TERRESTRIAL ECOLOGY 15

15.1 INTRODUCTION

The arid environments of Olympic Dam and the proposed infrastructure corridors support relatively intact, often sparse, communities of animals and plants, including listed threatened species and migratory birds. Although the region is largely uncleared, its ecological integrity has been degraded to some degree by the effects of grazing by cattle, sheep and rabbits and predation by feral animals.

At Olympic Dam, impact assessments and monitoring surveys of flora and fauna have been conducted for more than 20 years. Similar information has been collected by Santos in the area proposed for the desalination plant at Point Lowly. The infrastructure corridors, however, have been studied less intensively; for that reason they have been the focus of additional ecological surveys for the Draft EIS.

This chapter describes the effects the expansion project will have on habitat quality and native vegetation and animal communities. It discusses specific design modifications and management measures, including minimising the disturbance footprint of the project, preventing and deterring birds from accessing the tailings retention system (TRS), and minimising the impact of pipeline trenches on fauna. The chapter also assesses the effectiveness of these measures and the residual impacts of the proposed expansion on plant and animal communities, with a particular focus on listed species (including migratory birds). A framework for providing a Significant Environmental Benefit as per the *Native Vegetation Act 1991* is also included.

15.2 ASSESSMENT METHODS

15.2.1 DESKTOP REVIEW

Seasonal surveys of the flora and fauna inhabiting the existing mine site and infrastructure corridors have been undertaken during the past 25 years. These have included surveys associated with the 1982 and 1997 EIS and ongoing monitoring programs. Some of these surveys were undertaken after rain, and recorded ephemeral plants that would not have been detected otherwise.

Records of flora, fauna, plant associations and ecological communities that occur, or that are predicted to occur, in the project area were reviewed (see Figure 15.1). Particular attention was paid to known or potential occurrence of listed threatened species and listed migratory birds in the EIS Study Area. Major data sources included, but were not restricted to:

- Fatchen and Reid (1980); Graetz and Tongway (1980); Fatchen (1981); Kinhill-Stearns Roger (1982); Read (1994); Kinhill (1995); Kinhill (1997); BHP Billiton (2005a, 2006a) and unpublished flora and fauna database records from Olympic Dam and along the existing transmission line corridor to Port Augusta
- Western Mining Corporation (WMC) (1997) (published flora and fauna records of the existing Port Augusta to Olympic Dam transmission line corridor undertaken by John Read and Frank Badman); fauna surveys consisted of 18 pitfall lines, covering each environmental association and opportunistic bird, reptile and mammal surveys
- Neagle 2003 (An Inventory of the Biological Resources of the Rangelands of South Australia)
- Social and Ecological Assessment (1981 and 1998) (flora and fauna surveys of the desalination plant site)
- Brandle (1998) and Slaytor (1999) (biological surveys of the Stony Deserts and Lake Eyre South areas, respectively)
- South Australian Department for Environment and Heritage (DEH) Biological Database of South Australia (extracted May 2006 and September 2006 (for gas pipeline corridor options) and extracted again for review August 2008)
- Australian Government Department of the Environment, Water, Heritage and the Arts Protected Matters Search Tool (extracted July 2005 and extracted again for review October 2006, January and June 2007 and January 2008).

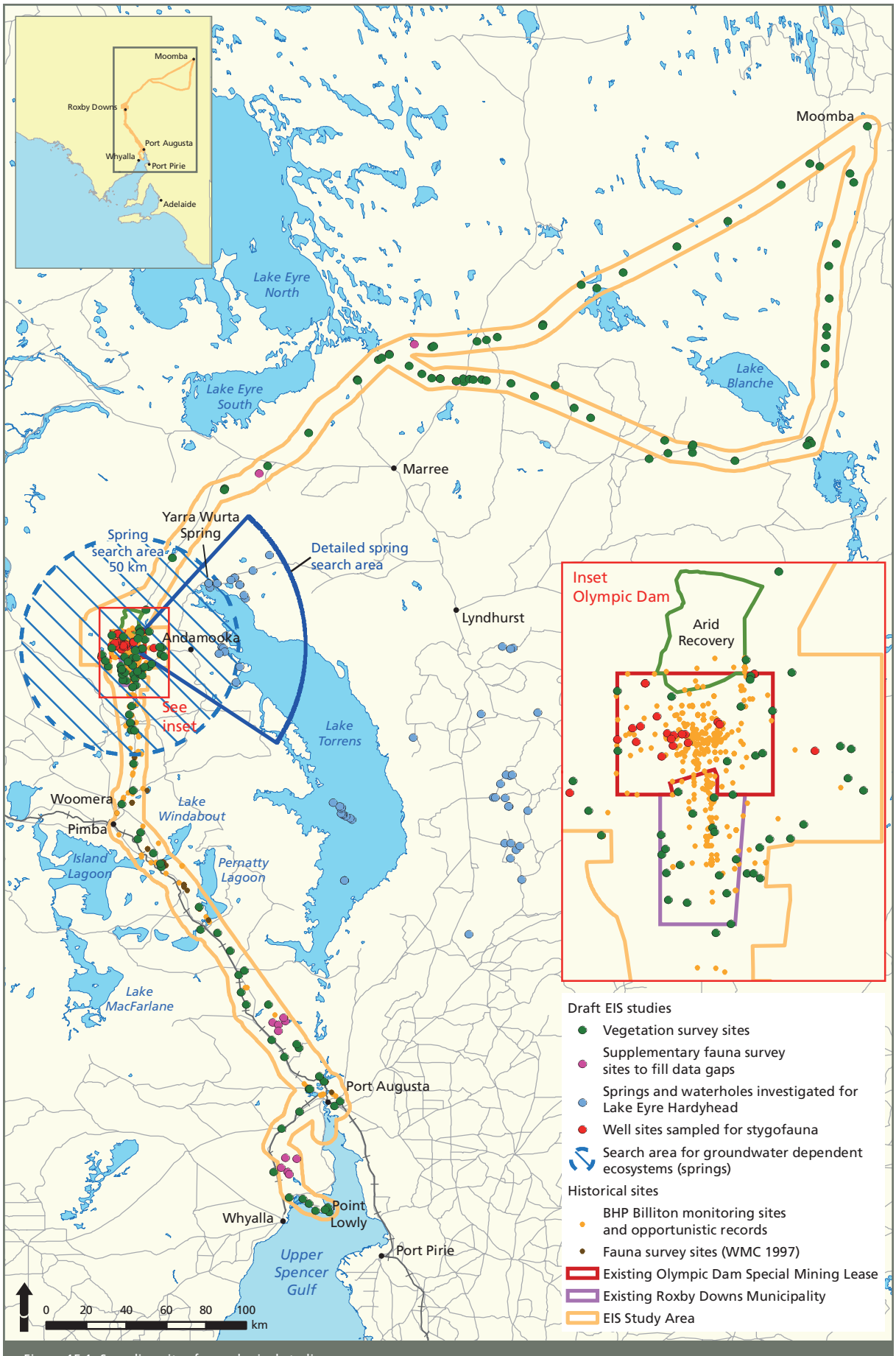

Figure 15.1 Sampling sites for ecological studies

The review of available biological data for the project area identified some information gaps where additional field surveys were required.

15.2.2 FIELD SURVEYS

The field surveys conducted to supplement existing information on flora and fauna are summarised in Table 15.1. The extent of the surveys in the infrastructure corridors included a 5 km wide buffer on either side of the proposed infrastructure.

Identification of vegetation associations and flora

Ortho-photography maps of the southern part of the project area (excluding the gas pipeline corridor options) were produced at a scale of 1:40,000. A reconnaissance survey of the southern part of the EIS Study Area was undertaken via helicopter in February 2006 to identify broad vegetation and habitat features that would be investigated during subsequent field work.

Vegetation in the southern part of the EIS Study Area was surveyed over 25 days during March, April and August 2006 (see Appendix N1). Eighty-four sites, each of approximately 1,000 m^2, were surveyed for vegetative composition (40 sites were in the EIS Study Area associated with the expanded SML and Roxby Downs Municipality and 44 sites were in the southern infrastructure corridor). An aerial vegetation survey of the westerly and northerly extension of the SML, the proposed saline water wellfield, the Hiltaba Village and relocated airport site was undertaken via helicopter in December 2007.

Table 15.1 Summary of terrestrial ecology studies undertaken

Study/survey	Consultant(s)	Date	Purpose/methods
Reconnaissance survey	Ecological Associates	20 Feb 2006	Preliminary mapping of vegetation associations via helicopter survey
Vegetation and habitat survey	Ecological Associates	27 Feb–6 Mar 2006	Ecological assessment of Special Mining Lease (SML) and dunes within the Roxby Downs Municipality
		27–31 Mar 2006	Ecological assessment of southern infrastructure corridor and desalination plant site (including a bat survey)
		18–24 Apr 2006	Ecological assessment of groundwater-dependent ecosystems near Lake Torrens
		28–29 Aug 2006	Survey of ephemeral plants on the southern third of the southern infrastructure corridor in response to a rainfall event
	RPS Ecos and RMP Environmental	14–21 Oct 2006	Ecological assessment of gas pipeline corridor options
	ENSR	5–6 Dec 2007	Ecological assessment of expanded SML, proposed water wellfield, Hiltaba Village and relocated airport
	EBS	14–18 Jan 2008	Ecological assessment of additional gas pipeline sites via helicopter survey
	RMP Environmental	23–25 Jan 2008	Vegetation assessment and mapping of gas pipeline corridor options south of Moomba
Fauna survey	Ecological Associates	10–17 Sept 2007	Survey of fauna within poorly surveyed sections of the southern infrastructure corridor
	Ecological Horizons (John Read)	21 Jan–8 Feb 2008	Survey of gibber plains east of Olympic Dam for the Thick-billed Grasswren and Plains Rat
Stygofauna survey	Natural Resource Services	4–9 June 2006	Assessment of stygofauna communities inhabiting groundwater within 40 km of Olympic Dam
Yarra Wurta Spring and western Lake Torrens spring survey	Access Macquarie	18–22 Apr 2006	Assessment of stromatolites
	Ecological Associates		Ecological assessment of Yarra Wurta Spring and other springs
	Rudi Kuiter and Graham Walker		Genetic assessment of the Lake Eyre Hardyhead
	SA Museum		
North-eastern and central Lake Torrens spring survey	Aquasave	26–29 Sept 2006	Assessment of refuge habitat for the Lake Eyre Hardyhead in the Lake Torrens catchment (via helicopter)
Eastern Lake Torrens and Flinders Ranges	Aquasave	26 Nov–2 Dec 2006	Assessment of refuge habitat for the Lake Eyre Hardyhead in the Lake Torrens catchment (via vehicle)
Tailings retention system (TRS)	Graham Carpenter	17 May 2006	Review of TRS bird and other wildlife monitoring data, site visit to TRS and discussions with BHP Billiton environmental staff
	Brett Lane and Associates	February 2008	Review of the potential effect of expanded tailings beaches on shorebirds

Vegetation surveys in the gas pipeline corridor options were carried out over 14 days in October 2006 and January 2008 (see Appendix N1). Sixty-five sites of approximately 1 ha were surveyed for vegetative composition.

Data from these sites, previous vegetation mapping and interpretation of ortho-photographic maps and medium-resolution (15 m) satellite imagery were combined and used to define the vegetation communities in the entire EIS Study Area (including a 10 km wide EIS Study Area for the infrastructure corridors)(see Appendix N2). Detailed vegetation maps for the EIS Study Area were then produced.

Vegetation associations were classified according to the dominant overstorey species and the vegetation structure in accordance with the method used for the Biological Survey of South Australia (Heard and Channon 1997). Incidental observations of plant species and vegetation associations outside the designated survey sites were also recorded.

The vegetation surveys during April and May 2006 were conducted when ephemeral species were largely absent due to dry seasonal conditions. As a result of substantial rain in the EIS Study Area in June 2006, an additional survey covering the southern part of the EIS Study Area (from the SML and southwards) was undertaken in August 2006 to specifically survey ephemeral species that may have emerged.

All plants observed were either identified to species level in the field, or representative voucher specimens were collected for subsequent identification with assistance from the State Herbarium of South Australia. Species nomenclature follows the *Census of South Australian Vascular Plants* (Barker et al. 2005). Introduced plant species that are cited throughout the chapter are denoted by an asterisk (*).

Vegetation associations, native plant species and exotic plants recorded for the EIS Study Area are listed in Appendices N2, N3 and N4 respectively.

Identification of fauna and fauna habitat

The existing fauna databases of the EIS Study Area are comprehensive, particularly in the region surrounding Olympic Dam (see Appendix N5 for complete lists, and Appendix N6 for priority species). They have been developed from detailed field surveys and annual monitoring during the past 25 years. Extensive fauna surveys have also been carried out by DEH in the Stony Deserts region, which makes up a large proportion of the gas pipeline corridor options. Figure 15.1 shows the previous BHP Billiton survey locations within the EIS Study Area.

Fauna habitat types in the EIS Study Area were surveyed concurrently with the vegetation surveys. Opportunistic sightings of fauna were recorded during the survey. The main aim of the survey was to establish the presence of, and map the habitats known to potentially support, listed threatened fauna.

Less information was available for two of the areas in the southern half of the southern infrastructure corridor. A fauna survey was therefore undertaken at 10 sites covering each of the major habitat types between Whyalla and 40 km north-north-west of Port Augusta (see Figure 15.1). The first set of five sites was located on Kootaberra Station near Uro Bluff, approximately 40 km north-north-west of Port Augusta. The second set of five sites was located on Tregalana Station between 25 and 30 km north of Whyalla.

A survey of the sites, based on the methods of the Biological Survey of South Australia, was conducted over one week in September 2007. The survey involved trapping (pitfall and Elliot traps), bird records, active searches for vertebrate fauna in litter, debris, hollows and bark, and spotlighting. The survey assessed the fauna of the main habitat types of each site (see Appendix N7).

Although no threatened insectivorous bats had ever been recorded in the EIS Study Area, a survey for these bats (i.e. microchiropteran bats) was conducted to identify common species in the area. The survey was conducted over four nights near Roxby Downs in March 2006 using an Anabat II bat detection system. Recorded echolocation calls were subsequently assigned to species by Greg Ford, Anabat's call-analysis specialist.

Species nomenclature follows *A List of the Vertebrates of South Australia* (Robinson et al. 2000). Native and introduced fauna species recorded for the EIS Study Area are listed in Appendix N5.

Groundwater-dependent ecosystems

The potential effects of groundwater drawdown on groundwater-dependent ecosystems were investigated by collecting baseline ecological data from 45 springs and water bodies within about 200 km of Olympic Dam (see Figure 15.1). The status of each spring, lists of flora and fauna, and water quality data were recorded. Plants were identified in the field and invertebrate fauna were sampled opportunistically and identified. Fish were surveyed using both seine nets and traps, or were collected using hand nets (DEH Scientific Permit Number Z25315 1) (see Appendix N8).

The Lake Eyre Hardyhead, which is a relatively common native fish species in the Lake Eyre Basin and endemic to South Australia, was recorded in Yarra Wurta Spring. Live Lake Eyre Hardyheads were transported to Adelaide for genetic characterisation at the South Australian Museum using electrophoresis (see Appendix N8).

Subsequent surveys of water bodies in the vicinity of Lake Torrens were undertaken to determine if additional populations of the Lake Eyre Hardyhead occur in the Lake Torrens Basin (see Table 15.1 and Figure 15.1).

To identify potential stromatolites at Yarra Wurta Spring, five core samples of algal material and nine rock samples were collected from several locations in the spring. All samples were analysed at Macquarie University by Professor Malcolm Walter (see Appendix N8).

Groundwater fauna

Subterranean fauna that inhabit groundwater (i.e. stygofauna) were surveyed in the Andamooka Limestone and Arcoona Quartzite aquifers at Olympic Dam (Natural Resource Services 2006). Of the 21 wells sampled (see Figure 15.1), 15 were considered to be in the zone influenced by current mining operations and six outside.

Modified plankton nets made of 150 µm nylon mesh were used to retrieve samples using two methods at each well:

- non-disturbed samples were collected by lowering a net slowly to just above the bottom of the well and then hauling it to the surface. This method targeted stygofauna potentially present in the water column
- disturbed samples were collected by agitating the net at the base of the well before hauling it to the surface. This targeted stygofauna potentially present in the sediment.

Samples were preserved in ethanol and refrigerated before being identified at either the BHP Billiton Olympic Dam environmental laboratory or the consultant's freshwater macro-invertebrates laboratory in Adelaide.

15.2.3 CALCULATING SIGNIFICANT ENVIRONMENTAL BENEFITS

Under the SA *Native Vegetation Act 1991*, approval to clear native vegetation may be conditional on providing significant environmental benefits (SEB), as defined by the Native Vegetation Council. The SEB may include setting aside a suitable area of land for conservation purposes, a financial payment to the Native Vegetation Fund, or a combination of both (DWLBC 2005) (see Appendix N9 for details).

If the SEB entails setting aside land for conservation, the Native Vegetation Council applies the following criteria (DWLBC 2005):

- the land is to be in the same natural resource management region as the cleared land
- the area required is calculated using a ratio of the area to be conserved versus the area to be cleared. The ratio is determined using established indicators of vegetation condition and a formula provided by the Native Vegetation Council. The ratio varies from 2:1 in areas dominated by weeds and with only scattered areas or patches of native vegetation, up to 10:1 in areas of intact vegetation
- if the SEB entails payment to the Native Vegetation Council, the amount would be calculated using a formula provided by the council.

Clearing is proposed in the Arid Lands, Eyre Peninsula, and Northern and Yorke Peninsula Natural Resource Management (NRM) regions. The area of cleared land was determined using a geographic information system (GIS), with which the proposed disturbance footprints were overlaid onto the 1:40,000 vegetation maps, enabling the area to be calculated for each project component (see Appendix N9).

15.2.4 IMPACT AND RISK ASSESSMENT

The assessment of impacts and risks for the proposed expansion has been undertaken as two separate, but related, processes (see Section 1.6.2 of Chapter 1, Introduction, and Figure 1.11).

Impacts and benefits are the consequence of a known event. They are described in this chapter and categorised as high, moderate, low or negligible in accordance with the criteria presented in Table 1.3 (Chapter 1, Introduction).

A risk assessment describes and categorises the likelihood and consequence of an unplanned event. These are presented in Chapter 26, Hazard and Risk.

The potential to impact listed plants, animals and migratory birds with geographic ranges that could overlap the EIS Study Area was assessed. This entailed determining the likely presence of listed species within the EIS Study Area, and establishing if there was a credible risk of impact to each species based on its ecology and/or behaviour (see Appendix N6). This assessment was used to derive a priority list of species that warranted more detailed investigation. The residual impact of the expansion on each priority species was assessed by considering the particular project hazards, the likelihood of the species being affected, the mitigation measures that would be implemented, and the consequences of the residual impact on the species (see Sections 15.5.4 and 15.5.5 for outcomes).

An assessment against the EPBC Act for assessing significant impacts on listed species was also undertaken.

15.3 EXISTING ENVIRONMENT

15.3.1 REGIONAL CONTEXT

The proposed expansion is located predominantly in the Gawler Bioregion, with the gas pipeline corridor options crossing the Stony Plains, Simpson-Strzelecki Dunefields and Channel Country Bioregions. These bioregions are arid to semi-arid with high summer temperatures and low rainfall. The bioregions consist of a range of land systems, including extensive gently undulating gibber plains with mesas and salt lakes in the south and north-east, and extensive dunefields and sandplains in the north and around Olympic Dam (see Chapter 10, Topography and Soils, for details and locations of land systems).

The dominant vegetation across the project area is low grassland, chenopod shrubland or acacia woodland/shrubland, with drainage lines supporting taller shrubland or woodland. The native vegetation across most of the EIS Study Area is relatively intact, but some areas are highly disturbed. Although the area is too arid for agriculture, sheep and cattle grazing of the rangelands is extensive. Grazing by livestock and rabbits has degraded vegetation to varying degrees (Kingoonya Soil Conservation Board 2002; Gawler Ranges Soil Conservation Board 2004).

Habitat modification through grazing by livestock and rabbits, and the introduction of predators such as foxes and cats, has resulted in the extinction of numerous small to medium sized mammals in the region (Morton 1990).

The region supports few natural, permanent water bodies with drinkable water, although the springs of the GAB (including the GAB springs complex on the gas pipeline corridor options) are notable exceptions. Waterholes on the larger rivers in the north-east of the region (such as Clayton and Frome Rivers and Strzelecki Creek) can persist for months after the infrequent occurrence of large flows. Permanent water also occurs at Saint Mary Pool in the gas pipeline corridor options. There are also saline springs, including the Yarra Wurta Spring near Lake Torrens, and large ephemeral lakes that provide important waterbird habitat when flooded. A flowing well on the Clayton River within the gas pipeline corridor options has created an extensive permanent wetland that supports a wide range of native birds.

The gas pipeline corridor options intersect two conservation reserves – Lake Eyre National Park abuts the northern edge of the corridor and Strzelecki Regional Reserve is crossed (see Chapter 9, Land Use, Figure 9.5). The gas pipeline corridor also crosses the Strzelecki Creek wetland system, which is listed in the Directory of Important Wetlands in Australia (Environment Australia 2001). Strzelecki Creek and its floodplain are generally completely dry, but can support large numbers of waterbirds when inundated by infrequent, large Cooper Creek flows.

15.3.2 VEGETATION ASSOCIATIONS

The vegetation associations in the SML, the Roxby Downs Municipality, along the transmission line corridor from Olympic Dam to Port Augusta and along the section of the gas pipeline corridor option that follows the water supply pipeline from Wellfield B south to Olympic Dam have been described previously by Graetz and Tongway (1980); Fatchen (1981); Kinhill-Stearns Roger (1982); Kinhill (1995); WMC (1997) and Kinhill (1997).

The vegetation surveys of the EIS Study Area undertaken for this assessment identified 78 vegetation types, which have been grouped into 24 associations. Typical vegetation sequences occurring in the vicinity of Olympic Dam are shown in Figure 15.2. The distribution of each vegetation association within the EIS Study Area is shown in Figure 15.3 (Olympic Dam area), Figure 15.4a (gas pipeline corridor) and Figure 15.4b (southern infrastructure corridor). Descriptions of each association are provided in Table 15.2. More comprehensive descriptions and vegetation distribution maps are provided in Appendices N1 and N2.

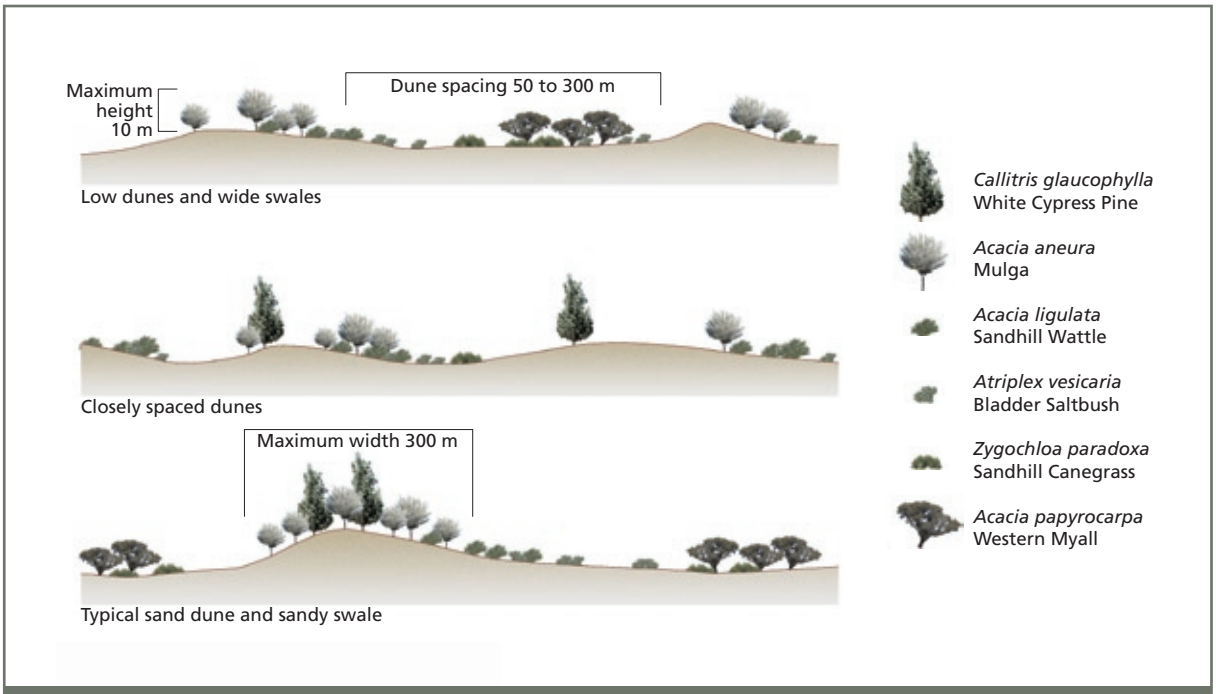

Figure 15.2 Typical vegetation sequences occurring near Roxby Downs

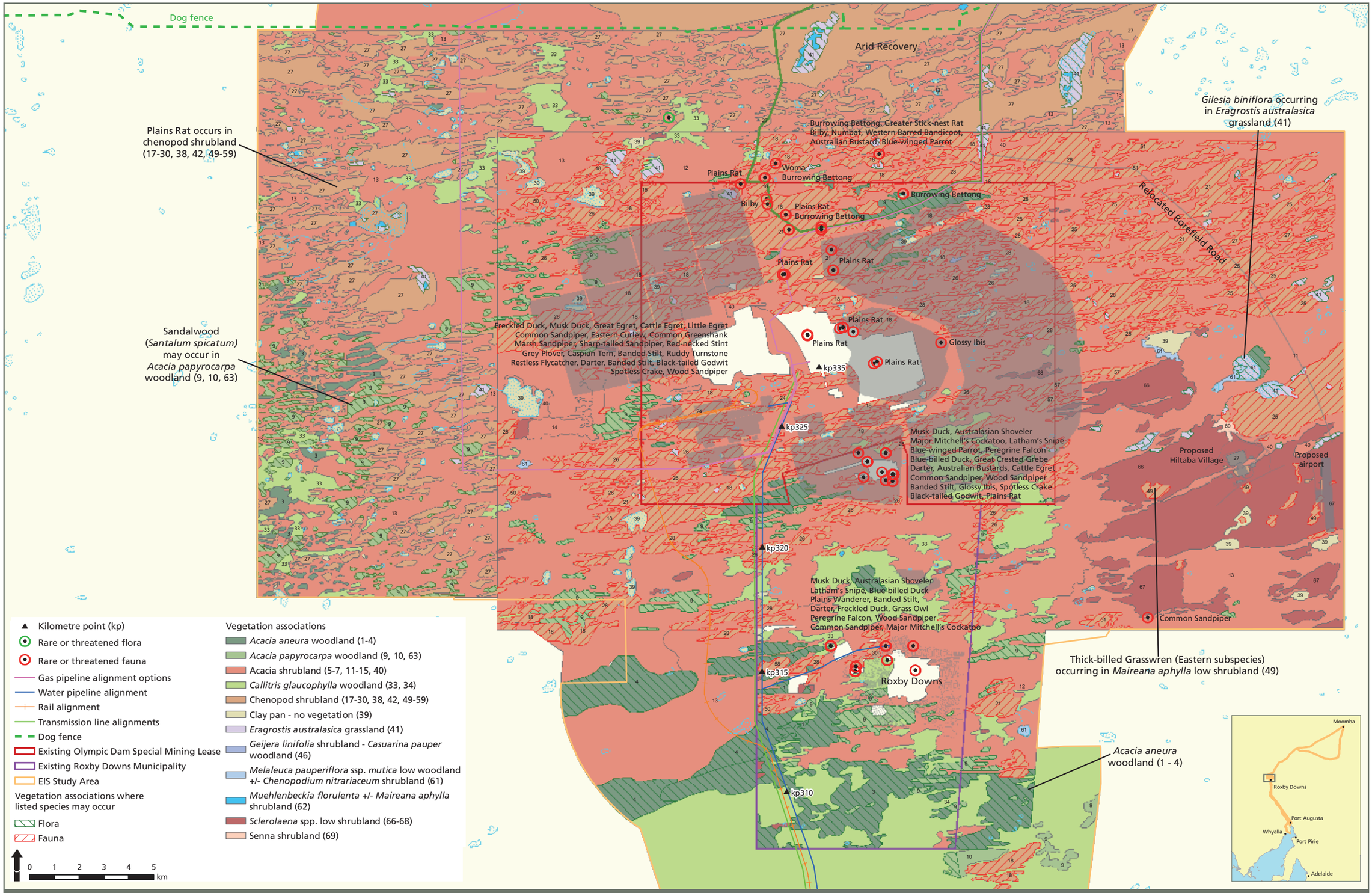

Figure 15.3 Vegetation associations and records of listed species at Olympic Dam

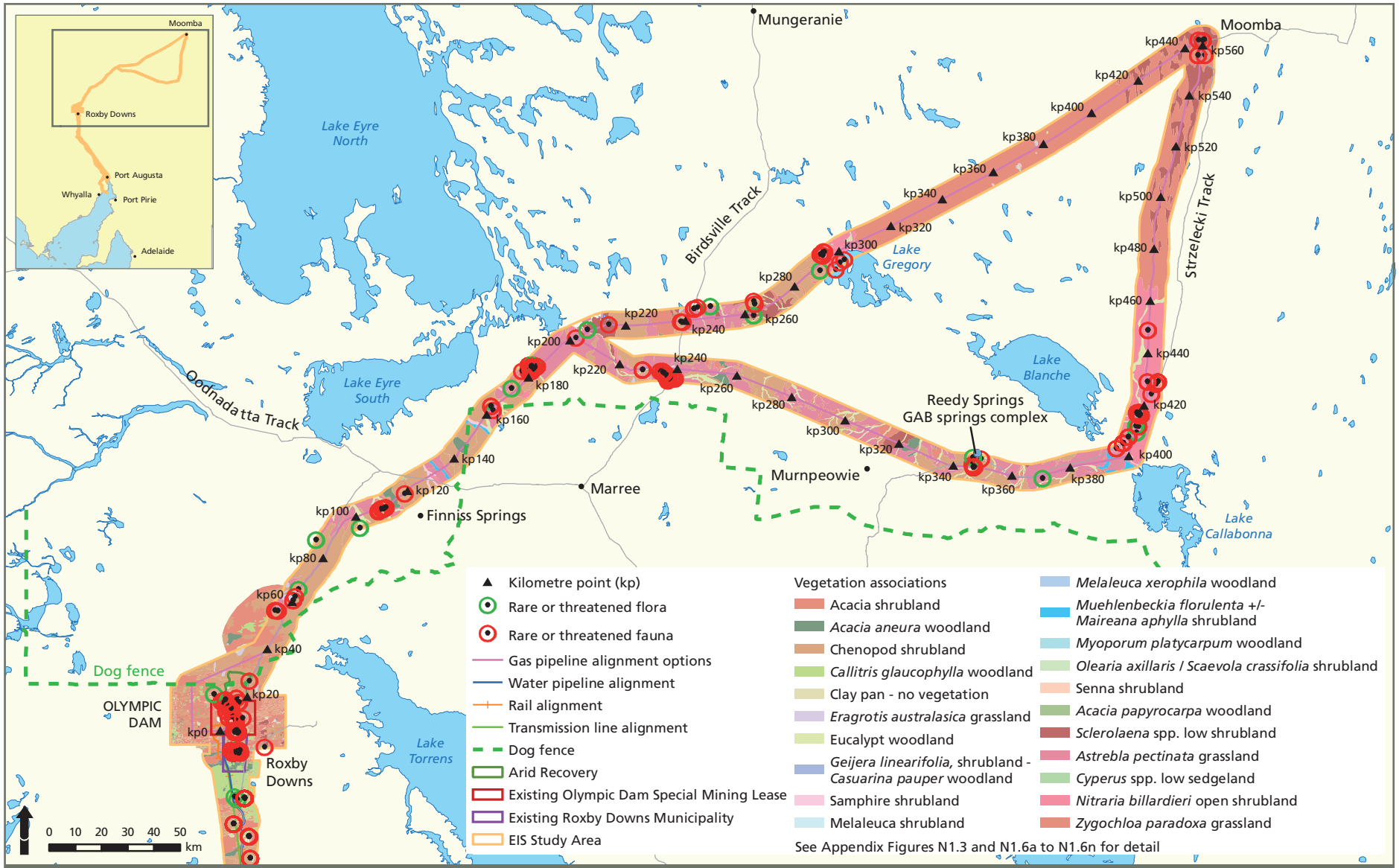

Figure 15.4a Vegetation associations and records of listed species within the gas pipeline corridor options

Figure 15.4b Vegetation assocations and records of listed species within the southern corridor

Table 15.2 Vegetation associations of the EIS Study Area

Vegetation association	Vegetation types (see Appendix N1 Table N1.2)	Description
Acacia aneura woodland	1–4	Low, open woodland dominated by *A. aneura* on sandplains, in sandy swales and on the lower slopes of dunes. Sandplains of the Hesso land system have a mosaic of *A. aneura* and *A. papyrocarpa* woodland or *Casuarina pauper* woodland. The understorey is dominated by grasses, especially *Enneapogon* spp., *Aristida* spp. and *A. aneura* woodlands, which also occur along rocky watercourses in the Arcoona land system (see Plate 15.1). Further north in the sandy flats between dunes of the Strzelecki land system, *A. aneura* forms a very sparse open woodland, often with *Senna* spp. and *Eremophila* spp.
Acacia shrubland	5–7, 11–15, 40, 75, 77	Tall, open shrubland dominated by *Acacia ligulata*, *A. ramulosa* and *Dodonaea viscosa* ssp. *angustissima* on dune crests and dune slopes, with *A. aneura* on lower dune slopes. Dunes in the Hesso land system are dominated by *A. burkittii*. Tall, open shrubland on clayey dunes around saline lake systems have tall, open *A. ligulata* shrubland with an understorey of *Maireana pyramidata* or other chenopod shrubs. Tall open shrubland of *A. tetragonophylla* occur on rocky watercourses or on shallow, clayey sands east of large lagoons in the Roxby land system. In the Strzelecki, Collina and Hope dunefield land systems in the north and east, the dominant understorey under very sparse *A. ligulata* is *Zygochloa paradoxa* and ephemeral herbs. On some dunes, the *A. ligulata* shrubland is replaced by a sparse *Z. paradoxa* grassland (see Plate 15.2)
Alectryon oleifolius ssp. *canescens* tall shrubland	15	Tall, open shrubland on low dunes with an understorey of *Maireana* spp. and *Rhagodia spinescens*
Chenopod shrubland	17–30, 38, 42, 49–59, 72	Low, open shrubland dominated by *Atriplex vesicaria* on clay soils in interdune swales, on gibber tablelands and clay loam plains. *Maireana sedifolia* becomes dominant on outcropping limestone or on shallow soils over a calcrete layer. *M. pyramidata* shrubland is common on run-off areas or on sandy soils around lagoons. *Sclerostegia* spp. is co-dominant on the slopes and gibber plains of the Arcoona tableland. *M. astrotricha* is a subdominant species in the Roxby land system. The understorey of chenopod shrubland is frequently dominated by *Sclerolaena* spp. Other herbs and grasses may be frequent following rainfall events (see Plates 15.3 and 15.4). *Dissocarpus paradoxus* dominates with *Sclerolaena* spp. in some parts of the Cooryaninna and Oodnadatta land systems
Avicennia marina forest	31	Low mangrove woodland in the intertidal zone at the head of Spencer Gulf
Callitris glaucophylla woodland	33, 34	Open woodland on deep sands on crests of widely spaced dunes or in dune and sandy swales of closely spaced dunes, where it forms a mosaic with *A. aneura* woodland. Understorey may include *A. ramulosa* and the ground layer is dominated by grasses, *Enneapogon* spp. and *Aristida* spp. (see Plate 15.5)
Casuarina pauper woodland	36, 37	Open-to-closed woodland formation on clay loam plains, forming a mosaic with chenopod shrubland or *A. papyrocarpa* woodland. Closed woodland has a very sparse understorey and open woodlands have an understorey of chenopod shrubs. Forms low open woodland on steep scarp slopes and in rocky watercourses. In the Tent Hill land system the understorey may include *Triodia irritans*
Clay pan – no vegetation	39	Small, unvegetated clay-based basins in interdune swales or large, ephemeral drainage basins that may have a salt crust, particularly in the north-east in the Hope land system of the Strzelecki Desert
Eragrostis australasica grassland	41	Open, perennial tussock grassland in run-on areas in interdune swales or drainage basins on gibber tableland subject to frequent inundation. *Muehlenbeckia florulenta* is sometimes associated. After rainfall the understorey has a cover of herbs and grasses including *Eragrostis setifolia* and *Atriplex spongiosa* (see Plate 15.6)
Eucalypt woodland	43–45, 76	Open woodland dominated by eucalypt species. *Eucalyptus intertexta* woodland occurs along watercourses draining hills in the Tent Hill land system. *E. camaldulensis* occurs along watercourses draining the Flinders Ranges. *E. socialis* and *E. gracilis* mallee woodlands occur in the Bittali land system. These woodlands have an understorey of chenopod shrubs on shallow clay loam soils and a diverse assemblage of shrubs, including *Eremophila* spp., *Beyeria lechenaultia* and *Senna* spp. on sandy soils. North and east of Olympic Dam, major drainage channels are sparsely lined with *E. coolabah*, often with an understorey of *A. stenophylla* (see Plate 15.7)
Geijera linearifolia shrubland – *Casuarina pauper* woodland	46	A mosaic of open *Geijera linearifolia* tall shrubland and open *Casuarina pauper* woodland on shallow, shaley soils on steep coastal slopes of the Tent Hill land system. There is a diverse but sparse shrubby understorey of chenopod shrubs, *Hakea* spp., and *Acacia* spp.

Plate 15.1 Provisionally threatened Mulga *Acacia aneura* woodland

Plate 15.5 Cypress Pine *Callitris glaucophylla* woodland

Plate 15.2 Sparse Sandhill Wattle *Acacia ligulata* shrubland and Sandhill Canegrass *Zygochloa paradoxa* hummock grassland

Plate 15.6 Canegrass *Eragrostris australasica* grassland

Plate 15.3 Cottonbush *Maireana aphylla* shrubland

Plate 15.7 Coolibah *Eucalyptus coolabah* woodland in a larger watercourse on the gas pipeline corridor

Plate 15.4 Chenopod *Atriplex vesicaria* shrubland on gibber

Table 15.2 Vegetation associations of the EIS Study Area (cont'd)

Vegetation association	Vegetation types (see Appendix N1 Table N1.2)	Description
Samphire shrubland	48, 74	*Halosarcia* spp. Low, open-or-closed shrubland around the margins of saline lakes, in saline drainage areas and the supra-tidal zone of Spencer Gulf. *Sclerostegia tenuis* and other samphires can be found fringing the small salt lakes in the Hope, Blanche and Oodnadatta land systems
Melaleuca shrubland	60	Tall, open shrubland of *Melaleuca lanceolata* on sandy soils on low dunes near the coast. Understorey of *Atriplex vesicaria*, *Beyeria lechenaultia* and *Westringia rigida*
Melaleuca xerophila woodland	61	Low, open woodland on sandy or clay gypseous soils fringing lagoons or the margins of sandy watercourses. Sparse understorey of shrubs including *Halosarcia* spp. and *Frankenia serpyllifolia*
Muehlenbeckia florulenta/ Maireana aphylla shrubland	62	Open shrubland in drainage areas in interdune swales (*Muehlenbeckia florulenta*) or on gibber tablelands (*Maireana aphylla*) shrublands are more common (see Plate 15.3). Subdominant overstorey includes *Chenopodium nitrariaceum*. Understorey of *Eragrostis setifolia* and herbaceous species following rainfall
Myoporum platycarpum woodland	64	Open woodland on clay loam plains most frequently as a mosaic with *A. papyrocarpa* woodland. Understorey of chenopod shrubs
Olearia axillaris/Scaevola crassifolia shrubland	65	Low shrubland on loose sands on coastal dunes at Port Bonython. Other subdominant overstorey species are *A. longifolia* var. sophorae and *Myoporum insulare*
Senna shrubland	69	Open *Senna artemisioides* shrubland with emergent *A. aneura* and *A. papyrocarpa* on sandplains in the Hesso Land System
Acacia papyrocarpa woodland	9, 10, 63	Open woodland at the edge of interdunal swales or in small swales in the Roxby land system and on sandplains and clay-loam plains in land systems to the south. Understorey typically dominated by chenopod shrubs, including *Atriplex vesicaria*, *Maireana sedifolia* and *M. pyramidata*. Forms a mosaic with *A. aneura* woodland on sandplains and *Myoporum platycarpum* and *Casuarina pauper* on clay-loam plains (see Plate 15.8)
Sclerolaena spp. low shrubland	66–68, 78	Very low open shrubland to ephemeral herbland on gibber plains and in interdunal swales on clay soils. In the north around Moomba, grasses can be codominant and in some areas, *Atriplex nummularia* ssp. *nummularia* can form localised taller shrublands over the association. In the run-on flats and gilgai areas of the Mumpie and Kalatinka land systems, *Atriplex spongiosa* is often codominant with *Sclerolaena* spp.
Cyperus spp. low sedgeland	71	Low, often quite dense sedgelands associated with outflows from GAB springs north of Olympic Dam and on Murnpeowie Station to the east, most often dominated by *C. laevigatus* with a subdominance of *C. gymnocaulos*
Nitraria billardieri open shrubland	73	Low, sparse shrubland that dominates the low, jumbled white sand dunes of the Collina land system in the east and is subdominant in minor sandy parts of the gibber/gilgai areas of the Oodnadatta and Kalatinka land systems north-east of Olympic Dam. *Salsola tragus* and *Zygophyllum* spp. are often associated (see Plate 15.9)
Astrebla pectinata grassland	70	Dominant association in gilgai areas in the extensive gibber land systems of Mumpie, Kalatinka, Flint and Oodnadatta. The high moisture holding capacity of the gilgais also supports annual saltbushes, herbs and grasses after rain (see Plate 15.10)

Plate 15.8 Myall *Acacia papyrocarpa* woodland with understorey of chenopod shrubland

Plate 15.9 Nitre-bush *Nitraria billardieri* shrubland

Plate 15.10 Barley Mitchell-grass *Astrebla pectinata* grassland

Searches of Australian and South Australian databases, published literature and studies undertaken for this assessment identified one listed and one provisionally listed ecological community:

- The nationally endangered 'community of native species dependent on natural discharge of groundwater from the GAB', which is also listed as endangered in South Australia (Neagle 2003). This community is present at one location, where the northern edge of the gas pipeline corridor option intersects the Reedy Springs GAB springs complex on Murnpeowie Station (see Appendix N1, Figure N1.6g).
- One ecological community provisionally listed as 'vulnerable' in South Australia: Mulga *Acacia aneura* low woodland on sandplains (Neagle 2003) (see Plate 15.1). In South Australia, this community is threatened by extensive fires in good seasons, followed by inhibited regeneration due to rabbit grazing. It is poorly conserved in the formal reserves system (Neagle 2003).

15.3.3 NATIVE FLORA

Surveys by Fatchen (1981), ongoing monitoring surveys by BHP Billiton and the South Australian Department for Environment and Heritage (DEH), and the surveys undertaken for the Draft EIS (hereafter current surveys) have recorded the following numbers of native flora species (see Appendix N3 for lists):

- 242 in the expanded SML and Roxby Downs Municipality
- 414 in the southern infrastructure corridor
- 493 in the gas pipeline corridor options
- 25 at the Point Lowly desalination plant site.

15.3.4 LISTED FLORA

Categories of listed species include rare, vulnerable, endangered, critically endangered and presumed extinct; with vulnerable, endangered and critically endangered species being collectively termed 'threatened' species, and rare species assumed not to be threatened.

Data collated from the relevant flora databases, published literature and the surveys undertaken for this assessment established that 34 listed plant species have been recorded or have geographic ranges that overlap the EIS Study Area under Australian and/or South Australian legislation (see Appendix N3 and N6 for species lists).

15.3.5 INTRODUCED FLORA

Surveys by Fatchen (1981), ongoing monitoring surveys by BHP Billiton, the current surveys and the Biological Databases of South Australia have recorded the following numbers of introduced flora species (see Appendix N4 for lists):

- 45 species in the expanded SML and Roxby Downs Municipality
- 87 species in the infrastructure corridors
- 28 species in the gas pipeline corridor options
- 12 species at the Point Lowly desalination plant site.

Of these, 14 are declared weeds and 15 are environmental weeds, as defined in the South Australian Arid Lands Pest Management Strategy 2005–2010 (Pitt et al. 2006) (see Table 15.3 and Appendix N4).

Declared pest plants are invasive species that landholders are obliged to control under the *Natural Resources Management Act 2004*. Declared plants are grouped into 11 classes, which define the degree to which they should be controlled. Some species are required to be reported to the relevant NRM Board, although no such species were found within the EIS Study Area during the flora surveys.

Environmental pest plants are also invasive species that can have potentially significant economic, social and ecological impact. They are not specifically listed or targeted for control under the Act, but may be identified as requiring control by specific Natural Resources Management (NRM) Boards (see Appendix N4).

The majority of weed species recorded are ephemeral species that can respond rapidly to favourable cool-season rains (Badman 1995). Badman (1995) found that two separate suites of weeds occur at Olympic Dam: those that have been widespread in the general area for many years, and those that occupy wet areas around the town and mine. Although the density of introduced plants in the SML, the Roxby Downs Municipality and infrastructure corridors is low, they are relatively common along tracks, dams, roadsides and other areas of disturbance.

The most common introduced species at Olympic Dam is *Brassica tournefortii*, which occurs on most dunes and sandy swales, but has not been associated with land disturbance. In the southern infrastructure corridor two introduced species (listed as environmental weeds) are common: *Carrichtera annua* dominates the ground layer in chenopod shrubland and *Acacia papyrocarpa* woodland on clay-loam soils in the southern part of the corridor. *Brassica tournefortii* is common on dunes in the

Table 15.3 Declared weed species and their occurrence in the EIS Study Area

Species	Class[1]	Control area	Location[2]
Khaki Weed *Alternanthera pungens*	1	Whole of SA	C
Bridal Creeper *Asparagus asparagoides*	2	Whole of SA	C
Onion Weed *Asphodelus fistulosus*	7	District Councils of Coorong, Kingston, Mt Remarkable, Orroroo Carrieton, Peterborough, Robe, Tatiara and Yorke Peninsula, the Regional Councils of Goyder and Port Pirie, and the Mid Murray Council	L, C, DP, B2
Innocent Weed *Cenchrus* spp.	2	Whole of SA	L
Salvation Jane *Echium plantagineum*	3	Whole of SA	L, C
Three-corner Jack *Emex* spp.	2	Whole of SA	L, C
African Boxthorn *Lycium ferocissimum*	2	Whole of SA	C
Horehound *Marrubium vulgare*	3	Whole of SA	C, DP
Athel Pine *Tamarix aphylla*	11	Whole of SA	L
Prickly Pear *Opuntia* spp.	1	Whole of SA	L, C
Jerusalem Thorn *Parkinsonia aculeata*	1	Whole of SA	C
Caltrop Tribulus *terrestris*	2	Whole of SA	L, C, DP, GC
Bathurst Burr *Xanthium spinosum*	2	Whole of SA	C
Noogoora Burr *Xanthium strumarium* spp. agg.	2	Whole of SA	L

[1] Indicates the level of control required (1 = highest level of control required).
[2] C = southern infrastructure corridor; DP = desalination plant region; GC = gas pipeline corridor options; L = expanded SML and Roxby Downs Municipality.

northern part of the corridor, where it forms patches that sometimes dominate the ground layer. *Brassica tournefortii* also occurs on dunes in the gas pipeline corridor options.

15.3.6 NATIVE FAUNA AND HABITATS

Fauna occurring in the EIS Study Area have been described by Fatchen and Reid (1980); Graetz and Tongway (1980); Social and Ecological Assessment (1981); Kinhill-Stearns Roger (1982); Read (1994); Kinhill (1995) and BHP Billiton (2005a, 2006a). These surveys and ongoing monitoring of fauna by BHP Billiton have led to a comprehensive understanding of the distribution, abundance and habitat preferences of fauna in the region.

The above mentioned surveys and those conducted during this assessment have identified the following numbers of fauna species in the EIS Study Area (see Appendix N5 for lists):

- 184 bird, 29 mammal, 47 reptile and one amphibian in the SML and Roxby Downs Municipality
- 174 bird, 14 mammal, 63 reptile and one amphibian in the southern infrastructure corridor
- 169 bird, 14 mammal, 51 reptile and four amphibians in the gas pipeline corridor options
- 83 bird, seven mammal, 20 reptile and no amphibians in the Point Lowly desalination plant area.

Birds

Bushbirds are abundant in the area, particularly in association with acacia and *Callitris glaucophylla* woodland, chenopod shrubland, acacia shrubland on dunes and acacia and eucalyptus woodland on drainage lines. Large, dense shrubs in swamps, including *Maireana aphylla* and *Chenopodium nitrariaceum*, provide habitat for sedentary, small species (see Plate 15.3).

Waterbirds are attracted to artificial water bodies, including the Roxby Downs sewage ponds and evaporation ponds associated with the tailings retention system (TRS). The proposed infrastructure corridors are close to, or overlap, several large, ephemeral lakes, including the Arcoona Lakes, Pernatty Lagoon, Ironstone Lagoon and Lake Windabout in the south (see Appendix N1, Figures N1.4a, N1.4b and N1.4c), and the southern tip of Lake Eyre, Lake Callabonna and Lake Gregory in the north (see Appendix N1, Figures N1.6c, N1.6h and N1.6l). These lakes support large populations of waterbirds when flooded (Read and Ebdon 1998). The Strzelecki Creek system in the north-east of the EIS Study Area is predominantly dry but can also support large populations of waterbirds when it floods during large Cooper Creek flows. Other waterbird habitats include the coastal wetlands of Upper Spencer Gulf (see Appendix N1, Figure N1.4e) and bore drains in the gas pipeline corridor options.

Mammals

The dunefields around Olympic Dam provide a diversity of woodland, shrubland and grassland habitat for mammal species. Cracking clay soils in swales provide sheltering habitat for some species of small mammals, and dunes provide habitat for burrowing species. Large trees with rough bark or hollows such as *Acacia aneura*, *Callitris glaucophylla*, *Eucalyptus coolabah* and *Acacia papyrocrapa* provide shelter for insectivorous bats.

Four species of insectivorous bat were recorded during surveys in the Roxby Downs Municipality: Southern Freetail-bat

Mormopterus planiceps, Gould's Wattled Bat *Chalinolobus gouldii*, Inland Broad-nosed Bat *Scotorepens balstoni* and unidentified Long-eared Bat *Nyctophilus* sp. Although the first three species are listed as common, the status of the unidentified species is uncertain as the recorded call sequences were not of sufficient length to enable confirmation of the species. It is, however, most likely to be a common long-eared bat as no listed bat species have been recorded, or are listed in relevant fauna databases as likely to occur, in the area. Most bat activity was recorded in an open *Atriplex vesicaria/ Sclerostegia* spp. shrubland site, where all four species occurred.

The most significant habitat for mammals in the Olympic Dam region is in Arid Recovery (see Section 15.3.10 for details).

In the infrastructure corridors, regions of localised drainage on gibber tablelands characterised by cracking clay soils support a high diversity of fauna. Small mammals such as Forrest's Mouse *Leggadina forresti*, dunnarts *Sminthopsis* spp. (see Plates 15.11 and 15.12) and planigales *Planigale* spp. (see Plate 15.13) are found on these tablelands (Owens and Read 1999). Low-lying patches of deep-cracking clays also provide refuge habitat for the threatened Plains Rat *Pseudomys australis* (see Plate 15.14) (Brandle et al. 1999).

The extensive dunefields in the north of the EIS Study Area in the gas pipeline corridor options support fewer large shrubs and trees than the dunefields around Olympic Dam, and the

Plate 15.11 Fat-tailed Dunnart *Sminthopsis crassicaudata*

Plate 15.12 Stripe-faced Dunnart *Sminthopsis macroura*

Plate 15.13 Giles Planigale *Planigale gilesi*

Plate 15.14 Plains Rat *Pseudomys australis*

diversity of habitats is lower. The open shrubland and grassland habitats provide habitat for small mammals such as the threatened Dusky Hopping-mouse *Notomys fuscus*.

Reptiles and amphibians

Shrubland and woodland with intact understorey, leaf-litter layers and woody debris provide a diversity of habitat for reptile species. Loose or stabilised sand on dunes is important for burrowing species and some reptiles use the burrows of other animals or cracks in clay soils for shelter. The region supports a relatively high diversity of reptiles (Read and Owens 1999).

Frogs in the region inhabit clay pans, small swamps, waterholes and billabongs associated with temporary streams (Read and Owens 1999). With its unpredictable rainfall and lack of permanent freshwater limiting suitable habitats, the Olympic Dam region has a relatively small diversity of amphibians. One frog species, the Trilling Frog *Neobatrachus centralis* (see Plate 15.15), is well adapted to the arid environment and survives dry conditions by burrowing into the soil. It is relatively abundant in the region (Read 1999).

Three additional species of frog have been recorded on the gas pipeline corridor options. The Red Tree Frog *Litoria rubella* occurs at Clayton Station, and two species of frog found in the Cooper Creek system have been recorded near Moomba: the Green Tree Frog *Litoria caerulea* and the Broad-palmed Frog

Plate 15.15 Trilling Frog *Neobatrachus centralis*

Litoria latopalmata. The latter two species are likely to occur infrequently in the Moomba region when it is inundated by large Cooper Creek floods.

Subterranean fauna

No stygofauna were identified in the samples collected during the baseline survey. This result is consistent with a previous survey for stygofauna at Olympic Dam, when none were detected (Wyatt et al. 2002). Although this study does not preclude the presence of stygofauna at Olympic Dam, their presence is unlikely as the saline, low permeability aquifers in the region may not provide suitable habitat.

15.3.7 LISTED FAUNA

Data collated from the relevant databases and published literature established that 101 fauna species protected under Australian and/or South Australian legislation have been recorded or have geographic ranges that overlap the EIS Study Area (see Appendix N6 for a list of species). Of these, 41 are listed as migratory birds and 78 species are listed as rare or threatened.

The results of detailed field surveys during the past decade, and the habitat assessments conducted for the current study, indicate that 84 of the 101 species have been recorded in the EIS Study Area (Appendices N5 and N6). Twenty-three of these species have the potential to be affected by the proposed expansion and are therefore investigated further in Section 15.5.5.

15.3.8 INTRODUCED FAUNA

Nineteen introduced vertebrate species have been recorded in the EIS Study Area (see Appendix N5).

The main introduced pests are the Red Fox *Vulpes vulpes*, Cat *Felis catus*, House Mouse *Mus musculus* and Rabbit *Oryctolagus cuniculus* (BHP Billiton 2005b). Monitoring by BHP Billiton (BHP Billiton 2005a, 2005b, 2006a) has established that fox numbers have decreased during the past two decades largely due to baiting programs, cat numbers have remained constant and rabbit numbers have decreased dramatically as a result of the introduction of rabbit haemorrhagic disease in 1996.

15.3.9 YARRA WURTA SPRING

Yarra Wurta Spring is one of a complex of springs that is the closest groundwater-dependent ecosystem to Olympic Dam. It is not a Great Artesian Basin (GAB) mound spring. It consists of two highly saline springs (about 1 km apart) on the edge of Lake Torrens in the Lake Torrens National Park (see Plate 15.16). The western spring consists of two vents that feed a pool approximately 50 m long and 3–4 m wide. The eastern spring is about 1 km long.

Plate 15.16 Yarra Wurta Spring with samphire *Halosarcia halocnemoides* shrubland

Vegetation

Within the pool, layered, mat-like algal structures are present above the mud. Vascular plants occur on damp soils approximately 0.5 m above the surface water level of the spring vents and pool, with an open shrub layer dominated by samphire *Halosarcia halocnemoides longispicata* occurring on the sandy surrounds.

Within the drainage line surrounding the spring and continuing for about 40 m north, patches of vegetation appear to be fed by groundwater (see Plate 15.16). They consist of a low shrubland of *Lawrencia squamata*, *Frankenia foliosa*, *Maireana cannonii* and *Halosarcia halocnemoides longispicata*.

No flora or plant associations of conservation significance were recorded at the spring or surrounding areas. A full list of species occurring at the site is provided in Appendix N8.

Aquatic invertebrates

A community of invertebrates, including the brine shrimp *Parartemia minuta*, the small cladocerans, *Daphniopsis queenslandensis* and *Moina baylyi*, several species of ostracods, chironomids and rotifers have previously been recorded from Yarra Wurta Spring (Williams et al. 1998). Freshwater invertebrates were also identified from several other surveyed springs (see Appendix N8). None of these was found to be rare, threatened or otherwise significant.

Lake Eyre Hardyhead

The main biological feature of Yarra Wurta Spring is that it supports a population of the Lake Eyre Hardyhead *Craterocephalus eyresii* (see Plate 15.17). The spring is one of only several known refuge habitats for the Lake Eyre Hardyhead in the Lake Torrens catchment (see Figure 15.5 for catchment boundaries and Lake Eyre Hardyhead records). The other known populations occur in the groundwater-fed refuge waterholes in Willochra Creek in the Flinders Ranges, the southern end of Lake Torrens (Wagner and Unmack 2000; DWLBC 2003b), and more recently along the western side of Lake Torrens on Bosworth Station (J Rowntree, Coffey Natural Systems, pers. comm., 9 July 2008).

Plate 15.17 Lake Eyre Hardyhead *Craterocephalus eyresii*

An assessment of 45 springs in and surrounding Lake Torrens failed to detect additional populations of the species, despite historical records of their presence (see Figure 15.5 and Appendix N8).

Genetic analysis of several Lake Eyre Hardyheads sampled from Yarra Wurta Spring established that they are the same species as the populations of Lake Eyre Hardyheads occurring widely in the Lake Eyre Basin (see Appendix N8) (Wagner and Unmack 2000; DWLBC 2003b). Genetic analysis was able to differentiate between the Yarra Wurta Hardyhead and populations sampled from Lake Eyre South and the Willochra Creek catchment. However, it did not identify the Yarra Wurta population as a genetically different species or subspecies from the other two populations (see Appendix N8 for details).

The Lake Eyre Hardyhead is unlikely to be an important food resource for birds during flooding in Lake Torrens because its density is low compared with the highly abundant brine shrimp. Furthermore, a study of the waterbirds in Lake Torrens established that during floods the avifauna is dominated by species that feed on brine shrimp (e.g. Banded Stilts and Red-necked Avocets), rather than fish (e.g. terns, Hoary-headed Grebes and cormorants) (Bellchambers and Carpenter 1990).

Stromatolites

The microbial mats and rock formations in Yarra Wurta Spring were found to be precursors of stromatolites, and fossilised stromatolites, respectively (see Plate 15.18). The algal mats and fossilised stromatolites were considered to be similar to those occurring in springs throughout the world and therefore of only minor scientific interest (Professor M Walter, Australian Centre for Astrobiology, Macquarie University, pers. comm., 1 June 2006) (see Appendix N8 for details).

15.3.10 ARID RECOVERY

Established in 1997, Arid Recovery is an ecosystem restoration initiative within, and immediately north of, the Olympic Dam SML. It is a partnership between BHP Billiton, the community group Friends of Arid Recovery, the South Australian DEH and the University of Adelaide. The program is based around an 86 km^2 (8,600 ha) fenced reserve, with 60 km^2 free of foxes, rabbits and cats. It is the largest fully fenced enclosure in Australia that is completely free of cats, rabbits and foxes. The unique design of the boundary fence (see Plate 15.19) prevents

Plate 15.18 Fossilised stromatolites in Yarra Wurta Spring

Plate 15.19 Arid Recovery rabbit, cat and fox-proof fence

Figure 15.5 Spring locations in the context of surface water regions

the re-entry of feral animals into the reserve. Facilities within Arid Recovery include a hide, viewing platform, accommodation and field laboratory (see Plates 15.20 and 15.21).

Plate 15.20 Hide to view fauna within Arid Recovery

Plate 15.21 Viewing platform within Arid Recovery

Most of Arid Recovery is within a number of pastoral leases, although the southern section (7 km^2) was purposefully located within the SML to provide an opportunity to monitor interactions between threatened species and a large scale mining operation (see Figure 15.3).

The aim of Arid Recovery is to facilitate the restoration of arid zone ecosystems through survey, education, applied research and partnerships between industry, government, academia and the community. Arid Recovery also conducts extensive monitoring and environmental research in the mining and pastoral leases surrounding the reserve. The program has reintroduced locally extinct native fauna within the fenced area, including the threatened Greater Stick-nest Rat *Leporillus conditor* (see Plate 15.22), Burrowing Bettong *Bettongia lesueur* (see Plate 15.23), Greater Bilby *Macrotis lagotis* (see Plate 15.24), Western Barred Bandicoot *Perameles bougainville* (see Plate 15.25), and the Numbat *Myrmecobius fasciatus* (see Plate 15.26). The first four species are breeding and have been successfully established in the Arid Recovery reserve. The Woma Python *Aspidites ramsayi* was introduced in 2008. Native fauna that have naturally re-established within the fenced area are the Spinifex Hopping Mouse *Notomys alexis* (see Plate 15.27)

Plate 15.22 Greater Stick-nest Rat *Leporillus conditor*

Plate 15.23 Burrowing Bettong *Bettongia lesueur*

Plate 15.24 Greater Bilby *Macrotis lagotis*

Plate 15.25 Western Barred Bandicoot *Perameles bougainville*

and Plains Rat *Pseudomys australis* (see Plate 15.4). The abundance of existing native mammals within Arid Recovery has also increased up to six times for some species.

Plate 15.26 Numbat *Myrmecobius fasciatus*

Plate 15.27 Spinifex Hopping-mouse *Notomys alexis*

Ultimately, the goal of Arid Recovery is to re-establish threatened fauna in the region without the need for fences to exclude feral predators. As such, a research program was initiated in 2004 to investigate the viability of introducing bilbies to an area outside the reserve, with varying results. In 2008 the program was extended with the release of the Burrowing Bettong outside the fence.

BHP Billiton is committed to the continued support of Arid Recovery through:

- ongoing financial support
- maintaining a distance of 500 m between the toe of the RSF and Arid Recovery
- scientific, managerial and professional support.

15.4 DESIGN MODIFICATIONS TO PROTECT ENVIRONMENTAL VALUES

15.4.1 ENVIRONMENTAL VALUES

The flora, fauna and terrestrial ecosystems of the EIS Study Area and their biodiversity, tourism and recreational values have been described in Section 15.3. The main values include:

- local and regional biodiversity, including listed flora and fauna
- extensive areas of intact native vegetation and high quality habitat
- Yarra Wurta Spring and associated communities
- Arid Recovery and associated threatened fauna
- eco-tourism and recreation opportunities associated with Arid Recovery and desert wilderness areas.

15.4.2 MAJOR ELEMENTS OF THE PROJECT DESIGN

The location of project infrastructure and modifying designs to minimise disturbance footprints provided the greatest opportunity to minimise the potential impacts on terrestrial ecology. This has been achieved by:

- maintaining a distance of 500 m between Arid Recovery and the toe of the RSF outer slopes to avoid direct impacts and minimise indirect impacts
- locating the water supply pipeline, transmission line, gas supply pipeline and rail line adjacent to existing corridors to reduce habitat fragmentation and edge effects
- increasing the target design height of cells of the new TSF from the current 30 m to 65 m, thereby reducing the disturbance footprint
- adopting a 5 m wide clearance corridor for the transmission line (in addition to 100 square metre tower footprints), rather than a 20–30 m wide corridor, and therefore minimising the disturbance footprint.

TSF design is the main infrastructure component where modifications to the existing water balance have been included to reduce the area of free tailings liquor accessible to fauna and increase protection of wildlife. The design modifications are to:

- reduce the volume of liquor stored in the TSF by modifying the design of the expanded metallurgical plant to increase liquor recycled back into the plant
- avoid any new areas of open liquor by:
  - not building additional evaporation ponds
  - increasing the rate of liquor loss via evaporation by constructing larger TSF cells
  - restricting access by fauna to free liquor by collecting supernatant liquor that has not evaporated from beaches in a central decant area, and covering the decant pond with netting (or similar)
  - restricting access by fauna to free liquor by covering the 60 ha stormwater/tailings water balance ponds with netting (or similar).

In addition to the above measures, the expansion provides an opportunity to improve the management of existing tailings liquor. Depending on the water balance, there may be capacity within the expanded TSF to recycle free liquor from the existing evaporation ponds and tailings cells over the larger beaches of the new TSF cells, which may substantially reduce or even eliminate the area of free liquor currently accessible to birds.

Additional flora and fauna mitigation measures and standard controls to avoid or minimise impacts are described in Section 15.5.

Offsets would be used to compensate for residual impacts associated with the proposed expansion. The objective of the offsets would be to:

- compensate for vegetation clearance by setting aside an adequate area of land for conservation purposes, or by making a payment to the Native Vegetation Fund (consistent with the Native Vegetation Council formula), such that an SEB is provided
- ensure that land set aside to compensate for vegetation clearance provides successful and long lasting benefits to the environment by providing offsets in a timely manner and including provisions in the SEB for the long-term security and management of the land set aside
- initiate or fund suitable projects to compensate for specific residual impacts, such that an SEB is provided.

15.5 IMPACT ASSESSMENT AND MANAGEMENT

The following sections present the assessment of impacts on terrestrial flora and fauna associated with the proposed expansion, taking into account project design modifications applied to reduce impacts. No impacts on flora or fauna are expected at the Port of Darwin as the development would occur on previously disturbed or reclaimed land.

15.5.1 VEGETATION CLEARANCE

Table 15.4 and Figure 15.6 show the estimated areas to be cleared of vegetation for each major component of the proposed expansion for the construction period (up to Year 10) and at Year 20 and Year 40 of the operation phase.

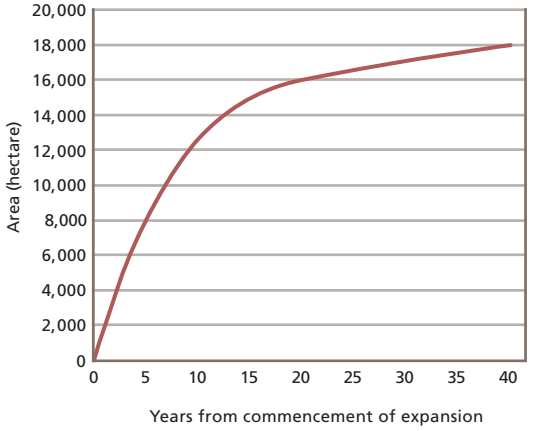

Figure 15.6 Cumulative vegetation clearance

Table 15.4 Predicted vegetation clearance associated with each project component

Project site	Cumulative total (ha)		
	Predicted construction period (Year 10)	Year 20	Total vegetation cleared (Year 40)
Open pit and perimeter	173.0	264.0	1009.5
RSF and haul roads	4791.0	6443.0	6721.4
TSF	2467.0	4399.6	4399.6
Metallurgical plant and associated facilities	977.7	977.7	977.7
Roxby Downs and heavy industrial estate	515.0	515.0	515.0
Hiltaba Village and airport	160.1	160.1	160.1
Rail (30 m) and intermodal facility	443.9	443.9	443.9
Gas pipeline and facilities (30 m)	1,342.2–1,684.7[1]	1,342.2–1,684.7	1,342.2–1,684.7
Water pipeline (30 m)	992.9	992.9	992.9
Electrical transmission line and substation (5 m)	166.5	166.5	166.5
Access corridor (60 m), landing facility (land component) and Port Augusta pre-assembly yard	73.2	73.2	73.2
Desalination plant and associated facilities	28.7	28.7	28.7
Marine facilities (landing pier and intake/outfall pipelines)	2.7	2.7	2.7
Borefield Road (60 m)	41.4	41.4	41.4
Passing bays and borrow pits	32.0	32.0	32.0
Miscellaneous (e.g. mobile camps, rest areas and ancillary infrastructure)	20.0	20.0	20.0
Total	**12,227–12,570**	**15,902–16,246**	**16,926–17,269[1]**

[1] Range reflects the shortest and longest alternative gas pipeline routes; totals include clearance within three NRM regions.

The proposed expansion would result in the clearance of 16,926–17,269 ha of native vegetation, depending on the gas pipeline route chosen. About 1,000 ha of the EIS Study Area does not currently support native vegetation as the areas have already been cleared or support salt lakes and are therefore naturally devoid of vegetation. The greatest clearance of vegetation would result from construction of the RSF, TSF and open pit (12,131 ha or about 70%).

The effect of emissions on vegetation is likely to be relatively minor because the areas at greatest potential risk from dust and sulphur dioxide would already have been cleared extensively of vegetation during construction of the open pit, RSF, TSF and metallurgical facilities (13,108 ha). Although dust emissions may have some adverse effects on vegetation around the outer edge of the RSF during dumping of mine rock, the effects are likely to be relatively minor and have not been included as vegetation clearance.

Clearance of vegetation would be required in 21 of the 24 vegetation associations identified in the EIS Study Area and in three seagrass communities (see Figures 15.3, 15.4a, 15.4b and Table 15.5). The area of each association within the EIS Study Area was also calculated to provide an indication of the local percentage loss of each vegetation association (Table 15.5) (see Appendix N9).

The vegetation associations in which clearing would occur are widespread in South Australia. The proposed percentage loss of each association within the EIS Study Area (totalling about 1.3%) would result in no change to their conservation status.

No clearance of vegetation would be required outside South Australia as the facilities at the Port of Darwin occur on previously cleared or reclaimed land.

Table 15.5 Predicted vegetation clearance for each vegetation association

Vegetation associations	Area (ha)	Area of association within EIS Study Area (ha)	Percentage (%)
Acacia aneura woodland (1–4)	319.4	70,235.7	0.5
Acacia papyrocarpa woodland (9, 10, 63)	438.7	96,213.5	0.5
Acacia shrubland (5–7, 11–15, 40, 77)	8142.9	144,586.0	5.6
Astrebla pectinata grassland (70)	0.3	30.0	1.0
Avicennia marina forest (31)	408.4	152,764.2	0.3
Amphibolis antarctica	0.1	856.0	0.0
Beyeria lechenaultii/Westringia rigida low shrubland (32)	0.0	30.3	0.0
Callitris glaucophylla woodland (33–34)	671.1	26,010.0	2.6
Casuarina pauper woodland (36–37)	7.5	10,521.8	0.1
Chenopod shrubland (17–30, 38, 42, 50–59, 72)	5997.2	422,688.9	1.4
Clay pan – ephemerals (39)	209.8	15,987.2	1.3
Cyperus spp. low sedgeland (71)	0.0	322.6	0.0
Eragrotis australasica grassland (41)	58.4	4,787.7	1.2
Eucalypt woodland (43–45, 76)	105.7	33,378.2	0.3
Geijera linearifolia, shrubland – *Casuarina pauper* woodland (46)	5.1	199.1	2.6
Maireana aphylla shrubland (49)	40.2	14,297.7	0.3
Melaleuca shrubland (60)	0.0	234.7	0.0
Melaleuca xerophila woodland (61)	0.9	371.4	0.2
Muehlenbeckia florulenta +/– *Maireana aphylla* shrubland (62)	7.8	4,783.9	0.2
Myoporum platycarpum woodland (64)	2.6	352.2	0.7
Nitraria billardieri open shrubland (73)	232.0	79,070.3	0.3
Olearia axillaris/Scaevola crassifolia shrubland (65)	1.7	84.1	2.0
Posidonia spp.	2.4	1,250.0	0.2
Samphire shrubland (48, 74)	18.2	8,425.4	0.2
Sclerolaena spp. low shrubland (66–68, 78)	443.8	65,877.7	0.7
Senna shrubland (69)	1.1	1,505.8	0.1
Zostera spp.	0.3	25.0	1.2
Zygochloa paradoxa grassland (75)	134.2	203,854.0	0.1
Total	**17,249**[1]	**1,358,743**	**1.3**

[1] Total does not include miscellaneous clearance of 20 ha from Table 15.4 (vegetation types are unknown) or previously cleared areas; assumes longest gas pipeline route.

Measures to address vegetation clearance in South Australia focus on SEB offsets. These include setting aside an area for conservation in the same Natural Resource Management (NRM) region as the vegetation loss, or making a suitable payment to the Native Vegetation Fund (calculated using a formula provided by the Native Vegetation Council) (Appendix N9).

The areas in which clearing is proposed are in the Arid Lands, Eyre Peninsula, and Northern and Yorke NRM regions. The components of the Native Vegetation Management Plan for the proposed Olympic Dam expansion would be (see Appendix N9 for details):

- sections of the cleared infrastructure corridors where revegetation would occur within a reasonable timeframe would require a smaller SEB than permanently cleared areas
- within the South Australian Arid Lands NRM region (where BHP Billiton leases pastoral land), the proposed clearance of 17,002 ha of vegetation (assuming the longest gas pipeline option) would require 126,650 ha to be set aside for conservation. This is almost eight times the area proposed for clearance, as required under the Native Vegetation Act (see Appendix N9 for details). BHP Billiton proposes to set side the required land area on its pastoral lands in the South Australian Arid Lands NRM region for creation of an SEB. The method of ensuring adequate ongoing management of the set aside lands would be negotiated with the South Australian Government. The potential sites for these set asides are shown in Appendix N9 (Figure N9.3)
- in the Northern and Yorke NRM region (where BHP Billiton does not own land), the proposed clearance of 165 ha would require an SEB offset area of 1,042 ha
- in the Eyre Peninsula NRM region (where BHP Billiton does not own land), the proposed clearance of 100 ha would require an SEB offset area of 586 ha
- to offset clearance in the Northern and Yorke and Eyre Peninsula NRM regions, BHP Billiton would use the services of a third party to facilitate the achievement of the SEB(s) in compliance with the Native Vegetation Act. The SEB set aside(s) would occur in the Northern and Yorke and Eyre Peninsula NRM regions, or in an equivalent region, as agreed with the Native Vegetation Council and other stakeholders
- to offset the loss of 3 ha of seagrass in Spencer Gulf, BHP Billiton would make an SEB payment of $3,900 into the Native Vegetation Fund.

The initial vegetation clearance is categorised as having a moderate residual impact, reflecting a long-term impact on a common receiver. Implementing the vegetation clearance offset strategy, however, would create a moderate residual benefit as it would represent a long-term local benefit.

15.5.2 HABITAT FRAGMENTATION

Removing native vegetation can fragment habitats, introduce weeds along the disturbed area (and therefore introduce edge effects), and pose a barrier to the movement of fauna. Habitat fragmentation is a relatively minor issue in the context of the proposed expansion because the vegetation of the EIS Study Area is typically sparse (see Plates 15.1 to 15.10). Furthermore, linear infrastructure corridors would be located adjacent to existing linear infrastructure, and this would minimise habitat fragmentation.

Fragmentation may occur during construction as movements of small animals could be interrupted until infrastructure easements are rehabilitated and groundcover vegetation is re-established. The impact would therefore only be short-term.

The rail corridor is the only linear infrastructure that could create an ongoing impediment to the movement of small mammals and reptiles. The residual impact during the operation phase of the infrastructure corridors is considered to be negligible.

The construction of the open pit, the RSF and the TSF could fragment some habitats at Olympic Dam. In view of the large expanse of similar habitat in the local area, however, the residual impact would be low because fauna would quickly adjust to the habitat disruption (see Table 15.5 and Appendix N9). The impact on habitat value would be off set by the set-aside proposals described above and in Appendix N9.

15.5.3 EFFECTS ON LISTED ECOLOGICAL COMMUNITIES

One endangered ecological community, listed in South Australia (Neagle 2003) and under the Australian Government EPBC Act, has been recorded in the EIS Study Area. The community of native species dependent on natural discharge of groundwater from the GAB is present on the northern edge of the gas pipeline corridor option where it traverses the Reedy Springs GAB springs complex on Murnpeowie Station. There would be no impact on this community as the GAB springs and the vegetation they support would be avoided by the pipeline and any ancillary infrastructure (e.g. construction camps, pipe stacking sites, mainline valves), most likely by a distance of several kilometres. Furthermore, no water would be extracted from GAB springs or groundwater wells within 20 km of the springs during gas pipeline construction.

Although threatened ecological communities are not presently listed under South Australian legislation, Mulga *Acacia aneura* low woodlands on sandplains are considered to be potentially vulnerable (i.e. are provisionally listed) (Neagle 2003). The location and extent of this community are shown in Figures 15.3, 15.4a and 15.4b. The proposed expansion would require the clearing of 334 ha of Mulga low woodland, which represents less than 1% of the community that occurs in the EIS Study Area (see Table 15.5). The residual impact is considered to be low because:

- Mulga low woodland is relatively common throughout many areas of northern South Australia (70,236 ha occur in the EIS Study Area)
- threats to this association are mainly due to grazing of immature trees rather than widespread clearing (Neagle 2003)

- the proposed clearance of some of the vegetation association would have very little if any effect on the conservation status of the association in South Australia.

The impact on Mulga woodland may be offset to some degree by the presence of Mulga woodland in several of the areas being considered as SEB set-aside areas (e.g. McCormack Reserve, and Kookaburra and Wimbrina East paddocks).

15.5.4 EFFECTS ON LISTED FLORA

Of the 34 rare or threatened plant species occurring or having suitable habitat in the EIS Study Area, the screening process (see Appendix N6) has identified that 11 species could be affected by the proposed expansion (see Table 15.6). The locations of each species and/or their preferred habitats in the project area are shown in Appendix N1, Figures N1.3, N1.4 a-f and N1.6 a-n. Management measures to detect and avoid potential impacts on threatened flora, including species that have not yet been detected, include:

- further field surveys to confirm the presence/absence of listed threatened species in the disturbance footprints of the linear infrastructure when the alignment has been finalised. The surveys would target those vegetation types that are likely to support listed threatened species. For example, pre-construction surveys searching for Sandalwood would occur in areas within corridors that are proposed for disturbance and that support *Acacia papyrocarpa* woodland
- where possible infrastructure alignments would be adjusted to avoid areas that contain listed threatened plants
- before disturbance, areas found to contain listed threatened plants and close to disturbance works would be marked as no-go areas on construction design drawings and in the field with flagging tape and/or hazard fencing.

BHP Billiton currently implements a monitoring program for listed threatened species. The program aligns with the EPBC Act and the *National Parks and Wildlife Act 1972* (NPW) by adopting the at-risk classifications:

- populations of Category 1 species are critically reliant on habitats that occur in areas affected by the Olympic Dam operation
- populations of Category 2 species are partially reliant on habitats that occur in areas affected by the Olympic Dam operation.

The monitoring program currently includes only Category 1 plant species (i.e. Pipe Wort *Eriocaulon carsonii* associated with GAB mound springs). The proposed expansion would not require any additional species to be added to Category 1. Four state-listed threatened flora species, *Santalum spicatum*, *Gilesia biniflora*, *Ophioglossum polyphyllum* and *Atriplex kochiana*, occur in or near the SML and are included as Category 2 species. The expansion would require the addition of the Desert Lime *Citrus glauca* to the monitoring program as a Category 2 species.

With the implementation of pre-construction botanical surveys and management actions, the residual impact on listed flora is considered to be negligible (see Table 15.6).

15.5.5 EFFECTS ON LISTED FAUNA

One hundred and one species of rare, threatened or listed migratory fauna have geographic ranges that overlap the EIS Study Area (Appendix N6). Of these, 18 listed rare or threatened species and five listed migratory bird species may be affected by the proposed expansion (based on the screening process outlined in Appendix N6) and are therefore discussed further in Table 15.7 and below. Known locations of some of these species and their potential distribution within the EIS Study Area are shown in Appendix N1, Figures N1.3, N1.4 a-f and N1.6 a-n.

The effects on fauna (other than Arid Recovery fauna) categorised as having a negligible to moderate level of residual impact (as defined in Table 1.3 of Chapter 1, Introduction) are discussed below. Effects on fauna that have been reintroduced to Arid Recovery are discussed in Section 15.5.10. Effects on listed migratory birds resulting from the expanded TSF are discussed in Section 15.5.7. There is considered to be no credible risk to marine/water/migratory birds from the desalination plant.

Ampurta – *Dasycercus hillieri*

The Ampurta is a small mammal that occurs in sand dune habitats in the southern half of the Simpson Desert, the northern Tirari Desert and the western edge of the Strzelecki Desert. It has been recorded both east and west of Lake Eyre (Southgate 2006). A recent evaluation of the species' conservation status in South Australia by DEH has led to its removal from the South Australian listings of rare or threatened species. Its national rating, however, has not yet changed from Endangered.

It is possible that the Ampurta occurs in the Strzelecki Desert dunefields on the gas pipeline corridor option (on corridor option 1 that proceeds directly from Moomba to Olympic Dam). The Ampurta has been recorded 3.5 km north of gas pipeline corridor option 1, although this represents the current southern-most record of the species. Searches for Ampurta tracks further to the south did not detect the species (Southgate 2006).

Construction of the gas supply pipeline would have a localised and short-term impact on the Ampurta if it was present. Individual animals may be affected by vegetation removal, earthworks or temporary entrapment in the open pipeline trench, but it is unlikely that there would be significant effects at a population level. Mitigation measures outlined in Section 15.5.11 would ensure that Ampurta mortality from trench entrapment was very low. The proposed expansion would affect less than 1% of available Ampurta habitat within the EIS Study Area.

The residual impact on the Ampurta would be low.

Table 15.6 Residual impact on listed flora

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact[2]
		Aus	SA				
Atriplex kochiana	Koch's Saltbush		V	A small, short-lived perennial to 40 cm tall. It occurs on gibber slopes with other chenopod shrubs in northern regions of the state and has been reported in *Atriplex vesicaria/Sclerostegia* sp. low shrubland While no records are known from the proposed disturbance footprint, individuals of the species have been previously collected from Arid Recovery and the Arcoona Plateau, and therefore the species may occur in the SML, Roxby Downs Municipality and the northern sections of the southern infrastructure corridors	Clearance for open pit, RSF, TSF and other infrastructure around the SML Dust and other emissions from the mine	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Citrus glauca	Desert Lime		V	Shrub to small tree that suckers prolifically forming dense groves, usually restricted to heavy brown clays, desert loams or red earths. Native to Queensland and New South Wales, with some isolated occurrences in central South Australia where it is common in the southern Flinders Ranges and surrounding areas from Mambray Creek in the south to 50 km south-east of Olympic Dam in the north. Four SA Herbarium records are within the southern infrastructure corridor 10–20 km north of Port Augusta	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Eleocharis papillosa	Dwarf Desert Spike-rush	V	R	Small, erect, perennial sedge, grows to less than 10 cm high. All records are from temporary wetlands; predominantly freshwater and semi-saline swamps with one record from the edge of a temporary riverine waterhole. Known from eight remote locations in Northern Territory, from the northern Tanami Desert to the Finke Bioregion and Simpson Desert. Recorded within gas pipeline corridor at two locations on Frome Creek and another minor drainage line feeding into Lake Eyre South, both more than 2 km north of corridor centreline	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Frankenia plicata		E	V	Low, mat-forming perennial shrub on lower slopes of hills and in small run-off channels. All confirmed records of this species are from the Breakaways. The 2003 review of threatened species in South Australia recommended that this species was sufficiently common so as to not warrant a conservation rating. A more recent DEH SPRAT assessment found that this judgement was based on incorrect and unvouchered records and it was considered that a new state rating of vulnerable may be more appropriate There is one unvouchered record in the gas pipeline corridor near the Reedy Springs complex on Murnpeowie Station	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Frankenia subteres			R	Small perennial shrub. South Australian distribution is mainly in the northern Flinders Ranges, with very few records further north in the Lake Eyre botanical region. There is one vouchered record in the gas pipeline corridor on Murnpeowie Station in open gibber/gilgai undulating plains.	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Gilesia biniflora	Western Tar-vine		R	Prostrate perennial herb that occurs in run-on areas in swamps or interdune corridors. Located mainly in the northern regions of the state. Two vouchered records exist in the gas pipeline corridor options in open, undulating chenopod shrublands	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible

Table 15.6 Residual impact on listed flora (cont'd)

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact[2]
		Aus	SA				
Malacocera gracilis	Slender Soft-horns		V	Annual or short-lived perennial herb that occurs on saline clay soils or on gypseous mounds. It has been collected from the transmission line corridor 6 km north-east of the Davenport Substation. It is located in Eyre Peninsula and Eastern botanic regions. There is a herbarium record from Port Augusta and many records on the eastern side of Spencer Gulf (Red Cliffs, Winninowie). The other Eyre Peninsula record is well to the east of the EIS Study Area	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Ophioglossum polyphyllum	Large Adder's-tongue		R	Perennial rhizomatous fern with large, leathery leaves. Has been collected from swales in mulga woodland and also from tussock grassland on gibber plains of the Gairdner–Torrens, North-Western, Lake Eyre and Eastern botanic regions. There are several herbarium records from the Lake Windabout area. Records of this species from the SML and Municipality of Roxby Downs (Kinhill 1997) are not supported by herbarium records, although an *Ophioglossum* sp. was definitely present in this area in 1989	Clearance for open pit, RSF, TSR and other infrastructure Dust and other emissions from the mine	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Orobanche cernua var. australiana	Australian Broomrape		R	Brown parasitic herb 15–45 cm high. Grows in dry sandy creek beds. Parasitic on native *Senecio* spp., including *S. cunninghamii*, but data on host range are poor. Spread over a large number of coastal and inland environments from the West Coast to Riverland and north to Lake Eyre. There are two vouchered specimens from Motecollina Bore in the gas pipeline corridor options	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Santalum spicatum	Sandalwood		V	Shrub or small tree in woodland or shrubland that is a root parasite of other plants. It is highly valued for its fragrant oil that is used to produce perfume and incense. It was recorded from the transmission line corridor from about kp 140–173 More than 20 scattered mature plants were recorded during the present assessment in *Acacia papyrocarpa* woodland. There are also old records for the Lincoln Gap area. The species is also known to occur in the Whyalla Conservation Park and on rocky slopes in the Department of Defence's Cultana Training Area (CTA). Located throughout the arid to semi-arid zone of South Australia, north to about the Dog Fence north of Olympic Dam, further north in the Great Victoria Desert, but not in the Far North of the state	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible
Zygophyllum crassissimum	Thick Twinleaf		R	Fleshy perennial shrub to 60 cm high with ascending spreading branches. Distributed in the Lake Eyre, North West and Gairdner–Torrens botanical regions of South Australia, and southern Northern Territory. Located mainly north and west of the project area. There is one vouchered record from 1957 in the gas pipeline corridor options at Montecollina Bore	Corridor clearance	Survey disturbance footprint, attempt to identify, mark and avoid plant(s)	Negligible

[1] Status: R = rare; V = vulnerable; E = endangered.
[2] See Chapter 1, Introduction, Table 1.3 for the description of residual impact criteria.

Table 15.7 Residual impact on listed fauna

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact
		Aus	SA				
Mammals							
Dasycercus hillieri	Ampurta	E		Occurs in the southern half of the Simpson Desert, including parts of South Australia, Northern Territory and Queensland, plus the northern Tirari Desert and western edge of the Strzelecki Desert in South Australia. Recorded both east and west of Lake Eyre (Southgate 2006). The gas pipeline corridor options pass within 3.5 km of most southerly records of this species (at the southern end of Lake Eyre), but it was not recorded by Southgate (2006) at Ampurta survey sites in the corridor Inhabits sand dunes with *Zygochloa paradoxa* and areas around salt lakes with *Nitaria billardieri*. Diet comprises mainly invertebrates, supplemented with small reptiles and rodents	Corridor clearance Open gas supply pipeline trench	Trench management plan	Low
Notomys fuscus	Dusky Hopping-mouse, Wilkiniti	V	V	Recorded in the gas pipeline corridor options 100–160 km south of Moomba, near Montecollina Bore. Known from scattered records in south-western Queensland, the south-eastern Strzelecki Desert (predominantly south and east of Strzelecki Creek), with recent records from Waraninna Creek and Mulka and Etadunna stations, on the western edge of the Strzelecki Desert and Quinyambie pastoral lease, east of Lake Frome Inhabits dune and sand plain systems. Diet consists of seeds, green plants (when available) and occasionally insects	Corridor clearance		Low
Pseudomys australis	Plains Rat	V	V	Recorded in SML, Arid Recovery, Arcoona tableland and gas pipeline corridor options near Lake Eyre South Widespread in western Lake Eyre Basin from Northern Territory border to Lake Eyre South, gibber tableland west of Lake Torrens, (Arcoona plateau) Inhabits low lying patches of deep cracking clay common on gibber plains and gentle slopes supporting sparse chenopod shrubland and other ephemeral vegetation that appears after rain. Feeds on seeds, leaves (particularly of chenopods) and insects. Research within Arid Recovery has found that the Plains Rat uses a variety of habitat including dunes	Clearance for open pit, RSF, TRS, Hiltaba Village, airport and other infrastructure Noise, dust and other emissions from the mine Open trench	Recent extension to Arid Recovery SEB offsets SEB offsets Trench management plan	Moderate

Table 15.7 Residual impact on listed fauna (cont'd)

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact
		Aus	SA				
Bettongia lesueur lesueur	Boodie Burrowing Bettong	V	E	Species reintroduced into Arid Recovery in 1999 and surrounding pastoral properties in 2008. Only macropod to inhabit burrows regularly. Diet consists mainly of tubers, bulbs, seeds, and the green (succulent) parts of some plants	Noise, dust and other emissions from the mine	Recent extension to Arid Recovery	Moderate
Leporillus conditor	Wopilkara, Greater Stick-nest Rat	V	V	Species reintroduced to Arid Recovery in 1998 Although there are no records of the species in the Gawler Bioregion, it is believed to have once been part of the extensive range of the species Nests located at Coorlay Lagoon on southern infrastructure corridor and on the gas pipeline corridor options on Murnpeowie Station Occurs in perennial shrublands of succulent and semi-succulent chenopod species. Inhabits hills, breakaways, escarpments and rocky outcrops. Builds large (1 m × 1.5 m) nests of sticks with an interior nest of soft grass and other vegetation. Diet strictly herbivorous, consisting of the leaves and fruits of succulent plants	Noise, dust and other emissions from the mine Open trench	Recent extension to Arid Recovery Trench management plan	Moderate
Macrotis lagotis	Bilby	V	V	Species reintroduced to Arid Recovery in 2000 and has been recorded breeding outside of the reserve on the SML and surrounding pastoral properties Inhabits shrubland, hummock grasslands, forblands and open woodlands in semi-arid areas. Forages on insects, seeds, tubers, fruits and green (succulent) plant material	Noise, dust and other emissions from the mine Open trench	Recent extension to Arid Recovery Trench management	Moderate
Myrmecobius fasciatus	Numbat	V	E	Species reintroduced to Arid Recovery in 2005. A number of released animals were taken by predators following their release. By January 2008 only one male was known to remain	Noise, dust and other emissions from the mine	Recent extension to Arid Recovery	Moderate
Perameles bougainville	Western Barred Bandicoot	E	E	Species reintroduced to Arid Recovery in 2001 Formerly inhabited *Atriplex* spp. and *Maireana* spp. plains in South Australia Forages for insects and other small animals, seeds, roots, tubers and green (succulent) plant material	Noise, dust and other emissions from the mine	Recent extension to Arid Recovery	Moderate

Table 15.7 Residual impact on listed fauna (cont'd)

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact
		Aus	SA				
Reptiles							
Aspidites ramsayi	Woma		R	Occurs in arid areas of central Australia. Attempts made to reintroduce the Woma to Arid Recovery in 2008 (unsuccessful at the time of writing). Sparse records on the gas pipeline corridor options north of the SML and near Moomba Inhabits dunefields and sandy plains with a variety of vegetation. Shelters in animal burrows, or under dense bushes or hummock grasses	Open trench	Trench management plan	Negligible
Morelia spilota imbricata	Carpet Python		R	Found on the Eyre Peninsula between Port Augusta and Ceduna One South Australian Museum record from 1950 near proposed desalination plant Occurs in mallee scrub areas that receive run-off water from nearby outcrops or rocky hills. Extensively found in rock outcrops, ravines, escarpments, rivers, creeks and floodplains lined with Red Gum. Shelters in hollows or deep rock and soil crevices, in large rock piles, in leaf litter or in rabbit warrens	Open trench	Trench management plan	Negligible
Nephrurus deleani	Pernatty Knob-tailed Gecko	V	R	Restricted to pastoral leases in the vicinity of Pernatty Lagoon and Lake MacFarlane, intersected by southern infrastructure corridor Inhabits crests and slopes of red dunes and nearby sandy swales and rises. Also on whitish lunette dunes associated with salt lakes and nearby flats. Dominant plants may include *Acacia* spp., *Alectryon oleifolius*, *Duboisia hopwoodii*, *Dodonaea viscosa* and *Zygochloa paradoxa*. Feeds on medium sized insects, spiders and scorpions	Open trench Corridor clearance	Trench management plan	Low
Vermicella annulata	Common Bandy-Bandy		R	Distributed mainly in northern Western Australia and throughout most other mainland states expect south-eastern Australia One South Australian Museum record from 1950 near Port Augusta Nocturnal burrowing snake found in wide range of habitats including mallee and mulga woodland, acacia scrub and spinifex-covered sandhills	Open trench	Trench management plan	Negligible
Bush Birds							
Amytornis textilis modestus	Thick-billed Grasswren (Eastern sub-species)	V		Recently recorded just north of Arid Recovery (J Read, pers. comm., 1 Feb 2008). Preferred habitat occurs in chenopod shrublands dominated by *Atriplex* spp. and *Maireana* spp. to the east of the expanded SML and near Andamooka. Surveys within the preferred habitat to the east of the expanded SML and along the alignment of the proposed relocation of Borefield Road did not detect the species. Recorded in the gas pipeline corridor options on Murnpeowie Station near Montecollina Bore. Sedentary, ground dwelling species	Corridor clearance Noise, dust and other emissions from the mine	SEB offsets	Negligible

Table 15.7 Residual impact on listed fauna (cont'd)

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact
		Aus	SA				
Migratory/Water/Marine Birds							
Actitis hypoleucos	Common Sandpiper	Mi, CJB, Ma	R	Recorded in SML, southern infrastructure corridor and desalination plant area Inhabits coastal and inland wetlands. Breeds in Eurasia and migrates to Australia Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells	TRS	Cover open water with netting or similar (see Section 15.5.7)	High[2]
Ardea alba	Great Egret	Mi, CJ, Ma		Recorded in SML, southern infrastructure corridor and gas pipeline corridor options. Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells Found in most of the tropical and warmer temperate parts of the world Prefers shores of lakes, ponds, and rivers; freshwater and saltwater marshes, mudflats, shallow lagoons, estuaries. Requires trees or shrubs near the water for nesting	TRS	Cover open water with netting or similar (see Section 15.5.7)	Moderate[2]
					Collision with transmission line conductors	Attach markers to conductors near ephemeral lakes	
Biziura lobata	Musk Duck	Ma	R	Recorded in SML, southern infrastructure corridor, desalination plant area and gas pipeline corridor options. Records of being a visitor to TRS and mortality recorded Found only in Australia. Ranges from north-west Western Australia, through the south and east to southern Queensland, and can be found several hundred kilometres inland in some areas. Prefers deep freshwater lagoons, with dense reed beds	TRS	Cover open water with netting or similar (see Section 15.5.7)	Negligible[3]
					Collision with transmission line conductors	Attach markers to conductors near ephemeral lakes	
Calidris acuminata	Sharp-tailed Sandpiper	Mi, CJB, Ma		Recorded in SML, infrastructure corridors and desalination plant area. Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells Breeds in the boggy tundra of North-East Asia and is strongly migratory, wintering in south-east Asia and Australasia	TRS	Cover open water with netting or similar (see Section 15.5.7)	Moderate[2]
Calidris ruficollis	Red-necked Stint	Mi, CJB, Ma		Recorded in SML, corridor and desalination plant area. Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells Forages in wet grassland and soft mud. Widespread in small flocks; likely to be found wintering with flocks of the endemic Wrybill in areas where they are present. Breeds in arctic. Winters in South-East Asia and Australia as far south as Tasmania	TRS	Cover open water with netting or similar (see Section 15.5.7)	Moderate[2]
Cladorhynchus leucocephalus	Banded Stilt		V	Recorded in SML, infrastructure corridors and desalination plant area. Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells Occurs in large flocks, sometimes consisting of tens of thousands of birds. Breeds on islands in inland salt lakes on the rare occasions when they are inundated. Breeding events are sometimes threatened by predation from Silver Gulls	TRS	Cover open water with netting or similar (see Section 15.5.7)	High[2]
					Collision with transmission line conductors	Attach markers to conductors near ephemeral lakes	

Table 15.7 Residual impact on listed fauna (cont'd)

Species name	Common name	Status[1]		Distribution, habitat and biology	Project hazard	Mitigation measures	Residual impact
		Aus	SA				
Oxyura australis	Blue-billed Duck		R	Recorded in SML and gas pipeline corridor options. Records of being a visitor to TRS and mortality recorded Occupies deep permanent water bodies in southern Australia Aggregates in large flocks in autumn and winter, dispersing to smaller water bodies when feeding	TRS	Cover open water with netting or similar (see Section 15.5.7)	Negligible[3]
					Collision with transmission line conductors	Attach markers to conductors near ephemeral lakes	
Pluvialis squatarola	Grey Plover	Mi, CJB, Ma		Recorded in SML, southern infrastructure corridor and desalination plant area. Record of one mortality at the TRS. Likely to utilise beach areas of TSF cells	TRS	Cover open water with netting or similar (see Section 15.5.7)	Moderate[2]
Sterna caspia	Caspian Tern	Mi, C, Ma		Recorded in SML, southern infrastructure corridor and desalination plant area. Records of being a visitor to TRS and mortality recorded. Likely to utilise beach areas of TSF cells Usually nests on ground among debris or sometimes on floating material	TRS	Cover open water with netting or similar (see Section 15.5.7)	Moderate[2]
Stictonetta naevosa	Freckled Duck		V	Recorded in SML, southern infrastructure corridor and gas pipeline corridor options. Wetlands across southern Australia. Records of being a visitor to TRS and mortality recorded	TRS	Cover open water with netting or similar (see Section 15.5.7)	Negligible[3]
					Collision with transmission line conductors	Attach markers to conductors near ephemeral lakes	

[1] Status: R = rare; V = vulnerable; E = endangered; Ex = extinct; Mi = migratory; C = CAMBA; J = JAMBA; B = Bonn; Ma = marine.
[2] Assumes that mortalities would be a long-term occurrence, but the viability or the population size of the species would not be significantly affected.
[3] Assumes that new areas of open water would be covered, and although the increased area of reflective beaches may result in increased visitation, the design measures in which liquor from the existing operation is directed to the new tailings cells would result in significantly less open water habitat being available.

Note: Woolley (2005) has argued that, using taxonomic precedence, the Ampurta *D. hillieri* should be named *D. cristicauda* and referred to as the Crest-tailed Mulgara, and the Mulgara *D. cristicauda* should be named *D. blythi* and referred to as the Brush-tailed Mulgara. The name Ampurta *D. hillieri* has been used in this document to minimise confusion, as it is consistent with the current state and national listings.

Dusky Hopping-mouse – *Notomys fuscus*

The Dusky Hopping-mouse is known to occur in dune and sandplain systems in south-western Queensland and in the Strzelecki Desert. Although many of the post 1990 records are from south and east of Strzelecki Creek, it has also been recorded in the north-eastern Strzelecki Desert, south-east of Moomba and more recently on the western and north-western edge of the Strzelecki Desert on Murnpeowie, Mulka and Etadunna stations.

The distribution and relative abundance of the Dusky Hopping-mouse throughout the Strzelecki Desert is unclear, primarily as a result of the limited accessibility through most of the area. However, recent records suggest that it may occur throughout the Strzelecki Desert.

DEH has undertaken long-term population monitoring at Montecollina Bore, which is within the gas pipeline corridor options approximately 160 km south of Moomba (Moseby et al. 2006). Tracks of the species have been noted on dunes for at least 60 km north of this location (R Brandle, Scientific Officer, DEH, pers. comm., 1 November 2006). Population levels at this site showed marked fluctuations over an eight-year period, suggesting a 'boom and bust' population cycle, with dispersal over a wide area occurring in good conditions. Small areas may become locally extinct during dry conditions and are recolonised from the surrounding large areas of suitable habitat (Moseby et al. 2006).

Construction of the gas supply pipeline would have a localised and short-term impact on the Dusky Hopping-mouse. Individual animals may be affected by vegetation removal, earthworks or temporary entrapment in the open pipeline trench. In a regional context, the proposed expansion would affect a negligible percentage of available habitats, which are very extensive. It is unlikely that there would be significant effects at a population level. Mitigation measures outlined in Section 15.5.11 would ensure that mortality from trench entrapment is very low. Particular emphasis would be placed on monitoring the open trench in areas where the Dusky Hopping-mouse is known to occur.

The residual impact on the Dusky Hopping-mouse would be low.

Plains Rat – *Pseudomys australis*

The Plains Rat occurs in environments with cracking clay soils over a wide area of the arid zone of South Australia, from north-west of Lake Eyre to west of Lake Torrens. The most important habitat is chenopod low shrubland on gibber plains and tablelands in the Lake Eyre Basin, particularly in the Lake Eyre South catchment, north and east of Coober Pedy and south-west of Lake Eyre South. The Plains Rat forms complex systems of burrows, often associated with drainage depressions (gilgais) on gibber plains (Brandle et al. 1999).

Monitoring at Olympic Dam has shown that the Plains Rat occurs in Arid Recovery, the SML, and the northern sections of the infrastructure corridor on the Arcoona Plains (see Appendix N1, Figures N1.3, N1.4 a-f and N1.6 a-n). A resident population occurs on gibber plains and areas of cracking clay soil in the SML, and individuals have been recorded in disturbed areas adjacent to infrastructure at Olympic Dam. The Plains Rat was recorded on the gas pipeline corridor options on cracking clays near Screech Owl Creek (south of Lake Eyre South) during construction of the water supply pipeline in 1996 (see Appendix N1, Figure N1.6c). Research at Arid Recovery suggests the Plains Rat is likely to have historically used all habitats, but is now restricted to cracking clay habitats, where predator numbers are lower (A Bester, Arid Recovery, pers. comm., 31 October 2008).

The Plains Rat is known to increase in numbers during good conditions, sometimes erupting into plagues, and becomes extremely scarce between periods of peak abundance (Brandle and Moseby 1999). It is considered likely that no populations of the Plains Rat are permanently associated with a particular habitat patch or 'refugia'. Rather, Plains Rat populations consist of a number of dynamic regional populations utilising a network of primary core areas, with rare widespread dispersal between regions (Moseby et al. 1999).

Some populations of the Plains Rat in the vicinity of the expanded mine would be displaced by construction activities to adjacent habitat. Although some Plains Rat habitat would be lost during the mine expansion (less than 2% of suitable habitat within the EIS Study Area), a large area of similar habitat would be available for colonisation near the mine. The viability of local populations is unlikely to be affected.

Similarly, construction of the gas and water supply pipelines would result in localised, short-term disturbance of a small percentage of Plains Rat habitats, but is unlikely to significantly affect local populations. Mitigation measures outlined in Section 15.5.11 would ensure that mortality from open trench entrapment is very low.

The residual impact on the Plains Rat is categorised as moderate, reflecting a short-term impact to a sensitive receiver.

Pernatty Knob-tailed Gecko – *Nephrurus deleani*

The Pernatty Knob-tailed Gecko occurs in the dunefield and sandplain land system where it builds burrows at the base of low vegetation (see Plate 15.28). Its habitat and the proposed infrastructure alignments are shown on Figure 15.7. Within its known range, important habitat occurs in the dunes along a 50 km section of the infrastructure corridor between Island Lagoon and Dutton Lake (see Appendix N1, Figures N1.4b and N1.4c, kp 158–212) (Ehmann 2005). The highest density of the species is reported to be between Pernatty Lagoon and Lake Windabout (Kinhill 1998).

Plate 15.28 Pernatty Knob-tailed Gecko *Nephrurus deleani*

It is vulnerable to impact because it is territorial, not highly mobile, difficult to detect during the day and would be susceptible to heat stress if it became trapped in the open trench during construction of the water supply pipeline. Habitat loss and potential impacts on the gecko are significant as it is one of the rarest reptiles in South Australia and its range is limited. Construction of the water supply pipeline and transmission line, however, would result in only short-term impacts.

Measures to mitigate potential impacts of the open trench on the gecko between kp 158–212 are presented in Section 15.5.11 (see Figure 15.7). In addition to these, the following measures would be undertaken:

- a management plan would be developed prior to construction to ensure that appropriate management and mitigation measures were implemented
- pre-construction surveys by qualified personnel would be carried out to determine if final positions or alignments of infrastructure should be moved to minimise potential impacts on gecko habitat
- the trench would be left open for as little time as possible from kp 158–212
- a water-soaked, sawdust-filled hessian bag would be placed in the open trench every 100 m from kp 158–212
- qualified personnel would monitor the open trench every morning and release trapped geckos.

With implementation of the survey and monitoring measures listed above, the residual impact on the Pernatty Knob-tailed Gecko would be low.

Thick-billed Grasswren (eastern subspecies) – *Amytornis textilis modestus*

Thick-billed Grasswrens are sedentary birds that typically occupy territories of approximately four to five hectares. In the Roxby Downs–Andamooka region they usually occupy gibber plains vegetated with emergent chenopod shrubs including Old-man Saltbush *Atriplex nummularia omissa*, Cotton-bush *Maireana aphylla*, Black Bluebush *M. pyramidata* and Swamp Canegrass *Eragrostis australasica*, particularly the dense vegetation where run-off collects or along watercourses (NPWS 2002). They shelter at the base of shrubs, in animal burrows or in ground crevices, and nest at the base of chenopod shrubs (Rowley and Russell 1997). A recovery plan for the Thick-billed Grasswren (eastern subspecies) has been prepared (NSW National Parks and Wildlife Service 2002).

Although reasonably common further north in the Lake Eyre catchment, there have been few Thick-billed Grasswren records south of the Dog Fence or the Roxby Downs–Andamooka region (J Read, pers. comm., 12 February 2008. Read et al. 2000a). There have been several confirmed records of the Thick-billed Grasswren about 50 km east of Olympic Dam, near Andamooka, and two records about 20 km to the north near Arid Recovery (A Black, Honorary Associate South Australian Museum, pers. comm., 12 December 2007).

Although suitable habitat for the Thick-billed Grasswren occurs in Cotton-bush low shrubland on the gibber plain about 2.5 km south-west of the proposed Hiltaba Village and near the proposed airport, surveys of the area could not confirm the presence of Grasswrens in the area (see Appendix N7). Suitable habitat also exists within the pipeline supply corridors, although the species was not recorded in the field assessment of these areas. The loss of about 8 ha of Cotton-bush low shrubland at the airport site would represent about 5% of Cotton-bush low shrubland, and about 0.002% of chenopod shrubland in the EIS Study Area. An additional 10 ha would fall within the airport perimeter fence and therefore be exposed to noise impacts. Only a small proportion of available habitat would be affected, however, and birds would be likely to move from the affected areas to adjacent areas of suitable habitat.

Suitable habitat would be identified and set aside to offset the loss of Thick-billed Grasswren habitat near the proposed airport. For example, setting aside more of the Red Lake paddock (north of Arid Recovery), where a population of Thick-billed Grasswrens has recently been observed (J Read, pers. comm., 12 February 2008), may be a suitable offset. A significant proportion of the pastoral land included in the package of offsets would contain dense chenopod shrubland along watercourses or drainage depressions that would potentially provide suitable habitat for the Thick-billed Grasswren.

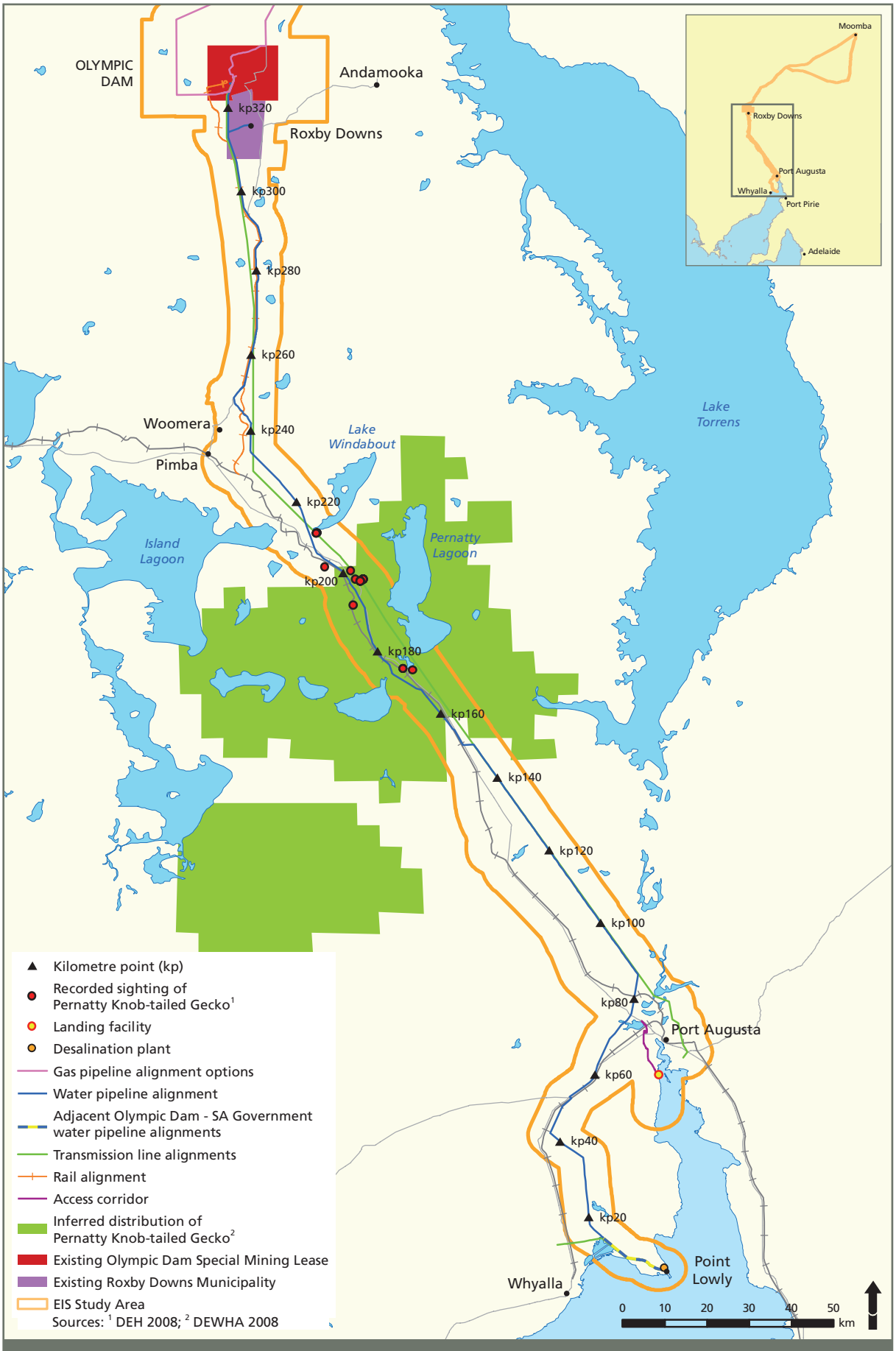

Figure 15.7 Pernatty Knob-tailed Gecko habitat in the southern corridor

The residual impact of the proposed expansion on the Thick-billed Grasswren (eastern subspecies) would be negligible.

Listed birds

BHP Billiton bird monitoring at the existing TRS has recorded visits by four rare or threatened species, and eight listed migratory species. Of these, occasional mortalities have been recorded for 10 species: the Banded Stilt *Cladorhynchus leucocephalus*, the Great Egret *Ardea alba*, the Sharp-tailed Sandpiper *Calidris acuminata*, the Red-necked Stint *Calidris ruficollis*, the Caspian Tern *Sterna caspia*, the Common Sandpiper *Actitis hypoleucos* and the Grey Plover *Pluvialis squatarola* (which generally inhabit wetlands, shores and/or beaches), and the Freckled Duck *Stictonetta naevosa*, the Musk Duck *Biziura lobata* and the Blue-billed Duck *Oxyura australis* (which generally inhabit open water).

Although the proposed TSF would continue to pose a hazard to the listed birds that utilise the beach areas of the TSF cells, impacts of the proposed expansion on open water birds (i.e. Freckled Duck, Musk Duck and Blue-billed Duck) would be avoided by the design measures that would ensure free tailings liquor in new ponds is not accessible to fauna. Furthermore, the expansion is likely to result in a benefit to open water species should the water balance enable the existing areas of free liquor to be reduced or eliminated (see Section 15.5.7).

Residual impacts on listed birds are discussed in Section 15.5.7.

Recovery Plans

Of the listed species of fauna potentially affected by the mine expansion, Recovery Plans have been prepared for the Greater Bilby (Pavey 2006), and the Thick-billed Grasswren (NPWS 2002). Recovery Plans for the Ampurta, Plains Rat, Boodie, Numbat and Western Barred Bandicoot are currently in preparation by a range of interested parties, including government agencies, non-government organisations, consultants and individuals. It is considered that the mine expansion would have no effect on the recovery of each of these species.

Monitoring of listed fauna

BHP Billiton has a monitoring program for listed fauna based on the following at-risk classifications:

- populations of Category 1 species are critically reliant on habitats that occur in areas affected by the Olympic Dam operation
- populations of Category 2 species are partially reliant on habitats that occur in areas affected by the Olympic Dam operation.

The monitoring program includes regular monitoring of GAB spring fauna, weekly monitoring of bird mortalities associated with the TRS, quarterly surveys of terrestrial birds, monthly records of waterbirds, annual field sampling of small mammals and reptiles, and opportunistic records.

The current monitoring program only includes the fauna associated with GAB springs as Category 1 species. The Pernatty Knob-tailed Gecko *Nephrurus deleani* is not currently listed as an at-risk species at Olympic Dam. Its limited habitat, however, and the potential threat posed by construction activities associated with the water supply pipeline and transmission line would result in its inclusion as a Category 1 species.

Several Category 2 fauna species occurring at Olympic Dam, including the Thick-billed Grasswren (eastern subspecies) *Amytornis textilis modestus*, are included in the monthly monitoring surveys. No additional Category 2 species would be added as a result of the proposed expansion.

15.5.6 COMPARISON WITH EPBC ACT

The Department of Environment, Water, Heritage and the Arts (DEWHA) has developed administrative guidelines to assist proponents to determine if their project could have a significant impact on fauna and flora species listed by the EPBC Act (DEWHA 2006).

Nationally listed species that could occur within the EIS Study Area include 13 threatened plant species, 25 threatened animal species and 32 migratory species. These species were initially screened to derive a list of species at credible risk from the expansion project (see Appendix N6), and then assessed against the DEWHA guidelines (see Table 15.8 and Appendix E1). It is concluded that the residual impact on each species would not be significant as defined under the Act and accompanying guidelines.

The nearest wetlands of international importance to the project area are the Coongie Lakes and Lake Pinnaroo Ramsar wetlands. Whilst Lake Pinnaroo is at least 100 km from the project area in New South Wales, the gas pipeline corridor passes within 1.5 km of the Coongie Lakes Ramsar Wetlands. The sections of Cooper Creek floodplain traversed near Moomba are only very occasionally flooded and are at least 50 km from the important wetlands on the main Cooper channel. In view of the significant distance between the proposed development and the permanent and semi-permanent wetlands, there is no credible risk of the mine expansion adversely affecting the Ramsar wetlands.

15.5.7 TAILINGS RETENTION SYSTEM AND WILDLIFE

The existing tailings retention system (TRS) consists of 400 ha of the TSF and 133 ha of evaporation ponds. In the prevailing arid environment in which surface water is uncommon, fauna are attracted to the artificial water bodies created by the TRS. The liquor stored in the TRS is acidic (pH less than 2 to 3.5) and therefore toxic to fauna that ingest it.

BHP Billiton has monitored fauna mortalities associated with the TRS since 1996 and publicly reported the results. Between 1996 and 2005 up to 50 bird mortalities per year were reported. In 2005 BHP Billiton revised the TRS monitoring practices and recorded 895 fauna mortalities in 2006, 311 in 2007 and 282 in 2008 (BHP Billiton 2006, 2007 and 2008, respectively). These

Table 15.8 Assessment of nationally listed species at credible risk of being affected by the mine expansion

Species name	Common name	Status[1] (Aus)	Significant impact[2]	Comment
Plants				
Eleocharis papillosa	Dwarf Desert Spike-rush	V	No	Negligible impact on species resulting from corridor clearance
Frankenia plicata		E	No	As above
Mammals				
Dasycercus hillieri	Ampurta	E	No	No records in the EIS Study Area, but the possibility of some mortalities associated with the open trench cannot be ruled out. Implementation of the trench management plan would mean that effects on the population size would be insignificant
Notomys fuscus	Dusky Hopping-mouse, Wilkiniti	V	No	As above
Pseudomys australis	Plains Rat	V	No	As above
Arid Recovery spp.				
Bettongia lesueur lesueur	Boodie Burrowing Bettong	V	No	Species introduced to Arid Recovery. Air emissions and noise may reduce the value of some habitat, but the impact would not interfere substantially with the recovery of the species
Leporillus conditor	Wopilkara, Greater Stick-nest Rat	V	No	As above
Macrotis lagotis	Bilby	V	No	As above
Myrmecobius fasciatus	Numbat	V	No	As above
Perameles bougainville	Western Barred Bandicoot	E	No	As above
Reptiles				
Nephrurus deleani	Pernatty Knob-tailed Gecko	V	No	Some mortalities may occur associated with the open trench, but effects on the population size would be insignificant
Bush birds				
Amytornis textilis modestus	Thick-billed Grasswren (Eastern sub-sp)	V	No	Some preferred habitat would be cleared (Cottonbush *Maireana aphylla*), but there is abundant similar habitat in the region
Migratory birds				
Actitis hypoleucos	Common Sandpiper	Mi, CJB, Ma	No	Ongoing mortalities may occur on the beaches of the TSF cells, but effects on population sizes would be insignificant
Ardea alba	Great Egret	Mi, CJ, Ma	No	As above
Calidris acuminata	Sharp-tailed Sandpiper	Mi, CJB, Ma	No	As above
Calidris ruficollis	Red-necked Stint	Mi, CJB, Ma	No	As above
Pluvialis squatarola	Grey Plover	Mi, CJB, Ma	No	As above
Sterna caspia	Caspian Tern	Mi, C, Ma	No	As above

[1] Status: V = vulnerable; E = endangered; Mi = migratory; C = CAMBA; J = JAMBA; B = Bonn; Ma = marine.
[2] Assessment based on DEWHA 2006 guidelines.

numbers would underestimate the actual number of mortalities associated with the TRS as some carcasses are scavenged or sink prior to counting. Most bird mortalities have been recorded around the accessible edges of the evaporation ponds rather than the TSF cells.

Mortalities of 49 bird species have been recorded, including six migratory bird species listed under the EPBC Act and four bird species listed under the NPW Act (see Appendix N10). Mortalities of flocking waterbirds such as the Banded Stilt *Cladorhynchus leucocephalus*, Red-necked Avocet *Recurvirostra novaehollandiae* and Black Swan *Cygnus atratus*, which are sometimes attracted to the TRS, have also been recorded. Few mortalities of flocking bush birds such as the Zebra Finch *Taeniopygia guttata* and Budgerigar *Melopsittacus undulatus*, however, have been recorded. In addition to birds, mortalities of seven species of mammal and eight species of reptile and amphibian have been recorded.

Several measures to deter fauna from visiting the TRS have been investigated with varying degrees of success (BHP Billiton 2005b; Donato Environmental Services 2007). BHP Billiton continues to investigate wildlife deterrent devices and regular monitoring of the wildlife mortalities associated with the TRS. The outcomes of these programs would continue to be reported in publicly available documents such as BHP Billiton's annual environmental report.

The proposed expansion provides an opportunity to address the issue of bird mortalities through improved design. Design modifications adopted by BHP Billiton to reduce bird mortalities are summarised in Section 15.4.2 and detailed in Chapter 5, Description of the Proposed Expansion (Section 5.5.6).

Net effects on open water species such as ducks, swans and cormorants would be lessened by improved design, despite the increased area of reflective wet beaches possibly attracting more birds to the TRS (B Lane, Brett Lane and Associates, pers. comm., 23 April 2008). Covering the new ponds with netting or similar to prevent access to free tailings liquor would in the short term result in no change to the area of open water accessible to waterbirds (see Plates 15.29a and 15.29b). Directing tailings liquor from the existing operation to the expanded TRS would in the medium term result in a net benefit to open water species as the existing areas of free liquor on TSF cells 1 to 4 and the evaporation ponds would be eliminated or significantly reduced over time (see Chapter 5, Description of the Proposed Expansion, Section 5.5.6 for details). Residual effects on open water species are therefore likely to be a negligible impact in the short term and a moderate benefit in the medium term.

Impacts on shorebirds and other species that are attracted to the tailings beaches, such as stilts, dotterels and plovers, would be affected by two significant changes to the TSF. The 3,300 ha increase in the area of wet beaches containing small rivulets and sheet flow of acid liquor is assumed to result in increased mortalities of shorebirds. The increase would be lessened to some degree however, by design measures that eliminated shore habitat on the new TSF cells by creating rocky edges to the central decant ponds. The residual impact of the expanded TSF facilities is categorised as moderate on common (including migratory) shorebirds, and high on two species of rare or threatened shorebirds (as per the criteria identified in Table 1.3 of Chapter 1, Introduction). Ongoing mortalities would comprise a relatively small percentage of local populations and would not adversely affect the local viability of shorebird species.

The Banded Stilt may occasionally be at risk of larger numbers of mortalities than other shorebirds as it is a flocking species that sometimes occurs in the region in flocks of thousands. The species is attracted to inland salt lakes to breed after heavy rainfall events. Thirty such breeding events have been recorded in the last 80 years, 25 in Western Australia and five in South Australia (see Appendix N11 for details). It is considered unlikely that a significant proportion of the Banded Stilt population would arrive on the tailings ponds at Olympic Dam in a single event or regularly, as most breeding events occur in

Plate 15.29a Example of netting to exclude birds from a mine dewatering pond

Plate 15.29b Example of netting to exclude birds

Western Australia. However, there is a remote chance that a large flock may land on the tailings ponds, which may result in a significant one-off impact on the species' population. Discussions with wader bird specialists Brett Lane and David Donato (pers. comm., 23 April 2008) suggest that the worst-case effects on the Banded Stilt (occurring when a large flock is attracted to the TSF during an inland breeding event) may result in a potential loss of up to 15% of the species' population (see Appendix N11 for details). A risk assessment for the proposed expansion (see Chapter 26, Hazard and Risk) determined that the risk to the Banded Stilt population was high (which is considered 'tolerable' in terms of the Australian risk assessment standard; see Chapter 26, Hazard and Risk, for details). Ongoing management and research is occurring to reduce the risk. In the first instance, BHP Billiton would support SA DEH initiatives to minimise predation by gulls on Banded Stilt eggs during occasional large breeding events in the region.

15.5.8 GROUNDWATER DRAWDOWN

Effects on Yarra Wurta Spring

The Yarra Wurta Spring complex is the closest groundwater-dependent ecosystem to Olympic Dam, lying about 45 km to the

north-east. Modelling of groundwater drawdown associated with the open pit has shown that drawdown would extend about 25 km north-east of Olympic Dam and therefore would not affect the spring (see Chapter 12, Groundwater, for details).

Extraction of groundwater from the Motherwell saline wellfield for the first six years of the expanded operation, prior to the desalination plant being operational, has been included in the above modelling (see Chapter 12, Groundwater). It is likely that BHP Billiton would continue extraction from this wellfield to reduce demand from the desalination plant. Monitoring of drawdown during the first six years of operation of the wellfield would supply sufficient data to determine whether ongoing extraction was feasible without affecting Yarra Wurta Spring. Extraction would be managed to protect the environmental value of the spring (see Chapter 12, Groundwater).

The residual impact on Yarra Wurta Spring and therefore the Lake Eyre Hardyhead population would be negligible.

Effects on vegetation

Groundwater drawdown associated with the new open pit mine would not affect deep-rooted terrestrial vegetation for two reasons. The groundwater of the Andamooka Limestone aquifer is hyper-saline and therefore would not be usable by trees and shrubs in the region. The groundwater is also at least 50 m below the ground surface, which is significantly beyond the depth to which tree roots are reported to penetrate (Jackson et al. 1999).

Effects on subterranean fauna

Impacts on subterranean fauna are not expected to occur as no stygofauna communities have been recorded in the groundwater in the Olympic Dam region (see Section 15.3.6).

15.5.9 EFFECTS OF EMISSIONS ON FLORA AND FAUNA

For the purpose of the Draft EIS, effects of emissions on flora and fauna have been addressed in three areas:

- effects on flora
- effects on fauna
- radionuclides.

Effects on flora

Ecological monitoring at Olympic Dam has indicated that dust, saline aerosols, sulphur dioxide and other emissions from the mine can have compounding or overlapping impacts on flora in the immediate vicinity of the mine (WMC 2004; BHP Billiton 2005b to 2007 and 2008). The relationship between emissions and damage to plants is complex, and is influenced by:

- vegetation age – seeds, new growth, young plants or mature plants are affected differently
- vegetation species – plant species have varying susceptibilities to pollutants
- nature of the pollutant – sulphur dioxide, salt and dust affect plants in different ways
- concentration of pollutants – effects on plants are related to the concentration of pollutants
- duration of exposure – a brief exposure is likely to have a different effect to a prolonged exposure
- frequency of exposure – regular exposure is likely to have a different effect to occasional or once-off exposure
- rainfall intensity and frequency – rainfall can significantly change the effects of pollutants on plants at Olympic Dam
- a combination of the above.

While the effects of various emissions on plants are complex, monitoring has established a footprint area over which changes in community structure and effects on plant health can be measured.

Monitoring to establish a footprint over which detectable effects can be attributed to gaseous emissions is based on visual inspection of plants for 12 symptoms including leaf loss, pitting of leaves, necrotic spots on leaves, damage to leaf tips and leaf dulling.

Monitoring in 2006 established that an area of 2,670 ha surrounding the metallurgical plant (extending up to 7.5 km from the plant) showed detectable foliage damage attributed to gaseous emissions. Monitoring results for 2007 established that the area showing measurable effects had reduced to 2,290 ha, probably as a result of higher rainfall in 2007 than in 2006. Changes in community structure of vegetation have been detectable up to 8.3 km from the metallurgical plant.

The mine expansion has the potential to increase the area of vegetation affected by air emissions as the load of some, but not all emissions, would increase. The load of saline mists emitted from ventilation shafts (i.e. raise bores) that intercept saline groundwater would not change significantly as a result of the proposed expansion as no new raise bores would be required for the new open pit mine. Dust (i.e. total suspended particulates) and sulphur dioxide emissions, however, would increase as a result of the proposed expansion.

Air quality modelling using Calpuff has been used to investigate ground level dust concentrations for the expansion, with model predictions showing that mining and haulage activities associated with the open pit and rock storage facility are the greatest contributors to dust. The modelling also predicts that dust deposition as a result of the expanded operation would be virtually negligible (less than 0.15 g/m^2/month) outside the expanded SML (see Chapter 13, Greenhouse Gas and Air Quality, for details). Therefore, it is expected that some effects on vegetation would be detectable within the expanded SML and within the southern areas of Arid Recovery, but there is unlikely to be a detectable effect outside the SML.

Sulphur dioxide (and other sulphur oxide gases, hydrogen fluoride and copper compounds) is generated via the copper smelting process (i.e. flash smelting furnace and anode furnaces). The sulphur dioxide rich off-gases are directed to the acid plant

where about 99% are captured and converted to sulphuric acid. During normal operations, residual emissions from this process are vented to the atmosphere via the acid plant exhaust stack. These emissions have a very low concentration of sulphur dioxide (1,050 mg/Nm^3) but are continuous.

On occasions, when interruption to the power supply triggers a standard safety procedure, sulphur dioxide rich off-gases are directed to bypass the scrubbers and are vented directly to the atmosphere. The new acid plants for the proposed expansion would be designed with additional redundancy to significantly reduce the potential for such occurrences.

Sulphur is an essential nutrient to plants, being a critical component of the amino acids that build proteins within a plant. However, even low concentrations of sulphur dioxide can have a detectable effect on plants as they absorb the gas through their foliar stomata, which may result in damage to foliar tissue.

The total load of sulphur dioxide emissions from the expanded operation would be about nine times more than the existing operation. The simplest means of estimating the impact of sulphur dioxide from the expanded operation on vegetation is by extrapolating from the existing area of impact using emission loads. Direct extrapolation, however, is not possible as the effect is non-linear. An alternative method of extrapolation is to compare the expanded Olympic Dam operation with other sulphur dioxide-emitting operations, including those with significantly greater sulphur dioxide emissions than the proposed Olympic Dam expansion (see Figure 15.8). These comparisons suggest that the proposed increase in sulphur dioxide emissions would result in an extension of the area with detectable effects on vegetation to about 13 km from the metallurgical plant.

Effects of emissions on vegetation would continue to be monitored at Olympic Dam.

While the extrapolations for measurable effects to plants from gaseous emissions are not definitive, the available information indicates that the proposed expansion has the potential to increase the area over which impacts to vegetation may occur, and that this impact would be largely confined to the expanded SML. The residual impact is therefore categorised as moderate, reflecting a long-term impact to a common receiver. The impacts of gaseous emissions on vegetation would be compensated to some extent by setting aside 126,650 ha of pastoral land in the Arid Lands NRM region as part of the SEB offset strategy (see Section 15.5.1), which would result in a moderate residual benefit in the long term.

Effects on fauna

Gaseous emissions that affect flora, as discussed above, also have the potential to reduce the habitat value of ecosystems for animals. This section however addresses additional emissions (i.e. noise and light) that are not known to affect plants, but could reduce habitat value for animals.

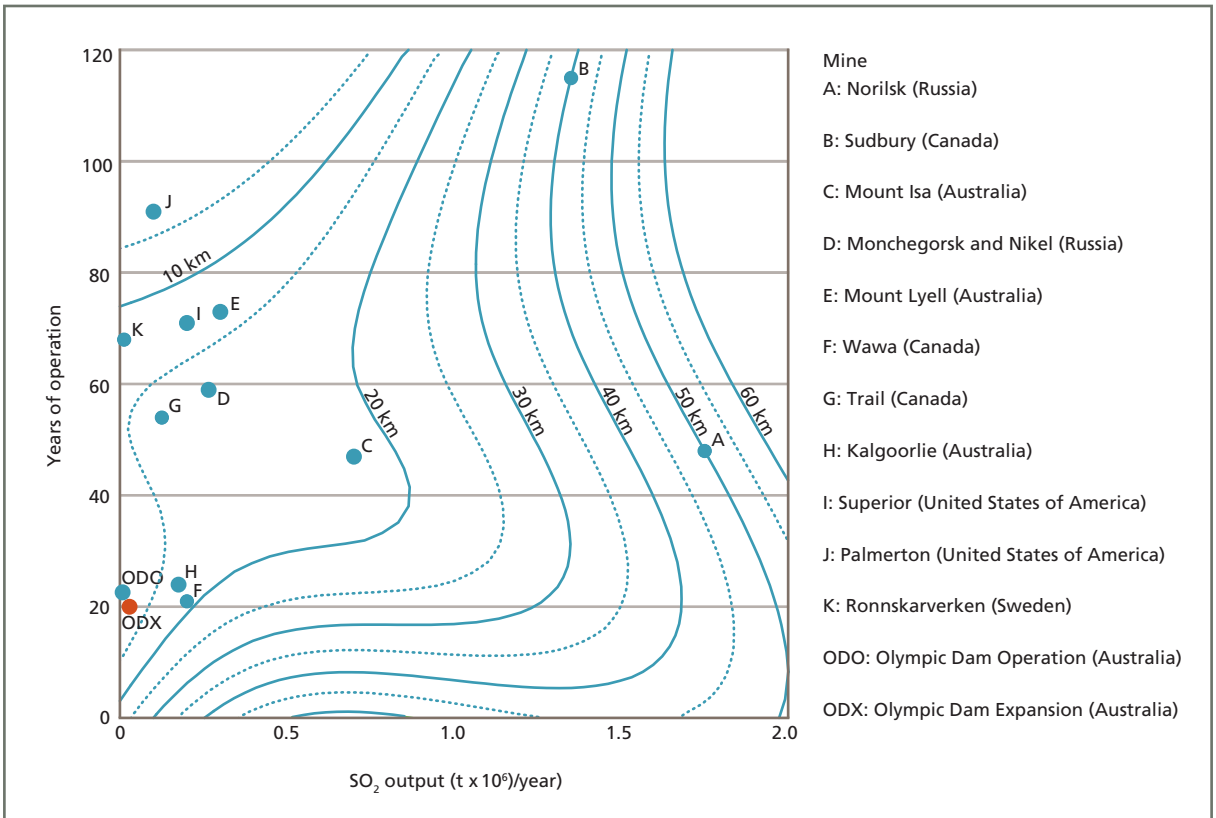

Figure 15.8 Extent of the impact of SO_2 emissions

Noise

Increased noise can lower the value of habitat by disrupting the behaviour of fauna, affecting fecundity and social interactions. The effects of noise on fauna have been studied at Olympic Dam but are difficult to differentiate from the effects of other emissions such as dust and sulphur dioxide (Read 1996; Read 1998; Read et al. 2000). Incidental observations suggest that fauna can become accustomed to noise to some degree, but subtle effects on behaviour are poorly understood.

Noise levels associated with the expanded operation would increase as a result of the transport of ore and mine rock by haul trucks and blasting in the open pit. The effects of noise on fauna and habitat value would be significant in the immediate vicinity of the haul roads and open pit, but would be rapidly attenuated by distance. Noise modelling suggests that levels would be significantly attenuated within 500 m of the source, and generally reduce to 40–65 dB(A) within 2 km of the source (see Chapter 14, Noise and Vibration, and Appendix N12). This area of potential affect would not extend outside of the boundaries of the extended SML except to the north of the operation where it would extend into the southern sections of Arid Recovery.

Reduced habitat value within 2 km of the expanded mining operation would be compensated for by setting aside 126,650 ha of pastoral land in the Arid Lands NRM region for conservation purposes as part of the SEB offset strategy.

Light

Artificial light at night could affect the foraging behaviour, predator/prey interactions, reproduction, migration and social interactions of fauna.

Many groups of insects, including moths, lacewings, beetles, bugs, caddis flies, craneflies, midges, hoverflies, wasps and bush crickets, are attracted to light (Longcore and Rich 2006). Some fauna, such as insectivorous bats and geckos, often feed on insects attracted to artificial lighting (Perry and Fisher 2006; Rydell 2006). Birds may become disoriented when attracted to artificial lighting, resulting in collision with structures, exhaustion and increased predation (Gauthreaux and Belser 2006; Montevecchi 2006). Some small rodents and marsupials are also reported to forage less when there is a high level of illumination (Beier 2006).

An increase in the amount of artificial lighting associated with the expanded operation is therefore likely to affect fauna in several ways. Depending on the types of lights used, the lights may attract large numbers of insects that would in turn provide foraging opportunities for bats, some birds and ground dwelling fauna. Light spilling from work sites would combine with the effects of noise, dust and other emissions in lowering the value of habitat adjacent to the mine. Light spillage would be mitigated to some degree by using screens and directional lighting where appropriate. Impacts on insects may be mitigated to some extent by the use of appropriate lamps, which are less attractive to insects than conventional lights.

The effects of noise and light emissions on fauna are likely to reduce habitat value within at least 2 km of the expanded mining operation. As per the management categories listed in Chapter 1, Introduction (see Section 1.6.2), this would represent a high residual impact to those reintroduced threatened species within Arid Recovery (i.e. a long-term impact to a sensitive receiver). As such, this would remain an area of management focus for the proposed expansion.

Radionuclides

Radionuclide concentrations in soil and vegetation have been measured in the environment around the current operation since 1982. There is some evidence of increases in soil radionuclide concentrations in the area immediately adjacent to the operation (i.e. within about 3 km), particularly immediately adjacent to the TSF. Beyond this zone there is no clear evidence of an increase in radionuclide concentration over pre-operational levels, or in surface soil concentrations over those in deeper soil, although there is an indication of a slight increase in Pb-210. All soil radionuclide concentrations remain within the range found naturally in the local area and worldwide (UNSCEAR 2000).

Radionuclide concentrations in vegetation (saltbush and mulga) have shown a large relative increase in U-238, Th-230 and Ra-226 concentrations close to the operational areas (less than 3 km). A smaller relative increase in Pb-210 and Po-210 concentration has also been observed. This increase is most likely due to deposition of operationally-generated dusts onto the foliage of the plants. The Pb-210 and Po-210 increases were most noticeable in the early years of operation, prior to additional controls on smelter emissions being introduced. More recent (2005) results show increases in mulga, but not in saltbush in this zone (BHP Billiton 2006).

There is also increased radionuclide concentrations in vegetation at sites near the existing SML boundary (approximately 4–5 km from the operational areas), although these increases are less than those closer in. At greater distances (approximately 25 km) there is no clear evidence of increased concentrations for the longer lived radionuclides (U-238, Th-230 and Ra-226), but there are increases of Pb-210 and Po-210 in mulga, but not in saltbush.

The potential effect of these environmental radionuclide concentrations on non-human receptors has been investigated using a screening method developed by the European Commission entitled Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA)(ERICA Program 2007). Two screening levels were used in the assessment: the default ERICA screening level, and a level proposed by UNSCEAR (UNSCEAR 1996).

The UNSCEAR screening level is derived from doses that have been shown to have slight effects in the most sensitive plant species, but have no significant deleterious effects in the wider range of plants present in natural communities. Dose rates were well below the UNSCEAR level for all species. Using the default

ERICA level however, the dose rate for lichen/bryophytes was exceeded, and marginally exceeded for trees, shrubs and grasses within 3 km of the operation. The dose rate for grazing mammals, reptiles, soil invertebrates and detritivorous invertebrates were well below the screening levels.

A similar screening assessment was undertaken using radionuclide concentrations predicted for the proposed expansion. The results indicated that the radiological risk to non-human biota as a result of increased dust deposition from the expanded Olympic Dam operation is negligible (see Appendix S for details).

Radionuclide concentrations in soil and vegetation in the Olympic Dam region would continue to be monitored throughout the life of the operation.

15.5.10 ARID RECOVERY

Dust, noise, light and gaseous emissions from the expanded operation may reduce the quality of habitat in the southern part of Arid Recovery. Modelling of emissions suggest that dust and gaseous emissions may affect the health of vegetation in the southern sections of Arid Recovery, and noise and light may affect the behaviour of fauna (see Section 15.5.9). Fauna affected may include the threatened Plains Rat *Pseudomys australis*, Bilby *Macrotis lagotis*, Greater Stick-nest Rat *Leporillus conditor*, Burrowing Bettong *Bettongia lesueur*, Numbat *Myrmecobius fasciatus* and Western Barred Bandicoot *Perameles bougainville*, that have naturally re-established in, or have been introduced to, Arid Recovery over the past 10 years.

Although some degree of habituation to noise and light would occur, some species may no longer utilise the habitat in the southern section of Arid Recovery. However, the effects on listed fauna within Arid Recovery would not constitute a significant impact on the recovery of reintroduced species as per the EPBC Act criteria (see Section 15.5.6).

As noted in Section 15.5.9, the residual impact on the threatened species introduced to Arid Recovery is categorised as high, reflecting a long-term impact to a sensitive receiver.

15.5.11 OTHER POTENTIAL IMPACTS AND MANAGEMENT

Entrapment of fauna by the temporary water and gas supply pipeline trenches

Trenches open during pipeline construction act as pitfall traps for small mammals and reptiles. Pipeline projects in arid regions of Australia have resulted in an average of 10–40 animals per kilometre falling into open trenches (MBS Environmental 2006). For example, installation of the 214 km Wellfield B pipeline by WMC in 1997 resulted in the capture of 18 animals per kilometre. Similarly, more than 3,000 animals, including 90 individuals of a nationally listed vulnerable snake, were captured and released during the laying of a 390 km gas pipeline in central Queensland (Wilson and Swan 2005).

With implementation of appropriate mitigation measures to ensure that trapped fauna are either able to escape from the trench or are released by environmental personnel, the mortality of fauna is reported to be as low as 3–5% (MBS Environmental 2006).

A trench management plan would be implemented to minimise fauna mortalities associated with the open trench during the construction of the water supply and gas supply pipelines. This would include:

- using appropriately skilled and resourced personnel to collect, identify and release fauna that fell into the trench
- assigning sufficient personnel to ensure that all sections of open trench were checked for fauna before 10 am each day in summer and midday in winter
- leaving trench plugs (i.e. filled-in sections) or bridges/planks at regular intervals to allow fauna to cross
- leaving ramps at regular intervals to allow fauna to escape (spacing would be about 250 m in summer and 500 m in winter)
- placing a water-soaked, sawdust-filled hessian bag in the trench every 250 m in summer and 500 m in winter to provide shelter for trapped fauna before capture and release (they would be placed every 100 m in the Pernatty Knob-tailed Gecko habitat – see Section 15.5.5).

With implementation of the above mitigation measures, the residual impact of the pipeline trenches on fauna would be low.

The 320 km water supply pipeline and 400–560 km gas supply pipeline trench provide a significant ecological research opportunity for the period they are open. The identification of fauna captured in the pipeline trenches would provide valuable data for the South Australian DEH's Biological Survey Database of South Australia. The opportunity provided by the pipeline trenches to conduct a comprehensive fauna survey would result in a moderate residual benefit.

Birds and the transmission line

Bird injuries and mortalities may occur as a result of collisions with transmission line conductors and occasionally through electrocution.

The greatest mortality risk is in the vicinity of the Arcoona system of lakes (kp 250–300: see Appendix N1, Figures N1.4a and N1.4b) which, when filled, support large populations of waterbirds, including the vulnerable Freckled Duck and the rare Musk Duck (Read and Ebdon 1998). Several dead swans and ducks were found near the existing 132 kV transmission line adjacent to Purple Lake (kp 284) during surveys for the 1997 EIS and before construction of the 275 kV transmission line (WMC 1997).

The proposed transmission line would only marginally increase the risk of bird collisions as it would be located next to two existing lines. The cumulative effect of the three transmission lines would be relatively low. Nevertheless, the risk would be further reduced by attaching highly visible reflective markers (that would also be visible at night) to the conductors at

regular intervals on the sections of the transmission line within one to two kilometres of ephemeral lakes (e.g. Lake Mary kp 276–280, Purple Lake kp 284–287, Coorlay Lagoon kp 292–295). With these measures in place the residual impact on birds would be low.

Weeds

Regional priorities and strategies for weed control in South Australia are determined by the Natural Resource Management (NRM) Boards established under the South Australian Natural Resources Management Act. Weed control within the EIS Study Area would therefore fall within the jurisdiction of three NRM regions: the South Australian Arid Lands, Eyre Peninsula, and Northern and Yorke NRM regions.

The South Australian Arid Lands NRM Board has published the SA Arid Lands Pest Management Strategy 2005–2010, in which priority weeds are identified, and protocols for monitoring, mapping and control of weeds in the region recommended (Pitt et al. 2006).

In 2004, BHP Billiton collaborated with Arid Recovery, the Roxby Downs Council and the Andamooka Progress and Opal Miners Association to develop a weed management strategy for the Olympic Dam region. This strategy assigned responsibility to BHP Billiton to manage pest plants at Olympic Dam, along the two existing transmission lines from Port Augusta to Olympic Dam and on the pastoral leases owned by BHP Billiton. The strategy identified 13 high-priority weeds in the region that require control actions. No additional declared or environmental weeds were identified during botanical surveys for the Draft EIS (see Appendix N4).

The strategy would be updated before construction of the proposed expansion began to ensure the new areas encompassed by the project (e.g. the water supply pipeline from Point Lowly, the desalination plant at Point Lowly and the gas supply pipeline from Moomba) were included. Hiltaba Village and the airport are located on Andamooka Station (which is owned by BHP Billiton) and therefore fall within the area covered by the existing Weed Management Strategy.

Prior to the construction phase, BHP Billiton would develop appropriate weed control strategies for the Eyre Peninsula and Northern and Yorke NRM regions in consultation with the respective boards. The Eyre Peninsula NRM Board is currently targeting *Asparagus* weeds such as Bridal Creeper, Bridal Veil and the newly identified Western Cape form of Bridal Creeper. The Northern and Yorke NRM Board is targeting Bridal Creeper, Salvation Jane, Horehound, Gorse, White Weeping Broom, Bridal Veil, Boneseed, Silverleaf Nightshade, Knapweed, African Boxthorn and other roadside pest plants.

Various activities may facilitate the spread of weeds or support their growth at disturbed sites. These include the movement of weeds and/or their seeds to new areas on vehicles or equipment, and the promotion of optimal conditions for weed growth through soil disturbance. Measures to mitigate the spread of weeds would include:

- liaising with the relevant NRM Boards before undertaking weed control activities or developing targeted weed management strategies
- ensuring the diligent cleaning of plant, equipment and vehicles before construction work started and after access to areas infested by declared weeds
- identifying areas where weed hygiene measures would be implemented by undertaking searches for declared weeds during the field surveys for the final infrastructure locations
- minimising the disturbance from construction and operational activities wherever possible
- ensuring that vehicles remained on designated tracks to minimise disturbance and weed spread
- conducting follow-up surveys 12 months after construction, and/or after significant summer and winter rains to determine the need for weed control
- undertaking control activities for declared and environmental species where they occurred on lands owned by BHP Billiton.

Implementing the above mitigation measures would result in the residual risk of spreading weeds within the project area being low.

Vertebrate animal pests

Development projects could result in an increase in the numbers of cats and dogs (both domestic and feral) and foxes. Foxes and cats prey on native fauna and are a major threat to the survival of small mammals, reptiles and ground-dwelling birds (Read and Bowen 2001) (see Plate 15.30). Populations of foxes and cats may increase because of expanded landfill sites and an increase in the number of road-kills to scavenge. The number of feral dogs in the region may also increase, but is not expected to pose a significant ecological issue.

Increased Silver Gull populations at Olympic Dam have been associated with habitat provided by sewage and other ponds, and food wastes associated with the landfill site. A further increase may occur in response to the increased human activity in the region. Large populations of gulls at times prey on the eggs of the Banded Stilt, and have prompted the South Australian DEH to undertake management programs in the Lake Eyre region (Neagle 2003). BHP Billiton would monitor gull populations at Olympic Dam and communicate the results to DEH to assist its programs.

Routine feral animal monitoring and control programs that BHP Billiton currently undertakes in the Olympic Dam region would continue. These include:

- regularly monitoring populations of feral animals via spotlight surveys to determine the need, timing and location of trapping programs (the fringes of landfill sites, accommodation and workplaces may be the focus of such surveys)

Plate 15.30 Feral cat from Roxby Downs and prey, consisting of mainly small lizards

- conducting regular programs to control and monitor feral cats and foxes, in accordance with previous programs in Arid Recovery.

In support of the Roxby Downs Council's proposed by-laws to manage cats and dogs more effectively in Roxby Downs, BHP Billiton, in collaboration with the Council, would:

- inform new residents about the ecological impacts associated with cats
- subsidise a de-sexing program for cats
- subsidise the installation of cat enclosures (runs) in backyards
- investigate the possible establishment of an RSPCA branch in the township.

Further management measures would be considered in support of the Roxby Downs Council to:

- fence landfill sites to minimise access by feral animals, including cats and foxes
- improve the management of landfill sites to ensure that non-recycled organic rubbish was buried as quickly as possible.

By implementing the above mitigation measures, the residual impact associated with the proliferation of feral animals in the Olympic Dam region has been categorised as moderate, reflecting the potential for a long-term impact on common receivers.

Recreational activities around Roxby Downs

The proposed population increase in Roxby Downs and Hiltaba Village is likely to increase recreational use of the areas surrounding the township and the environmentally significant sites in the wider region, such as the GAB springs, Lake Torrens, Lake Eyre and Andamooka.

Recreational activities may include off-road driving and riding, bush camping, sightseeing and, after periods of heavy rainfall, boating and kayaking. If uncontrolled, these activities could degrade the natural environment through increased littering, degradation and erosion of vehicle and pedestrian tracks, wood collection, lighting of bushfires, disturbance to wildlife and degradation of native vegetation and habitats. As discussed in Chapter 19, Social Environment, Section 19.5.4, provision of suitable community services would be likely to minimise adverse effects on the natural environment.

BHP Billiton would implement a management plan to minimise the environmental impact of recreational activities around Roxby Downs. An active program would be initiated for all employees and residents. Measures to manage recreational activities would include:

- constructing additional recreational facilities and designating (via the Roxby Downs Draft Master Plan) appropriate areas of natural vegetation for passive recreational purposes, such as walking and picnicking, outside the Roxby Downs township
- encouraging the use of existing designated recreational driving areas
- continuing to implement education, training and awareness programs for BHP Billiton employees and contractors via inductions

- informing the new residents of Roxby Downs and Hiltaba Village about appropriate recreational sites, opportunities and practices
- working with community groups to increase community support for better management of recreational activities in the vicinity of Roxby Downs
- encouraging membership of four-wheel-drive and motorbike clubs to promote responsible off-road driving
- investigating the feasibility of establishing and sign-posting four-wheel-drive and motorbike circuits near Roxby Downs and managing unauthorised off-road driving
- continuing discussions with government to ensure sufficient resources were available to monitor inappropriate off-road driving, and closing off and rehabilitating inappropriate tracks
- implementing education strategies, such as 'Leave No Trace', which address outdoor ethics principles for the appropriate management of natural areas.

By implementing the above mitigation measures, the residual impacts associated with the increased recreational use of the environment in the vicinity of Roxby Downs has been categorised as moderate, reflecting the potential for a long-term impact on common receivers.

Bushfires

Although occasional bushfires are a natural occurrence, the increased incidence of bushfires as a result of human activity could have profound effects on the ecology of the arid zone.

Bushfires may be initiated by careless recreational activities such as camping and off-road driving, and by welding during the installation of the gas and water supply pipelines. Educating the workforce concerning the risks of bushfires and adopting standard precautions during welding activities would ensure that the residual risk was low.

There is very little, if any, potential for bushfires to be initiated by vegetation coming into contact with transmission lines, as the vegetation in the region is typically low.

Groundwater mound associated with the TSF

The predicted groundwater mound resulting from seepage from the TSF would remain about 30–35 m below the ground surface (see Chapter 12, Groundwater), which is significantly beyond the depth to which tree roots in the area would penetrate (Jackson et al. 1999). The groundwater mound would therefore have no impact on vegetation.

Effects of the desalination plant and landing facility on waterbirds

Development of the desalination plant at Point Lowly and the barge landing facility 10 km south of Port Augusta would have no detectable effect on waterbird communities in Upper Spencer Gulf as none of the important roosting, feeding or nesting habitats and resources would be affected. The nearest significant waterbird habitat is Ward Spit, 5 km east of the desalination plant. Potential indirect effects on food resources would not occur as the return water discharges from the desalination plant would have a negligible effect on the marine ecosystem of Spencer Gulf (see Chapter 16 Marine Environment, for details).

15.6 FINDINGS AND CONCLUSIONS

Vegetation clearance

- About 16,962–17,269 ha of native vegetation would require clearing for the proposed expansion (depending on the gas pipeline alignment chosen). A large proportion of this vegetation is already disturbed because it is located near the existing mining operation or linear infrastructure. Clearing would occur in 21 vegetation associations; each association is relatively widespread and abundant in the rangelands of South Australia. The percentage loss of each vegetation association within the EIS Study Area varies between 0 and 6, with an overall loss of 1.3 across all associations within the EIS Study Area.
- Proposed environmental offsets developed in accordance with the Native Vegetation Act would ensure that native vegetation clearance would result in a residual environmental benefit to the region, through the setting aside of 126,650 ha of pastoral land in the Arid Lands NRM region for conservation.

Listed flora and vegetation communities

- Some clearance of Mulga *Acacia aneura* low woodland (provisionally listed as vulnerable) would be of minor ecological significance as it is relatively common in the SML, the infrastructure corridors and northern South Australia. Ecological threats to Mulga relate to inhibited regeneration following fire due to rabbit grazing and browsing by cattle.
- Impacts on the national and state endangered ecological community that depends on discharge from GAB springs would be avoided by aligning the gas supply pipeline at least several kilometres away from the GAB springs of the Reedy Springs GAB springs complex.
- While no records of Koch's Saltbush *Atriplex kochiana* are known from the proposed disturbance footprint, individuals of the species have been previously collected from Arid Recovery and the Arcoona Plateau
- Impacts on listed flora would be minimised by identifying, marking and avoiding plants whenever possible. Residual impacts on listed flora (which are predominantly ephemerals or short-lived shrubs) would be negligible.
- No significant impacts would occur on flora listed under the EPBC Act as matters of national environmental significance.

Listed fauna

Sixteen species of listed fauna could be affected by the proposed expansion. Impacts on each are summarised below.

- Clearance within the SML would have a moderate residual impact on local populations of the Plains Rat *Pseudomys australis*.

- Clearance and construction activities along a 50 km section of the southern infrastructure corridor (kp 158–212) may affect individuals, rather than populations of, the Pernatty Knob-tailed Gecko *Nephrurus deleani*. With implementation of appropriate mitigation measures the residual impact on the gecko would be low.
- Clearance and construction within the infrastructure corridors may affect the Dusky Hopping-mouse *Notomys fuscus*, Ampurta *Dasycercus hillieri*, Woma *Aspidites ramsayi*, Carpet Python *Morelia spilota imbricata*, Common Bandy-Bandy *Vermicella annulata* and Thick-billed Grasswren (eastern subspecies) *Amytornis textilis modestus*. The impacts, however, would be localised and unlikely to affect the regional distribution or abundance of each species. The residual impact on these species would therefore be negligible to low.
- Emissions from the expanded operation have been categorised as having a high residual impact on the five listed species of small mammals that have been reintroduced to Arid Recovery.
- The expanded TSF beaches would pose a hazard to two rare or threatened shorebird species, the Banded Stilt *Cladorhynchus leucocephalus* and Common Sandpiper *Actitis hypoleucos*, and five migratory shorebird species, the Caspian Tern *Sterna caspia*, Great Egret *Ardea alba*, Grey Plover *Pluvialis squatarola*, Red-necked Stint *Calidris ruficollis* and Sharp-tailed Sandpiper *Calidris acuminata*. Although design measures have been taken to minimise shore habitat on the new TSF cells, the residual impact of the expanded TSF facilities on the rare or threatened species and the migratory species would be high and moderate, respectively. Occasional mortalities, however, would not adversely affect the viability of any of these species.
- No significant impacts would occur to fauna species listed under the EPBC Act as matters of national environmental significance as per the Australian Government assessment criteria.

Habitat fragmentation

- Vegetation clearance would be unlikely to result in significant fragmentation of habitat because the vegetation is generally sparse and the disturbance would mainly occur adjacent to existing infrastructure such as the mine, roads, access tracks, powerlines and pipelines.
- Movement of small animals may be interrupted temporarily during construction of linear infrastructure until easements were rehabilitated. The residual impact would be low initially, reducing to negligible following revegetation.

Groundwater-dependent ecosystems

- No communities of stygofauna were recorded in the groundwater in the Olympic Dam region.
- Yarra Wurta Spring supports a population of the Lake Eyre Hardyhead *Craterocephalus eyresii*, microbial mats that are the precursors of stromatolites, and fossilised stromatolites. None of these is considered to be of significant scientific interest.
- Regional groundwater modelling indicates that these groundwater communities would not be affected by the proposed expansion as the flow of the Yarra Wurta Springs would not be affected by drawdown caused by the open pit or the Motherwell saline wellfield.

Roxby Downs sand dune reserves

Arid Recovery landscape

Emissions

- The effects of gaseous and dust emissions from the expanded operation on vegetation are likely to be buffered to some extent by the extensive areas of the RSF and TSF surrounding the open pit and expanded metallurgical plant.
- Dust and sulphur dioxide emissions associated with the expanded operation would increase the area of measurable effect on vegetation and may change the structure of vegetation communities close to the emissions sources. The area over which emissions would have detectable effects on vegetation is difficult to determine, but is likely to extend several kilometres beyond the area affected by the current operation (i.e. about 13 km), but would be restricted largely to the expanded SML.
- Emissions of dust, sulphur dioxide, noise and light may reduce the value of fauna habitat for about 2 km from the edge of the RSF, which would include the southern section of Arid Recovery.
- Reduced habitat value would be mitigated by protecting and managing suitable habitat elsewhere in the region as part of the SEB offsets to compensate for vegetation clearance. By implementing suitable offsets, impact on habitat near Olympic Dam may result in a residual benefit to habitat conservation in the region.

Tailing storage facilities and fauna

- Improvements to the TSF design would lessen water use and eliminate the need for additional evaporation ponds. Central decant ponds containing free tailings liquor would be covered (with netting or similar) to reduce access by birds.
- Design modification to prevent access to free liquor and eliminate or reduce the area of existing liquor would result in a negligible residual impact on open water birds in the short term, and possibly a moderate net benefit in the medium term.
- The expanded TSF beaches would pose a hazard to some species of birds. The increased area of wet beaches on the TSF (about 3,300 ha) may attract more shorebirds and greater mortalities of some species may occur. The residual impact on shorebirds that utilise beaches has been categorised as moderate for common (including migratory) species, and high for two rare or threatened species (i.e. the Banded Stilt and Common Sandpiper).

Other issues

- Construction of pipeline trenches would pose a temporary hazard to small ground-dwelling fauna. The implementation of standard management measures, such as manual removal of fauna from open trenches and the provision of escape ramps and water-soaked hessian sacks as shelter, would result in a low residual impact on fauna. The open trench would be used as an opportunity to undertake a comprehensive survey of the fauna of the region, providing some residual benefit.
- The proposed expansion may result in the spread of weeds and feral animals in the region. Implementation of appropriate hygiene, control and education measures would ensure that the residual impacts associated with weeds and feral animals were low and moderate, respectively.
- The increase in the population of Roxby Downs would be likely to result in increased recreational activity in the surrounding environment. Provision of appropriate recreational facilities and education programs to address degradation of the environment would ensure that residual impacts were moderate.