

DELIVERING OUR TRANSPORT FUTURE NOW

north-south corridor northern connector



Project Impact Report

An environmental, social and economic assessment
Technical Reports



Government of South Australia
Department for Transport,
Energy and Infrastructure

DELIVERING OUR TRANSPORT FUTURE NOW

north-south corridor northern connector



Flora

Project Impact Report Technical Report No. 3



Government of South Australia
Department for Transport,
Energy and Infrastructure

Northern Connector Technical Report Flora

February 2011

Prepared by:

EBS Ecology Pty Ltd

4/48 Barwell Road Kurralta Park SA 5037

Prepared for:

Department for Transport, Energy and Infrastructure

77 Grenfell Street
Adelaide SA 5000

GPO Box 1533
Adelaide SA 5001

Telephone: 1300 793 458

Facsimile: + 61 8 8343 2005

Email: dtei.northernconnector@saugov.sa.gov.au

COPYRIGHT: Use or copying of this document in whole or in part without the written permission of Environment and Biodiversity Services constitutes an infringement of copyright.

LIMITATION: This report has been prepared on behalf of and for the exclusive use of Environmental and Biodiversity Services Client, and is subject to and issued in connection with the provisions of the agreement between Environmental and Biodiversity Services and its Client. Environmental and Biodiversity Services accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

Table of Contents

	Page number
Executive summary	vii
1 Introduction.....	1
1.1 The Northern Connector	1
1.1.1 Project area	5
1.1.2 Main elements of the project.....	5
1.2 Policy and legislative requirements	6
1.2.1 <i>Environment Protection and Biodiversity Conservation Act 1999</i> ...	6
1.2.2 <i>National Parks and Wildlife Act 1972</i>	7
1.2.3 <i>Native Vegetation Act 1991</i>	7
1.2.4 <i>Natural Resources Management Act 2004</i>	9
1.2.5 <i>Development Act 1993</i> – significant tree legislation	9
1.2.6 DTEI Vegetation Removal Policy.....	10
1.3 Assessment methodology.....	10
2 Existing conditions.....	13
2.1 Biodiversity overview	13
2.1.1 Landscape context.....	13
2.1.2 Pre-European vegetation	15
2.1.3 Landscape features	15
2.1.4 Existing biodiversity values	16
2.2 Flora	17
2.2.1 Terrestrial vegetation associations	17
2.2.2 Aquatic flora.....	33
2.2.3 Species of conservation significance	33
2.2.4 Weed species	34
3 Potential impacts of the project on existing conditions	39
3.1 Construction impacts	39
3.1.1 Flora.....	39
4 Management and mitigation	43
4.1 Measures to minimise impacts during planning and design	43
4.2 Measures to minimise impacts during construction	44

4.3 Measures to minimise impacts during operation	44
4.3.1 Vegetation offsets – <i>Native Vegetation Act 1991</i>	45
4.3.2 Revegetation and landscaping	45
Glossary	47
Abbreviations	50
References	51

List of figures

	Page number
Figure 1.1 Location plan	3
Figure 1.2 The Northern Connector proposed road and rail route	4
Figure 2.1 Environmental Associations (IBRA)	14
Figure 2.2 Grey Mangrove Low Open Forest, intertidal Samphire and Chenopod Shrubland	19
Figure 2.3 River Red Gum Woodland over Chenopod Shrubland	20
Figure 2.4 Planted Woodland vegetation	21
Figure 2.5 River Sheoak Low Closed Forest near Little Para Estuary	22
Figure 2.6 Cottonbush Low Shrubland with scattered native grasses	23
Figure 2.7 Samphire Very Low Open Shrubland	24
Figure 2.8 Nitre Bush, Marsh saltbush, Ruby Saltbush Open Shrubland	25
Figure 2.9 Common Reed and Bulrush Reedbeds	26
Figure 2.10 Salt Club-rush +/- Rush Sedgeland	27
Figure 2.11 River Red Gum Open Woodland over exotic grasses	28
Figure 2.12 Planted Mixed Shrubland	29
Figure 2.13 Exotic Grassland / Herbland	30
Figure 2.14 Vegetation map - northern section	36
Figure 2.15 Vegetation map - central section	37
Figure 2.16 Vegetation map - southern section	38

List of tables

	Page number
Table 2.1 Descriptions of vegetation associations in the Northern Connector project area.....	31
Table 2.2 Flora species of State conservation significance*	34
Table 2.3 Declared and environmental weed species recorded in project area ..	34
Table 2.4 Additional weed species recorded in project area	35
Table 3.1 Native vegetation type and condition in the project corridor	40

Appendices

Appendix A

Native flora species recorded in the project area or in the wider region

Executive summary

This report details the results of flora surveys undertaken for the Northern Connector project. The surveys covered the project site and surrounding areas during spring–summer 2008–2009 and summer 2011 in order to identify vegetation associations and flora species occurring within the project area. Species or communities identified as having conservation significance were assessed for the likely impacts of the Northern Connector project.

Of the 12 vegetation associations within the Northern Connector project area, 7 represent remnant native vegetation and 5 represent planted exotic and planted native vegetation.

A total of 49.79 hectares of native vegetation (as defined by the *Native Vegetation Act 1991*) lie within the Northern Connector project corridor. The overall condition ranges from very poor (e.g. degraded samphire areas) to excellent (remnant mangrove forest).

Two flora species of state conservation significance, as listed under the *National Parks and Wildlife Act 1972* (NPW Act), were found to occur within the Northern Connector project area: the Vulnerable Hoary Rush (*Juncus radula*) and Endangered Black Cotton-bush (*Maireana decalvans*). Both species are located in the remnant native chenopod shrubland in the SA Water revegetation area near Jobson and Summer roads. No flora species of national conservation significance (species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) were located, or are known to occur, within the project area.

It is proposed to mitigate the impacts of the project and offset the loss of native vegetation by ensuring that a significant environmental benefit (SEB) is achieved for the project in accordance with the requirements of the *Native Vegetation Act 1991*. The SEB would be achieved through a combination of payment into the Native Vegetation Fund and on-ground rehabilitation and revegetation works.

Non-native vegetation requiring removal from the project corridor would also be offset through on-ground landscaping and revegetation works.

1 Introduction

1.1 The Northern Connector

The proposed Northern Connector (the project) will form a strategic link in road and rail between northern regions of South Australia, and further afield, to the Port of Adelaide, Adelaide metropolitan area and southern regions (Figure 1.1).

It will be an integrated road and rail transport corridor comprising a new 15.6 km expressway standard road (three lanes in each direction) and a 30.9 km single track, national freight rail line. The road component would run west of the existing Port Wakefield Road, from the new Northern Expressway interchange with Port Wakefield Road in the north to the Port River Expressway and South Road interchange in the south (Figure 1.2). The rail component will primarily run west of the new road carriageways, and link with existing rail lines at Virginia to the north, Dry Creek to the south and Port Adelaide to the west (Figure 1.2).

The project has been developed in response to the *South Australia's Strategic Plan* (Government of South Australia 2007a) and *The 30-Year Plan for Greater Adelaide* (Department of Planning and Local Government 2010) which forecasts a significant increase in population growth, road and rail traffic, and economic expansion in the northern Adelaide region.

The Northern Connector project has also been listed as a 'project with real potential' by the Australian Government. Infrastructure Australia identified the national significance of the project and the clear and positive contribution it would make to achieving Australia's policy goals.

The Northern Connector will form an integral component of Adelaide's North–South Corridor extending from the Northern Expressway at Gawler to the Southern Expressway at Old Noarlunga (Figure 1.2), as identified in the *Strategic Infrastructure Plan for South Australia: 2010 Discussion Paper* (DTEI 2010). It is both integrated (encompassing transport and land use priorities) and multi-modal (encompassing rail and road).

It would form a new link in the Adelaide Urban National Land Transport Network, connecting the Adelaide–Perth/Darwin corridor, mining activity in the states north, the Adelaide–Sydney corridor, areas of the Riverland and Barossa Valley in South Australia, and the Sunraysia area in New South Wales and Victoria, with key freight destinations in Adelaide's north-west suburbs, including the Port of Adelaide, rail terminals, industry zones and Adelaide Airport.

The completed road link will allow a largely unimpeded journey from Port Wakefield, the Mid North, Barossa Valley and Riverland to the Port of Adelaide and the future non-stop North–South Corridor (incorporating the South Road Superway).

Key Northern Connector road benefits will be:

- improved traffic conditions, access and safety for road users and local communities along the route by reducing freight on Port Wakefield Road and Main North Road

- improved freight efficiency and export opportunities
- a safer, faster connection to suburban destinations such as Adelaide Airport, sporting venues, beaches and businesses, in southern and western suburbs
- reduced travel times for commuters travelling to and from the northern suburbs
- reduced overall vehicle emissions due to smoother traffic flow.

The rail component is critical to the interstate freight network managed by Australian Rail Track Corporation. Key Northern Connector rail benefits will be:

- improved safety for road users and quality of life for nearby residents by significantly reducing freight rail traffic through suburban area to the east of Port Wakefield Road (Salisbury North and South, Parafield Gardens, Mawson Lakes)
- 'unlocked' commercial and industrial development opportunities along the corridor, including the Economic Development Precinct in Gillman and Defence SA in Port Adelaide
- a freight transport mode shift from road freight to rail freight
- less environmental impact of heavy rail freight transport through suburban communities
- improved rail freight transport efficiencies through higher speed and shorter connection to the port and intermodal facilities
- improved rail access to intermodal terminals in Adelaide and the Port of Adelaide for rail freight transport from the north and west of South Australia and from Darwin and Perth.

Construction and operation of the Northern Connector would bring significant benefits but many, often competing, environmental, social, economic and engineering issues have had to be balanced to achieve project objectives. Inevitably, due to the scale, nature and location of the project, some adverse impacts would occur. Where possible, measures will be put in place to minimise and/or offset these impacts.

The release of this *Project Impact Report* is part of the project's planning and environmental impact assessment processes. It represents a key aspect in determining the appropriate location and extent of the project to enable a corridor to be defined for future construction.

The Department for Transport, Energy and Infrastructure (DTEI) is currently seeking and investigating funding for the construction of the Northern Connector project. If approved and funded in the near future, construction could be completed by 2017.

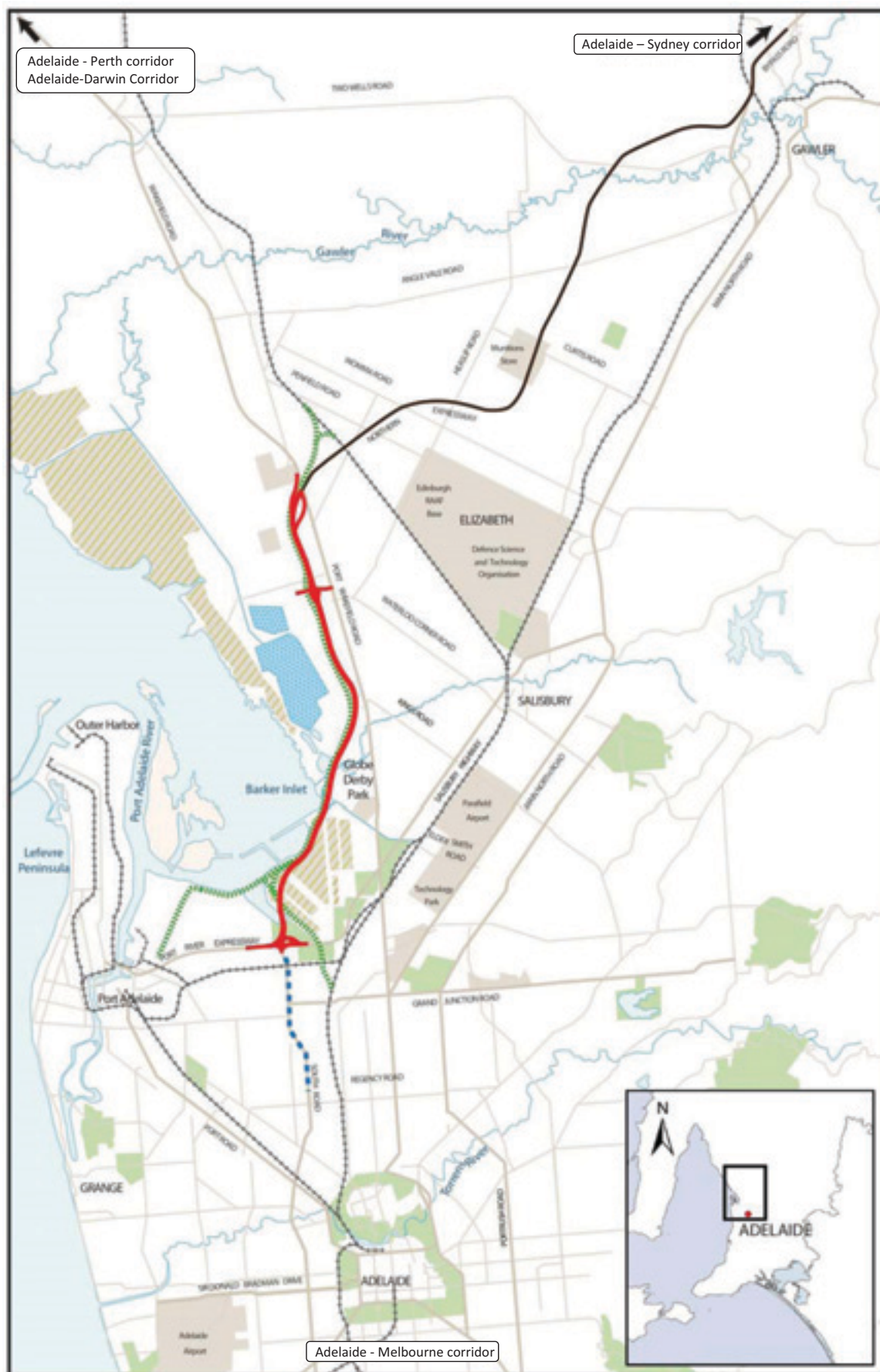




Figure 1.2 The Northern Connector proposed road and rail route

1.1.1 Project area

The project, located in Adelaide's outer northern metropolitan area, approximately 12 km north of Adelaide's central business district (Figure 1.1), will pass through three council areas —City of Playford, City of Salisbury and City of Port Adelaide Enfield — and through the suburbs of Virginia, Waterloo Corner, St Kilda, Bolivar, Globe Derby Park, Dry Creek, Wingfield and Gillman.

The project area has been zoned into three sections (Figure 1.2) to facilitate design, planning and assessment of the corridor:

- Northern section — relatively low population agricultural land, typically used for horticulture
- Central section — adjacent to and immediately east of the SA Water Bolivar Wastewater Treatment Plant
- Southern section — incorporates Globe Derby Park, with a small resident population on semi-rural land holdings used for horse agistment and training facilities; open land primarily used for salt production and the Greenfields and Barker Inlet wetlands; vacant land at Gillman; and the more densely populated urban industrial area of Wingfield.

1.1.2 Main elements of the project

The main elements of the project are:

- a new road (15.6 km), three lanes in each direction, between the Northern Expressway and the South Road–Port River Expressway junction
- four road interchanges: Northern, Waterloo Corner, Bolivar (on-ramp) and Southern
- Port Wakefield Road–Waterloo Corner and Port Wakefield Road–Bolivar Road intersection upgrades to connect to the Northern Connector interchange ramps
- approximately 30.9 kilometres of standard gauge, single-track freight rail line with maintenance/access track, generally located to the west of the road carriageways
- four rail bridges separating rail freight from road traffic
- two 2 km rail passing loops at Gillman and north of Waterloo Corner interchange
- a shared-use (pedestrian and cyclist) path
- Barker Inlet north wetland modifications
- wetland offset or rehabilitation areas (for flood storage, water quality treatment and habitat)
- swale drains and detention basins

- landscaping.

1.2 Policy and legislative requirements

The key pieces of legislation and policy relating to flora include:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *National Parks and Wildlife Act 1972*
- *Native Vegetation Act 1991*
- *Natural Resources Management Act 2004*
- *Development Act 1993* — significant tree provisions
- Vegetation Removal Policy: *Standard operating procedure under the Native Vegetation Act 1991* (DTEI 2009)
- State Natural Resources Management Plan 2006 (DWLBC 2006)

1.2.1 *Environment Protection and Biodiversity Conservation Act 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was developed as a legislative framework for the protection and management of matters of national environmental significance (Department of the Environment, Water, Heritage and the Arts (DEWHA) 2007) (now Department of Sustainability, Environment, Water, Population and Communities (SEWPAC)). Its primary objectives relevant to the Northern Connector project are to:

- provide for the protection of the environment, especially Matters of National Environmental Significance (MNES)
- conserve Australian biodiversity
- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- promote ecological sustainable development through the conservation and ecologically sustainable use of natural resources.

The seven Matters of National Environmental Significance are:

- world heritage properties
- national heritage properties
- wetlands of international importance (Ramsar wetlands)
- threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- nuclear actions (including uranium mining).

MNES relevant to this project include nationally threatened flora and fauna species, migratory bird species and marine bird species.

A referral under the EPBC Act has been prepared and will be submitted for the project. The EPBC Act stipulates that this referral is released for public comment. All public submissions received are assessed and, if relevant to the Act, are taken into consideration. The Minister or a delegate will then decide whether the likely

environmental impacts of the project are such that it should be assessed under the EBPC Act.

Once a project has been assessed, SEWPAC makes a recommendation to the Minister or delegate about whether or not the project should be approved to proceed and whether any specific conditions need to be attached to that approval. In addition to considering potential impacts on MNES in making the decision, the Minister also considers the social and economic impact of any project.

MNES relevant to the project are discussed in Chapter 2 and potential impacts to them are discussed in Chapter 3. Recommendations on these MNES are presented in Chapter 4.

1.2.2 *National Parks and Wildlife Act 1972*

South Australia's *National Parks and Wildlife Act 1972* (NPW Act) principally provides for the establishment and management of reserves, the conservation of wildlife in a natural environment, and for other purposes such as permits for the keeping of native animals and compliance.

The NPW Act protects all native flora and fauna in South Australia and lists species of State conservation significance in Schedule 7 (Endangered), 8 (Vulnerable), and 9 (Rare) of the Act. A number of species listed under these schedules are considered likely to occur in the project area. However, there are no approval requirements under this legislation if a listed species is likely to be impacted upon by a project. If native vegetation is to be removed on a project, the impacts on native vegetation are assessed under the *Native Vegetation Act 1991*.

1.2.3 *Native Vegetation Act 1991*

South Australia's *Native Vegetation Act 1991* (NV Act) and Native Vegetation Regulations 2003 provide for the conservation, protection and enhancement of native vegetation in South Australia. The NV Act applies throughout the State, except some areas of metropolitan Adelaide, and covers both private and public land. The Act covers all native vegetation and dead trees that provide habitat for endangered fauna species.

It is an offence to clear native vegetation unless the clearance is in accordance with the NV Act. Approval to clear native vegetation can be granted by the Native Vegetation Council, a statutory body established under the Act. In other cases, clearance may be undertaken pursuant to 'exemptions' in the Native Vegetation Regulations 2003. The Native Vegetation Act applies within some areas of the Northern Connector project site.

The native vegetation in the project area consists of a mixture of remnant vegetation areas, vegetation which is naturally regenerating from revegetation areas, and disturbed areas that have been colonised naturally by local native species. Areas classified as native vegetation have been assessed under the Native Vegetation Act and have been assigned a Significant Environmental Benefit (SEB) ratio. Remnant scattered trees also in the project area may need to be assessed individually once

the final design for the project and the full extent of proposed vegetation clearance is known.

Clearance of native vegetation associated with the Northern Connector project would fall under regulation 5(1)(h) Works on behalf of the Commissioner of Highways of the Native Vegetation Act, and would be permitted providing the requirements of this regulation are addressed.

Regulation 5(1)(h), Works on behalf of the Commissioner of Highways, of the Native Vegetation Act states that:

Pursuant to Section 27(1)(b) of the Act, native vegetation may, subject to any other Act or law to the contrary, be cleared if:

- (i) The clearance is incidental to work being undertaken by or on behalf of the Commissioner of Highways; and
- (ii) except where the clearance is incidental to repair or maintenance work, there is no other practicable alternative that would involve no clearance or the clearance of less vegetation or the clearance of vegetation that is less significant or (if relevant) the clearance of vegetation that has been degraded to a greater extent than the vegetation proposed to be cleared; and
- (iii) either—
 - (A) the clearance is undertaken in accordance with a standard operating procedure determined or approved by the Council for the purposes of this provision or a management plan that has been approved by the Council and either there will be a significant environmental benefit at the site of the relevant work or within the same region of the State, or the Commissioner of Highways or another person undertaking the work has, on application to the Council to proceed with clearing the vegetation in accordance with this provision, made a payment into the Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit in the manner contemplated by section 21(6) of the Act; or
 - (B) the clearance is incidental to repair or maintenance work and the person undertaking the clearance—
 - has given at least 10 business days notice in writing outlining the proposed clearance to a person who has the care, control or management of the land before commencing the clearance (unless the land is under the care, control or
 - management of the Commissioner of Highways); or
 - is acting in accordance with a standard operating procedure determined or
 - approved by the Council for the purposes of this provision; or
 - is acting in a situation of urgency that requires action without delay; and
- (iv) the person undertaking the clearance complies with any guidelines relating to the protection of native vegetation from the spread of plant diseases or noxious weeds, or from unnecessary damage during the performance of any work, prepared by the Council in accordance with section 25 of the Act.

The native vegetation in the project subject to the legislative requirements of the Native Vegetation Act is discussed in Chapter 2 and the potential impacts to native vegetation values in Chapter 4. Section 4.3 discusses the legislative requirements to offset native vegetation clearance, including the options to pursue an SEB through set-aside areas or a payment to the Native Vegetation Fund.

1.2.4 *Natural Resources Management Act 2004*

In 2004 the South Australian Government enacted legislation to promote sustainable use and management of the State's natural resources. The *Natural Resources Management Act 2004* (NRM Act) established an integrated management arrangement that:

- (i) recognises and protects the intrinsic value of natural resources
- (ii) seeks to protect biological diversity and support and encourage the restoration or rehabilitation of ecological systems and processes that have been lost or degraded
- (iii) provides for the protection and management of catchments and the sustainable use of land and water resources and to enhance and restore or rehabilitate land and water resources that have been degraded
- (iv) seeks to support sustainable primary and other economic production systems with particular reference to the value of agriculture and mining activities to the economy of the State
- (v) provides for the prevention or control of impacts caused by pest species of animals and plants that may have an adverse effect on the environment, primary production or the community; and
- (vi) promotes educational initiatives and provides support mechanisms to increase the capacity of people to be involved in the management of natural resources.

The NRM Act provides for the control of pest flora and fauna species (Section 2.2.3).

The State Natural Resources Management (NRM) Plan 2006 (DWLBC 2006), a requirement under the NRM Act, contains the strategic policy, at a State level, for managing South Australia's natural resources and provides a framework for all natural resources management initiatives. The plan identifies a 50 year vision for NRM in South Australia and sets the policies, milestones and strategies to achieve the vision.

1.2.5 *Development Act 1993 – significant tree legislation*

The Northern Connector project area is located in metropolitan Adelaide (within the City of Playford, City of Salisbury and the City of Port Adelaide Enfield). Therefore the 'significant tree' provisions of the *Development Act 1993* apply to the project. The legislation states that development approval is required if any tree that meets the size requirements (see below), is either removed or impacted upon as part of the project and consent under the Native Vegetation Act, is not required. The significant tree definition is:

- any tree with a trunk circumference of 2.0 m or more – or, in the case of trees with multiple trunks, that have trunks with a total circumference of 2.0 m or more and an average circumference of 625 mm or more – measured at a point 1.0 m above natural ground level; or
- any tree identified as a significant tree in a Development Plan.

The significant tree provisions of the Development Act will be relevant to the project if construction requires the clearance or causes an impact to a significant tree (any tree meeting the requirements above and not requiring approval under the Native Vegetation Act). The current route is likely to impact upon some significant trees. Any significant trees requiring removal or major pruning will require approval from the Development Assessment Commission.

1.2.6 DTEI Vegetation Removal Policy

The Department for Transport, Energy and Infrastructure (DTEI) Vegetation Removal Policy details the procedures and approvals required to undertake pruning, removal, and clearance of vegetation or any other action that causes the destruction of vegetation associated in maintenance and construction works undertaken by, or on behalf of DTEI.

The Vegetation Removal Policy details DTEI's responsibilities under different legislation. DTEI's internal vegetation removal approval procedure requires internal approval for the removal of vegetation not covered by legislation (such as the Native Vegetation Act or the Development Act).

1.3 Assessment methodology

Methods

Extensive background research, vegetation mapping and verification of flora values through field surveys were used to compile this Flora Technical Report.

Background research

Background research into the project area was conducted by literature review and database search. The literature review examined available reports relevant to the project area, such as site based vegetation reports, management plans, recovery plans, action plans, revegetation projects, scoping reports and assessments of biodiversity values for specific areas. Data and information supplied by Delta Consulting, which has undertaken biological projects in and near the project area over a number of years, also formed part of the background research.

The databases searched were:

- EPBC Protected Matters to determine if any potential MNES exist; this online query tool returns results based on bioregions (DEWHA 2006).

- Biological Databases of South Australia (BDBSA) for flora previously recorded in close proximity to the project area; BDBSA includes data collected by the Department of Environment and Natural Resources (DENR) (formerly the Department for Environment and Heritage (DEH), State Herbarium and South Australian Museum
- Provisional list of Threatened Ecosystems in South Australia (DEH 2002)
- *Naturemaps* to collect further SA Biological Survey flora site information (site descriptions), up-to-date and cross-referenced aerial photography (plus Google maps and imagery) and spatial datasets, such as floristic mapping; DENR floristic vegetation and coastal saltmarsh and mangrove mapping.

Numerous reports documenting the flora values of specific areas in this region were used to map and locate known populations of flora species of conservation significance and to generate a field survey list of flora species known to occur in the region. Survey data collected by EBS for the Port Wakefield Road Upgrade project also contributed to recently documented flora values within sections close to the project site area.

Field survey

All vegetation types in the project area were assessed to establish the vegetation communities present, their condition and the overall ecological significance of the native vegetation.

Each vegetation association was visited either in winter, spring or summer 2008-09 or summer 2011 and all plant species (native and exotic plant species) recorded. Site photographs were taken and the site was marked with a GPS coordinate. Specimens were collected for later identification if a plant species was unknown to the observer. General observations were also made throughout the project area to document vegetation condition across the landscape.

The extent of each vegetation community was mapped and manually drawn onto printed aerial photographs while in the field and later digitally transferred into geographical information system (GIS) software (MapInfo 8).

2 Existing conditions

2.1 Biodiversity overview

2.1.1 Landscape context

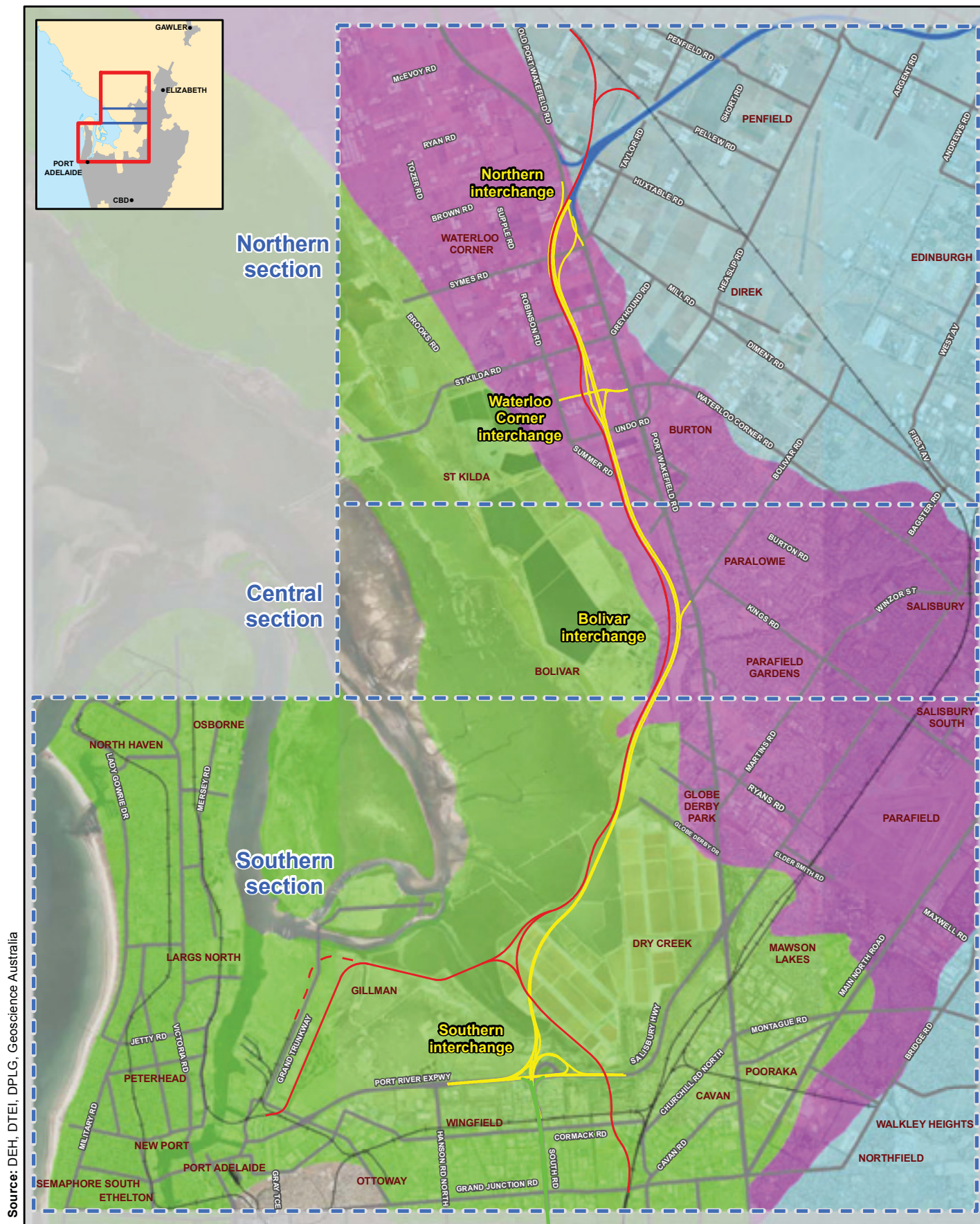
The Adelaide Plains, on which the Northern Connector project is located, lie in the most southern parts of the Eyre and Yorke Block bioregion and in the Flinders Lofty Block bioregion (IBRA 6.1, after Thackway and Cresswell 1995). For the project, the Adelaide Plains region is defined as Onkaparinga Estuary to Port Wakefield and east to the foothills of the Mount Lofty Ranges.

In terms of ecological classification, the project would occur in the Parham and Mallala associations of the St Vincent subregion in the Eyre and Yorke Block bioregion (Figure 2.1).

The project area lies wholly in the Adelaide and Mount Lofty Ranges Natural Resources Management Board region and most of it in the Cape Borda to Barossa Naturelinks Corridor.

The northern and central section of the project occurs in the Mallala Association, which is described as an undulating plain with occasional dunes supporting mainly grasslands on brown calcareous loams, hard pedal red duplex soils and brownish sands (Laut et al. 1977). Since European settlement, 96.8% of the native vegetation in this association has been cleared, a very high level of clearance. Only 1.8% of the association (or about 110 ha) is conserved in private Heritage Agreements. No areas of native vegetation are formally protected under the public reserves system. Representative samples of native vegetation, especially any native vegetation inland from the coast are a conservation priority in this association because there are so few examples already conserved and very few opportunities for further protection.

The southern section of the project occurs in the Parham Association, which is described as a coastal complex of tidal flats, dunes, swamps and sandy beaches, backed by a gently sloping plain supporting low woodlands of mangrove, chenopod shrubland of samphire and open heath of Coast Daisy Bush, Coast Beard Heath and Coastal Wattle on grey non-cracking plastic clays, grey duplex soils, whitish sands, grey calcareous loams and greyish calcareous sands (Laut et al. 1977). In this association 46.5% of the native vegetation has been cleared since European settlement, which is considered to be a moderate level of native vegetation cover overall but is quite high compared to most agricultural regions of South Australia. It is calculated that 1,698 ha (9.4% of the association) (DEH 2002) is protected in three public protected areas (Port Gawler Conservation Park (CP), Fort Glanville CP and Torrens Island CP). An estimated 53.5% of the association supports native vegetation that usually occurs as coastal shrublands (DEH 2002).



Source: DEH, DTEL, DPLG, Geoscience Australia

Figure 2.1 Environmental (Interim Biogeographic Regionalisation of Australia) associations

2.1.2 Pre-European vegetation

Historically, the landscape supported large expanses of coastal saltmarsh communities (saline aquatic and semi-aquatic samphire low shrublands in areas that are frequently subject to tidal inundation) (Kraehenbuehl 1996; Graham et al. 2001; Coleman and Cook 2008). Shrublands subject to periodic shallow freshwater inundation from flooding events with floristically intact riparian ecosystems (Gawler, Light and Little Para rivers) also provided a suite of wetland and woodland habitat areas. Floodplain shrublands such as lignum and chenopod shrublands, were extensive, whilst other shrublands occupied slightly higher ground (including *Nitraria billardiarei*, *Atriplex paludosa* ssp. *paludosa* and *Maireana brevifolia*). Terrestrial vegetation types also included sedgeland (Gahnia filum), grasslands (Lomandra effusa, Austrodanthonia species, Austrostipa species) with River Red Gum woodlands along the major rivers, creeks and extending out to flood wash plains (Berkinshaw 2004a). Open grassy box woodlands inland from the coast featured on rises and plains. Native pine woodlands would have also featured on sandy rises (Kraehenbuehl 1996).

2.1.3 Landscape features

Originally, the physical attributes of the Adelaide Plains landscape would have included an extensively vegetated coastal fringe, westerly flowing rivers from the Mount Lofty Ranges extending to deltas in intertidal zones with vast flood out areas and seasonally inundated riparian wetlands created by the ephemeral ponding of winter rain (Kraehenbuehl 1996).

The structural vegetation description for the Adelaide Plains region is a mixture of inland low open box woodlands (Grey Box, Mallee Box), riparian and floodplain River Red Gum woodlands, samphire shrublands in low lying saline depressions, chenopod shrublands, coastal shrublands on low dune rises, low sedgelands in seasonally inundated freshwater depression, tall reedbeds and open grasslands on vast open plains (Kraehenbuehl 1996).

The current highly modified landscape has few historical ecosystem features remaining. Extending from the Mount Lofty Ranges, westerly flowing rivers with riparian areas, ephemeral ponds and wetlands still extend to floodplains but the drainage patterns now include constructed wetlands, levee banks, drains and shallow open water surfaces managed for commercial salt harvesting.

Remnant coastal landscape features include tidal flats and creeks, saltmarshes, ridges, dunes, intertidal coastal areas and extensive mangroves (especially at North Arm Creek). The modification of the landscape to improve stormwater management at Barker Inlet and Greenfields Wetlands has replicated some of the historical ecosystems and now provides extensive wetland habitat for a range of species. The water drainage channels and pondage systems constructed for salt harvesting provides areas of permanent surface water storage dams. This 'artificial' physical characteristic is noticeable in the landscape and replicates some wetland habitat types for waders.

Today's landscape features include levee banks that provide access routes throughout most low lying areas, largely for the control and maintenance of salt evaporation ponds, sewerage treatment beds and protection of low lying areas from flooding. These levee banks allow for a range of shrubland habitats influenced by factors such as access to fresh or saline water or elevation from low lying areas. This is especially evident in Barker Inlet.

2.1.4 Existing biodiversity values

The Northern Adelaide Coastal Plains are classified as 'fragmented' (McIntyre and Hobbs 2000), indicating that 40–90% of the remnant vegetation has been destroyed. The remaining 53.5% of the Parham environmental association appears to be a high figure because it includes large areas of coastal mangroves. The remaining remnant vegetation is isolated, reduced in structural and species diversity, reduced in habitat value and vulnerable to invasion by environmental weeds and feral animals.

Although the Northern Adelaide Coastal Plains are considered to be fragmented, they have also been highlighted as a region of high ecological importance (Berkinshaw 2004a). Remnant vegetation patches contain flora and fauna species of conservation significance, despite the high level of disturbance and modification from multiple land uses. Due to the historical broad-scale clearance of the Adelaide Plains (from Hallett Cove to Gawler River), the remnant vegetation in the project area is considered to be of conservation significance at a landscape scale to the whole Adelaide Plains region (Environmental & Biodiversity Services 2007).

The narrow band of coastal vegetation from the project area north to Port Wakefield is relatively continuous. It is predominately a mixture of samphire and mangrove communities with small areas of shrubland and woodland vegetation.

Mangrove communities, particularly those in the Port River–Barker Inlet, are under threat from the high level of nutrients entering the ocean from stormwater, wastewater treatment plants and soda products factory outfall (Baker 2004). The high nutrient loads have resulted in significantly increased production of *Ulva lactuta* (green algae) offshore. The *Ulva lactuta* washes ashore and smothers mangrove seedlings, pneumatophores and small seagrass seedlings (Baker 2004). Mangrove areas are a critical part of the fishing industry, as breeding ground for a range of marine species. They also protect the coast against storms and play a slow but continuous role of land building (City of Salisbury 2008).

Landscape modifications have most noticeably been the loss of sedgeland, grassland and woodland habitat. The extensive mangrove forests remain because of the low landscape value of saline areas for agricultural development. The loss of Thatching Grass (*Gahnia filum*) sedgelands in the region has led to a dramatic decline and suspected local extinction of the Yellowish Sedge-skipper Butterfly.

The Cheetham Salt Ltd salt fields and the Port River mouth have been identified as areas of international importance in South Australia for shorebirds (Watkins 1993). The salt fields are ranked fourth in importance in South Australia (Watkins 1993). They consist of two types: the concentration ponds that stretch along the coast and provide important habitat, and the crystallisation fields which are of limited habitat

value. Wilson (2000) further identified the Port River–Barker Inlet area as an important site for wader birds. Artificial wetlands, such as the concentration ponds and the Bolivar WWTP areas, are valued for supplying habitat for a variety of species, mainly waders and waterbirds. These areas have thus been included in the boundary of the Barker Inlet and St Kilda Wetland of National Importance [SA005].

Known areas of conservation value close to the project site include Little Para Estuary, Greenfields Wetlands, Bolivar WWTP, Cheetham Salt Ltd salt fields and nearby areas such as Thompsons Creek and Little Para Linear Park (Berkinshaw 2004a; Coleman and Cook 2000; KBR 2004). Other areas of conservation value include the vegetated areas around Port Parham (coastal), Buckland Park (grassland/chenopod shrubland), Buckland Park Lake (aquatic ecosystem), Gawler River (River Red Gum lined banks) and Port Gawler Conservation Park (mangroves and coastal shrublands).

Biodiversity values for the area therefore include a diversity of fauna and avifauna habitat areas, areas of known ecosystem (wetlands, rivers, shrublands, woodlands) conservation value, and birds of State and national conservation significance.

2.2 Flora

2.2.1 Terrestrial vegetation associations

Within the project area, native vegetation, as defined by the Native Vegetation Act, consists of remnant vegetation and disturbed areas that have been naturally colonised by local native species. A total of 55 native flora species were recorded in the Northern Connector project area during the current vegetation assessment (see Attachment A for full species list); a further 70 native species have been previously recorded in proximity to the project site (Biological Databases of South Australia).

Remnant native vegetation in the landscape is still evident and indicative of the presence of the former extensive coastal fringe vegetation, such as mangrove forests, samphire and chenopod shrubland, and open grassy woodlands.

The understorey condition of the River Red Gum creeklines has been highly modified by weed invasion, particularly exotic perennial grasses such as Kikuyu, Rice Millet and Couch. Changes in the landscape ecology, especially altered drainage patterns and influences from tracks, the creation of salt fields and loss of vegetation cover have all degraded the remnant vegetation.

In the project area, the highest quality areas are the mangrove forests which have been able to persist and colonise mudflat areas and are not prone to extensive weed invasion.

A total of 12 vegetation associations (native and exotic) were mapped in the project area, 7 of which represent native vegetation. None of the associations are listed as threatened ecological communities under the *Environment Protection and*

Biodiversity Conservation Act 1999 (EPBC Act) or are on the provisional list of state threatened ecosystems (DEH 2002).

Areas that have been revegetated using Australian native species (but not necessarily with species that are indigenous to the local area) are evident in seven vegetation associations in the project area.

Vegetation association descriptions

Each of the 12 defined vegetation associations for the project area are described below (Figures 2.2–13), summarised in Table 2.1 and mapped in Figures 2.14–17).

Vegetation Association 1. Grey Mangrove (*Avicennia marina* var. *resinifera*) Low Open Forest



Figure 2.2 Grey Mangrove Low Open Forest, intertidal Samphire and Chenopod Shrubland

Vegetation type: Remnant native vegetation

Vegetation structure: Low Closed Forest

Description: Mangroves on mudflats of delta environments on a firm muddy to clayey soil with tidal flows

Location: North Arm Creek, Dry Creek

Location in project site: Southern section

Condition: Excellent

Vegetation Association 2. River Red Gum (*Eucalyptus camaldulensis* var. *camaldulensis*) Woodland over Low Chenopod Shrubland (*Maireana decalvans*, *M.brevifolia*, *M.enchylaenoides*, *M.aphylla*)



Figure 2.3 River Red Gum Woodland over Chenopod Shrubland

Vegetation type: Remnant native vegetation

Vegetation structure: Low Open Woodland with Chenopod Shrubland

Description: Terrestrial woodland ecosystem

Location: Bolivar

Location in project site: Central section

Condition: Poor

Vegetation Association 3. Planted Woodland of Eucalypt (*Eucalyptus spp*), Acacia (*Acacia spp*) (including *Acacia pendula*), Paperbark (*Melaleuca spp*). Sheoak (*Allocasuarina verticillata* and *Casuarina cunninghamiana*) and Old Man Saltbush (*Atriplex nummularia ssp. nummularia*)



Figure 2.4 Planted Woodland vegetation

Vegetation type: Planted vegetation

Vegetation structure: Mixed Low Woodland

Description: Roadside amenity planting

Location: Bolivar, Swan Alley, Little Para, Dry Creek, Between Perkins Drive and Whicker Road, Reserve Parrallel with Whicker Road, North of Cormack Road and Greenfields, Barker Inlet South

Location in project site: Central and Southern section

Condition: Established vegetation, very poor to moderate

Vegetation Association 4. River Sheoak (*Casuarina cunninghamiana*) Low Closed Forest



Figure 2.5 River Sheoak Low Closed Forest near Little Para Estuary

Vegetation type: Planted vegetation

Vegetation structure: Low Closed Forest

Description: Dense revegetation patches at constructed wetlands, roadside amenity plantings

Location: Between Grand Junction Road and Cormack Road

Location in project site: Southern section

Condition: Established vegetation (can be invasive), poor to moderate

Vegetation Association 5. Cottonbush (*Maireana aphylla*) Low Shrubland with scattered native grasses (*Austrodanthonia* sp. (Wallaby Grass), *Austrostipa* sp. (Spear Grass) and *Eragrostis* sp. (Love Grass))



Figure 2.6 Cottonbush Low Shrubland with scattered native grasses

Vegetation type: Remnant native vegetation

Vegetation structure: Low Open Shrubland

Description: Terrestrial low shrubland with scattered grasses

Location: Jobson Road

Location in project site: Northern and Central section

Condition: Very poor to moderate

Vegetation Association 6. Samphire (*Tecticornia blackiana* +/- *T. quinqueflora*, +/- *T. arbuscula*, +/- *Suaeda australis*, +/- *T. halocnemoides* +/- *T. pergranulata*) Very Low Open Shrubland



Figure 2.7 Samphire Very Low Open Shrubland

Vegetation type: Remnant native vegetation

Vegetation structure: Very Low Shrubland

Description: Saltmarsh plant community in saltwater wetlands

Location: Barker Inlet, North Arm, Swan Alley, Little Para, Dry Creek, Between North Arm and Grand Trunkway, Reserve parallel with Whicker Road

Location in project site: Southern section

Condition: Very poor to excellent

Vegetation Association 7. Nitre Bush (*Nitraria billardierei*), Marsh Saltbush (*Atriplex paludosa*), Ruby Saltbush (*Enchylaena tomentosa*) Open Shrubland



Figure 2.8 Nitre Bush, Marsh saltbush, Ruby Saltbush Open Shrubland

Vegetation type: Remnant/planted/colonising native vegetation

Vegetation structure: Open Shrubland

Description: Terrestrial low open shrubland with scattered grasses

Location: Barker Inlet

Location in project site: Southern section

Condition: Poor to moderate

Vegetation Association 8. Common Reed (*Phragmites australis*) and Bulrush (*Typha domingensis*) Reedbeds on shallow channels



Figure 2.9 Common Reed and Bulrush Reedbeds

Vegetation type: Remnant/planted/colonising native vegetation

Vegetation structure: Tall reedbed

Description: Freshwater tall reedbed

Location: Barker Inlet

Location in project site: Southern section

Condition: Moderate

Vegetation Association 9. Flat-sedge (*Cyperus vaginatus*) / Water-buttons (*Cotula*

coronopifolia) Sedgeland on shorelines



Figure 2.10 Salt Club-rush +/- Rush Sedgeland

Vegetation type: Remnant/planted/colonising native vegetation

Vegetation structure: Low sedgeland

Description: Freshwater low sedgeland

Location: Barker Inlet

Location in project site: Southern section

Condition: Moderate

Vegetation Association 10. Planted River Red Gum (*Eucalyptus camaldulensis* var. *camaldulensis*) Open Woodland over exotic grasses



Figure 2.11 River Red Gum Open Woodland over exotic grasses

Vegetation type: Planted vegetation (includes Significant Trees)

Vegetation structure: Open Woodland

Description: Revegetation area adjoining remnant native River Red Gum woodland

Location: Swan Alley, Little Para

Location in project site: Southern section

Condition: Very poor (but includes significant and scattered trees)

Vegetation Association 11. Planted Mixed Shrubland (*Melaleuca brevifolia*, *M. halmaturorum*, *M. lanceolata*, *M. oraria*, *M. quinquinervia*, *M. styphellioides*, *Acacia notabilis*, *A. paradoxa*, *A. pycnantha*, *A. sophorae*, *A. stenophylla*, *A. victoriae*)



Figure 2.12 Planted Mixed Shrubland

Vegetation type: Planted vegetation

Vegetation structure: Shrubland

Description: Shrubland revegetation at constructed wetlands, mixed plantings of Australian native species, with only some indigenous to South Australia and local to the region

Location: Barker Inlet

Location in project site: Southern section

Condition: Very poor

Vegetation Association 12. Exotic Grassland / Herbland



Figure 2.13 Exotic Grassland / Herbland

Vegetation type: Planted vegetation

Vegetation structure: Exotic Grassland

Description: Open grassland / herbland of, Couch, Kikuyu and Galenia

Location: Between Perkins Drive and Whicker Road, Reserve Parrallel with Whicker Road, Between Grand Junction Road and Cormack Road, North of Cormack Road, Greenfields, Barker Inlet South, parrallel with Grand Trunkway

Location in project site: Southern section

Condition: Established grassy area, Very poor

Table 2.1 Descriptions of vegetation associations in the Northern Connector project area

	Plant association	Vegetation type	Description	Location	Proposal area
1	Grey Mangrove (<i>Avicennia marina</i> var. <i>resinifera</i>) Low Open Forest	Remnant native vegetation	Mangroves on mudflats of delta environments on a firm muddy to clayey soil with tidal flows	North Arm Creek, Dry Creek	Southern
2	River Red Gum (<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>) Woodland over Low Closed Chenopod Shrubland (<i>Maireana decalvans</i> , <i>M. brevifolia</i> , <i>M. aphylla</i> , <i>M. encyloaenoides</i>)	Remnant native vegetation (see 8)	Terrestrial woodland ecosystem	Bolivar	Central
3	Planted woodland of eucalypt (<i>Eucalyptus</i> spp.), wattle (<i>Acacia</i> spp. including <i>Acacia pendula</i>), Paperbark (<i>Melaleuca</i> spp.). Sheoak (<i>Allocasuarina verticillata</i> and <i>Casuarina cunninghamiana</i>) and Old Man Saltbush (<i>Atriplex nummularia</i> ssp. <i>nummularia</i>)	Planted vegetation	Roadside amenity planting	Bolivar, Swan Alley, Little Para, Dry Creek, Between Perkins Drive and Whicker Road, Reserve Parrallel with Whicker Road, North of Cormack road and Greenfields, Barker Inlet South	Central and Southern
4	River Sheoak (<i>Casuarina cunninghamiana</i>) Low Closed Forest	Planted vegetation	Shrubland revegetation at constructed wetlands and Roadside amenity planting	Between Grand Junction Road and Cormack Road	Southern
5	Cottonbush (<i>Maireana aphylla</i>) Low Chenopod Shrubland with scattered native grasses (<i>Austrodanthonia</i> sp. <i>Austrostipa</i> sp and <i>Eragrostis</i> sp.)	Remnant native vegetation	Dryland coastal zone ecosystem	Jobson Road	Northern and Southern
6	Samphire (<i>Tecticornia blackiana</i> +/- <i>T. quinqueflora</i> , +/- <i>T. arbuscula</i> , +/- <i>Suaeda australis</i> , +/- <i>T. halocnemoides</i> +/- <i>T. pergranulata</i>) Very Low Open Shrubland	Remnant native vegetation	Saltwater wetlands in delta environments on a firm muddy to clayey soil, consisting of intertidal (submergent) samphire in tidal zones and supratidal (emergent) samphire on seasonally inundated flats, saline depressions, chenier ridges and dune rises	Barker Inlet, North Arm, Swan Alley, Little Para, Dry Creek, Between North Arm and Grand Trunkway, Reserve parrallel with Whicker Road	Southern

	Plant association	Vegetation type	Description	Location	Proposal area
7	Nitre Bush (<i>Nitraria billardierei</i>), Marsh Saltbush (<i>Atriplex paludosa</i>), Ruby Saltbush (<i>Encalypta tomentosa</i>) Open Shrubland	Remnant/planted native vegetation	Terrestrial low open shrubland with scattered grasses	Barker Inlet	Southern
8	Common Reed (<i>Phragmites australis</i>) and Bulrush (<i>Typha</i> sp.) Reedbeds	Remnant/planted/ colonising native vegetation	Freshwater tall reedbed	Barker Inlet	Southern
9	Flat-sedge (<i>Cyperus vaginatus</i>) / Water-buttons (<i>Cotula coronopifolia</i>) Sedgeland	Remnant/planted/ colonising native vegetation	Freshwater low sedgeland on shorelines	Barker Inlet	Southern
10	River Red Gum (<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>) Open Woodland over exotic grasses	Planted vegetation	Revegetation area adjoining remnant native woodland	Swan Alley, Little Para	Southern
11	Planted Mixed Shrubland (<i>Melaleuca brevifolia</i> , <i>M. halmaturorum</i> , <i>M. lanceolata</i> , <i>M. oraria</i> , <i>M. quinquinervia</i> , <i>M. styphelioides</i> , <i>Acacia notabilis</i> , <i>A. paradoxa</i> , <i>A. pycnantha</i> , <i>A. sophorae</i> , <i>A. stenophylla</i> , <i>A. victoriae</i>)	Planted vegetation	Shrubland revegetation at constructed wetlands	Barker Inlet	Southern
12	Exotic Grassland / herbland	Exotic		Between Perkins Drive and Whicker Road, Reserve Parrallel with Whicker Road, Between Grand Junction Road and Cormack Road, North of Cormack Road, Greenfields, Barker Inlet South, parrallel with Grand Trunkway	Southern

2.2.2 Aquatic flora

Aquatic plants in the Northern Connector project area are associated with mangroves, saltmarsh and wetland habitats. Known aquatic plants include seagrasses and hypersaline tolerant seagrasses such as *Ruppia* species and *Lepilaena* species. In areas of high salinity, green and red macroalgae grow. Benthic mats of algae and bacteria crust the exposed mud surface and the floors of shallow pools. Pelagic plankton including diatoms, chlorophytes, dinoflagellates and filamentous blue-green bacteria are found in samphire pools as well as in the mangrove creeks and freshwater reed swamps.

At the freshwater–saltwater interface, floating plants such as duckweeds (*Lemna* spp. and *Wolffia* spp.) and water-buttons (*Cotula crassifolia*) are common. *Azolla* spp. are generally only found in the freshest areas. Submerged saltwater/freshwater species include algae such as *Enteromorpha* spp. and *Chaetomorpha* spp. Pondweeds (e.g. *Potamogeton* spp., *Myriophyllum* spp.) prefer the freshwater end of the zones (Coleman 1996).

2.2.3 Species of conservation significance

National threatened species

No flora species of national conservation significance were recorded in the Northern Connector project area during the flora assessments. One species of national significance, the Vulnerable Bead Glasswort (*Tecticornia flabelliformis*), is known to occur in the region; the nearest known records are from Middle Beach, Parham and Light Beach to the north of the project area (South Australian Herbarium 2009).

Bead Glasswort is a woody, perennial saline area low shrub that grows to approximately 20 cm high (DEH 2006). It is found on the margins of some salt lakes and on low ground that is subject to flooding. Bead Glasswort flowers and fruits between January and May. The plant dies back when flooded in winter and then regenerates after the water dries out (DEH 2006).

No other flora species of national conservation significance are likely to occur in the Northern Connector project area.

State threatened species

A total of five flora species of State conservation significance have been recorded either in or adjacent to the project area (see Table 2.2).

The two species known to be in the Northern Connector project area, occur in the patch of remnant Cottonbush vegetation association near Jobson Road and Summer Road. The remaining three species are considered likely to occur in the project area due to the proximity of known records and presence of suitable habitat.

A total of 49 species of regional significance (Southern Lofty botanical region) have been recorded in or adjacent to the project area (Attachment A).

Table 2.2 Flora species of State conservation significance*

Scientific name	Common name	NPW Act	Regional (Southern Lofty)
<i>Eragrostis infecunda</i>	Barren Cane-grass	R	V
<i>Juncus radula</i>	Hoary Rush	V	E
<i>Maireana decalvans</i>	Black Cottonbush	E	E
<i>Myoporum parvifolium</i>	Creeping boobialla	R	V
<i>Sclerolaena muricata</i> var. <i>villosa</i>	Five-spine Bindyi	R	

* as listed in the Schedules of the NPW Act (Version 21.2.2008) green highlight: recorded during field survey in project area Source: DEH database search (Berkinshaw 2004b; Coleman and Cook 2008)

Status: E = Endangered, V = Vulnerable, R = Rare

2.2.4 Weed species

A number of introduced weed species were recorded during the flora assessment of the project area. Table 2.3 lists the weed species recorded which are either declared under the *Natural Resources Management Act 2004* (NRM Act) and/or are considered to be serious environmental weed species. Introduced weeds (declared, environmental and agricultural) and non-indigenous native plants are common across the project area, particularly along roadsides and in ornamental plantings. A range of introduced species have been planted for visual amenity value, although some of them, such as Athel Pine (*Tamarix aphylla*), are declared species and serious environmental weeds.

A total of 21 introduced species are considered to be serious environmental weeds and a further 11 are declared under the NRM Act (Table 2.3). A further 13 weed species were observed during the field survey, of which 5 are considered invasive or potentially invasive (see Table 2.4).

Table 2.3 Declared and environmental weed species recorded in project area

Scientific name	Common name	Status
<i>Acacia saligna</i>	Golden Wreath Wattle	E
<i>Agave</i> sp.	Century Plant	E
<i>Arctotheca calendula</i>	Capeweed	E
<i>Conyza bonariensis</i>	Flaz-leaf Fleabane	E
<i>Cynara cardunculus</i> ssp. <i>flavescens</i>	Artichoke Thistle	D
<i>Cyperus brevifolius</i>	Mullumbimby Couch	D
<i>Emex</i> sp.	Three-cornered Jack	D
<i>Eragrostis curvula</i>	African Lovegrass	D
<i>Euphorbia paralias</i>	Sea-spurge	E
<i>Galenia pubescens</i>	Coastal Galenia	E
<i>Gazania rigens</i>	Gazania	E
<i>Heliotropium europaeum</i>	Common Heliotrope	E

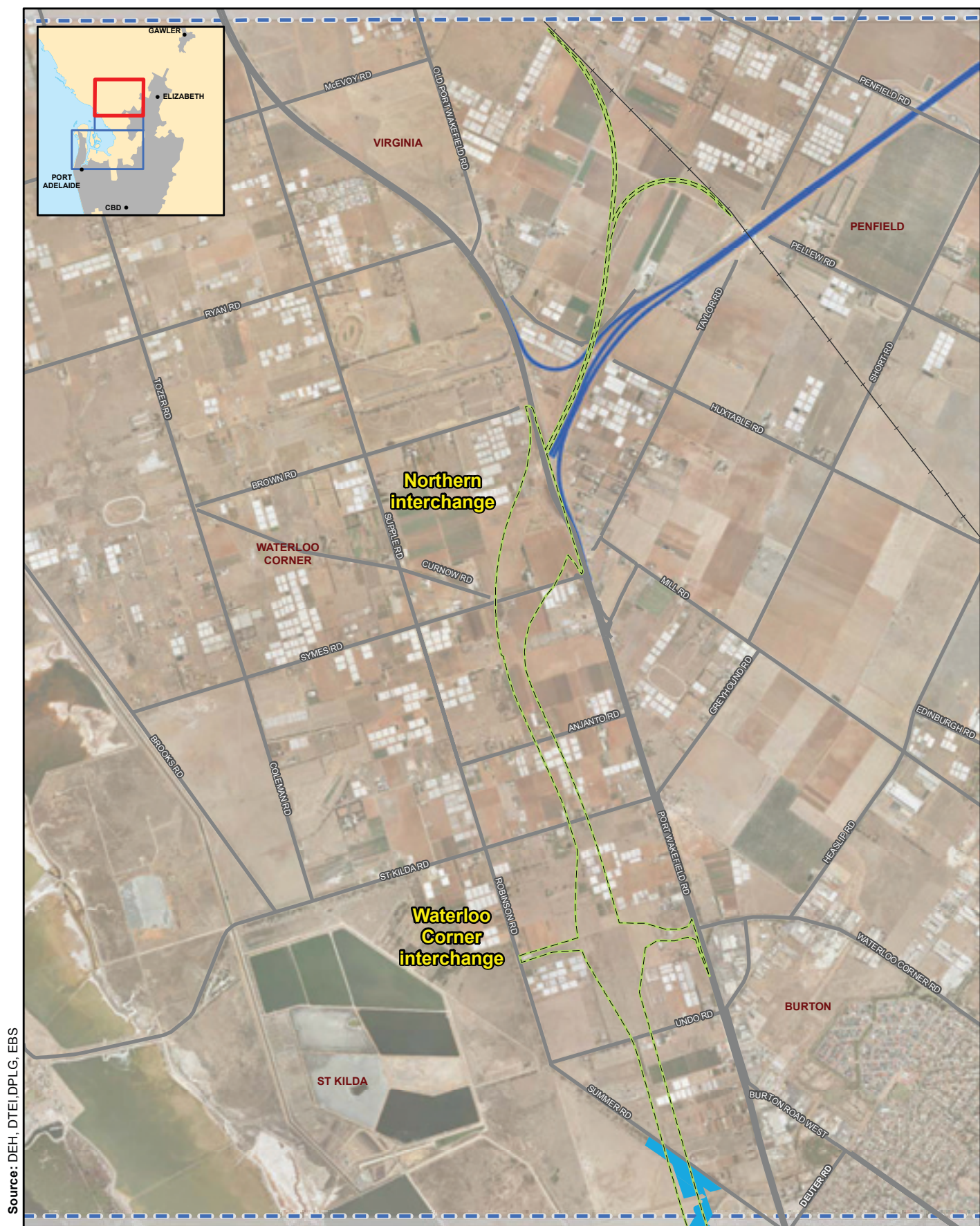
Scientific name	Common name	Status
<i>Hypochaeris radicata</i>	Deep-rooted cats ear	E
<i>Lactuca serriola</i>	Prickly Lettuce	E
<i>Lagurus ovatus</i>	Hare's-tail Grass	E
<i>Limonium lobatum</i>	Statice	E
<i>Lophopyrum ponticum</i>	Tall Wheatgrass	E
<i>Lycium ferocissimum</i>	African Boxthorn	D
<i>Malva parviflora</i>	Small-flowered Mallow	E
<i>Marrubium vulgare</i>	Horehound	D
<i>Mesembryanthemum crystallinum</i>	Common Ice-plant	E
<i>Olea europaea</i> ssp. <i>europaea</i>	Olive	D
<i>Oxalis pes-caprae</i>	Soursob	D
<i>Pennisetum clandestinum</i>	Kikuyu	E
<i>Piptatherum miliaceum</i>	Rice Millet	E
<i>Polygonum aviculare</i>	Wireweed	E
<i>Schinus molle</i>	Pepper-tree	E
<i>Solanum elaeagnifolium</i>	Silver-leaf Nightshade	D
<i>Solanum nigrum</i>	Blackberry Nightshade	E
<i>Sonchus oleraceus</i>	Common sow-thistle	E
<i>Tamarix aphylla</i>	Athel Pine	D
<i>Tribulus terrestris</i>	Caltrop	D

Status: E = Environmental weed, D = declared plant under the NRM Act

Table 2.4 Additional weed species recorded in project area

Scientific name	Common name	Comments
<i>Acacia cyclops</i>	Western Coastal Wattle	Rounded shrub or small tree
<i>Bromus diandrus</i>	Great Brome	Tufted grass
<i>Cakile maritima</i>	European Sea-rocket	Succulent, greyish-green annual herb
<i>Carpobrotus edulis</i>	South African Pigface	Succulent herb
<i>Casuarina cunninghamiana</i>	River Sheoak	Evergreen tree
<i>Chenopodium album</i>	Fat Hen	Erect greyish-green annual herb
<i>Critesion hystrix</i>	Mediterranean Barleygrass	Annual grass
<i>Ehrharta villosa</i>	Pyp Grass	Perennial grass
<i>Elymus farctus</i>	Sea Wheatgrass	Perennial grass
<i>Juncus acutus</i>	Spiny Rush	Tussock forming rush
<i>Limonium X campanyonis</i>	Sea Lavender	Annual herb
<i>Mesembryanthemum nodiflorum</i>	Slender Ice-plant	Spreading annual herb
<i>Phyllostachys aurea</i>	Golden Bamboo	Loosely clumping bamboo

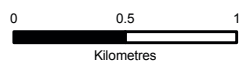
Highlighted species are potential environmental weeds in Adelaide Plains region.



Source: DEH, DTEI, DPLG, EBS



Figure 2.15 **Vegetation map within corridor**
Central section



- | | | |
|-----------------------------|------------------------------|------------------|
| Northern Connector boundary | Embankment | 2, River Red Gum |
| Existing roads | 3, Planted eucalypt woodland | |
| | 5, Cotton-bush | |

Source: DEH, DTEI, DPLG, EBS

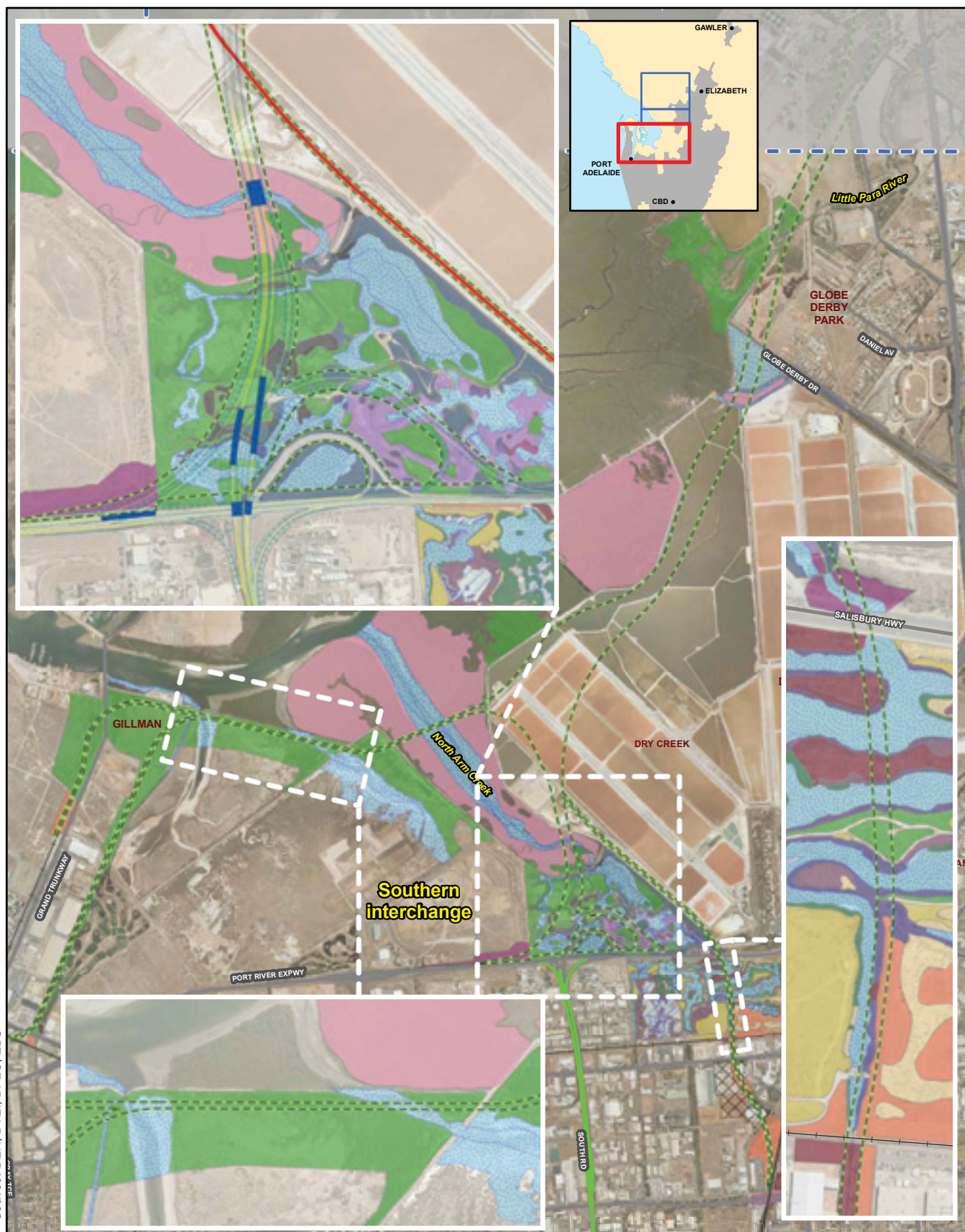
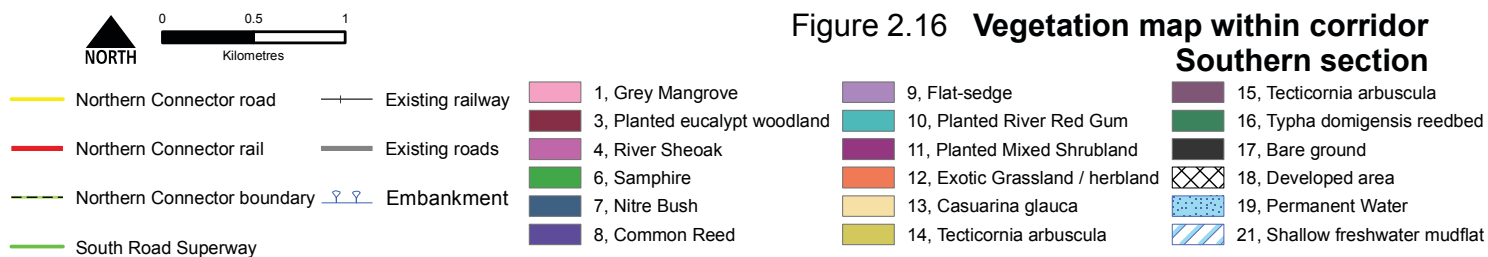


Figure 2.16 Vegetation map within corridor
Southern section



3 Potential impacts of the project on existing conditions

3.1 Construction impacts

3.1.1 Flora

Clearance of both native and non-native vegetation would be necessary for construction of the project. The level of impacts identified in this section are based on a concept level design only and would thus be a conservative indication of vegetation clearance levels. A detailed vegetation survey during the detailed design phase of the project would more accurately identify the impacts of the Northern Connector project. Detailed design would also allow identification of measures to minimise vegetation clearance that have not been taken into account in this assessment (e.g. retain existing vegetation where possible and incorporate into landscape design).

Any vegetation clearance would further contribute to the loss of native vegetation in a region already highly modified by human use. The existing landscape is currently significantly fragmented with very little remnant native vegetation remaining, even with the moderate levels of remnant fringing samphire and mangrove habitats.

A large proportion of the planted vegetation in the constructed stormwater management wetlands, established 10–15 years ago, has reached maturity and is now colonising the area. Its value as a natural feature in the landscape is highlighted by the direct benefit of habitat provisions, water quality and other ecosystem services.

The planted vegetation around Bolivar WWTP contains mature trees, some of which are now of a size to be classified as 'significant' under the *Development Act 1993*. Some trees requiring removal may contain hollows. This would result in the loss of habitat for a range of avifauna and mammal species but this has not yet been quantified. Removal of vegetation in this area may also impact on the size and integrity of the remnant/planted River Red Gum (*Eucalyptus camaldulensis* var. *camaldulensis*) woodland patch on SA Water land, which also contains a number of very old, pre-European settlement River Red Gums.

Northern Connector vegetation clearance

Approximately 49.79 ha of native vegetation, as defined by the *Native Vegetation Act 1991* would need to be cleared for the Northern Connector corridor. This vegetation includes mangrove forest, samphire shrubland, reedbeds, open shrublands and chenopod shrublands with very small areas of River Red Gum woodland. Native vegetation in the project area was assigned a condition rating and a corresponding significant environmental benefit (SEB) ratio (Table 3.1).

The total area of vegetation mapped within the Northern Connector project area is 85.21ha. This does not represent all of the vegetation present in the project area as there are also open paddocks, agricultural land and salt ponds.

Clearance of some remnant native vegetation and naturally regenerating local native species would require approval under the *Native Vegetation Act 1991*, however, not all areas of native vegetation within the corridor are covered by the Native Vegetation Act. Clearance or impact on any significant trees would require approval under the *Development Act 1993*.

The potential impacts and risks to native and planted vegetation are:

- direct removal of remnant native chenopod and samphire shrubland, woodland, mangroves and reedbeds
- fragmentation of vegetation by the traverse of a wide road and rail corridor and a rail link in the southern section of the project area, resulting in the division and fragmentation of wetland vegetation and ecosystems
- fragmentation of the plantation vegetation at Bolivar WWTP
- potential introduction and spread of weeds and/or soil pathogens.

The project would impact on sections of the Barker Inlet Wetlands North, Barker Inlet Wetlands South and an area of mangroves, however the proposed corridor has the lowest potential impact on habitats of all corridor options investigated during the project's planning phase. Given the extent of mangroves in Barker Inlet, the impact to a relatively small area of mangroves was considered preferable to the loss of a larger area of more diverse habitat in Barker Inlet Wetlands North.

Information on mitigation measures and vegetation offsets are provided in Section 4.

Table 3.1 Native vegetation type and condition in the project corridor

Condition (SEB ratio)	Vegetation association number	Vegetation association description
Excellent (10:1)	1	Mangrove (<i>Avicennia marina</i> var. <i>resinifera</i>) Low open forest
	6	Samphire (<i>Tecticornia</i> spp. Samphire, <i>Sclerostegia arbuscula</i> , <i>Suaeda australis</i> , <i>Tecticornia</i> spp.) Low Shrubland
Good (8:1) (7:1)	8	Common reed (<i>Phragmites australis</i>) and Bulrush (<i>Typha domingensis</i>) reedbeds on shallow channels
	6	Samphire (<i>Tecticornia</i> spp., <i>Sclerostegia arbuscula</i> , <i>Suaeda australis</i> , <i>Tecticornia</i> Samphire spp.) Low Shrubland
Moderate (6:1)	8	Common reed (<i>Phragmites australis</i>) and Bulrush (<i>Typha domingensis</i>) reedbeds on shallow channels
	3	Planted woodland of eucalypt (<i>Eucalyptus</i> spp.), wattle (<i>Acacia</i> spp. including <i>Acacia pendula</i>), Paperbark (<i>Melaleuca</i> spp.). Sheoak (<i>Allocasuarina verticillata</i> and <i>Casuarina cunninghamiana</i>) and Old Man Saltbush (<i>Atriplex nummularia</i>)
	5	Cottonbush (<i>Maireana aphylla</i>) low chenopod shrubland with mixed Eucalypt Low woodland remnant and revegetation

Condition (SEB ratio)	Vegetation association number	Vegetation association description
	7	Nitre Bush (<i>Nitraria billardierei</i>), Marsh Saltbush (<i>Atriplex paludosa</i>), Ruby saltbush (<i>Enchylaena tomentosa</i>) Open shrubland
	9	Flat-sedge (<i>Cyperus vaginatus</i>) / Water-buttons (<i>Cotula coronopifolia</i>) Sedgeland
	6	Samphire (<i>Tecticornia</i> spp., <i>Sclerostegia arbuscula</i> , <i>Suaeda australis</i> , <i>Tecticornia</i> spp.) Low Shrubland
	2	River Red Gum (<i>Eucalyptus camaldulensis</i>) Woodland over Low Chenopod Shrubland (<i>Maireana decalvans</i> , <i>M.brevifolia</i> , <i>M.enchylaenoides</i> , <i>M.aphylla</i>)
	6	Samphire (<i>Tecticornia</i> spp., <i>Sclerostegia arbuscula</i> , <i>Suaeda australis</i> , <i>Tecticornia</i> spp.) Low Shrubland
	3	Planted woodland of eucalypt (<i>Eucalyptus</i> spp.), wattle (<i>Acacia</i> spp. including <i>Acacia pendula</i>), Paperbark (<i>Melaleuca</i> spp.). Sheoak (<i>Allocasuarina verticillata</i> and <i>Casuarina cunninghamiana</i>) and Old Man Saltbush (<i>Atriplex nummularia</i>)
	7	Nitre Bush (<i>Nitraria billardierei</i>), Marsh Saltbush (<i>Atriplex paludosa</i>), Ruby saltbush (<i>Enchylaena tomentosa</i>) Open shrubland
Very poor (2:1) (1:1)	5	Cottonbush (<i>Maireana aphylla</i>) low chenopod shrubland with mixed Eucalypt Low woodland remnant and revegetation
	6	Samphire (<i>Tecticornia</i> spp. Samphire, <i>Sclerostegia arbuscula</i> Shrubby Samphire, <i>Suaeda australis</i> Austral Seablite, <i>Tecticornia</i> spp.) Low Shrubland
	2	River Red Gum (<i>Eucalyptus camaldulensis</i>) Woodland over Low Chenopod Shrubland (<i>Maireana decalvans</i> , <i>M.brevifolia</i> , <i>M.enchylaenoides</i> , <i>M.aphylla</i>)
	3	Planted woodland of eucalypt (<i>Eucalyptus</i> spp.), wattle (<i>Acacia</i> spp. including <i>Acacia pendula</i>), Paperbark (<i>Melaleuca</i> spp.). Sheoak (<i>Allocasuarina verticillata</i> and <i>Casuarina cunninghamiana</i>) and Old Man Saltbush (<i>Atriplex nummularia</i> ssp. <i>nummularia</i>)
	7	Nitre Bush (<i>Nitraria billardierei</i>), Marsh Saltbush (<i>Atriplex paludosa</i>), Ruby saltbush (<i>Enchylaena tomentosa</i>) Open shrubland
	10	River Red Gum (<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>) Open Woodland over exotic grasses
	11	Planted Mixed Shrubland (<i>Melaleuca brevifolia</i> , <i>M. halmaturorum</i> , <i>M. lanceolata</i> , <i>M. oraria</i> , <i>M. quinquinervia</i> , <i>M. styphelioides</i> , <i>Acacia notabilis</i> , <i>A. paradoxa</i> , <i>A. pycnantha</i> , <i>A. sophorae</i> , <i>A. stenophylla</i> , <i>A. victoriae</i>)

4 Management and mitigation

Management of project impacts to flora have followed a general principle (in order of preference) of:

- avoiding impacts
- minimising impacts
- mitigating impacts
- compensating for residual impacts.

4.1 Measures to minimise impacts during planning and design

Impacts on flora in the project area have been avoided and/or minimised through the corridor selection process and the development of the proposed alignments. Initial environmental studies and flora assessments helped guide the corridor alignments through the project area.

Mitigation/management measures to minimise impacts on flora species include the following:

- identification of species or species habitat of conservation significance within the project corridor
- designing the corridor to limit the removal of native vegetation and fauna habitat
- development of a Construction Environmental Management Plan
- development of an Operational Environmental Management Plan.

The outcomes of the preliminary environmental studies contributed to several changes being made to the proposed original project corridor, including the:

- route through the Northern section was chosen to avoid the patch of *Gahnia filum* habitat
- route through the Central section was chosen to avoid most SA Water buffer/revegetation plantings
- identification of possible wetland offsets
- the road and rail corridor through the Southern section were chosen to avoid the higher value sections of the Barker Inlet Wetlands north. The road corridor was moved further west over the North Arm Creek mangroves, to conserve more of the Barker Inlet Wetlands North freshwater habitat areas. This impacted upon a greater area of mangroves but allowed for the conservation of a larger area of wetland.

Further information on the project corridor assessment process can be found in the Project Impact Report.

4.2 Measures to minimise impacts during construction

Best practice environmental management would be required for the duration of the pre-construction and construction phases of the project to minimise any impacts on the local environment. This includes development and implementation of a detailed Project Environmental Management Plan and a Construction Environmental Management Plan (CEMP). Implementation of the CEMP would include measures such as:

- clearly identifying the construction area, with the extent of works pegged and flagged to minimise the risk of inadvertent damage to vegetation
- confining vehicle access to existing roads where possible to reduce the spread of weeds
- no dumping of materials/waste or diversion of drainage lines that will impact on vegetation during construction
- placing fencing around vegetation which is located within the project corridor, but which is not being removed as a consequence of the project
- immediately cleaning up any pollution events that occur (e.g. spilling of hydrocarbons) to ensure minimal impact to vegetation
- ensuring imported fill material is clean and does not include any exotic species or propagules of exotic species
- cleaning all earthmoving machinery of soil and vegetation prior to entering or exiting the site
- inducting all site personnel and ensuring personnel are aware of mitigation measures to be implemented to reduce impacts to flora
- adopting an adaptive management approach to identify impacts associated with construction of the road network and developing or altering processes and procedures to eliminate or minimise these impacts
- developing specific management plans, such as a detailed Weed Management Plan and a Soil Erosion and Drainage Management Plan, to ensure all issues are addressed and managed accordingly.

It is vital to minimise the width of the construction corridor and limit the loss or damage of vegetation at the edges of the construction zone. A construction footprint minimised by containing and removing all waste products, and securing all building materials, would likely reduce the impacts to flora.

4.3 Measures to minimise impacts during operation

A range of measures would be implemented to minimise and compensate for impacts on flora during the operation of the Northern Connector project. These measures include:

- off-setting the loss of native vegetation by achieving a significant environmental benefit (SEB) for the project and completing appropriate revegetation and landscaping
- maintaining any rehabilitated areas including weeding, watering and replacing any dead plant stock as necessary
- adopting an adaptive management approach to identify impacts associated with operation of the road network and developing or altering processes and procedures to eliminate or minimise these impacts.
-

4.3.1 Vegetation offsets – *Native Vegetation Act 1991*

All native vegetation in South Australia is protected under the provisions of the *Native Vegetation Act 1991*. Clearance of vegetation is prohibited unless it is approved by the Native Vegetation Council (NVC) or the activity requiring the clearance is exempted by the regulations under the Act. For clearance of native vegetation, a Significant Environmental Benefit (SEB) is required.

The primary aim of the SEB is to achieve a net environmental gain, which contributes to improving the biodiversity values of the region, rather than simply off-setting the clearance. The SEB can be achieved in several ways. A combination of the following options may also be considered by the NVC:

- (1) a payment to the Native Vegetation Fund as established under the *Native Vegetation Act 1991*
- (2) provision of an appropriate offset through the identification of land that can be protected and managed as a set-aside (conservation) area
- (3) alternative offset activities such as revegetation or weed control (bushcare) works in areas of native vegetation

DTEI would undertake extensive revegetation and landscaping as part of the Northern Connector project which, in addition to its amenity value, may be used to offset some vegetation clearance.

The SEB requirements for the project would be calculated once the final detailed design is complete and exact impacts are known.

4.3.2 Revegetation and landscaping

Revegetation and landscaping for the Northern Connector project are covered in the Project Impact Report. Revegetation components are likely to incorporate revegetation and rehabilitation of wetland areas; landscaping is likely to focus on improving amenity and biodiversity within the project corridor.

Glossary

Adelaide Plains project region: the landscape scale region that extends from Onkaparinga Estuary to Port Wakefield and east to the foothills of the Mount Lofty Ranges (Figure 1.3)

Biodiversity: the variety of all life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form

Bioregion: extensive (continental scale) regions distinguished from adjacent regions by their broad physical and biological characteristics

Conservation: the protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment

Ecological community: a characteristic suite of interacting species that are adapted to particular conditions of soil, topography, water availability and climate

Ecological processes: dynamic interactions among and between biotic (living) and abiotic (non-living) components of the environment

Ecosystem: a dynamic complex of plant, animal, fungal and microorganism communities and the associated non-living environment interacting as an ecological unit

Ecosystem services: services of ecosystems beneficial to humans, such as the transformation of natural assets (soil, plants and animals, air and water) into things that we value (e.g. clean air, pollination, soil fertility)

Endemic: exclusively native to a specified region or site

Fragment: restricted areas of habitat surrounded by areas of mostly destroyed habitat (most relevant to modified landscapes)

Fragmentation/fragmented landscapes: division or separation of natural areas by the clearance of native vegetation for human land uses, isolating remnants and species and affecting genetic flow

Habitat: physical place or type of site where an organism, species or population naturally occurs together with the characteristics and conditions that render it suitable to meet the lifecycle needs of that organism, species or population

Habitat diversity: the number of different types of habitats within a given area

IBRA subregion: subdivision of a bioregion based on broad physical and biological characteristics; a system of related and interconnected landsystems within an IBRA region

Invasive species: any animal pest, weed or disease that can adversely affect native species and ecosystems

Land degradation: the decline in quality of natural resources of the land resulting from human activities on the land

Landform: any of the numerous features that make up the surface of the earth, such as plain, plateau or canyon

Landscape: heterogeneous area of land or sea that is of sufficient size to achieve positive results in the recovery of species or ecological communities, or in the protection and the enhancement of ecological and evolutionary processes

Landsystem: a group of local ecological communities derived from a landscape pattern of related and interconnected local ecosystems in a subregion

Native species: a plant or animal species that occurs naturally in South Australia

Native vegetation (as defined by the *Native Vegetation Act 1991*): a plant or plants of a species indigenous to South Australia (i.e. naturally occurring local native plants) including a plant or plants growing in or under waters of the sea but does not include plant or part of a plant that is dead nor plant intentionally sown or planted (amendments to the Act (2003) cover dead trees that provide habitat for endangered species)

Project area: area defined by the polygon outline that encases the project route (Figure 1.2)

Project corridor: area defined as including the Northern Connector route, including the road width of 120 m and rail spur width of 30 m, as well as the impact zone and construction footprint (Figure 1.2)

Remnant: areas (generally small) of native plant communities that are found in otherwise cleared landscapes

Restoration: assisting the recovery of ecological systems to a state in which the viability of species and ecological communities, and ecosystem function, are improved

Revegetation: the process of replanting and rebuilding the soil of disturbed land; can increase the area of suitable habitat in the landscape, improve the quality of existing habitat and help to link remnant or isolated habitats through 'stepping stones' and corridors

Significant tree (as defined by the *Development Act 1993*): any tree with a trunk circumference of 2.0 m or more – or, in the case of trees with multiple trunks, that have trunks with a total circumference of 2.0 m or more and an average circumference of 625 mm or more – measured at a point 1.0 m above natural ground level; or any tree identified as a significant tree in a Development Plan (as defined by the City of Port Adelaide Enfield and City of Salisbury under the Development Act)

Species: a group of organisms capable of interbreeding with each other but not with members of other species

Species diversity: variability (richness and abundance) of biota in an area; an index of community diversity that takes into account both species richness and the relative abundance of species

Subspecies: distinct geographical ranges of interbreeding natural populations of species that are reproductively isolated and possess distinguishing characteristics from other populations of the same species

Terrestrial: land-based biodiversity including inland aquatic ecosystems, such as rivers, streams, lakes, wetlands, springs, groundwater and groundwater dependent ecosystems, and the native inland aquatic species in these areas

Threatened species and/or ecological communities: a species or ecological community that is Vulnerable or Endangered

Threatening processes: the dominant limiting factors and constraints to the ongoing conservation of biodiversity

Vegetation association: A stable plant community of definite composition presenting a uniform appearance and growing in more or less uniform habitat conditions

Vegetation condition: the condition, composition and density of the plants in an area

Viability: likelihood of long-term survival of the example/population of a particular ecosystem or species

Abbreviations

AMLR NRM Board	Adelaide and Mount Lofty Ranges Natural Resources Management Board
AWQC	Australian Water Quality Centre
BDSA	Biological Databases of South Australia
Bolivar WWTP	Bolivar Wastewater Treatment Plant
DEH	Department for Environment and Heritage
DTEI	Department for Transport, Energy and Infrastructure
EBS	Environmental and Biodiversity Services
EIA	Environmental Impact Assessment
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
MNES	Matters of National Environmental Significance
NPW Act	<i>National Parks and Wildlife Act 1972</i>
NRM	Natural Resources Management
SEB	Significant Environmental Benefit

References

Baker, J. L. (2004) Towards a System of Ecologically Representative Marine Protected Areas in South Australian Marine Bioregions - Technical Report. Coast and Marine Conservation Branch, Department for Environment and Heritage, South Australia.

Berkinshaw, T. 2004a. Mangroves to mallee multi-site management plan for the northern Adelaide coastal plains. Greening Australia, SA.

City of Salisbury. 2008. Wetlands – A natural solution. (<http://cweb.salisbury.sa.gov.au/manifest/servlet/page?pg=16069&stypen=html>)

Coleman, P and Cook, F. 2000. Local recovery plan for the Yellowish Sedge-skipper and Thatching grass, Dry Creek. Delta Environmental Consulting, South Australia.

Coleman, P and Cook, F. 2008. Little Para Estuary: Saltmarsh retreat zone. Report prepared for the Urban Forest Biodiversity Program, DEH.

DEH. 2002. Provisional list of state threatened ecosystems. Department for Environment and Heritage, Adelaide.

Department of the Environment, Water, Heritage and the Arts. 2006. EPBC Act Policy statement 1.1: Significant impact guidelines: Matters of National Environmental Significance. Commonwealth of Australia, Canberra.

DTEI. 2009. Vegetation Removal Policy. Department for Transport, Energy and Infrastructure, Walkerville SA.

DWLBC. 2006. State Natural Resources Management Plan 2006. Natural Resources Management Council, Adelaide.

Environmental and Biodiversity Services. 2007. St Kilda antenna fields action plan. Department of Defence and the DEH Urban Forest Biodiversity Program, Adelaide.

Graham, A, Oppermann, A and Inns, R. 2001. Biodiversity plan for the Northern agricultural districts. Department for Environment and Heritage, Adelaide.

KBR. 2004. Barker Inlet wetlands and the Range wetlands: Review and Assessment. Report. Transport SA, Walkerville SA.

Kraehenbuehl, D. N. 1996. Pre-European vegetation of Adelaide – A survey from the Gawler River to Hallett Cove. Nature Conservation Society of SA, Adelaide.

Laut, P., Heyligers, P.C., Keig, G., Loffler, E., Margules, C., Scott, R. M. and Sullivan, M. E. 1977. Environments of South Australia. CSIRO, Canberra.

McIntyre, S. and Hobbs, R. 2000. Human impacts on landscapes: Matrix condition and management priorities. In: J. L. Craig, N. Mitchell and D. A. Saunders (eds) Nature Conservation 5: Nature conservation in production environments: Managing the matrix. Surrey Beatty and Sons, Chipping Norton NSW, pp. 301–307.

Thackway, R. and Cresswell, I. D. (eds). 1995. an interim biogeographic regionalisation for Australia: A framework for establishing the national system of reserves, Version 4.0. Australian Nature Conservation Agency, Canberra.

Wilson, J. R., 2000, South Australian Wader Surveys: January and February 2000, a joint project between the Australasian Wader Studies Group and the South Australian Ornithologists Association.

Appendix A

Native flora species recorded in the project area or in the wider region

Scientific name	Common name	AUS	SA	SL
<i>Acacia acinacea</i>	Wreath Wattle			N
<i>Acacia hakeoides</i>	Hakea Wattle			K
<i>Acacia ligulata</i>	Umbrella Bush			K
<i>Acacia longifolia</i> var. <i>sophorae</i>	Coastal Wattle			N
<i>Acacia notabilis</i>	Notable Wattle			K
<i>Acacia oswaldii</i>	Umbrella Wattle			E
<i>Acacia paradoxa</i>	Kangaroo Thorn			
<i>Acacia pycnantha</i>	Golden Wattle			
<i>Acacia salicina</i>	Willow Wattle			V
<i>Adriana klotzschii</i>	Coast Bitter-bush			U
<i>Allocasuarina verticillata</i>	Drooping sheoak			
<i>Alyxia buxifolia</i>	Sea Box			R
<i>Atriplex cinerea</i>	Coast Saltbush			
<i>Atriplex paludosa</i> ssp. <i>paludosa</i>	Marsh Saltbush		K	U
<i>Atriplex rhagodiodes</i>	River saltbush			
<i>Atriplex semibaccata</i>	Berry Saltbush			
<i>Atriplex suberecta</i>	Lagoon Saltbush			
<i>Austrostipa curticoma</i>	Short-crest Spear-grass			U
<i>Austrostipa elegantissima</i>	Feather Spear-grass			U
<i>Austrostipa nitida</i>	Shining Spear-grass			
<i>Austrostipa scabra</i>	Rough Spear-grass			
<i>Austrostipa</i> sp.	Spear-grass			
<i>Avicennia marina</i> var. <i>resinifera</i>	Grey Mangrove			
<i>Bolboschoenus caldwellii</i>	Salt Club-rush			
<i>Bolboschoenus medianus</i>	Marsh Club-rush			R
<i>Callitris preissii</i>	Southern Cypress Pine			U
<i>Callistomen rugulosus</i>	Scarlet bottlebrush			
<i>Carex apressa</i>	Tall sedge			
<i>Carpobrotus rossii</i>	Native Pigface			
<i>Chenopodium pumilio</i>	Clammy Goosefoot			
<i>Chloris truncata</i>	Windmill Grass			
<i>Convolvulus erubescens</i>	Australian Bindweed			
<i>Convolvulus remotus</i>	Grassy Bindweed			
<i>Crassula colorata</i>	Dense Crassula			
<i>Cressa cretica</i>	Rosinweed			V
<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge			
<i>Cyperus vaginatus</i>	Stiff Flat-sedge			
<i>Cyperus</i> sp.				
<i>Danthonia caespitosa</i>	Common Wallaby-grass			
<i>Danthonia racemosa</i>	Slender Wallaby-grass			
<i>Danthonia setacea</i>	Small-flower Wallaby-grass			
<i>Danthonia</i> sp.	Wallaby-grass			
<i>Dianella revoluta</i> var. <i>revoluta</i>	Black-anther Flax-lily			

Scientific name	Common name	AUS	SA	SL
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	Round-leaf Pigface			
<i>Distichlis distichophylla</i>	Emu-grass			N
<i>Einadia nutans</i> ssp. <i>nutans</i>	Climbing Saltbush			
<i>Eleocharis acuta</i>	Common Spike-rush			
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	Ruby Saltbush			
<i>Enneapogon nigricans</i>	Black-head Grass			
<i>Enteropogon acicularis</i>	Umbrella Grass			Q
<i>Eragrostis dielsii</i> var. <i>dielsii</i>	Mulka			K
<i>Eragrostis infecunda</i>	Barren Cane-grass		R	V
<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>	River Red Gum			
<i>Eucalyptus largiflorens</i>	River Box			V
<i>Eucalyptus porosa</i>	Mallee Box			U
<i>Euphorbia drummondii</i>	Caustic Weed			
<i>Eutaxia diffusa</i>	Large-leaf Eutaxia			V
<i>Frankenia pauciflora</i>	Southern Sea-heath			
<i>Gahnia filum</i>	Thatching Grass			R
<i>Tecticornia fiabelliformis</i>	Bead Samphire			V
<i>Tecticornia halocnemoides</i> ssp. <i>halocnemoides</i>	Grey Samphire			
<i>Tecticornia indica</i> ssp. <i>bidens</i>	Brown-head Samphire			K
<i>Tecticornia pergranulata</i>	Black-seed Samphire			
<i>Tecticornia pergranulata</i> var. <i>divaricata</i>	Black-seed Samphire			
<i>Tecticornia</i> sp.	Samphire			
<i>Isolepis nodosa</i>	Knobby Club-rush			
<i>Juncus kraussii</i>	Sea Rush			
<i>Juncus pallidus</i>	Pale Rush			
<i>Juncus radula</i>	Hoary Rush		V	E
<i>Juncus subsecundus</i>	Finger Rush			
<i>Lawrencia squamata</i>	Thorny Lawrencia			K
<i>Lepidium pseudohyssopifolium</i>			U	E
<i>Leptochloa fusca</i>	Beetle Grass			
<i>Leucopogon parviflorus</i>	Coast Beard-heath			
<i>Lomandra effusa</i>	Scented Mat-rush			R
<i>Lomandra multiflora</i> ssp. <i>dura</i>	Hard Mat-rush			
<i>Lysiana exocarpi</i>	Harlequin mistletoe			
<i>Lythrum hyssopifolia</i>	Lesser Loosestrife			
<i>Maireana aphylla</i>	Cottonbush			V
<i>Maireana brevifolia</i>	Short-leaf Bluebush			
<i>Maireana decalvans</i>	Black Cottonbush		E	E
<i>Maireana enchylaenoides</i>	Wingless Fissure-plant			U
<i>Maireana oppositifolia</i>	Salt Bluebush			
<i>Marsilea drummondii</i>	Common Nardoo			R

Scientific name	Common name	AUS	SA	SL
<i>Melaleuca halmaturorum</i>	Swamp Paperbark			
<i>Melaleuca lanceolata</i>	Dryland Tea-tree			U
<i>Mimulus repens</i>	Creeping Monkey-flower			R
<i>Minuria cunninghamii</i>	Bush Minuria			
<i>Muehlenbeckia florulenta</i>	Lignum			R
<i>Myoporum insulare</i>	Common Boobialla			
<i>Myoporum montanum</i>	Native Myrtle			K
<i>Myoporum parvifolium</i>	Creeping Boobialla		R	V
<i>Myoporum viscosum</i>	Sticky Boobialla			U
<i>Myriophyllum</i> spp.	Milfoil			* all sp.rated
<i>Nitraria billardierei</i>	Nitre-bush			
<i>Olearia axillaris</i>	Coast Daisy-bush			
<i>Paspalidium jubiflorum</i>	Warrego Summer-grass			K
<i>Phragmites australis</i>	Common Reed			
<i>Pittosporum phylliraeoides</i>	Native Apricot			R
<i>Portulaca oleracea</i>	Common Purslane			
<i>Puccinellia stricta</i> var. <i>stricta</i>	Australian Saltmarsh-grass			
<i>Rhagodia candolleana</i>	Sea-berry Saltbush			
<i>Rhagodia crassifolia</i>	Fleshy Saltbush			
<i>Rhagodia parabolica</i>	Mealy Saltbush			V
<i>Rhagodia spinescens</i>	Spiny Saltbush			E
<i>Salsola kali</i>	Buckbush			
<i>Samolus repens</i>	Creeping Brookweed			U
<i>Tecticornia blackiana</i>	Thick-headed Samphire			
<i>Tecticornia quinqueflora</i>	Beaded Samphire			
<i>Schoenoplectus validus</i>	River club-rush			
<i>Schoenus apogon</i>	Common Bog-rush			
<i>Sclerolaena</i> sp.	Bindyi			
<i>Sclerostegia arbuscula</i>	Shrubby Samphire			
<i>Sclerostegia</i> sp.	Samphire			
<i>Senna artemisioides</i> ssp. × <i>coriacea</i>	Broad-leaf Desert Senna			
<i>Suaeda australis</i>	Austral Seablite			
<i>Threlkeldia diffusa</i>	Coast Bonefruit			
<i>Triglochin striatum</i>	Streaked Arrow-grass			
<i>Typha domingensis</i>	Narrow-leaf Bulrush			
<i>Vittadinia cuneata</i>	Fuzzy New Holland Daisy			
<i>Vittadinia gracilis</i>	Woolly New Holland Daisy			
<i>Wilsonia backhousei</i>	Narrow-leaf Wilsonia			V
<i>Wilsonia humilis</i> var. <i>humilis</i>	Silky Wilsonia			U
<i>Wilsonia rotundifolia</i>	Round-leaf Wilsonia			V

Total = 125 species; 55 species observed during field survey (marked in green)

Sources: Christie (2003); The Landscape Company (1999); Smith and Brewer (n.d.); Berkinshaw (2004a); Coleman and Cook (2003); DEH Biological Survey database (2008); EBS field survey observations 2007

Conservation Rating: Aus = National; SA = State; SL = Southern Lofty Botanical Region

Conservation Status Codes

X = Extinct/Presumed extinct: not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred

EN or E = Endangered: Rare and in danger of becoming extinct in the wild

T = Threatened: likely to be either Endangered or Vulnerable but insufficient data for a more precise assessment

VU or V = Vulnerable: Rare and at risk from potential threats or long term threats which could cause the species to become endangered in the future

K = Uncertain: likely to be either Threatened or Rare but insufficient data for a more precise assessment.

R = Rare: has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area); not currently exposed to significant threats but warrants monitoring and protective measures to prevent reduction of population sizes

U = Uncommon: less common species of interest but not Rare enough to warrant special protective measures

N = Not of particular significance/Common (also indicated by blank entry)

For more information

For more information, to make an enquiry or join the mailing list contact the Northern Connector project team.

Phone: 1300 793 458 (interpreter service available)

Email: dtei.northernconnector@sa.gov.au

Visit the website: www.infrastructure.sa.gov.au and then follow the prompts.

Για περισσότερες πληροφορίες γι' αυτό το πρόγραμμα οδοποιίας τηλεφωνήστε στο **1300 793 458**. Διαθέτουμε και διερμηνείς.

Se desiderate altre informazioni su questo progetto stradale telefonate al **1300 793 458**. Ci sono interpreti a disposizione.

Để có thêm thông tin về công trình đường bộ này xin hãy gọi điện thoại số **1300 793 458**. Sẽ có phiên dịch viên.

បើចង់ទទួលព័ត៌មានបន្ថែមទៀតអំពីគម្រោងផ្លូវថ្នល់នេះ សូមទូរស័ព្ទមកលេខ **1300 793 458** មានអ្នកបកប្រែភាសាផង។

www.infrastructure.sa.gov.au | 1300 793 458