

ALINTA DBNGP LOOPING 10

Rehabilitation Management Plan

November 2005

CONTENTS

1	INTRODUCTION	1
2	REHABILITATION REVIEW.....	1
2.1	REHABILITATION OBJECTIVES	2
3	EXISTING VEGETATION	2
3.1	FLORA AND VEGETATION.....	2
3.2	VEGETATION STUDIES	4
3.2.1	<i>Study Method</i>	4
3.2.2	<i>Study Results</i>	7
3.3	OTHER ENVIRONMENTAL VALUES	10
4	REHABILITATION STRATEGY.....	11
5	REHABILITATION METHODS	11
5.1	WEED MANAGEMENT.....	11
5.2	DIEBACK (PHYTOPHTHORA CINNAMOMI) MANAGEMENT	11
5.3	PRIORITY AND RARE FLORA MANAGEMENT	12
5.4	RESOURCE MANAGEMENT	13
5.5	SOIL PROFILE AND LANDFORM.....	13
5.6	ESTABLISHMENT OF NATIVE VEGETATION.....	13
6	COMPLETION CRITERIA.....	14
7	REFERENCES	18

APPENDICES

Appendix A: Proposed Species for Seeding of AOD

Appendix B: Rehabilitation Study Results

1 INTRODUCTION

Alinta on behalf of DBNGP (WA) Nominees Pty Limited propose to install an additional gas pipeline within the existing DBNGP corridor south of Compressor Station CS 10 located immediately north of Thomas Road in Kwinana. The additional pipe is to be installed over a distance of approximately 23km to just south of Punrak Road. The corridor traverses 2 Bush Forever Sites and the Leda Nature Reserve as well as several small areas of remnant native vegetation on private property.

The project will seek to re-establish native vegetation over the pipeline area of disturbance (AOD) following installation of the pipe.

This rehabilitation plan is based on the rehabilitation plan prepared by Woodman Environmental Consulting Pty Ltd for Ecos Consulting (Aust) Pty Ltd, Sept 2005.

2 REHABILITATION REVIEW

The project area was inspected by Greg Woodman of Woodman Environmental Consulting Pty Ltd and Grant Lamb and Dr. Mark Garkaklis of the Department of Conservation and Land Management on the 29th July and 8th August 2005. The easement was reviewed with the aim to identify achievable and acceptable rehabilitation objectives for the different sections of the project area. Plant cover, species richness and weed cover were observed during the site inspections and objectives and methods discussed.

Vegetation condition on the easement varied markedly as follows:

Leda Bush Forever site and other areas of remnant native vegetation on private property not in Bush Forever were in very poor condition with extremely low species diversity and native plant cover. The current condition of the vegetation in these areas is attributable to on going high levels of 3rd party access, regular fires and weed incursion. Previous rehabilitation results on the easement in these areas has been poor and little material in the way of native vegetation or topsoil currently remains to facilitate rehabilitation following the Looping 10 project.

Leda Nature Reserve and the Lowlands Bush Forever site adjacent to Hymus Swamp were in better condition than other areas as a result of reduced 3rd party access, however neither site was in pristine condition as a result of historical disturbance. Areas of good quality vegetation were identified in these areas off the easement and the rehabilitation of the easement had provided both topsoil and native vegetation cover that can be re-utilised for rehabilitation of the Looping 10 project. These areas were viewed as having greater intrinsic biodiversity values than the remainder of the project area and rehabilitation measures should attempt to return some measure of the local biodiversity.

2.1 Rehabilitation Objectives

The project area was divided into two functional areas with respect to existing condition, environmental significance and biological values. Rehabilitation objectives were set for the two areas as follows:

Objective 1: Provide native cover of local dominant understorey species that will stabilise soil and help reduce 3rd party access.

Leda Bush Forever site and other areas of remnant native vegetation on private property not in Bush Forever.

Objective 2: Provide native cover of local species that will stabilise soil and help reduce 3rd party access and provide increased understorey biodiversity than is currently present on the easement.

Leda Nature Reserve and the Lowlands Bush Forever site adjacent to Hymus Swamp.

3 EXISTING VEGETATION

3.1 Flora and Vegetation

Previous studies along the corridor have been conducted between October 2002 and May 2003 (Strategic Environmental Review for the proposed corridor widening of the DBNGP) and 26th August to 6th September 2004 (Additional flora and vegetation studies in the Leda and Kemerton areas supporting responses to submissions on the Strategic Environmental Review) by Mattiske Consulting Pty Ltd. These studies included mapping of vegetation types on two occasions. Mapping of plant communities on the existing previously cleared easement was conducted over the entire project area, followed by additional studies within the Leda Bushland Bush Forever site and the Leda Nature Reserve. The additional studies included alignments of mapped communities with Floristic Community Types (FCTs) according to Gibson *et al.* (1994) following analysis of floristic data collected in plots. Analysis involved Bray-Curtis Polar Ordination and flexible UPGMA agglomerative hierarchical fusion within the PATN pattern analysis package. In addition, Declared Rare Flora or Priority Listed Flora were noted at recording sites. This work identified a single Priority 4 species (that was regarded as a planted individual due to being outside its known geographical range) and several small occurrences of a threatened ecological community (FCT26A) along the current pipeline corridor.

The vegetation existing along the pipeline easement has been described as follows (Bowman Bishaw Gorham 2004):

Leda Bushland Bush Forever Site

The following plant communities have been defined:

G3 Open Woodland of *Eucalyptus gomphocephala*, *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over low mixed shrubs and herbs.

G4a Open Woodland of *Eucalyptus gomphocephala* over Thicket of *Acacia rostellifera* with *Clematic linearifolia* over scattered low shrubs and exotic herbs and grasses.

G5b Open Woodland of *Eucalyptus gomphocephala* over Low Forest or Low Woodland of *Melaleuca raphiophylla* and *Acacia rostellifera* over wetland shrubs, herbs and sedges.

LH Heath of mixed shrubs on shallow soils over limestone.

Leda Nature Reserve

G3 Open Woodland of *Eucalyptus gomphocephala*, *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over low mixed shrubs and herbs.

G4a Open Woodland of *Eucalyptus gomphocephala* over Thicket of *Acacia rostellifera* with *Clematic linearifolia* over scattered low shrubs and exotic herbs and grasses.

G4b Open Woodland of *Eucalyptus gomphocephala* over *Acacia saligna*, *Acacia rostellifera* and exotic herbs and grasses in low lying areas.

G5b Open Woodland of *Eucalyptus gomphocephala* over Low Forest or Low Woodland of *Melaleuca raphiophylla* and *Acacia rostellifera* over wetland shrubs, herbs and sedges.

LH Heath of mixed shrubs on shallow soils over limestone.

Lowlands Bush Forever Site (Hymus Swamp)

B1 Disturbed Low Open Woodland of *Banksia ilicifolia* – *Eucalyptus marginata* subsp. *marginata* – *Allocasuarina fraseriana* over low shrubs and pastoral grasses.

K1 Disturbed Low Shrubland of *Kunzea ericifolia* subsp. *ericifolia* over *Regelia ciliata* over pastoral grasses.

Private Property Remnants

Plant communities on other private property remnants consisted of disturbance communities containing some remnant overstorey species over pastoral grasses and other weed species.

3.2 Vegetation Studies

Woodman Environmental have conducted vegetation condition and weed cover assessments of the easement and adjacent native vegetation along the easement. These studies were designed to provide the following information:

- An indication of the potential for regeneration of the easement following the proposed installation of the lateral.
- The conservation significance of adjacent vegetation.
- Baseline weed data to aid in design of hygiene protocols and weed management measures.

In addition, baseline vegetation monitoring plots were established in native vegetation adjacent to the easement and supplemented with opportunistic recordings to identify species suitable for use in rehabilitation of the easement following installation of the pipeline loop.

Declared Rare Flora (DRF) and Priority flora searching has also been conducted at appropriate times to provide data supporting management of the impacts of the pipeline construction on these species.

3.2.1 Study Method

Flora Species

Flora studies for the DBNGP Looping 10 survey focused on additional searching for the Declared Rare Flora and Priority Flora species known to occur in the vicinity of the corridor. A preliminary review of CALM's GIS database undertaken by Greg Woodman and Mark Garkakalis (Swan Region Regional Ecologist) identified three DRF and three Priority flora species in close proximity to the survey area:

Caladenia huegelii (DRF)

Drakaea elastica (DRF)

Diuris micrantha (DRF)

Dillwynia dillwynioides (P3)

Stylidium longitubum (P3)

Acacia lasiocarpa var *bracteolata* long peduncle variant (P1)

Caladenia huegelii, *Diuris micrantha* and *Drakaea elastica* are orchids that are only above ground and identifiable for a limited time during the year. *Drakaea elastica* should be searched for at two times during the year, initially in August when its distinctive glossy green leaves appear and are highly visible, then again in October to November when it is in full flower. *Caladenia huegelii* flowers between September to October with the peak survey period coinciding with mid to late September depending on rainfall and temperature. *Diuris micrantha* occurs in winter wet swampy sites and flowers in September to early October. *Dillwynia dillwynioides* flowers from August to December and is quite distinctive and easy to find during spring. *Stylidium longitubum* flowers October to December in seasonal wetlands. *Acacia lasiocarpa* var *bracteolata* long

pedunde variant flowers between May to August. Therefore, field flora surveys were conducted as follows:

1. Brief inspection of significant plant communities during August with searching of appropriate habitat for *Drakaea elastica* and *Acacia lasiocarpa* var *bracteolata* long pedunde variant;
2. Grid inspection of appropriate habitat for *Caladenia huegelii* and *Diuris micrantha* during mid to late September with searching of remnant vegetation for other DRF or Priority species; and
3. Grid inspection of appropriate habitat for *Drakaea elastica* and *Stylidium longitubum* in October to confirm presence/absence of these species.

Grid searching included the 30m previously cleared easement with an additional 10m buffer to either side to identify flora at risk from accidental machinery incursion or edge effects of the operations.

Any significant trees within the DBNGP corridor were identified and location recorded.

Weed and Vegetation Condition Mapping

The survey area was inspected for the presence of environmental and Declared weed species, with particular emphasis placed on access routes and areas of previous disturbance and streamzones.

The condition of the vegetation within the study area was mapped using the condition scales given in the Bush Forever documentation (Government of Western Australia 2000). The definitions of the condition ranking is given in Table 1.

Table 1: Vegetation Condition Ranking Scale (from Bush Forever 2000)

Rating	Scale	Description
Pristine	1	Pristine or nearly so, no obvious signs of disturbance
Excellent	2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
Very Good	3	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	4	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing
Degraded	5	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fire, the presence of very aggressive weeds, partial clearing, dieback and grazing
Completely Degraded	6	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs

Rehabilitation Studies

The vegetation mapping conducted previously by Mattiske Consulting was utilised to identify suitable locations for data collection.

Four 10m x 10m plots were established within the Leda Nature Reserve and another four plots were established within the Lowlands Bush Forever site to collect species composition and density data for vegetation in better condition than the remaining sections of the Looping 10 project area. Plots were established in dominant plant communities for each area.

Plot data and opportunistic recording of species were reviewed to identify keystone and dominant understorey species in each area that will be suitable for rehabilitation purposes. Species lists have been developed for seed collection based on the two identified objectives in the different areas of the project.

Within each quadrat, the following data was collected for each plant species:

- Number of plants (except for rhizomatous species)
- Percentage foliage cover

Phytophthora cinnamomi

The survey area was traversed in a vehicle by personnel experienced and accredited for the detection and mapping of *Phytophthora cinnamomi* to CALM standards. High risk plant communities and landscapes were inspected on foot for symptoms of the plant pathogen's presence. Samples of soil and vegetation material from any dead or dying indicator plant species were collected and analysed for the presence of *P. cinnamomi*. Any obvious disease boundaries found were marked in the field using day-glo pink (*P. cinnamomi* infested) or white (uninterpretable) flagging tape.

3.2.2 Study Results

Flora Species

The only DRF or Priority Flora species identified during the survey was *Drakaea elastica*. 17 individuals were identified in 7 (seven) locations within the DBNGP easement between KP 17 and KP 18.5 (Lowlands Bushland, Western Block). Population locations were marked and 5m buffers were created with fence droppers and pink survey tape around the populations.

Two mature flowering plants of *Calochilus* sp. were also located 4 m to the south-west of the existing pipeline in Lowlands Bushland, Western Block. This orchid is rarely seen however it is not a priority species.

Weed and Vegetation Condition Assessment

Appendix A (to be completed) will present the results of the vegetation condition and weed cover assessments. The pipeline AOD has been completely cleared in the past and regeneration of the AOD has been minimal in all sections except the Lowlands Bush Forever Site near Hymus Swamp. Vegetation regeneration at this site has been restricted to dense stands of *Kunzea glabrescens* with occasional shrubs and annual orchid species at ground level. Significant numbers of orchids were observed at this location on the AOD during spring 2005. Vegetation condition rankings for adjacent vegetation ranged from 4/5 within the Leda Nature Reserve and Lowlands Bush Forever Site to 6 in most other areas indicating that remnant vegetation adjacent to the AOD is generally in a poor condition with areas considered to be degraded to a point where recovery to a good condition is considered impossible.

A single Declared plant species (Arum Lily – *Zantedeschia aethiopica*) was recorded from five locations along the AOD. The locations of this species are presented in Table 2 of Appendix A. The Arum lily is listed under Section 37 of the *Agriculture and Related Resources Protection Act 1976* as a P1, P4 species within the municipal district of

Serpentine-Jarrahdale. Species categorised as P1 under the *Agriculture and Related Resources Protection Act 1976* have prohibitions on the movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder. In addition a category of P4 identifies management tasks including prevention of the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery and requires treatment to destroy and prevent seed set on all plants.

The highly invasive and competitive species *Watsonia* sp. was also recorded at two locations as presented in Appendix A.

The majority of weed species recorded along the AOD were naturalised species common to developed areas and road verges in the south-west of Western Australia. Several of the grasses are highly invasive and likely to compete with native species in a rehabilitation environment. Weed covers recorded along the AOD were high with many areas having between 65% and 100% cover. Figure 1 presents the weed cover classes along the AOD with locations of *Zantedeschia aethiopica* and *Watsonia* sp. also presented.

Rehabilitation Studies

Appendix B (under development) will present the results of the plot and opportunistic species recordings as described in the method section. The following list of species have been identified for use in seed mixes to rehabilitate the respective portions of the AOD (tree species have been removed to protect the long term integrity of the pipe):

Objective 1: Provide native cover of local dominant understorey species that will stabilise soil and help reduce 3rd party access.

Leda Bush Forever Site & other remnant vegetation on Spearwood Dunes

Acacia pulchella
Acacia rostellifera
Conostylis aculeata subsp. *aculeata*
Dryandra lindleyana
Dryandra sessilis
Hakea lissocarpha
Hardenbergia comptoniana
Jacksonia furcellata
Kennedia coccinea
Kennedia prostrata
Macrozamia riedlei
Melaleuca systema
Xanthorrhoea preissii

Objective 2: Provide native cover of local species that will stabilise soil and help reduce 3rd party access and provide increased understorey biodiversity than is currently present on the easement.

Leda Nature Reserve

Acacia pulchella
Acacia rostellifera
Anigozanthos manglesii
Bossiaea eriocarpa
Calectasia narragarra
Conostylis aculeata subsp. *aculeata*
Daviesia triflora
Dianella revoluta
Dichopogon capillipes
Dryandra lindleyana
Hakea lissocarpha
Hakea prostrata
Hardenbergia comptoniana
Hovea pungens
Jacksonia furcellata
Kennedia coccinea
Kennedia prostrata
Lepidosperma leptostachyum
Macrozamia riedlei
Melaleuca systema
Philothea spicatus
Phyllanthus calycinus
Scaevola canescens
Stirlingia latifolia
Xanthorrhoea gracilis
Xanthorrhoea preissii

Lowlands Bush Forever site adjacent to Hymus Swamp

Astartea fascicularis
Calothamnus lateralis
Cyathochaeta avenaceae
Gompholobium tomentosum
Hypolaena exsulca
Jacksonia furcellata
Kunzea glabrescens
Kunzea ericifolia
Lepidosperma longitudinale
Regelia ciliata
Scholtzia involucrata
Thysanotus patersonii
Xanthorrhoea brunonis

The remaining small sections originally mapped as remnant vegetation have condition ratings of 5 or 6 and active rehabilitation methods would have little value in these areas.

Phytophthora cinnamomi

The Looping 10 pipeline corridor was assessed for the presence of disease caused by *Phytophthora cinnamomi* in September 2005. The assessment was performed by Mr Evan Brown of Glevan Consulting. Evan is currently accredited by the Department of Conservation and Land Management (CALM) to provide this service.

The entire alignment was inspected for the presence of the disease. At each site where sufficient vegetation free of the disease was detected, this vegetation was demarcated by tying day-glow orange flagging tape across the corridor using a buffer of approximately twenty metres from the active edge of the disease. The knot in the flagging tape always faces the diseased vegetation.

The demarcation lines in the corridor are valid for a period of twelve months. Should any operations be proposed for beyond September 2006, the demarcation lines and any areas now considered to be free of the disease would need to be re-assessed.

Maps showing the dieback boundaries are currently under development. Dieback boundaries will be incorporated into the Environmental Line Lists prior to construction. Dieback lines will also be demarcated along the AOD with relevant hygiene measures implemented at dieback boundaries during the construction operation.

3.3 Other Environmental Values

The pipeline corridor crosses several wetland areas along its length including the Serpentine River. These areas have all been mapped as Conservation Category wetlands. These areas are described as wetlands that possess a high degree of naturalness and should be managed to maintain and enhance natural attributes and functions (Hill *et al.* 1996). Both the Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) and the Water and Rivers Commission Position Statement: Wetlands (2001) oppose any activities that lead to further loss or degradation of Conservation Category wetlands or their buffers. These wetlands are all listed on the draft Register of Protected Wetlands (Map Sheet 2033) under the *Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004*. After KP 11, the majority of the proposed pipeline route traverses Multiple Use wetlands. There are also 6 Resource enhancement wetlands within 250m of the proposed route after KP 11. Between KP 17.0 – 18.6 the route traverses the Conservation category wetland Lowlands Bushland, Western Block. At KP 20.7 the route passes adjacent to a Conservation Category wetland, and at KP 22.4 the route traverses a small Conservation Category Wetland.

4 REHABILITATION STRATEGY

The rehabilitation strategy for the Looping 10 Gas Pipeline Project focusses on the timely reinstatement of areas of clearing on the AOD. Where possible, significant trees on the AOD that do not pose a threat to the integrity of the pipe will be retained and sensitive areas such as the Serpentine River will use HDD to prevent erosion of the riparian zone. The Environmental Management Plan for the project presents management measures designed to minimise impacts of the pipeline construction (Ecos Consulting (Aust) Pty Ltd 2005).

Section 2 identifies the objectives of the rehabilitation program. These objectives aim to provide stable landforms that are vegetated with indigenous species suitable for the areas. They also aim to restrict third party access and provide habitat values to the AOD that will promote flora colonisation and fauna usage.

5 REHABILITATION METHODS

Rehabilitation of the pipeline easement will be integrated with all project activities and objectives. Studies on the easement have demonstrated a restricted ability of the vegetation systems on the easement to recover from disturbance due to weed invasion and third party activities. This data has been utilised to develop the rehabilitation procedures.

5.1 Weed Management

The invasive weed species *Watsonia* sp. and Declared plant *Zantedeschia aethiopica* have been recorded on the easement

The AOD areas currently displaying weed covers in excess of 50% will be selectively sprayed with Glyphosate to reduce weed seed loads in the topsoil in order to improve establishment of native species in the rehabilitation. This will be conducted prior to construction commencing.

Weed covers and species will be included in rehabilitation monitoring to facilitate management of weed issues following completion of the rehabilitation. Annual monitoring results will be used to develop weed management programs in consultation with CALM and ongoing weed control is expected in the early years of rehabilitation to promote native species cover development.

Weed hygiene will be implemented during all operations in accordance with the Weed Hygiene Protocol (Ecos Consulting (Aust) Pty Ltd 2005).

5.2 Dieback (*Phytophthora cinnamomi*) Management

Maps showing dieback boundaries are currently under development from results of the dieback surveys. The maps will be included in the Hygiene Protocol for Looping 10.

Hygiene management will be in accordance with the Hygiene Protocol for the project and will include the following provisions:

1. All vehicles and machinery will arrive at the project area in a clean state free from soil, mud, soil slurry and vegetation material.
2. Soil and vegetation stripped from the AOD will be stored immediately adjacent to the site where it originated.
3. No topsoil or vegetation material will be transported along the corridor.
4. Any material to be imported to the pipeline corridor, eg. Pipe padding, must be certified to be free from *P. cinnamomi* to the satisfaction of CALM.
5. Hydrotest water will be disposed of in a manner acceptable to CALM and in a location that will not compromise the hygiene status of remnant native vegetation.
6. All vehicles and machinery will be cleaned down prior to leaving the project site to prevent the spread of *P. cinnamomi* from the project area to areas of uninfested native vegetation in the region.

Additional management measures will also be developed if survey results necessitate the need to do so.

5.3 Priority and Rare Flora Management

Management of significant species along the AOD will involve a comprehensive approach consisting of the following steps:

1. Surveys for DRF and Priority flora species will be conducted at the appropriate time during Spring 2005 (section 3.2).
2. Locations of all Declared Rare and Priority flora identified on the easement will be mapped and marked in the field.
3. Where practical and in consultation with CALM these plants will be protected from disturbance through the use of fencing and sign-posting on site.
4. Construction personnel will be provided with information on these species and the management practises being implemented at inductions and toolbox meetings.

In the event that DRF or Priority flora cannot be avoided and destruction of some plants is necessary to implement the project, the following management steps will be taken:

1. Plants that are required to be impacted will be individually marked in the field.
2. The impact of removal of the plants on the conservation status of the species will be assessed at a local and regional scale by a qualified botanical consultant in consultation with officers of CALM.
3. Options for transplanting of individual plants or salvage of biological material for later propagation will be discussed with key Government stakeholders.
4. An application to take DRF will be prepared and submitted to CALM for approval by the Minister for the Environment in accordance with the Wildlife Conservation Act 1950.

5.4 Resource Management

Native vegetation on the easement is a valuable resource for the rehabilitation process in that it provides seed, carbon material, stabilises the soil surface, cools the soil surface, provides habitat for fauna and provides micro habitats for capturing additional seed dispersing from adjacent vegetation. In addition, where trees can be retained on the easement they will provide habitat, cover and structure.

Vegetation will be cleared and stored in a windrow adjacent to the AOD immediately adjacent to where it was cleared from. This will ensure that respread vegetation will be located in the appropriate vegetation type and position in the landscape to make best use of any remaining seed stored on the stems.

Topsoil is an essential component of a successful rehabilitation program as it contains the majority of the naturally stored seed for the existing vegetation that propagate using seed as their prime strategy. Topsoil will be removed using a grader that will cut the top 50mm to 100mm of soil and store it in a windrow on the easement edge immediately adjacent to where it was removed from. Similarly to vegetation, this will ensure that topsoil is respread within the appropriate position in the landscape and vegetation type. Topsoil will not be picked up and moved along the easement. Topsoil will not be used for padding in the pipe trench. Topsoil will not be driven on or disturbed in any way prior to being respread on the AOD.

5.5 Soil Profile and Landform

Trench spoil will be removed and stored in a windrow adjacent to the trench. Following installation of the pipe, the trench will be backfilled and compacted. The surface of the AOD will then be graded to original surface contours and lightly ripped to a depth of 40cm to alleviate any compaction from vehicle and machinery movement. Ripping on contour will not be possible due to the constrained width of the AOD, however shallow ripping with narrow tines should not result in the generation of deep furrows and a light drag bar will be utilised behind the machine to smooth the final surface.

Topsoil will be graded evenly back over the AOD following ripping, ensuring that topsoil is not transported along the easement.

5.6 Establishment of Native Vegetation

Native vegetation will be established on the easement utilising the following methods:

1. From the topsoil seedbank (geospores).
2. From plant stored seed (bradyspores).
3. From applied seed.

Points 1 and 2 above have been addressed in the previous section. Studies on the existing easement have shown that the easement has not generally recovered well following installation of the original Dampier to Bunbury pipe and that the easement has a significant weed issue where it traverses native vegetation. In this situation active

rehabilitation in the form of an applied seed mix to increase the establishment of native species is considered necessary.

Species lists have been compiled from the easement studies to generate seed mixes for application to the various sections of the easement. Trees are considered a threat to the integrity of the pipeline and only those understorey species that are known to produce viable seed have been selected for the rehabilitation mix.

The proposed seed mixes for woodland areas are presented in Section 3.2.2. The seed mixes will be applied at a rate of 3kg/ha to promote a high initial establishment rate.

6 COMPLETION CRITERIA

Table 2 presents the completion criteria for the entire Looping 10 Pipeline Project AoD including the rehabilitation specific criteria. Specific vegetation and weed criteria relate to the various sections of native vegetation of the AOD.

Table 2: Completion Criteria for the Looping 10 Pipeline Project

Aspect	Objective	Criteria	Assessment method
Construction	To ensure that the key commitments that will influence recovery of the pipeline easement are implemented during construction	100% compliance with the weed hygiene protocol.	Audit during the operation
		100% compliance with the dieback hygiene protocol	Audit during the operation
		Vegetation and topsoil is cleared and stored in accordance with the EMP.	Audit during the operation
		Significant plant species are protected in accordance with the plan.	Audit during the operation
Decommissioning	To ensure that all visual disturbances are removed by immediate remedial action to the greatest extent practicable	All equipment, materials and litter are removed from the AOD	Visual inspection of AOD

Aspect	Objective	Criteria	Assessment method
Landform	To reinstate the land to provide suitable conditions for natural recolonisation of native vegetation and support natural surface water movement	Natural contours should be re-instated to pre-disturbance conditions	Visual inspection of AOD
		There should be no active erosion rills in excess of the surrounding land *	GPS record and physical measurement of any points of erosion
Vegetation and Weeds – Leda Nature Reserve and Lowlands Bushland, Western Block (Hymus Swamp) where 3 rd party access is restricted.	To facilitate the establishment of indigenous plant species within each vegetation type on the AOD	There should be no bare patches longer than 10m after 12 & 24 months.	Visual assessment, with particular emphasis in erosion prone areas
		The foliage cover of declared and environmental weeds on the AOD should be similar to surrounding undisturbed areas at 12 & 24 months	Assessment by photographic and visual survey
		A minimum of 1 native plant per square metre when averaged over the entire area rehabilitated at 12 months and 2 native plants per square metre when averaged over the entire area rehabilitated at 24 months.	Assessment of a representative number quadrats within each vegetation type

Aspect	Objective	Criteria	Assessment method
		Percentage foliage cover of native species indigenous to each plant community is greater than or equal to 40% of foliage cover in undisturbed areas outside the easement at 24 months (excluding pipeline access track)	Assessment of a representative number quadrats within each vegetation type
		Species richness greater or equal to 50% of richness in undisturbed areas outside the easement at 24 months	Assessment of a representative number quadrats within each vegetation type
Vegetation and Weeds – Leda Bushland and Surrounding Remnant Vegetation (Not including Leda Nature Reserve) where 3 rd party access is not restricted.	To facilitate the establishment of indigenous plant species within each vegetation type on the AOD	There should be no bare patches longer than 10m after 12 & 24 months when inconsistent with the original condition.	Visual assessment, with particular emphasis in erosion prone areas
		The foliage cover of declared and environmental weeds on the AOD should be similar to surrounding undisturbed areas at 12 & 24 months	Assessment by photographic and visual survey
		A minimum of 1 native plant per square metre when averaged over the entire area rehabilitated at 24 months.	Assessment of a representative number quadrats within each vegetation type

Aspect	Objective	Criteria	Assessment method
		Percentage foliage cover of native species indigenous to each plant community is greater than or equal to 30% of foliage cover in undisturbed areas outside the easement at 24 months* (excluding pipeline access track)	Assessment of a representative number quadrats within each vegetation type
		Species richness greater or equal to 50% of richness in undisturbed areas outside the easement at 24 months	Assessment of a representative number quadrats within each vegetation type

It is Alinta's preference that CALM witness the seed distribution process during rehabilitation.

If the monitoring occasions note areas that do not meet these criteria then discussions will be held with CALM regarding recommended remedial action. It is expected that failed areas will be actively reinstated with planting of appropriate species in failed areas during autumn 2007 in consultation with an appropriately qualified botanical consultant and CALM. Any areas of high weed cover will be treated with an appropriate program in consultation with CALM.

The monitoring will be based on permanent quadrats established following rehabilitation, in addition to a foot reconnaissance of the entire rehabilitated easement to survey for bare areas and weed infestation.

Monitoring will be conducted annually in spring until the rehabilitated areas have regenerated to a stable condition, to the satisfaction of CALM and DoE.

* While best endeavors will be made to achieve these Completion Criteria there may be some exclusions in the heavily degraded Bush Forever and Leda Reserve sections that are frequented by recreational 4WD and trail bike users where 3rd party access is not restricted. In the event that uncharacteristic seasonal weather conditions prevail, this shall be taken into consideration in relation to the completion criteria. In this event where areas are not meeting success criteria joint site reviews will be undertaken to determine appropriate remedial action, if required, to DoE and CALM requirements

7 REFERENCES

Beard (1981)

Vegetation Survey of Western Australia: Swan Region 1:1 000 000 Vegetation Series, The Vegetation of the Swan Area. Explanatory Notes to Sheet 7, and Map Sheet 7. Published by University of Western Australia Press, Perth.

Beard (1990)

Plant Life of Western Australia. Published by Kangaroo Press, New South Wales.

Bowman Bishaw Gorham (2004)

Dampier to Bunbury Natural Gas Pipeline Widening Kwinana to Bunbury Project Strategic Environmental Review. Report prepared for Gas Pipeline Working Group

Churchward, H. M. and McArthur, W. M. (1980)

Landforms and Soils of the Darling System, Western Australia. In: The Atlas of Natural Resources Darling System Western Australia. Published by the Department of Conservation and Environment, Western Australia 1980.

Department of Agriculture (2004)

Declared Plants List. Updated 25 March 2004. Publicly available list
<http://www.agric.wa.gov.au/>

Department of Conservation and Land Management (2003)

List of Threatened Ecological Communities on the Department of Conservation and Land Management's Threatened Ecological Community (TEC) Database endorsed by the Minister for the Environment.

Department of Conservation and Land Management (2004)

Declared Rare and Priority Flora List for Western Australia. Publicly available list produced by the Department of Conservation and Land Management, updated 19 July 2004.

Environmental Protection Authority (2003)

Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Draft Guidance Statement No 51, February 2003.

Environmental Protection Authority (2004)

Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004.

Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. (1994)

A Floristic Survey of the Southern Swan Coastal Plain. Unpublished Report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the conservation Council of Western Australia (Inc.)

Government of Western Australia (1997)

Wetlands Conservation Policy for Western Australia. Minister for the Environment and Minister for Water Resources, Perth

Government of Western Australia (2000)

Bush Forever Volume 1, Policies, Principles and Processes. Published by the Department of Environmental Protection, Perth.

Hedde, E. M., Loneragan, O. W., and Havel, J. J. (1980)

Vegetation Complexes of the Darling System, Western Australia. In: The Atlas of Natural Resources Darling System Western Australia. Published by the Department of Conservation and Environment, Western Australia 1980.

Hill, A.L. *et al.* (1996)

Wetlands of the Swan Coastal Plain Volume 2: Wetland mapping, classification and evaluation. Water and Rivers Commission and Department of Environment, Western Australia

Woodman Environmental Consulting Pty Ltd (2005 in prep.)

Alinta Networks Dampier to Bunbury Natural Gas Pipeline Looping 10 Project - Rare Flora and Vegetation Studies. Unpublished report prepared for Ecos Consulting (Aust) Pty Ltd.

Appendix A
Vegetation and Condition Assessment Results

Appendix B:

Rehabilitation Study Results

DBNGP LOOPING 10

FLORA AND VEGETATION STUDIES

ASSESSMENT METHOD

June 2005



WOODMAN ENVIRONMENTAL CONSULTING PTY LTD
A.C.N. 088 055 90

DOCUMENT REVISION HISTORY

Revision	Description	Originator	Reviewed	Date
A	Released for client review	GW	DW	31-05-05
B	Client	GW	Client	13-06-05
C	Client	GW	Client	29-06-05
D	Client	GW	Client	29-07/05
0	Final	GW	CALM	20-09-05

Reference: ECOS 05-11

DISCLAIMER

This document is prepared in accordance with and subject to an agreement between Woodman Environmental Consulting Pty Ltd (“Woodman Environmental”) and the client for whom it has been prepared (“Ecos Consulting (Aust) Pty Ltd”) and is restricted to those issues that have been raised by the Client in its engagement of Woodman Environmental and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such Documents.

Any organisation or person that relies on or uses this document for purposes or reasons other than those agreed by Woodman Environmental and the Client without first obtaining the prior written consent of Woodman Environmental, does so entirely at their own risk and Woodman Environmental denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

CONTENTS

DESCRIPTION OF PROJECT AND PROJECT AREA.....	1
REVIEW OF EXISTING INFORMATION	1
LEGISLATIVE AND POLICY SETTING.....	2
PROPOSED METHODS.....	2
VEGETATION MAPPING.....	2
<i>Final Vegetation Map Production</i>	2
<i>Vegetation Condition Map Production</i>	2
FLORA.....	2
<i>Flora Species</i>	2
WEED MAPPING	3
PHYTOPHTHORA CINNAMOMI	4
REHABILITATION.....	4
REFERENCES.....	5

DESCRIPTION OF PROJECT AND PROJECT AREA

Alinta on behalf of DBNGP (WA) Nominees Pty Limited propose to install an additional gas pipeline within the existing DBNGP corridor south of Compressor Station CS 10 located immediately north of Thomas Road in Kwinana. The additional pipe is to be installed over a distance of approximately 23km to just south of Punrak Road. The corridor traverses 2 Bush Forever Sites and the Leda Nature Reserve as well as several small areas of remnant native vegetation on private property.

Previous studies along the corridor have been conducted between October 2002 and May 2003 (Strategic Environmental Review for the proposed corridor widening of the DBNGP) and 26th August to 6th September 2004 (Additional flora and vegetation studies in the Leda and Kemerton areas supporting responses to submissions on the Strategic Environmental Review) by Mattiske Consulting Pty Ltd. These studies included mapping of vegetation types on two occasions, alignments with Floristic Community Types (FCTs) according to Gibson et al. 1994 following analysis of floristic data collected in plots. Analysis involved Bray-Curtis Polar Ordination and flexible UPGMA agglomerative hierarchical fusion within the PATN pattern analysis package. In addition, Declared Rare Flora or Priority Listed Flora were noted at recording sites. This work identified a single Priority 4 species (that was regarded as a planted individual due to being outside its known geographical range) and several small occurrences of a threatened ecological community (FCT26A) along the current pipeline corridor.

Preliminary discussions with the Department of Conservation and Land Management (CALM), Department of Environment (DOE) and Department of Industry and Resources (DOIR) have indicated that the project will require additional targeted flora and vegetation assessments to address potential impacts to significant plant communities (TECs and regionally significant vegetation) and Declared Rare and Priority Flora. The existing area for the proposed Looping 10 has been previously surveyed (Mattiske, 2003 and 2004). CALM requested that Alinta develop an assessment method that will be submitted for review and discussion prior to commencement of studies. This document fulfils that request.

Review of Existing Information

A review of all available existing information on the DBNGP Looping 10 survey area will be carried out at the commencement of the project. This review will involve obtaining copies of reports of previous surveys carried out in the local area (for Bush Forever etc.), a search of the Library and Information Service of Western Australia (encompassing the state and university libraries) and discussion with local Department of Conservation and Land Management and Office of Bush Forever personnel. In particular, two of Mattiske Consulting's Vegetation and Flora surveys will be reviewed (Mattiske 2003 and 2004). All information obtained will be reviewed and summarised. A search of the Department of Conservation and Land Management (CALM) Rare and Priority flora and Threatened Ecological Community (TEC) databases will also be carried out. This search will provide an up to date list of all Rare and Priority flora taxa and TECs known to occur within the project area.

Legislative and Policy Setting

The DBNGP Looping 10 survey area is within the Swan Coastal Plain, System 6 area and as such any environmental assessment for the project will be subject to the Environmental Protection Authority (EPA) document “Guidance for the Assessment of Environmental Factors No. 10” – Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region (EPA 2003a). Portions of the survey area are vegetated with some areas included within existing conservation estate and Bush Forever Sites.

PROPOSED METHODS

Flora and Vegetation assessments have been conducted for the survey area in the past, however additional work is required to bring the previous works in accordance with the Environmental Protection Authority (EPA) document “Guidance for the Assessment of Environmental Factors No. 51” – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (EPA 2004). Due to the location of the survey area, the presence of regionally significant bushland and the potential presence of DRF species, the appropriate level of investigation should be Level 2.

Vegetation Mapping

The vegetation mapping conducted previously by Matiske Consulting will be re-visited outside of areas re-mapped in the Leda area and “vegetation Communities” will be aligned with FCTs according to Gibson *et al.* 1994 where possible to provide an indication of the regional conservation significance of communities. Communities that resemble listed Threatened Ecological Communities (TECs) will be visited in the field for verification purposes.

Final Vegetation Map Production

Vegetation mapping of the DBNGP corridor has been conducted in the past and this will not be conducted again as part of this study.

Vegetation Condition Map Production

Where native vegetation is present in the survey area a separate map showing vegetation condition will be developed in accordance with the methods described in the Bush Forever documents (Government of Western Australia 2000). This information will be used to facilitate the determination of conservation significance of the plant communities mapped.

Flora

Flora Species

Flora studies for the DBNGP Looping 10 survey will focus on additional searching for the Declared Rare Flora and Priority Flora species known to occur in the vicinity of the corridor. A preliminary review of CALM’s GIS database undertaken by Greg Woodman

and Mark Garkakalis (Swan Region Regional Ecologist) identified three DRF and three Priority flora species in close proximity to the survey area:

Caladenia huegelii (DRF)

Drakaea elastica (DRF)

Diuris micrantha (DRF)

Dillwynia dillwynioides (P3)

Stylidium longitubum (P3)

Acacia lasiocarpa var *bracteolata* long peduncle variant (P1)

Caladenia huegelii, *Diuris micrantha* and *Drakaea elastica* are orchids that are only above ground and identifiable for a limited time during the year. *Drakaea elastica* should be searched for at two times during the year, initially in August when its distinctive glossy green leaves appear and are highly visible, then again in October to November when it is in full flower. *Caladenia huegelii* flowers between September to October with the peak survey period coinciding with mid to late September depending on rainfall and temperature. *Diuris micrantha* occurs in winter wet swampy sites and flowers in September to early October. *Dillwynia dillwynioides* flowers from August to December and is quite distinctive and easy to find during spring. *Stylidium longitubum* flowers October to December in seasonal wetlands. *Acacia lasiocarpa* var *bracteolata* long peduncle variant flowers between May to August. Therefore, it is proposed that field flora surveys will be conducted as follows:

1. Brief inspection of significant plant communities during August with searching of appropriate habitat for *Drakaea elastica* and *Acacia lasiocarpa* var *bracteolata* long peduncle variant;
2. Grid inspection of appropriate habitat for *Caladenia huegelii* and *Diuris micrantha* during mid to late September with searching of remnant vegetation for other DRF or Priority species; and
3. Grid inspection of appropriate habitat for *Drakaea elastica* and *Stylidium longitubum* in October to confirm presence/absence of these species.

Grid searching will include the 20m previously cleared easement with an additional 10m buffer to either side to identify flora at risk from accidental machinery incursion or edge effects of the operations. The location of all DRF and Priority Flora species located will be included on vegetation maps of the survey area to indicate communities of conservation significance and areas requiring management to protect flora values. Rare Flora Report forms will be submitted to CALM and Specimens submitted to the State Herbarium if required. Plants will be marked in the field in the event that they can be avoided.

Any significant trees within the DBNGP corridor will be identified and location recorded.

Weed Mapping

The survey area will be inspected for the presence of environmental and Declared weed species, with particular emphasis placed on access routes and areas of previous disturbance and streamzones. This data will be utilised to prepare a map of weed cover

for the survey area that will be used to generate weed hygiene plans and procedures for the proposed installation of the pipeline.

Phytophthora cinnamomi

The survey area will be traversed in a vehicle by personnel experienced and accredited for the detection and mapping of *Phytophthora cinnamomi* to CALM standards. High risk plant communities and landscapes will be inspected on foot for symptoms of the plant pathogen's presence. Samples of soil and vegetation material from any dead or dying indicator plant species will be collected and analysed for the presence of *P. cinnamomi*. Any obvious disease boundaries found will be marked in the field using day-glo pink (*P. cinnamomi* infested) or white (uninterpretable) flagging tape. Any locations of *P. cinnamomi* will be illustrated on a map if recorded and a hygiene plan and management plan will be produced to effectively manage this issue.

Rehabilitation

A rehabilitation plan will be developed for the project Environmental Management Plan (EMP) that will address reuse of vegetation material and topsoil resources on the corridor to maximise the success of rehabilitation works.

Vegetation monitoring plots measuring 10m x 10m will be established in adjacent undisturbed vegetation to collect plant presence and density and foliage cover data to be used for any active rehabilitation processes as well as developing completion criteria for monitoring of success of the rehabilitation post pipeline installation. Final rehabilitation procedures, native plot and monitoring parameters and completion criteria will be agreed with CALM and DoE. These will then be incorporated into the (EMP) that will be approved by the Department of Industry and Resources (DoIR).

REFERENCES

- Beard, J. S. (1981)
Vegetation Survey of Western Australia, Swan 1:1 000 000. Map and Explanatory Notes to Sheet 7. Published by University of Western Australia Press, Perth.
- Beard, J. S. (1990)
Plant Life of Western Australia. Published by Kangaroo Press, NSW.
- Bowman Bishaw Gorham (2004)
Dampier to Bunbury Natural Gas pipeline Corridor Widening – Kwinana to Bunbury Project. Strategic Environmental Review. Prepared for the Gas Pipeline Working Group – Department of Industry and Resources.
- Department of Agriculture (2001)
A database on the Vegetation of Western Australia. Stage 1. CALMScience.
- Department of Conservation and Land Management (2004)
Phytophthora and the Disease Caused By It – Management Guidelines. Department of Conservation and Land Management, Como Western Australia.
- Department of Environment and Heritage (2005)
Interim Biogeographic Regionalisation for Australia – Version 5.1 Western Australia. www.deh.gov.au/parks/nrs/ibra/version5-1/wa
- Environment Australia (2000)
Revision of the Interim Biogeographical Regionalisation for Australia (IBRA) and Development of Version 5.1. – Summary Report. Department of Environment and Heritage, Canberra.
- Environmental Protection Authority (2003)
Guidance for the Assessment of Environmental Factors – Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region. Guidance Statement No 10, January 2003.
- Environmental Protection Authority (2004a)
Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No 51, June 2004.
- Government of Western Australia (2000)
Bush Forever Volume 1, Policies, Principles and Processes. Published by the Department of Environmental Protection, Perth.

Green, J.W. (1985)

Census of Vascular Plant Species of Western Australia. Department of Agriculture, Perth.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. and Lloyd, S.G. (1997)

Western Weeds. A Guide to the Weeds of Western Australia. Published by The Plant Protection Society of Western Australia (Inc.), Victoria Park Western Australia

Mattiske Consulting (2003)

Flora and Vegetation Survey of the Proposed Kwinana to Australind Gas Pipeline Infrastructure Corridor, Unpublished

Mattiske Consulting (2004)

Flora and Vegetation Survey of the Proposed Kwinana-Bunbury Gas Pipeline Routes in the Vicinities of Kemerton and Leda, Unpublished

McArthur, W.M. and Bettenay, E. (1960)

The development and distribution of soils on the Swan Coastal Plain, Western Australia. CSIRO Soil Publication No. 16.

Muir, B.G. (1977)

Biological Survey of the Western Australian Wheatbelt. Part II. *Records of the Western Australian Museum*, Supplement No. 3.

Podger, F.D., James, S.H., and Mulcahy, M.J. (1996)

Review of Dieback in Western Australia: Report to the Western Australian Minister for the Environment – Volume 1, Report and Recommendations.

**FLORA AND VEGETATION SURVEY OF THE
PROPOSED KWINANA TO AUSTRALIND
GAS PIPELINE
INFRASTRUCTURE CORRIDOR**

Prepared for:

**Bowman Bishaw Gorham and
Department of Mineral and Petroleum Resources**

Prepared by:

Mattiske Consulting Pty Ltd

November 2003



MATTISKE CONSULTING PTY LTD

TABLE OF CONTENTS

	Page
1. SUMMARY.....	1
2. INTRODUCTION	2
2.1 Location.....	2
2.2 Climate	2
2.3 Vegetation.....	3
2.4 Declared Rare and Priority Flora.....	3
2.5 Local and Regional Significance	5
2.6 Threatened Ecological Communities.....	6
3. OBJECTIVES	6
4. METHODS	6
4.1 Flora.....	7
4.2 Vegetation.....	7
5. RESULTS	7
5.1 Flora.....	7
5.2 Conservation Status of the Flora.....	8
5.3 Vegetation.....	9
5.4 Significant Vegetation Communities.....	13
6. DISCUSSION.....	13
6.1 Flora.....	13
6.2 Vegetation.....	16
6.2.1 Communities and Disturbance	16
6.2.2 Significance of Vegetation.....	16
6.3 Plant Diseases	17
7. RECOMMENDATIONS.....	18
8. LIST OF PARTICIPANTS	19
9. ACKNOWLEDGEMENTS	19
10. REFERENCES	20

TABLES

- 1: Definition of Rare and Priority Flora Species (Department of Conservation and Land Management 2003)
- 2: Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act 1999)
- 3: Summary of Location of Priority Species along the alignment of the Kwinana to Australind Infrastructure Corridor
- 4: Total Number of Vegetation Communities along the Kwinana to Australind Infrastructure Corridor
- 5: Specific Requirements for Declared Plant control and landholder obligations (WA Department of Agriculture, 2002)

FIGURES

- 1: Legend Map to Vegetation Communities along Proposed Corridors
- 2-27: Vegetation Maps

APPENDICES

- A: Vascular Plant Species recorded on proposed Kwinana to Australind Pipeline, October 2002 – October 2003
- B: Vascular Plant Species in Vegetation Communities on proposed Kwinana to Australind Pipeline Route, 2002 – 2003

1. SUMMARY

Mattiske Consulting Pty Ltd was commissioned by Bowman Bishaw Gorham on behalf of the Department of Industry and Resources Gas Pipeline Working Group to review the vegetation of the proposed gas pipeline infrastructure corridor from Kwinana to Australind. The proposed project was undertaken to review the option of expanding the existing corridor as compared with alternative options. The proposed parallel corridors traverse some 125 kilometres. The area surveyed is located within the Darling Botanical District of the Southwest Botanical Province (Beard 1990).

The survey of the flora and vegetation values was based on aerial photograph interpretation and on further field studies carried out on the ground, as required. A total of 69 families, 195 genera and 326 plant taxa (including varieties and subspecies) were recorded within the survey area. Species representation was greatest amongst families Myrtaceae, Papilionaceae, Proteaceae and Poaceae, a flora composition typical of the Darling Botanical District.

No plant species listed as Declared Rare Flora under the Wildlife Conservation Act (1950) were located during the survey. No plant species listed as Vulnerable, Threatened, Endangered or Critically Endangered under the EPBC Act (1999) were located during the survey.

One Priority Four species (*Acacia flagelliformis*), one Priority Three species (*Acacia semitrullata*) and one Priority One species (*Boronia juncea* subsp. *juncea*) were located within the proposed corridor alignment. It is recommended that further fieldwork be undertaken in the specific areas and vegetation communities that support these endangered species during the construction phase to determine any methods that can minimize disturbance to the native vegetation.

Seventy-nine introduced species were observed in the survey area. Some of these species are particularly aggressive and therefore require management so that infestations do not spread or intensify during operational activities. These include the declared plants (under Section 37 of the Agriculture and Related Resources Protection Act, 1976). Paterson's Curse (*Echium plantagineum*), Cotton Bush (*Gomphocarpus fruticosus*), Prickly Pear (*Opuntia* spp.), Blackberry (*Rubus fruticosus*) and Arum Lily (*Zantedeschia aethiopica*). Consequently, there is a need to maintain vehicle hygiene and cleaning operations to limit the spread of weeds in the project areas. Several of the introduced species (not native to Western Australia) were planted in paddocks and rehabilitation areas along the route.

A total of forty-two vegetation communities were recorded on the infrastructure corridor.

Seven vegetation communities are defined as locally significant. The locally significant communities are associated with the presence of Priority Flora, restricted or isolated remnants and the presence of flora exhibiting range extension.

The Threatened Ecological Community (C2 which is equivalent to 3a community as defined by Gibson *et al.* 1994 and recommended for listing by English and Blyth 1997 and 1999; occurred on five localized areas on the alignment. However the community was very degraded and in most cases only the occasional *Corymbia calophylla* or *Kingia australis* plants were present.

Consequently the pockets of C2 community were so disturbed, fragmented and small that they were considered to be not sustainable, nor regarded of any value. This community is listed pursuant to Schedule 2 of the Environmental Protection Biodiversity Conservation Act (1999); however in view of the degree of degradation there should be no need for referral to Environment Australia.

Many of the vegetation communities occurring within the corridor are classified as Degraded (5) according to the standardized scale commonly used in the Perth Metropolitan area and in Bush Forever publications (Keighery, 1994). These are communities occurring as fragments within grazing paddocks in the southern dairy farming areas.

Based on relative conservation values of the various alternative routes recommendations have been made as to the preferred alternative routes. The key issues appear to relate to the Leda section of the route where the route options are constrained and choices have to be made between loss of vegetation in reserves, conservation category wetlands and an EPP lake. The majority of the remaining route has relatively low native biological values, as large sections on the central and eastern option for the southern section near Bunbury and Australind. have been largely cleared and/or disturbed and through the Kemerton area the route largely follows already cleared alignments, tracks or paddocks.

2. INTRODUCTION

2.1 Location

Mattiske Consulting Pty Ltd was commissioned by Bowman Bishaw Gorham on behalf of the Department of Industry and Resources Gas Pipeline Working Group to review the vegetation of the proposed gas pipeline infrastructure corridor from Kwinana to Australind. The proposed project was undertaken to review the options of expanding the existing corridor as compared with alternative route options. The area surveyed is located within the Darling Botanical District of the Southwest Botanical Province (Beard 1990).

The survey was conducted by several botanists from Mattiske Consulting Pty Ltd in a series of field trips from October 2002 to October 2003. The multiple surveys occurred as result of alternative routes formulated by environmental officers from Bowman Bishaw Gorham.

2.2 Climate

The Darling Botanical District experiences a Dry Mediterranean climate with 5-6 dry months each year. The Dry Mediterranean climate falls in the relatively humid zone of the southwest (Beard 1990).

2.3 Vegetation

The survey area lies within the Darling Botanical District of the Southwest Botanical Province (Beard 1990) and thus exhibits characteristics of this province.

Dominant plant families within the Drummond Botanical Sub-district of the Darling Botanical District include Proteaceae (*Grevillea*, *Banksia*), Myrtaceae (*Eucalyptus*, *Melaleuca*) and Mimosaceae (*Acacia*). The Drummond Botanical Sub-district is characterised by *Banksia* woodland on leached sands with *Melaleuca* swamps where ill-drained; woodland of tuart (*Eucalyptus gomphocephala*), jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) on less leached soils (Beard, 1990).

2.4 Declared Rare and Priority Flora

In general, legislation regulates the destruction of indigenous flora. The prohibition of picking wildflowers exists in most circumstances unless special authorization is obtained. Uncontrolled disturbance of indigenous flora would lead to the destruction of some species, particularly of those that are more susceptible to the effects of picking than others.

The Department of Conservation and Land Management assign conservation status to flora that are restricted geographically or threatened by local processes. Regulations aim to protect populations and conserve species.

Declared Rare Flora species are gazetted under section 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to “take” or damage rare flora without Ministerial approval. Section 23F of the Wildlife Conservation Act (1950) defines “to take” as “... to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means”. Those species listed as Declared Rare Flora may not be taken without the specific written approval of the Minister for the Environment. This prohibition applies equally to both Crown and private land; to licensed and unlicensed persons; and to the owners and occupiers of land on which rare flora is found (Department of Conservation and Land Management 2003).

As there is a large Western Australian flora, there are many species that are known from only a few collections, or a few sites, but which have not been adequately surveyed. Such flora may be rare or threatened, but cannot be considered for declaration as rare flora until such survey has been undertaken. These flora species are included on a supplementary conservation list called the Priority Flora List. Priority Flora species are under consideration for declaration as ‘rare flora’ but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents a definition of Declared Rare and the four Priority Flora ratings.

Table 1: Definition of Rare and Priority Flora Species (Department of Conservation and Land Management 2003)

Conservation Code	Category
R	<p>Declared Rare Flora – Extant Taxa</p> <p>“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 and have been gazetted as such.”</p>
P1	<p>Priority One – Poorly Known Taxa</p> <p>“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.”</p>
P2	<p>Priority Two – Poorly Known Taxa</p> <p>“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 (i.e. not currently endangered). Such taxa are under consideration for declaration as ‘rare flora’, but urgently need further survey.”</p>
P3	<p>Priority Three – Poorly Known Taxa</p> <p>“Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as ‘rare flora’ but need further survey.”</p>
P4	<p>Priority Four – Rare Taxa</p> <p>“Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.”</p>

Threatened species are a matter of national environmental significance under the Environmental Protection and Biodiversity Conservation Act (1999). A person must not take an action that has, will have, or is likely to have a significant impact on a listed threatened species or ecological community, without approval from the Commonwealth Minister for the Environment and Heritage. Table 2 presents the definitions of the categories of threatened species under the EPBC Act (1999).

Table 2: Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act 1999)

Category Code	Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

2.5 Local and Regional Significance

Vegetation communities are referred to as Locally Significant where the presence of Priority Flora species has been recorded, where they provide a range extension of particular taxa from previously recorded locations, or where they are very restricted to one or two locations or occur as small isolated communities. In addition, communities that exhibit unusually high structural and species diversity are also of Local Significance (Mattiske, pers. comm.).

Vegetation communities are referred to as Regionally Significant where they are limited to specific landform types, are uncommon or restricted vegetation community types within the regional context, or support populations of Declared Rare Flora significance (Mattiske, pers. comm.).

2.6 Threatened Ecological Communities

Communities are described as ‘Threatened Ecological Communities’ (TEC’s) if they have been defined by the Western Australian Threatened Ecological Communities’ Scientific Advisory Committee and found to be Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). For definitions of TEC categories and criteria refer to English and Blyth (1997, 1999).

Selected vegetation communities have also been listed as “Threatened Ecological Communities” under the EPBC Act (1999). The TEC’s at the national level are defined on the Environment Australia website (www.ea.gov.au).

3. OBJECTIVES

The general objective of this project was to describe and define the botanical values associated with the proposed gas pipeline infrastructure corridors from Kwinana to Australind for Bowman Bishaw Gorham on behalf of the Department of Industry and Resources Development Gas Pipeline Working Group. The specific objectives of the flora and vegetation survey were to:

- collect and identify the vascular plant species present in the field survey area,
- search for any rare, endangered or significant flora species,
- review the conservation status of the vascular plant species by reference to current literature and current listings by the Department of Conservation and Land Management (2003) and plant collections held at the State Herbarium and current listings associated with the Environmental Protection Biodiversity Conservation Act (1999),
- identify any weed species present,
- define and map the plant communities present,
- review the local and regional significance of the plant communities recorded,
- assess relative conservation values of the various alternative routes, and
- prepare a report that summarizes the findings.

4. METHODS

The vegetation of the Kwinana to Australind infrastructure corridors was surveyed following the pipeline alignments by all accessible tracks and where time permitted, traversing areas on foot. Field surveys were conducted between October 2002 and October 2003 by botanists from Mattiske Consulting Pty Ltd. The multiple surveys occurred as result of the alternative routes formulated by environmental officers from Bowman Bishaw Gorham.

The recording sites were selected in areas, which supported native species. Detailed recordings were undertaken to identify baseline structure of communities and further sites were recorded where local variation occurred. Aerial photography was then used to extrapolate the distribution of the vegetation and the community boundaries.

4.1 Flora

A database search was undertaken of records held by the Department of Conservation and Land Management for Declared Rare and Priority Flora species likely to occur in the vicinity of the project area. Relevant species were examined at the Western Australian State Herbarium prior to the field survey being undertaken.

The flora of the survey area was described and collected systematically at each survey site by botanists from Mattiske Consulting Pty Ltd during field trips from October 2002 to May 2003. All plant specimens collected during the field survey were dried and fumigated in accordance with the requirements of the Western Australian Herbarium. The plant species were identified and then compared with pressed specimens housed at the Western Australian Herbarium. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded follows the Western Australian Herbarium (2003) database.

4.2 Vegetation

The vegetation communities occurring along the survey corridor were described in detail. The use of a standard data collection form ensured the data was collected in a systematic and consistent manner. At each site the following records were made: topography, percentage litter cover, soil type, percentage of bare ground, outcropping rocks and their type, pebble type and size, and time since fire. For each species recorded, the average height and percent foliage cover of species both alive and dead was noted.

Aerial photography was used to extrapolate and map plant communities in combination with running notes made during the course of the survey. The vegetation maps and descriptions provided in this report includes all vegetation communities occurring within the infrastructure corridors.

5. RESULTS

5.1 Flora

A total of 69 families, 195 genera and 326 plant taxa (including varieties and subspecies) have been recorded along the various Kwinana to Australind proposed gas pipeline infrastructure corridors (Appendix A). Within these families, the genera *Eucalyptus*, *Melaleuca* and *Banksia* are predominant in the Woodland communities and *Agonis* and *Astartea* were predominant in the shrubland communities. Among the perennial plant population, the Myrtaceae and Proteaceae contained the greatest number of taxa and typify the remnant *Eucalyptus* Woodlands of the southwest region

A total of seventy-nine introduced species were observed in the route option areas (Appendix A). Five of these were Declared Plants under Section 37 of the Agriculture and Related Resources Protection Act (1976), those being Arum Lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*), Cotton Bush (*Gomphocarpus fruticosus*), Paterson's Curse (*Echium plantagineum*) and Prickly Pear (*Opuntia* sp.). Several of the introduced species (not native to Western Australia) were planted in paddocks and rehabilitation areas along the route.

5.2 Conservation Status of the Flora

No plant species listed as Declared Rare Flora under the Wildlife Conservation Act (1950) were located during the survey. No plant species listed as Vulnerable, Threatened, Endangered or Critically Endangered, under the EPBC Act (1999) were located during the survey.

The Priority Four species, *Acacia flagelliformis* was found in only one location within the proposed corridor alignments whilst the Priority Three species, *Acacia semitrullata* was found to occur in a number of locations within a number of vegetation communities along the proposed corridors. One Priority One species, *Boronia juncea* subsp. *juncea* was located in a number of locations within the proposed corridor alignments. It is recommended that further fieldwork be undertaken in the specific areas and vegetation communities that support these endangered species during the construction phase to determine any methods that can minimise disturbance to the native vegetation.

The recorded locations of the Priority species are summarised below in Table 3.

Table 3: Summary of Location of Priority Species along the alignment of the Kwinana to Australind Infrastructure Corridor

* Note that all locations are in WGS84.

Priority Species	Conservation Status	MGA mE	MGA mN
<i>Boronia juncea</i> subsp. <i>juncea</i>	P1	384831	6331840
		386651	6328707
		386707	6330653
		387300	6334560
<i>Acacia semitrullata</i>	P3	384438	6320945
		384523	6320925
		384550	6331840
		384620	6331800
		384640	6330340
		385270	6338653
		385340	6323032
		386200	6336000
		386958	6340798
		386637	6336388
		386645	6336262
386721	6330941		
388636	6351340		
<i>Acacia flagelliformis</i>	P4	384610	6330650

Marsdenia velutina was located within communities G4 and G5 which occur on all the proposed Leda section routes of the proposed gas pipeline corridor. This species was found approximately 2200km outside its previously recorded range, with the closest recorded occurrences being located in the Eastern Kimberley and far North Kimberley coast. This species is acting as an introduced species in this environment.

5.3 Vegetation

A total of 42 vegetation communities were recorded along the proposed routes for the alignment of the Kwinana to Australind gas pipeline infrastructure corridor. The vegetation communities recorded on the alignment have been grouped into twelve structural groups for the project area (Table 4).

Table 4: The Total Number of Vegetation Communities along the Kwinana to Australind Infrastructure Corridor

Group	Total Communities
<i>Agonis flexuosa</i> Woodlands and Forests	2
<i>Banksia</i> Woodlands	6
<i>Corymbia calophylla</i> Woodlands	7
<i>Eucalyptus rudis</i> Woodlands	6
<i>Eucalyptus marginata</i> subsp. <i>marginata</i> Woodlands	6
<i>Eucalyptus gomphocephala</i> Woodlands	5
<i>Eucalyptus decipiens</i> Woodlands	1
<i>Kunzea ericifolia</i> subsp. <i>ericifolia</i> Shrublands	2
<i>Melaleuca</i> Woodlands	4
Closed Heath	3
Sedgeland	1
TOTAL	42

The vegetation communities recorded in the project area are defined below with the community descriptions based on Beard (1990). The species recorded in each community are summarised in Appendix B.

Eucalyptus rudis Woodlands

- R1: Disturbed Low Open Woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* over *Pteridium esculentum* and pastoral grasses.
- R2: Disturbed Low Open Woodland of *Eucalyptus rudis* - *Corymbia calophylla* over *Melaleuca preissiana*, *Melaleuca raphiophylla* and *Taxandria linearifolia* over pastoral grasses in association with watercourses.
- R3: Disturbed Low Open Woodland of *Eucalyptus rudis* - *Corymbia calophylla* over *Kunzea ericifolia* subsp. *ericifolia* over pastoral grasses.
- R4: Disturbed Low Open Woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* with pockets of *Corymbia calophylla* over pastoral grasses.
- R5: Disturbed Low Open Woodland of *Eucalyptus rudis* over *Melaleuca preissiana* with *Juncus pallidus* in depressions, over pasture grasses.
- R6: Woodland of *Eucalyptus rudis* – *Melaleuca raphiophylla* over *Melaleuca teretifolia* and *Astartea fascicularis* over *Lepidosperma longitudinale*.

Corymbia calophylla Woodlands

- C1: Disturbed Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* – *Melaleuca raphiophylla* over *Xanthorrhoea preissii*, *Viminaria juncea*, **Gladiolus caryophyllaceus* and pastoral grasses.
- C2: Disturbed Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* over *Kingia australis* and *Hypocalymma angustifolium* over pastoral grasses.
- C3: Low Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii*, *Dasypogon bromeliifolius* and *Adenanthos meisneri*.
- C4: Disturbed Open Woodland of *Corymbia calophylla* - *Eucalyptus rudis* over *Agonis flexuosa* over pastoral grasses.
- C5: Disturbed Low Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* over *Taxandria linearifolia*, *Astartea fascicularis*, *Baumea articulata* and *Juncus pallidus* over pastoral grasses.
- C6: Disturbed Low Open Woodland of *Corymbia calophylla* - *Eucalyptus marginata* subsp. *marginata* - *Banksia menziesii* - *Allocasuarina fraseriana* over *Kunzea ericifolia* subsp. *ericifolia* over pasture grasses.
- C7: Disturbed Low Open Woodland of *Corymbia calophylla* - *Eucalyptus wandoo* over *Melaleuca preissiana* over pasture grasses.

Eucalyptus marginata subsp. marginata Woodlands

- M1: Disturbed Open Woodland of *Eucalyptus marginata* subsp. *marginata* over *Cartonema philydroides*.
- M2: Open Woodland of *Eucalyptus marginata* subsp. *marginata* – *Corymbia calophylla* over *Kunzea ericifolia* subsp. *ericifolia*, *Pericalymma ellipticum* and *Acacia pulchella* var. *glaberrima* over Poaceae species.
- M3: Open Woodland of *Eucalyptus marginata* subsp. *marginata* - *Banksia ilicifolia* - *Banksia grandis* - *Banksia littoralis* and *Nuytsia floribunda* over *Kunzea ericifolia* subsp. *ericifolia*, *Acacia pulchella*, *Stirlingia latifolia*, *Xanthorrhoea preissii* and *Dasypogon bromeliifolius*.
- M4: Woodland of *Eucalyptus marginata* subsp. *marginata* - *Corymbia calophylla* - *Banksia attenuata* and *Banksia grandis* over *Xanthorrhoea preissii*, *Hibbertia hypericoides*, *Aotus procumbens*, *Macrozamia riedlei*, *Dasypogon bromeliifolius* and *Bossiaea eriocarpa*.
- M5: Woodland of *Eucalyptus marginata* subsp. *marginata* - *Corymbia calophylla* - *Banksia attenuata* - *Banksia grandis* and *Xylomelum occidentale* over *Kunzea ericifolia* subsp. *ericifolia*, *Hibbertia hypericoides*, *Daviesia incrassata* subsp. *incrassata*, *Brachyloma preissii*, *Persoonia saccata* and *Acacia willdenowiana*.

Eucalyptus gomphocephala Woodlands

- G1: Open Woodland of *Eucalyptus gomphocephala* - *Corymbia calophylla* over pasture species.
- G2: Open Woodland of *Eucalyptus gomphocephala* - *Allocasuarina fraseriana* over low mixed shrubs and herbs.
- G3: Open Woodland of *Eucalyptus gomphocephala* – *Eucalyptus marginata* subsp. *marginata*– *Banksia* species over low mixed shrubs and herbs.
- G4: Open Woodland of *Eucalyptus gomphocephala* over *Acacia saligna*, *Acacia rostellifera*, *Dryandra sessilis* var. *cygnorum* and low mixed shrubs.
- G5: Open Woodland of *Eucalyptus gomphocephala* over *Acacia* species and *Melaleuca raphiophylla* and low sedges and shrubs.

Eucalyptus decipiens Woodlands

- E1: Low Open Woodland of *Eucalyptus decipiens* - *Banksia littoralis* - *Acacia rostellifera* over *Dryandra sessilis* var. *cygnorum* and low mixed shrubs.

Banksia Woodlands

- B1: Disturbed Low Open Woodland of *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* - *Allocasuarina fraseriana* over low shrubs and pastoral grasses.
- B2: Disturbed Open Woodland of *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* - *Allocasuarina fraseriana* - *Xylomelum occidentale* over *Hibbertia hypericoides*, *Hibbertia huegelii* and *Hyalosperma cotula*.
- B3: Open Woodland of *Banksia attenuata* – *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia*, *Stirlingia latifolia*, *Calytrix fraseri*, *Adenanthos meisneri* and *Dasypogon bromeliifolius*.
- B4: Open Woodland of *Banksia attenuata* – *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia*, *Allocasuarina humilis*, *Stirlingia latifolia* and mixed shrubs.
- B5: Open Woodland of *Banksia attenuata* – *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia* with occasional *Nuytsia floribunda* and *Corymbia calophylla* over *Melaleuca thymoides*, *Calytrix fraseri*, *Acacia pulchella* var. *glaberrima* and mixed shrubs.
- B6: Open Woodland of *Banksia ilicifolia* - *Banksia attenuata* - *Agonis flexuosa* and *Eucalyptus marginata* subsp. *marginata* over dense *Kunzea ericifolia* subsp. *ericifolia* with *Bossiaea eriocarpa*, *Hibbertia hypericoides*, *Dasypogon bromeliifolius*, *Acacia pulchella* and *Patersonia occidentalis*.

Melaleuca Woodlands

- P1: Disturbed Open Woodland of scattered *Melaleuca preissiana* over *Juncus pallidus* and pastoral grasses.

- P2: Disturbed Low Open Woodland of *Melaleuca raphiophylla* - *Melaleuca preissiana* over *Astartea fascicularis* over pasture grasses and sedges.
- P3: Low Open Woodland of *Melaleuca preissiana* and occasional *Eucalyptus marginata* subsp. *marginata* and *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and *Calytrix* species over *Dasypogon bromeliifolius*.
- P4: Low Open Woodland of *Melaleuca preissiana* with either *Agonis flexuosa* or *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and *Calytrix* species over *Dasypogon bromeliifolius*.

Agonis flexuosa Woodlands and Forests

- F1: Open Forest of *Agonis flexuosa* – *Eucalyptus marginata* subsp. *marginata* over grasses.
- F2: Open Woodland of *Agonis flexuosa* with occasional *Banksia attenuata*, *Banksia ilicifolia* and *Nuytsia floribunda* over mixed shrubs.

Kunzea ericifolia subsp. ericifolia Shrublands

- K1: Disturbed Low Shrubland of *Kunzea ericifolia* subsp. *ericifolia* over *Regelia ciliata* over pastoral grasses.
- K2: Tall Shrubland of *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and mixed shrubs over *Meeboldina scariosa*, with occasional emergent *Eucalyptus marginata* subsp. *marginata*, *Banksia attenuata* and *Banksia ilicifolia*.

Closed Heath

- H1: Closed Heath of Myrtaceae species, including *Kunzea ericifolia* subsp. *ericifolia*, *Pericalymma ellipticum*, *Astartea fascicularis* and *Melaleuca* species over *Baumea* and *Meeboldina* species, with occasional emergent trees of *Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata*.
- H2: Closed Heath of *Pericalymma ellipticum* – *Hypocalymma angustifolium* shrubs over mixed sedges, with occasional emergent *Melaleuca preissiana*, *Nuytsia floribunda* and very occasional *Banksia littoralis* trees.
- H3: Closed Heath of *Astartea fascicularis* – *Calothamnus lateralis* and *Cassytha racemosa* over mixed sedges.

Sedgelands

- S1: Sedgelands of *Baumea*, *Meeboldina* and *Juncus* species over pastures in disturbed areas.

5.4 Significant Vegetation Communities

Vegetation communities B2, B4, B5, C5, H3 and M4 are regarded as Locally Significant due to the presence of *Acacia semitrullata* (P3), Community H2 is regarded as Locally Significant to the presence of *Acacia flagelliformis* (P4) and community H3 is regarded as Locally Significant due to the presence of *Boronia juncea* subsp. *juncea* (P1).

Vegetation Community C2 is regarded as ‘Threatened Ecological Communities’ (TEC’s) as described by English and Blyth (1997, 1999) or under the EPBC Act (1999). Five areas of this community were located during the survey. These were centered at:

6411600 mN 397850 mE
 6406050 mN 397850 mE
 6404800 mN 397850 mE
 6400600 mN 397700 mE
 6400400 mN 397700 mN

The Threatened Ecological Community (C2 which is equivalent to 3a community as defined by Gibson *et al.* 1994 and recommended for listing by English and Blyth 1997 and 1999; this community is also listed at the Federal level under the EPBC Act 1999) occurred on five localized areas on the alignment. However the community was very degraded and in most cases only the occasional *Corymbia calophylla* or *Kingia australis* plants were present. Consequently these pockets were so disturbed and fragmented (small) that they were considered to be not sustainable, nor regarded as of any value. This community is listed pursuant to Schedule 2 of the Environmental Protection Biodiversity Conservation Act (1999). However in view of the degree of degradation, there should be no need for referral to Environment Australia.

Wetlands in the Wellesley area (near Kemerton) are considered to be significant because of the lack of remnant vegetation left on the Swan Coastal Plain and as it provides one of the few opportunities left to link native vegetation corridors (and associated wildlife corridors) from the coast to eastern areas of the Swan Coastal Plain. This area is under increasing pressure from industrial estates, the expansion of the Australind and Bunbury urban areas and from sand and mineral sand operations.

6. DISCUSSION

6.1 Flora

The flora and vegetation assessment undertaken on the Kwinana to Australind infrastructure corridor recorded 69 families, 195 genera and 326 plant taxa, including subspecies and varieties (Appendix A). The low number of taxa recorded during a survey of such relatively large size reflects the high degree of disturbance and the large area of cleared pasture, particularly in the southern portion. The major families recorded reflect the predominant types of vegetation communities recorded. In view of the seasonal conditions and particular period of drought, it is predicted that additional species would be recorded if further survey work were undertaken during other seasons or in more favourable rainfall periods.

No plant species listed as Declared Rare Flora under the Wildlife Conservation Act (1950) were located during the survey. No plant species listed as Vulnerable, Threatened, Endangered or Critically Endangered, under the EPBC Act (1999) were located during the survey. One Priority Four species (*Acacia flagelliformis*), One Priority Three species (*Acacia semitrullata*) and one Priority One species (*Boronia juncea* subsp. *juncea*) were located within the proposed corridor alignment. It is recommended that further fieldwork be undertaken in the specific areas and vegetation communities that support these species during the construction phase to determine any methods that can minimize disturbance to the native vegetation.

The construction staff operating in the area will need to be informed of the recorded locations of the populations of Priority Flora taxa found along the proposed pipeline infrastructure corridor. All operators will also need to be informed of the potential for individual plants likely to be found at additional locations, particularly where the route may alter from that assessed in the present survey.

A high number of weeds are found to occur within the proposed pipeline infrastructure corridors. The abundance of weeds far exceeds the diversity of weed species recorded. This is because a small number of introduced species are common pasture weeds and occur in dense numbers in grazing paddocks. A total of 77 introduced species were identified within the infrastructure corridor. Five of the recorded weed species, Arum Lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*), Cotton Bush (*Gomphocarpus fruticosus*), Paterson's Curse (*Echium plantagineum*) and Prickly Pear (*Opuntia* sp.) are listed as declared plants under Section 37 of the Agriculture and Related Resources Protection Act (1976). Declared Plants are weeds, which already are or have the potential to become pest weeds. Declared Plants are classed with a priority rating depending on the level or treatment they require for their control, which differs for each weed in different areas of the state. This priority ranking system should not be confused with the Priority status applied to native plant species under threat of extinction. The specific requirements for Declared Plant control and landholder obligations (WA Department of Agriculture, 2003) are summarized in Table 5.

Arum Lily (*Zantedeschia aethiopica*), Blackberry (*Rubus fruticosus*) and Cotton Bush (*Gomphocarpus fruticosus*) are listed by the WA Department of Agriculture as having P1 and P4 requirements for control. Paterson's Curse (*Echium plantagineum*) is listed as having P1 and P3 requirements.

Prickly Pear (*Opuntia* sp.) is listed as a Declared Plant and has requirements for control and landholder obligations in other areas of the state. However there are no requirements for control of the Prickly Pear in the area of this study.

One of the species located was found to be outside of its normal range of occurrence. *Marsdenia velutina* was recorded within communities G4 and G6. The WA Herbarium currently holds four specimens of *Marsdenia velutina* which each represent a separate population. The closest population of this species is located on Mabel Downs in the East Kimberley (approximately 2200km away), with the remaining three populations being located on the far north Kimberley coast, in the Kalumburu region. A population is considered to exhibit a range extension when it is located more than 100km away from previously recorded populations. This species is acting as an introduced species in this environment.

Within the project area, threats to flora conservation currently include the introduction of exotic plant species (weeds), grazing by domestic stock, feral animals and kangaroos, mining, associated infrastructure and vehicular activity, (not necessarily in the order of degree of threat). In terms of land management and potential impacts on natural resources, addressing these issues may have implications for future land use and nature conservation.

Table 5: Specific Requirements for Declared Plant control and landholder obligations (WA Department of Agriculture, 2003)

(Modified from the WA Department of Agriculture website <http://www.agric.wa.gov.au>)

Specific Requirements	Management Actions
<p>P1</p> <p>Prohibits movement</p>	<p>The movement of plants or their seeds is prohibited within the State.</p> <p>This prohibits the movement of contaminated machinery and produce including livestock and fodder.</p>
<p>P3</p> <p>Aims to control infestation by reducing area and/or density of infestation</p>	<p>The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.</p> <p>Treat to destroy and prevent seed set all plants:-</p> <ul style="list-style-type: none"> • Within 100 metres inside of the boundaries of the infestation. • within 50 metres of roads and highwater mark on waterways. • within 50 metres of sheds, stock yards and houses. <p>Treatment must be done prior to seed set each year.</p> <p>Of the remaining infested area:-</p> <ul style="list-style-type: none"> • Where plant density is 1-10 per hectare treat 100% of infestation. • Where plant density is 11-100 per hectare treat 50% of infestation. • Where plant density is 101-1000 per hectare treat 10% of infestation. <p>Properties with less than 2 hectares of infestation must treat the entire infestation.</p> <p>Additional areas may be ordered to be treated.</p>
<p>P4</p> <p>Aims to prevent infestation spreading beyond existing boundaries of infestation.</p>	<p>The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.</p> <p>Treat to destroy and prevent seed set all plants:-</p> <ul style="list-style-type: none"> • within 100 metres inside of the boundaries of the infested property • within 50 metres of roads and highwater mark on waterways • within 50 metres of sheds, stock yards and houses <p>Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation.</p> <p>Additional areas may be ordered to be treated.</p>

6.2 Vegetation

6.2.1 Communities and Disturbance

A total of forty two vegetation communities were located and mapped within the corridor alignments. The vegetation communities recorded along the Kwinana to Australind infrastructure corridor were not particularly diverse, despite the high number of communities recorded. The high number of communities recorded during this survey reflects the large area surveyed and to some degree the diversity of landforms within the survey area. Many of the vegetation communities differ only slightly from one another and the contrasts are more than likely due to a loss of structure and diversity due to degradation from intensive farming practises throughout much of the survey area, particularly in the southern portion.

The predominant plant communities were *Eucalyptus* Woodlands over various other tree and shrub species. There were also many *Melaleuca* Woodlands and *Banksia* Woodlands, while less common were *Agonis* Woodlands, *Kunzea* Shrublands, Heaths and Sedgeland. Pastures were also very common.

The condition of the vegetation throughout the survey area ranged from Very Good (3) to Degraded (5), in accordance with the condition scale, adapted from *Keighery* (1994) and used for the Perth Metropolitan area in Bush Forever publications (Department of Environmental Protection, 2000). Evidence of disturbance was largely associated with roads, railway lines, powerlines, existing pipeline corridors and variable grazing pressure associated beef and dairy farms, particularly in the southern portion. In most cases, communities described as “Disturbed” exist as fragments within or adjacent to Completely Degraded (6) pasture, containing only introduced pastoral grasses and being completely void of native species. Most of the communities not specifically defined as “Disturbed” should be regarded as being in Good (4) condition, with the exception of communities E1 and G1.

6.2.2 Significance of Vegetation

Seven of the communities recorded in the Kwinana to Australind infrastructure corridor survey area are regarded as significant. Vegetation communities are referred to as locally significant where the presence of priority flora species has been recorded, where they maintain a range extension of particular taxa from previously recorded locations, or where they are very restricted to one or two locations and/or occur as small isolated communities. In addition, communities that exhibit unusually high structural and species diversity are also of local significance.

Vegetation communities are referred to as Regionally Significant where they are limited to specific landform types, are uncommon or restricted community types within the regional context, or are recognized as a threatened ecological community or supports Declared Rare Flora.

Local Significance

Seven vegetation communities supported Priority Flora taxa (communities B2, B4, B5, C5, H2, H3 and M3). Three Priority Flora species have been located within the survey area (Department of Conservation and Land Management, 2001). In general, vegetation communities in which Priority Flora taxa have been recorded are Locally Significant. These should be avoided whenever possible during construction and operational activities.

Regional Significance

The Threatened Ecological Community (C2 which is equivalent to 3a community as defined by Gibson *et al.* 1994 and recommended for listing by English and Blyth 1997 and 1999; this community is also listed at the Federal level under the EPBC Act 1999) occurred on five localized areas on the alignment, however the community was very degraded and in most cases only the occasional *Corymbia calophylla* or *Kingia australis* plants were present.

Consequently the pockets of C2 community were so disturbed and fragmented (small) that these pockets were considered to be not sustainable and not regarded as of any value. This community is listed pursuant to Schedule 2 of the Environmental Protection Biodiversity Conservation Act (1999); however in view of the degree of degradation should not require referral to Environment Australia.

Therefore, none of the communities recorded along the Kwinana to Australind infrastructure corridor were defined as Regionally Significant due to the degree of disturbance in this community.

Degree of Land Clearing

Vegetation communities located in the agricultural areas should be considered both restricted and isolated as they occur in an environment predominantly cleared for primary production. For the most part, vegetation communities described occur as small isolated communities and are very restricted to one or two locations in the survey area.

Therefore, the majority of the vegetation along the routes (with the exception of a few key areas near Leda and Kemerton) has been largely disturbed by agricultural activities, weed invasions, urban expansion and existing infrastructure corridor developments that few sections of the proposed routes are significant in either a local or regional context.

6.3 Plant Diseases

The fungal disease – *Phytophthora cinnamomi* has been confirmed on the low lying wetlands within the Kemerton area of the route alignment and consequently there is a need to take a precautionary approach to all of the vehicle movements along the route to ensure maximum vehicle hygiene is maintained at all times. This dieback has been present for some time and has led to the decline in several susceptible species including *Banksia littoralis* and *Banksia ilicifolia* in these low lying areas.

Therefore every effort should be made to maintain vehicle hygiene measures at all times.

7. RECOMMENDATIONS

The route has been revised on numerous occasions in localised areas so as to minimise the degree of clearing along the alignment. Therefore there is only minimal disturbance to remnant areas of native vegetation, particularly in the agricultural areas. The latter revisions and attempts to minimise the disturbance of native vegetation is in line with the Environmental Protection Authority (EPA) Position Statement No. 2 (Environmental Protection Authority 1999a) and Environmental Protection Authority (EPA) Bulletin 966 (Environmental Protection Authority 1999b).

The width of the clearing along the proposed infrastructure corridor should be kept to a minimum and prior to any earthworks a detailed inspection should be undertaken on the ground by a botanist and engineer to determine any methods that can minimize disturbance to the native vegetation.

Rehabilitation after construction should aim to return disturbed areas to their pre-production state, or better. The following points should be considered in the preparation of a rehabilitation program:

- the spread of invasive weeds and dieback (in less disturbed areas) be minimized by maintaining vehicle hygiene or other suitable means of control;
- any viable seed be collected for future rehabilitation work;
- unnecessary clearing of vegetation beyond that strictly required is avoided, particularly larger trees present through most of the survey area, which provide habitats of many forms and are an integral part of the ecosystem; and
- establishment program for the species through translocation trials or seed collection trials. The latter should be undertaken in consultation with experts in this field (eg. Kings Park Botanic Gardens or the Department of Conservation and Land Management).
- stockpiling of topsoil, log debris and leaf litter removed during clearing for future use in rehabilitation programs in the immediate area. If possible, stockpiled topsoil should be directly replaced on disturbed areas.

The impact of *Phytophthora cinnamomi* presents a major threat to the ecology and conservation of susceptible vegetation communities throughout Western Australia. The occurrence of *P. cinnamomi* is not specific to land tenure. Effective control of *P. cinnamomi* (i.e. detection, research and management, requires the combined efforts of the general public, industries and the federal, state and local government departments (Shearer 1990). With respect to the Kwinana to Australind infrastructure corridor, the key area of concern is in the low-lying swamp and wetland areas along the alignment and more specifically in the Kemerton area.

Tracks need to be rationalised and managed to allow access, yet minimize disturbance to developing and established vegetation. In particular, general access should be restricted, albeit denied in sensitive or problematic areas (e.g. restoration areas, weed eradication trials, location of endangered flora, weed infested areas, areas of high erosion). Tracks that are no longer required should be physically blocked off and rehabilitated.

Disturbance to the vegetation in the way of loss or fragmentation may adversely affect the long term viability, condition and diversity of vegetation occurring along certain areas of the infrastructure corridor. Increasing edge effects will invariably reduce the resilience of the vegetation communities to cope with disturbances (e.g. fire, weed invasion) in both the short and long term. Increased fragmentation and associated perimeter area ratios of bushland areas also incur greater management expense (pers. comm. E.M. Matiske, J. Quilty) to the landholders. It is therefore reiterated that disturbance is minimized wherever possible and consideration is given to edge effects and increasing fragmentation.

A management plan to reduce the impact of the future pipeline construction will need to address issues including erosion, rehabilitation, track use and access, soil hygiene, weed control strategies, remnant vegetation and fragmentation.

8. LIST OF PARTICIPANTS

The following personnel of Matiske Consulting Pty Ltd were involved in this project:

Principle Ecologist:

- Dr. E. Matiske

Senior Botanist:

- Dr. P. Armstrong

Botanists:

- Mr. P. Montague
- Ms. K. Honczar
- Ms. N. Whittington
- Ms. K. Freeman
- Mr. S. Chalwell

9. ACKNOWLEDGEMENTS

The author would like to thank Mr Phil Bayley for assistance with the field survey and the staff members of the Department of Mineral and Petroleum Resources Gas Pipeline project team.

In addition, the authors would like to particularly thank Mr Allan White and staff of CAD Resources for assistance with the map production phase.

10. REFERENCES

- Beard J.S. (1990)
Plant Life of Western Australia. Kangaroo Press, Kenthurst, New South Wales.
- Bureau of Meteorology (2001)
Climate Averages for specific sites. Publicly available data prepared by the Bureau of Meteorology, Commonwealth of Australia.
http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml
- Department of Agriculture (2003)
Declared Plants List. Publicly available list prepared by the Department of Agriculture, Western Australia.
- Department of Conservation and Land Management (2003)
Declared Rare and Priority Flora List. Publicly available list prepared by the Department of Conservation of Land Management, Western Australia.
- Department of Environmental Protection (2000)
Bush Forever – Volume 2.
Department of Environmental Protection, Perth.
- English, V and J. Blyth (1997)
Identifying and Conserving Threatened Ecological Communities (TECs) in the South West Botanical Province. ANCA National Reserves System Cooperative Program: Project Number N702.
- Environment Australia (2003)
National list of Threatened Species, Ecological Communities and Threatening Processes. Commonwealth of Australia.
<http://www.environment.gov.au/cgi-bin/forms/sprat/public/publicthreatenedlist.pl?wanted=flora>
- Environmental Protection Authority (1999a)
Environmental Protection of Native Vegetation in Western Australia. Position Statement No. 2. Environmental Protection Authority, Perth.
- Environmental Protection Authority (1999b)
Clearing of Native Vegetation – environmental advice on the issues arising from use of Section 38 to assess clearing proposals in the agricultural area, and implications for the other areas of Western Australia. Advice to the Minister for the Environment from the Environmental Protection Authority (EPA) under Section 16(j) of the *Environmental Protection Act 1986*. Environmental Protection Authority, Perth.
- English, V. and Blyth, J. (1997)
Identifying and conserving threatened ecological communities in the South West Botanical Province. National Parks and Wildlife and Department of Conservation of Land Management, Western Australia.
- Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. (1994). *A Floristic Survey of the Swan Coastal Plain*. Unpublished Report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia, Perth, Western Australia.

Keighery, B.J. (1994)

Vegetation and Flora Report for System Six Proposed Reserve-M53.

Unpublished report for the Department of Environmental Protection, Perth, Western Australia.

Shearer, B.L. (1990)

Dieback of Native Plant Communities caused by Phytophthora species – A Major Factor affecting Land Use in South-Western Australia. In: *Land and Water Research News* **5**, pp. 15-26.

Western Australian Herbarium (2003)

Florabase – Information on the Western Australian Flora. Department of Conservation and Land Management.

<http://www.calm.wa.gov.au/science/florabase.html>

Western Australian Herbarium (2003)

Max –Western Australian Plant Census. Department of Conservation and Land Management.

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
DENNSTAEDTIACEAE	<i>Pteridium esculentum</i>
ZAMIACEAE	<i>Macrozamia riedlei</i>
PINACEAE	* <i>Pinus pinaster</i> * <i>Pinus sp.</i>
ARAUCARIACEAE	* <i>Araucaria heterophylla</i>
CUPRESSACEAE	<i>Actinostrobus pyramidalis</i> <i>Callitris sp.</i>
POACEAE	<i>Amhipogon laguroides</i> <i>Austrodanthonia occidentalis</i> <i>Austrostipa compressa</i> <i>Austrostipa sp.</i> * <i>Avena fatua</i> * <i>Avena sp.</i> * <i>Briza maxima</i> * <i>Briza minor</i> * <i>?Bromus sp.</i> * <i>Cynodon dactylon</i> * <i>Cynodon sp.</i> * <i>Ehrharta calycina</i> * <i>Ehrharta longiflora</i> * <i>Eragrostis curvula</i> * <i>Hordeum leporinum</i> * <i>Lagurus ovatus</i> * <i>Pennisetum clandestinum</i> * <i>Pennisetum macrourum</i> * <i>Pennisetum setaceum</i> * <i>Pentaschistis airoides</i> * <i>Phalaris aquatica</i> <i>Poaceae sp.</i>
CYPERACEAE	<i>Baumea juncea</i> * <i>Cyperus eragrostis</i> <i>Ficinia nodosa</i> <i>Gahnia trifida</i> <i>?Lepidosperma brunonianum</i> <i>Lepidosperma effusum</i> <i>Lepidosperma longitudinale</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
CYPERACEAE (Continued)	<i>Lepidosperma squamatum</i> <i>Lepidosperma</i> sp. <i>Mesomelaena stygia</i> <i>Mesomelaena tetragona</i> <i>Schoenus curvifolius</i> <i>Schoenus</i> sp. ? <i>Schoenus</i> sp. <i>Tricostularia neesii</i> var. <i>neesii</i>
ARECACEAE	* <i>Washingtonia filifera</i>
ARACEAE	* <i>Zantedeschia aethiopica</i>
RESTIONACEAE	<i>Desmocladius asper</i> <i>Desmocladius fasciculatus</i> <i>Desmocladius flexuosus</i> <i>Hypolaena exsulca</i> <i>Lyginia barbata</i> <i>Lyginia imberbis</i> <i>Meeboldina coangustata</i> <i>Meeboldina roycei</i> (ms)
CENTROLEPIDACEAE	<i>Centrolepis drummondiana</i>
COMMELINACEAE	<i>Cartonema philydroides</i>
JUNCACEAE	* <i>Juncus acutus</i> <i>Juncus pallidus</i> <i>Juncus subsecundus</i> <i>Juncus</i> sp.
DASYPOGONACEAE	<i>Dasypogon bromeliifolius</i> <i>Kingia australis</i> <i>Lomandra caespitosa</i> <i>Lomandra hermaphrodita</i> <i>Lomandra nigricans</i> <i>Lomandra sericea</i> <i>Lomandra sonderi</i> <i>Lomandra</i> ? <i>suaveolens</i> <i>Lomandra</i> sp.

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
XANTHORRHOEACEAE	<i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preissii</i>
PHORMIACEAE	<i>Dianella revoluta</i> var. <i>divaricata</i>
ANTHERICACEAE	<i>Corynotheca micrantha</i> <i>Dichopogon capillipes</i> <i>Johnsonia acaulis</i> <i>Johnsonia</i> sp. <i>Laxmannia squarrosa</i> <i>Thysanotus multiflorus</i> <i>Thysanotus patersonii</i> <i>Thysanotus thyrsoides</i> <i>Tricoryne elatior</i>
ASPHODELACEAE	* <i>Trachyandra divaricata</i>
COLCHIACEAE	<i>Burchardia umbellata</i>
HAEMODORACEAE	<i>Conostylis aculeata</i> subsp. <i>aculeata</i> <i>Conostylis aculeata</i> subsp. <i>preissii</i> <i>Conostylis juncea</i> ? <i>Conostylis</i> sp. <i>Haemodorum simplex</i> <i>Haemodorum spicatum</i> <i>Phlebocarya ciliata</i>
AGAVACEAE	* <i>Agave americana</i>
IRIDACEAE	* <i>Gladiolus caryophyllaceus</i> * <i>Gladiolus undulatus</i> <i>Patersonia occidentalis</i> * <i>Romulea rosea</i> * <i>Watsonia meriana</i> var. <i>bulbillifera</i> * <i>Watsonia</i> sp.
ORCHIDACEAE	<i>Cyrtostylis</i> sp. * <i>Disa bracteata</i> <i>Epiblema grandiflorum</i> var. <i>grandiflorum</i> <i>Eriochilus dilatatus</i> subsp. <i>dilatatus</i> (ms) <i>Leporella fimbriata</i> <i>Lyperanthus nigricans</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
ORCHIDACEAE (Continued)	<i>Microtis media</i> subsp. <i>media</i> <i>Oligochaetochilus vittatus</i> <i>Prasophyllum parvifolium</i> Orchidaceae sp. Orchidaceae sp. 2
CASUARINACEAE	<i>Allocasuarina fraseriana</i> <i>Allocasuarina humilis</i> <i>Casuarina obesa</i>
MORACEAE	* <i>Ficus marophylla</i>
PROTEACEAE	<i>Adenanthos meisneri</i> <i>Adenanthos obovatus</i> <i>Banksia attenuata</i> <i>Banksia grandis</i> <i>Banksia ilicifolia</i> <i>Banksia littoralis</i> <i>Banksia menziesii</i> <i>Conospermum triplinervium</i> <i>Dryandra lindleyana</i> <i>Dryandra sessilis</i> var. <i>cygnorum</i> <i>Grevillea crithmifolia</i> <i>Grevillea preissii</i> subsp. <i>preissii</i> <i>Grevillea vestita</i> subsp. <i>vestita</i> <i>Hakea varia</i> <i>Persoonia longifolia</i> <i>Persoonia saccata</i> <i>Petrophile linearis</i> ? <i>Petrophile serruriae</i> <i>Stirlingia latifolia</i> <i>Synaphea spinulosa</i> subsp. <i>spinulosa</i> <i>Xylomelum occidentale</i>
LORANTHACEAE	<i>Nuytsia floribunda</i>
POLYGONACEAE	* <i>Acetosella vulgaris</i> <i>Muehlenbeckia adpressa</i> * <i>Rumex crispus</i> * <i>Rumex pulcher</i> * <i>Rumex</i> sp.

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
AMARANTHACEAE	<i>Ptilotus drummondii</i> var. <i>drummondii</i> <i>Ptilotus polystachyus</i>
AIZOACEAE	* <i>Carpobrotus edulis</i>
CARYOPHYLLACEAE	* <i>Petrorhagia dubia</i>
RANUNCULACEAE	<i>Clematis linearifolia</i> * <i>Ranunculus muricatus</i>
LAURACEAE	<i>Cassytha racemosa</i>
DROSERACEAE	<i>Drosera erythrorhiza</i> <i>Drosera menziesii</i> <i>Drosera pallida</i> <i>Drosera pulchella</i> <i>Drosera</i> sp. (climbing)
CRASSULACEAE	* <i>Crassula alata</i> var. <i>alata</i>
PITTOSPORACEAE	<i>Billardiera variifolia</i> Pittosporaceae sp.
ROSACE	* <i>Rubus fruticosus</i>
MIMOSACEAE	<i>Acacia alata</i> * <i>Acacia decurrens</i> <i>Acacia extensa</i> <i>Acacia flagelliformis</i> (P4) <i>Acacia huegelii</i> * <i>Acacia longifolia</i> * <i>Acacia podalyriifolia</i> <i>Acacia pulchella</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Acacia rostelifera</i> <i>Acacia saligna</i> <i>Acacia semitrullata</i> (P3) <i>Acacia trigonophylla</i> <i>Acacia willdenowiana</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
PAPILIONACEAE	<i>Aotus gracillima</i>
	<i>Aotus procumbens</i>
	? <i>Aotus</i> sp.
	<i>Bossiaea eriocarpa</i>
	<i>Daviesia incrassata</i> subsp. <i>incrassata</i>
	<i>Daviesia physodes</i>
	<i>Dillwynia</i> sp. A Perth Flora (pn)
	<i>Euchilopsis linearis</i>
	<i>Gompholobium capitatum</i>
	<i>Gompholobium confertum</i>
	<i>Gompholobium scabrum</i>
	<i>Gompholobium tomentosum</i>
	<i>Gompholobium venustum</i>
	<i>Hardenbergia comptoniana</i>
	<i>Hovea trisperma</i>
	<i>Jacksonia furcellata</i>
	<i>Jacksonia horrida</i>
	<i>Jacksonia sternbergiana</i>
	<i>Kennedia prostrata</i>
	* <i>Lotus suaveolens</i>
	* <i>Lupinus cosentinii</i>
	* <i>Lupinus</i> sp.
	* <i>Medicago</i> ? <i>polymorpha</i>
	<i>Nemcia</i> ? <i>capitata</i>
	<i>Oxylobium lineare</i>
	<i>Templetonia retusa</i>
	* <i>Trifolium arvense</i>
	* <i>Trifolium</i> sp.
<i>Viminaria juncea</i>	
GERANIACEAE	* <i>Erodium botrys</i>
	<i>Geranium retrorsum</i>
	<i>Geranium</i> sp.
	* <i>Pelargonium capitatum</i>
OXALIDACEAE	* <i>Oxalis caprina</i>
RUTACEAE	<i>Boronia dichotoma</i>
	<i>Boronia juncea</i> subsp. <i>juncea</i> (P1)
	<i>Philotheca spicata</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
TREMANDRACEAE	<i>Platytheca galioides</i> <i>Tetratheca hirsuta</i>
POLYGALACEAE	<i>Comesperma calymega</i> <i>Comesperma confertum</i>
EUPHORBIACEAE	* <i>Euphorbia peplus</i> * <i>Euphorbia terracina</i> <i>Phyllanthus calycinus</i> <i>Poranthera drummondii</i> * <i>Ricinus communis</i>
ANACARDIACEAE	* <i>Schinus molle</i> * <i>Schinus terebinthifolia</i>
STERCULIACEAE	* <i>Brachychiton acerifolius</i> <i>Thomasia cognata</i>
DILLENIACEAE	<i>Hibbertia huegelii</i> <i>Hibbertia hypericoides</i> <i>Hibbertia racemosa</i> <i>Hibbertia stellaris</i> <i>Hibbertia subvaginata</i> <i>Hibbertia vaginata</i>
VIOLACEAE	<i>Hybanthus calycinus</i>
CACTACEAE	* <i>Opuntia stricta</i>
LYTHRACEAE	* <i>Lythrum hyssopifolia</i>
MYRTACEAE	<i>Agonis flexuosa</i> <i>Astartea fascicularis</i> <i>Astartea</i> sp. Brixton Road (pn) <i>Astartea</i> sp. Juniperina (pn) <i>Baeckea camphorosmae</i> <i>Calothamnus lateralis</i> <i>Calytrix flavescens</i> <i>Calytrix fraseri</i> <i>Corymbia calophylla</i> <i>Eucalyptus decipiens</i> * <i>Eucalyptus globulus</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
MYRTACEAE	<i>Eucalyptus gomphocephala</i>
(Continued)	<i>Eucalyptus marginata</i> subsp. <i>marginata</i>
	<i>Eucalyptus rudis</i>
	<i>Eucalyptus wandoo</i>
	<i>Eucalyptus</i> sp.
	<i>Hypocalymma angustifolium</i>
	<i>Hypocalymma robustum</i>
	<i>Kunzea ericifolia</i> subsp. <i>ericifolia</i>
	<i>Kunzea glabrescens</i>
	<i>Melaleuca hamulosa</i>
	<i>Melaleuca huegelii</i>
	<i>Melaleuca incana</i> subsp. <i>incana</i>
	<i>Melaleuca lateritia</i>
	<i>Melaleuca nematophylla</i>
	<i>Melaleuca pauciflora</i>
	<i>Melaleuca preissiana</i>
	<i>Melaleuca raphiophylla</i>
	<i>Melaleuca systema</i>
	<i>Melaleuca teretifolia</i>
	<i>Melaleuca thymoides</i>
	<i>Melaleuca viminea</i> subsp. <i>viminea</i>
	<i>Pericalymma ellipticum</i>
	<i>Regelia ciliata</i>
	<i>Scholtzia involucrata</i>
	<i>Taxandria linearifolia</i> (ms)
HALORAGACEAE	<i>Gonocarpus paniculatus</i>
APIACEAE	<i>Daucus</i> sp.
	<i>Platysace filiformis</i>
	<i>Trachymene pilosa</i>
	<i>Trachymene</i> sp.
	<i>Xanthosia huegelii</i>
EPACRIDACEAE	<i>Astroloma pallidum</i>
	? <i>Astroloma</i> sp.
	<i>Brachyloma preissii</i>
	<i>Conostephium pendulum</i>
	<i>Leucopogon australis</i> subsp. <i>acutifolius</i> (ms)
	<i>Leucopogon conostephioides</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
EPACRIDACEAE (Continued)	<i>Leucopogon oxycedrus</i> <i>Leucopogon ?parviflorus</i> <i>Leucopogon polymorphus</i> <i>Leucopogon propinquus</i> <i>Leucopogon</i> sp. <i>Lysinema ciliatum</i>
PRIMULACEAE	* <i>Anagallis arvensis</i>
LOGANIACEAE	<i>Logania serpyllifolia</i> subsp. <i>angustifolia</i> <i>Phyllangium paradoxum</i>
GENTIANACEAE	* <i>Centaurium erythraea</i>
MENYANTHACEAE	<i>Villarsia albiflora</i>
ASCLEPIADACEAE	* <i>Asclepias</i> sp. * <i>Gomphocarpus fruiticosus</i> * <i>Marsdenia ?velutina</i>
BORAGINACEAE	* <i>Echium plantagineum</i>
LAMIACEAE	<i>Hemiandra pungens</i> * <i>Mentha pulegium</i> * <i>Mentha</i> sp.
SCROPHULARIACEAE	* <i>Parentucellia viscosa</i>
OROBANCHACEAE	* <i>Orobanche minor</i>
RUBIACEAE	<i>Opercularia hispidula</i> <i>Opercularia vaginata</i>
LOBELIACEAE	<i>Lobelia tenuior</i>
GOODENIACEAE	<i>Dampiera linearis</i> <i>Goodenia pulchella</i> subsp. Coastal Plain A (M. Hislop 634) (pn) ? <i>Lechenaultia floribunda</i> <i>Scaevola glandulifera</i>

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON PROPOSED KWINANA
TO AUSTRALIND PIPELINE, OCTOBER 2002 - OCTOBER 2003**

Note: * Denotes introduced taxa

Family	Species
STYLIDIACEAE	<i>Levenhookia stipitata</i>
	<i>Stylidium brunonianum</i>
	<i>Stylidium brunonianum</i> subsp. <i>brunonianum</i>
	<i>Stylidium calcaratum</i>
	<i>Stylidium ?carnosum</i>
	<i>Stylidium divaricatum</i>
	<i>Stylidium junceum</i>
	<i>Stylidium piliferum</i> subsp. <i>piliferum</i>
	<i>Stylidium schoenoides</i>
ASTERACEAE	* <i>Arctotheca calendula</i>
	<i>Asteridea pulverulenta</i>
	* <i>Cirsium vulgare</i>
	* <i>Conyza</i> sp.
	<i>Cotula coronopifolia</i>
	<i>Hyalosperma cotula</i>
	* <i>Hypochaeris glabra</i>
	<i>Lagenophora huegelii</i>
	<i>Podolepis lessonii</i>
	<i>Senecio</i> sp.
	<i>Siloxerus humifusus</i>
	* <i>Sonchus oleraceus</i>
* <i>Ursinia anthemoides</i>	

Eucalyptus rudis Woodlands

- R1:** Disturbed Low Open Woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* over *Pteridium esculentum* and pastoral grasses.
- R2:** Disturbed Low Open Woodland of *Eucalyptus rudis* - *Corymbia calophylla* over *Melaleuca preissiana*, *Melaleuca raphiophylla* and *Taxandria linearifolia* over pastoral grasses in association with watercourses.
- R3:** Disturbed Low Open Woodland of *Eucalyptus rudis* - *Corymbia calophylla* over *Kunzea ericifolia* subsp. *ericifolia* over pastoral grasses.
- R4:** Disturbed Low Open Woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* with pockets of *Corymbia calophylla* over pastoral grasses.
- R5:** Disturbed Low Open Woodland of *Eucalyptus rudis* over *Melaleuca preissiana* with *Juncus pallidus* in depressions, over pasture grasses.
- R6:** Woodland of *Eucalyptus rudis* *Melaleuca raphiophylla* over *Melaleuca teretifolia* and *Astartea fascicularis* over *Lepidosperma longitudinale*.

Corymbia calophylla Woodlands

- C1:** Disturbed Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* *Melaleuca raphiophylla* over *Xanthorrhoea preissii*, *Viminaria juncea*, **Gladiolus caryophyllaceus* and pastoral grasses.
- C2:** Disturbed Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* over *Kingia australis* and *Hypocalymma angustifolium* over pastoral grasses.
- C3:** Low Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii*, *Dasyopogon bromeliifolius* and *Adenanthos meisneri*.
- C4:** Disturbed Open Woodland of *Corymbia calophylla* - *Eucalyptus rudis* over *Agonis flexuosa* over pastoral grasses.
- C5:** Disturbed Low Open Woodland of *Corymbia calophylla* - *Melaleuca preissiana* over *Taxandria linearifolia*, *Astartea fascicularis*, *Baumea articulata* and *Juncus pallidus* over pastoral grasses.
- C6:** Disturbed Low Open Woodland of *Corymbia calophylla* - *Eucalyptus marginata* subsp. *marginata* - *Banksia menziesii* - *Allocasuarina fraseriana* over *Kunzea ericifolia* subsp. *ericifolia* over pasture grasses.
- C7:** Disturbed Low Open Woodland of *Corymbia calophylla* - *Eucalyptus wandoo* over *Melaleuca preissiana* over pasture grasses.

Eucalyptus marginata subsp. marginata Woodlands

- M1:** Disturbed Open Woodland of *Eucalyptus marginata* subsp. *marginata* over *Cartonema phylloides*.
- M2:** Open Woodland of *Eucalyptus marginata* subsp. *marginata* *Corymbia calophylla* over *Kunzea ericifolia* subsp. *ericifolia*, *Pericalymma ellipticum* and *Acacia pulchella* var. *glaberrima* over Poaceae species.
- M3:** Open Woodland of *Eucalyptus marginata* subsp. *marginata* - *Banksia ilicifolia* - *Banksia grandis* - *Banksia littoralis* and *Nuytsia floribunda* over *Kunzea ericifolia* subsp. *ericifolia*, *Acacia pulchella*, *Stirlingia latifolia*, *Xanthorrhoea preissii* and *Dasyopogon bromeliifolius*.
- M4:** Woodland of *Eucalyptus marginata* subsp. *marginata* - *Corymbia calophylla* - *Banksia attenuata* and *Banksia grandis* over *Xanthorrhoea preissii*, *Hibbertia hypericoides*, *Aotus procumbens*, *Macrozamia riedlei*, *Dasyopogon bromeliifolius* and *Bossiaea eriocarpa*.
- M5:** Woodland of *Eucalyptus marginata* subsp. *marginata* - *Corymbia calophylla* - *Banksia attenuata* - *Banksia grandis* and *Xylomelum occidentale* over *Kunzea ericifolia* subsp. *ericifolia*, *Hibbertia hypericoides*, *Daviesia incrassata* subsp. *incrassata*, *Brachyloma preissii*, *Persoonia saccata* and *Acacia willdenowiana*.

Eucalyptus gomphocephala Woodlands

- G1:** Open Woodland of *Eucalyptus gomphocephala* - *Corymbia calophylla* over pasture species.
- G2:** Open Woodland of *Eucalyptus gomphocephala* - *Allocasuarina fraseriana* over low mixed shrubs and herbs.
- G3:** Open Woodland of *Eucalyptus gomphocephala* *Eucalyptus marginata* subsp. *marginata* *Banksia* species over low mixed shrubs and herbs.
- G4:** Open Woodland of *Eucalyptus gomphocephala* over *Acacia saligna*, *Acacia rostellifera*, *Dryandra sessilis* var. *cygnorum* and low mixed shrubs.
- G5:** Open Woodland of *Eucalyptus gomphocephala* over *Acacia* species and *Melaleuca raphiophylla* and low sedges and shrubs.

Eucalyptus decipiens Woodlands

- E1:** Low Open Woodland of *Eucalyptus decipiens* - *Banksia littoralis* - *Acacia rostellifera* over *Dryandra sessilis* var. *cygnorum* and low mixed shrubs.

Banksia Woodlands

- B1:** Disturbed Low Open Woodland of *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* - *Allocasuarina fraseriana* over low shrubs and pastoral grasses.
- B2:** Disturbed Open Woodland of *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* - *Allocasuarina fraseriana* - *Xylomelum occidentale* over *Hibbertia hypericoides*, *Hibbertia huegelii* and *Hyalosperma cotula*.
- B3:** Open Woodland of *Banksia attenuata* *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia*, *Stirlingia latifolia*, *Calytrix fraseri*, *Adenanthos meisneri* and *Dasyopogon bromeliifolius*.
- B4:** Open Woodland of *Banksia attenuata* *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia*, *Allocasuarina humilis*, *Stirlingia latifolia* and mixed shrubs.
- B5:** Open Woodland of *Banksia attenuata* *Banksia ilicifolia* - *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia* with occasional *Nuytsia floribunda* and *Corymbia calophylla* over *Melaleuca thymoides*, *Calytrix fraseri*, *Acacia pulchella* var. *glaberrima* and mixed shrubs.
- B6:** Open Woodland of *Banksia ilicifolia* - *Banksia attenuata* - *Agonis flexuosa* and *Eucalyptus marginata* subsp. *marginata* over dense *Kunzea ericifolia* subsp. *ericifolia* with *Bossiaea eriocarpa*, *Hibbertia hypericoides*, *Dasyopogon bromeliifolius*, *Acacia pulchella* and *Patersonia occidentalis*.

Melaleuca Woodlands

- P1:** Disturbed Open Woodland of scattered *Melaleuca preissiana* over *Juncus pallidus* and pastoral grasses.
- P2:** Disturbed Low Open Woodland of *Melaleuca raphiophylla* - *Melaleuca preissiana* over *Astartea fascicularis* over pasture grasses and sedges.
- P3:** Low Open Woodland of *Melaleuca preissiana* and occasional *Eucalyptus marginata* subsp. *marginata* and *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and *Calytrix* species over *Dasyopogon bromeliifolius*.
- P4:** Low Open Woodland of *Melaleuca preissiana* with either *Agonis flexuosa* or *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and *Calytrix* species over *Dasyopogon bromeliifolius*.

Agonis flexuosa Woodlands and Forests

- F1:** Open Forest of *Agonis flexuosa* *Eucalyptus marginata* subsp. *marginata* over grasses.
- F2:** Open Woodland of *Agonis flexuosa* with occasional *Banksia attenuata*, *Banksia ilicifolia* and *Nuytsia floribunda* over mixed shrubs.

Kunzea ericifolia subsp. ericifolia Shrublands

- K1:** Disturbed Low Shrubland of *Kunzea ericifolia* subsp. *ericifolia* over *Regelia ciliata* over pastoral grasses.
- K2:** Tall Shrubland of *Kunzea ericifolia* subsp. *ericifolia* over *Hypocalymma angustifolium* and mixed shrubs over *Meeboldina scariosa*, with occasional emergent *Eucalyptus marginata* subsp. *marginata*, *Banksia attenuata* and *Banksia ilicifolia*.

Closed Heath

- H1:** Closed Heath of Myrtaceae species, including *Kunzea ericifolia* subsp. *ericifolia*, *Pericalymma ellipticum*, *Astartea fascicularis* and *Melaleuca* species over *Baumea* and *Meeboldina* species, with occasional emergent trees of *Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata*.
- H2:** Closed Heath of *Pericalymma ellipticum* *Hypocalymma angustifolium* shrubs over mixed sedges, with occasional emergent *Melaleuca preissiana*, *Nuytsia floribunda* and very occasional *Banksia littoralis* trees.
- H3:** Closed Heath of *Astartea fascicularis* *Calothamnus lateralis* and *Cassytha racemosa* over mixed sedges.

Sedgeland

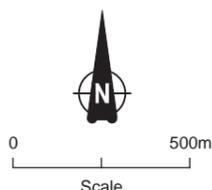
- S1:** Sedgelands of *Baumea*, *Meeboldina* and *Juncus* species over pastures in disturbed areas.

Disturbed Areas

- D:** Disturbed, drains, plantations, pasture, roads and buildings.
- (d):** Partially disturbed, eg. M3(d) partially disturbed M3.

Notes:

This map to be read in conjunction with Mattiske Consulting Pty Ltd report Numberd DRD0301/101/03



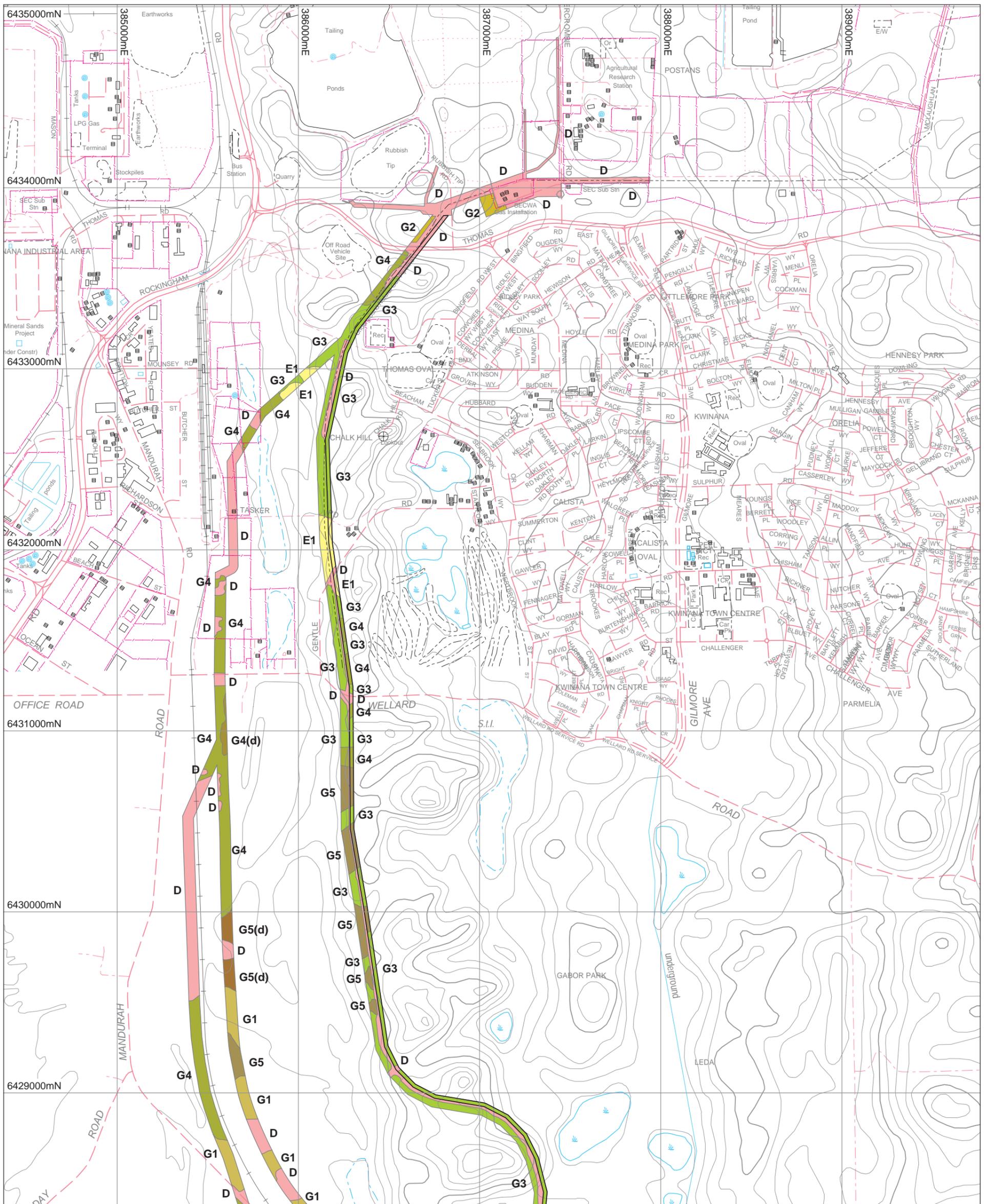
Bowman Bishaw Gorham
Environmental Management Consultants



**KWINANA TO AUSTRALIND
GAS PIPELINE CORRIDOR
Figure 1
VEGETATION**

Author: E. M. Mattiske

November 2003



Notes:

For detailed legend refer figure numbered 1
 Horizontal Datum: GDA94(Zone 50)
 This map to be read in conjunction with Mattiske Consulting Pty Ltd
 report Numberd DRD0301/101/03



0 500m
 Scale

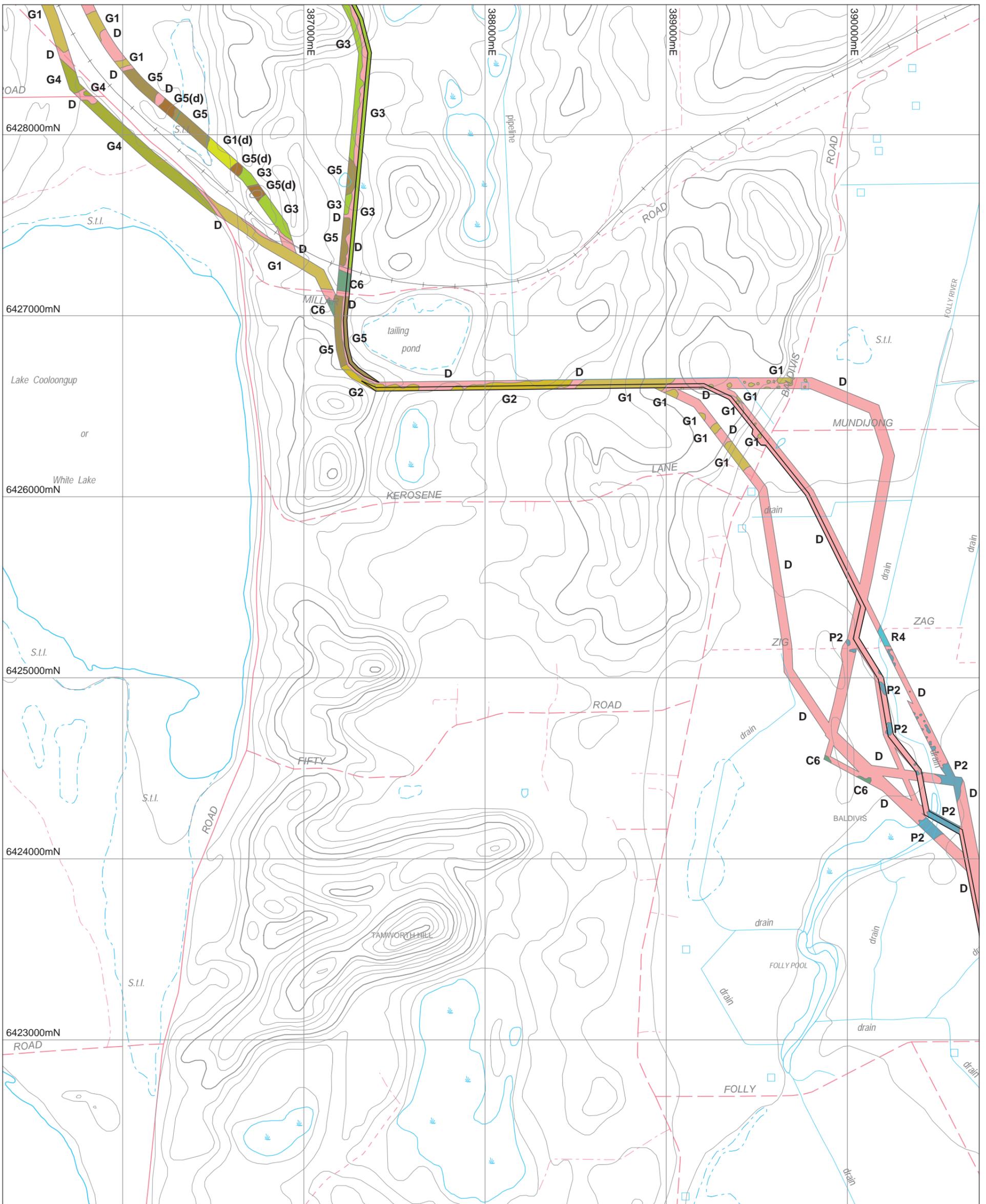
Bowman Bishaw Gorham
 Environmental Management Consultants



**KWINANA TO AUSTRALIND
 GAS PIPELINE CORRIDOR
 Figure 2
 VEGETATION**

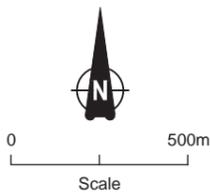
Author: E. M. Mattiske

November 2003



Notes:

For detailed legend refer figure numbered 1
 Horizontal Datum: GDA94(Zone 50)
 This map to be read in conjunction with Mattiske Consulting Pty Ltd
 report Numberd DRD0301/101/03



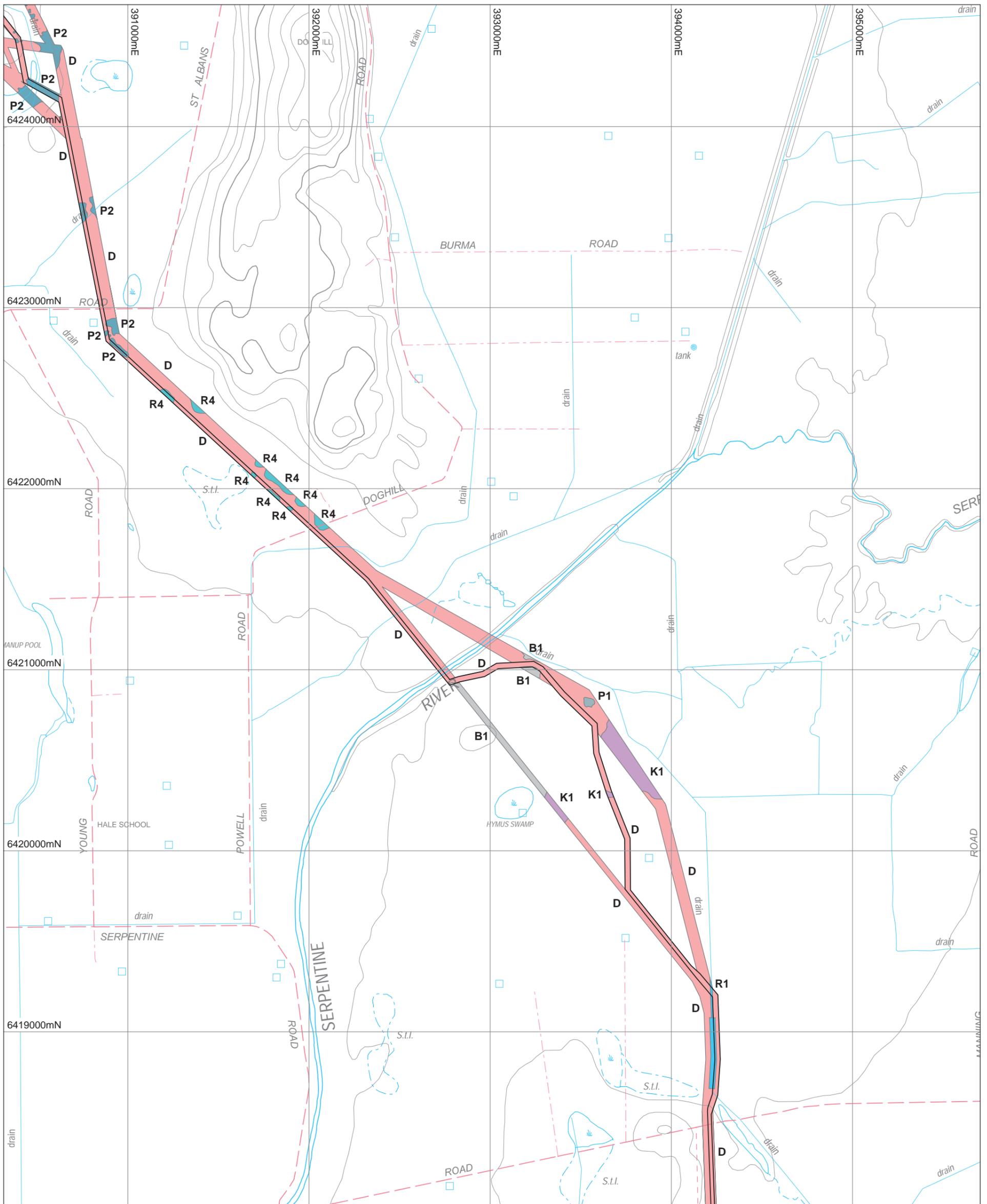
Bowman Bishaw Gorham
 Environmental Management Consultants



**KWINANA TO AUSTRALIND
 GAS PIPELINE CORRIDOR
 Figure 3
 VEGETATION**

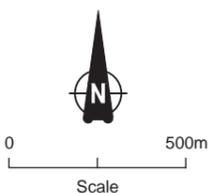
Author: E. M. Mattiske

November 2003



Notes:

For detailed legend refer figure numbered 1
 Horizontal Datum: GDA94(Zone 50)
 This map to be read in conjunction with Mattiske Consulting Pty Ltd
 report Numberd DRD0301/10103



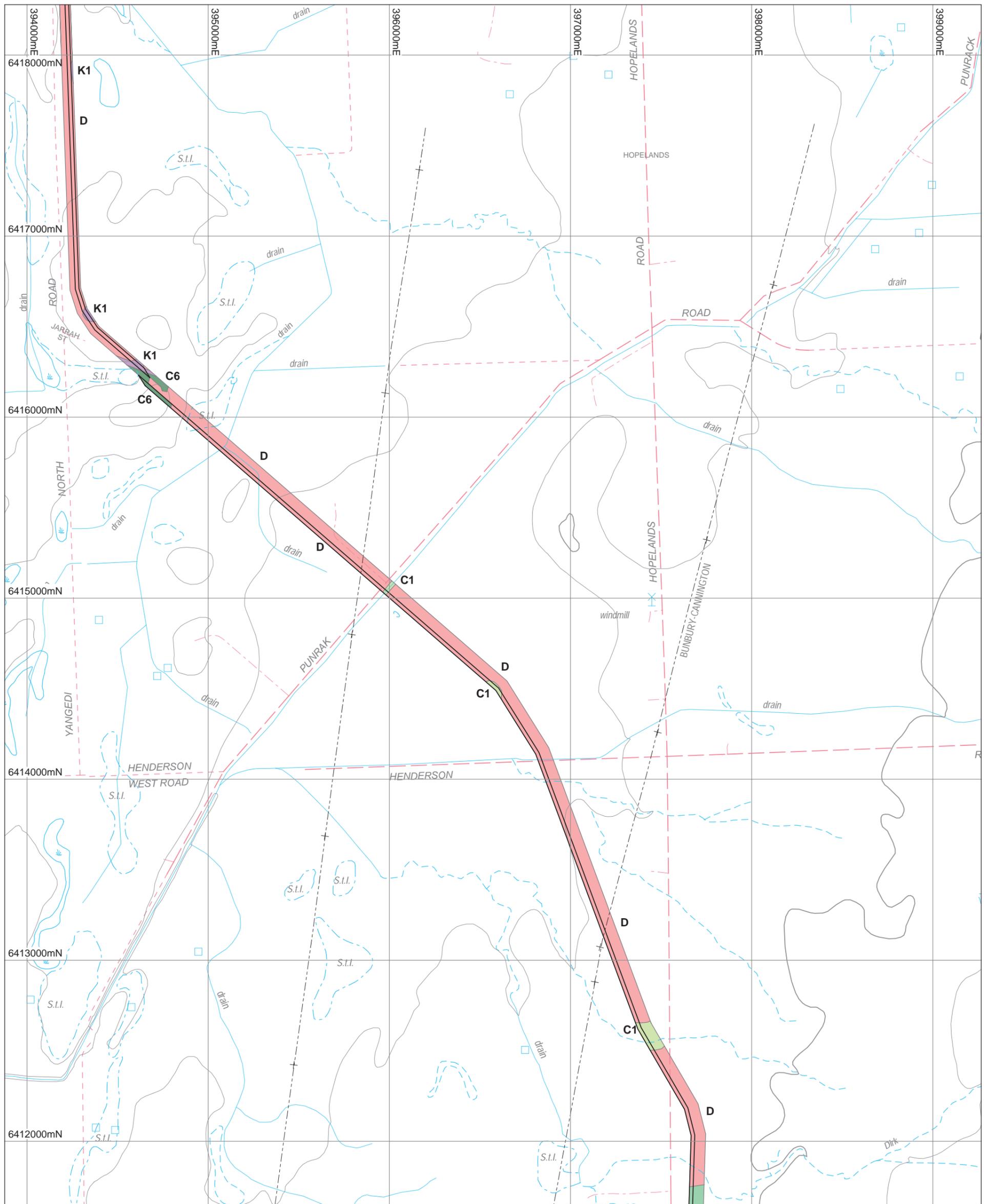
Bowman Bishaw Gorham
 Environmental Management Consultants



**KWINANA TO AUSTRALIND
 GAS PIPELINE CORRIDOR
 Figure 4
 VEGETATION**

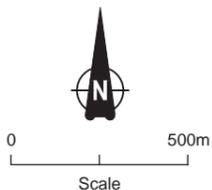
Author: E. M. Mattiske

November 2003



Notes:

For detailed legend refer figure numbered 1
 Horizontal Datum: GDA94(Zone 50)
 This map to be read in conjunction with Mattiske Consulting Pty Ltd
 report Numberd DRD0301/101/03



Bowman Bishaw Gorham
 Environmental Management Consultants



**KWINANA TO AUSTRALIND
 GAS PIPELINE CORRIDOR
 Figure 5
 VEGETATION**

Author: E. M. Mattiske

November 2003