax-lily, and the regulatory requirements for translocation
- Identify Matted Flax-lily and Arching Flax-lily plants to be salvaged
- Outline the criteria and process for the selection of suitable recipient site(s) for the translocated plants
- Provide details on pre- and post-translocation management actions for the salvage and recipient sites
- Establish clear and effective protocols for the salvage, translocation, propagation, management and monitoring of plants that must be removed prior to project construction
- Identify roles and responsibilities for the parties involved in the translocation process
- Establish benchmarks for translocation success
- Outline future reporting requirements and provide guidelines for potential contingency and adaptive-management measures during the monitoring period
- Satisfy regulatory requirements under Australian Government and Victorian Government legislation.

1.2 What is translocation?

Translocation is 'the deliberate transfer of plants or regenerative plant material from an *ex situ* collection or natural population to a new location, usually in the wild. It includes reintroduction, introduction, reinforcement, assisted migration and assisted colonization' (Commander *et al*., 2018). Commander *et al*. (2018) describes translocations as occurring for two reasons:

- to assist in the management and conservation of threatened plant species (here termed Conservation Translocation); and to
- ameliorate the impacts of urban, agricultural or industrial development on a threatened species (here termed Mitigation Translocation).

Mitigation Translocations occur when the source population is under immediate threat of destruction and needs to be moved (Commander *et al*., 2018). In the case of Matted Flax-lily and Arching Flax-lily and the North-East link project, this plan is considered a mitigation translocation plan.

1.3 Project description

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from Springvale Road to near Hoddle Street.

The North East Link alignment and its key elements assessed in the Environment Effects Statement (EES) include:

- **M80 Ring Road to the northern portal** – from the M80 Ring Road at Plenty Road, and the Greensborough Bypass at Plenty River Drive, North East Link would extend to the northern portal near Erskine Road utilising a mixture of above, below and at surface road sections. This would include new road interchanges at the M80 Ring Road and Grimshaw Street.
- **Northern portal to southern portal** – from the northern portal the road would transition into twin tunnels that would connect to Lower Plenty Road via a new interchange, before travelling under residential areas, Banyule Flats and the Yarra River to a new interchange at Manningham Road. The tunnel would then continue to the southern portal located south of the Veneto Club.
- **Eastern Freeway** – from around Hoddle Street in the west through to Springvale Road in the east, modifications to the Eastern Freeway would include widening to accommodate future traffic volumes and new dedicated bus lanes for the Doncaster Busway. There would also be a new interchange at Bulleen Road to connect North East Link to the Eastern Freeway.

These areas are illustrated in Figure 1-1.

The project would also improve existing bus services from Doncaster Road to Hoddle Street through the Doncaster Busway, as well as pedestrian connections and the bicycle network, with connected walking and cycling paths from the M80 Ring Road to the Eastern Freeway. For a detailed description of the project, refer to EES Chapter 8 – Project description.

1.4 Vegetation within the Project boundary

Vegetation within the project boundary is predominantly located within the Gippsland Plain bioregion, and to a lesser extent the Highlands–Southern Fall and Victorian Volcanic Plain bioregions.

The northern parts of the project generally pass through areas that have been previously disturbed. The woodland and forest areas that remain have regenerated or have been re-planted, and are generally in poor to moderate condition. The exceptions to this are the larger intact areas of woodland within Simpson Barracks and a small area of Commonwealth land immediately south of Simpson Barracks. Simpson Barracks contains a relatively large area of remnant woodland/forest (EVC 55: Plains Grassy Woodland), particularly for this part of otherwise urbanised Melbourne.

Key areas of riparian and floodplain vegetation located within the project boundary are associated with the Yarra River and its tributaries, including Koonung Creek in the south and Banyule Creek near the centre of the project area. Vegetation in these areas generally consists of Floodplain Riparian Woodland (EVC 56) or Swampy Riparian Woodland (EVC 83). These areas contain a mature or developing canopy of River Red Gum *Eucalyptus camaldulensis*, which form remnant patches or occur as isolated scattered trees. The understorey shrub layer is generally species-

rich, although herbs and graminoids are largely absent due to the presence of high-threat weeds, including Wandering Trad *Tradescantia fluminensis*.

The project boundary also contains several areas of good quality remnant Plains Grassy Woodland (EVC 55) and Valley Grassy Forest (EVC 47), which are characterised by a canopy layer comprising several *Eucalyptus* species and a grassy understorey.

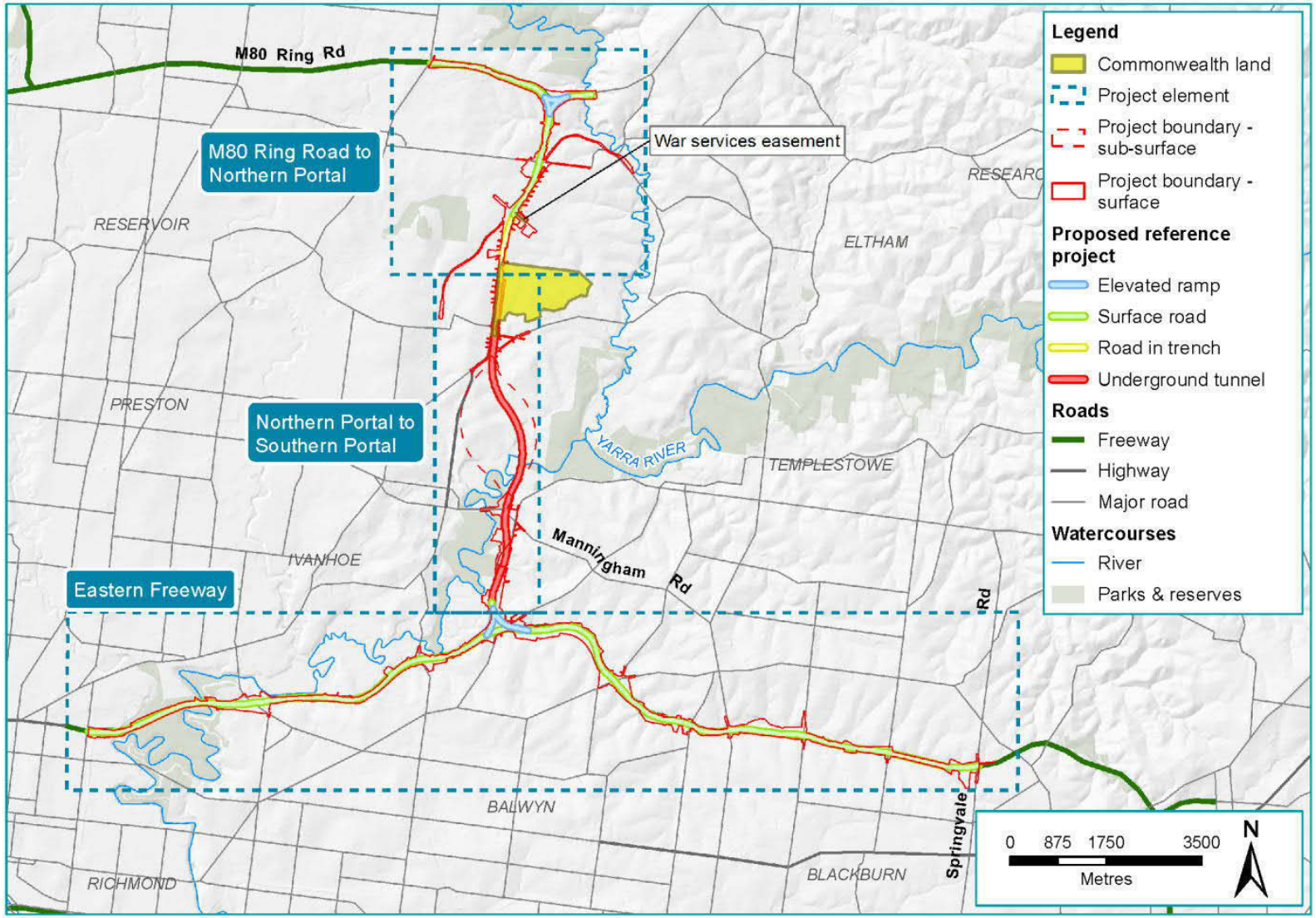


Figure 1-1 North East Link overview

1.5 Matted Flax-lily background

1.5.1 Species description

The National Recovery Plan for the Matted Flax-lily *Dianella amoena* (Carter, 2010) describes Matted Flax-lily as:

> *...in the family Hemerocallidaceae (formerly included in the family Liliaceae) is a tufted, mat–forming perennial lily. Plants are rhizomatous and can form loose clumps up to 5 m wide. Rhizomes are yellow and slender, with shoots arising every 10–30 cm. Leaves are grey-green, dull crimson at the base, narrow and tapering, to 45 cm long by 12 mm wide, and broadly V-shaped, with a prominent abaxial keel along the midrib and loose clasping leaf sheaths. Blades, sheaths and midribs usually have small, irregularly spaced teeth. Leaves are deciduous in summer if plants are water-stressed (Gray & Knight 2001). The inflorescence is erect, 20–90 cm long, with a slender, arching scape that bears several bluish, star-shaped, nodding, sweetly fragrant flowers. Perianth segments are pale to deep blue-violet, recurved, elliptic, to 10 mm long by 3 mm, the outer tepals with five veins, the inner tepals with three veins. There are six stamens, to 7 mm long, with pale yellow filaments, orange strumae and pale lime-yellow anthers, while the style is whitish-translucent, to 6 mm long. Fruits are ovoid purple berries to 7 mm long, and seeds are shiny black and smooth, to 3 mm long. Flowering occurs from October to April* (description from Carr & Horsfall, 1995).

Typical images of the plant in various stages of growth and reproduction are shown in Plate 1a –d.

Plate 1a–d Matted Flax-lily in situ (Cameron Miller, Emerge Associates)

1.5.2 Conservation status

Matted Flax-lily is listed as Endangered under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999 (*'EPBC Act') and the Victoria Department of

Environment, Land, Water and Planning's (DELWP) Advisory List, and as Threatened under the Victorian Government's *Flora and Fauna Guarantee Act 1988* ('FFG Act'). In 2010, a National Recovery Plan was prepared for the species, outlining recovery objectives and actions necessary to ensure the long-term survival of the species. The Recovery Plan identified the major current threats to the species as weed invasion and competition, habitat destruction and disturbance, and population fragmentation (Carter, 2010).

1.5.3 Habitat and ecology

In Victoria, Matted Flax-lily typically occurs in grassland and grassy woodland habitats with fertile, well-drained to seasonally-wet soils ranging from sandy loams to heavy cracking clays (Carr & Horsfall, 1995; Gray & Knight, 2001).

Matted Flax-lily is typically found in association with native grasses such as Common Wheat Grass *Anthosachne scabra*, Common Tussock-grass *Poa labillardierei*, Kangaroo Grass *Themeda triandra*, Grey Tussock-grass *Poa sieberiana*, Wallaby Grass *Rytidosperma racemosa* var. *racemosa*, and Weeping Grass *Microlaena stipoides* var. *stipoides*. In grassy woodland habitat, associated tree species include Blackwood *Acacia melanoxylon* and a variety of *Eucalyptus* species, including River Red Gum *Eucalyptus camaldulensis*, Long-leaved Box *E. goniocalyx*, Red Stringybark *E. macrorhyncha* subsp. *macrorhyncha*, Yellow Box E. *melliodora*, Swamp Gum *E. ovata*, Snow Gum *E. pauciflora* subsp. *pauciflora*, and Red Box *E. polyanthemos* subsp. *vestita*. Matted Flax-lily is also found in association with various introduced grasses and herbs (Carr & Horsfall, 1995; Gray & Knight, 2001; Carter 2010).

Flowers are buzz-pollinated by the native Blue-banded Bee *Amegilla cingulata*. Fruits are readily formed but recruitment is often considered low or absent due to habitat disturbance and weed competition, with generally no seedlings produced. Instead, the species typically reproduces vegetatively through the production of rhizomes and ramets. The species can also be propagated by division (Carter, 2010; Ralph, 2003). However, given the size of some of the observed plants and their isolation from other plants within the project area, there is the potential that some of these have been produced through sexual reproduction and seed dispersal.

1.5.4 Current population and distribution

Matted Flax-lily is currently known to occur in Victoria and Tasmania. Approximately 2,500 plants are estimated to remain in the wild in Victoria, found in approximately 120 sites (Carter, 2010). Multiple populations are known from the northern suburbs of Melbourne, typically within remnant vegetation along roadsides and within rail corridors, in conservation reserves, and in translocation sites (Carter, 2010). The distribution of Matted Flax-lily at the time of writing the Recovery Plan is shown in Figure 1-2.

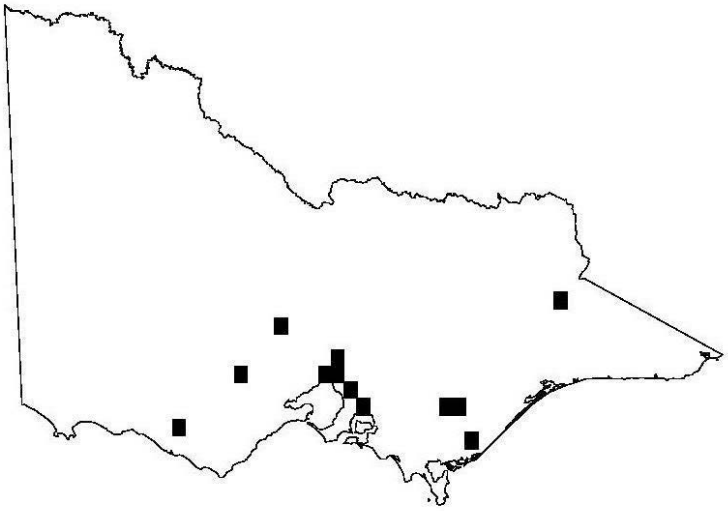


Figure 1-2 Distribution of Matted Flax-lily in 2010 (Carter, 2010)

It should be noted that the Recovery Plan is somewhat outdated, and since the expansion of Melbourne's urban growth boundary, additional records and sites have been found as demonstrated by a recent extract of Matted Flax-lily observations from NatureKit (DELWP, 2017), shown in Figure 1-3.

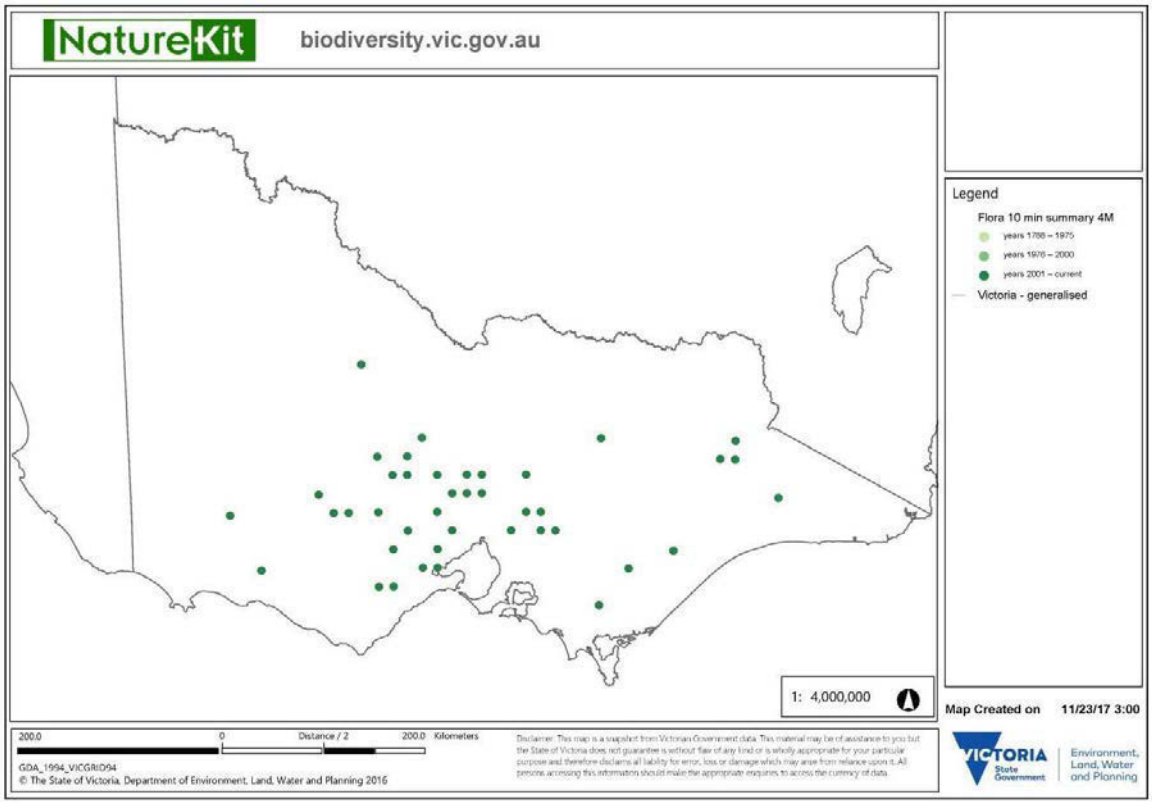


Figure 1-3 Current observations of Matted Flax-lily from 2000–2017 (DELWP, 2017)

1.5.5 Population and distribution within project area

Suitable habitats within the project area were surveyed between October and December 2017. Matted Flax-lily was identified at three sites within the project area defined for the project's EPBC referral:

- Commonwealth land (Simpson Barracks)
- M80 Ring Road reserve

- Hurstbridge rail line

Each of these sites was surveyed on two separate events by a team of ecologists. Table 1-1 summarises the Matted Flax-lily observations and Figure 1-4 shows the mapped observations for individuals/patches recorded during targeted surveys for the project. Overall, approximately 11 hectares of Matted Flax-lily habitat occurs within the project boundary. Figure 1-5 shows previous mapped observations at Simpson Barracks (HLA, 2007).

Table 1-1 Results of the Matted Flax-lily survey for North East Link

Approximate number of individuals	Approximate area encompassed by patches (m^2)
Whole assessment (i.e. inside and outside of the project boundary)	
217 + one large patch (15 x 2 m)	8529
Within the project boundary	
95 (including one large patch (15 x 2 m)	3134

Paper Size A3

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Matted Flax-lily
- Matted Flax-Lily Patch

NORTH EAST LINK PROJECT

North East Link Project
Environment Effects Statement (EES)

Job Number 31-35006
Revision E
Date 21 Jun 2019

Matted Flax-lily Locations M80

Figure 1-4
(Page 1 of 5)

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Matted_Flax_Lily_A3L_RevF.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Paper Size A3

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Matted Flax-lily
- Matted Flax-Lily Patch

North East Link Project
Environment Effects Statement (EES)

Job Number 31-35006
Revision E
Date 21 Jun 2019

Matted Flax-lily Locations
Hurstbridge rail line

Figure 1-4
(Page 2 of 5)

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Matted_Flax_Lily_A3L_RevF.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Paper Size A3

0 7 14 21 28

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Matted Flax-lily
- Matted Flax-Lily Patch

North East Link Project
Environment Effects Statement (EES)

Job Number	31-35006
Revision	E
Date	21 Jun 2019

Matted Flax-lily Locations Hurstbridge rail line

Figure 1-4
(Page 3 of 5)

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Matted_Flax_Lily_A3L_RevF.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Paper Size A3

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Matted Flax-lily
- Matted Flax-Lily Patch

North East Link Project
Environment Effects Statement (EES)

Matted Flax-lily Locations Hurstbridge rail line

Job Number	31-35006
Revision	E
Date	21 Jun 2019

Figure 1-4
(Page 4 of 5)

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Matted_Flax_Lily_A3L_RevF.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Paper Size A3

0 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Matted Flax-lily
- Matted Flax-Lily Patch

NORTH EAST LINK PROJECT

North East Link Project
Environment Effects Statement (EES)

Job Number	31-35006
Revision	E
Date	21 Jun 2019

Matted Flax-lily Locations Simpson Barracks

Figure 1-4
(Page 5 of 5)

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Matted_Flax_Lily_A3L_RevF.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

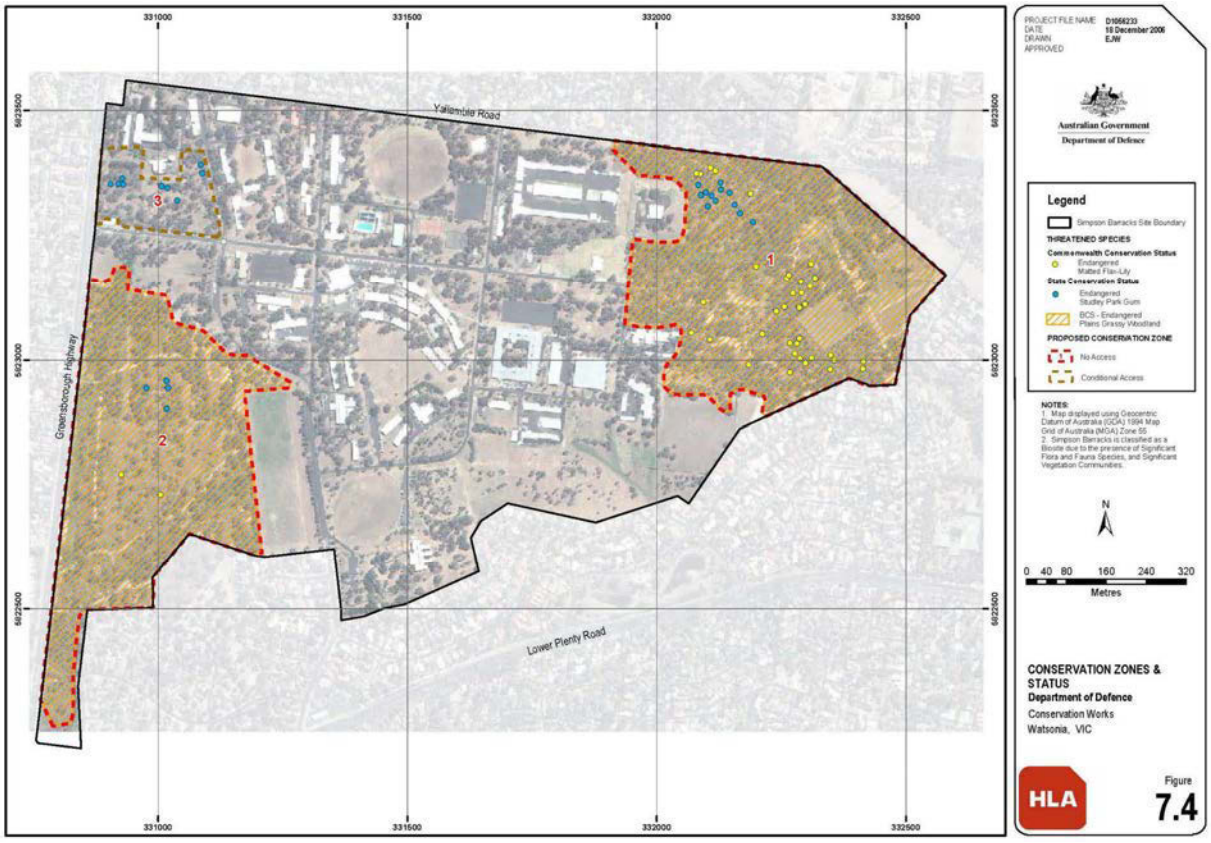


Figure 1-5 Previously mapped distribution of Matted Flax-lily within Simpson Barracks (HLA, 2007)

1.6 Arching Flax-lily background

1.6.1 Species description

Arching Flax-lily is a perennial graminoid that grows to 1.3-metres tall in solitary tufts or loose patches up to 40-centimetres wide. Its leaves are glaucous, rather thick-textured and firm, measuring 12 to 25 millimetres wide at midpoint when flattened. It flowers from November to December (Flora of Victoria, 2018). The leaves are known to have a prominent central rib. Flowers have an open pyramidal panicle to 30 x 60 centimetres with long spreading side branches and strongly fragrant flowers (Bull, 2014).

Typical images of the plant are shown in Plate 2.

Plate 2 a-b Arching Flax-lily in situ (Tim Wills, GHD)

1.6.2 Conservation status

Arching Flax-lily is not listed under the EPBC Act or the FFG Act. It is considered a vulnerable taxon under the DELWP Advisory List.

1.6.3 Habitat and ecology

In Victoria, Arching Flax-lily typically occurs in well-drained skeletal soils often associated with rocky outcrops, full sun and semi-shade (Bull, 2014). Once considered widespread over the volcanic plains, many populations are now small and isolated as a result of habitat clearance, grazing and disturbance.

1.6.4 Current population and distribution

Following urban expansion, many of the remaining populations of this species are very small and fragmented in Victoria, where it is mainly concentrated in the Victorian Volcanic Plain and Victorian Riverina bioregions (refer to Figure 1-6).

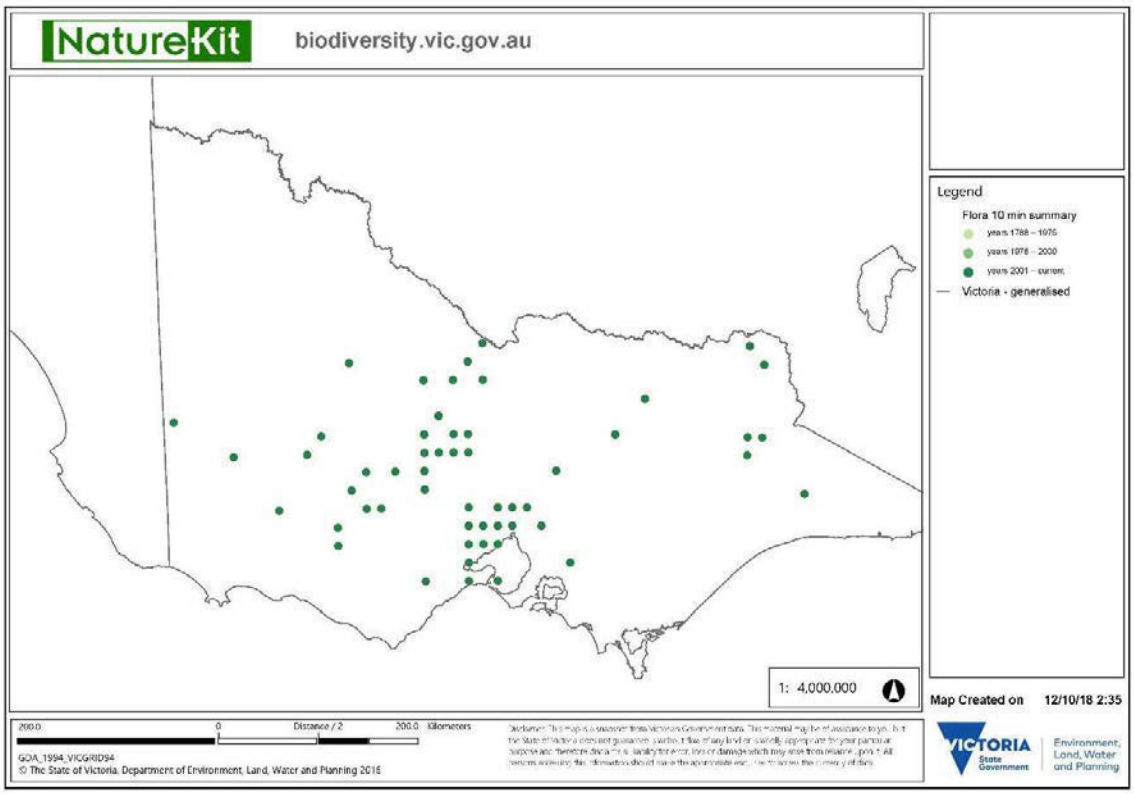


Figure 1-6 Current observations of Arching Flax-lily from 2000 – 2018 (DELWP, 2018)

1.6.5 Population and distribution within project area

Two individuals were identified during field assessments at Simpson Barracks, although one of these is located outside the project boundary. One individual was observed within the project boundary at Colleen Reserve and a further three individuals were identified within the project boundary on the north side of the Eastern Freeway, between Yarra Boulevard and the Yarra River on Crown land recognised as a Public Park and Recreational Zone. These locations are shown in Figure 1-7.

Paper Size A3

0 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Arching Flax-lily

North East Link Project
Environment Effects Statement (EES)

Job Number	31-35006
Revision	A
Date	21 Jun 2019

Figure 1-7

(Page 1 of 2)

Arching Flax-lily Locations

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Arching_Flax_lily_distribution _A3L_RevB.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Paper Size A3

0 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Project boundary - sub-surface
- Project boundary - surface
- Arching Flax-lily

North East Link Project
Environment Effects Statement (EES)

Job Number	31-35006
Revision	A
Date	21 Jun 2019

Figure 1-7
(Page 2 of 2)

Arching Flax-lily Locations

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Ecology\3135006_Arching_Flax_lily_distribution _A3L_RevB.mxd

Data source: CIP Imagery - DELWP - 2018 | Roads, LGA, Watercourses, Rail - Vicmap - 2018 | Project Boundary, MFL Locations - GHD,AECOM, BLA - 2018. Created by:trighetti

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

2. Regulatory setting and approvals

This section summarises the regulatory environment and permit requirements that relate to the translocation of Matted Flax-lily.

2.1 Environment Protection and Biodiversity Conservation Act 1999

NELP referred the North East Link project to the Commonwealth Department of the Environment and Energy (DoEE) on 17 January 2018 for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act').

On 13 April 2018 the delegate for the Minister for the Environment and Energy determined that the project is a 'controlled action' that has the potential to have a significant impact on the environment on Commonwealth land and on Matters of National Environmental Significance (MNES). The decision notice also advised that the project would be assessed through a Public Environment Report (PER).

The ecological assessment prepared for the project's EPBC referral concluded the project would likely have a significant impact on Matted Flax-lily based on its potential to fragment an existing population and remove habitat to the extent the species is likely to decline.

When considered as part of a development proposal, translocation may be proposed as a mitigation measure, particularly for Matted Flax-lily. DoEE (2016) states '*The rhizomatous nature of Matted Flax-lilies allows plants to be translocated. Translocation has occurred at a number of sites*'. Translocation plans/strategies are factored into the approval decisions under section 133 of the EPBC Act to address any residual impacts MNES (DSEWPaC, 2013). Given that translocation measures are recognised to reduce residual impacts, ultimately this can lead to a reduction in required offsets. Any offsets for residual impacts to this MNES would be assessed under the EPBC Act offsets policy (DSEWPaC, 2012).

2.1.1 Application of Commonwealth outcomes-based policy

The Australian Government has developed policy and guidance on outcomes-based conditions under the EPBC Act. Outcomes-based conditions specify the environmental outcome that must be achieved by an approval holder without prescribing how that outcome should be achieved. Outcomes-based conditions allow approval holders to be innovative and achieve the best environmental outcome at the lowest cost, while increasing the public transparency of the required environmental outcomes.

With this in mind, a proposed environmental outcome that specifically relates to Matted Flax-lily has been developed, as well as measures to achieve this outcome. The proposed outcome for Matted Flax-lily detailed in this Salvage and Translocation Plan, are summarised in Table 2-1.

Table 2-1 Proposed outcome for Matted Flax-lily

Outcome
Matted Flax-lily populations directly impacted by North East Link must be translocated in accordance with a Salvage and Translocation Plan prepared to the satisfaction of the Department of Environment and Energy. There must be a net gain in the number of Matted Flax-lily plants/patches due to North East Link, measured by comparing the pre-impact and 10 year post-impact number of Matted Flax-lily plants/patches within the North East Link project boundary and approved translocation recipient sites. **Purpose of proposed outcome** As direct impacts on Matted Flax-lily would be unavoidable, the purpose of this proposed outcome is to require that Matted Flax-lily impacted by North East Link are successfully translocated so there is no net loss in their overall numbers or decline in the species due to North East Link.

2.1.2 Commonwealth offsets

Offsets are required under the EPBC Act to compensate for any residual impacts to MNES once avoidance and mitigation measures have been considered (DSEWPaC, 2012). An offset must deliver an overall conservation outcome that improves or maintains the viability of the MNES and should be tailored specifically to the attribute of the MNES that is to be affected.

Translocation measures for Matted Flax-lily are recognised as a successful and viable method to reduce residual impacts to negligible levels. Given that recent nearby projects (e.g. Mernda Rail Extension Project, Epping-South Morang Extension Project) comprising substantial removal of this species have not required offsets, it is proposed that consistent with this approach, offsets are not required for this project. Should DoEE consider that even with proposed translocation, residual impacts to Matted Flax-lily are likely, then NELP will be required to offset residual impacts in-line with the Commonwealth offset policy.

2.2 Flora and Fauna Guarantee Act 1988

Under section 48 of the FFG Act, a permit is required from the Secretary of DELWP for the translocation of flora listed under the Act. As part of the FFG Act permit application, a Salvage and Translocation Plan is to be submitted describing the justification, nature of and likely success of translocation as described in Appendix 1 and 2 of the *Procedures Statement for Translocation of Threatened Native Flora in Victoria* (Department of Environment and Primary Industries [DEPI] 2013c). This document also addresses the principles and decision-making framework that are used by DELWP when assessing a Salvage and Translocation Plan.

2.3 Permits and approvals

Before undertaking the proposed salvage and translocation of the Matted Flax-lily, NELP would:

- Seek approval from DoEE to salvage and translocate Matted Flax-lily
- Seek a general permit application for threatened species and ecological communities (section 201) from DoEE under the EPBC Act 1999
- Obtain a permit from DELWP pursuant to section 48 of the FFG Act for the translocation of listed flora.

Arching Flax-lily is not a ‘protected’ plant under the FFG Act or EPBC Act and as such does not trigger permit requirements.

3. Translocation management plan

3.1 Translocation activities

This section summarises the activities that would be undertaken to translocate the Matted Flax-lily[1]. Further detail is provided in Sections 4 to 7.

3.1.1 Salvage

Construction timing depends on the timing of planning and environmental approvals and procurement, and is indicatively envisaged to start in 2020. It is proposed that salvage would occur shortly before construction commencement. Salvaged material would be propagated in a nursery with demonstrated suitable experience with native plants (and preferably with Matted Flax-lily), and translocated to the selected recipient sites provided that:

- Plants have recovered from the disturbance of the salvage process, which is most readily identified by the new vegetative growth
- A sufficient number of clones have been propagated from the salvaged plants so the required number of individuals are able to be planted to satisfy any required offset

It is proposed that, where possible, whole plants (or sufficient material to produce the clones required) would be salvaged at least six weeks before construction works started, allowing for the salvage of any additional material if required. If sufficient material is not present, more clones may need to be produced from a lesser number of individuals, as discussed in Section 4.3.

Translocation would be completed under the supervision of a suitably qualified botanist approved by DELWP and the botanist would generally follow the Guidelines for the Translocation of Threatened Plants in Australia (Commander *et al.*, 2018) as applicable. The selection of a suitably qualified botanist to undertake salvage activities would be the responsibility of the construction contractor.

3.1.2 Nursery management

A suitable nursery for propagation would be engaged before salvage works started. Existing nurseries under consideration and with experience in Matted Flax-lily salvage and propagation include:

- ABZECO ecological consultants
- Victorian Indigenous Nursery Co-operative (VINC)
- Australian Ecosystems
- Merri Creek Management Committee (MCMC)
- Whittlesea City Council nursery

Initial conversations have been held with a number of the above-mentioned nurseries. Commercial quotes will be sought in mid-late 2019 for the salvage and propagation activities.

3.1.3 Recipient site management

Recipient sites would be identified in accordance with the process outlined in Section 1.

[1] It should be noted that Arching Flax-lily will be treated in the same way as Matted Flax-lily within this Plan. Therefore, generally, specific controls for Arching Flax-lily are not provided unless stated otherwise.

The ongoing management of each recipient site after translocation would be undertaken for 10 years following initial translocation, or until long-term performance benchmarks were met (see Section 7.1).

General management requirements are described in Section 5 and site-specific requirements would be developed once the recipient sites were identified.

3.2 Management responsibilities

Responsibilities of each party are summarised in Table 3-1.

Table 3-1 Translocation program responsibilities

Activity	Responsibility	Monitoring and reporting
Plant salvage and nursery management		
Pre-clearance survey	NELP	NELP
Nursery selection	NELP[2]	NELP
Plant salvage	Contractor	NELP
Nursery management until translocation completed	Contractor	NELP
Nursery management of "insurance" plants (after translocation)	Contractor until practical completion. NELP from practical completion to year 10.*	NELP
Recipient site management		
Site preparation	To be determined following selection of site(s)	NELP
Planting	To be determined following selection of site(s)	NELP
Management: Years 1 to 10	To be determined following selection of site(s)	NELP

** NELP will engage a suitably qualified contractor*

3.3 Timing and schedule

The proposed salvage of Matted Flax-lily material within the project disturbance area would be undertaken before construction of the project started and once the necessary approvals were obtained. This would likely be in 2020.

The optimal time for salvage and translocation is when Matted Flax-lily is not flowering or fruiting, daily maximum temperatures are low, soil moisture is high, and the corresponding increase in vegetative growth means the species can be easily identified in the field. Matted Flax-lily typically begins flowering in October and finishes setting seed by the end of April. Mean daily maximum temperatures in the project area are lowest during winter (June-August), which is also the season of most consistent rainfall (i.e. the highest mean number of days of rainfall per month). Conducting salvage and translocation between winter and early spring enhances the chance of success, primarily because the plants are more resilient to disturbance at this time, and because this timing allows for a longer period of beneficial growing conditions before the arrival of summer heat. Therefore, it is the preference that salvage would occur during winter or early spring before construction started, but provided that rainfall and other climatic

[2] In consultation with DoEE

conditions are suitable. Salvage and translocation may occur outside this time period if climatic conditions are conducive and/or if supplemental watering and monitoring were conducted to ensure the survival of the plants. Based on the current project timelines, salvage is expected to occur in autumn-winter 2020.

The exact timing of salvage and other translocation actions is yet to be determined. Table 3-2 summarises the timeline for translocation activities relative to the initial salvage event.

Table 3-2 Summary schedule for translocation

Task	Action	Timeframe
1	Pre-clearance surveys of salvage site, including installation of protective fencing around plants to be salvaged	Within 6 months before salvage
2	Identification of a suitable nursery	Within 3 months before salvage
3	Pre-translocation watering - undertake an appropriate watering schedule to maintain plant health and optimise translocation success	Assessment of plants to be translocated approximately 1 month before removal
4	Salvage of plants to be translocated	Prior to start of construction
5	Labelling of plants	During salvage and propagation at nursery
6	Propagation of clones (six per plant)	After transport of salvaged material to the nursery and then as needed during nursery management period
7	Nursery management	For up minimum of five years and up to 10 years following salvage, or until long-term performance criteria have been met
8	Preparation of a Management Plan for the recipient sites	Within 6 months before planting of salvaged material
9	Physical preparation of the recipient sites	Minimum of 6 months before planting of salvaged material
10	Initial translocation to recipient sites to include 4 clones of each plant (where possible) and 2 retained as a safety net in the nursery	Preference is within the 1st year of nursery management period (subject to site conditions) but no longer than 2 years Optimal time is for translocation is winter-early spring
11	Active recipient site management	For 10 years following initial translocation or until long-term performance criteria have been met
12	Monitoring period	Periodically for 10 years following salvage, or until long-term performance criteria have been met (monitoring schedule provided in Section 7)
13	Replacement plantings	As needed for 10 years following initial translocation; optimal time is winter-early spring
14	Reporting	Reports after salvage and initial translocation, and then annually for 10 years or until long-term performance criteria have been met. Reports to be delivered to DoEE and DELWP
15	Adaptive management measures	As needed during 10-year monitoring period, or until long-term performance criteria are met
16	Evaluation of long-term performance criteria	At end of 5th year following initial translocation. Further evaluation annually for years 5-10

4. Salvage and translocation

Survival rates for Matted Flax-lily that have been translocated for other developments in the local area have been high. The most relevant and recent examples are the South Morang Rail Extension Project and Melbourne Wholesale Markets. In addition, the Mernda Rail Extension Project has also been granted approval to translocate plants, although while these have been salvaged they are yet to be translocated. It is understood that the plants (clones) in the nursery are doing very well. Provided certain safeguards are in place, the translocation procedure is generally considered low risk.

This document incorporates protocols and procedures that have been informed by the translocation plans prepared for the Mernda Rail Extension Project (AECOM, 2016) and other translocation plans prepared for recent projects in Victoria, and have therefore been proven to be effective for the species in the local area. Measures to be implemented for the management and monitoring of the translocated plants are detailed in Section 7.

4.1 Pre-clearance surveys

The detectability of Matted Flax-lily plants and/or populations is known to vary significantly within and between seasons, and numbers of plants in a defined area can fluctuate markedly. This presents some difficulty both when defining a number of individuals to be impacted, but also provides uncertainty around the final number of Matted Flax-lily that are able to be salvaged and translocated. As such, it is proposed that a pre-clearance survey is implemented before construction works started (within the three months before construction). The aim of this survey is to confirm the total number of plants to be translocated and to identify any new individuals.

The pre-clearance survey would utilise the following methodology:

1. All patches identified by previous surveys would be located by differential GPS, and any deviations from previously recorded locations and/or additional patches identified during the salvage recorded using the GPS unit
2. Each patch or plant would be marked with a red flag by a qualified botanist. The flag nominates the individual is considered suitable for salvage
3. Appropriate protective fencing would be installed around each patch to protect the plants from damage before translocation
4. A qualified botanist would survey the area post-salvage to ensure all plants identified for translocated have been salvaged
5. A tally of plants would be recorded and mapped
6. The final removal number would be updated, and provided to DoEE and DELWP

4.2 Proposed end-uses of salvaged plants

The Matted Flax-lilies salvaged from within the project disturbance area will be divided, propagated and managed to reproduce vegetatively (that is, clone) to establish a nursery population of a sufficient number of plants to allow for a variety of end-uses, including as back-up material for each salvaged patch in case of plant mortality within the recipient sites. Establishing a nursery population would also provide an appropriate amount of time to prepare the recipient site(s) (such as weed control, fencing and vermin control) to maximise the probability of the clones surviving after replanting.

It is the intent that six clones are created from each plant, although this number may vary depending on the quality of the salvaged material. Where sufficient material cannot be obtained to generate six clones (for example small ramets/plants < 10 X 10 centimetres), a whole plant may be initially removed with the view to clone this plant in the nursery at a later date. Alternatively, where more than six clones can be created, this would be undertaken to increase the number of clones available for translocation and insurance.

The proposed end-uses of the propagated material include:

- Four clones would be grown at the nursery until the following winter-spring planting season, or until they become sufficiently established in the nursery, at which point they would be translocated to the recipient sites (proving suitable climatic conditions prevail).
- Two clones would be retained at the nursery for five to ten years. This material would be used for insurance to provide replacement plants in the case of losses of plants at the recipient site. If, at the end of the five-year period, not all these plants had been used for replacement planting, they would be provided to Parks Victoria and/or other local agencies or organisations for revegetation projects in the region.

The goals of these proposed end-uses are:

1. To ensure the proposed performance benchmarks are met at the recipient site (see Section 7.1).
2. Once those performance benchmarks have been met, to provide additional plants for other projects to expand the population and distribution of the Matted Flax-lily within Victoria.

4.3 Salvage protocol

A qualified botanist would oversee the salvage of all plants identified by the pre-clearance surveys as being suitable for translocation. All vegetative material of viable Matted Flax-lily plants within the proposed project disturbance area would be removed and salvaged utilising the following procedure:

1. Plants would be watered the day before the removal, or for several days if conditions are dry, to loosen the soil and to ensure the plants are not water-stressed during salvage and transport.
2. All patches previously marked with a red flag during the pre-clearance survey would be removed and recorded on a monitoring sheet. It is proposed that only enough material (attached ramets and rhizomes) is collected to generate the six clones. Any excess plant material can be left *in situ.*
3. For each patch removed, the extent (length and width) would be measured, recorded and a photo taken along with an estimation of the height of ramets.
4. Material would be dug from the ground by hand using suitable equipment that has been cleaned of dirt and debris before each day's removal work.
5. Plants/divisions should be excavated as intact clumps, so that sufficient soil is maintained around the root system to keep roots from exposure and desiccating. This would be achieved by wrapping the clump of roots in a wet hessian or similar material until plants are potted-up at the nursery.

6. Patches would be separated into divisions of a size that fits the transport container (polystyrene box or similar sealed container) to allow for ease of handling and transport. Care would be taken to ensure that sufficient root material was included with each division and that ramets were not separated from their attached rhizome/root base, to the extent practicable. Ideally, small plate-sized material would be left intact (approximately 14-centimetre diameter pots). If smaller pieces of rhizomes or ramets accidentally become separated from the larger divisions, these may be gathered and taken to the nursery, as Matted Flax-lily can be propagated from relatively small pieces of vegetative material.
7. Plant material other than Matted Flax-lily would be removed from the salvaged material prior to transport to the nursery.
8. All vegetative material removed would be labelled by patch and division identifiers, using small aluminium 'dog-tag' labels attached with wire, and recorded on a tracking form according to the system described in Section 4.4 (below), to monitor the number of divisions created and to facilitate identification and tracking upon arrival at the nursery.
9. Depending on soil moisture levels, the excavated divisions may need to be hand-watered so the soil is moist before transport.
10. Once all plants were lifted from the ground and placed into transport containers, they would be promptly transported to the nursery.

Consideration would be given to the preservation of material for the purpose of genetic testing, subject to further consultation with DoEE and DELWP.

4.4 Labelling

The correct labelling of all salvaged material needs to be undertaken so that plants can be identified and tracked throughout the entire removal, propagation, translocation and monitoring process.

Plants would be labelled with small metal labels at the salvage site during the removal and division process, using a numeric system that identified the patch and field division number. For example, the divisions from Patch 01 would be labelled 01-01, 01-02, 01-03 and so on.

At the nursery, the plants would be further divided to a size appropriate to the propagation containers – 14 to 24-centimetre diameter pots (6 to 10-inch pots) or other suitable propagation containers. The metal dog-tag would be replaced with a staked metal nursery label, and the side of the pots also labelled with a permanent marker. The nursery label would include the patch number and, in place of the two-digit field division number, use a three-digit nursery clone number (01-001, 01-002) to simplify tallying of the total number of divisions taken from the parent plant.

4.5 Propagation and nursery management

All plants to be grown at the nursery would be potted in a medium specifically designed for propagating native plants. Where achievable, six clones would be created to allow for four to be planted at the recipient site after one year, and two to be retained in the nursery as potential replacement plants in the case of mortality at recipient sites.

After the clones were potted, they must be managed correctly to maximise survival and good health within the nursery environment. Appropriate management would depend on conditions and the length of stay in the nursery. Watering, fertilisation, and disease and pest control would need to be undertaken to maximise survival and sufficient growth over the nursery management period. Disease and pest control in the nursery would be important so that no diseases or pests were introduced to the recipient site during delayed translocation. Correct hygiene procedures should be practiced at all times within the nursery. Any plants suspected of being infected by a pathogen or disease should be treated according to nursery guidelines or destroyed and disposed of appropriately to avoid spread of the pathogen/disease. Plants suspected of carrying a pathogen/disease or having pests would not be introduced to the recipient site. Weeding of pots would also be undertaken periodically and before translocation.

Generally, Matted Flax-lilies do well within a nursery environment and may spread to fill their container. If plants become pot-bound, further division and correct labelling would be undertaken.

Nursery populations would be monitored by a qualified botanist every six months in the first two years, and annually thereafter during the life of the program. Results of the nursery monitoring would be included in the translocation program's annual report (see Section 7.5).

Before planting into the recipient site, plants need to be 'hardened-off' (exposed to conditions similar to those at the recipient site) gradually so they are not stressed by a sudden change in watering regime, sun and wind exposure, or temperature. Before the plants are translocated into the recipient site(s), the health and readiness of the plants for translocation must be inspected and approved by the project botanist.

4.6 Planting procedure

The translocation to the recipient site would occur once plants were established within the nursery and conditions at the site (such as climate, soil moisture and weed control) are favourable. The ideal time to conduct translocation is during winter or early spring, when temperatures are cool and rainfall is more consistent. Planting would be overseen by a qualified botanist approved by DELWP. Planting of the plants/clones at the recipient site would be accomplished by adopting the following practices:

1. Holes would be pre-dug systematically and filled with water the day before translocation occurs; the holes would be dug roughly twice as wide and slightly deeper than the pot in which the material is grown in. The holes should be laid out in a loose grid formation, with plants spaced 3-5 metres apart, to assist in later monitoring of the plants. Holes should be placed so as to avoid impacts to existing native vegetation at the site, to the extent practicable.

   Holes should also be placed so they are not too close to any perimeter fence, any large trees or other vegetation that would excessively shade the translocated plants or compete with them for water or nutrients. The spoils from the hole should be broken down into small clumps and mixed with a small amount of weed-free planting medium to serve as backfill during planting.

2. The pre-dug planting holes would be re-filled with water just before the translocation to moisten and soften the surrounding soil and facilitate quick root growth. Any high-threat weeds not already removed from the area immediately around the hole should also be removed at this time.

3. The potted plants would be well watered before translocation.

4. After being transported from the nursery, the plants would be laid out systematically at pre-identified recipient holes. The plants would be arranged so that divisions planted next to each other are from different parent plants to facilitate cross-pollination and enhance genetic diversity within the recipient site.

5. Care should be taken when removing the material from the pot to avoid damage to the plant and to keep the planting medium intact around the root system. If the plant is root-bound, the outer layer of roots may be loosened by hand or with pruning shears, taking care to not cause excessive damage to the roots.

6. The translocated material should be placed in the centre of the planting hole at a sufficient depth so the top of the root ball sits slightly lower than the surrounding soil surface, to create a slight basin to capture water.

7. The backfill material would be placed around the root ball and tamped down slightly so it is packed around the root ball and no large air pockets remain. Care should be taken to minimise disturbance of the root ball and avoid over-compacting the soil during backfilling. To avoid crown rot, the backfill soil should not cover the crown of the plant.

8. The area around the plant would be covered with a 7–10-centimetre layer of certified weed-free mulch consisting of organic material (such as wood chips or pea straw). Mulch should not cover the crowns of the plants. If considered appropriate and necessary, weed matting would also be considered to supress the establishment of weeds.

9. The plant would be watered-in immediately after placement in the hole. Watering should continue until the soil in the planting depression is saturated, taking care not to displace the mulch when watering.

10. The plant would be labelled according to the nursery number, using a small metal label attached to a metal stake embedded in the ground, and the location of the plant recorded using a differential GPS.

11. Immediately following translocation, the basal diameter and height of each clump and the number of ramets per clump would be measured to establish a baseline for monitoring the success of translocation. Reference photos would also be taken of the recipient site after the translocation episode is complete, to serve a visual baseline for subsequent monitoring, and the photo point location recorded using GPS.

5. Translocation recipient site selection

Before translocation, an appropriate recipient site(s) must be identified. As the aim of the translocation is to 'reduce the risk of extinction' (Commander *et al*., 2018), the selection of a suitable recipient site is highly important. It is proposed that the final selection of a site will T occur once this Plan is approved by DELWP and in consultation with DoEE.

In considering whether a site is a suitable translocation recipient site, a key consideration is the presence, historical or otherwise, of Matted Flax-lily at that site. A site that has remained undisturbed following recent extinction of the species, or where the species is present in low numbers in otherwise suitable habitat and is not currently protected through relevant planning controls is considered to be the best option.

Securing such an area for active ecological management in perpetuity would provide a strong ecological benefit for the species. Whilst the presence of an existing, large and self-sustaining population at a potential recipient site may indicate the habitat would be suitable for translocated plants, there is a risk the addition of more plants to the site may adversely affect the current population, and so this should be avoided. However, translocation to sites with existing self-sustaining populations and/or sites which are already under active conservation management can be undertaken in circumstances that would benefit the species and the community or ecosystem at the site, and where no other more suitable sites are available.

A number of criteria would be considered when identifying potential recipient sites for the Matted Flax-lilies to be translocated. Selection factors for consideration are documented in Figure 5-1 and are based on criteria presented in Commander *et al.* (2018).

Once a recipient site(s) is selected, this Plan will be updated to reflect the selected process, the specific site arrangements for the translocation, and the ongoing management of plants at the site.

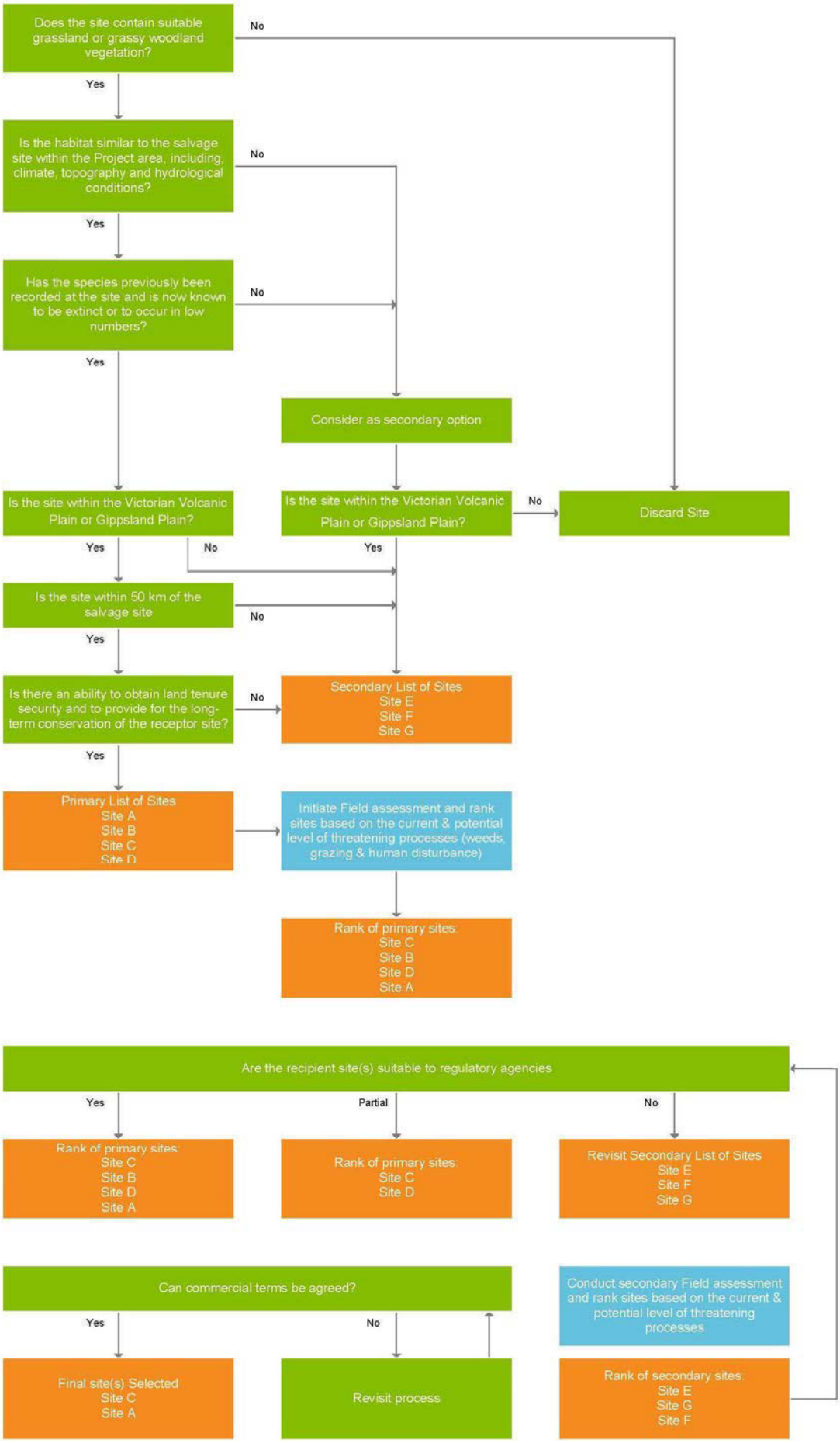


Figure 5-1 Recipient site selection flowchart

5.1 Potential recipient sites

NELP has completed investigations of nine potential recipient sites within the City of Whittlesea, City of Banyule, City of Darebin and/or in the eastern section of Simpson Barracks, including:

- Southern Redgum Reserve, Enterprise Drive, Bundoora
- Marigold Reserve, Yallambie
- 185 Bridge Inn Road, Wollert
- Mernda Village Conservation Reserve (East of Brahe Drive), Mernda
- Harry Pottage Reserve, Macleod
- Habitat Link (Gresswell Forest Nature Conservation Reserve), Macleod
- Cherry Street Reserve, Macleod
- Forensic Drive, Macleod
- Simpson Barracks

Further information on these sites is presented below and all sites are mapped on Figure 5-2.

5.1.1 Southern Redgum Reserve, Enterprise Drive, Bundoora

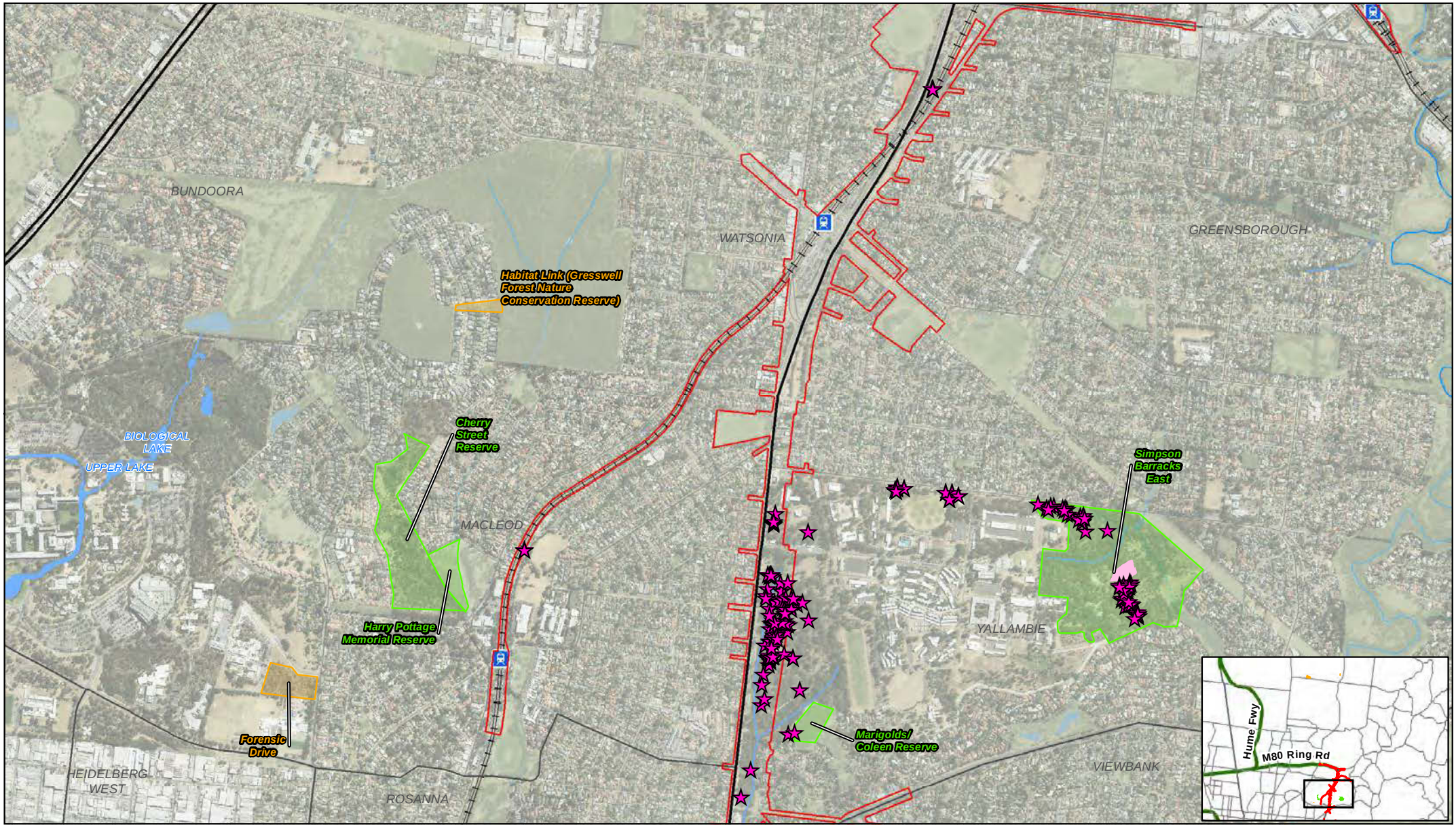
This site is located within the Victorian Volcanic Plain and is managed by the City of Whittlesea for conservation purposes. It is a small reserve on flat ground, with the M80 Ring Road to the south and industrial buildings surrounding. The canopy comprises an open woodland of River Red Gum *Eucalyptus camaldulensis*. There was low recruitment, with a couple of saplings present. The sparse mid-storey comprised primarily planted shrubs 1–2-metres high, including Sticky Wattle *Acacia howittii*, Burgan *Bursaria spinosa* and *Cassinia* sp. The understorey was dominated by weeds, including Kikuyu *Cenchrus clandestinus*, Couch *Cynodon dactylon*, Cocksfoot *Dactylis glomerata*, Panic Veldt-grass *Erharta erecta* and Annual Veldt-grass *Erharta longifolia*. Native ground-storey species were sparse, including Berry Saltbush *Atriplex semibaccata*, Nodding Saltbush *Einadia nutans*, Wallaby Grass *Rytidosperma* spp. and Cotton Fireweed *Senecio quadridentatus*. The northern edge of the site was dominated by Wallaby Grass and had an overall lower ground-storey cover (high cover of bare ground and moss/lichen) than the rest of the reserve, which was dominated by weeds. Logs were present throughout the reserve and litter cover was around 40 per cent, as shown in Plate 2.

A kangaroo was present on the reserve and is likely a permanent resident. The reserve has undergone obvious management, with planted shrubs and sprayed weeds, including a few individuals of Montpellier Broom *Genista monspessulana*. Two soil samples were taken as outlined in Table 5-1.

Suitability as a translocation site

There are no current or historic records of Matted Flax-lily or Arching Flax-lily on the site according to the Victorian Biodiversity Atlas (VBA)[3]. The site is also on the Victorian Volcanic Plain rather than the preferred Gippsland Plain bioregion, where most of the individuals for translocation originate. The soil and vegetation are suitable, though the understorey requires further management to reduce the cover of weeds. This site is therefore considered a potentially suitable Matted Flax-lily and Arching Flax-lily recipient site.

[3] https://vba.dse.vic.gov.au/vba/#/ (accessed 29/01/2019)



Paper Size A4

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Matted Flax lily
- Primary Sites
- Secondary Sites
- Matted Flax lily Patch
- Project boundary - surface

North East Link Project

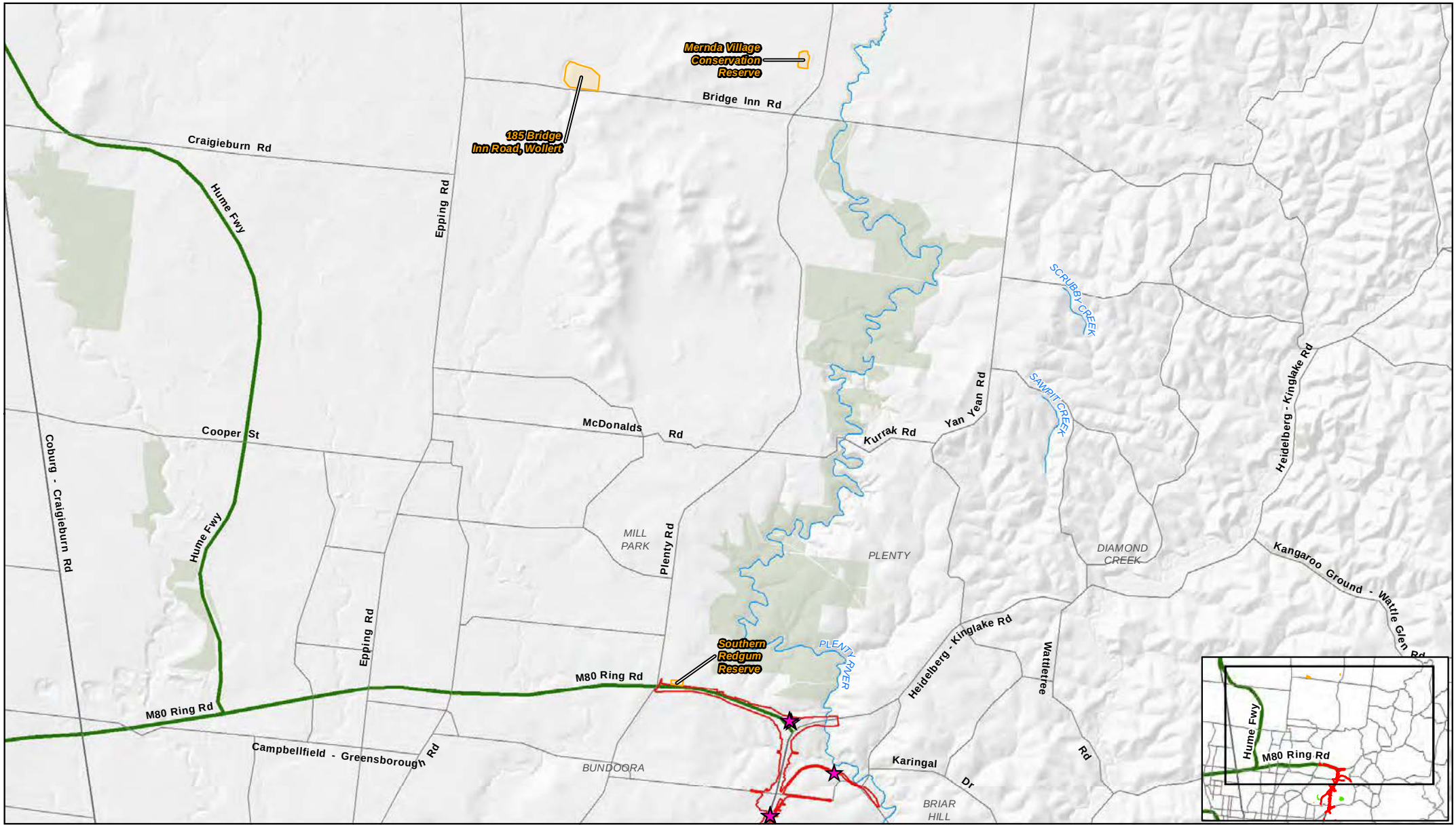
Matted Flax-lily

Job Number 31-35006
Revision C
Date 19 Jun 2019

Figure 5-2
Page 1 of 2

G:\31\35006\GIS\Maps\Working\Operational\Ecology\Ad hoc\20190618_MFL\3135006_MFL_A4L_RevC.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A4

0 1,000 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Legend

- Matted Flax lily
- Secondary Sites
- Matted Flax lily Patch
- Project boundary - surface

North East Link Project

Matted Flax-lily

Job Number	31-35006
Revision	C
Date	19 Jun 2019

Figure 5-2
Page 2 of 2

G:\31\35006\GIS\Maps\Working\Operational\Ecology\Ad hoc\20190618_MFL\3135006_MFL_A4L_RevC.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Table 5-1 Soil samples, Southern Redgum Reserve

Pit 1	Pit 2
Horizon A1: 0-24 centimetres deep, colour brown-grey, texture a clay loam	Horizon A1: 0-28 centimetres deep, colour brown-grey, texture a clay loam Horizon A2: 28-30 centimetres deep, colour light brown tinged yellow, texture a silty clay loam

Plate 3 A. West side of Enterprise Drive reserve, and B. east side of Enterprise Drive reserve

5.1.1 Marigold Reserve, Yallambie

Marigold Reserve (sometimes referred to as Collen Reserve) is a council reserve of approximately 2.3 hectares that is contiguous with Simpson Barracks (refer to Plate 4a). Marigold Reserve occurs on fertile soils on a generally flat /undulating plain that rise from the shallow valley of Banyule Creek drainage line. Marigold Reserve contains a fenced area of land managed for conservation purposes, other areas of EVC and other area of passive recreation that contain large remnant River Red Gums. An area of approximately 1.35 hectares in the north of Marigold Reserve is considered to be suitable for Matted Flax-lily translocation (refer to Plate 4b).

The vegetation observed within Marigold Reserve is consistent with Plains Grassy Woodland of the Gippsland Plain bioregion. The best condition remnant vegetation occurs to the north of the Reserve, is contiguous with Simpson Barracks and therefore contains vegetation that is very similar to that described in the Barracks. The dominant overstorey species was River Red Gum and both large and small trees were present (refer to Plate 4c &d). The EVC contained a sparse to moderately dense mid-storey layer including *Acacia* species, *Cassinia* and *Bursaria* as well as recruiting canopy species. The grassy assemblage typically included common species such as Weeping Grass *Microlaena stipoides* var. *stipoides* and Tussock-grass, while a range of forbs and rushes were also present, including Yellow Rush-lily *Tricoryne elatior*, Kidney-weed *Dichondra repens*, Wattle Mat-rush *Lomandra filiformis* and Black-anther Flax-lily *Dianella revoluta*. Threatened Matted Flax-lily were also observed within the Reserve. Weed species observed included Hawthorn, Quaking grass and exotic succulents.

Drilling completed as part of North East Link geotechnical investigation program indicates that a thin cover of residual soils (which can be extensively weathered), underlain by clay and then siltstone occurs. The clay is a weathering product of the siltstone. There are small outcrops of Quaternary alluvial sediments associated with Banyule Creek to the west of the Reserve.

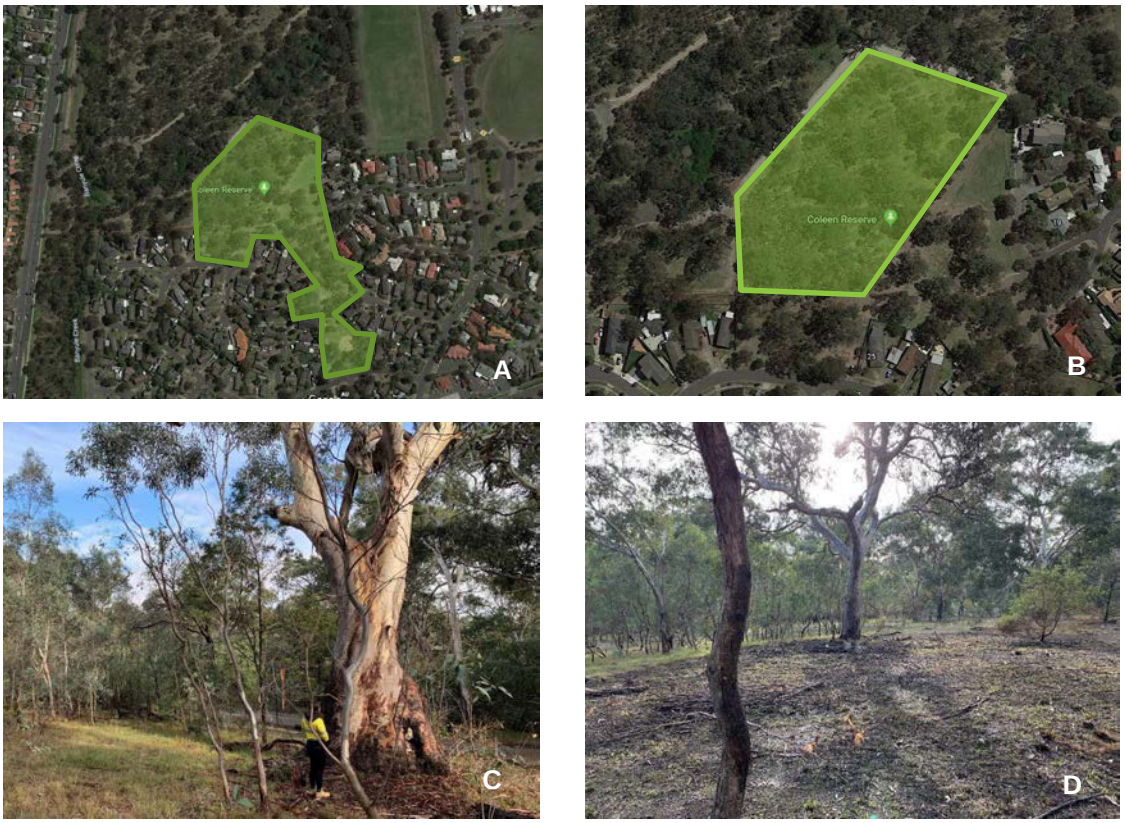


Plate 4 Marigold Reserve, A. Outline of the Reserve B. Area considered as a suitable recipient site C. looking north at a large Eucalypt, and D. looking north-east within a small burnt area.

Suitability as a translocation site

Emerge Associates Cameron Miller observed and mapped the occurrence of Matted Flax-lily within Marigold Reserve. In addition, local community members were aware of the presence of the species. The Reserve occurs within the Gippsland Plain bioregion. Given the existing records of Matted Flax-lily, low abundance of the species within the reserve and the similarity in soil and vegetation characteristics with Simpson Barracks, Marigold Reserve is considered a suitable site.

5.1.2 185 Bridge Inn Rd, Mernda

This site is located within the Victorian Volcanic Plain and managed by the City of Whittlesea. The reserve is bordered by Darebin Creek at the base of a slope along the west and north edges of the site. The western third of the site is on a small hill; the north-east corner contains a shallow depression and the rest of the site occurs on a flat plain. The north end of the site showed some erosion and exposed rock. Scattered River Red Gum canopy trees were present on the site as well as dense patches of recruitment cohorts on the eastern edge and centre of the site. The understorey was dominated by introduced Sweet Vernal-grass *Anthoxanthum odoratum*, Cocksfoot, Toowoomba Canary-grass *Phalaris aquatica* and Ribwort *Plantago lanceolata*. Smaller sections of the reserve were dominated by Wallaby Grass, primarily under the Eucalyptus regeneration or in disturbed/mown areas. Scattered Berry Saltbush and Nodding Saltbush were also present, as shown in Plates 3A–C).

A number of listed weeds were present in and around the site. Along the southern and western edges of the reserve Broom *Genista* sp., African Boxthorn *Lycium ferocissimum* and Gorse *Ulex europaeus* were present. Scattered Spanish Artichoke *Cynara cardunculus* subsp. *flavescens* was also present within the site. Kangaroos and rabbits were present onsite. There was also

evidence of mowing around the paddock edges. An old well located on the hill has Aboriginal cultural significance. Three soil samples were taken, which are outlined in Table 5-2.

Table 5-2 Soil samples, 185 Bridge Inn Rd

Pit 1 Horizon A1: 0-15 centimetres deep, colour brown-grey, texture a clay loam	**Pit 2** Horizon A1: 0-20 centimetres deep, colour brown-grey becoming browner at depth, texture a clay loam (high root content near the surface; rock fragments at depth)
Pit 3 Horizon A1: 0-10 centimetres deep, colour brown-grey, texture clay loam (flakes and clumps of clay)	

Plate 5 A. Western portion of Bridge Inn Road reserve B. North end of Bridge Inn Road reserve and C. *E. camaldulensis* regeneration along the eastern edge of Bridge Inn Road reserve

Suitability as a translocation site

There are no current or historical records of Matted Flax-lily or Arching Flax-lily on site according to the VBA. The site occurs on the Victorian Volcanic Plain rather than the preferred Gippsland Plain bioregion and the site is dominated by introduced vegetation. However, the site is comprised of suitable soil. Ultimately, while the location is considered suitable, the site requires a significant amount of management and is not recommended as a translocation site for Matted Flax-lily and Arching Flax-lily.

5.1.3 Mernda Village Conservation Reserve (East of Brahe Drive), Mernda

This site is located within the Victorian Volcanic Plain and managed by the City of Whittlesea. The majority of the site is a flat or slightly undulating floodplain. The site is going through a dry period, with cracked ground and low vegetation cover, with evidence of dead understorey vegetation. Scattered River Red Gum forms an open woodland. Planted River Red Gum saplings at 2–4-metres high are evenly distributed through the site and are of generally poor health. The understorey is primarily dominated by introduced species, including Annual Veldt-

grass, White Fumitory *Fumaria capreolata*, Cleavers *Galium aparine*, Rye-grass *Lolium* sp. and Hogweed *Polygonum aviculare*. The area is dominated by bare ground, with low amounts of litter and cryptogamic crust. A couple of patches, each around 50-metres long by 20-metres wide, were dominated by dense Wallaby-grass. Large logs are scattered across the site.

A small section in the north-west has been revegetated with some native shrubs and grasses, including *Acacia* spp., *Grevillea* spp. and Kangaroo Grass *Themeda triandra*, though the understorey remains dominated by introduced grasses. Mernda Drain runs along the eastern edge of the site and has evidence of revegetation. The slope down to the drain is rocky. The canopy was dominated by River Red Gum, with one or two individuals of Swamp Gum *Eucalyptus ovata*. The sparse mid-storey consisted of planted shrubs, including *A. howittii,* Lightwood *Acacia implexa, Black Wattle A. mearnsii,* Hedge Wattle *A. paradoxa* and Kurwan. The groundstorey was dominated by introduced species, including Oat *Avena* spp., Rye-grass, Ribwort and Sharp Buttercup *Ranunculus muricatus*. Native ground-storey species included Sheep's Burr *Acaena echinata*, Rush *Juncus* spp. and Cotton Fireweed.

The reserve had minor evidence of kangaroos and rabbits. Management of the site appeared to include revegetation efforts and mowing of the large patches of Wallaby Grass.

Suitability as a translocation site

There are no current or historical records of Matted Flax-lily or Arching Flax-lily on site according to the VBA, however, the site is known to contain Matted Flax-lily. The site is also on the Victorian Volcanic Plain rather than the preferred Gippsland Plain bioregion. However, there is some suitable vegetation on site, with the area around Mernda Drain considered the most suitable translocation site. The understorey vegetation requires management to reduce the cover of weeds, but the area around Mernda Drain is considered a potentially suitable site for Matted Flax-lily and Arching Flax-lily translocation.

Plate 6 A. Floodplain along the western edge of Mernda Village Conservation Reserve B. Area dominated by Wallaby Grass and C. Area adjacent to Mernda Drain

5.1.4 Harry Pottage Reserve, Macleod

Harry Pottage Reserve is within the Gippsland Plain bioregion and managed by Banyule City Council. The reserve has two distinct halves: the east side is an old landfill site that has been turned into a public park and playground, the west side contains a patch of remnant native vegetation.

The east side consists primarily of typical introduced ground-storey species, including Couch, Annual Meadow-grass *Poa annua* and Clover *Trifolium* spp. Garden-beds have been formed with east and west facing aspects and mulched with a thick layer of wood-chippings shown in Plate 5A. These have been planted with native trees and shrubs. A single soil sample was taken within the introduced grasses outside the garden-beds, listed in Table 5-3.

Table 5-3 Soil sample, Harry Pottage Reserve (east)

Pit 1
Horizon A1: 0-8 centimetres deep, colour brown-dark grey, texture a clay loam (rock and root fragments)

The west side consisted of a patch of remnant native vegetation. The canopy comprised scattered River Red Gum, with a sub-canopy layer of River Red Gum, Silver Wattle *Acacia dealbata* and Lightwood. The mid-storey included Golden Wattle *Acacia pycnantha*, *Cassinia* sp., River Red Gum and Burgan *Kunzea ericoides*. The understorey was dominated by native grasses, including Wattle Mat-rush *Lomandra filiformis*, Weeping Grass *Microlaena stipoides* var. *stipoides*, Wallaby Grass, and Kangaroo Grass, shown in Plate 5B.

A low weed cover included Veldt-grass *Ehrharta* sp., Yorkshire Fog *Holcus lanatus*, Onion Grass *Romulea rosea* and Montpellier Broom. Matted Flax-lily is already present at the site in relatively robust numbers, shown in Plate 5C.

Suitability as a translocation site – East

There is a record from 2002 of Matted Flax-lily on the site according to the VBA; there are no current or historical records of Arching Flax-lily. However, while the site is within the Gippsland Plain bioregion, the same region in which most of the individuals for translocation occur, the heavily disturbed nature of this area makes it unsuitable as a translocation site.

Suitability as a translocation site - West

Matted Flax-lily was identified as occurring on site during the field assessment. There are no current or historical records of Arching Flax-lily according to the VBA. The site occurs in the Gippsland Plain bioregion and contains suitable vegetation of good quality. If the population of Matted Flax-lily on site is small, translocation to this site may positively contribute to expanding the current gene pool. However, if the population is already well established and self-sustaining, adding additional individuals may have a negative impact.

The site is considered suitable for translocation of Arching Flax-lily and potentially suitable for Matted Flax-lily.

Plate 7 A. East half of Harry Pottage Reserve. B. West half of Harry Pottage Reserve and C. A cluster of Matted Flax-lily in the west half

5.1.5 Habitat Link (Gresswell Forest Nature Conservation Reserve), Macleod

Habitat Link in within the Gippsland Plain bioregion and managed by Parks Victoria. This site forms a link between the Gresswell Forest and Gresswell Hill Conservation reserves. The east side of the site is an open Eucalypt woodland dominated by River Red Gum with a mid-story of Silver Wattle, Lightwood, *Cassinia* sp. and Cherry Ballart *Exocarpos cupressiformis.* The ground layer is a mosaic of weedy and native grasses including: Kikuyu**,** Cocksfoot, Plantain and Wallaby Grass. Native graminoids included Spear Grass *Austrostipa* sp., Weeping Grass and Wallaby Grass. The east side is down a slope and fringes some good quality vegetation near the lower fence, as shown in Plate 6A-B.

The west end of the site is more open and disturbed. There is some loose gravel through the site and areas of bare ground. Sparse River Red Gum formed the overstorey and *Cassinia* sp. was present in the midstorey. Kikuyu, Couch, Ribwort and Wallaby Grass dominated the ground layer. This area seems very exposed and is located near the top of a slope, as shown in Plate 6C.

Habitat Link has undergone significant disturbance during the development of the surrounding housing estate. The site is adjacent to housing, paths and roads. There is also a large kangaroo population in Gresswell Forest which links up with the site. Only limited conservation management has occurred at this site but management is keen to improve this site to form a better link between Gresswell Forest and Gresswell Hill.

Suitability as a translocation site

There are no current or historical records of Matted Flax-lily or Arching Flax-lily on site according to the VBA, however there are records of Matted Flax-lily in the adjoining Gresswell Forest. Although the site is in the preferred Gippsland Plain bioregion, the west side of the site is not considered suitable as a translocation site for Matted Flax-lily and Arching Flax-lily due to being heavily disturbed and mostly cleared of native vegetation. The east side of the site is considered potentially suitable, as it contains a greater abundance of native vegetation, however, much work would need to occur to get it into a suitable condition for translocation.

Plate 8 A. Possible locations (green polygons) for translocation in the Habitat Link. B. Site 1 at the east end of Habitat Link. C. Site 2 at the west end of the Habitat Link

5.1.6 Cherry Street Reserve, Macleod

Cherry Street Reserve is within the Gippsland Plain bioregion and managed by Darebin City Council. This site contains areas of fenced off native vegetation surrounded by more weedy areas (mown) and well used pedestrian pathways. There is a *Eucalyptus camaldulensis* overstorey, dominated by smaller recruiting individuals, with a dense midstorey of *Acacia* ssp. and *Cassinia* sp. In the better quality areas, the ground layer was dominated by Kangaroo Grass, Wallaby Grass and Weeping Grass. Other groundstorey species included Spear Grass, Small-leaved Clematis *Clematis microphylla,* Black-anther Flax-lily, Nodding Saltbush, Wattle Mat-rush, Cotton Fireweed and a variety of lilies (Luke Sandham, Darebin Council pers comm).

Large patches of introduced grasses, including Kikuyu, Brome *Bromus* sp. and Plantain are present through the site adjacent to the fenced native vegetation. The sites identified by Darebin City Council are in transition zones between good quality areas of native vegetation and patches of introduced grasses, shown in Plate 9.

Cherry Street Reserve is Darebin City Council's most important bushland reserve. There is significant investment in weed control and thinning out eucalypt regeneration, which shades out the understorey. The site is adjacent to suburban housing and contains walking paths. The bottom proposed site had bitumen throughout the soil surface in the open part of the site, which would not be suitable for translocation. There has been some soil movement across the site.

A soil sample was taken at each of the proposed translocation locations in Cherry Street Reserve, as outlined in Table 5-4.

Table 5-4 Soil samples, Cherry Street Reserve

Pit 1 Horizon A1: 0-12 centimetres deep, colour light brown, texture a clay loam (lumps of clay) Horizon A2, 12-16 centimetres deep, colour yellow-brown, texture a light clay	**Pit 4** Horizon O1, 0-1 centimetres deep, colour pale grey, exposed soil Horizon A1, 1-17 centimetres deep, colour brown, texture a silty clay loam (clay fragments)
Pit 2 Horizon A1, 0-15 centimetres deep, colour grey-brown, texture a clay loam Horizon A2, 15-20 centimetres deep Horizon A3, 20-26 centimetres deep Horizon A4, 26-30 centimetres deep, colour pale grey, texture a clay loam sand (fine and powdery)	**Pit 5** Horizon A1, 0-18 centimetres deep, colour brown, texture a clay loam
Pit 3 Horizon O1, 0-7 centimetres deep, organic matter Horizon A1, 7-20 centimetres deep, colour grey-brown, texture a sandy clay loam Horizon A2, 20-23 centimetres deep, colour darker orange-brown, texture a higher clay content	

Plate 9 A. Proposed locations for translocation (green polygons). B. Transition zone between native and introduced vegetation. C. Fenced off native grassy woodland in the north-west of the reserve. D. Southern most translocation site, open area contains bitumen

Suitability as a translocation site

There are no current or historical records of Matted Flax-lily or Arching Flax-lily on site according to the VBA. However, the site occurs in the Gippsland Plain bioregion and the soil is suitable. The locations within Cherry Street reserve chosen as potential translocation sites vary in their suitability, primarily due to variation in the amount of native vegetation present. The majority of locations occur in areas predominantly cleared of native vegetation and dominated by introduced grasses. The locations considered suitable for translocation of Matted Flax-lily and Arching Flax-lily are: the northern-most, triangular-shaped location and the southern-most location. The other locations are not considered suitable as they would require extensive management.

5.1.7 Forensic Drive, Macleod

Forensic Drive is within the Gippsland Plain bioregion and managed by Darebin City Council. The site comprised of native vegetation fenced off from weedy roadside curbs. The canopy is dominated by Lightwood and Black Wattle *Acacia mearnsii*, as well as River Red Gum. There are patches of dense regeneration of the canopy species. The midstorey consisted of multiple *Acacia* spp. and *Cassinia* sp. The understorey is dominated by Weeping Grass, as well as Spear Grass, Wattle Mat-rush, Wallaby Grass and Kangaroo Grass, as shown in Plate 10.

There has been heavy management of Chilean Needle Grass *Nassella neesiana* around the edges of the site, leaving bare patches. These patches are where Darebin City Council would like to translocate Matted Flax-lily. The site has been intentionally lit by arsonists a couple of times.

Soil samples taken at the site are listed in Table 5-5.

Table 5-5 Soil samples, Forensic Drive

Pit 1	Pit 2
Horizon A1: 0-23 centimetres deep, brown colour, texture a clayey sand (clay lumps) Horizon A2: 23-32 centimetres deep, gold brown colour, texture a clayey sand	Horizon A1: 0-20 centimetres deep, chocolate brown colour, texture a clay loam, sandy

Plate 10 A. Proposed area for translocation (green polygon). B. Native vegetation at Forensic Drive reserve

Suitability as a translocation site

There is a record from 2002 of Matted Flax-lily on the site according to the VBA; there are no current or historical records of Arching Flax-lily. The site is within the preferred Gippsland Plain bioregion and contains suitable soil and vegetation. Although the risk of disturbance is higher due to the small size of the site, the site does have some suitability for Matted Flax-lily and Arching Flax-lily translocation. However, at this point it is considered a secondary site.

5.1.8 Simpson Barracks

Detailed information on the environmental values of Simpson Barracks is provided in EES Technical report – Ecology. However, one area not covered within that report is a detailed assessment of the soils of the Matted Flax-lily loss site or within a proposed recipient area to the east of the site. Sampling was completed as detailed in Table 5-6 to provide assessment of the soils of the Matted Flax-lily loss site and that within a proposed recipient area to the east of the site. The results show that the soil within the west (impact site) and east (potential recipient site) are of a similar nature and therefore the eastern portion of Simpsons Barracks is suitable as a recipient site.

Table 5-6 Soil assessment results, Simpson Barracks

Impact area soil results	Recipient area soil results
Pit 1 Horizon A2: 1-25 centimetres deep, colour brown, texture a clay loam Horizon A3: 25-35 centimetres deep, colour light brown , texture a sandy clay loam with iron nodules	**Pit 4** Horizon A2: 1-7 centimetres deep, colour brown, texture a clay loam Horizon A3: 7-40+ centimetres deep, colour light brown / yellow, texture a clay loam sandy (coarse, gravelly)
Pit 2 Horizon O1: 0-2 centimetres deep Horizon A1: 2-7 centimetres deep, colour brown, texture a loam Horizon A2: 7-30 centimetres deep, colour brown, texture a clay loam Horizon A3: 30-45+ centimetres deep, texture a clay loam sandy	**Pit 5** Horizon A2: 1-10 centimetres deep, colour brown, texture a clay loam Horizon A3: 10-35+ centimetres deep, colour light brown / yellow, texture a clay loam sandy (small gravel)

Pit 3	Pit 6
Horizon A2: 1-20 centimetres deep, colour brown, texture a clay loam (sandy)	Horizon A2: 1-8 centimetres deep, colour brown, texture a clay loam
Horizon A3: 20-30+ centimetres deep, colour light brown, texture a clay loam sandy with iron nodules, gravelly	Horizon A3: 8-35+ centimetres deep, colour light brown-yellow, texture a sandy clay (with gravel)

Suitability as a translocation site

The majority of Matted Flax-lily and Arching Flax-lily proposed for removal occurs within Simpson Barracks. Within the Barracks there are two areas of Matted Flax-lily concentration; a western area close to Greensborough Road and a second area to the east over the ridgeline in Rentons Ridge. Given this, it appears that both sides of the site have suitable habitat and ecosystem function to support the persistence of species despite the difference in aspect and vegetation.

Two important considerations whether to locate a recipient site in Simpson Barracks is whether the site is large enough to support a more concentrated population and where might a recipient site be located. In response to this, the site is large and is considered to contain many areas where Matted Flax-lily does not occur at high concentrations on both sides of the Barracks (west and east). Areas under consideration include remnant vegetation west of Mackay Road and the parade ground, an area north of Blamey Road and west of Steele Avenue and an area in central-south Simpson Barracks with a mix of remnant vegetation and revegetation. These areas contain lower-densities of Matted Flax-lily. Therefore, Simpson Barracks is considered a suitable recipient site, noting micro-siting of the recipient area is required if this site is selected.

5.2 Rank of sites

Following the process outlined in Figure 5-1 nine sites where considered as potential recipient sites. However, in response to comments from the regulators and stakeholders a further refinement in the selection process has been considered; that is, a preference for sites within the Gippsland Plain bioregion rather than the Victorian Volcanic Plain. This requirement reflects that fact that the majority of losses of Matted Flax-lily occur within the Gippsland Plain. In addition, an additional field assessment was completed in June 2019 to re-assess the suitability of potential sites based on their general characteristics, vegetation attributes, size and potential for edge effects and management intent (for conservation purposes). Sites have now been ranked into ‘primary’ and ‘secondary’ sites as described below:

5.2.1 Primary sites

Those sites within the Gippsland Plain bioregion that occur within 50 kilometres of the salvage sites and were considered to have suitable grassy woodland, Matted Flax-lily habitat and existing or previous records of Matted Flax-lily are:

- Marigold Reserve, Yallambie
- Harry Pottage Reserve (west), Macleod
- Simpson Barracks, Yallambie.

5.2.2 Secondary sites

The remaining sites did not meet one or more criteria and are therefore considered as secondary sites, including:

- Cherry Street Reserve, Macleod

- Southern Redgum Reserve, Enterprise Drive, Bundoora
- 185 Bridge Inn Road, Wollert
- Mernda Village Conservation Reserve (East of Brahe Drive), Mernda
- Habitat Link (Gresswell Forest Nature Conservation Reserve), Macleod
- Forensic Drive, Macleod

5.3 Next steps in site selection

Between June 2019 – December 2019 further conversations will be held with Banyule and Darebin Councils and the Department of Defence to progress discussions relating to recipient site selection. Ultimately, 1-2 sites are to be selected from which detailed on-ground site planning and management can be progressed.

6. Recipient site management

Before and following translocation, management and maintenance activities at the recipient site would be required to control threatening processes, and improve the health, growth and survivorship of the translocated plants.

This section provides broad management activities required across the selected recipient sites to achieve a successful translocation program. To ensure the longevity of recipient sites, the sites would require a holistic management approach to improve the ecological value of the entire site rather than focusing just on the health of translocated plants. In some cases, this would involve enhancing and restoring parts of the recipient site not directly related to the translocated plants.

Management responsibilities and site security information is presented in Section 3.

6.1 Watering

Watering of translocated plants at the recipient site would be undertaken to ensure that plants established quickly and survived through dry periods during the establishment phase (considered here to include the first summer endured by the planted material). Supplementary watering can be critical to the survival of plants during the first year, and particularly the first summer after translocation, when they are still establishing their root systems and are more prone to drought-stress. The frequency and volume of watering required during this period is dependent on a number of factors, including the time of year that translocation occurs, rainfall, temperature, soil type and topography. After the plants have lived through the first summer, supplemental watering would unlikely be required unless the plants showed signs of water-stress.

A suggested watering schedule is outlined in Table 6-1. The schedule may be modified based on the time of planting as well as monitoring of weather conditions, soil moisture, and the condition of the translocated plants at the recipient site. The quantity of water used for each watering episode would be sufficient to promote survival of the translocated plants, as informed by monitoring of soil moisture and the condition of the plants at the recipient site.

Table 6-1 Watering requirements for translocated plants

Months after planting	Period between significant rainfall events[1] that will trigger watering	Watering schedule
0–3	1 week	Weekly[2]
3–9	2 weeks	Weekly
9–21	1–2 months	Monthly
21–36	1–2 months	Only if plants display signs of stress

[1]A 'significant rainfall event' will be defined as ≥20 mm of rainfall within a 24-hour period; rainfall and watering records will be included the project monitoring reports.
[2]More frequent monitoring may be required in the first months if planting occurs outside of the preferred winter to early spring.

6.2 Weed control

Control of high-threat weeds within and adjacent to the location(s) of transplanted Matted Flax-lilies would be undertaken before translocation. This includes woody, grassy and herbaceous weeds.

After an initial weed control effort before translocation, an ongoing weed control program would occur biannually at times of the year when weeds were germinating and actively growing (autumn and spring). Spring weed control timing is critical so that high-threat weeds can be targeted before setting seed. The weed control methods would include undertaking spot-spraying using broad-leaf and grass selective herbicide. Woody weeds would be removed using the cut-paint method and germinates treated with a broad-leaf selective herbicide. The alternate use of selective herbicides reduces the likelihood of off-target damage, increases the ability of applicators to target broad-leaf weeds amongst indigenous grasses, and assists exotic grass control amongst indigenous herbs.

Noxious weeds would be maintained at <1% cover within five metres of any planted material within the first five years of management. To achieve this, carefully targeted spot-spraying with selective herbicides must only be undertaken at distances greater than 50 centimetres away from translocated plants. Mulching and hand weeding would be required to remove weeds within 50 centimetres of translocated plants.

Herbicide application must only be undertaken during conditions considered suitable by an experienced operator, and all operators must be familiar with the range of exotic and indigenous species present on site. Before application, the contractor would be informed of the locations of the translocated plants, and instructed in the identification of Matted Flax-lily and other sensitive native species occurring at the recipient site. This would ensure that plants are not affected by off-target application or overspray.

Nursery stock would be inspected before planting to avoid introducing weeds to the recipient site, and additional weed control undertaken at the recipient site before and after the replanting of the salvaged material. Monitoring of weed levels at the recipient site would be performed according to the monitoring schedule outlined in Section 7.3, with weed control actions as needed according to the monitoring results and associated observations of environmental conditions.

6.3 Pest animal control

If rabbits and/or hares were present within fenced recipient areas, or posed a threat to isolated plants, a combination of habitat removal, warren destruction and baiting would need to be undertaken.

Baiting would ideally be undertaken in late summer to mid-autumn when populations are naturally low, and repeated each year as required. Baiting can also be undertaken during winter and spring, although this may not be as effective if there is high availability of natural feed (potentially reducing the desirability of baits). Given translocation sites are within close proximity to neighbouring properties, roadsides and pedestrian paths, appropriate warning signage must be erected at access points and along fence lines prior to laying baits. Sites would need to be revisited four days after baiting to remove uneaten baits and again 12 days after laying baits to remove any dead carcasses. Uneaten baits and carcasses must be buried to a depth of at least 500 millimetres in cleared areas outside recipient sites.

Surveys for rabbits and active warrens at recipient sites would be undertaken at least twice yearly, and any warrens located fumigated and destroyed. Following each warren treatment, affected areas would be re-sown with indigenous grasses and follow-up weed control undertaken as required.

6.4 Biomass control

An integrated biomass control program would be implemented with the aim of reducing competition for light, nutrients and moisture from grassy weeds. In the later stages of the management plan, biomass control would reduce competition (thatching) from native grasses and promote understorey species diversity. A mixture of low impact techniques would reduce biomass and may include low intensity burning, slashing, spraying and hand removal. Techniques would vary between recipient site(s) due to management protocols required by the respective site managers.

Any proposed burns would be carried out during autumn (cool burn) with the aim of reducing competition from annual grassy weeds and to encourage germination of native understorey herbs and graminoids.

Cut grass would be removed from recipient sites where this has the potential to smother translocated plants (a hand mower with a catcher may be used if appropriate for parts of each site). For lower quantities of biomass, a brush cutter would be used as this would likely disperse grass in the process of slashing.

Care would be taken to protect translocated Matted Flax-lilies and other newly established plants during slashing. Before a plot was slashed, each Matted Flax-lily would have a fluorescent flag placed near its base or several flags placed around the edge of the colony for plants consisting of numerous ramets. High quantity areas of biomass within translocated plants would be removed by hand to prevent damage or cause significant disturbance to the Matted Flax-lilies.

Spring slashing would occur before exotic grasses and herbs setting seed to prevent seed spread.

6.5 Fencing

The design and construction of fencing would ensure the exclusion of herbivores known to occur in the vicinity and which pose a potential threat to the translocated plants at each recipient site. Decisions on fencing type would be made following the identification of recipient site(s), as existing fencing may vary and the nature of the herbivore threats may differ.

Fences would be inspected on a regular basis after translocation, including during the project monitoring events conducted, and maintained as necessary. The translocated plants would also be monitored for evidence of grazing, and additional measures, such as use of cages or tree guards for individual plants, may be implemented as necessary. Additional pest fauna controls, such as bait traps for snails or similar pests, would also be implemented if the need was indicated by monitoring.

On occasion, herbivore control may be too difficult to achieve and individual plants may be caged. This would be considered as an option if other herbivore control was not effective.

6.6 Enhancement planting

Recipient sites may be selectively revegetated with local indigenous plants particular to the relevant EVC. Plants chosen would predominately be from understorey lifeforms and consist of herbs, groundcovers, daisies, lilies and graminoids to assist with weed suppression and potentially attracting pollinators. Understorey plants suitable for enhancement planting are listed in Table 6-2.

Areas that have been removed of woody, herbaceous and grassy weeds may require revegetation with indigenous grasses to provide competition against colonising weeds. Areas containing existing understory grasses would require supplementing with herbs, groundcovers, daisies and lilies to improve species diversity.

Enhancement planting would be scheduled to occur in year two and beyond to allow targeted weed control and to provide optimum opportunity for translocated Matted Flax-lilies to establish.

Table 6-2 Understory species suitable for enhancement planting

Common name	Scientific name
Shrubs	
Sweet Bursaria	*Bursaria spinosa*
Hedge Wattle	*Acacia paradoxa*
Groundcovers	
Berry Saltbush	*Atriplex semibaccata*
Kidney Weed	*Dichondra repens*
Purple Coral-pea	*Hardenbergia violacea*
Running Postman	*Kennedia prostrata*
Berry Saltbush	*Atriplex semibaccata*
Daisies	
Clustered Everlasting	*Chrysocephalum semipapposum*
Wiry Buttons	*Leptorhynchos tenuifolius*
Lilies	
Chocolate Lily	*Arthropodium strictum*
Grasses	
Common Wallaby-grass	*Rytidosperma caespitosa*
Brown-back Wallaby Grass	*Rytidosperma duttoniana*
Clustered Wallaby-grass	*Rytidosperma racemosa*
Australian Wheat Grass	*Anthosachne scabra*
Wattle Mat-rush	*Lomandra filiformis*
Spiny-headed Mat-rush	*Lomandra longifolia*
Weeping Grass	*Microlaena stipoides*
Velvet Tussock-grass	*Poa morrisii*
Large Tussock-grass (volcanic plains form)	*Poa labillardieri*

7. Monitoring and reporting

Monitoring of the translocated plants as well as the conditions at each recipient site would be required to identify key threatening processes, determine whether additional management actions are necessary, track the health, growth and survivorship of the translocated plants, and demonstrate whether performance benchmarks and regulatory requirements were being met.

Monitoring would be performed by a qualified botanist familiar with Matted Flax-lily biology and ecology. As detailed in Section 7.3, monitoring at the recipient site(s) would include the documentation of threatening processes, such as water stress, pest animals and signs of grazing, weed infestation and other site disturbances. In addition, the condition, growth rates, reproduction, and survivorship of the translocated material would be monitored.

7.1 Performance benchmarks

The translocation process does stress salvaged plants, and without active management, most plants would be unlikely to survive. Successful translocation of Matted Flax-lily has occurred within Victoria, with the first two years following re-planting seen as the most critical period for plant establishment. Once planted material has survived for a period of five years, it is considered established at that location and is otherwise part of the broader ecosystem in which it has been planted (Commander, 2018). However, each salvage and translocation operation needs to be carefully planned, managed, and monitored so that plants successfully become established at the recipient site within the agreed-upon timeframe.

The overall goals of the proposed Matted Flax-lily translocation program are to ensure that genetic diversity of the species is conserved and that the population affected by the project is re-established into suitable habitat and managed for the survival and reproduction of this species. Individual performance criteria have been created to assess the translocation program's progress towards meeting those goals. The following performance criteria are derived from Vallee *et al.* (2004) with adaptation to suit the circumstances of the current project and species to be translocated. The criteria are divided according to the phase of the proposed translocation program:

Propagation and nursery management:

1. The required number of transplants were available for the proposed translocation
2. Correct labelling and documentation was maintained throughout the propagation and nursery management period
3. Techniques for successful propagation of Matted Flax-lily developed through past translocation projects in Victoria were tested and/or advanced
4. A genetically representative collection was maintained

Habitat and threat management:

1. Good-quality habitat was restored or maintained within the recipient site
2. Management and maintenance activities were carried out at suitable intervals and to the required standard
3. Threatening processes, including weed invasion, were eliminated or effectively controlled

Translocation criteria (1 to 10 years):

For the translocation of each species:

1. At least 85 percent of transplanted clones survived, including representatives from the range of genetic individuals salvaged
2. The translocated populations displayed similar growth, development and vigour as naturally occurring populations
3. Transplants survived to a reproductive stage (producing flowers and fruit)
4. If plants didn't survive to reproductive stage, then the plants were replaced
5. Regeneration occurred in the translocated individuals (since the recruitment of Matted Flax-lily through seed is thought to be rare, the production of ramets at a rate similar to naturally occurring populations is considered sufficient to meet this criterion)
6. The number of individuals within the population was stable, or had increased by natural (including vegetative) recruitment
7. Adequate levels of genetic diversity were maintained

The number of surviving plants at the end of the 10-year monitoring program that are needed to meet the long-term success criteria would depend on the number of clones propagated and planted out. Condition and success of the clones would continue to be monitored for up to 10 years with the aim of achieving 85 per cent survival of clones by the fifth year. If performance targets are met within five years, it is envisaged that a significantly reduced monitoring program could be developed for the remaining five years[4]. Should 85 percent survival not be achieved at the end of five years, contingency planning would be initiated (refer Section 7.2).

7.2 Contingency and adaptive management

A sufficient number of clones would be propagated and retained in the nursery to replace any losses of the translocated plants at the recipient sites to ensure 100 percent genetic survivorship of salvaged material. This is critical to the success of the approach. Based on previous translocation programs, Matted Flax-lily can be successfully propagated in a nursery setting and a large number of clones can often be produced from a single parent plant.

The primary criteria for triggering replanting would be plant mortality at the recipient sites, based on the judgement of the project botanist. Plants in poor health and/or which are not sufficiently growing either in width or number of ramets should first be watered before being considered for replacement.

The health and survivorship of the translocated plants would be monitored according to the protocol described in Section 5.3, and if the translocated population appears to be declining and/or performance benchmarks were not being met, the root cause of the decline would be assessed, and further adaptive management measures developed in consultation with DELWP. If the root cause is determined to be an aspect of the management of the recipient sites (such as insufficient watering or weed control), then modifications to site management would be evaluated and implemented as needed. In addition, if survivorship criteria were not being met, the number of clones in the nursery can be increased by creating further divisions of established nursery stock so that sufficient clones were available to replace losses. If contingency measures were implemented (at the end of the five-year monitoring period), the monitoring period would be extended until the 10- year period. Performance measures and contingency measures are presented in Table 7-1.

[4] This program would place a greater focus on the monitoring and management of threats to maintain the population rather than intensely monitoring population dynamics, recruitment and alike.

Table 7-1 Performance management and contingency planning

Year for completion of Activity	Standard to be achieved	Contingency
Pre-planting	• 100% salvage of pre-clearance plants • Where achievable six clones to be created to replace salvaged plants	• If the six clones cannot initially be established, additional clones to be produced when plant mass is sufficient • Two clones maintained in nursery conditions
End of 1st year	• >85% survivorship	• Do nothing and continue to monitor
	• <85% survivorship	• Replant up to 85% survivorship of 4 clones
End of 2nd year	• >85% survivorship	• Do nothing and continue to monitor
	• <85% survivorship	• Replant up to 85% survivorship of 4 clones
End of 3rd year	• >85% survivorship	• Do nothing and continue to monitor
	• <85% survivorship	• Replant up to 85% survivorship of 4 clones
End of 4th year	• >85% survivorship	• Do nothing and continue to monitor
	• <85% survivorship	• Replant up to 85% survivorship of 4 clones
End of 5th year	• Achieved a performance target of at least 85% of clones surviving? • If this is the case the salvage and translocation plan is declared a success.	• No contingency management required • Amend monitoring program years 5-10 • Actively manage sites to 'maintain' population through threat management.
Years 5-10	• If the performance target has not been met at the end of a 5-year period continue with replanting strategy for a further five years.	• Review the existing strategy and explore options to improve success rates • Replant with 'insurance clones' as required to achieve performance target and monitor until performance target achieved

Note: This table will be modified and updated to reflect the starting point at the time of salvage. This will allow % targets to be converted to actual targets.

7.3 Monitoring schedule

Generally, monitoring would need to occur more frequently immediately following replanting to confirm that new transplants were establishing themselves at each site. Monitoring can be undertaken less frequently once the plants become established. Therefore, monitoring would be conducted weekly for the first month after replanting, monthly during the second through fifth month, and then quarterly through the remainder of the two-year period. Monitoring would be conducted on a six-monthly basis up to five years. At the end of the five-year period a review is proposed to tailor the management and monitoring program for the remaining five years.
A reduced monitoring program would be implemented for Years 5 -10. This schedule may be revised, with approval of DoEE and DELWP, depending on establishment rates and achievement of performance benchmarks. A final site assessment would be conducted at the end of the tenth year after the initial translocation event to confirm that performance benchmarks have been met. The reporting schedule for providing the results of the monitoring to DoEE and DELWP is discussed below in Section 7.5.

7.4 Monitoring protocol

Monitoring at the recipient site would be undertaken or overseen by a qualified botanist approved by DELWP. Monitoring would also be undertaken in consultation with land managers (e.g. Council biodiversity officer). Monitoring would include the following components:

1. A population count of all translocated Matted Flax-lilies at the site.
2. An assessment of the growth and condition of the plants for four 25 m^2 quadrats set up in established locations that are easily locatable and repeatable. Quadrat monitoring would be conducted each summer, when the plants are most actively growing. Information to be collected would focus on plant health and cover, but also consider other information such as plant reproduction, weed abundance and diversity, grazing impacts and other issues.
3. Photo point monitoring at established locations showing representative views of the translocated population. Photos would be taken each quarter.
4. A general site assessment and threats analysis for the entire recipient site.

A monitoring form would be completed for each monitoring event to record the results of the monitoring, including:

- Location and population of individual plants
- Plant cover and growth (basal diameter and height of each patch, number of ramets per patch)
- Presence of flowers and/or fruits and height of inflorescence or infructescence
- Evidence of herbivory or pathogens
- Presence and cover of weed species
- Other potential or occurring threats or management issues
- Maintenance or corrective actions completed or recommended

7.5 Reporting

NELP would submit an initial report summarising the results of the salvage and nursery propagation to DoEE and DELWP within three months after salvage. A report would also be provided after the initial translocation and again after the first three months of monitoring. A summary report would be prepared each year for 10 years.

The reports would discuss the survivorship and growth of the plants and include information on conditions at the recipient site and the nursery and an assessment of the status of the translocation program relative to the established performance benchmarks. The report would also discuss occurring or potential threats or management issues and any maintenance or corrective actions taken or proposed. The reports would include rainfall and watering data, the monitoring forms for each monitoring event and the quarterly photos taken from each established photo point.

A final report would be provided after the tenth year and include an analysis of whether the translocation program had achieved the long-term performance benchmarks, or whether further management and monitoring was required, and a summary of lessons learned and recommendations for future translocation programs.

8. References

Bull, M 2014, *Flora of Melbourne: a guide to the indigenous plants of the greater Melbourne Area* (fourth edition*)*, Hyland House Publishing Pty Ltd

Carr, GW & Horsfall, PF 1995, Studies in the Phormiaceae (liliaceae) 1: New Species and combinations in Dianella Lam. Ex. Juss, in Muelleria 8; (3):365-378

Carter, O 2010, National Recovery Plan for the Matted Flax-lily *Dianella amoena*, Department of Sustainability and Environment, Victoria

Commander, L.E., Coates, D., Broadhurst, L., Offord, C.A., Makinson, R.O. and Matthes, M. (2018). *Guidelines for the translocation of threatened plants in Australia*. Third Edition. Australian Network for Plant Conservation, Canberra.

DELWP 2017, Victorian Department of Environment, Land, Water and Planning, NatureKit viewer sourced at: <http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>

DEPI 2013a, Victorian Department of Environment and Primary Industries, Biodiversity Conservation Strategy for Melbourne's Growth Corridors, Melbourne, May 2013, available at <http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/melbourne-strategic-assessment/conservation-strategies#A2.2a>

DEPI 2013b, Victorian Department of Environment and Primary Industries, *Permitted clearing of native vegetation – biodiversity assessment guidelines*, Melbourne, September 2013

DEPI 2013c, Victorian Department of Environment and Primary Industries, *Procedures Statement for Translocation of Threatened Native Flora in Victoria,* Melbourne, June 2013

DoEE 2016. Australian Department of the Environment and Energy, *Dianella amoena* — Matted Flax-lily, <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64886> (2016)

DoE 2012, Australian Department of the Environment, Offsets Assessment Guide spreadsheet, <http://www.environment.gov.au/epbc/publications/ epbc-act-environmental-offsets-policy>, October 2012

DSEWPaC. 2013. Australian Department of Sustainability, Environment, Water, Population and Communities, *Environment Protection and Biodiversity Conservation Act 1999 Policy Statement: Translocation of Listed Threatened Species – Assessment under Chapter 4 of the EPBC Act,* <https://www.environment.gov.au/resource/epbc-act-policy-statement-translocation-listed-threatened-species-assessment-under-chapter>

DSEWPaC 2012, Department of Sustainability, Environment, Water, Population and Communities Environment Protection and Biodiversity Act 1999 Environmental Offsets Policy, <http://www.environment.gov.au/system/files/resources/ 12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-policy_2.pdf>, October 2012

Flora of Victoria 2018, < https://vicflora.rbg.vic.gov.au/flora/taxon/f1086f96-0684-4534-b78d-04b26a2925a9> (accessed 10/12/2018)

HLA 2007, *Biodiversity Assessments and Strategies for Simpson Barracks*, prepared by HLA Environsciences

Ralph, M 2003, *Growing Australian Native Plants from Seed,* second edition, Bushland Horticulture. Fitzroy

Tasmanian Department of Primary Industries and Water 2008, *Threatened Flora of Tasmania: Dianella amoena,*<http://www.dpiw.tas.gov.au/inter.nsf/Attachments/LJEM-74ZUT6/$FILE/Dianella%20amoena.pdf>

GHD

180 Lonsdale Street
Melbourne Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com

www.ghd.com

Appendix G Studley Park Gum Management Framework

Studley Park Gum Management Framework

North East Link Project

Project No: VEP19-002(05)

Prepared for North East Link Project (Major Transport Infrastructure Authority)
29 July 2019

Document Control

Doc name:	Studley Park Gum Management Framework North East Link Project				
Doc no.:	VEP19-002(05)--001				
Version	**Date**	**Author**		**Reviewer**	
D	29 July 2019	Daniel Roocke	DWR	Cameron Miller	CJM
	Final issue				

Executive Summary

The North East Link Project (a division of the Major Transport Infrastructure Authority), on behalf of the Victorian State government, is currently undertaking the North East Link project (referred to herein as 'the project') to the north-east of the Melbourne Central Business District.

Ecological impact assessments have determined that, if approved, the project will impact *Eucalyptus* x *studleyensis* (Studley Park gum) which is listed as 'endangered' on the Department of Environment, Land, Water and Planning (DELWP) *Advisory List of Rare or Threatened Plants in Victoria 2014* (DEPI, 2014). In total, 60 Studley Park gum individuals have the potential to be impacted directly and indirectly by the project. It is proposed that all impacts be offset in accordance with the *Guidelines for the removal, destruction and lopping of native vegetation* (DELWP, 2017). Whilst there are no legislative requirements to mitigate impacts to Studley Park gum, DELWP have requested actions to compensate for the impacts to Studley Park gum.

Impacts to Studley Park gum will be mitigated through two activities:

1. Implementation of the *Environmental Performance Requirement FF6* which requires the development and implementation of a *Groundwater Dependent Ecosystem Monitoring and Mitigation Plan;* and

2. Implementation of this *Studley Park Gum Management Framework* to translocate 98 Studley Park gum trees within an appropriate recipient site.

The goal of this translocation is to initiate and deliver the establishment of a new population of Studley Park gum to ensure their ongoing conservation. To achieve this goal, it is proposed to establish 98 Studley Park gum trees in an appropriate recipient site.

The following actions are proposed to be undertaken to achieve the goal:

- Develop and implement a *Seed Collection and Propagation Plan* which provides detailed methods for the collection, storage and propagation of Studley Park gum seeds.
- identify appropriate recipient site(s) to use for the establishment of a Studley Park gum population.
- Develop and implement a *Management Plan* for the recipient site which includes detailed site-specific management actions.

A summary of the broad actions to be included within each plan is provided in this document.

Table of Contents

Contents

List of Tables

Figures

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
DELWP	Department of Environment, Land, Water and Planning
MTIA	Major Transport Infrastructure Authority
NEL	North East Link
NELP	North East Link Project

Table A2: Abbreviations – General terms

General terms	
DBH	Diameter at breast height
EES	Environment effects statement
EVC	Ecological vegetation class
PER	Public environment report
VBA	Victorian biodiversity atlas
VROTS	Advisory list of Victoria Rare and Threatened Species (flora and fauna)

Table A3: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre

1 Introduction

1.1 Project background

The North East Link Project (NELP) (a division of the Major Transport Infrastructure Authority (MTIA)), on behalf of the Victorian State government, is currently undertaking the North East Link (NEL) project (referred to herein as 'the project'). The NEL is a new freeway-standard road connection to the north-east of the Melbourne Central Business District that would complete Melbourne's ring road. Specifically, the NEL will connect the Metropolitan Ring Road (M80) to the Eastern Freeway and includes works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The impacts to biodiversity values due to the project have been determined through ecological impact assessments which informed the development of an *Environment Effects Statement* (EES) and *Public Environment Report* (PER). Ecological impact assessments have identified that the project has the potential to impact *Eucalyptus* x *studleyensis* (Studley Park gum) which is listed as 'endangered' on the Department of Environment, Land, Water and Planning (DELWP)'s *Advisory List of Rare or Threatened Plants in Victoria 2014* (DEPI, 2014). The location of the project is shown in **Figure 1**.

1.2 Purpose

Emerge Associates (Emerge) were engaged by GHD on behalf of NELP to produce a strategic management framework to mitigate project impacts to *Eucalyptus* x *studleyensis* (Studley Park gum). Native vegetation impacted by the project will be offset in accordance with clause 52.17 of the Victorian Planning Provisions and Guidelines for the removal, destruction or lopping of native vegetation (DELWP, 2017). There are no legislative requirements for additional offsets for the removal of a species on DELWP's advisory list, such as Studley Park gum if specific offsets were not triggered for the species. However, the Department of Environment, Land, Water and Planning (DELWP) have requested additional actions to mitigate impacts to Studley Park gum.

This *Studley Park Gum Management Framework* document provides a broad outline of the actions NELP propose to undertake to compensate for the impacts to Studley Park gum. Finer scale details on proposed actions will be provided in succeeding documents following approval of this management framework by DELWP.

2 Studley Park Gum

2.1 Morphology and taxonomy

Studley Park gum is a fertile hybrid taxon between *E. camaldulensis* subsp. *camaldulensis* (river red gum) and *E ovata* subsp. *ovata* (swamp gum). The leaf, bud and fruit character traits are intermediate between the two parent taxa but often show a closer affinity to one parent (VicFlora 2019).

Studley Park gum is one of eight described eucalyptus hybrids formally accepted by the National Herbarium of Victoria and is one of two named intersectional Victorian hybrids in the genus.

Due to the morphological variation within Studley Park gum, it is notoriously difficult to identify in the field. Genetic analysis is required to provide a definitive conclusion as to the identity of an individual, but is time consuming, costly and impractical.

2.2 Distribution

The majority of Studley Park gum records occur along the lower Yarra River to the north-east of Melbourne in suburbs such as Kew, Ivanhoe, Viewbank, Rosanna, Macleod, Yallambie and Watsonia.

The taxon has also been recorded to the south-east (Nar Nar Goon, near Clayton North, at Lysterfield Park and between Carrum Downs, Hampton Park and Lyndhurst), north-west (Riddells Creek) and south-west (Connewarre on the Bellarine Peninsula) of Melbourne (GHD, 2019a).

2.3 Conservation significance

Studley Park gum is listed as 'endangered' on DELWP's *Advisory List of Rare or Threatened Plants in Victoria 2014* (DEPI, 2014). Species on DELWP's advisory list are not under direct statutory protection but are considered during State approval processes. Studley Park gum is not listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* or the State *Flora and Fauna Guarantee Act 1988.*

Studley Park gum is of conservation significance due to scientific and evolutionary reasons (Cameron, Rule and Randall, 1999). The fact that Studley Park gum is a fertile is significant as many hybrids are sterile. Hybrids such as Studley Park gum have significance due to their potential to become new species (Cameron, Rule and Randall, 1999). The significance of Studley Park gum is further discussed in (GHD, 2019a).

2.4 Distribution within project area

Initial flora surveys conducted for the project recorded Studley Park gum within three areas:

- Two individuals were recorded within the project area near Watsonia railway station.

- One incidental record was noted in Banyule Flats outside of the area directly impacted by the project.[1]
- Multiple individuals comprising mature trees and several cohorts of varying age were recorded within Simpson Barracks but numbers not determined.

Additional surveys were undertaken within Simpson Barracks to determine the number of individuals within the project area (GHD, 2019a). Forty-four Studley Park gum individuals were recorded within the portion of the Simpsons Barracks that lies within the project area. This number does not include juvenile eucalypts that were unable to be positively identified due to lack of reproductive material.

The range of size classes recorded throughout the study area suggests that hybridisation may be actively occurring in this area (GHD, 2019a). In addition, field observations also suggested that back crossing to *E. camaldulensis* is likely to be occurring within Simpson Barracks and has occurred throughout the local area in the past (GHD, 2019a).

[1] However, it should be noted that this record is believed to be a misidentified record which is more likely to be another hybrid *E.trabutii* (GHD, 2019b).

3 Project impacts

All impacts to native vegetation will be offset in accordance with the *Guidelines for the removal or lopping of native vegetation* (the Guidelines) (DELWP, 2017) as documented in the offset strategy (GHD, 2019b). This report specifically addresses project impacts to Studley Park gum.

3.1.1 Direct impacts

The following Studley Park gum individuals will be directly impacted by the project:

- Two individuals near Watsonia railway station in Watsonia
- Forty-four individuals within Simpsons Barracks.

Individuals deemed to be directly impacted (assumed to be lost) by the project include whole trees and trees located just outside of the project boundary but where more than 10% of their 'tree protection zone' encroaches into the project boundary.

3.1.2 Indirect impacts

Indirect impacts to Studley Park gum may occur due to groundwater drawdown during construction and operation of the project. Groundwater modelling undertaken for the project identified potential for groundwater drawdown to impact ecological values within and around Simpson Barracks. The Environmental Effects Statement (EES) states that modelling indicates depth to groundwater at Simpson Barracks is approximately 10 metres at the shallowest point, which would be only accessible by large trees such as Studley Park gum. Two models have been prepared; a 2024 post-construction groundwater depth model, and a 2075 scenario (GHD, 2019c).

Based on the groundwater depth and drawdown modelling it has been estimated that 11 Studley Park gums (DBH>80cm) under the 2024 model (nine in Commonwealth land and two outside) would have a moderate to high risk of being negatively impacted at the end of construction. However, as presented in Revised GDE Assessment (GHD, 2019c), Environmental Performance Requirement (EPR) FF6 has been modified to account for the potential impacts of groundwater drawdown during construction as described below:

Prepare and implement a Groundwater Dependent Ecosystem Monitoring and Mitigation Plan. The Groundwater Dependent Ecosystem Monitoring and Mitigation Plan must be informed by the groundwater modelling and groundwater monitoring required by EPR GW1 and EPR GW2. Where the survival of Groundwater Dependent Large Trees not requiring removal is predicted to be affected by groundwater drawdown during construction or operation based on groundwater modelling outputs, measures should be included in the plan to maintain the health of large trees such as supplementary watering. In relation to any trees unlikely to survive during operation as a consequence of groundwater drawdown, offsets must be obtained in accordance with EPR FF2.

Given this, under the 2075 model, three Studley Park gums are considered to have the potential to be indirectly impacted permanently, as they would be impacted during operation. Therefore, in total 49 individual Studley Park gums are considered to be impacted by the project.

4 Mitigation

Impacts to Studley Park gum will be mitigated through 'translocation' into an approved recipient site. The term translocation refers to 'the deliberate transfer of plants or regenerative plant material from an *ex situ* collection or natural population to a new location, usually in the wild' (Commander *et al.*, 2018). According to (Commander *et al.*, 2018) the proposed Studley Park gum translocation can be classified as an 'introduction' as it will involve establishing a population in a site where it has not previously occurred but is within the known range of the species and provides similar habitat to known occurrences. Alternatively, if the recipient site contains an existing population of Studley Park gum this would be classified as 'reinforcement', where individuals are added to enhance the existing population.

4.1 Plan goal

The goal of this translocation is to initiate and deliver the establishment and ongoing management of a new population of Studley Park gum to ensure their conservation. To achieve this goal, it is proposed to establish a minimum of 98 Studley Park gum trees in a recipient site. This goal is based on a replacement ratio of two translocated Studley Park gums established for each individual impacted by the project.

To achieve the establishment goal of 98 plants, it is proposed that a total of 288 Studley Park gum saplings are initially planted at the recipient site. This takes into account unavoidable plant loss assuming a 70% survival rate for each year over a three-year period as described below:

- Year 0: 288 saplings planted
- Year 1: 201 saplings (@ 70% survival)
- Year 2: 141 saplings (@ 70% survival)
- Year 3: 98 plants established.

Actions proposed to be undertaken include seed collection and propagation**,** selection of a suitable recipient site and planting and management within the recipient site. Monitoring and evaluation will determine whether the goal has been met.

4.2 Associated plans

The following actions are proposed to be undertaken to achieve the goal:

- Develop and implement a *Seed Collection and Propagation Plan* which will provide detailed methodology for collection, storage and propagation of Studley Park gum seeds.
- Identify an appropriate recipient site to use for the Studley Park gum translocation.
- Develop and implement a *Management Plan* for the determined recipient site which includes detailed site-specific management requirements.

4.2.1 Management responsibilities and timing

The management responsibilities for tasks within each of the above actions are detailed in **Table 1**.

Table 1: Management framework program responsibilities

Task No.	Task	Responsibility	Timeframe
Seed collection and propagation plan			
1.	Seed collection	NELP	2019-2020
2.	Seed storage	NELP	From time of collection until propagated
3.	Identify a suitable nursery	NELP	2019
4.	Plant propagation	Contractor	ASAP on completion of task no. 3
Recipient site selection			
5.	Identify suitable recipient site	NELP	Mid 2019-2020
Recipient site management plan			
6.	Site preparation (e.g. weed control, access control)	Contractor (TBD following selection of site)	Within first year of completion of task no. 5
7.	Planting	Contractor (TBD following selection of site)	First winter after completion of task no. 6
8.	Monitoring and evaluation	NELP	For a minimum of 5 years from planting or until the goal is met
9.	Reporting to DELWP	NELP	Annually commencing in line with task no. 8
10.	Adaptive management measures	Contractor	As needed according to results of task no. 8

A summary of the broad actions to be included within each plan is provided in **Section 4.3-4.5**.

4.3 Seed collection and propagation plan

Emerge Associates have developed a separate plan which documents the principals and processes for the collection and propagation of vegetative material for the project. This Plan is entitled *Seed Collection and Propagation Plan, North East Link Project* (Emerge Associates, 2019). The following sections provide a summary of requirements outlined in the Plan.

4.3.1 Collection

The *Guidelines for the Translocation of Threatened Plants in Australia* (Commander *et al.*, 2018) states that 'for a population to persist in the long term it also needs to possess sufficient genetic diversity to retain its evolutionary potential to adapt to long-term environmental change or infrequent extreme events'.

To maximize genetic diversity in the translocated population seeds will be collected from individuals within the two populations of Studley Park gum impacted by the project (Watsonia and Simpson Barracks). As detailed in **Section 2.4**, the population of Studley Park gum in the Simpson Barracks is considered to be genetically diverse and composed of multiple generations of hybrids. The genetic similarity between the Simpson Barracks population and the other two populations impacted by the project is unknown, but collection of seeds from both populations will result in higher levels of genetic diversity in the translocated population. Furthermore, this management framework aims to mitigate impacts to the two impacted populations of Studley Park gum and therefore it is advantageous to collect seeds from each population.

Once collected, the viability of seeds will be determined and seeds will be labelled and stored appropriately. Seeds from each population will remain separate at all times. Seed collection will occur roughly every two months during the appropriate season (refer toEmerge Associates, 2019).

4.3.2 Propagation

Seeds are to be propagated at an accredited nursery. As detailed in **Section 4**, a minimum of 288 Studley Park gum plants will be required to be propagated for planting at the recipient site. Additional Studley Park gum plants will also need to be propagated and made available for supplementary (infill) planting (if required). Note that propagation will need to occur in advance of planting (approximately 8 to 12 months).

A horticulturalist experienced in native plant propagation will be engaged to undertake all propagation works. The seeds of Studley Park gum are not expected to be dormant and would therefore not require any pre-treatment prior to propagation. Seeds will be grown in a medium specifically designed for propagating native plants.

Correct hygiene measures must be practiced at all times in the nursery, and regular inspection for signs of disease and or/pests are to be undertaken by the horticulturalist. Any plants suspected of being infected with a pathogen or disease will be treated according to nursery guidelines to avoid infection of other plants. The horticulturalist engaged to undertake the propagation will be experienced in native plant propagation to maximise seedling survival and growth. Plants will be grown as tall as possible to facilitate deep planting as outlined in **Section 4.5.1**, however, they should not become pot-bound.

Prior to recipient site planting, plants will be ‘hardened off’ (gradually exposed to conditions similar to those at the recipient site) and in good condition, free of weeds in the pots and no signs of disease or pathogens. An appropriately experienced botanist will inspect and approve the condition of the plants prior to planting.

4.4 Recipient site selection

4.4.1 Site characteristics

The recipient site must provide appropriate conditions to enable plant survival and subsequent establishment of a self-sustaining population of Studley Park gum. To determine the features of a potentially suitable site, environmental attributes of current populations of Studley Park gum were

assessed. These attributes were used in a desktop analysis to determine potentially suitable recipient sites for translocation.

Five primary attributes and two secondary attributes were used to determine potential recipient sites, as listed in **Table 2**. Primary attributes were considered essential for potential sites, and secondary attributes were considered desirable.

Table 2: Attributes used in determining potential Studley Park gum recipient sites

Attribute	Condition
Primary attributes	
Studley Park gum records (VBA)	Within 5 km from Studley Park gum VBA records
EVC (1750 mapping)	EVC 55: Plains Grassy Woodland
	EVC 68: Creekline Grassy Woodland
Watercourses	Within 1 km of a watercourse
Project footprint area	Within 5 km of project footprint area
Size	Greater than 2.0 ha in size
Secondary attributes	
Tenure	Classified as 'public' or 'protected landscape – public' land use
Zoning	Classified as 'public conservation and resource zone' or 'public park and recreation zone'

4.4.2 Potential recipient sites

11 potential recipient sites within three broad areas were identified during the analysis, as shown in **Figure 1**. One site is located adjacent to the project area within the Simpson Barracks. Nine sites are located within the Yarra Valley Parklands, to the east of the project area. The remaining one site is located within Plenty Gorge Park, to the north of the project area. Other sites such as Marigold Reserve, Yallambie may also be considered if the above-mentioned sites are not considered acceptable.

The Simpson Barracks site is managed by the Australian Army and classified as 'Commonwealth land not controlled by planning scheme'. The Yarra Valley Parklands and Plenty Gorge Park sites are located within large reserves managed by Parks Victoria, which provides opportunities for the Studley Park gum translocation to contribute towards broader ecological conservation and enhancement.

Further investigations including site surveys would be required to determine if one of these potential recipient sites is suitable for translocation of Studley Park gum.

4.4.2.1 Simpson Barracks

The Simpson Barracks site extends over 118.3 ha and lies directly adjacent to the project area but outside of the impact area. Watsonia Drain and Banyule Creek lie within and adjacent to the Simpson Barracks site.

This site lies within the Gippsland Plain bioregion and 1750 EVC mapping indicates that the majority of the site supported EVC 55: Plains Grassy Woodland with some areas of EVC 68: Creekline Grassy Woodland. 2005 EVC mapping indicates that this site supports only small scattered patches of remnant vegetation. Multiple Studley park gum individuals were recorded within the western portion of this site during surveys in 2019 (GHD, 2019a).

Examination of aerial imagery shows that a large portion of this site supports buildings and infrastructure associated with its use as an army facility. Treed areas occur in the western, southern and eastern portions of the site and adjacent open areas that are currently bare or support grassland may provide opportunities for restoration. Area(s) within this site that would be suitable for planting of translocated Studley Park gum plants would need to be selected and approved by the Department of Defence.

The environmental attributes of the Simpson Barracks site are shown in **Figure 2**.

The Simpson Barracks site is considered the most suitable recipient site for translocation of Studley Park gum as it is directly adjacent to the majority of the Studley Park gum individuals being impacted by the project. The suitability of the site and potential for long-term protection of translocated Studley Park gum plants would need to be determined through consultation with the Department of Defence.

4.4.2.2 Yarra Valley Parklands

The nine Yarra Valley Parklands sites range in size from 2.3 ha to 106.8 hectares and lie within close proximity to each other (within approximately 4.5 kilometres). The sites lie alongside the Yarra River and/or its tributary the Plenty River.

These sites predominantly lie within the Gippsland Plain bioregion, except the two easternmost sites which bordering the Highlands – Southern Fall bioregion. 1750 EVC mapping indicates that all of these sites previously supported EVC 55: Plains Grassy Woodland and/or EVC 68: Creekline Grassy Woodland EVCs. 2005 EVC mapping indicates that all of these sites support some remnant native vegetation but also comprise large areas of agricultural grassland and/or parkland which provide opportunities for restoration. One existing Studley Park gum record occurs near these sites to the north west, and records of *E. camaldulensis* and *E. ovata* occur in the local area.

The environmental attributes of the Yarra Valley Parklands sites are shown in **Figure 3.**

The *Yarra Valley Parklands Management Plan* (Parks Victoria, 2008) indicates that the majority of these sites lie within 'landscape' and 'conservation and recreation' management zones, and one site also includes a portion of 'recreation' management zone. Generally, enhancement of remnant indigenous vegetation is supported within 'landscape' and 'conservation and recreation' management zones.

The Yarra Valley Parklands sites are considered the second most suitable recipient site for translocation of Studley Park gum due to multiple factors including landscape and historical vegetation suitability, close proximity to the project area and impacted Studley Park gum individuals and appropriateness of current management zoning. Some of these sites are larger than the area

required for the Studley Park gum translocation, and an appropriate area for planting such as open areas lacking tree canopy would need to be delineated.

4.4.2.3 Plenty Gorge Park

The Plenty Gorge Park site extends over approximately 56.1 ha and lies near the Plenty River and the Tanunda Wetlands (Parks Victoria, 2018).

This western portion of this site lies within the Victorian Volcanic Plain bioregion and the eastern portion lies within the Highlands – Southern Fall bioregion. 1750 EVC mapping indicates that nearly the entire site previously supported EVC 55: Plains Grassy, and 2005 EVC mapping indicates that remnant native vegetation currently exists on the eastern side of the site. The western side supports areas of agricultural grassland which provide opportunities for restoration. The closest existing Studley Park gum record occurs approximately 3.3 km south of this site and records of *E. camaldulensis* and *E. ovata* occur in the local area.

The environmental attributes of the Plenty Gorge Park site are shown in **Figure 4**.

The site lies within 'park area 4 – south' in the *Plenty Gorge Park Master Plan* and revegetation/tree planting is included as a recommendation for this area (Parks Victoria, 2018) .

The Plenty Gorge Park site is considered a sub-optimal recipient site compared to the Yarra Valley Parklands sites as it is located further away from the project area, the impacted Studley Park gum individuals and existing Studley Park gum records. However, if the Yarra Valley Parklands sites are determined to be unsuitable, the Plenty Gorge Park site may be appropriate, subject to further investigation.

4.5 Recipient site management plan

The ongoing management of the recipient site will be undertaken for a minimum of five years following planting at the recipient site, or until the goal is met (see **Section 4.1**). Management of the recipient site will be required to reduce threats to the translocated plants and maximize survival rates.

This section outlines general management actions which will be incorporated into the detailed management plan that will be prepared once the recipient site has been selected.

4.5.1 Planting

Studley Park gum tubestock grown from seed (refer **Section 4.3.2**) will be planted within a suitable area in the recipient site. The 288 plants required to meet the goal (refer **Section 4.1**) will be installed at the same time and within the first year of management of the recipient site.

Tubestock will be planted in the recipient site when environmental conditions such as rainfall and temperature are favorable. In the Melbourne region, the optimal time for planting is generally autumn or winter, once the winter rains have started and the ground is sufficiently moist. Planting will be initiated as soon as possible to allow plants the maximum time for establishment before the

summer dry period. Planting outside of this period is not recommended as survival rates will likely be reduced.

Planting of Studley Park gum tubestock will be undertaken by an experienced revegetation contractor and will incorporate the following actions:

- Tubestock will be well-watered prior to planting.
- Tubestock from each source population will be installed in a mixed arrangement to facilitate cross-pollination and enhance the genetic diversity within the translocated population.
- Planting holes will be roughly twice as wide and twice as deep as the pot. This will enable plants to be installed as deep as possible, with only the top portion of the plant above the ground. Deep planting positions the roots closer to water supplies and decreases water loss. This type of planting can also help to prevent herbivory from resulting in the death of seedlings, which can easily re-sprout if the top of the plant is removed. The deep planting method may be dependent on the recipient site selected and is subject to advice from the revegetation contractor.
- Planting holes will be approximately 20 metres apart to provide sufficient space for mature trees. A grid formation will provide ease of monitoring but the planting formation will be dependent on the shape of the selected recipient site.
- Care should be taken when removing plants from pots to avoid and minimize damage to the roots.
- Tubestock will be placed in the centre of the hole and backfilled with soil removed from that hole (mixed with an appropriate planting medium if required).
- Weed-free mulch will be spread around each plant, taking care to place mulch away from the stem of each plant to avoid rot.
- Each plant will be watered in immediately after planting, taking care not to displace the surrounding soil.
- Each plant will be labelled with a metal label attached to a metal stake embedded in the ground. The label should contain information regarding the source population.

Reference photos of the planting area should be taken at the time of planting to provide a baseline for future monitoring (see **Section 4.5.7.1**).

4.5.2 Watering

Supplementary watering is unlikely to be required if plants are installed during the optimal time (refer **Section 4.5.1**). However, seasonal factors such as rainfall and temperature and site-specific factors such as soil type and topography may induce hydrological stress on plants.

Once the recipient site has been determined the likely requirements for supplementary watering will be decided. If required, the frequency and volume of watering will be included in the management plan. Contingency watering during extended periods of drought or if plants are found to be suffering from hydrological stress should also be considered for inclusion in the management plan.

4.5.3 Weed control

Weed control will be conducted within the recipient site prior to planting of tubestock. Following planting, an ongoing weed control program will be implemented. At a minimum, the weed control

program will include biannual weed control (autumn and spring) for the first three years after initial planting. Following year 4, annual weed control within spring will be undertaken.

The most appropriate method to control weeds in the recipient site is likely to be chemical (herbicide), but may also include manual (hand weeding) based approaches. Alternative methods may be used if recommended by a licenced pest management technician and/or as determined during survey of the recipient site.

The majority of weed control treatments will be concentrated on the area immediately surrounding planted tubestock. Noxious weeds will be controlled to ensure that cover is less than 1% within a five metre radius from each installed tubestock. Other weeds will be eliminated or reduced in cover to a level that does not negatively impact tubestock.

4.5.4 Herbivory control

Dependent on the recipient site, animals such as rabbits and hares (pests) and kangaroos (native) can impact on plant establishment through herbivory. Consultation with the current management authority of the chosen recipient site will be undertaken during preparation of the management plan to determine whether pest animals are likely to be a threat to tubestock.

If required, actions such as destruction of rabbit warrens and hare nests, baiting and/or fencing could be undertaken to control pest animals. The suitability of baiting in areas accessible to the public will need to be discussed with the recipient site management authority. Monitoring will be undertaken to assess the impacts of herbivory on pest animals and contingency actions will be undertaken if required (refer **Section 4.5.7**).

4.5.5 Fencing and access control

Fencing of the recipient site would limit public access and may provide protection from herbivores. Consultation with the current management authority of the chosen recipient site will be undertaken during preparation of the management plan to determine the appropriateness of fencing the site, as it is likely dependent on existing infrastructure and management. For example, fencing may be installed around the tubestock planting area or, if the recipient site is located within a larger reserve, around the reserve perimeter.

If monitoring indicates that fencing is not providing sufficient protection to tubestock, additional protection methods will be investigated, such as plant cages or tree guards.

4.5.6 Enhancement planting

Enhancement of the recipient site by planting other native indigenous plants may be considered. Understorey life forms from the appropriate EVC would be suitable. This planting would likely be undertaken by the management authority of the recipient site or a local volunteer group.

4.5.7 Monitoring and evaluation

Monitoring of the translocated plants and the site conditions will be undertaken to assess the performance of the site in relation to the goal, as well as to identify management actions. A suitably qualified ecologist/botanist will undertake the monitoring.

4.5.7.1 Methods

Monitoring will involve a physical inspection of the tubestock in the recipient site. During this inspection the botanist will traverse the site and record:

- the total number of living translocated plants
- the condition of translocated plants (e.g. signs of drought stress/herbivory/disease)
- types and levels of threats to translocated plants (e.g. weeds)
- incidental observations within the recipient site
- maintenance requirements (e.g. fencing/signs of unauthorised access).

Photo point monitoring will also be undertaken during the above inspection. Locations for photo point monitoring will be determined at the time of tubestock planting and the spatial coordinates of each location will be recorded. During each photo monitoring event an oblique digital photograph will be taken in the same direction, height and orientation.

The results of each monitoring event will be consistently documented.

4.5.7.2 Timing

Monitoring will be undertaken frequently during the first three years after planting to determine whether plants are establishing and if contingency actions need to be undertaken to increase plant survival. During this time monitoring will be undertaken quarterly, at approximately the beginning of each season.

After this time, monitoring will be undertaken annually until the goal has been met (up until a maximum of ten years).

4.5.7.3 Evaluation and contingency

The results of the quarterly monitoring will be used to inform site management and track the survival of translocated plants.

An annual evaluation will be undertaken to determine progress of the site towards the goal. This will involve comparison of the number of surviving Studley Park gum plants in the recipient site to the goal.

The number of plants to be installed has been calculated based on a 70% survival rate for the first three years, after which the plant survival is likely to be stable. Therefore, the survival rate of Studley Park gum plants established from tubestock will be evaluated each year for at least five years. If the goal is met after five years the translocation can be declared a success and the site handed over to the management authority. Note that plants must have been planted in the recipient site for a minimum of three years to be considered ‘established’.

If plant survival is lower than 70% during the first three years after planting, it is unlikely that the goal will be met without implementation of contingency actions. Actions such as supplementary planting (using additional tubestock propagated from seed) will be implemented in this circumstance.

If the goal of 98 established Studley Park gum plants is not achieved after five years, implementation of the plan will continue until the goal is met, up to a total of ten years. Discussions with the relevant management authority will be undertaken if unforeseen factors impact upon the translocated plants (such as unauthorized access, vandalism or bushfire) or if the prescribed methods are ineffective.

A summary of evaluation process is provided in **Table 3**.

Table 3: Evaluation process for the recipient site

Timing	Measure	Action
Each year for 3 years after planting	>70% SPG survival	None required
	<70% SPG survival	Undertake supplementary planting
End of 4th year after planting End of 5th year after planting	≥98 SPG plants established (which have been planted in recipient site for at least 3 years)	Hand over site to management authority
	<98 SPG plants	Undertake supplementary planting
Years 5-10 (only required if goal is not met prior)	<98 SPG plants	Review management actions to improve success. Undertake supplementary planting

SPG = Studley Park gum plants established from tubestock.

4.5.7.4 Reporting

A monitoring report will be prepared by NELP at the end of each year. This report will include a summary of management actions undertaken that year and the results of each action. The report will include the results of each monitoring event undertaken that year (including photos form each photo point) and the results of the evaluation against the goal.

Note that this reporting may extend beyond ten years as the seed collection and propagation is likely to occur prior to planting.

5 References

Cameron, D., Rule, K. and Randall, R. (1999) 'Ressessment of Botanical values on streeton Views Estate Stage 11, Yallambie, with particular referenceto the significance of the natural Hybrid Eucalyptus Xstudleyensis Studley park Gum and the Endangered species Dianelle amoena Matted Flax Lily', (May).

Commander, L. E. *et al.* (2018) *Guidelines for the translocation of threatened plants in Australia*. Third edit. Edited by L. E. Commander et al. Australian Network for Plant Conservation, Canberra.

DELWP (2017) *Guidelines for the removal, destruction or lopping of native vegetation*. Department of Environment, Land, Water and Planning. Government of Victoria.

DEPI (2014) *Advisory list of rare or threatened plants in Victoria - 2014*.

Emerge Associates (2019) *Seed Collection and Propagation Plan*. Report prepared fro North East Link Project, Victoria.

GHD (2019a) *North East Link: Studley Park Gum Surveys Report*.

GHD (2019b) *North East Link Ecological Offsetting Strategy*.

GHD (2019c) *Revised GDE Assessment*.

Parks Victoria (2008) *Yarra Valley Parklands Management Plan*.

Parks Victoria (2018) *Plenty Gorge Park Master Plan*.

Figures

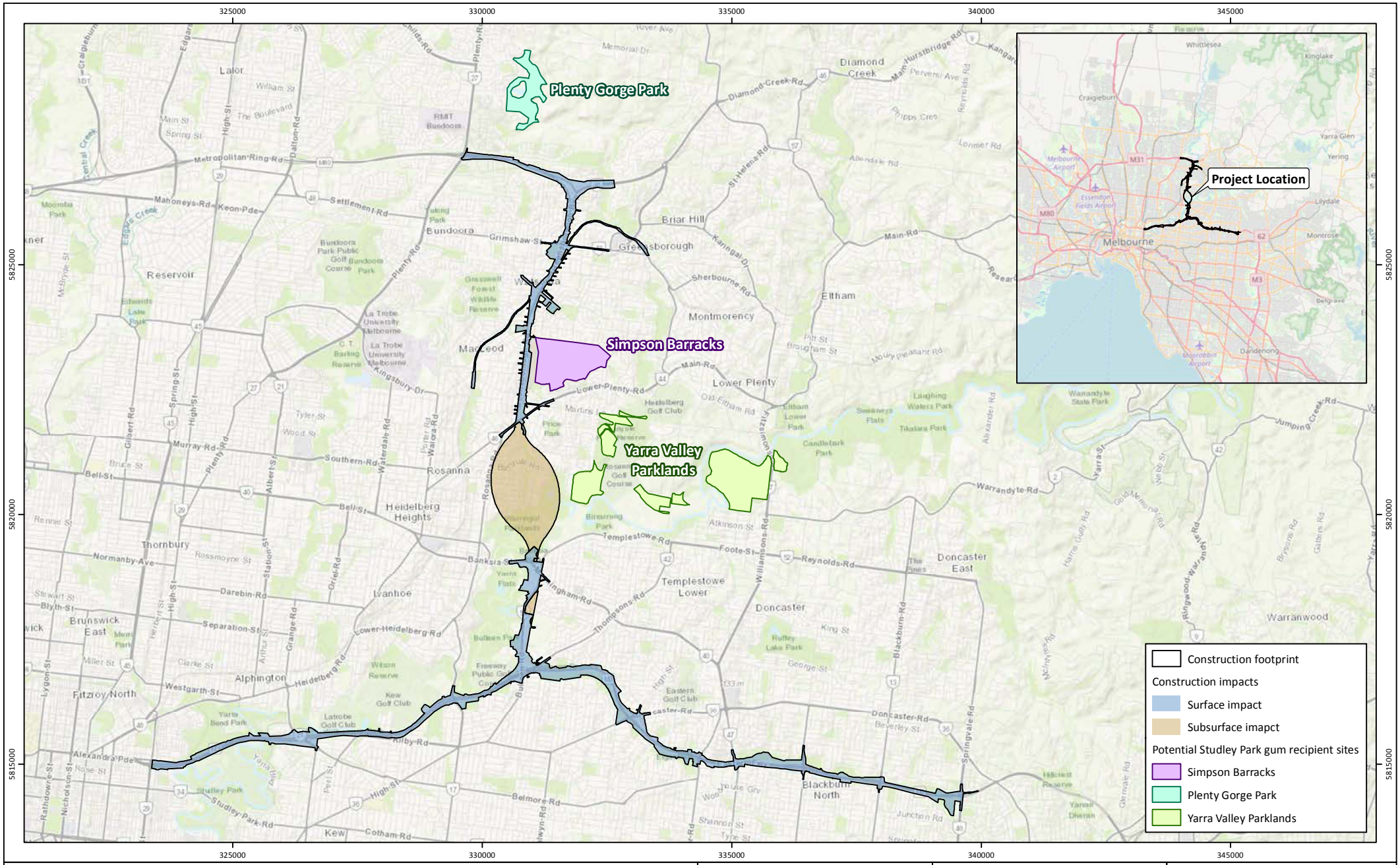


Figure 1: Potential Recipient Sites – Overview

Project: Studley Park Gum Management Framework
North East Link Project
Client: Major Transport Infrastructure Authority (North East Link Project)

Plan Number:
VEP19-002(05)--F01a
Drawn: KNM
Date: 23/07/2019
Checked: RAO
Approved: CJM
Date: 23/07/2019

N

0 1 2 3
Kilometres
Scale: 1:100,000@A4
GDA 1994 MGA Zone 55

emerge ASSOCIATES

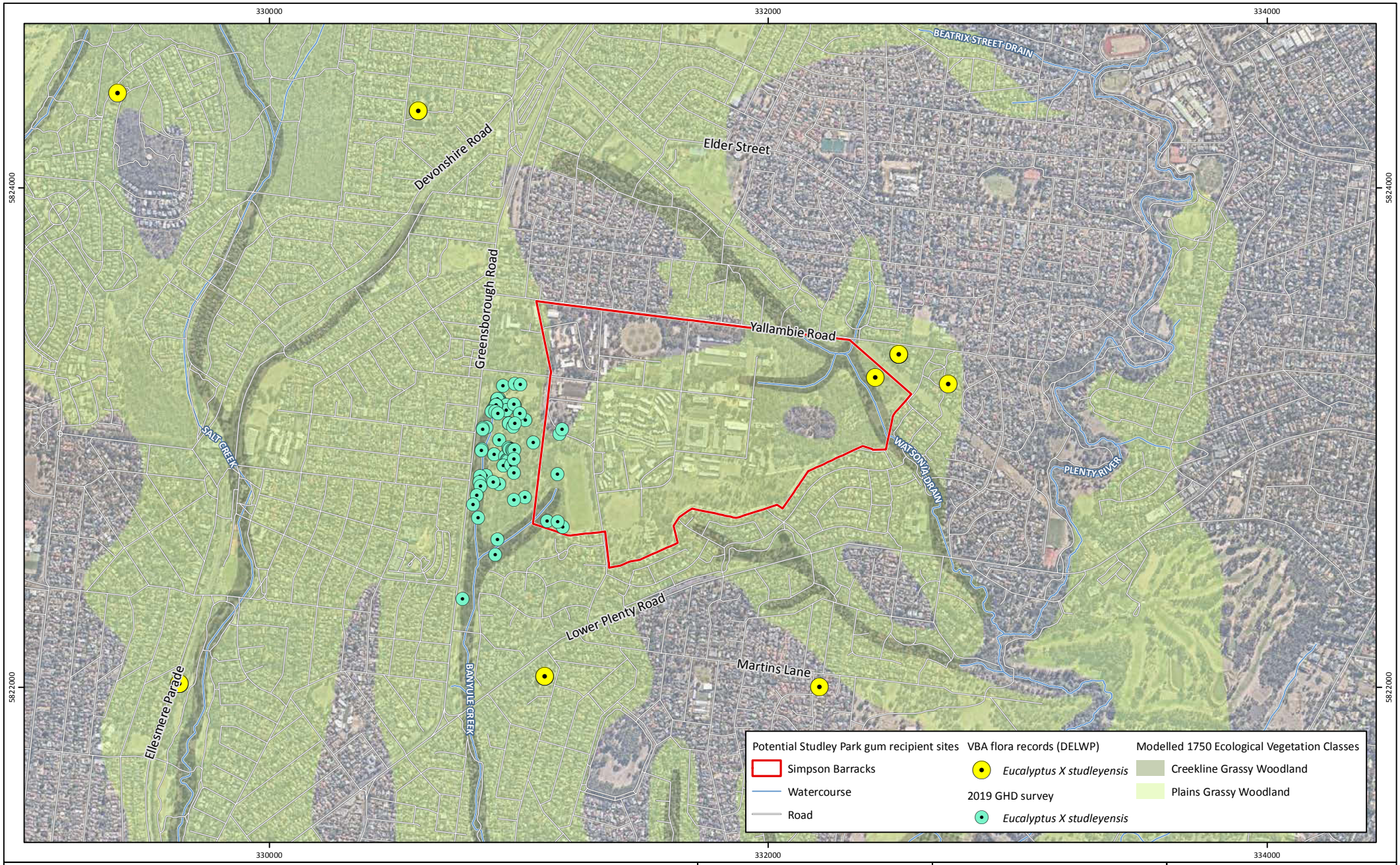


Figure 2: Potential Recipient Sites – Simpson Barracks

Project: Studley Park Gum Management Framework
North East Link Project

Client: Major Transport Infrastructure Authority (North East Link Project)

Plan Number:
VEP19-002(05)--F02a

Drawn:	KNM
Date:	23/07/2019
Checked:	RAO
Approved:	CJM
Date:	23/07/2019

N

0 200 400 600
Metres

Scale: 1:20,000@A4

GDA 1994 MGA Zone 55

emerge ASSOCIATES

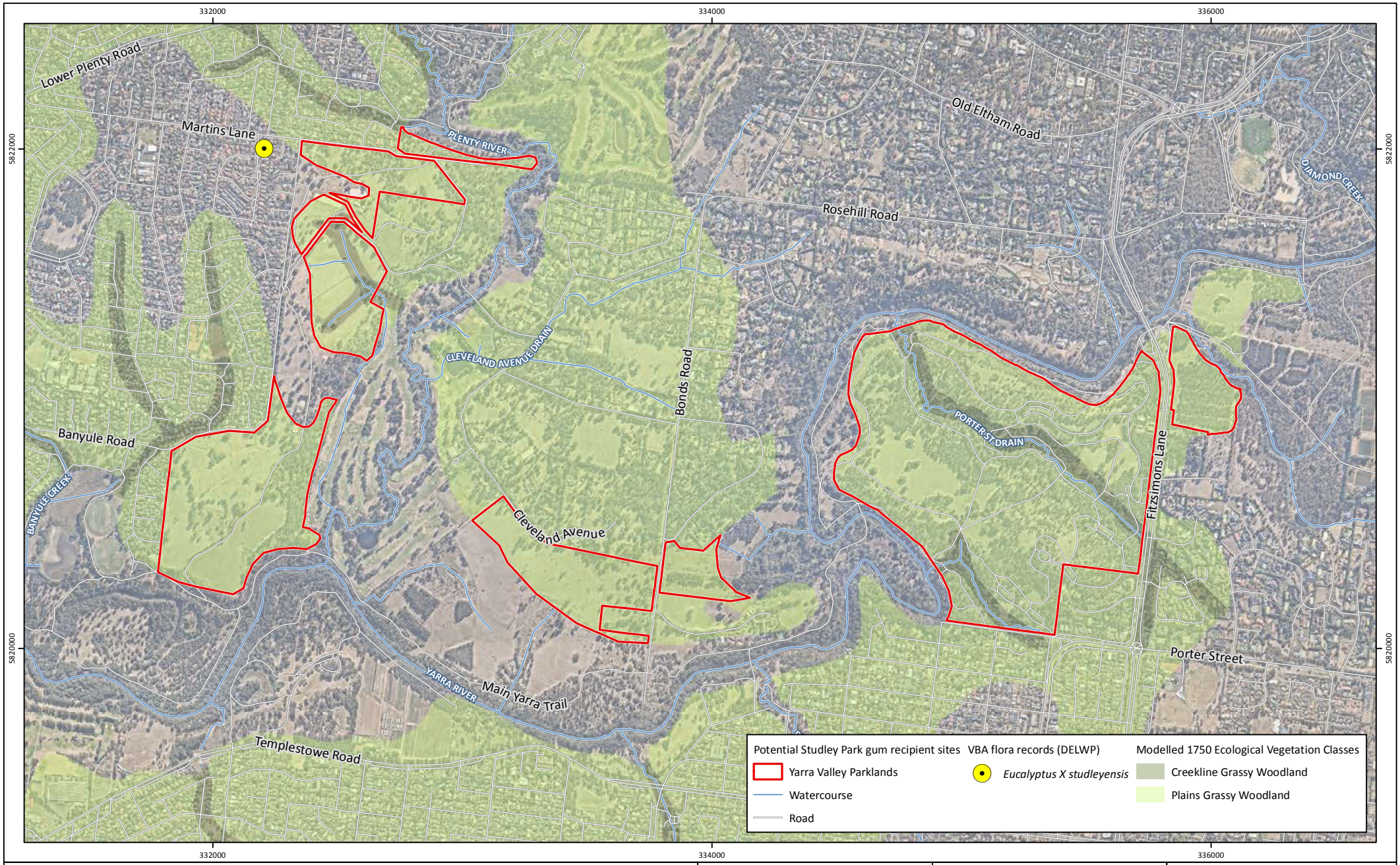


Figure 3: Potential Recipient Sites – Yarra Valley Parklands

Project:	Studley Park Gum Management Framework North East Link Project
Client:	Major Transport Infrastructure Authority (North East Link Project)

Plan Number:
VEP19-002(05)--F03a

Drawn:	KNM
Date:	23/07/2019
Checked:	RAO
Approved:	CJM
Date:	23/07/2019

N

0 200 400 600
Metres

Scale: 1:20,000@A4

GDA 1994 MGA Zone 55

emerge ASSOCIATES

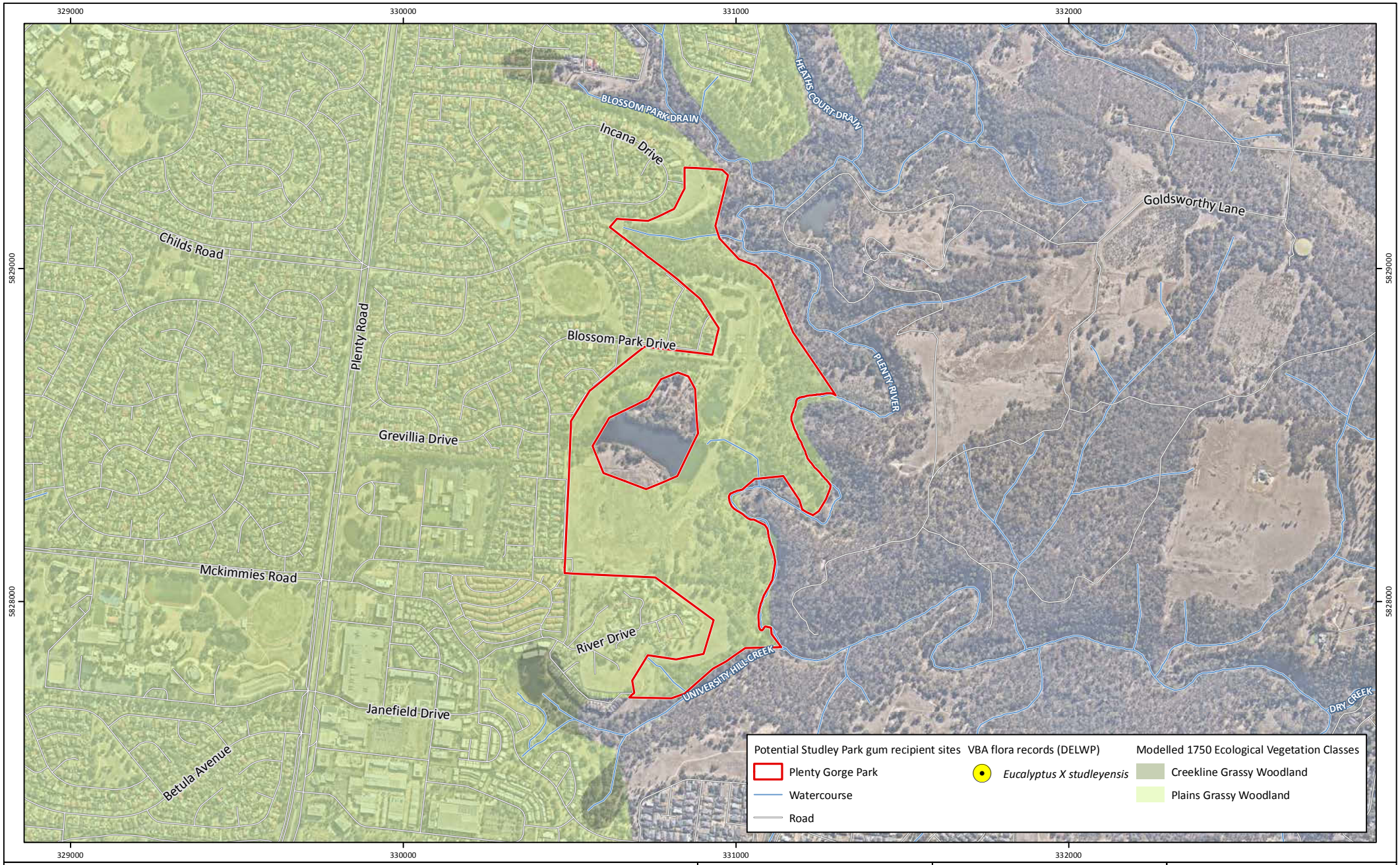


Figure 4: Potential Recipient Sites – Plenty Gorge Park

Project: Studley Park Gum Management Framework
North East Link Project
Client: Major Transport Infrastructure Authority (North East Link Project)

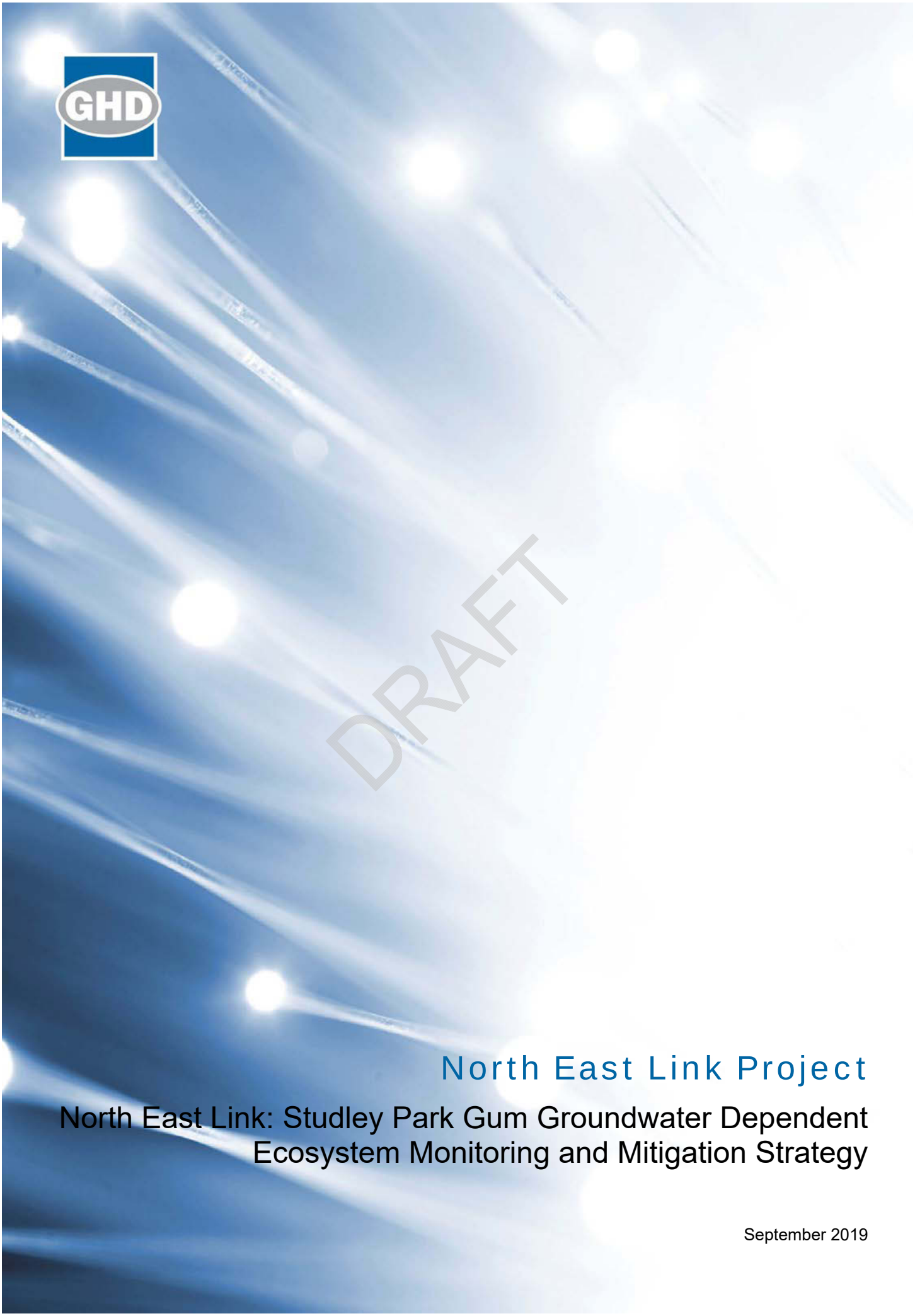
Plan Number:
VEP19-002(05)--F04a
Drawn: KNM
Date: 23/07/2019
Checked: RAO
Approved: CJM
Date: 23/07/2019

N

0 200 400 600
Metres
Scale: 1:15,000@A4
GDA 1994 MGA Zone 55

emerge ASSOCIATES

Appendix H Studley Park Gum Groundwater Dependent Ecosystem Monitoring and Mitigation Strategy



North East Link Project

North East Link: Studley Park Gum Groundwater Dependent Ecosystem Monitoring and Mitigation Strategy

September 2019

This report is prepared to inform planning approval processes and the public about the North East Link. This report may be of assistance to you but the North East Link Project (a division of the Major Transport Infrastructure Authority) and its employees, contractors or consultants (including the issuer of this document) do not guarantee that the report is without any defect, error or omission of any kind or is appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this report.

Table of contents

Table index

1. Introduction

1.1 Project background

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

Assessments of the impacts to biodiversity values in areas that may be impacted by North East Link have been undertaken through ecological impact assessments to inform the development of an Environment Effects Statement (EES) and Public Environment Report (PER). These biodiversity values are recognised by the Australian Government and the Victorian Government in legislation, frameworks and policies designed to facilitate their conservation.

The ecological impact assessment (EES Technical Report Q Ecology and PER Technical Appendix A – Flora and fauna) has identified that the project will directly impact patches of native vegetation (some containing large trees) and scattered native trees, which are protected by Victorian legislation. In addition, the project has the potential to indirectly impact Groundwater Dependent Ecosystems (GDEs) and large native trees outside the project boundary (as defined in the EES) as a result of groundwater drawdown.

For a detailed outline of GDEs, groundwater characteristics within the study area, potential impacts of groundwater drawdown, and the methods used to determine the risk of ecological impacts associated with groundwater drawdown, see the following documents:

- North East Link: *PER Technical Appendix A – Flora and fauna*
- *North East Link: EES Technical Report Q Ecology* (Section 10)
- North East Link: Revised assessment of ecological impacts associated with groundwater drawdown (July 2019), as included in *PER Technical Appendix A – Flora and fauna*

Of particular note, is the potential indirect impact via groundwater drawdown to the endangered taxon, *Eucalyptus X studleyensis* (Studley Park Gum) in areas adjacent to the project boundary within Simpson Barracks, as presented in the Revised PER Technical Appendix A – Flora and fauna.

1.2 Purpose

The purpose of this document is to provide the overarching strategy that would form the basis of the development of the Groundwater Dependent Ecosystem Monitoring and Mitigation Plan (GDEMMP) for Studley Park Gum in areas of Simpson Barracks outside of the North East Link project boundary.

It is noted that the GDEMMP which is implemented based on the detailed design would include measures to protect other GDEs, such as Bolin Bolin Billabong. This strategy does not cover GDEs other than the Studley Park Gum population at Simpson Barracks.

1.3 Objective

The objective of this strategy is to provide a framework for developing a detailed Groundwater Dependent Ecosystem Monitoring and Mitigation Plan (GDEMMP) for Studley Park Gum once planning and environmental approval is received for the Project.

The vegetation monitoring component of the program would be designed:

- So that any change in the condition of Studley Park Gum trees would be able to be detected during construction of North East Link (and in the ensuing years during operation)
- To determine whether groundwater drawdown was causing condition decline (if observed)
- To outline the parameters of a watering program for Studley Park Gum.

The vegetation monitoring component would be informed by groundwater modelling and monitoring undertaken for the detailed design of the project, which would provide critical information about changes to groundwater levels and quality to inform the GDEMMP.

2. Studley Park Gum

2.1.1 Description

Studley Park Gum (*Eucalyptus X studleyensis*) is a hybrid taxon between River Red Gum (*E. camaldulensis*) and Swamp Gum (*E. ovata*). It is a named intersectional *Eucalyptus* hybrid formally recognised by the National Herbarium of Victoria.

Leaf, bud and fruit character traits are intermediate between the two parent taxa but may vary morphologically and align more closely with one species or the other (VicFlora 2016).

2.1.2 Significance

Studley Park Gum has the following Commonwealth and Victorian listing status:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – not listed
- Victorian *Flora and Fauna Guarantee Act 1988* – not listed
- Advisory List of Rare or Threatened Plants in Victoria 2014 (DEPI 2014) – endangered.

2.1.3 Distribution

Studley Park Gum is known to occur along the lower Yarra River corridor north-east of Melbourne (e.g. Kew, Ivanhoe, Viewbank, Rosanna, Macleod, Yallambie, Watsonia). Almost all records are concentrated within the metropolitan area to the north and north-east of Melbourne; however, two reliably determined specimens are also known from Nar Nar Goon south-east of Melbourne and at Connewarre on the Bellarine Peninsula. Site records in the Victorian Biodiversity Atlas, herbarium records and field observations (K. Rule, pers. comm.; D. Cameron, DELWP, pers. comm.) indicate the taxon also occurs near Clayton North, at Lysterfield Park and between Carrum Downs, Hampton Park and Lyndhurst to the south-east of Melbourne, and at Riddells Creek to the north-west of Melbourne.

2.1.4 Location within Simpson Barracks

As part of the planning and environmental approval process for NEL, targeted surveys were conducted for Studley Park Gum at Simpson Barracks. A total of 127 trees were recorded, 44 of which were in the project boundary and 83 of which were outside the project boundary. The majority of trees were in good condition and the population was comprised of trees varying in size from immature saplings to mature large trees with a girth of over one metre. Young trees were not included in the survey since they were too immature to confidently identify. The results of the survey are presented in Table 1.

Table 1 Number of Studley Park Gum according to level of identification confidence

	Simpson Barracks – within the project boundary			Simpson Barracks – outside the project boundary		
Identification confidence class	High	Moderate	Poor	High	Moderate	Poor
Number of trees per class	19	13	12	40	25	18
Proportion of the study area (n=127)	34.6%			65.4%		
Total number of trees	44			83		

3. Overview of the GDEMMP

The GDEMMP would be designed to specify monitoring protocols and performance criteria for three components:

- Groundwater
- Climate
- Studley Park Gum.

3.1 Groundwater

3.1.1 Groundwater modelling

A groundwater model would be prepared for the detailed design, which would assist with predicting any impacts to GDEs due to construction or operation of the project. The groundwater model would be prepared in consultation with EPA Victoria and with reference to the Australian Groundwater Modelling Guidelines (June 2012), informed by field investigations, to predict changes in groundwater levels and flow and quality, as they are affected by construction, and develop mitigation strategies. The groundwater model would be updated to take account of any changes to construction techniques or operational design features, and additional monitoring data.

The impacts predicted by the groundwater modelling, as presented in the PER, would be re-assessed as part of the groundwater modelling carried out for the purposes of detailed design, and the monitoring program would be based on that. Should the model predict changes to groundwater that may pose a risk to the health of large Studley Park Gum trees at Simpson Barracks, a watering program would be implemented.

Those trees that are predicted to be affected by groundwater drawdown during operation would be offset in accordance with DELWP's Guidelines for the removal, destruction or lopping of native vegetation.

3.1.2 Watering program

Based on the groundwater modelling, a total of nine Studley Park Gum at Simpson Barracks (outside the project boundary) are modelled to be at a high to moderate risk of suffering premature mortality or condition decline, owing to groundwater drawdown associated with the Project during construction. These predictions would be reassessed based on the detailed design.

Impacts upon those trees predicted to be impacted during construction are to be mitigated via a watering program, which would commence in the first summer (December 1) following the onset of construction at the Simpson Barracks. The watering program would finish at the end of the summer (28 February), following completion of construction works at the Simpson Barracks, or once groundwater levels are predicted to return to a suitable level, as informed by groundwater modelling and monitoring. The frequency of watering would be determined based on a number of factors, including the rainfall that year, the predicted drawdown expected based on modelling, the results of groundwater monitoring and following review of the literature. The frequency of watering would be specified in the detailed GDEMMP.

3.1.3 Groundwater monitoring

Groundwater monitoring would be undertaken in accordance with a groundwater monitoring program which will require a pre-construction, construction and post-construction groundwater monitoring.

Monitoring of groundwater levels and groundwater quality would occur in a combination of existing bores (some of which would be lost during project construction) and newly installed monitoring wells. The monitoring well network would be confirmed during detailed design, i.e. based on the final project alignment, and proximity to existing GDEs. Groundwater monitoring would aim to confirm the predicted drawdown extent, drawdowns occurring in close proximity to the construction works, and groundwater conditions in a nominated 'control area'. Groundwater monitoring would be undertaken monthly during pre-construction, construction and for first 12 months of operation. After the first 12 months of operation, the program would be reviewed with aim of reducing to quarterly or to ceasing monitoring if recovery is matching predicted response.

In the event that groundwater monitoring identifies a measurable lowering of groundwater levels at Simpson Barracks, measures would be implemented to mitigate the monitored groundwater changes, and Studley Park Gum trees would be monitored for condition changes resulting from groundwater drawdown (see Section 3.3). Contingency measures, potentially including a more intensive watering program, would be implemented to maintain the health of Studley Park Gum trees. If the groundwater monitoring program finds that levels of groundwater are maintained, then trees would not need to be monitored or watered.

3.2 Climate

The monitoring program should incorporate climate data from the Bureau of Meteorology. This would help to determine whether any changes in Studley Park Gum tree condition are attributable to background climatic conditions, as opposed to groundwater drawdown associated with the Project. Variables to consider include the following:

- Temperature – mean daily maximum and minimum temperature
- Rainfall – mean daily and monthly rainfall

3.3 Studley Park Gum

The monitoring program should incorporate a comprehensive tree condition assessment of Studley Park Gum individuals within Simpson Barracks. Factors to consider in the development of the condition monitoring program are outlined below.

3.3.1 Condition monitoring method

The tree condition monitoring method should comprise a well-regarded and peer-reviewed method such as The Living Murray (TLM) Tree Condition Assessment for River Red Gum and Black Box (Souter *et al.* 2012). Key elements of this method include the following variables, which are each broken into a range of categories to assess overall tree condition in a semi-quantitative and repeatable manner:

- Bark cracking
- Crown extent
- Crown density
- Epicormic growth
- New tip growth
- Leaf die-off

- Tree dominance
- Extent of reproduction
- Mistletoe load
- Insect damage, e.g. psyllids
- Other biological stresses, e.g. possums, birds

Other aspects to monitor should include:

- Tree girth (diameter at breast height, i.e. 1.3 m above ground level)

3.3.2 Monitoring frequency

It is anticipated that monitoring would be undertaken quarterly during construction, and thereafter annually, until approximately 10 years after construction at Simpson Barracks has been completed. However, the frequency of the monitoring would be confirmed within the GDEMMP and include review points to assess the suitability and need for future monitoring based on a number of factors, including the groundwater model predictions, observed groundwater levels and observed tree health.

3.3.3 Monitoring design

Monitoring should follow a Before-After-Control-Impact (BACI) design, incorporating:

- Control trees (not modelled to be impacted by groundwater drawdown)
- Impact trees (modelled to be impacted by groundwater drawdown)
- Minimum of 1-year of baseline (before impact) monitoring
- Multiple years of post-impact monitoring following commencement of construction.

3.3.4 Trees to monitor

Trees at greatest risk of impact from groundwater drawdown are large trees (i.e. >80 cm DBH) where the current depth to groundwater is 10<20 m, and where groundwater is predicted to decrease by more than 1 m. The monitoring program should assess **all** large Studley Park Gum trees within this zone, as well as a sample of smaller trees (i.e. 25<80 cm DBH) in this zone.

Furthermore, ‘control’ specimens of Studley Park Gum should be monitored in areas where groundwater drawdown is not predicted to occur. This will help to determine whether there are any background effects occurring on Studley Park Gum condition irrespective of groundwater drawdown impacts associated with the Project.

Trees to be monitored should be permanently marked using tree tags.

3.3.5 Management measures

Should the Studley Park Gum tree monitoring record a decline in tree health which is due to the project, measures would be implemented to restore the health of trees, such as increasing watering intensity or frequency. This feedback loop of monitoring and implementation of measures would continue to maintain the health of the trees.

3.4 Data management

GHD recommends that all monitoring information is stored (and backed-up) in a digital format, which facilitates simple information handling and transfer. Microsoft ® Excel ™ or Access ™ databases are useful tools for the management of monitoring data.

3.5 Reporting

Annual monitoring reports should be prepared, and include the following:

- Summary of tree condition, groundwater monitoring (e.g. water level, quality) and climate data results
- Interpretation of any discernible trends in tree condition with regard to groundwater condition and climate
- Recommendations toward proactive and adaptive monitoring and management of the Studley Park Gum population at the barracks
- Recommendations regarding improvements or refinements to the groundwater monitoring system.

Upon the culmination of the monitoring program, a comprehensive final report should be prepared.

Reports are to be provided to the following agencies/organisations:

- Victorian Department of Environment, Land, Water and Planning (DELWP)
- Commonwealth Department of the Environment and Energy (DoEE)
- Department of Defence.

3.6 Quality assurance and control

The following should be considered during the monitoring program in order to achieve a high level of data quality and compliance with relevant licensing obligations:

- Tree condition monitoring must be undertaken by suitably qualified botanists familiar with the TLM tree condition method.
- Where possible, condition monitoring should be undertaken by the same personnel each year to minimise observer variability, which has the potential to mask subtle changes in tree condition.
- All groundwater and vegetation monitoring procedures, data collection and quality should be reviewed annually.
- Collation of groundwater data and reporting for management and licensing administration review.

4. References

Souter, N., Cunningham, S., Little, S., Wallace, T., McCarthy, B., Henderson, M. and Bennets, K. 2012. Ground-based survey methods for The Living Murray assessment of condition of river red gum and black box populations. Murray Darling Basin Authority

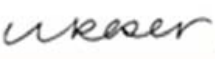
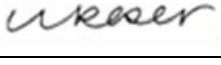
GHD

180 Lonsdale Street
Melbourne Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com

www.ghd.com

GHD
180 Lonsdale Street
Melbourne Victoria 3000
T: (03) 8687 8000 F: (03) 8687 8111 E: melmail@ghd.com

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final Draft	T Wills	K Aldous		M Roser		April 19
Final	T Wills	K Aldous		M Roser		September 19

www.ghd.com