FLORA ASSESSMENT OF PROPOSED PERTH SEAWATER DESALINATION PLANT KWINANA

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28th September 2004

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i SUMMARY

A survey was undertaken on 12th August and 26th September 2004 of the site proposed for a desalination plant at Kwinana. This area is included in the Quindalup vegetation complex.

The site is degraded as 39 species were planted or gazetted as weeds from a total of 64 species recorded during the survey. Although many plants were weeds they do assist in binding the dune and ensuring the soil is stabilized. The dune face at the ocean had been and continues to be undercut by wave action during storms. Many of the plants at this face were weeds but they have assisted with ensuring that wave erosion is minimized.

When development occurs it will be essential to ensure that the disturbance area is stablised with suitable plant species, or with mulching or laying of branches over the surface until the plants become established. A list of potential species for inclusion in any rehabilitation of the site was listed for the remnant bushland to the south of the site. *Acacia rostellifera* is a dominant species at the site, grows quickly and stabilizes the soil. This would be a good species to plant immediately the development has been completed. Many wattle species survive only a few years but do provide protection for other species. If only sections of the area are disturbed the plants surrounding the disturbance should also become established through their seed being dispersed naturally over the area.

The non-native trees and shrubs not classified by CALM (1999) as weeds should not be replanted in disturbed areas, but should not be removed from where they occur now. They do not appear to be spreading naturally as those observed were mature.

Plants of *Spinifex longifolius* were growing in some of the degraded areas. This species should be encouraged as it binds the soil and can take a reasonable amount of sand build up, thus assisting with erosion prevention. The sea side of the site is a very fragile environment, which can be readily damaged through plant destruction.

1. INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was contracted by the Water Corporation to undertake a flora and fauna survey of the proposed area for the establishment of a water desalination plant, adjacent to the Western Power site at Kwinana. Dr Eleanor Bennett of Bennett Environmental Consulting Pty Ltd undertook the botanical work and the fauna work was done by Mr Greg Harewood. The area is included in the coastal belt of the Drummond Subdistrict of the South West Botanical Province (Beard, 1981). Heddle et al, 1980) mapped the vegetation of the Darling System of Western Australia. The proposed development area is in the Quindalup Complex, the coastal dune system that is subdivided into two alliances, the strand and fore dune alliance and the mobile and stable dune alliance. The proposed desalination plant will be located in the strand and foredune alliance.

1.2 Scope of Works

There were two requirements with this contract.

i. To understand any floral sensitivities on the desalination site and
ii. To understand any fauna sensitivities on the desalination site.

This required that a list of known Declared Rare and Priority Flora and Fauna from the area and surrounding areas be obtained from the Department of Conservation and Land Management.

2. REGIONAL METHODOLOGY

2.1 Geology and Landform

The Swan Coastal Plain is generally of low relief, 20-30km wide, and composed of Quaternary continental sediments. Quaternary deposits (younger than 2 million years) are unconsolidated or partly lithified sediments, which relate to past erosional and depositional processes on the ancestral Swan Coastal Plain. These relate to the periods of higher and lower sea levels during the Pleistocene and Holocene (Recent).

The Holocene beach and sand dunes, which occur along the coastline are named the Safely Bay Sands. The unit overlies Tamala Limestone and its derived sands, and corresponds to the Quindalup soil unit. The sand is made up of shell fragments, variable amounts of quartz and minor amounts of feldspar. The calcium carbonate content is generally greater than 50% and in places exceeds 70%. Deposition of the Safety Bay Sand is continuing today (Biggs and Wilde, 1980).

The area surveyed occurs within the Quindalup unit, which consists of calcareous sands occurring as beach ridges and parabolic dunes (Churchward and McArthur, 1980).

2.2 Vegetation

Heddle et al. (1980) described the two alliances of the Quindalup Complex.

i. Strand and fore dune alliance contains *Angianthus cunninghamii, *Trachyandra divaricata, *Arctotheca nivea, Atriplex isatidea, *Cakile maritima, Calocephalus brownii, Carpobrotus virescens, *Pelargonium capitatum, Senecio pinnatifidus, Sonchus megalocarpus, Spinifex longifolius, Tetragonia implexicoma, Tetragonia zeyheri*.
ii. Mobile and stable dune alliance contains *Acacia cyclops, Anthocercis littorea, Lepidosperma gladiatum, Myoporum insulare, Nitraria schoberi, Olearia axillaris, Scaevola crassifolia, Scaevola nitida, Spyridium globulosum, Westringia rigida, Wilsonia backhousei.*

The vegetation varies between one place and another due to variations in the dune environment caused by edaphic and topographical factors and the degree of shelter from the salt-laden winds.

3. METHODS

The field assessment was undertaken on 12th August and 26th September 2004. The area proposed for inclusion in the development was traversed on foot and the different vegetation units and species present recorded. In addition the remnant bushland on the southern side of Barter Road was inspected, as this area could be a source of seed for any rehabilitation that may be required. As more species were flowering in September than August the identification of many of the weeds and some of the native plants were confirmed.

3.1 Vegetation

The vegetation units were described using the classification of vegetation in Bush Forever (Department of Environmental Protection, 2000). These are outlined in Table 1.

Table 1. Vegetation layers. Adapted from: Bush Forever (Department of Environmental Protection, 2000)

Life Form/ Height Class	Canopy Cover			
	100-70%	**70-30%**	**30-10%**	**10-2%**
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland

3.2 Vegetation Condition

The vegetation condition of the vegetation community was recorded using the 6-scale condition rating as appeared in Bush Forever (Department of Environmental Protection, 2000).

Table 2. Explanation of Vegetation Condition Rating (Department of Environmental Protection, 2000)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

3.3 Declared Rare and Priority Flora

A search of the CALM Rare Flora database was undertaken for the Kwinana Beach area, using the co-ordinates 32°10'-32°20'S and 115°45'-115°52'E. The results are listed in Table 4 and an explanation of the codes is given in Table 3.

Table 3. Code and description of Rare and Priority Flora categories

Code	Code Declared Rare and Priority Flora Categories
R	DRF (Declared Rare Flora) -Extant Taxa. Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection.
X	DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
1	Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat.
2	Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3	Priority Three -Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Table 4. Rare and Priority Flora listed by CALM for the area

Code	Species	Description	Flowering
R	*Diuris micrantha*	Tuberous, perennial, herb, 0.3-0.6 m high. Fl. yellow, brown. Brown loamy clay. Winter-wet swamps, in shallow water.	Sep-Oct
R	*Drakaea elastica*	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow. White or grey sand. Low-lying situations adjoining winter-wet swamps.	Oct–Nov
R	*Verticordia plumosa* var. *ananeotes*	Erect, sparsely branched shrub, 0.3–0.5 m high. Fl. pink, purple, white. Sandy loam. Seasonally inundated plains.	Nov–Dec
P3	*Aotus cordifolia*	Erect or straggling shrub, 0.3–1.5 m high. Fl. yellow. Peaty soils. Swamps.	Aug–Jan
P4	*Aponogeton hexatepalus*	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white. Mud. Freshwater: ponds, rivers, claypans.	Jul–Oct
P4	*Dodonaea hackettiana*	Erect shrub or tree, 1-5 m high. Fl. yellow, green, red. Sand. Outcropping limestone.	Jul-Oct
P4	*Jacksonia sericea*	Low spreading shrub, to 0.6 m high. Fl. orange. Calcareous & sandy soils.	Dec–Feb

4. RESULTS

The vegetation at the site has been modified considerably. *Eucalyptus utilis* and *Melaleuca lanceolata* have been planted extensively in the swales. *Eucalyptus utilis* occurs from the east of Albany to Esperance. *Melaleuca lanceolata* is recorded along the coastal regions of metropolitan Perth but the size of the plants at the Kwinana site indicate they were planted.

4.1 Vegetation Units

The species recorded from each of the vegetation units are listed in Appendix A, together with a photograph of the unit. The survey was undertaken when annual species were too small for positive identification so many of the grass species were not identified.

A total of 5 vegetation units were identified at the site. All were examples of the foredune alliance but the species present varied with the protection from the prevailing wind. Some species were only recorded in the swales, eg *Agonis flexuosa*.

- Low Open Forest of *Agonis flexuosa* subsp. *flexuosa* over a Tall Open Shrubland of Acacia *rostellifera* over a Grassland of weed species.
  This vegetation unit occurred on the northern side of Barter Road in a slightly wider section of the remnant bushland. Adjacent to the access track the area was degraded and included plants of *Scabiosa atropurpurea, Callitris preissii, Ehrharta calycina* as well as the native species *Acacia rostellifera*.

- Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* (previously *Eucalyptus platypus* subsp. *heterophylla*) and *Melaleuca lanceolata*.
  This was the dominant vegetation unit on the seaward side of the site. The small trees of *Eucalyptus utilis* and *Melaleuca lanceolata* occurred predominantly in the swales or areas protected from the wind. Areas of *Lepidosperma gladiatum* were common in this vegetation unit.

- Open Heath of *Acacia rostellifera* over Open Low Heath of *Rhagodia baccata* over annual species. This vegetation occurred at the northern end of the site, but 80% of all the *Acacia rostellifera* shrubs were dead. They had not been burnt, and from the aerial photograph appeared healthy when it was taken.

- Closed Grassland dominated by annual grasses but with many plants of a perennial grass including *Spinifex longifolius*. This occurred in a more open area, that appeared to have been cleared previously and was now regrowing.

- Low Open Shrubland of **Cakile maritima* and *Tetragonia omplexicoma* with occasional plants of *Spinifex longifolius* on the sea side of the dune face. This was the most exposed of the vegetation units.

In addition there was a triangular section fenced off from the remainder of the area. This had scattered planted trees including *Melaleuca cuticularis, Callitris preissii, Casuarina ? equisitifolia, Leptospermum laevigatum* and *Acacia saligna* over annual grasses. Near the turn around track there was one plant of **Acacia longifolia* (Sydney golden wattle) recorded.

4.2 Vegetation Condition

The vegetation condition of the total area surveyed varied between 4 and 5 (See Table 2), good to degraded. The Low Open Forest of *Agonis flexuosa* subsp. *flexuosa* and Tall Open Shrubland of *Acacia rostellifera* had a dense foliage cover but the understorey had been completely replaced by weeds.

4.3 Flora

A total of 27 vascular plant families, 53 genera and 64 species of which 39 were not native to the area. Weeds had mostly replaced the understorey so if the survey had been undertaken later in the season it is expected that the number of non-native species would increase considerably. The spring survey (September) increased the number of weed taxa and confirmed the identity of some native taxa.

4.4 Significant Flora

No significant flora, including Declared Rare or Priority flora were recorded from the site. None of the vegetation units present were Threatened Ecological Communities (English, 2004).

4.5 Introduced Plants

A total of 39 weeds and plantings were recorded from the site. Twenty seven have been determined as weeds by the Department of Conservation and Land Management (1999) and the Western Australian Herbarium (2004a,b) and their rating is given below in Table 5. The rating allocated to each weed by CALM is based on three criteria:

- **Invasiveness** – ability to invade natural bushland in good to excellent condition or ability to invade waterways.
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.
- **Environmental impacts** – Ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation unit.

Ratings indicate the following.

- **High** indicates this weed is prioritised for control and/or research ie prioritising funding to it.
- **Moderate** indicates control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** indicates monitoring of the weed and control where appropriate.
- **Low** indicates that this species would require a low level of monitoring.

Table 5. Weeds recorded during the survey classified according to CALM (1999)

Scientific Name	CALM Rating		
	Rating	Invasiveness	Impacts
**Bromus diandrus*	High	✓	✓
**Ehrharta calycina*	High	✓	✓
**Euphorbia terracina*	High	✓	✓
**Lagurus ovatus*	High	✓	✓
**Leptospermum laevigatum*	High	✓	✓
**Pelargonium capitatum*	High	✓	✓
**Romulea rosea*	High	✓	✓
**Arctotheca populifolia*	Moderate	✓	
**Arctotheca calendula*	Moderate	✓	
**Cakile maritima*	Moderate	✓	
**Carpobrotus edulis*	Moderate	✓	
**Crassula glomerata*	Moderate	✓	
**Cynodon dactylon*	Moderate	✓	
**Cyperus tenellus*	Moderate	✓	
**Ehrharta longiflora*	Moderate	✓	
**Euphorbia paralias*	Moderate	✓	
**Euphorbia peplus*	Moderate	✓	
**Hypochaeris glabra*	Moderate	✓	
**Lactuca serriola*	Moderate	✓	
**Oenothera drummondii*	Moderate	✓	
**Solanum nigrum*	Moderate	✓	
**Sonchus oleraceus*	Moderate	✓	

Scientific Name	CALM Rating		
	Rating	Invasiveness	Impacts
**Fumaria capreolata*	Mild		
**Oxalis pes-caprae*	Mild		
**Trachyandra divaricata*	Mild		
**Medicago polymorpha*	Mild		
**Ammophila arenaria*	Low		
**Arctotis stoechadifolia*	Low		
**Conyza parva*	Low		
**Lolium perenne* x *L. rigidum*			
**Oenothera mollissima*	Low		
**Ricinus communis*	Low		
**Scabiosa atropurpurea*	Low		
**Acacia longifolia*	Planted		
**Callitris preissii*	Planted		
**Casuarina ? equisitifolia*	Planted		
**Eucalyptus utilis*	Planted		
**Melaleuca cuticularis*	Planted		
**Melaleuca lanceolata*	Planted		

Seven of the weeds are rated as high, 15 as Moderate, 4 as mild and 6 as Low. Some of the weeds rated as High are widespread through the site eg **Bromus diandrus*, **Euphorbia terracina*, others are restricted to small areas at present eg **Ehrharta calycina*. All weeds classified as high should be targeted for removal. **Euphorbia paralias*, classified as moderate is now invading a lot of the beach front and should also be included as a species for immediate removal. Although some of the species are listed as weeds they have become so well established at coastal areas to be considered native species eg **Cakile maritima, *Arctotheca populifolia* and do stabilize the soil so should not be removed until other species are established.

4.6 Species recorded from southern side of Barter Road

As rehabilitation of the site is intended after the desalination plant has been installed the potential to obtain species from the adjoining area was determined. The vegetation on the southern side of Barter Road included more variety of species than at the site surveyed and generally fewer weeds.

Table 6. Native plants suitable for rehabilitation

FAMILY	SCIENTIFIC NAME	COMMON NAME
AIZOACEAE	*Tetragonia decumbens*	
APOCYNACEAE	*Alyxia buxifolia*	Dysentery bush
ASTERACEAE	*Senecio pinnatifidus*	Variable groundsel
CHENOPODIACEAE	*Rhagodia baccata*	Sea berry bush
CYPERACEAE	*Lepidosperma gladiatum*	Sword sedge
EPACRIDACEAE	*Leucopogon parviflorus*	Coastal beard heath
GOODENIACEAE	*Scaevola crassifolia*	Thick leaved scaevola
MIMOSACEAE	*Acacia cochlearis*	Rigid wattle
	Acacia cyclops	Coastal wattle
	Acacia rostellifera	Summer scented wattle
	Acacia saligna	Orange wattle
MYRTACEAE	*Melaleuca systena*	Coastal honey myrtle
PAPILIONACEAE	*Hardenbergia comptoniana*	Native hardenbergia
	Jacksonia furcellata	Grey stinkwood
POACEAE	*Spinifex longifolius*	Beach spinifex
RANUNCULACEAE	*Clematis microphylla*	Old man's beard
RHAMNACEAE	*Spyridium globulosum*	Basket bush

There were additional introduced species in this area that were not recorded from the site surveyed. These included: **Nerium oleander* (Oleander); **Rhamnus alaternus* (Buckthorn); **Pennisetum setaceum* (Fountain grass) as well as **Leptospermum laevigatum, *Oxalis pes-caprae, *Euphorbia terracina* and **Pelargonium capitatum* which were also recorded from the surveyed site. **Rhamnus alaternus* was common throughout the area where it was a small tree about 5m tall. Hussey *et al*. (1997) state that this weed has the potential to become a serious weed of disturbed bushland as the seeds are dispersed by birds.

5. DISCUSSION

The site for the proposed desalination plant is included in the Quindalup vegetation complex. A total of 53 species were recorded from the site of which 33 were planted or gazetted weeds. This indicates that the site is degraded, although many weeds were recorded they do assist in binding the dune and ensuring it is stabilized. The dune face at the ocean had been and continues to be undercut by wave action during storms. Many of the plants at this face were weeds but they have assisted with ensuring that wave erosion is minimized. When development occurs it will be essential to ensure that the disturbance area is stablised with suitable plant species, or with mulching or laying of branches over the surface until the plants become established. At the northern end of the site surveyed stabilizing material had been laid to reduce erosion.

Dominant native species in the remnant bushland to the south of the site were also listed as seed from these plants could be collected and used in the rehabilitation of the area. Acacia rostellifera is a dominant species at the site, grows quickly and stabilizes the soil. This would be a good species to plant immediately the development has been completed. Many wattle species survive only a few years but do provide protection for other species. If only sections of the area are disturbed the plants surrounding the disturbance should also become established through their seed being dispersed naturally over the area.

The non-native trees and shrubs not classified by CALM (1999) as weeds should not be replanted in disturbed areas, but should not be removed from where they occur now. They do not appear to be spreading naturally as those observed were all mature.

Plants of *Spinifex longifolius* were growing in some of the degraded areas. This species should be encouraged as it binds the soil and can take a reasonable amount of sand build up, thus assisting with erosion prevention. The sea side of the site is a very fragile environment, which can be readily damaged through plant destruction.

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APPENDIX A

Vegetation Units

KEY

ABBREVIATION	EXPLANATION
*	Introduces/weed species
?	Unsure if correct name
sp.	species
subsp.	Subspecies
var.	Variety
affin	Closest to the species

Low Open Forest of *Agonis flexuosa* subsp. *flexuosa* over a Tall Open Shrubland of Acacia *rostellifera* over a Grassland of weed species

Vegetation Condition 5 (Degraded)

Species recorded from vegetation unit

FAMILY	TAXON	HEIGHT (cm)	% COVER
APOCYNACEAE	*Alyxia buxifolia*	150	<1
ASPHODELACEAE	**Trachyandra divaricata*	35	10
ASTERACEAE	**Hypochaeris glabra*	5	<1
	Senecio pinnatifidus	20	<1
CYPERACEAE	**Cyperus tenellus*	5	<1
EUPHORBIACEAE	**Euphorbia peplus*	15	5
	**Euphorbia terracina*	20	5
	**Ricinus communis*	20	<1
FUMARIACEAE	**Fumaria capreolata*	200	<1
GERANIACEAE	**Pelargonium capitatum*	40	<1
IRIDACEAE	**Romulea rosea*	20	15
MIMOSACEAE	*Acacia rostellifera*	300	10
	Acacia saligna	25	5
MYRTACEAE	*Agonis flexuosa subsp. flexuosa*	500	60
	**Leptospermum laevigatum*	300	1
ONAGRACEAE	**Oenothera mollissima*	30	<1
OXALIDACEAE	**Oxalis pes-caprae*	20	10
PAPILIONACEAE	**Medicago polymorpha*	10	2
POACEAE	**Avena barbata*		
	**Bromus diandrus*	30	20
	**Cynodon dactylon*	15	20
	**Ehrharta longiflora*	15	5
	**Lagurus ovatus*	30	10
	**Lolium perenne* x *L. rigidum*	25	3
RHAMNACEAE	**Rhamnus alaternus*	100	<1
	Spyridium globulosum	120	<1

Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* and *Melaleuca lanceolata*.

Vegetation Condition 4 (Good) with areas of Vegetation Condition 5 (Degraded)

Species recorded from vegetation unit

FAMILY	TAXON	HEIGHT (cm)	% COVER
AIZOACEAE	*Carpobrotus virescens*	15	1
	Tetragonia implexicoma	30	2
APOCYNACEAE	*Alyxia buxifolia*	100	1
ASPHODELACEAE	**Trachyandra divaricata*	35	15
ASTERACEAE	**Arctotheca calendula*	15	1
	Olearia axillaris	50	<1
	Senecio pinnatifidus	10	5
	**Sonchus oleraceus*	5	<1
CHENOPODIACEAE	*Rhagodia baccata*	75	3
CRASSULACEAE	**Crassula glomerata*	5	1
CYPERACEAE	*Lepidosperma gladiatum*	70	5
DASYPOGONACEAE	*Acanthocarpus preissii*	50	<1
EUPHORBIACEAE	**Euphorbia peplus*	35	1
	**Euphorbia terracina*	30	1
GERANIACEAE	**Pelargonium capitatum*	25	2
GOODENIACEAE	*Scaevola crassifolia*	140	5
IRIDACEAE	**Romulea rosea*	15	5
LAURACEAE	*Cassytha racemosa* subsp. *racemosa*	5	<1
MIMOSACEAE	*Acacia cochlearis*	150	5
	Acacia rostellifera	300	30
	Acacia saligna	300	2
MYOPORACEAE	*Eremophila glabra*	40	<1
MYRTACEAE	*Agonis flexuosa* subsp. *flexuosa*	100	<1
	Calothamnus quadrifidus	60	1
	**Eucalyptus utilis*	300	10
	**Melaleuca cuticularis*	100	<1
	**Melaleuca lanceolata*	200	1
OXALIDACEAE	**Oxalis pes-caprae*	25	10
	**Lupinus cosentinii*		
PAPILIONACEAE	**Medicago polymorpha*	10	<1
POACEAE	**Avena barbata*		
	**Bromus diandrus*	15	40

FAMILY	TAXON	HEIGHT (cm)	% COVER
POACEAE (cont.)	**Ehrharta longiflora*	30	5
	**Lagurus ovatus*	20	5
	**Lolium perenne* x *L. rigidum*	30	1
SOLANACEAE	**Solanum nigrum*	10	<1

Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* and *Melaleuca lanceolata* (cont.)

Lepidosperma gladiatum was dominant in some of the swales.

Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* and *Melaleuca lanceolata*

Vegetation Condition 4 (Good)

Species recorded from vegetation unit

FAMILY	TAXON	HEIGHT (cm)	% COVER
AIZOACEAE	*Carpobrotus virescens*	10	4
	Tetragonia implexicoma	50	5
ASPHODELACEAE	**Trachyandra divaricata*	35	5
ASTERACEAE	**Conyza parva*	35	1
	**Hypochaeris glabra*	3	1
	**Lactuca serriola*	15	<1
	**Sonchus oleraceus*	15	1
CHENOPODIACEAE	*Rhagodia baccata*	250	40
CRASSULACEAE	**Crassula glomerata*	5	25
CYPERACEAE	*Lepidosperma gladiatum*	45	2
EUPHORBIACEAE	**Euphorbia peplus*	5	1
GOODENIACEAE	*Scaevola crassifolia*	60	2
MIMOSACEAE	*Acacia cyclops*	150	1
	Acacia rostellifera	400	50, 80% of which dead
MYRTACEAE	*Agonis flexuosa* subsp. *flexuosa*	150	1
POACEAE	**Ammophila arenaria*	40	5
	**Bromus diandrus*	5	30
	**Cynodon dactylon*	5	5
	Spinifex longifolius	40	3
RHAMNACEAE	*Spyridium globulosum*	40	1
SOLANACEAE	**Solanum nigrum*	15	1

Closed Grassland dominated by annual grasses but with many plants of a perennial grass including *Spinifex longifolius*.

Vegetation condition 4-5 (Good to Degraded)

Species recorded from vegetation unit

FAMILY	TAXON	HEIGHT (cm)	% COVER
AIZOACEAE	*Carpobrotus virescens*	10	10
	Tetragonia implexicoma	100	10
ASPHODELACEAE	**Trachyandra divaricata*	25	5
ASTERACEAE	**Arctotis stoechadifolia*	10	25
	Leucophyta brownii		
	Olearia axillaris	50	1
	Senecio pinnatifidus	15	5
CASUARINACEAE	**Casuarina ? equisitifolia*	150	1
CRASSULACEAE	**Crassula glomerata*		
CYPERACEAE	*Ficinia nodosa*	50	1
CHENOPODIACEAE	*Rhagodia baccata*	50	1
ONAGRACEAE	**Oenothera mollissima*	80	5
POACEAE	**Bromus diandrus*	20	30
	**Ehrharta longiflora*	30	5
	**Lagurus ovatus*	25	20
	**Lolium perenne* x *L. rigidum*	30	5
	Spinifex longifolius	150	2
	Unknown perennial grass	150	8

Low Open Shrubland of *Cakile maritima* and *Tetragonia decumbens* with occasional plants of *Spinifex longifolius*

Vegetation condition 3-4 (Very good - Good)

FAMILY	TAXON	HEIGHT (cm)	% COVER
AIZOACEAE	*Carpobrotus virescens*	15	1
	Tetragonia implexicoma	25	5
ASPHODELACEAE	**Trachyandra divaricata*	25	5
ASTERACEAE	*Arctotheca populifolia*	5	1
	**Sonchus oleraceus*		
BRASSICACEAE	**Cakile maritima*	30	10
CHENOPODIACEAE	*Atriplex vesicarius*	100	1
EUPHORBIACEAE	**Euphorbia paralias*	20	2
GERANIACEAE	**Pelargonium capitatum*	30	1
ONAGRACEAE	**Oenothera drummondii*	25	1
POACEAE	**Lolium perenne* x *L. rigidum*	10	2
	Spinifex longifolius	45	10

APPENDIX B

Species recorded from the area

FAMILY	SCIENTIFIC NAME	COMMON NAME
AIZOACEAE	*Carpobrotus virescens*	Coastal pigface
	Tetragonia implexicoma	Bower spinach
APOCYNACEAE	*Alyxia buxifolia*	Dysentery bush
ASPHODELACEAE	**Trachyandra divaricata*	Dune onion grass
ASTERACEAE	**Arctotis stoechadifolia*	Arctotis
	**Arctotheca populifolia*	Dune arctotheca
	**Arctotheca calendula*	Cape weed
	**Conyza parva*	Fleabane
	**Hypochaeris glabra*	Flat weed
	**Lactuca serriola*	Prickly lettuce
	Leucophyta brownii	Cushion bush
	**Sonchus oleraceus*	Sow thistle
	Olearia axillaris	Coastal daisybush
	Senecio pinnatifidus	Variable groundsel
BRASSICACEAE	**Cakile maritima*	Sea rocket
CASUARINACEAE	**Casuarina ? equisitifolia*	
CHENOPODIACEAE	*Atriplex vesicaria*	Bladder saltbush
	Rhagodia baccata	Berry saltbush
CRASSULACEAE	**Crassula glomerata*	Stonecrop
CUPRESSACEAE	**Callitris preissii*	Rottnest island pine
CYPERACEAE	**Cyperus tenellus*	Tiny flat sedge
	Ficinia nodosa	Knotted club rush
	Lepidosperma gladiatum	Sword sedge
DASYPOGONACEAE	*Acanthocarpus preissii*	
DIPSACEAE	**Scabiosa atropurpurea*	Purple pincushion
EUPHORBIACEAE	**Euphorbia paralias*	Sea spurge
	**Euphorbia peplus*	Petty spurge
	**Euphorbia terracina*	Geraldton carnation weed
	**Ricinus communis*	Castor oil plant
FUMARIACEAE	**Fumaria capreolata*	White fumitory
GERANIACEAE	**Pelargonium capitatum*	Rose pelargonium
GOODENIACEAE	*Scaevola crassifolia*	Thick leaved fanflower
IRIDACEAE	**Romulea rosea*	Guildford grass
LAURACEAE	*Cassytha racemosa* subsp. *racemosa*	Dodder laurel
MIMOSACEAE	*Acacia cochlearis*	Rigid wattle
	Acacia cyclops	Coastal wattle
	**Acacia longifolia*	Sydney golden wattle
	Acacia rostellifera	Summer scented wattle
	Acacia saligna	Orange wattle
MYOPORACEAE	*Eremophila glabra*	Tar bush
MYRTACEAE	**Leptospermum laevigatum*	Victorian teatree
	Agonis flexuosa subsp. *flexuosa*	Peppermint tree
	Calothamnus quadrifidus	One-sided bottlebrush
	**Eucalyptus utilis*	Coastal moort
	**Melaleuca cuticularis*	Salt water paperbark
	**Melaleuca lanceolata*	Rottnest teatree
ONAGRACEAE	**Oenothera drummondii*	Beach evening primrose
	**Oenothera mollissima*	Evening primrose
OXALIDACEAE	**Oxalis pes-caprae*	Soursob
PAPILIONACEAE	**Lupinus cosentinii*	WA blue lupin
	**Medicago polymorpha*	Burr medic
POACEAE	**Ammophila arenaria*	Marram grass
	**Avena barbata*	Bearded oat
	**Bromus diandrus*	Great brome
	**Cynodon dactylon*	Couch
	**Ehrharta calycina*	Perennial veldt grass

FAMILY	SCIENTIFIC NAME	COMMON NAME
POACEAE (cont.)	**Ehrharta longiflora*	Annual veldt grass
	**Lagurus ovatus*	Hare's tail grass
	**Lolium perenne* x *L. rigidum*	Rye grass
	Spinifex longifolius	Beach spinifex
RHAMNACEAE	**Rhamnus alaternus*	Buckthorn
RHAMNACEAE	*Spyridium globulosum*	Basket bush
SOLANACEAE	**Solanum nigrum*	Black berry nightshade

APPENDIX C

Vegetation Units

KEY

ABBREVIATION	DESCRIPTION
Af	Low Open Forest of *Agonis flexuosa* subsp. *flexuosa* over a Tall Open Shrubland of Acacia *rostellifera* over a Grassland of weed species
Eu	Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* and *Melaleuca lanceolata*
Ar	Open Heath of *Acacia rostellifera* over annual grasses with emergent *Eucalyptus utilis* and *Melaleuca lanceolata*
Sl	Closed Grassland dominated by annual grasses but with many plants of perennial grass including *Spinifex longifolius*
Cm	Low Open Shrubland of *Cakile maritima* and *Tetragonia decumbens* with occasional plants of *Spinifex longifolius*

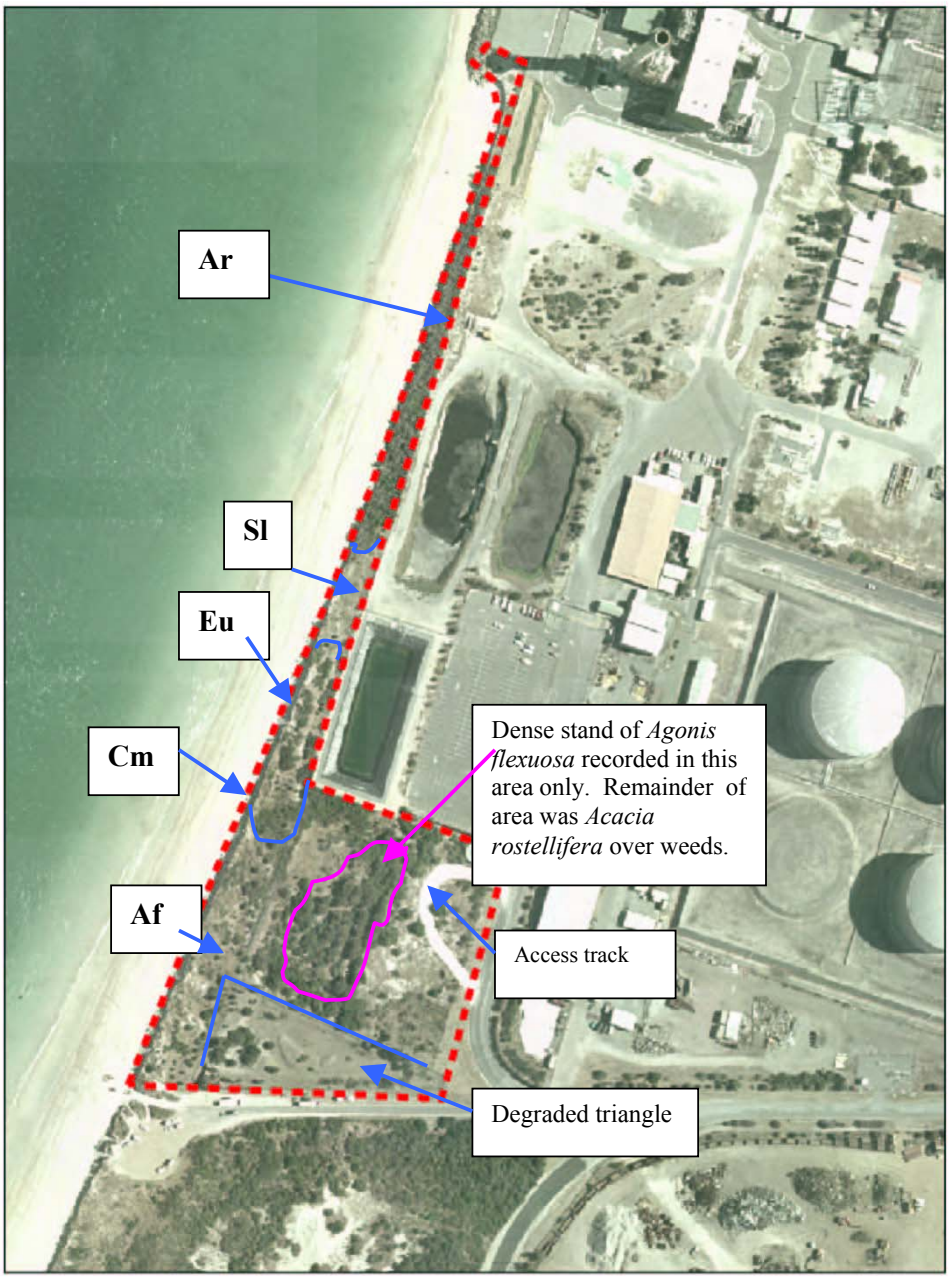

Figure 1: Study Area Boundary