

**KING BAY EASTERN LEASE AREA
INDUSTRIAL ESTATE
VEGETATION AND FLORA REPORT**

Prepared for:

BGC Contracting



Astron Environmental
Suite 7, 11 Hedland Place
PO Box 713
Karratha, WA 6714
Phone: (08) 9144 1679
Fax: (08) 9144 2638
Email: astron@astron.com.au

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BGC Contracting – King Bay East Industrial Area

KING BAY EASTERN LEASE AREA INDUSTRIAL ESTATE

VEGETATION AND FLORA REPORT

1 INTRODUCTION

1.1 BACKGROUND

In February 2003 Astron Environmental was commissioned to conduct a vegetation and flora survey of the proposed BGC Contracting King Bay Eastern Lease Area Industrial Estate. The proposed site is located approximately 10 km north-west from Karratha, on the Burrup Peninsula.

Development of the project necessitates the clearing and levelling of 20 ha of high rockpiled hilly terrain and dissecting gullies, resulting in the total removal of all vegetation on site.

The survey conducted for this report was undertaken on March 5th and 6th 2003. Although 20 mm of rain was recorded on the Burrup Peninsula in January 2003, this was not sufficient to conduct a valid “wet season” survey (Steve van Leeuwin, CALM Karratha, *pers comm*). The aim of this initial survey was to provide an indication of the vegetation and key flora species present, sufficient for inclusion in a submission to the Department of Environmental Protection (DEP).

1.2 THE SITE

The proposed site is located on the northern side of King Bay, extending from the rocky shore of the bay to King Bay Road, approximately 1.5 km east of Woodside Supply Base. According to the Burrup Land Use Management Plan (O’Brien, 1994), the proposed site is located in an area designated for industry. In the north-west corner of the proposed site there is a disturbed area of shallow borrowing around a rockpile, and an overgrown access track. The southern and south-eastern two thirds of the site remains undisturbed.

The lease site consists of a number of habitats including a large proportion of rock pile, hillocks with outcropping rock, upper undulating slopes and plateaus, lower slopes, two major drainage gullies, minor drainage lines, and a narrow coastal fringe of samphire paralleling an area of dense mangal.

The site is surrounded by industry service leases to the west and north-east, and by King Bay Road to the north. King Bay itself forms the southern boundary, and from the narrow rocky coastline, there is a relatively rapid rocky rise to a higher plateau area punctuated by numerous large rockpiles and outcrops. One particularly large, triangular shaped rocky hill formation, which slopes down from the middle of the site to King Bay, is flanked by two rocky gullies flowing north-south. Skeletal silty soils occur over much of the site, having depth only in the gullies and broader shallow drainage lines that cross the site. Each of these habitats contain a rich and diverse floral assemblage.



The high rockpile landform reaching down to the mangrove lined stony shoreline is the only remaining example of its kind on the southern edge of King Bay, and indeed on the entire Peninsula. All other occurrences of this landform type on the Burrup have previously been removed and flattened for industry. In contrast to the proposed development site, the land flanking the tidal inlet on the eastern side of Burrup Road, is quite different, consisting of coastal flats that gently give way to rocky hill slopes. The southern side of the inlet (opposite the proposed lease) is similarly landscaped with coastal flats. At no other site along the inlet do the rocky hills tumble down so abruptly into the mangal surrounding the inlet, so much so as to actually be contained within the mangal itself. (Plates 1, 2 & 3).

In their present form, the high rocky hills and associated vegetation within the site currently offers an effective visual barrier from Burrup Road (Plates 4 & 5) against the extensively cut, levelled and cleared banks of the inlet beyond the lease site and the associated industrial leases. (Plates 6 & 7)

1.3 AIMS

Considering the survey was conducted after inadequate rainfall, (see Figure 1), the limitations restricting a comprehensive knowledge of the flora and vegetation of the site were apparent. As a result, this survey was largely aimed at providing a general level of information sufficient to assist the relevant government bodies in making a low level assessment. With this in mind, the overall aims of the survey were to:

1. determine broadscale vegetation types from a visual assessment
2. identify, as far as possible, species listed on the Declared Rare and Priority Flora List
3. identify, as far as possible, species regarded as being “significant” on both a local and regional scale;
4. identify vegetation types regarded as being “significant” on both a local and regional scale and,
5. locate and identify, as far as possible, weed species.

A comprehensive vegetation and flora survey should be conducted following adequate rainfall.

1.4 THIS REPORT

This report describes the results of an initial vegetation and flora survey conducted at the proposed quarry site in March 2003. The existing state of knowledge of vegetation on the Burrup is described in Section 2. Methods used during the survey are given in Section 3, while the results are described in Section 4. Section 5 includes recommendations for the conservation of vegetation communities found on the proposed BGC quarry site.

1.5 LIMITATIONS

A major factor limiting the vegetation survey was the lack of rainfall in the months prior to the survey being undertaken. Until the time of the survey, only 24-30 mls (depending on which recording station the reading was taken from) had been recorded for the current summer (Figure 1). A further 21 ml was recorded immediately following the survey (previous to this report). Prior to that, substantial rainfall had not been recorded on the Burrup since June 2002, when 58-65 ml was recorded in a single rainfall event. It is worth noting that the most significant rainfall event previous to that was in January 2001, indicating the duration over which dry conditions have prevailed.



A paucity of rainfall in semi-arid areas reduces the effectiveness of a vegetation and flora survey in a number of ways. Primarily it results in a reduction in the estimates of species richness for a site, particularly for resident herbaceous annual and ephemeral species, which have either senesced, remained dormant and/or failed to germinate. A high rate of senescence or dormancy can also complicate the process of positive identification for a number of plant species. Reduced rainfall also forces a majority of perennial tree, shrub and dwarf shrub species into aestivation, resulting in a reduction in the estimate of their community dominance and cover. For these reasons, an intensive survey conducted in the middle of an extended dry season can lead to a misrepresentation of site dynamics and would not provide a level of information detailed enough to satisfy the current requirements for vegetation and flora surveys on the Burrup Peninsula.

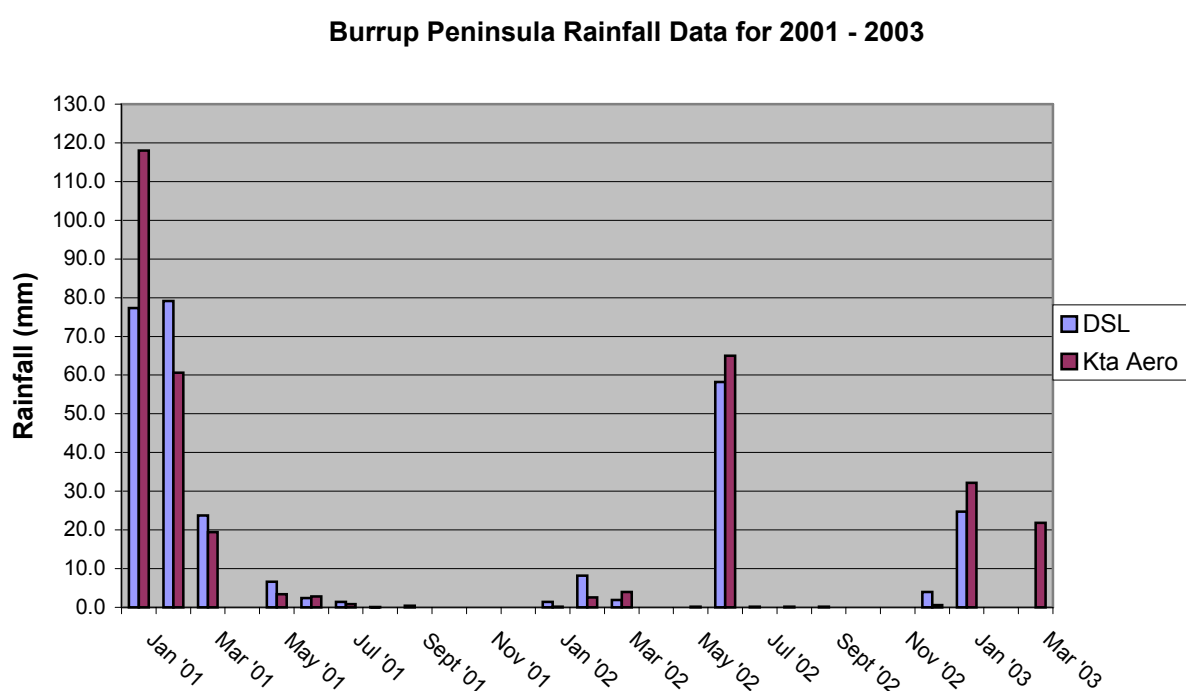


Figure 1: Rainfall data for Burrup Peninsula 2001 - 2003

A second major limitation to the survey is the lack of available specimens and/or descriptions of the “species of conservation significance”, as identified by Trudgen (2002), for confirmation of identification. For example there are five *Euphorbia* species on the list for conservation, some of which are apparently rare or newly recognised. At present, however, there are no specimens or detailed descriptions available in either the Western Australian or Pilbara Regional Herbariums with which comparisons can be made. There are in fact 13 taxa on this list which are only identified to species level (eg. *Euphorbia* sp). This makes assessment of the flora difficult to achieve.

2 VEGETATION AND FLORA OF THE BURRUP PENINSULA

2.1 EXISTING KNOWLEDGE OF VEGETATION ON THE BURRUP PENINSULA

The Burrup Peninsula is located at the western end of the Abydos Plains in the Pilbara region of Western Australia. The peninsula lies within the Fortescue Botanical District, which is part of the biogeographical region known as the Eremaean Botanical Province (Beard 1975), and within the Pilbara biogeographic region in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995). Beard (1975) described the vegetation of the botanical province as predominantly open grassy plains or mixed grass and spinifex with shrub steppe occurring further inland on the granite plains. Thackway and Cresswell (1995) described the vegetation as “Quaternary alluvial plains with a grass savanna of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* (now *A. stellaticeps*) over *Triodia pungens* (now *T. epactia*). Samphire, *Sporobolus* and Mangal occur on marine alluvial flats”.

The dominant vegetation type of the Burrup Peninsula can be broadly described as mid-dense hummock (*Triodia* sp) grass with mixed scrub and open low woodland, punctuated by habitat and substrate related minor communities. The result is a complex mosaic of vegetation assemblages that makes classification and mapping in the area a difficult task. As an indication of the complexity of vegetation for the Burrup Peninsula, Blackwell and Cala (1979) described a group of five basic vegetation units for the area, that were further divided into 28 communities.

Results of a recent survey of the area concluded that the Burrup Peninsula, along with Dolphin, Angel and Gidley Islands, comprise an arrangement of vegetation units distinct from the surrounding region (Trudgen and Griffin 2001; Trudgen 2002). In other words, the vegetation of the Burrup Peninsula is unique, a fact that is being overlooked. This is not a new observation: a similar observation was made by Blackwell *et al.* who, although recognising the Burrup Peninsula as part of the Abydos Plain, also identified it as containing a unique mixture of coastal and eremaeian species in close association with species more typical of the Northern (Kimberley) Botanical Province. Trudgen attributed much of this difference between the Burrup and its surrounds to a combination of geology, microclimates and episodes of isolation from the mainland at times of higher sea level.

The Burrup was also found to contain some 200 vegetation associations (each with small area of occurrence), a rich flora for its size, and a high number of geographically restricted or uncommon species (Trudgen 2002). A significant geographic based pattern for the distribution of floristic units on the peninsula, in accordance with landscape groups (i.e. rockpiles, slopes, drainage lines etc.), was also identified (Trudgen and Griffin 2001; Trudgen 2002).

In a review of the current knowledge of the area, Welker (2002) concluded that the Burrup Peninsula should be considered a different floristic sub-region of the west Pilbara, with a high level of conservation value at a regional level.

2.2 FLORA

To date a total of 390 vascular species have been recorded for the Burrup Peninsula (Weston, 1997). This includes flora recorded by van Leeuwen (1996), Blackwell *et al.* (1979), Long and Astron Environmental (1997, 1998, 1999, 2000) and Trudgen (2002).



2.3 PRIORITY SPECIES

The Department of Conservation and Land Management (CALM) Declared Rare and Priority Flora List (CALM 2000) identifies species that are considered to be under threat of extinction and prioritises these species based on the degree of that threat. The Declared Rare and Priority Flora List is covered under the *Wildlife Conservation Act, 1950*.

Four vascular plants classified on the Declared Rare and Priority Flora List, (CALM, 2000) are known from the Burrup Peninsula. These are:

- *Terminalia supranitifolia* Priority 1
- *Abutilon trudgenii* ms Priority 3
- *Gymnanthera cunninghamii* Priority 3
- *Eriachne tenuiculmis* Priority 3

And more recently (March 2003) *Stackhousia clementii* Priority 1.

The priority codes relating to these species are defined as follows (CALM, 2001):

Priority 1

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size or being on lands under immediate threat. Such taxa are under consideration for declaration as “rare flora” but are in urgent need of further survey.

Priority 3

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered). Such taxa are under consideration for declaration as “rare flora” but are in urgent need of further survey.

2.4 FLORA

In addition to the four Priority species listed for the Burrup Peninsula, Trudgen identified 37 species of conservation significance. These are species identified as having high conservation value as a result of a combination of varying rarities and restrictions. Nine of these species are perennials, 16 are annuals, six are annual/ephemerals and five are ephemerals (one species was unknown). As a result, it is possible that up to 75% of these species (i.e. all non-perennials) would not be identifiable unless rainfall had been adequate. It is worth noting that this percentage has the potential to be considerably higher, as it does not include those perennial species that exhibit dormancy.

2.5 SIGNIFICANT VEGETATION ASSOCIATIONS

Prior to the release of the Trudgen report (2002), significant vegetation on the Burrup Peninsula was based on the criteria listed below compiled from Long (1994) and Astron Environmental (1999, 2000). These criteria were established in the absence of any government or industry-agreed definitions. Significant vegetation was classified as that which:

- is poorly represented in the region

- makes a significant contribution to a particular ecological system
- contains an abundance of Priority and/or significant species
- is in a relatively pristine state
- is at the end of the species range.

Trudgen assesses “rarity” (and therefore significance) of vegetation based on methodologies outlined by the Australian Heritage Commission (1995), using the minimum area for protection of an ecosystem as recommended by the International Union for the Conservation of Nature (IUCN) and, English and Blyth (1997). Using the formulas developed in these references, Trudgen calculates vegetation rarity as governed by area. He defines 2000 ha as the lower limit for definition of a “rare” undisturbed vegetation association and 30% remaining as the threshold for “threatened” status. Given this definition, all vegetation on the Burrup is “significant”, meaning that the removal of any vegetation should be carefully considered, an aspect that continues to go unheeded.

A map showing the frequency of vegetation types on the Burrup was produced utilising the results of Trudgen (2002). This map has a frequency scale ranging from 1 only to 100 or more occurrences on the Burrup Peninsula. The map is a useful tool in assessing the significance of vegetation on any one area of the Burrup Peninsula.

Ten or fewer occurrences of any vegetation association should be treated as significant, and more so if those occurrences are limited to the area zoned for industry.

2.6 WEEDS

Environmental weeds have been defined as plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify the natural environment (CALM 1999). This process is usually adverse and often results in the decline of the communities they invade. Over the years a number of environmental weeds have become established on the Burrup Peninsula, with new introductions continuing to occur. The following list of 13 weed species has been compiled from personal observations (V. Long) and previous surveys conducted on the Burrup (Blackwell *et al.* 1979; Astron Environmental 1997, 1998, 2000). CALM (1999) has allocated a rating to weeds according to their perceived potential impact on the natural ecosystem in which they are found. The CALM rating for each of the known weeds on the Burrup Peninsula is also given below.

<i>Aerva javanica</i> - Kapok	High
<i>Cenchrus ciliaris</i> - Buffel Grass	High
<i>Cenchrus setigerus</i> - Birdwood Grass	High
<i>Cenchrus enchinatus</i> - Mossman River Grass	Low
<i>Rumex vesicarius</i> - Ruby Dock	High
<i>Stylosanthes hamata</i> - Caribbean stylo	Mild
<i>Bidens bipinnata</i> - Bipinnate Beggar-Ticks	TBA
<i>Euphorbia hirsuta</i> - Strawberry Weed	Moderate
<i>Passiflora foetida</i> - Wild Passionfruit	High
<i>Solanum nigrum</i> - Nightshade	Moderate
<i>Chloris barbata</i> - Purple-top chloris	Low
<i>Pennisetum setaceum</i> - Fountain grass	Mild



Malvastrum americanum – Spiked Malvastrum

Moderate

3 METHODS

A literature survey, that included a search of the Rare and Priority species database (CALM 2000), was completed prior to the field survey. Aerial photographs of the site were also studied and a number of key habitats identified.

A botanical survey was carried out on the 5th and 6th of March 2003 under Conservation and Land Management licence numbers CE000259 and NE002888

Each of the habitats identified in the aerial photographs was visited in the field. Vegetation height and density, the presence of major species, and the occurrence of Priority species, detectable weed species or discernible species were recorded in 50 m x 50 m quadrats within habitats. Roughly the equivalent area was searched for all habitats in which 50m x 50 m quadrats were not appropriate (eg. along a narrow gully). Particular effort was taken to keep within particular habitat types whenever searches were made. Opportunistic sightings of flora outside the quadrats were noted separately. Specific communities that had previously been identified as “significant” were searched. The strata were recorded using the height intervals given in Specht, as modified by Aplin (1979), in order to standardise records with the Burrup survey (Trudgen 2002). It should be noted that height and density of the canopy described in this report is relative to the semi-arid environment in which these species occur. A vegetation map was also produced.

4 RESULTS AND DISCUSSION

4.1 HABITAT TYPES

Although the area is relatively small, ten habitats were identified in the diverse topography of the proposed quarry site. These can generally be classified as:

Drainage lines – generally very shallow but distinct drainage lines

Drainage zones – shallow, broad drainage areas that can be quite extensive in size

Lower hill slopes – lower portion of the hill slope, generally with rock or boulder mantle

Upper undulating slopes and plateaus – these are often above rocky ridges or span between upper slopes of hills. They also occur as small areas between rocky ridges.

Rockpiles – these generally have random stands of often dense vegetation that occur in soil pockets

Rocky gullies – rock walled, generally narrow gullies with a distinctive drain flowing through them.

Flats associated with King Bay – these are coastal flats that are not inundated but, according to their vegetation type, are definitely associated with the bay.

Samphire flats – these are semi-saline, irregularly inundated tidal flats.

Pebbled foreshore - this occurs as a very narrow band along the edge of King Bay.

Disturbed areas – these include the shallow scrapings made in the north-north-western section of the site, the old access track and the power line.

4.2 VEGETATION TYPES

Seventeen distinct vegetation associations were identified on the site. These are described under their habitat types below and presented in Figure 2.

Drainage Line

GpAiTe

High shrubland (10-30% >2m) of *Grevillea pyramidalis*, *Acacia inaequilatera* over hummock grassland (30-70%) of mixed *Triodia epactia* (Burrup form) and *Triodia angusta* (Burrup form).

Occurs in a shallow drainage gully running north-south along the eastern boundary of the lease. It is fed from high rockpiled hills to the north and west. Soils are greyish red colluvial silts with scattered stones.

Associated species: Scattered *Acacia bivenosa*, *Dichrostachys spicata*, *Ipomoea costata* with annual herb *Trichodesma zeylanicum*.

Weed Species: None recorded

Priority/Significant Species: *Triumfetta appendiculata* (Burrup form), *Corchorus walcottii*, *Triodia epactia* (Burrup form), *Triodia angusta* (Burrup form)

GpAcoIpTe

High open shrubland (2-10%; 2m) of *Grevillea pyramidalis*, *Acacia colei*, *A. elacantha* over open shrubland (2-10%; 1m) of *Ipomoea costata* over hummock grassland of *Triodia epactia* (Burrup form).

Occurs in very shallow drainage line running east-west across slightly undulating upper terraces on western side of lease.

Associated Species: *Corymbia hamersleyana*, *Acacia bivenosa*.

Weed Species: None recorded

Priority/Significant Species: *Triodia epactia* (Burrup form)

AiEsTe

High Shrubland (10-30% 2m) of *Acacia inaequilatera*, *Ehretia saligna*, *Ipomoea costata* over open low hummock grassland of *Triodia epactia* (Burrup form).

Small pocket of vegetation on upper shallow north-south drainline, protected by rockpiled hills.

Associated species: *Dichrostachys spicata*, *Acacia bivenosa*, *Mukia maderaspatana*

Weeds: *Cenchrus ciliaris* (10%)

Priority/Significant Vegetation: *Triodia epactia* (Burrup form)



Drainage Zone

GpAbTa

High open/shrubland (2-20%, 1.5-2m) of *Grevillea pyramidalis*, *Acacia bivenosa* over hummock grassland (30-70%) of *Triodia angusta* (Burrup form).

Occurs in a broad drainage zone where the drainage line (GpAiTe) opens out onto the coastal strip, eastern side of the lease.

Associated species: *Ipomoea costata*, *Acacia elacantha*, *Corchorus walcottii*, *Adriana tomentosa*.

Weeds: *Cenchrus ciliaris* (2-5%) from track along eastern boundary.

Priority/Significant Species: *Triodia* species. One *Goodenia* sp. (vl-1583-01) was collected from this site. It needs further study – it is not one listed for the Burrup.

Lower Hill Slopes

TeAb(Rm)

Hummock grassland of *Triodia epactia* (Burrup form) with (*lianes of *Rhynchosia minima*) and very open herbs (2-10%) with scattered (<2%) shrubs of *Acacia bivenosa*, *Grevillea pyramidalis*.

(**R. minima* abundant but not mature at time of survey)

Occurs on the lower gentle eastern facing hill slopes on eastern side of the lease. Skeletal reddish brown silts with stony mantle.

Associated Species: *Dichrostachys spicata*, *Indigofera monophylla*, *Trichodesma zeylanicum*

Weed Species *Cenchrus ciliaris* from road along eastern boundary.

Priority/Significant Species: *Triodia epactia* (Burrup form)

ImTe

Low open (2-10%) to shrubland (10-30% <1m) *Indigofera monophylla* over hummock grassland (30-70%) of *Triodia epactia* (Burrup form). There are scattered (<2%) *Acacia bivenosa*.

Occurs on lower, protected south-eastern facing lower slope on eastern side of the site.

Associated Species: *Grevillea pyramidalis*, *Trichodesma zeylanicum*, *Solanum horridum*.

Weed Species: *Cenchrus ciliaris* from eastern track verge.

Priority/Significant Species: *Triodia epactia* (Burrup form)

Upper Undulating Slopes and Plateaus

GpAb(To)Te

Scattered (<2%) to very open mixed shrubland (2-10%; 1-2m) of *Grevillea pyramidalis*, *Acacia bivenosa*, *Hakea lorea* over **open herbland of *Trachymene oleracea* over hummock grassland (30-70%) of *Triodia epactia* (Burrup form).



(** *T. oleracea* abundant but mostly died off at time of survey)

Occurs on upper undulating stony plateau, surrounded by rockpiled hills.

Associated species: *Acacia elacantha*, *Acacia inaequilatera*, *Acacia colei*, *Cymbopogon ambiguus*

Weed species: None

Priority/Significant species: *Triodia epactia* (Burrup form), *Euphorbia* sp (vl-1583-03) may be one of the 5 *Euphorbia* species listed by Trudgen as having conservation significance.

Te(AbGp)

Hummock grassland (30-70%) of *Triodia epactia* over scattered (<2%) shrubs of *Grevillea pyramidalis*, *Acacia bivenosa*.

Occurs on slightly undulating upper terrace on south-western corner of lease, with skeletal red-brown silts with rocks and boulders and some outcropping rock.

Associated species: *Acacia colei*, *Acacia elacantha*, *Ipomoea costata*.

Weed Species: None

Priority/Significant species: *Triodia epactia* (Burrup form)

AcoAbTe

High shrubland (10-30%; 2m) of *Acacia colei*, *A. bivenosa* over hummock grassland (30-70%) of *Triodia epactia* (Burrup form).

Occurs on undulating stony upper slopes on western side of the lease.

Associated Species: *Grevillea pyramidalis*, *Trachymene oleracea*, *Trichodesma zeylanicum*

Weed Species: None recorded

Priority/Significant Species: *Euphorbia* sp, *Triodia epactia* (Burrup form)

Te(Gp)

Hummock grassland (30-70%) of *Triodia epactia* (Burrup form) with open herbs. There are scattered (<2%) *Grevillea pyramidalis* shrubs.

Occurs on eastern facing stony hillslopes and upper corridors and plateaus.

Associated Species: *Themeda* sp Burrup (B84), *Cymbopogon ambiguus*, *Trichodesma zeylanicum*, *Solanum horridum*, *Rhynchosia* sp Burrup (821C).

Weed Species: *Cenchrus ciliaris* on eastern side

Priority/Significant Species: *Themeda* sp Burrup, *Rhynchosia* sp Burrup (821C), *Triodia epactia* (Burrup form)

GpTe(To)

Shrubland (10-30% 1-2m) of *Grevillea pyramidalis* over low open shrubland (2-10%; 1m) of *Trachymene oleracea*, *Trichodesma zeylanicum* over hummock grassland of *Triodia epactia* (Burrup form).

Occurs on south-south-west facing high slopes with boulder mantle and skeletal silts.



Associated species: *Acacia colea*, *Hakea lorea*, *Themeda* sp Burrup (B84), *Solanum horridum*.

Weed Species: None recorded

Priority/Significant species: *Themeda* sp Burrup, *Rhynchosia* sp Burrup (821C), *Triodia epactia* (Burrup form)

Rockpile

TsBaSs

Open woodland (2-10% <5m) of *Terminalia supranitifolia*, *Brachychiton acuminatus*, *Ehretia saligna* var *saligna* over low shrubland (10-30% 1-2m) of *Scaevola* aff *spinescens* (vl-1583-02), *Rhagodia preissii* subsp *obovata*, over very open tussock grassland (2%) of *Cymbopogon ambiguus*.

Occurs in soil pockets and crevices, and around immediate base of rockpiles and outcrops.

Associated species: *Jasminium didymum* subsp *lineare*, *Triodia epactia* (Burrup form), *Pittosporum phylliraeoides* subsp *phylliraeoides*, *Flueggea virosa*, *Acacia coriacea*, *Rhynchosia* sp Burrup (B821C).

Weed Species: *Cenchrus ciliaris* (<2%)

Priority/Significant species: *Terminalia supranitifolia* (Priority 1), *Triumfetta appendiculata* (Burrup form), *Vigna* sp. is possibly *Vigna* sp Burrup (B18), *Themeda* sp Burrup (B84), *Paspalidium tabulatum* (Burrup form)

IpEs(Te)

Open shrubland (10-30%, 1-2m) of *Ipomoea costata*, *Ehretia saligna* over very open hummock grassland (2-10%) of *Triodia epactia* (Burrup form).

Occurs on upper, landward side of rockpiles associated with edge of King Bay, south west portion. Also found on rockpiles on south-east corner of site.

Priority/Significant species: None

Rocky Gully

ChTsFoTa

Open woodland (2-10% <10m) of *Corymbia hamersleyana*, *Terminalia supranitifolia* over high shrubland (10-30%; 1m) of *Ficus opposita*, *Flueggea virosa* subsp. *melanthesoides* over open low shrubland (2-10%, 1m) of *Dichrostachys spicata*, *Senna glutinosa* over Hummock Grassland of *Triodia angusta* (Burrup form) and *Triodia epactia*.

Occurs in deep rocky gullies running north-south through the site. Reddish brown colluvial soils with small rocks and boulders.

Associated Species: *Pittosporum phylliraeoides* subsp *phylliraeoides*, *Alectryon oleifolius* subsp *oleifolius*, *Brachychiton acuminatus*, *Clerodendrum tomentosa*, *Scaevola* aff *spinescens* (vl-1583-02), *Rhynchosia* sp Burrup (821C).

Weed species: *Cenchrus ciliaris* 5%



Priority/Significant species: *Terminalia supranitifolia* (Priority 1), *Corchorus walcottii*, *Themda* sp Burrup (B84),

It is possible that *Rhynchosia* sp Burrup (821C) is actually *Rhynchosia* sp King Bay (B181-13) – no specimens available to confirm this.

Flats Associated with King Bay

AaTa

High Shrubland (10-30%) to Open Scrub (30-70%; 2m) of *Acacia ampliceps*, *A. ampliceps* x *bivenosa* over dense hummock grassland of *Triodia angusta* (Burrup form).

Occurs on a low lying drainage area associated with King Bay, on the south-eastern corner of the lease. Brown silty soil, relatively deep with scattered stones and pebbles. There are deeper narrow drains within the drainage zone where species such as *Cyperus vaginatus* are found. There was a colony of Variegated Wrens here.

Associated species: *Myoporum montanum*, *Cyperus vaginatus*, *Adriana tomentosa*

Weed species: *Cenchrus ciliaris*, *Aerva javanica* invading from eastern road verge.

Priority/Significant species: *Triodia angusta* (Burrup form)

Ta

Closed hummock grassland (70-100%) of *Triodia angusta* (Burrup form).

Occurs on south facing lower hill slopes tapering to edges of King Bay, with skeletal silts and pebble and rock mantle.

Associated species: *Triodia epactia*, *Eriachne mucronata*, *Trianthema turgidifolia*, *Indigofera trita*.

Note: *Indigofera trita* could be more dense than apparent – currently dormant.

Weed Species: none

Priority/Significant Species: *Triodia* species

Samphire Flats Associated with King Bay

HdMsSv

Dwarf shrubland (10-30% <0.5m) of *Hemichroa diandra*, *Muellerolimon salicorniaceum*, *Halosarcia halocnemoides* over open low tussock grassland (10-30%) of *Sporobolus virginicus*.

Occurs on the narrow strip of saline flat bordering King Bay. This flat widens out at the extreme south-eastern corner of the lease. The grey, silty semi-saline silts can have either isolated, grey, pebbles and stones, or dense stony grey pebble mantle.

Associated species: *Frankenia pauciflora*, *Trianthema turgidifolia*

Priority/Significant species:



4.3 TRUDGEN VEGETATION UNITS

Thirteen vegetation associations were identified by Trudgen as occurring on the proposed BGC quarry site. These associations are given below.

TeCa *Triodia epactia* (Burrup form), *Cymbopogon ambiguus* hummock/tussock grassland.
This small area identified by the Trudgen survey was not found during the current survey. It was probably not detected because most *C. ambiguus* was dormant.

TeTh *Triodia epactia* (Burrup form), *Themeda* sp. Burrup (B84) hummock/tussock grassland.
This vegetation type was described during the current survey as having very open (2%) shrubs of *Grevillea pyramidalis* and *Acacia bivenosa*, hence it is coded GpAb(To)Te. The *Themeda* grassland in the Trudgen code indicates it was dominant at the time of that survey, but all *Themeda* was very dormant during the current survey and although it was listed as present, its abundance was difficult to estimate.

GpRmTsTe *Grevillea pyramidalis* subsp *pyramidalis* scattered shrubs over *Triumfetta appendiculata* (Burrup form) open low shrubland over *Triodia epactia* (Burrup form) hummock grassland with *Rhynchosia* cf *minima* lianes with *Tephrosia* aff *spina* (MET12,357) herbland.

This vegetation type was identified as two *Grevillea pyramidalis* shrublands during the current survey. One was definitely associated with an almost co-dominant component of *Acacia inaequilatera* (GpAiTe) and the other in the drainage zone, includes *Acacia bivenosa*. Due to the type of mapping being undertaken, Trudgen did not distinguish between the distinct drainage line and broader drainage zone.

TeRm *Triodia epactia* (Burrup form) hummock grassland with *Rhynchosia* cf *minima* lianes.

This vegetation type has been mapped in the current survey as *Triodia epactia* with scattered or very open *Grevillea pyramidalis* – Te(Gp) or GpAb(To)Te. There were occasional very immature *Rhynchosia* cf *minima*. On maturity this species may be a key component of the vegetation type but not under the current conditions. Presently there were an abundance of *Trachymene oleracea* (To) dormant but present, so they were included as a component species. However this indicates the problems with including non-perennials into long term vegetation descriptions.

ImTeAc *Indigofera monophylla* (Burrup form) scattered shrubs to low open heath over *Triodia epactia* (Burrup form) hummock grassland to closed hummock grassland.

This vegetation type corresponds to ImTe as described in the current survey. Trudgen mapped more of this vegetation type than was found in the current survey, but was noted that *Indigofera monophylla* was present but dormant at several sites. After more regular rainfall, it is probable that this species would be a key component in the vegetation present.

TeRm/TeAb *Triodia epactia* (Burrup form) hummock grassland with *Rhynchosia* cf *minima* lianes/*Triodia epactia* (Burrup form) hummock grassland with scattered *Acacia bivenosa* shrubs.

This is the only location on which this vegetation type has been recorded for the entire Burrup. It appears to be a mixture of two individual vegetation associations, neither distinct enough to dominate. The area was similarly mapped during this survey as TeAb(Rm) due to the fact that the liane, *Rhynchosia minima* was very immature at the time of the survey and did not, at that time, account for a key component species. Again, in a season of regular rainfall, *Rhynchosia minima* would most probably be a key species.

AcImTe *Acacia colei*/*A. elacantha* high open shrubland over *Grevillea pyramidalis* subsp. *pyramidalis* scattered shrubs over *Indigofera monophylla* (Burrup form) scattered shrubs to low open shrubland over *Triodia epactia* (Burrup form), *Triodia wiseana* (Burrup form) hummock grassland.

This vegetation type was described during the current survey as AcoAbTe. This equates to Trudgen's description. Aco is used by Astron to distinguish *Acacia colei* from the Ac used to describe *Acacia coriacea* (eg in the rock gully). The Ab included in Astron's description relates to the abundance of *Acacia bivenosa* with the *A. colei*. Due to the dry conditions, *Indigofera monophylla* (Im) was not present as a key component of the vegetation.

ChAcTh *Corymbia hamersleyana* scattered low trees to low woodland over *Acacia coriacea* subsp. *coriacea* high open shrubland over *Themeda* sp Burrup (B84), **Cenchrus ciliaris* tussock grassland.

This vegetation corresponds to the ChTsFoTa found during the current survey. Astron considered the *Terminalia supranitifolia*/*Ficus opposita* formed a major component of the sites surveyed in both gullies, more than the *Acacia coriacea*. It should be remembered that the Trudgen descriptions had to be refined and somewhat reduced from the original number described to make the map workable. This included some generalisation of the original codes to fit in with the majority of the descriptions for similar habitats. *Themeda* sp Burrup (Th) was present but was very dormant and well grazed and did not form a major part of the vegetation present.

Sm *Halosarcia* spp scattered low shrubs to low open heath.

Apparently the scope of work for the Burrup survey did not include surveying samphire areas, hence all samphire descriptions are very broadscale only. The mapping done by Astron for Dampier Nitrogen, of the King Bay – Hearson Cove tidal inlet on the eastern side of Burrup Road indicates how complicated the samphire vegetation is on the Burrup, and why the Trudgen map, in this instance, cannot be utilised for any assessment purposes.

TcSg *Terminalia canescens* scattered low trees to low forest over *Cyperus vaginatus*, *Triodia angusta* (Burrup form) sedgeland/hummock grassland with *Stemodia grossa* low herbland to open herbland.

This small pocket of vegetation marked was not identified during the current survey.



AaTaAt *Acacia ampliceps* scattered tall shrubs to high open shrubland over *Adriana tomentosa* open low shrubland over *Triodia angusta* (Burrup form) open hummock grassland.

This vegetation corresponds to Astron's AaTa.

Te *Triodia epactia* (Burrup form) hummock grassland.

One very small pocket of Te mapped by Trudgen is included in Astron's *Triodia epactia* grassland with very open *Grevillea pyramidalis*, *Acacia bivenosa*.

ItTa *Indigofera trita* low shrubland over *Triodia angusta* (Burrup form), (*Triodia epactia*) This corresponds to Astron's Ta. The *Indigofera trita* was dormant and not a dominant component of the vegetation at the time of mapping for this survey.

4.4 SIGNIFICANT VEGETATION

According to previous criteria established by Astron (1999, 2001) and Trudgen (2002), the following vegetation types on the BGC quarry site are considered to be significant.

ChTsFoTa

Open woodland (2-10% <10m) of *Corymbia hamersleyana*, *Terminalia supranitifolia* over high shrubland (10-30%; 1m) of *Ficus opposita*, *Flueggea virosa* subsp. *melanthesoides* over open low shrubland (2-10%, 1m) of *Dichrostachys spicata*, *Senna glutinosa* over Hummock Grassland of *Triodia angusta* (Burrup form) and *Triodia epactia*.

This vegetation type is significant because it includes tall tree (*Corymbia hamersleyana*) and relatively dense tall shrub species. The Priority 1 species *Terminalia supranitifolia* occurs here in abundance. Although it does not mention in the vegetation description (due to the fact that it is not a dominant species), the Priority 3 species, *Eriachne tenuiculmis* also occurs here, as do eight of the species of high conservation value as defined by Trudgen (2002).

A second feature that makes this vegetation type significant, is the presence of *Ficus opposita* var *indecora* with *Terminalia supranitifolia*. Although this *Ficus* does occur on rockpiles and gullies, it is not abundant (certainly not like *F. brachypoda*) and usually occurs in isolated occurrences. The strong association between the two species, both of which are more abundant than elsewhere on the Burrup, seems to occur in the King Bay – Woodside block described above. It was highlighted as being significant along the gully on the eastern side of the Western Stevedores loadout and laydown area.

GpAiTe

High shrubland (10-30% >2m) of *Grevillea pyramidalis*, *Acacia inaequilatera* over hummock grassland (30-70%) of mixed *Triodia epactia* (Burrup form) and *Triodia angusta* (Burrup form).

Relatively dense, high *Grevillea pyramidalis* shrubland in drainlines has been highlighted previously as significant (Astron 2001). Interestingly, a similar association, dominated by *G. pyramidalis* was noted

as significant on the Burrup Fertilisers site. Although the sites are very different, both contain drainage lines from upper rocky terrain on the northern boundary down to the King Bay coastal flats. Both sites have been allocated for development, both occur on the northern side of King Bay, although Burrup Fertilisers site is located east of Burrup Road. *Acacia inaequilatera* are scattered only in the *G. pyramidalis* association on the Burrup Fertilisers site; it is not co-dominant as identified for this survey.

Trudgen identifies four distinct *Grevillea pyramidalis* associations in his report. None of these match that described above for this report. It is to be expected that the results of such an extensive survey such as the one conducted by Trudgen *et al* cannot always be as accurate as a dedicated survey of one particular area. It is possible that the association does occur elsewhere on the Burrup but has not been detected by the Trudgen survey. However, because it has not been identified by Trudgen, it may be possible that this may be the only occurrence of this vegetation association on the Burrup Peninsula.

HdMsSv

Dwarf shrubland (10-30% <0.5m) of *Hemichroa diandra*, *Muellerolimon salicorniaceum*, *Halosarcia halocnemoides* over open low tussock grassland (10-30%) of *Sporobolus virginicus*.

Samphire vegetation within the King Bay has been identified as significant (Astron, 2001, 2002). The tidal inlet, which dissects the Burrup Peninsula is the only feature of its kind on the Burrup, and the vegetation found there is restricted to that particular habitat. In fact most of the samphire vegetation of the tidal inlet is not known to occur along the coastline generally. The association, HdMsSv, found on the BGC site is also found on the eastern side of the inlet, but it occurs within areas designated for industry.

IpEs(Te)

Open shrubland (10-30%, 1-2m) of *Ipomoea costata*, *Ehretia saligna* over very open hummock grassland (2-10%) of *Triodia epactia* (Burrup form).

This is believed to be an unusual vegetation type and indeed the rock formation upon which it occurs also appears very unique (V. Long pers obs). The vegetation type was not recorded by Trudgen probably because rockpile vegetation was not focused on during his survey. However, the author is not aware of this vegetation type being common on the Burrup and attributes it to the different rock formation that occurs here and its close vicinity to King Bay.

Significant Vegetation Types according to the Trudgen Frequency Map

According to the Trudgen frequency map there are six vegetation types that are significant on the BGC quarry site. These are shaded in Table 1 below.

TeRm/TeAb This is actually the combination of two vegetation associations found on the Burrup. It would seem in this case that the key components of both of those associations could not be separated out into two distinct associations on the site and were therefore combined. This combination of vegetation only occurs once on the Burrup Peninsula, and that occurrence falls within this quarry site. It is difficult to assess this vegetation type. Individually, TeRm occurs frequently over the Burrup both



within and outside of the conservation area. TeAb on the other hand, occurs almost totally within the area allocated for industry except for two tiny occurrences north of Withnell Bay. The Trudgen report does not state the reasoning behind combined vegetation types. It could be assumed that a vegetation association including each of the key species, TeAbRm, was not found elsewhere or in sufficiently large enough area to warrant it being itemised as an individual association in its own right. Because of the uncertainty of the status of this vegetation, its disturbance should be treated with caution.

GpRmTSTe is found once on the proposed site, once within the OMP Service Corridor adjacent the Syntroleum site, and once within the Syntroleum site itself. This places this vegetation type under great threat.

ChAcTh

This vegetation type is critically threatened and development will mean its extinction. According to the frequency maps, there are only two vegetation types, ChAcTh on the Burrup and these both occur within the two gullies on the BGC quarry site. The destruction of these two gullies would mean the total removal of this vegetation type from the Burrup Peninsula.

AaTaAt occurs twice on the proposed site, once immediately to the east of the site, and twice in the area marked for industry near Conzinc Bay. Consequently this vegetation type is under great threat. The shrub cover in this vegetation type is very dense, and provides very favourable habitat for birds. Several species were recorded in this vegetation during this survey including a large colony of Variegated Wrens. These will be displaced with development.

Table 1: Trudgen Associations found on Quarry Site

Code	Frequency on Burrup	Description of Association
TeRm/TeAb	1	<i>Triodia epactia</i> (Burrup form) hummock grassland with <i>Rhynchosia</i> cf <i>minima</i> lianes/ <i>Triodia epactia</i> (Burrup form) hummock grassland with scattered <i>Acacia bivenosa</i> shrubs.
GpRmTsTe	2-4	<i>Grevillea pyramidalis</i> subsp <i>pyramidalis</i> scattered shrubs over <i>Triumfetta appendiculata</i> (Burrup form) open low shrubland over <i>Triodia epactia</i> (Burrup form) hummock grassland with <i>Rhynchosia</i> cf <i>minima</i> lianes with <i>Tephrosia</i> aff <i>spina</i> (MET12,357) herbland.
ChAcTh	2-4	<i>Corymbia hamersleyana</i> scattered low trees to low woodland over <i>Acacia coriacea</i> subsp <i>coriacea</i> high open shrubland over <i>Themeda</i> sp Burrup (B84), * <i>Cenchrus ciliaris</i> tussock grassland.
AaTaAt	5-9	<i>Acacia ampliceps</i> scattered tall shrubs to high open shrubland over <i>Adriana tomentosa</i> open low shrubland over <i>Triodia angusta</i> (Burrup form) open hummock grassland.
TeRm	10-24	<i>Triodia epactia</i> (Burrup form) hummock grassland with <i>Rhynchosia</i> cf <i>minima</i> lianes.
TcSg	10-24	<i>Terminalia canescens</i> scattered low trees to low forest over <i>Cyperus vaginatus</i> , <i>Triodia angusta</i> (Burrup form) sedgeland/hummock grassland with <i>Stemodia grossa</i> low herbland to open herbland.
Sm	25-49	<i>Halosarcia</i> spp scattered low shrubs to low open heath.

Code	Frequency on Burrup	Description of Association
Te	25-49	<i>Triodia epactia</i> (Burrup form) hummock grassland.
ItTa	50-99	<i>Indigofera trita</i> low shrubland over <i>Triodia angusta</i> (Burrup form), (<i>Triodia epactia</i>)
TeCa	100 +	<i>Triodia epactia</i> (Burrup form), <i>Cymbopogon ambiguus</i> hummock/tussock grassland.
TeTh	100 +	<i>Triodia epactia</i> (Burrup form), <i>Themeda</i> sp. Burrup (B84) hummock/tussock grassland
ImTeAc	100 +	<i>Indigofera monophylla</i> (Burrup form) scattered shrubs to low open heath over <i>Triodia epactia</i> (Burrup form) hummock grassland to closed hummock grassland.
AcImTe	100+	<i>Acacia colei/A. elacantha</i> high open shrubland over <i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i> scattered shrubs over <i>Indigofera monophylla</i> (Burrup form) scattered shrubs to low open shrubland over <i>Triodia epactia</i> (Burrup form), <i>Triodia wiseana</i> (Burrup form) hummock grassland.

None of the vegetation types with low frequency that occur within the proposed site occur in any conservation area, which means they are all under great threat.

4.5 FLORA

The lack of effective rainfall prior to the field survey has resulted in a species list that does not reflect the entire flora that would be expected on the site. Rainfall is only considered “effective” when sufficient follow-up rainfall occurs ensuring that the surface soil remains moist for 5 consecutive days (Atkins 1985). In spite of this, however, ninety-one (91) taxa were recorded on the site including one fungi. These are listed in Table 2. The frequency of occurrence of each species on the site is presented in Appendix 1.

Table 2: Species List For BGC King Bay Eastern Extension Quarry Site, Burrup Peninsula

Family No	FAMILY	GENUS SPECIES
31	POACEAE	<i>*Cenchrus ciliaris</i> <i>Cymbopogon ambiguus</i> <i>Eriachne mucronata</i> <i>Eriachne tenuiculmis</i> (P3) <i>Paspalidium clementii</i> + <i>Paspalidium tabulatum</i> (Burrup form) <i>Sporobolus virginicus</i> + <i>Themeda</i> sp. Burrup (B84)) + <i>Triodia angusta</i> (Burrup form) + <i>triodia epactia</i> (Burrup Form) + <i>Triodia wiseana</i> (Burrup form)
32	CYPERACEAE	<i>Bulbostylis barbata</i> <i>Cyperus vaginatus</i>



Family No	FAMILY	GENUS SPECIES
87	MORACEAE	<i>Ficus opposita</i> var. <i>indecora</i>
90	PROTEACEAE	<i>Grevillia pyramidalis</i> subsp. <i>pyramidalis</i> <i>Hakea lorea</i>
105	CHENOPODIACEAE	<i>Enchylaena tomentosa</i> <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> <i>Rhagodia preissii</i> subsp. <i>obovata</i> <i>Threlkeldia diffusa</i>
106	AMARANTHACEAE	* <i>Aerva javanica</i> <i>Gomphrena cunninghamii</i> <i>Hemichroa diandra</i> <i>Ptilotus exaltatus</i>
107	NYCTAGINACEAE	<i>Boerhavia gardneri</i> <i>Commicarpus australis</i>
110	AIZOACEAE	<i>Trianthema turgidifolia</i>
111	PORTULACACEAE	<i>Portulaca oleraceae</i>
122	MENISPERMACEAE	<i>Tinospora smilacina</i>
137A	CAPPARACEAE	<i>Cleome viscosa</i> <i>Capparis spinosa</i>
152	PITTOSPORACEAE	<i>Pittosporum phylliraeoides</i> subsp. <i>phylliraeoide</i>
163	MIMOSACEAE	<i>Acacia ampliceps</i> <i>Acacia bivenosa</i> <i>Acacia colei</i> <i>Acacia coriacea</i> subsp. <i>coriacea</i> <i>Acacia elachantha</i> <i>Acacia inaequilatera</i> <i>Acacia orthocarpa</i> <i>Dichrostachys spicata</i>
164	CAESALPINIACEAE	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
165	PAPILIONACEAE	<i>Crotalaria novae-hollandiae</i> <i>Crotalaria medicaginea</i> <i>Indigofera colutea</i> <i>Indigofera monophylla</i> (Burrup form) <i>Indigofera trita</i> + <i>Rhynchosia</i> cf. <i>minima</i> + <i>Rhynchosia</i> sp. Burrup (821C)



Family No	FAMILY	GENUS SPECIES
		<i>Swainsona formosa</i> <i>Tephrosia rosea</i> var <i>clementii</i> <i>Tephrosia</i> aff. <i>eriocarpa</i> (VL 1583-05) <i>Vigna</i> sp.
185	EUPHORBIACEAE	<i>Adriana tomentosa</i> ?+ <i>Euphorbia</i> ? <i>coghlanii</i> (VL 1583-03) + <i>Euphorbia tannensis</i> subsp <i>eremophila</i> <i>Flueggia virosa</i> subsp <i>melanthesoides</i> <i>Leptopus decaisnei</i> var <i>decaisnei</i> <i>Phyllanthus ciccoides</i> <i>Phyllanthus maderaspatana</i>
207	SAPPINDACEAE	<i>Alectryon oleifolius</i> subsp. <i>oleifolius</i>
220	TILIACEAE	+ <i>Corchorus walcottii</i> + <i>Triumfetta appendiculata</i> (Burrup form) <i>Triumfetta clementii</i>
221	MALVACEAE	<i>Abutilon lepidum</i> <i>Abutilon</i> ? <i>fraseri</i> . (sterile) VL-1583-04
223	STERCULIACEAE	<i>Brachychiton acuminatus</i>
236	FRANKENIACEAE	<i>Frankenia pauciflora</i> var <i>pauciflora</i>
243	VIOLACEAE	<i>Hybanthus auranticus</i>
272	COMBRETACEAE	+ <i>Terminalia supranitifolia</i> (P1)
273	MYRTACEAE	<i>Corymbia hamersleyana</i>
281	APIACEAE	<i>Trachymene oleracea</i> (dead)
294	PLUMBAGINACEAE	<i>Muellerolimon salicorniaceum</i>
301	OLEACEAE	<i>Jasminum didymum</i> subsp. <i>lineare</i>
305	ASCLEPIADACEAE	<i>Cynanchum floribundum</i>
307	CONVOLVULACEAE	<i>Bonamia media</i> var <i>villosa</i> <i>Bonamia pannosa</i> <i>Ipomoea costata</i>
310	BORAGINACEAE	<i>Ehretia saligna</i> var. <i>saligna</i> <i>Trichodesma zeylanicum</i>
311	VERBENACEAE	<i>Clerodendrum tomentosum</i>



Family No	FAMILY	GENUS SPECIES
315	SOLANACEAE	<i>Solanum horridum</i> <i>Solanum lasiophyllum</i>
326	MYOPORACEAE	<i>Myoporum montanum</i>
337	CUCURBITACEAE	<i>Mukia maderaspatana</i>
341	GOODENIACEAE	<i>Goodenia microptera</i> <i>Goodenia</i> sp.1 (VL 1583-01) <i>Scaevola spinescens</i> (narrow leaf) VL 15483-02 <i>Scaevola</i> aff. <i>Spinescens</i>
345	ASTERACEAE	<i>Pterocaulon sphaeranthoides</i> <i>Streptoglossa decurrens</i> <i>Podaxis</i> sp.

* = weed species + = Species of conservation value (Trudgen 2002)
P = Priority Species

The ninety (90) vascular plants recorded on the site are represented by 36 families and 67 genera. The Poaceae (grass) and Papilionaceae (Pea) families were best represented, both being represented by 11 species. It is expected that species number and diversity would be increased following rainfall.

4.6 PRIORITY AND SIGNIFICANT FLORA

Two Priority species were found on the site. The Priority 1 species, *Terminalia supranitifolia* was found frequently on rock piles and in the rocky gullies. *Eriachne tenuiculmis*, Priority 3, was found in the rocky gullies.

Terminalia supranitifolia

Terminalia supranitifolia is a low tree species which occurs on rockpiles, rock outcrops and in rocky gullies on the Burrup Peninsula (Plates 8 & 9). One other population of this species only has been found, near the Chichester Ranges, south of Karratha. The species is not found on the Burrup south of Dampier Road, it is not found on West Intercourse Island, nor was it recorded during the Dampier Archipelago Island survey (Long, 1987). The tree is a remnant Kimberley species (Blackwell 1979), however it is not known to occur in the Kimberley. It is a stunted, spreading tree and can easily be mistaken from a distance for *Ficus brachypoda*, another low rock-spreading species on the Burrup. Although some ad hoc attempts have been made to propagate this species, none have been successful to date. Each project approved on the Burrup Peninsula approves the destruction of many individual plants, and no commitments are made to research propagation to replace what is lost.

The abundance of *Terminalia supranitifolia* in the general vicinity of the proposed site has been documented previously (Astron 1997, Astron 2001). The area south of the King Bay inlet, north

through to the Woodside (WOP) plant site and bounded along the eastern side by the Woodside quarry road, contains a particularly high abundance of this species. It is considered to be one of the densest populations of the species for the entire Burrup (V. Long per obs). Trudgen (2002) concluded that vegetation on the Burrup was very dependent on a combination of geology and microclimate. It is possible that the abundance of *Terminalia supranitifolia* in this area is associated not only with the rock formation that occurs here but also the particular orientation of this area within the Burrup Peninsula.

It is unfortunate that Trudgen (2002) did not focus on rockpile vegetation or the abundance of *Terminalia supranitifolia* over the entire Burrup during the Burrup vegetation survey. The information regarding the abundance of *T. supranitifolia* over the entire Burrup would have been invaluable to the assessment process. In 1997, Astron conducted a vegetation survey for Gorgon Australia on their proposed site between the MOF wharf and King Bay. Astron expressed its concerns in that report (Astron, 1977) regarding the high density of *T. supranitifolia* in the area. Following that, in 1998, Astron began some voluntary counts in random quadrats over randomly situated rockpiles in the northern portions of the Burrup Peninsula. This voluntary survey was never completed due to other work commitments.

A total of 47 *Terminalia supranitifolia* were recorded on the site within the areas surveyed. This included trees both within quadrats searched and opportunistic records. Because of the actual area of rockpile terrain on the site and the time available for the survey, it is probable that not all trees were counted. It is interesting that a total of 47 *Terminalia supranitifolia* was also counted for the recently cleared loadout and laydown area adjacent to Dampier Wharf. The area of the Dampier Wharf site (8.6ha) and that of the rocky area within the Eastern Lease area (8.5ha) are similar and relatively small in size. By comparison, 35 trees were counted on the Burrup Fertilisers lease, (outside of the King Bay-Woodside block described above) within a rocky area that accounts for 14 ha. Although *Terminalia supranitifolia* has been recorded over most of the Burrup, the abundance and distribution of populations throughout the peninsula has not yet been adequately determined. Areas surveyed to date, however, (including Burrup Fertilisers, Astron 2001, GTL, Astron 2002, Syntroleum, Astron 1999, Water Corporation, Astron 2001, BGC, Astron 2002, Gorgon, Astron 1997, Woodside, Astron 2002, Mermaid Marine, Astron 1999) indicate that this species is more abundant within the King Bay – Woodside block, the area within which the proposed development site is located.

Eriachne tenuiculmis

Eriachne tenuiculmis is a Priority 3 tussock grass that occurs in rocky or stony drainage gullies on the Burrup Peninsula. It has now been recorded at various other locations in the Pilbara. It was found dormant at the time of survey, within both the north-south deep rocky gullies. It did not appear to be abundant within this area.

4.7 SPECIES OF CONSERVATION SIGNIFICANCE ACCORDING TO TRUDGEN (2002)

The species of conservation value were recorded on the proposed site.



Table 3: Species with High Conservation Value According to Trudgen (2002)

Species Recorded on BGC Quarry Site	Status of Species
	Priority Species
<i>Terminalia supranitifolia</i>	Priority 1. Geographically restricted except for Burrup Peninsula, Dolphin Island, populations small or very small and disjunct.
<i>Eriachne tenuiculmis</i>	Priority 3. More common than previously thought. Neither uncommon or very restricted, although restricted to the Fortescue Botanical District.
	Locally common, moderately restricted, newly recognised.
<i>Paspalidium tabulatum</i> (Burrup form)	Very geographically restricted and moderately habitat restricted. Not previously recognised as distinct.
<i>Themeda</i> sp Burrup (B84)	Very geographically restricted and moderately habitat restricted. Not previously recognised as distinct.
	Locally very common to abundant, moderately restricted, newly recognised.
<i>Triodia angusta</i> (Burrup form)	Moderately geographically restricted and moderately habitat restricted (rockpiles and some lower slopes). Not previously recognised as distinct.
<i>Triodia epactia</i> (Burrup form)	Quite geographically restricted. Not previously recognised as distinct.
<i>Triodia wiseana</i> (Burrup form)	Quite geographically restricted and moderately habitat restricted mostly on mid-slopes. Not previously recognised as distinct.
<i>Rhynchosia</i> sp Burrup (82-1C)	Locally common but very geographically restricted with records in the data set only from Burrup Peninsula and Dolphin Island.
<i>Corchorus walcottii</i>	Locally common, quite restricted geographically (Not strictly newly recognised but restricted in circumscription).
<i>Triumfetta appendiculata</i> (Burrup form)	Locally common, quite restricted geographically. Not previously recognised as distinct.
<i>Euphorbia tannensis</i> subsp <i>eremophila</i> (Burrup form)	Fairly geographically restricted. Not previously recognised as distinct.

It is possible that the *Euphorbia ? coghlanii* is one of the 5 *Euphorbia* species listed by Trudgen. At this stage there are no descriptions or comparative material available.

Of the flora species recorded on site that have been highlighted for conservation by Trudgen (2002), the following comments can be offered.

- *Terminalia supranitifolia* (Priority 1 species) occurs on the rockpile capped hills, on smaller hillslope rockpiles and along both the walls and floor of the rocky drainage gullies found on the site. Forty-seven (47) of these trees will be removed for the project.
- *Eriachne tenuiculmis* was found, dormant along the floor of the rocky gullies. As Trudgen (2002) indicates, this species is relatively common, not only on the Burrup Peninsula but elsewhere in the Pilbara Region.
- *Paspalidium tabulatum* (Burrup form) was found at the base of the rock gully walls. The author agrees with Trudgen that this species is restricted to the particular habitat of the Burrup Peninsula. In 1989, after trying to key out Burrup specimens of *P. tabulatum*, specimens were sent to Mike Lazarides, author of many grass species, in Canberra. He sent the specimens back as *Paspalidium* aff *tabulatum*, meaning they most closely conform to the description for that species but are also distinctly different

- *Themeda* sp. Burrup (B84) was found, dormant, on the upper hill slopes and in one of the rocky gullies. It appeared not to be abundant, but due to its dormancy, its abundance was difficult to assess. This species is found over most of the Burrup Peninsula.
- *Triodia epactia* (Burrup form), *T. angusta* (Burrup form), *T. wiseana* (Burrup form) are all present on the site. *T. epactia* is the most frequent being found at all sites. *T. angusta* is recorded along the drainline along the eastern boundary of the site, and *T. angusta* grassland is associated with the perimeter of King Bay tidal inlet. *T. wiseana* is not abundant on the site, being recorded in only two locations, in association with other *Triodia* species.
- *Rhynchosia* sp Burrup (B84) was found along the base of the rocky walls of the gullies and also around the base of rockpiles. It is found relatively frequently in these habitats over much of the Burrup. It was dormant and may be more abundant on the site than this survey indicates. This species is quite distinct from *Rhynchoisa* aff *minima* but until the Trudgen report, both types have always been referred to as *Rhynchoisa minima*. In fact, neither fit that description and both need further research.
- *Corchorus walcotti* was found along the shallow drainage gully on the eastern side of the lease and along one of the rocky gullies. This species is often found on plateaus. It is currently dormant due to the dry conditions, and it is probable that it may be present in other habitats on the site. It is widely represented over the entire Burrup but needs more research.
- *Triumfetta appendiculata* (Burrup form) was found along the drainage line on the eastern side of the lease, and on the rockpiles. This species needs further research. It is widespread on the Burrup.
- *Euphorbia tannensis* subsp *eremophila* (Burrup form) was found on one hill slope only on the eastern side of the lease. It is not abundant, but occurs over most of the Burrup.

5 CONCLUSION

The proposed quarry site is the last remaining portion of the original landform, representing steep rocky terrain dropping down into King Bay tidal inlet. It is unique; nowhere else on the Burrup or adjacent Pilbara coastline is it represented. The site acts as a visual barrier from Burrup Road, screening the industry on the cleared, levelled land behind.

One vegetation association, TeRm/TeAb as defined by Trudgen (Trudgen 2002) that occurs on the site is totally restricted to that site. Destruction of the site will result in the total loss of this vegetation type from the Burrup Peninsula and the Fortescue Botanical District.

Five other vegetation types (Trudgen 2002, Astron 2001) have been identified as being under great threat.

- One vegetation association, GpAiTe identified during the Astron survey, does not match any of those identified by Trudgen and may therefore not occur elsewhere on the Burrup.
- One vegetation association identified by both Trudgen and Astron, ChAcTh, only occurs on the BGC site and the destruction of the gullies within the site will result in its total loss from the Burrup Peninsula.



-
- One rockpile association, IpEs(Te), identified by Astron (Trudgen did not include rockpile vegetation) is known by the author as only occurring on this site. In addition to this, the rock formation upon which it occurs is quite unique, not being known to occur elsewhere, and particularly aesthetic.
 - Two other vegetation types, GpRmTsTe and AaTaAt only occur elsewhere on areas of proposed development. Should these developments eventuate, they will be lost from the Burrup Peninsula.

Of the 6 Significant vegetation associations above, four are found in the southern and south-western half of the site. The remaining two are found along the eastern border. There is an abundance of Priority 1 species on the site, particularly on the southern half of the site. Most of the Significant species (Trudgen 2002) occur on the southern half of the site. It can therefore be concluded that the southern half in its entirety and significant associations along the eastern border of the site should be preserved.

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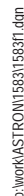


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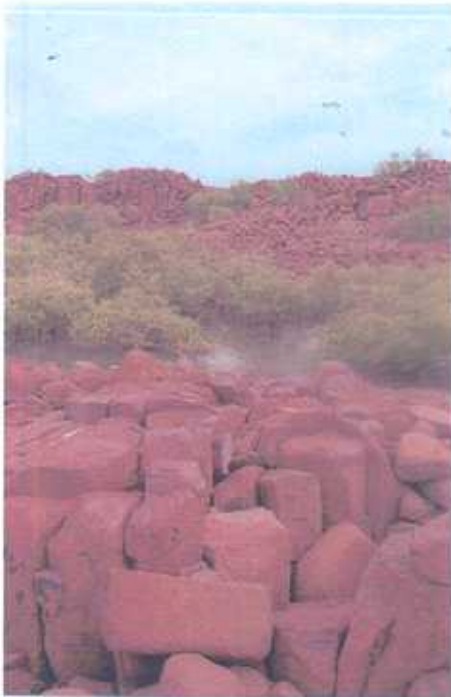


Plate 1: Rocky landform drops down into mangal on the proposed BGC quarry site. This is the only representation of this landform remaining on the Burrup Peninsula.



Plate 2: High rocky landform on the BGC quarry site drops down into mangal of *Avicennia marina* var *marina*, *Rhizophora stylosa*, *Ceriops tagal*, *Bruguiera exaristata*, *Aegialitis annulata*.



Plate 3: The BGC quarry site includes a small area of samphire vegetation, hedged between the rockpiles and the mangal.

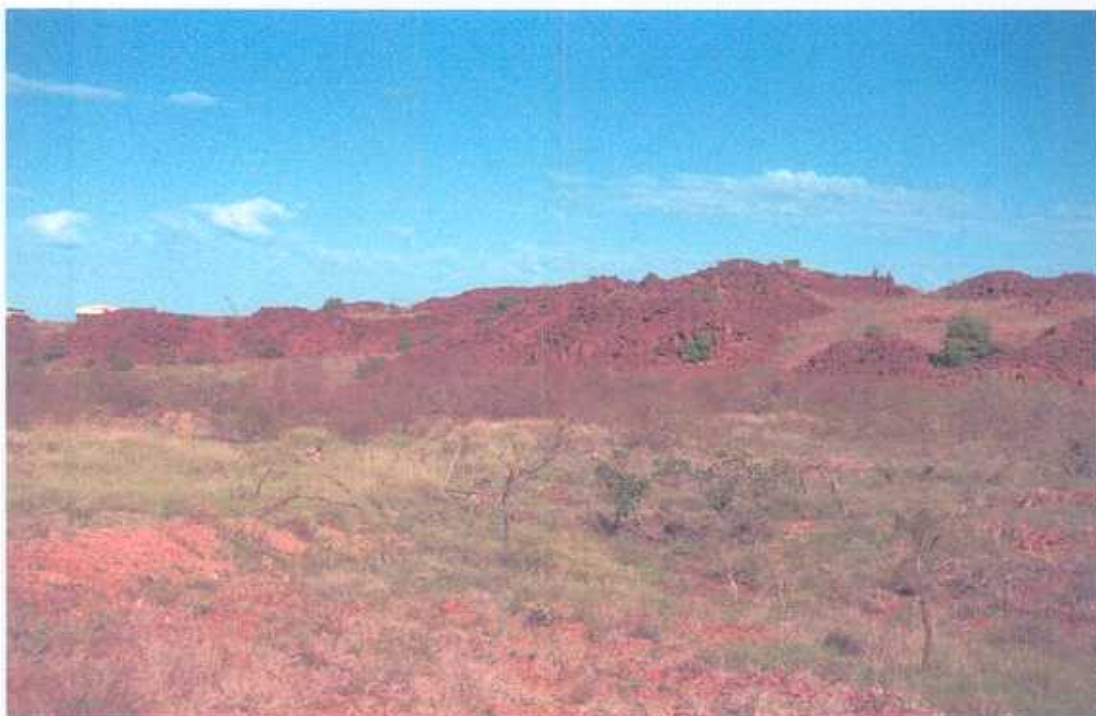
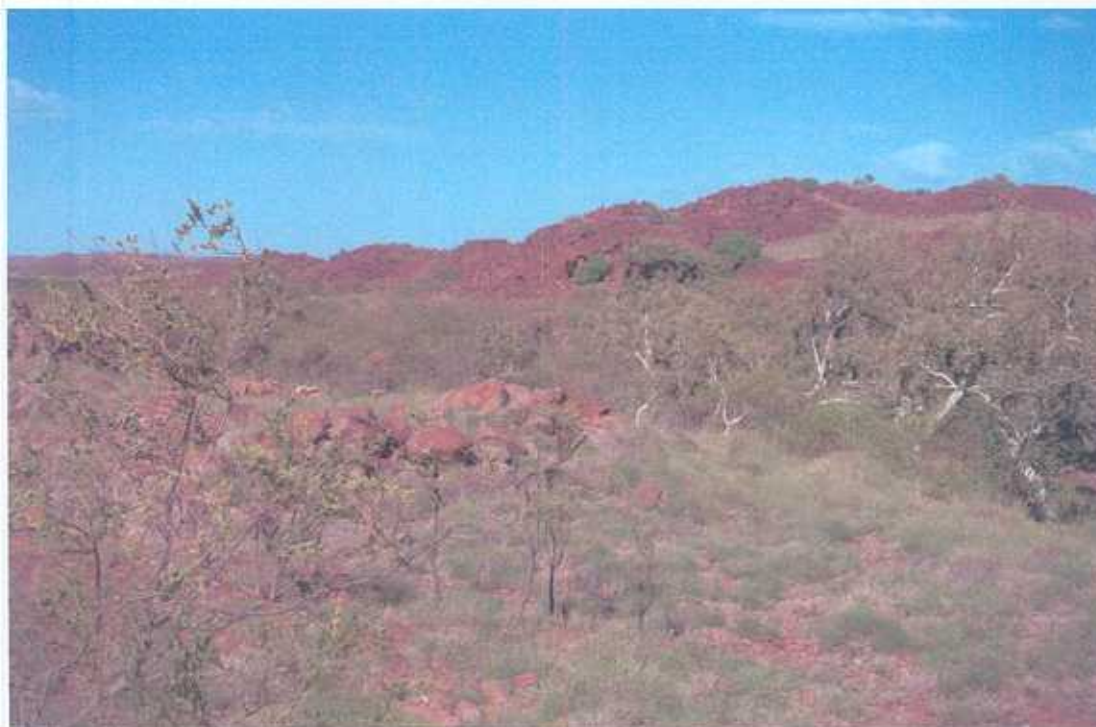


Plate 4



Plates 4 and 5: From Burrup Road, the proposed BGC site currently acts as a visual barrier to the industry related sites behind. (see LH corner, plate 4). The high terrain also feeds a tree lined drainline adjacent to Burrup Road.

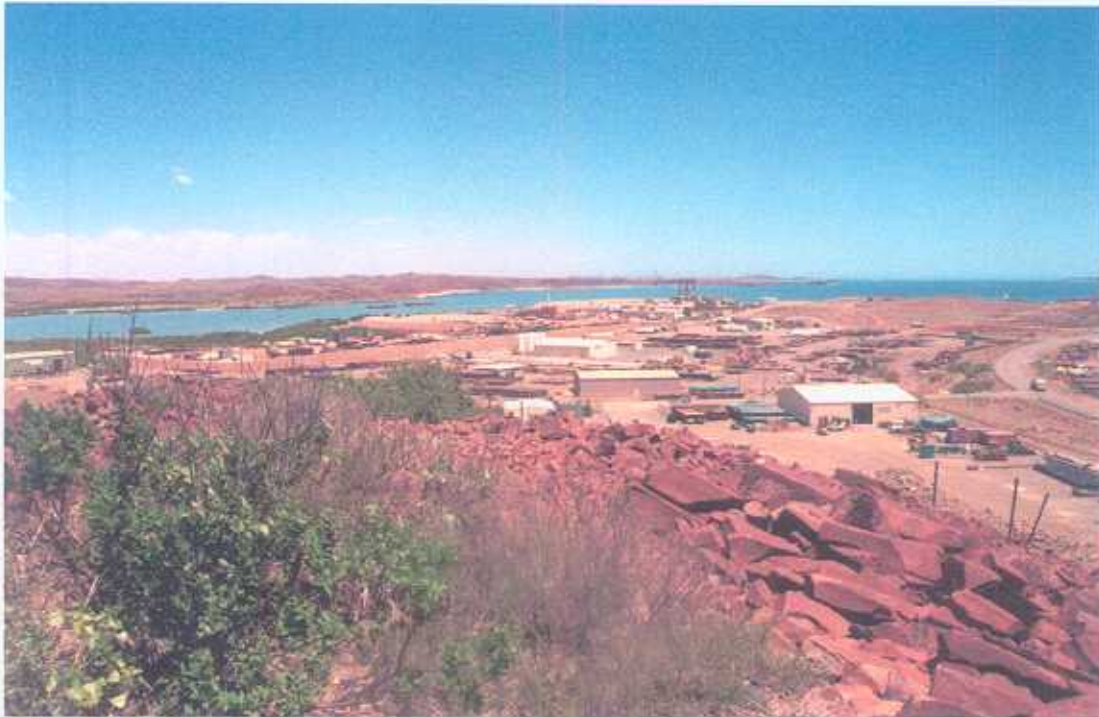


Plate 6



Plates 6 and 7: The once rugged terrain along the remainder of the King Bay inlet out to the west has been cleared and levelled for industry.



Plate 8: Priority 1 species, *Terminalia supranitifolia* with *Corymbia hamersleyana* at the broad end of one rocky gully on proposed quarry site.



Plate 9: Priority 1 species, *Terminalia supranitifolia* in deeper rocky gully on proposed quarry site.



Plate 10: Drainline along eastern side of site with *Grevillea pyramidalis*, *Acacia inaequilatera* over mixed hummock grass (GpAiTe).



Plate 11: Dense high shrubland of *Acacia ampliceps* over bird species including Varigated Wrens. South-eastern poi



Plate 12: Rockpile vegetation, with *Terminalia supranitifolia*, *Brachychiton acuminatus*, *Ehretia saligna*.



Plate 13: Vegetation of the lower hill slopes of scattered to very open mixed shrubland including *Grevillea pyramidalis*, *Hakea lorea*, *Acacia bivenosa*, over *Triodia epactia* (Burrup form) (GpAb(To)Te)



Plate 14: A small area of samphire vegetation with *Sporobolus virginicus* occurs in the extreme south-east corner, bordering the mangal fringing King Bay.



Plate 15: Monospecific *Triodia angusta* (Burrup form) occurs.



Plate 16: Much of the perennial and most of the annual and ephemeral vegetation was dormant at the time of survey.



Plate 17: Disturbed area on the north-western portion of the lease where shallow scraping has occurred.



APPENDIX 1





Table A1: Species List For BGC King Bay Eastern Extension Quarry Site, Burrup Peninsula

Family No	FAMILY	GENUS SPECIES	SITE
31	POACEAE	<i>*Cenchrus ciliaris</i> <i>Cymbopogon ambiguus</i> <i>Eriachne mucronata</i> <i>Eriachne tenuiculmis</i> (P3) <i>Paspalidium clementii</i> <i>Paspalidium tabulatum</i> <i>Sporobolus virginicus</i> + <i>Themeda</i> sp. Burrup (B84) + <i>Triodia angusta</i> (Burrup form) + <i>Triodia epactia</i> (Burrup form) + <i>Triodia wiseana</i> (Burrup form)	1,2,3,5,6,7,15,16,17 5,6,10,13,16 9 10 5,18 11 8 6, 16, 18 1,2,7,9,10 1,2,3,4,5,6,9,10,11,12,13, 14,15,16,17,18 9
32	CYPERACEAE	<i>Bulbostylis barbata</i> <i>Cyperus vaginatus</i>	10,16 7,10
87	MORACEAE	<i>Ficus opposita</i> var. <i>indecora</i>	1,6,10
90	PROTEACEAE	<i>Grevillia pyramidalis</i> subsp. <i>pyramidalis</i> <i>Hakea lorea</i>	1,2,3,4,6,7,12,13,14,15, 16,18 4,18
105	CHENOPODIACEAE	<i>Enchylaena tomentosa</i> <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> <i>Rhagodia preissii</i> subsp. <i>obovata</i> <i>Threlkeldia diffusa</i>	5 8 1,5,6,10 9
106	AMARANTHACEAE	<i>*Aerva javanica</i> <i>Gomphrena cunninghamii</i> <i>Hemichroa diandra</i> <i>Ptilotus exaltatus</i>	7 4,10,14,16 8 18
107	NYCTAGINACEAE	<i>Boerhavia gardneri</i> <i>Commicarpus australis</i>	1,15,16 5
110	AIZOACEAE	<i>Trianthema turgidifolia</i>	8,9
111	PORTULACACEAE	<i>Portulaca oleraceae</i>	15
122	MENISPERMACEAE	<i>Tinospora smilacina</i>	1,5,6,10
137A	CAPPARACEAE	<i>Cleome viscosa</i> <i>Capparis spinosa</i> var. <i>nummularia</i>	5,6,15
152	PITTOSPORACEAE	<i>Pittosporum phylliraeoides</i> subsp. <i>phylliraeoides</i>	5,6,7



Family No	FAMILY	GENUS SPECIES	SITE
163	MIMOSACEAE	<i>Acacia ampliceps</i> <i>ACACIA BIVENOSA</i> <i>Acacia colei</i> <i>Acacia coriacea</i> subsp <i>coriacea</i> <i>Acacia elachantha</i> <i>Acacia inaequilatera</i> <i>Acacia orthocarpa</i> <i>Dichrostachys spicata</i>	7 1,2,3,4,7,12,13,14,15,16 12,14,18 5,6,10 2,4,6,10,12,13,14 1,4,17 1 1,3,5,6,10,17
164	CAESALPINIACEAE	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	6,12
165	PAPILIONACEAE	<i>Crotalaria novae-hollandiae</i> <i>Crotalaria medicaginea</i> <i>Indigofera colutea</i> <i>Indigofera monophylla</i> (Burrup form) <i>Indigofera trita</i> + <i>Rhynchosia</i> cf. <i>minima</i> + <i>Rhynchosia</i> sp. Burrup (821C) <i>Swainsona formosa</i> <i>Tephrosia rosea</i> var <i>clementii</i> <i>Tephrosia</i> aff. <i>eriocarpa</i> (VL 1583-05) <i>Vigna</i> sp.	2,15 14 10,16 1,3,6,15,16,17 9 5,6,14,15,16,18 3,10 1 10 14,18 5
185	EUPHORBIACEAE	<i>Adriana tomentose</i> ?+ <i>Euphorbia</i> ? <i>coghlanii</i> (VL 1583-03) + <i>Euphorbia tannensis</i> subsp <i>eremophila</i> (Burrup form) <i>Flueggia virosa</i> subsp <i>melanthesoides</i> <i>Leptopus decaisnei</i> var <i>decaisnei</i> <i>Phyllanthus ciccoides</i> <i>Phyllanthus maderaspatana</i>	2,7 4,10,14,18 15 5,6,10 15 10 6,10,14,15
207	SAPPINDACEAE	<i>Alectryon oleifolius</i> subsp. <i>oleifolius</i>	1,5,6,10
220	TILIACEAE	+ <i>Corchorus walcottii</i> + <i>Triumfetta appendiculata</i> (Burrup form) <i>Triumfetta clementii</i>	1,2,6 1,5 1,2,6,10,14,15,16
221	MALVACEAE	<i>Abutilon lepidum</i> <i>Abutilon fraseri</i> . (sterile) VL-1583-04	1,6,14,18 1,10,15,18
223	STERCULIACEAE	<i>Brachychiton acuminatus</i>	1,5,10
236	FRANKENIACEAE	<i>Frankenia pauciflora</i> var <i>pauciflora</i>	8
243	VIOLACEAE	<i>Hybanthus auranticus</i>	14,15
272	COMBRETACEAE	+ <i>Terminalia supranitifolia</i> (P1)	5,6,10



Family No	FAMILY	GENUS SPECIES	SITE
273	MYRTACEAE	<i>Corymbia hamersleyana</i>	6,10,13,14
281	APIACEAE	<i>Trachymene oleracea</i> (dead)	4,10,14,18
294	PLUMBAGINACEAE	<i>Muellerolimon salicorniaceum</i>	8
301	OLEACEAE	<i>Jasminum didymum</i> subsp. <i>lineare</i>	5,6
305	ASCLEPIADACEAE	<i>Cynanchum floribundum</i>	9,15,16
307	CONVOLVULACEAE	<i>Bonamia media</i> var <i>villosa</i> <i>Bonamia pannosa</i> <i>Ipomoea costata</i>	4 14 2,10,11,12,13,17
310	BORAGINACEAE	<i>Ehretia saligna</i> var. <i>saligna</i> <i>Trichodesma zeylanicum</i>	5,6,10,11,14,17 1,3,10,14,15,16,18
311	VERBENACEAE	<i>Clerodendrum tomentosum</i>	6
315	SOLANACEAE	<i>Solanum horridum</i> <i>Solanum lasiophyllum</i>	1,2,3,4,5,10,14,15,16,18 3,14,16
326	MYOPORACEAE	<i>Myoporum montanum</i>	7
337	CUCURBITACEAE	<i>Mukia maderaspatana</i>	1,2,3,10,15,17
341	GOODENIACEAE	<i>Goodenia microptera</i> <i>Goodenia</i> sp.1 (VL 1583-01) <i>Scaevola spinescens</i> (narrow leaf) VL 15483-02 <i>Scaevola</i> aff. <i>spinescens</i>	9 2 2,5 6,14
345	ASTERACEAE	<i>Pterocaulon sphaeranthoides</i> <i>Streptoglossa decurrens</i> <i>Podaxis</i> sp.	1 4,14,15,18 3

* = weed species

+ = Species of conservation significance (Trudgen 2002)

P = Priority species