FLORA AND VEGETATION SURVEYS OF THE FERRAUS LIMITED RAIL CORRIDOR OPTIONS

G&G Environmental Pty Ltd

ACN 112 603 433

ABN 83112603433

7 Bebich Dr. WANNEROO WA 6065

Ph (08) 9294 2646

Fax (08) 9294 1673

gwells@ggenvironmental.com.au

www.ggenvironmental.com.au

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EXECUTIVE SUMMARY

G&G Environmental Pty Ltd was commissioned by FerrAus Limited to undertake a flora and vegetation assessment of the prospective FerrAus Eastern Pilbara Rail (FEPR) southern and northern corridor sections and associated borrow pits, which forms part of the FerrAus Pilbara Project (FPP).

Three separate surveys were conducted and are described in this report. A desktop review of the flora and vegetation of the FEPR northern rail corridor section; a level 1 survey of the areas identified as possible borrow pits for the northern rail corridor section; and a level 2 survey of the first 79 km of the FEPR corridor, referred to as the southern rail corridor section, and associated borrow pit.

The main objectives of the surveys were to identify the vascular plant species present in the survey areas; conduct various database searches for populations of plants of conservation significance; conduct targeted on ground searches for Threatened and Priority flora in and around quadrat survey locations in the southern corridor section and borrow pits and FEPR; conduct database search for populations of exotic plant species particularly declared plants; conduct targeted on ground searches for exotic plant species in and around quadrat survey locations in the northern section rail borrow pits and FEPR survey areas; define and map vegetation types present in the northern section rail borrow pits and FEPR survey areas; review the local and regional significance of the vegetation types defined; and record the condition of vegetation in the northern section rail borrow pits and FEPR survey areas, as agreed in the scope of works. In addition, the potential conservation significance of the vegetation types and land systems present in the survey areas was assessed.

Previous vegetation surveys (Biota 2004, Mattiske 2007, Mattiske 2008, Van Vreeswyk *et al* 2004, Ecologia 2007, Ecologia 2009) were reviewed to identify the types of vegetation recorded on different landforms; to note any flora and vegetation of conservation significance and suitable habitat for such species likely to occur within the survey area, to identify potential weed species, and to compile a list of plant species and vegetation types. Searches of the DEC's *Threatened (Declared Rare) Flora* database, the *Western Australian Herbarium Specimen* database and the *Declared Rare and Priority Flora List* were conducted and the locations of T and priority flora were overlayed over a map of the rail corridor to identify populations previously recorded within close proximity of the survey area. The botanical surveys and lists of TECs and PECs were reviewed to identify whether vegetation communities of conservation significance were previously recorded in the vicinity of the corridor options. The EPBC search tool was also used to determine national scale TEC listed under the EPBC Act. SLIP Enabler (2011) was utilised to search for conservation estate areas (eg. national parks, regional parks) for the Pilbara bioregion in combination with maps from Van Vreeswyk *et al.* (2004) to identify whether any of the land systems present in the corridor were represented in a conservation estate and to locate potential ESAs. A comprehensive list of species within the corridor, including flora of conservation value and exotics was compiled from NatureMap (2011). The conservation status, brief description, habitat preference, flowering season and images of T, priority flora, and weeds either recorded at the FPP in previous surveys, or identified as potentially occurring within the FPP from database searches were compiled and printed as a 'field guide'. Habitat for each of the species was

compared to vegetation/habitat within the corridor. The taxon was considered to potentially occur within the corridor if suitable habitat for the species was present.

For the level 1 and level 2 surveys quadrat-based sampling of vegetation was undertaken in areas chosen on the basis of topography, interpretation and ground truthing of Google Earth images, previously mapped vegetation types, field observations of vegetation structure, floristics and condition, and the vegetation mapping carried out following the first phase of the survey. Data recorded included cover values of all present species, description of topography, description of the vegetation based on NVIS (2003), evidence of vegetation disturbance and the vegetation condition based scale of Keighery (1994). Targeted searches for T and priority flora were conducted in and around quadrat survey locations, where landform and vegetation resembled the brief habitat description for the species..

A total of 38 quadrat surveys were conducted for the level 1 survey of the northern borrow pit options in a single season (November 2010). A total of 96 quadrat surveys were conducted for the level 2 survey of the FEPR southern corridor option over two seasons. 51 sites were assessed during the initial survey in 2010. 45 new quadrats were surveyed in 2011 with repeat observations taken at 16 of the sites surveyed the previous year.

Vegetation sub-formations were defined from clusters of sampling sites on a dendrogram produced from a statistical ordination tests utilising species presence and cover values. The description, species composition and photographs of the field sites were compared with the data from surveys previously conducted at the FPP Where the dominant species of vegetation types were congruent with those of previous surveys, and numerous other species were also common to both, the vegetation was named in accordance with the earlier survey. The vegetation sub-formations were mapped by plotting boundaries visible on Google Earth, contour lines and changes in the vegetation recorded on GPS during surveys. The description of the vegetation sub-formations were compared with the major vegetation groups of NLWRA (2001), the mapped vegetation of Beard (1975) and regional site types of Van Vreeswyk *et al.* (2004) to provide an indication of the potential local and regional conservation significance of the vegetation in the survey areas. Where landform and the broad vegetation description were congruent and numerous of the species recorded were common a sub formation of the current survey was considered to resemble the broader site type of Van Vreeswyk *et al* (2004). Site types were examined to provide an indication of whether the sub-formation defined for the current survey resembled a broadly distributed or restricted site type and whether the site type is represented in conservation reserves or unallocated crown land. A species list for the current survey compiled from the survey quadrat data and opportunistic collections while traversing the area. The current conservation status of each of the species recorded was determined from Florabase (2011) and/or NatureMap (2011) and the mapped range of each species examined to determine whether the survey areas represented a range extension for any of the recorded species. In addition, the proportion of each of the defined vegetation types and land systems of Van Vreeswyk *et al* (2004) within the corridor was ascertained to assess potential conservation significance of the vegetation types and land systems that occur within the survey areas.

The combined reconnaissance surveys recorded 351 plant taxa of which approximately 30% were annual species recorded following both winter and summer rainfall. The high number of taxa recorded and the intensity and timing of the survey effort by experienced field botanists are evidence that the flora of the FPP has been adequately surveyed. With the review of both regional and localised previous botanical surveys, adherence to the methodology of the EPA guidelines for flora surveys and adoption of the National Vegetation Inventory System (NVIS 2003) to describe vegetation it is considered that adequate resources were utilised to define and assess the conservation significance of the vegetation defined. As some of the vegetation boundaries were drawn from apparent changes in the vegetation from aerial photographs some inaccuracies in the depiction of the boundaries may be expected.

DESKTOP SURVEY OF THE FEPR NORTHERN CORRIDOR OPTION

In excess of 1% of the Adrian, Fan and Marillana land systems occur within the northern corridor option none of which are represented in the conservation estate or on UCL. The corridor option may therefore be considered to represent a moderate to high conservation value for these land systems particularly the Adrian and Marillana systems restricted to the Fortescue valley. The Fortescue land system is also restricted in total area and distribution and therefore may be considered to have moderate conservation value. The remaining land systems cover a substantially larger area and as only a small proportion of each occur in the corridor option it may be considered to have a low conservation level.

A review of the vegetation types recorded for the land systems present in the FEPR northern rail corridor option identified several vegetation types that may be expected to occur, namely:

- *Triodia* hummock grasslands on stony rises and rocky hills;
- *Triodia* hummock grasslands on sandy plains and sand dunes;
- *Acacia* and/or *Eucalyptus* woodlands along creek lines and drainage foci and on alluvial plains; and
- *Acacia* woodlands and shrublands, tussock grasslands and sparse shrublands on hardpan plains.

No Threatened ecological Community, Priority Ecological community or Environmentally Sensitive areas were recorded for the survey area. Priority flora have been recorded in *Acacia* woodlands, *Triodia* hummock grasslands and riparian vegetation in flora surveys conducted in close proximity to the northern corridor option. In accordance to government guidelines vegetation that represents habitat for priority flora may be considered locally significant.

The DEC Clearing Permit Decision Report states that “native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland”. Several creeks traverse the northern rail corridor option and clearing of the riparian vegetation of these creeks would be at variance with the DEC Clearing Permit Decision Report statement.

A list of 313 taxa representing 44 families and 125 genera that may potentially occur in the FEPR northern rail corridor was dominated by plant families and genera that are characteristic of the Pilbara bioregion.

A total of 33 flora of conservation significance were recorded within a 100 km distance of the northern corridor option but none within the survey area despite a significant activity in the region during the surveying, construction and operation of the BHP Billiton Iron Ore Mainline. The records include one T species, *Lepidium catapycnon* but there is no suitable habitat in the survey area described for the species. Review of the habitat for each of the priority species indicated that suitable habitat for 15 taxa comprised of five P1, two P2, seven P3 and one P4 may potentially occur in the survey area.

Given the number of priority species for which suitable habitat is likely to occur is possible that some populations still could be found. However, the possibility of significant populations of any priority flora occurring within the survey area is low.

Suitable habitat for 21 introduced species (weeds) recorded within 100 km of the survey area is likely to occur within the rail corridor option. None of the weed species are a declared plant under the *Agriculture and Related Resources Protection Act 1976* for the survey area. It is considered highly likely that common weed species of the region, e.g. *Aerva javanicum*, *Cenchrus ciliaris* , *Malvastrum americanum* and *Portulaca oleracea* will occur in the corridor option due to the presence of both suitable habitat and disturbance to the natural vegetation resulting from the construction and operation of the BHP Billiton Iron Ore Mainline. It is recommended that strict weed hygiene measures therefore be applied during any consequent construction and operation of a rail system in the corridor option.

RAIL BORROW PIT OPTIONS NORTHERN SECTION (LEVEL 1 SURVEY)

The borrow pit options were considered to be potentially of moderate to high conservation value for the Adrian and Marillana land systems as in excess of 1% of their known area occurred in the survey area. Both of the land systems were recorded in a single borrow pit and it is recommended that other borrow pit options be utilised in order to limit impacts to the restricted land systems.

A total of 17 vegetation types were defined for the borrow pit options to the level of sub-formation of the NVIS 2003. None of the sub-formations resembled a TEC of national or regional significance, a PEC or ESA and each resembled vegetation types previously mapped that are common and widespread. It is therefore considered that none of the sub-formations represent regionally significant vegetation.

Biota (2004) considered vegetation on sand dunes in the Hamersley Ranges and Fortescue Plains regions to be potentially locally significant due to the fragile nature of the system and scarcity of habitat. Vegetation sub-formations 10a of the current survey also inhabited red sand dunes with a restricted/scarce distribution and may therefore be considered potentially locally significant.

Vegetation sub-formation 5b did not closely resemble the regional vegetation types of prior surveys. However, this sub-formation was comprised of isolated common grasses and herbs and it is not

considered that disturbance to this vegetation would significantly impact on the floral diversity of the region or immediate locality.

Vegetation sub-formation 3c was riparian vegetation of two minor creeks and represented a very small total area and proportion of the borrow pit options. The survey area also appears to represent a small range extension for *Atalaya hemiglauca* which was recorded in this sub-formation. In accordance to government guidelines the 3c sub-formation may be considered potentially locally significant as it represents habitat for a species at the limit of it's known range, has limited area and distribution. Clearing of this vegetation would also be at variance with the condition of the DEC Clearing Permit Decision Report. It is recommended that disturbance to this vegetation sub-formation be avoided and minimised wherever possible.

Vegetation condition in the borrow pit options was excellent to pristine for the most part, however several disturbed areas were also mapped. Many of the disturbed areas were previously utilised borrow pits, presumably for construction and maintenance of the BHP Billiton Iron Ore Mainline. It is recommended that where possible borrow options containing disturbed areas be utilised in preference to undisturbed options during any subsequent construction and maintenance of a rail corridor.

No T or priority flora were recorded in the borrow pit options and this concurs with the indication from the desktop survey that there is a low probability of significant populations of priority flora occurring within the survey area.

Review of the distribution of each of the species recorded in the borrow pit options identified range extensions for three species. In accordance with government guidelines (EPA2004) these species may be considered potentially locally significant as they represent recent increases to the known range of the taxa. All of the species were recorded in vegetation sub-formations that resemble widespread communities which are typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape.

Three introduced flora were recorded in the borrow pit options, *Cenchrus ciliaris*, *Malvastrum americanum* and *Portulaca oleracea.* None are a declared plant under the *Agriculture and Related Resources Protection Act 1976* and all are common weed species of the Pilbara and Gascoyne regions. As the weeds were recorded in areas proposed as borrow pits for the construction of a rail corridor it is recommended that strict weed hygiene practices be employed during any subsequent construction to minimise the potential of spreading the weeds.

FEPR SOUTHERN SECTION RAIL CORRIDOR OPTION – LEVEL 2

The southern rail corridor was considered to potentially represent moderate conservation value for the Cadgie, Fan, Divide and Washplain land systems due to the proportion of each of the systems occurring in the rail corridor option and associated borrow pits. As the total area is far larger than the disturbance by construction of a rail corridor, it is unlikely that it would significantly impact on the regional value of these land systems. However, it is recommended that disturbance to each of these land systems be minimised.

A small borrow pit option was comprised almost entirely of the Cadgie land system. It is recommended that other borrow pit options be used in preference to this area to reduce impacts to this restricted land system.

A total of 41 vegetation types were defined for the FEPR southern section rail corridor and associated borrow pit options to the level of sub-formation of the NVIS 2003. None of the sub-formations resembled a TEC of national or regional significance, a PEC or ESA. The majority of the sub-formations resembled vegetation types previously mapped that are common and widespread and were therefore not considered to represent regionally or locally significant vegetation.

Biota (2004) considered vegetation on sand dunes in the Hamersley Ranges and Fortescue Plains regions to be potentially locally significant due to the fragile nature of the system and scarcity of habitat. Vegetation sub-formations 10b of the current survey also inhabited red sand dunes with a restricted/scarce distribution. Furthermore, this sub-formation represents the limits of the range of one species and comprises a novel combination of species not recorded elsewhere in the survey area and consequently did not resemble previously recorded vegetation types. For these reasons this vegetation may be considered potentially locally significant and it is recommended that disturbance to these dunes be avoided.

Vegetation sub-formation 11 occurred at a single location within the survey area and did not resemble previously described vegetation. The sub-formation surrounded a permanent waterhole and appears to provide a valuable refuge to both native animals and domestic stock. It is recommended that disturbance to this sub-formation and the waterhole be avoided.

Vegetation sub-formations 2a, 2c, 3d and 9h are a habitat for several species with an extension to the known distribution range. These sub-formations represent *Triodia* hummock grassland, *Acacia* open woodland and riparian vegetation that were also identified by Mattiske (2008). In accordance to government guidelines the sub-formations may be considered potentially locally significant. However, each of these sub-formations resembled vegetation recorded in regional surveys and it is likely that they occur in the broader landscape.

Vegetation sub-formation 9h, 4a and 9l represented habitat for the priority 4 species *Goodenia nuda*, and priority 3 species *Olearia mucronata*. These sub-formations may be considered potentially locally significant as they represent habitat for conservation significant species.

Two priority flora were recorded within the rail corridor, *Olearia mucronata* (P3), *Goodenia nuda* (P4). The vegetation in which each of the priority species were recorded at the FPP resemble widespread communities typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape. It is recommended that site personnel be familiarised with the priority flora to facilitate reporting of further sightings and minimise the potential for disturbance to populations.

Review of the distribution of the species identified range extensions for 14 species. In accordance with government guidelines (EPA2004) these species may be considered potentially locally significant as

they represent recent increases to the known range of the taxa. With the exception of one species (*Oldenlandia pterospora* in vegetation sub-formation 10b) each of the species was recorded in vegetation sub-formations that resemble widespread communities which are typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape.

Five introduced taxa were recorded in the FEPR southern rail corridor option, *Bidens bipinnata*, *Cenchrus ciliaris*, *Malvastrum americanum*, *Portulaca oleracea* and *Sonchus oleraceus*. None of the species are a declared plant and all have broad distributions in Western Australia and have been previously recorded in the Gascoyne and Pilbara bioregions.

Portulaca oleracea was the most widespread species and was recorded in almost half of the quadrat surveys in a variety of habitat types and vegetation communities. The remaining species were typically recorded in riparian and /or grove/intergrove vegetation with *Cenchrus ciliaris* also recorded on the lower slopes of a few low rocky hills. Large infestations of *Cenchrus ciliaris* in riparian vegetation where it dominated the grass stratum reduced the condition of the vegetation to very good, Despite the widespread distribution of *Portulaca oleracea* and the *Cenchrus ciliaris* infestations at a few locations, in general, the level of weed infestation within the southern rail corridor was considered low.

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1.0 INTRODUCTION

1.1 SCOPE OF WORK

G&G Environmental Pty Ltd was commissioned by FerrAus Limited (FerrAus) to undertake a flora and vegetation assessment of a prospective rail corridor option for the FerrAus Pilbara Project (FPP). The FPP consists of open strip mining for iron ore mining at two mine site areas, identified as Robertson Range Area (RRA) and Davidson Creek Area (DCA), the provision of a Service Corridor (SC) that will connect the two mine sites, the development of a rail loop at the DCA, and the establishment of a rail line at one of two proposed alignments (**Figure 1**). The two rail line options are identified as the FerrAus Eastern Pilbara Rail (FEPR) and the Northern Rail Alignment.

The assessment consisted of the following components:

1. A desktop review of the flora and vegetation of the FEPR northern rail corridor option (**Figure 1**) using on-line databases and publicly available reports relating to that area;
2. Reconnaissance surveys of the areas identified by FerrAus as possible borrow pits for the northern rail corridor option; and
3. Systematic surveys of the first 79 km of the southern rail corridor and associated borrow pit options, equivalent to a Level 2 survey effort as described by the Western Australian Environmental Protection Authority (EPA 2004).

Details of the survey areas are summarised in **Table 1**.

Table 1: Survey areas for the rail options

Survey Areas	Details	Survey Level
FEPR, Northern Section	a 200 m corridor along eastern edge of BHP State Agreement Lease for ~104 km Northern Section, 30 pits ~ ha	Desktop review
Rail Borrow Pit Options, Northern Section	Northern Section, 30 pits ~3700 ha.	Level 1
FEPR, Southern Section	500 m buffer either side of centre line-for approximately 79 km from FPP to BHP Billiton Iron Ore Mainline and 13 borrow pit options, ~8900 ha.	Level 2 (Systematic survey)

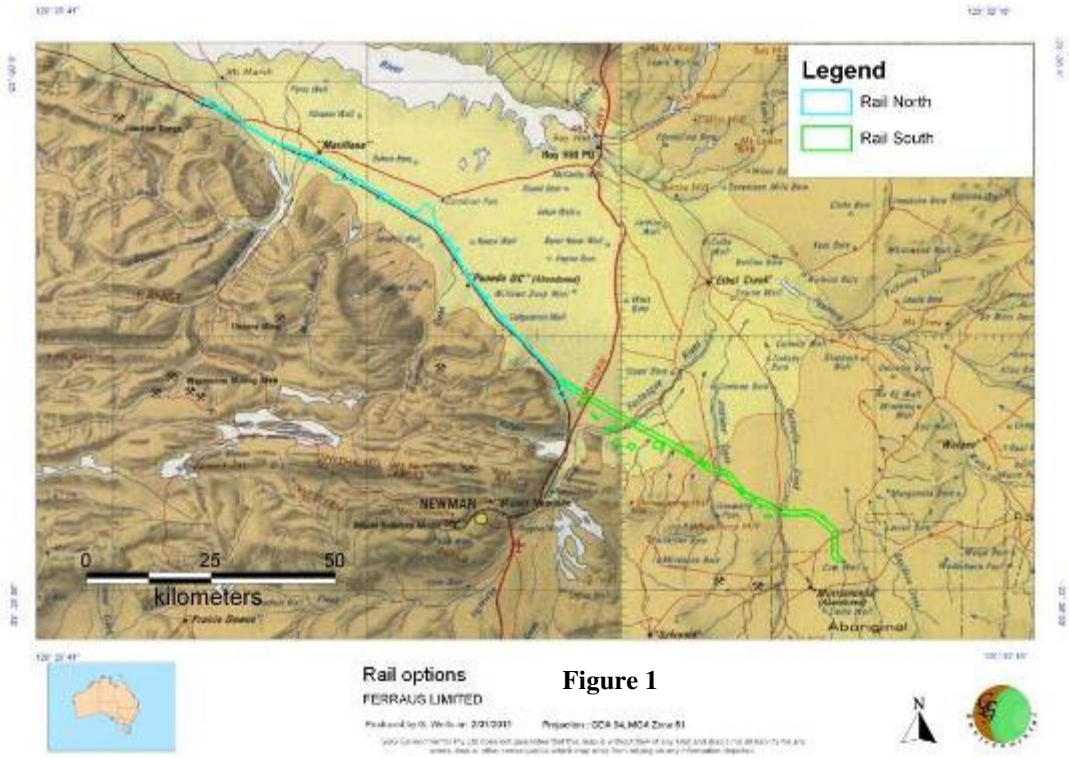


Figure 1

The objectives of the surveys were to:

- identify the vascular plant species present in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) survey areas;
- conduct various database searches for populations of plants of conservation significance, including Threatened Flora (T), priority flora, geographically restricted taxa, endemic taxa, taxa at limits of recorded range, extensions to the recorded range of taxa and vegetation of conservation significance (TEC, PEC, ESA);
- conduct targeted, on ground searches for T and priority flora in and around quadrat survey locations in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) survey areas where landform and vegetation resembled the brief habitat description for the species compiled from the database searches;
- conduct database searches for populations of introduced plant species (weeds) particularly Declared Plants;
- conduct targeted, on ground searches for introduced plant species in and around quadrat survey locations in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) survey areas;
- define and map vegetation types present in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) survey areas;
- review the local and regional significance of the vegetation types defined;

- record the condition of vegetation in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) survey areas, and
- assess potential impact of the infrastructure footprint on the vegetation types in the northern section rail borrow pits and FEPR (southern section and borrow pits option 6) and previously described land systems present.

1.2 OVERVIEW OF THE FEPR

The FPP is located in the north-eastern section of the Gascoyne bioregion approximately 80 km east of the township of Newman in Western Australia (**Figure 1**). The rail corridor option travels in a north westerly direction from the FPP and passes into the Pilbara bioregion, where it meets up with the rail corridor to Port Hedland, being developed by Brockman Resources Limited. The first 79 km of the 183 km corridor is through predominantly grazing country, while the remainder follows the alignment of the BHP Billiton Iron Ore Pty Ltd (BHPBIO) rail line from Newman to Port Hedland.

1.3 BIOREGIONAL SETTING

1.3.1 Climate

The FEPR rail is located within the hot summer (October to April) - mild winter (May to September) bioclimatic region. The climate has been described by Beard (1990) as arid tropical with 9-11 dry months a year and summer rainfall influenced by the local topography. A major influence on the flora and vegetation are heavy rains associated with cyclones (Mattiske 2005b). Cyclones often cross the coastline and travel over the Fortescue Valley system toward Newman.

The closest weather recording station (BoM, www.bom.gov.au) is located at Newman airport. Newman has a long term average daily maximum temperature of 31.4°C and long term average daily minimum temperatures of 17.4°C (**Table 2**). Average daily maximum temperatures range from 22.3°C (July) to 39°C (January).

The long term average rainfall is 311.5mm. Approximately 63% of the annual average rainfall occurs during the summer wet season with the remaining 37% from April to November (**Figure 3**).

Rainfall for the calendar year prior to the initial survey conducted by G&G Environmental (158.6mm) was well below the long term average of 270.8mm (**Figure 2**). However, rainfall in the two months preceding the October 2010 survey and the second survey season in March 2011was well above average.

Table 2: Long term temperature and rainfall averages recorded at the Newman BoM weather stations. Temperature averages for Newman are from records taken over a 31 year period, 1965-1997, rainfall for a 34 year period 1965-1997.

NEWMAN												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max °C	39	37.2	35.8	31.6	26	22.4	22.3	24.8	29.2	33.6	36.6	38.3
Mean min °C	25.3	24.4	22.4	18.4	13	9.6	8.1	10.1	13.7	17.9	21.4	23.9
Mean rain mm	51.4	80.1	38.6	25.3	23.2	25	12.6	10.5	4.1	3.9	9.8	27

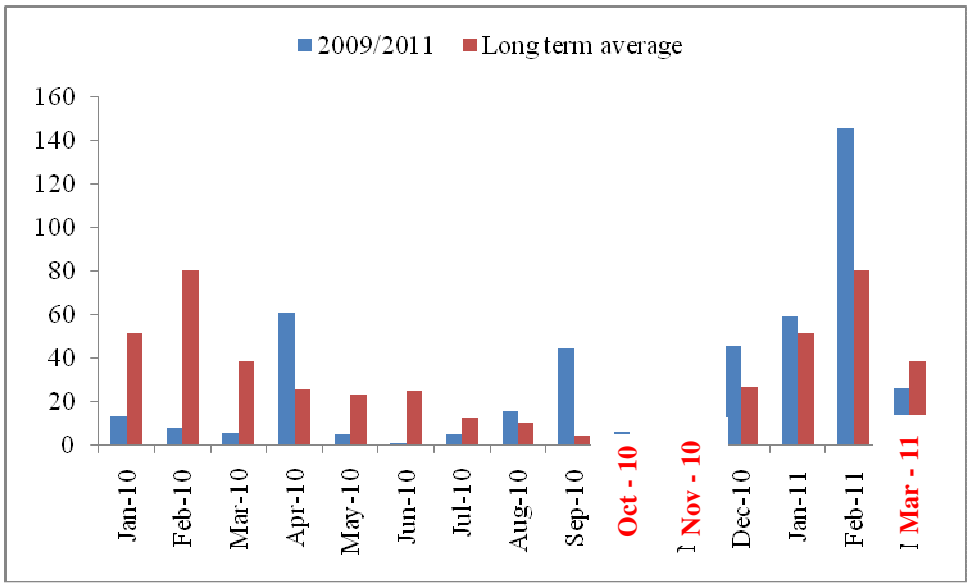


Figure 2: Monthly rainfall (mm) for the nine months prior to the initial October 2010 survey and for the entire survey period(blue) and long term monthly averages (red) for the Newman weather station (Source: BoM 2011). Field surveys were conducted during the months highlighted by red print.

1.3.2 IBRA Regions and Land Systems

The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Australian continent into 85 bioregions and 403 sub-regions based on major geomorphic features (DEH 2005). The FEPR corridor option passes from the Augustus sub-region of the Gascoyne bioregion into the Fortescue Plains (Pil2), sub-region of the Pilbara bioregion (**Figure 3**).

Augustus is the largest sub-region of the Gascoyne bioregion covering 10,687,739 ha and is characterised by rugged, low, Proterozoic sedimentary and granite ranges that support Mulga (*Acacia aneura*) woodlands and *Triodia* and mulga parklands (Desmond *et al*. 2003). Broad flat valleys divide the ranges. About 10.3% of the bioregion lies within conservation estate. Extensive sheep and cattle grazing is the main land use on pastoral leasehold in the bioregion. Mining is important for the bioregion's economy.

The Fortescue Plains sub-region is characterised by alluvial plains and river frontages; salt marsh, mulga-bunch grass and short-grass communities on alluvial plains; and River Gum woodlands in the

drainage lines. The sub-region is the northern limit of Mulga (*Acacia aneura*) communities. Dominant land-use includes grazing of native pastures, unallocated crown land, crown reserves for conservation and Aboriginal lands (Kendrick 2001).

The survey areas intercept twelve land systems mapped by Van Vreeswyk *et al* (2004); *Adrian*, *Boolgeeda*, *Cadgie*, *Divide*, *Fan*, *Fortescue*, *Jamindie Marillana*, *Newman*, *River*, *Urandy* and *Washplain* (see **Figures 4 and 5** and **Table 3**). Land systems are areas "with a recurring pattern of topography, soils and vegetation" (Christian and Stewart 1953 in Van Vreeswyk *et al* 2004). The recurring patterns are visible from aerial photography and other remotely sensed images (Van Vreeswyk *et al* 2004). Descriptions by Van Vreeswyk *et al* (2004) of each of the land systems present at the FPP, including general landform features, geology, geomorphology and vegetation, are summarised in **Table 3.**

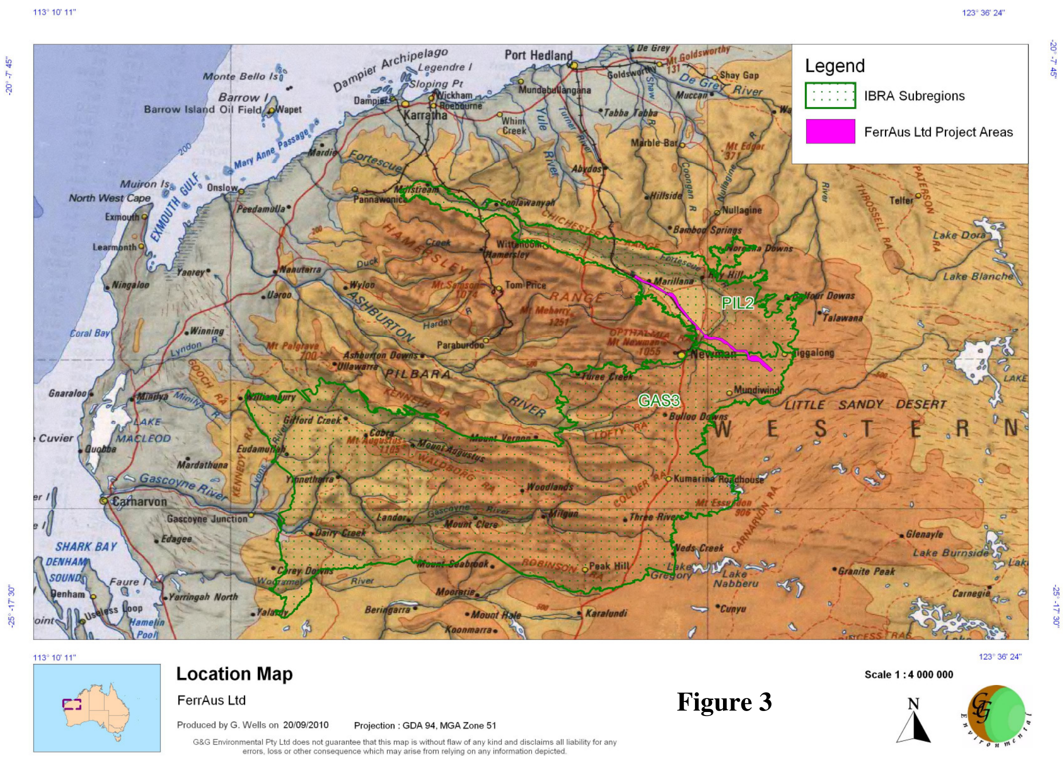
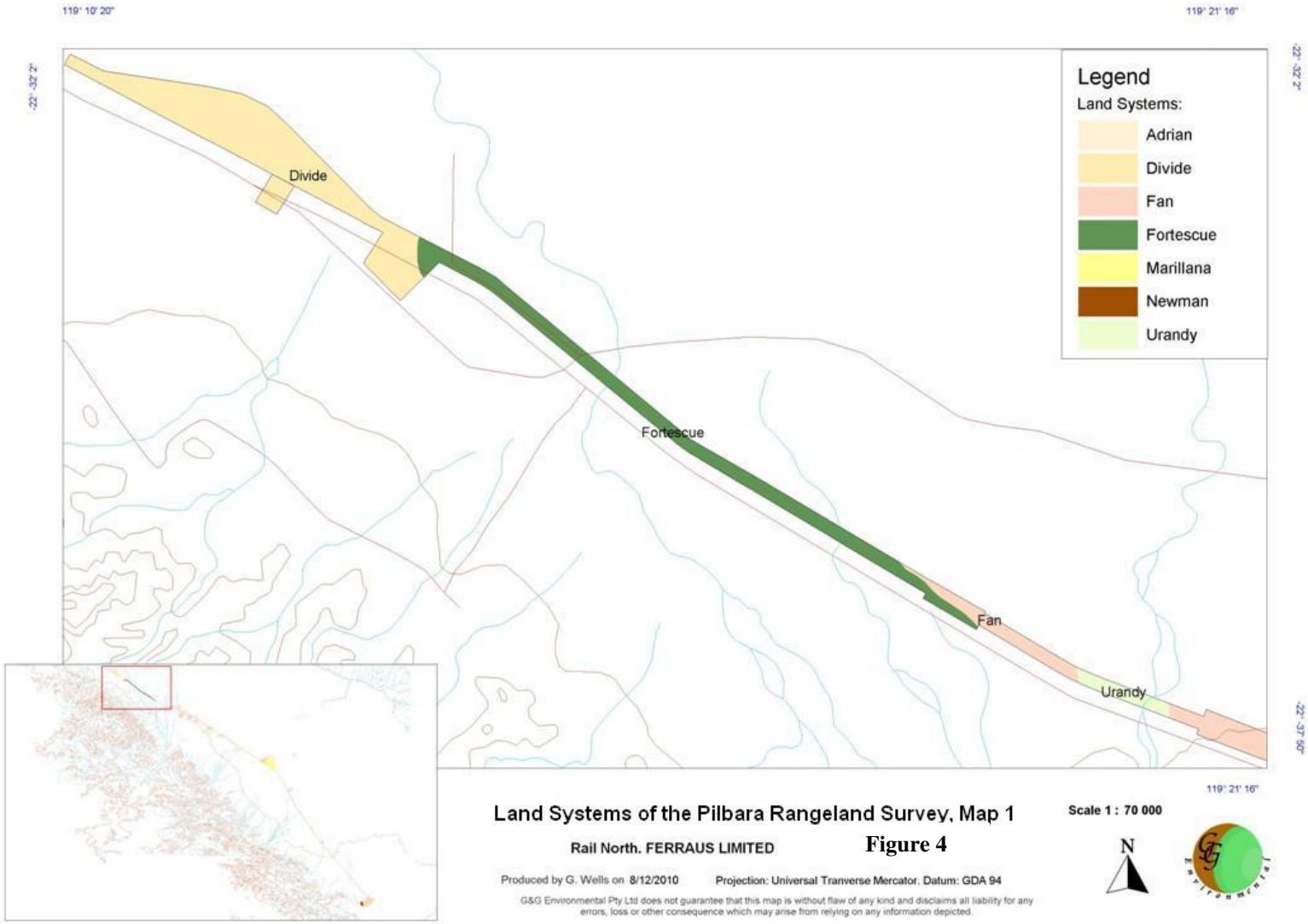


Figure 3

1.3.3 Vegetation and Flora

On a national scale, the Australian Native Vegetation Assessment, conducted as a component of the National Land and Water Resources Audit (NLWRA 2001), defined 23 major vegetation groups for Australia, ten of which occur in the Gascoyne and twelve in the Pilbara (**Table 4**). Vegetation in the Gascoyne bioregion is dominated by three major groups *Acacia* forests and woodlands, *Acacia* shrublands and hummock grasslands with other shrublands and chenopod shrublands also common. Eucalypt woodlands, tussock grasslands and other grasslands comprise minor components of the bioregion's vegetation. Hummock grasslands, *Acacia* forests and woodlands and Tussock grasslands dominate the Pilbara with *Acacia* shrublands also common. Heath, *Casuarina* forests and woodlands, chenopod shrublands and other shrublands are minor components of the bioregions vegetation.

A substantial proportion of four of the major vegetation groups present in the Gascoyne and Pilbara bioregions have been altered since European settlement (**Table 5**) with the majority of these changes documented in the agricultural areas of Australia. Disturbance to the remaining major vegetation groups has been comparatively low. Each of the major vegetation groups are represented in protected areas.


119° 10' 20"
119° 21' 16"
-22° 32' 2"
-22° 37' 50"
Legend
Land Systems:
Adrian
Divide
Fan
Fortescue
Marillana
Newman
Urandy
Divide
Fortescue
Fan
Urandy
Land Systems of the Pilbara Rangeland Survey, Map 1
Rail North. FERRAUS LIMITED
Scale 1 : 70 000
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Produced by G. Wells on 8/12/2010
Projection: Universal Tranverse Mercator. Datum: GDA 94
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Figure 4

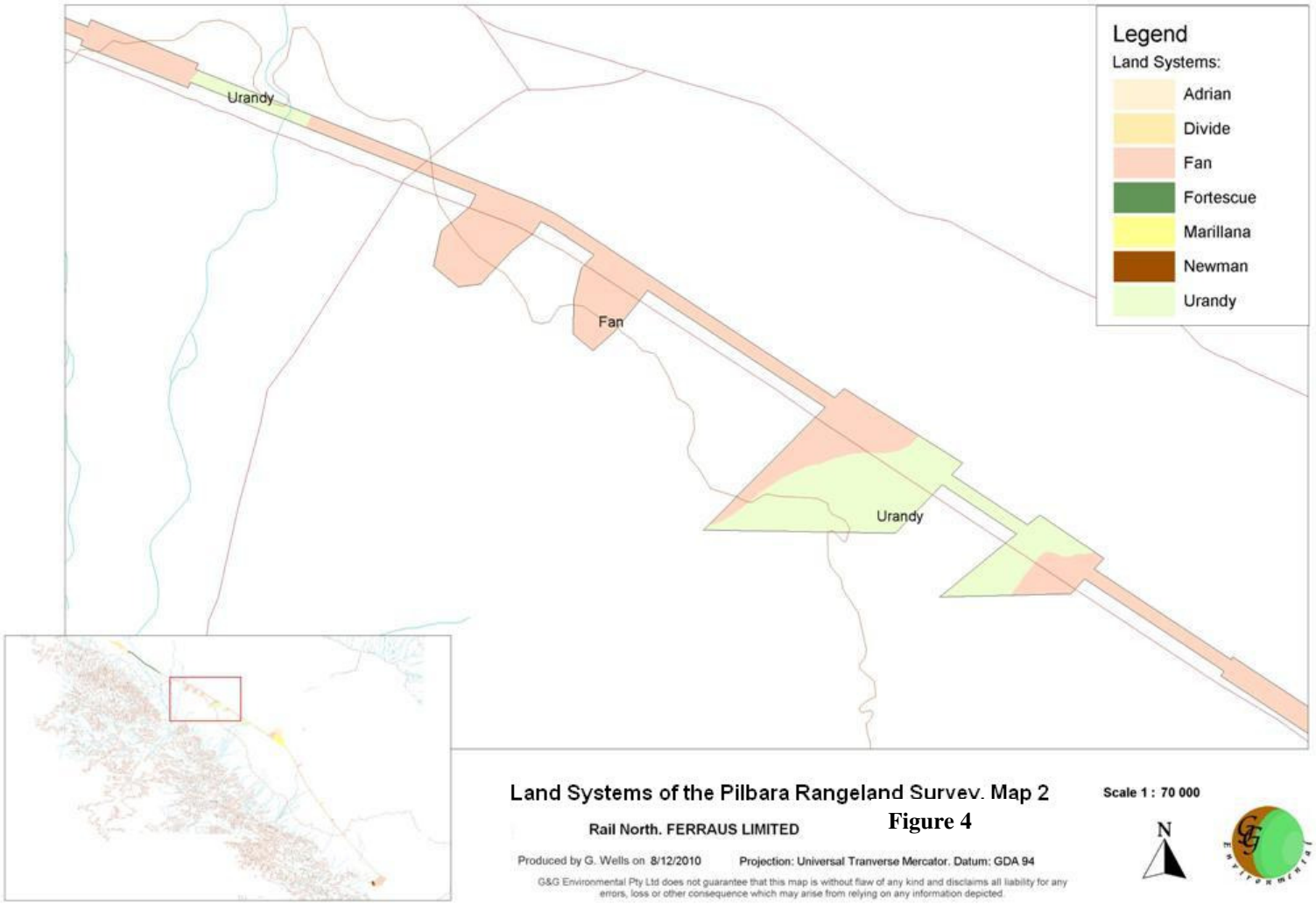
Legend
Land Systems:
Adrian
Divide
Fan
Fortescue
Marillana
Newman
Urandy
Urandy
Fan
Urandy
Land Systems of the Pilbara Rangeland Survey. Map 2
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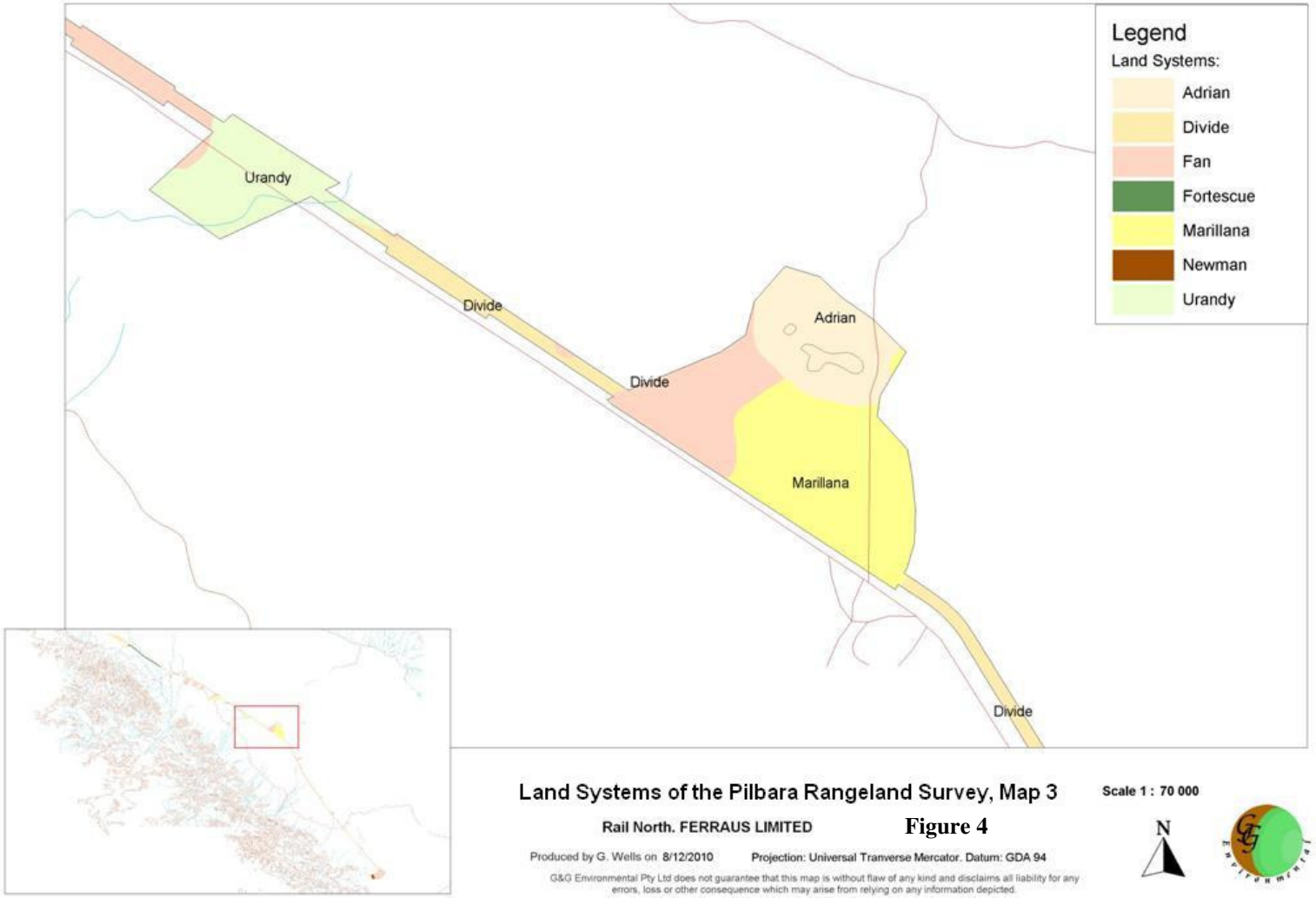
Figure 4



Land Systems of the Pilbara Rangeland Survey, Map 3

Rail North. FERRAUS LIMITED

Figure 4

Scale 1 : 70 000

N

Produced by G. Wells on 8/12/2010 Projection: Universal Tranverse Mercator. Datum: GDA 94

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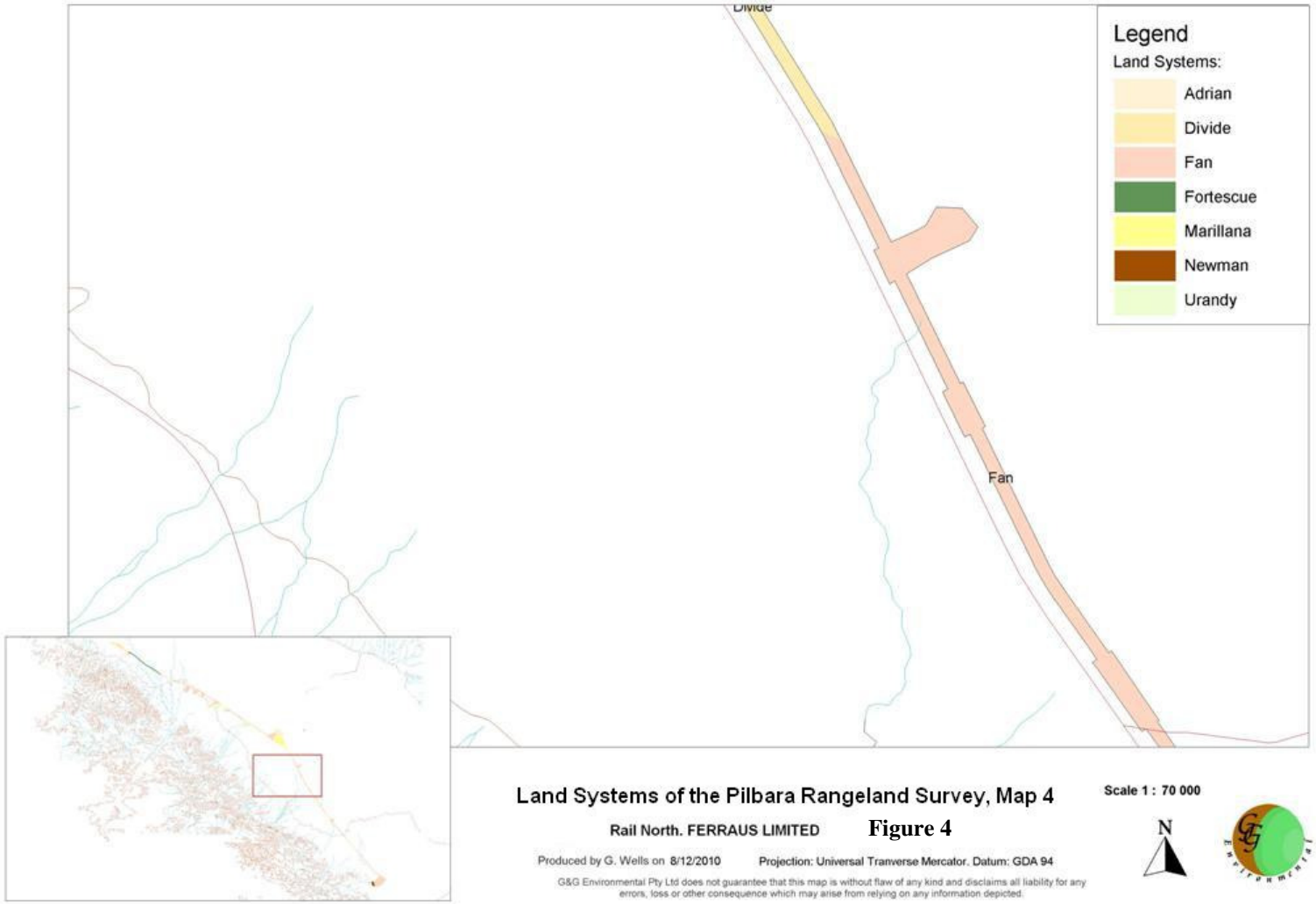
Legend
Land Systems:
Adrian
Divide
Fan
Fortescue
Marillana
Newman
Urandy
Fan
Land Systems of the Pilbara Rangeland Survey, Map 4
Rail North. FERRAUS LIMITED
Figure 4
Produced by G. Wells on 8/12/2010
Projection: Universal Tranverse Mercator. Datum: GDA 94
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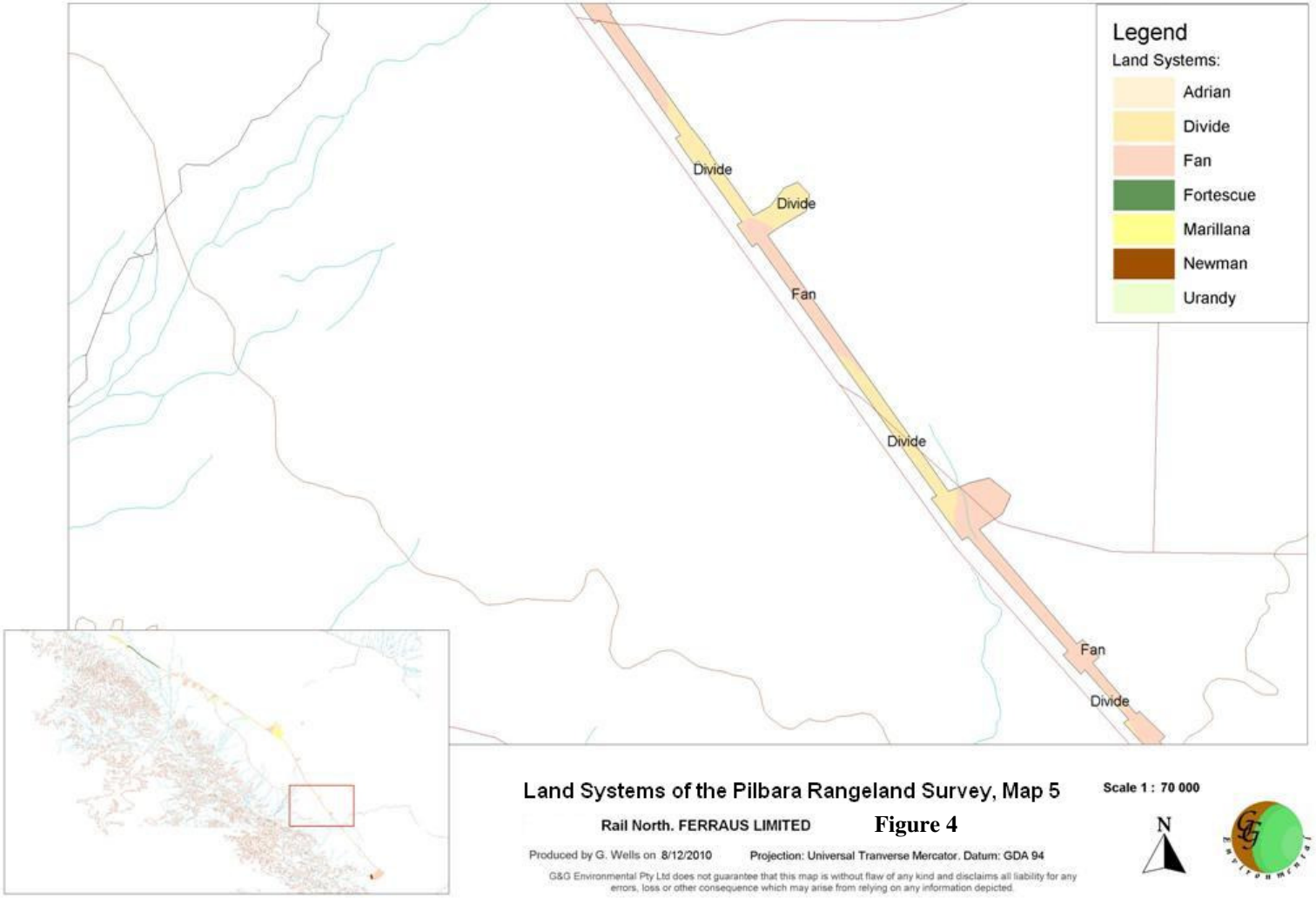
Scale 1 : 70 000
N



Land Systems of the Pilbara Rangeland Survey, Map 5

Rail North. FERRAUS LIMITED **Figure 4**

Scale 1 : 70 000

Produced by G. Wells on 8/12/2010 Projection: Universal Tranverse Mercator. Datum: GDA 94

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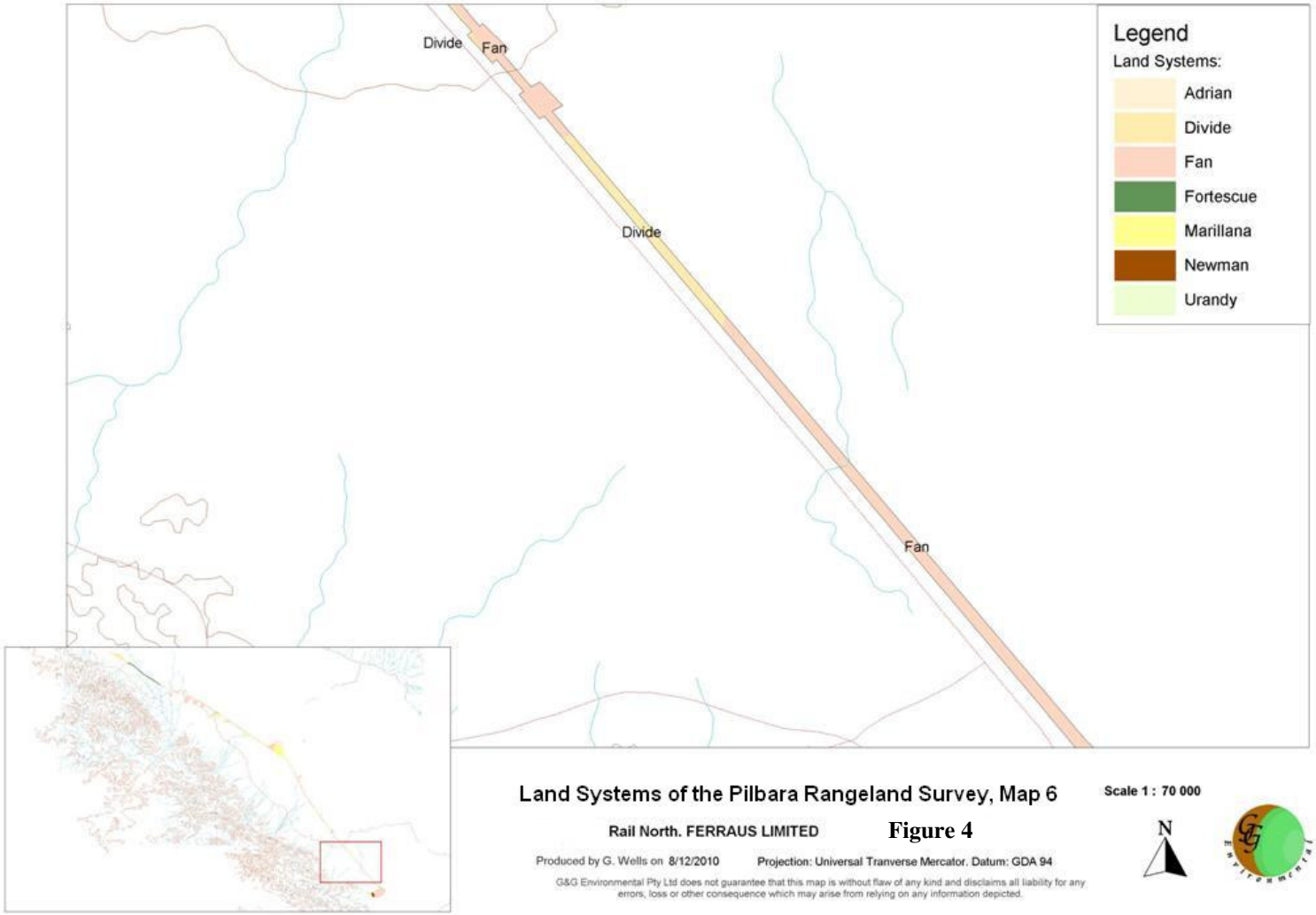

Land Systems of the Pilbara Rangeland Survey, Map 6

Rail North. FERRAUS LIMITED

Figure 4

Scale 1 : 70 000

N

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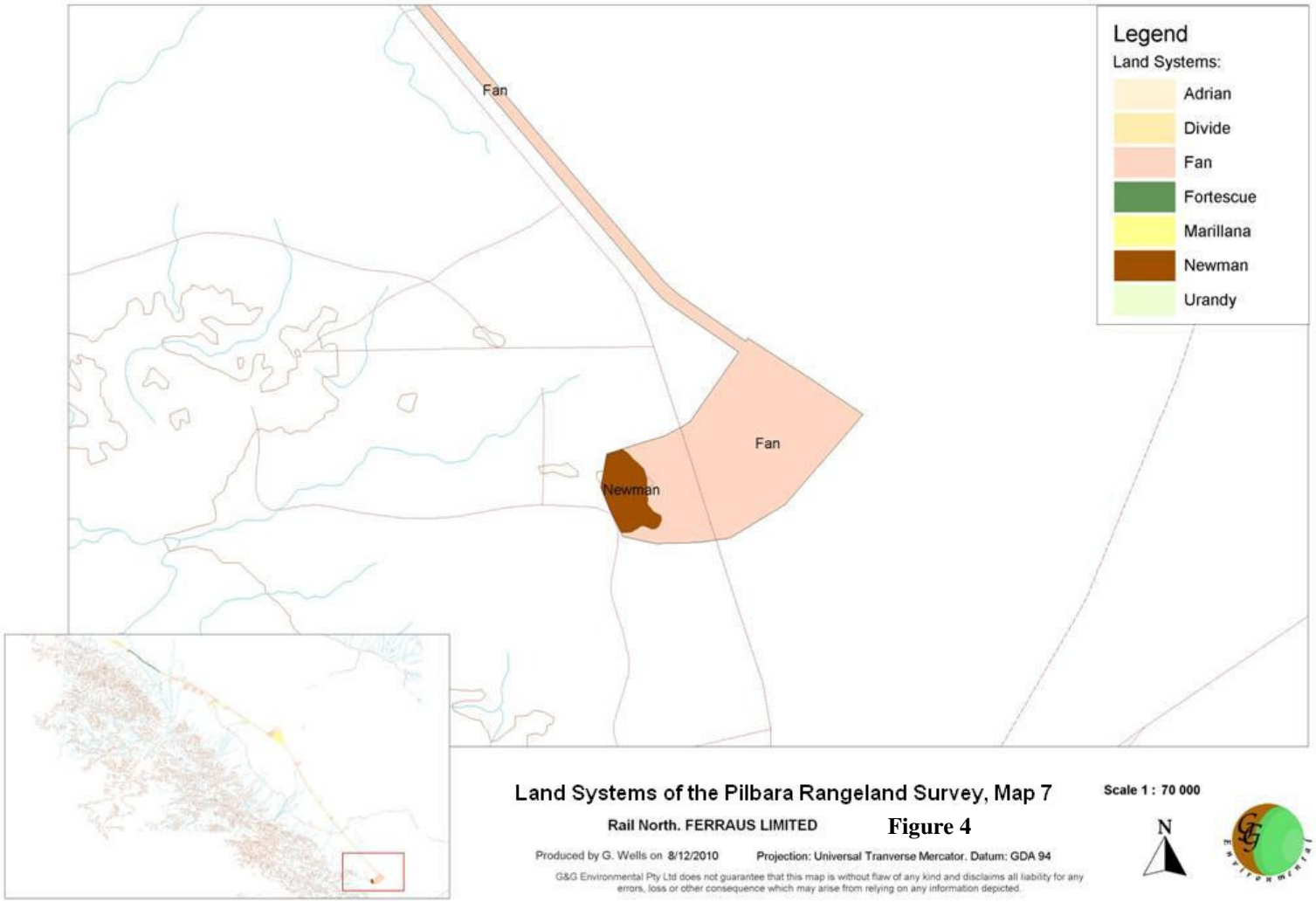
Legend
Land Systems:
Adrian
Divide
Fan
Fortescue
Marillana
Newman
Urandy
Fan
Fan
Newman
Land Systems of the Pilbara Rangeland Survey, Map 7
Rail North. FERRAUS LIMITED
Figure 4
Produced by G. Wells on 8/12/2010
Projection: Universal Tranverse Mercator. Datum: GDA 94
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Scale 1 : 70 000
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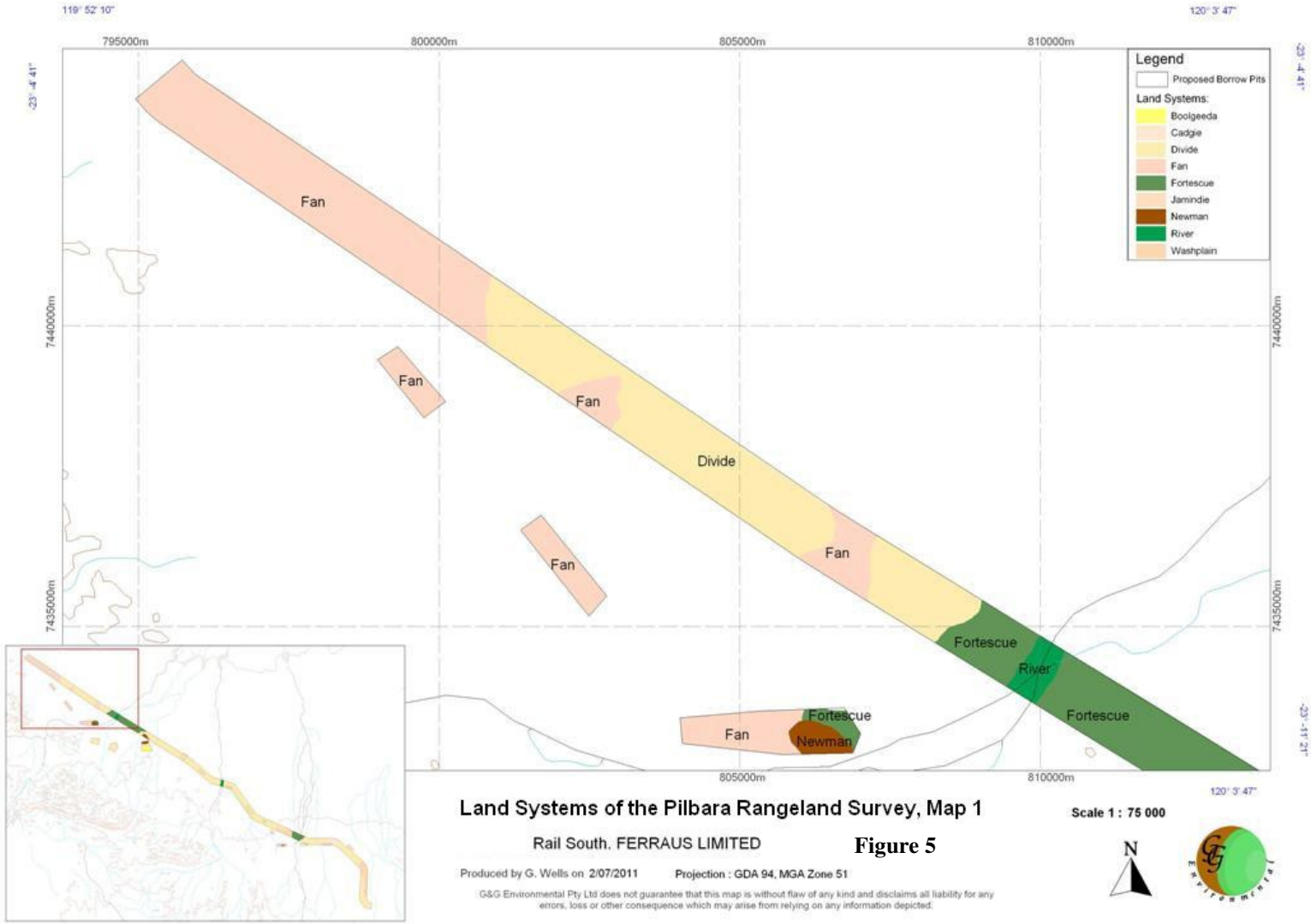
119° 52' 10"
120° 3' 47"
795000m
800000m
805000m
810000m
-23° 4' 41"
-23° 11' 21"
7440000m
7435000m
Legend
Proposed Borrow Pits
Land Systems:
Boolgeeda
Cadgie
Divide
Fan
Fortescue
Jamindie
Newman
River
Washplain
Fan
Fan
Fan
Divide
Fan
Fan
Fortescue
River
Fortescue
Fortescue
Fan
Newman
Land Systems of the Pilbara Rangeland Survey, Map 1
Rail South. FERRAUS LIMITED
Figure 5
Scale 1 : 75 000
N
Produced by G. Wells on 2/07/2011
Projection : GDA 94, MGA Zone 51
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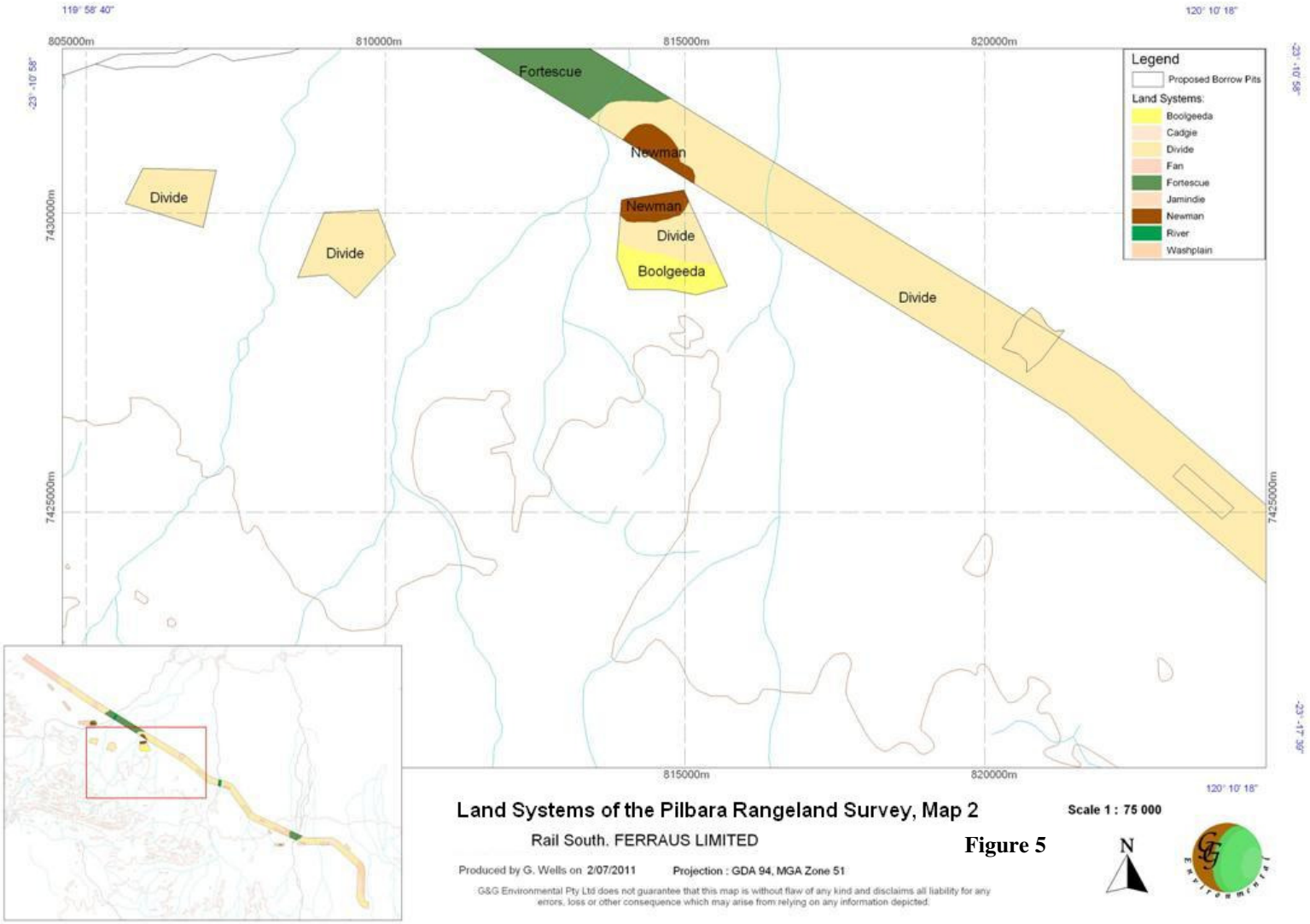
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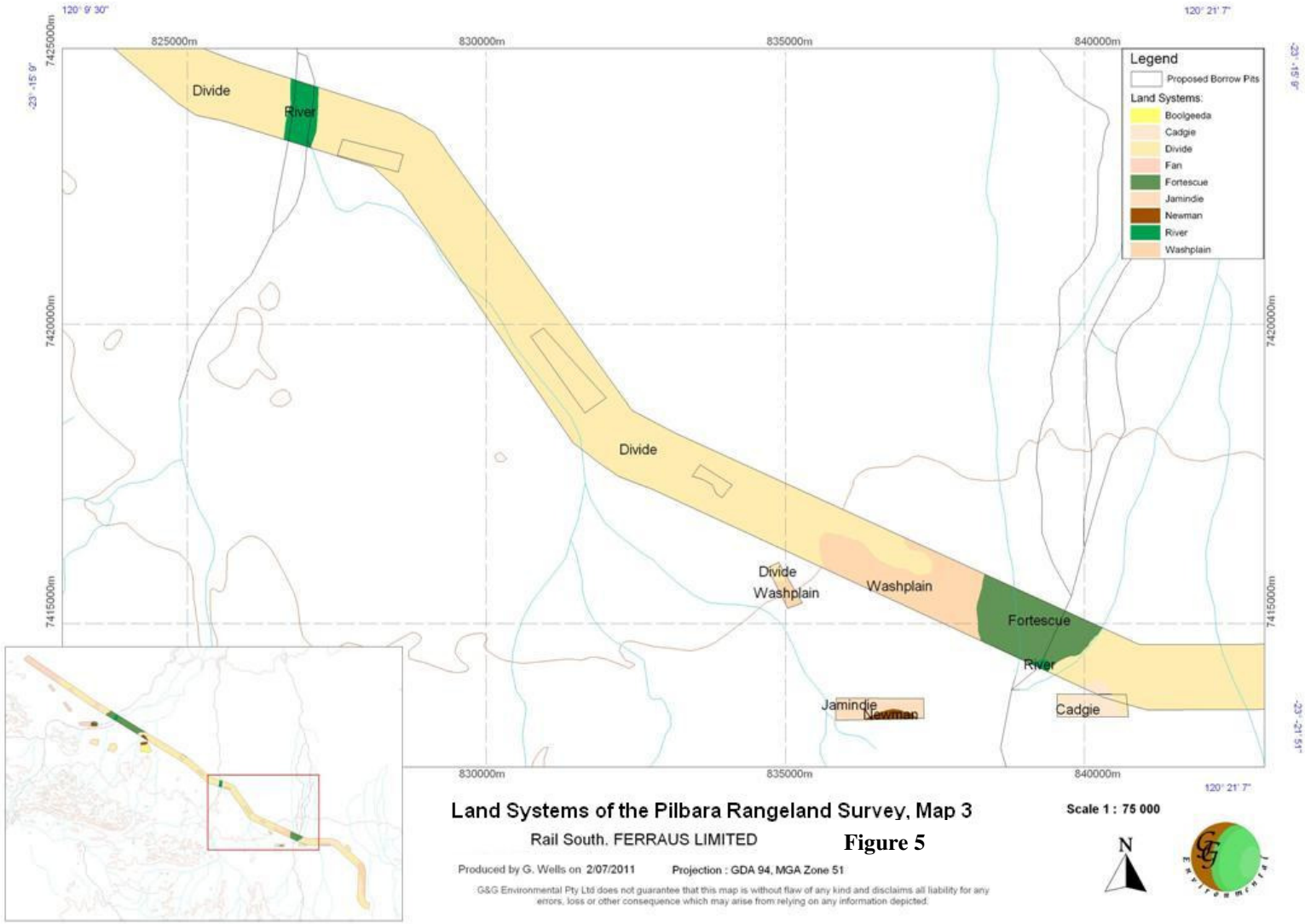
120° 10' 18"
805000m
810000m
815000m
820000m
7430000m
7425000m
-23° 10' 58"
-23° 17' 35"
Fortescue
Newman
Newman
Divide
Boolgeeda
Divide
Divide
Divide
Legend
Proposed Borrow Pits
Land Systems:
Boolgeeda
Cadgie
Divide
Fan
Fortescue
Jamindie
Newman
River
Washplain
Land Systems of the Pilbara Rangeland Survey, Map 2
Rail South. FERRAUS LIMITED
Scale 1 : 75 000
Produced by G. Wells on 2/07/2011
Projection : GDA 94, MGA Zone 51
G&G Environmental Pty Ltd does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.
N

Figure 5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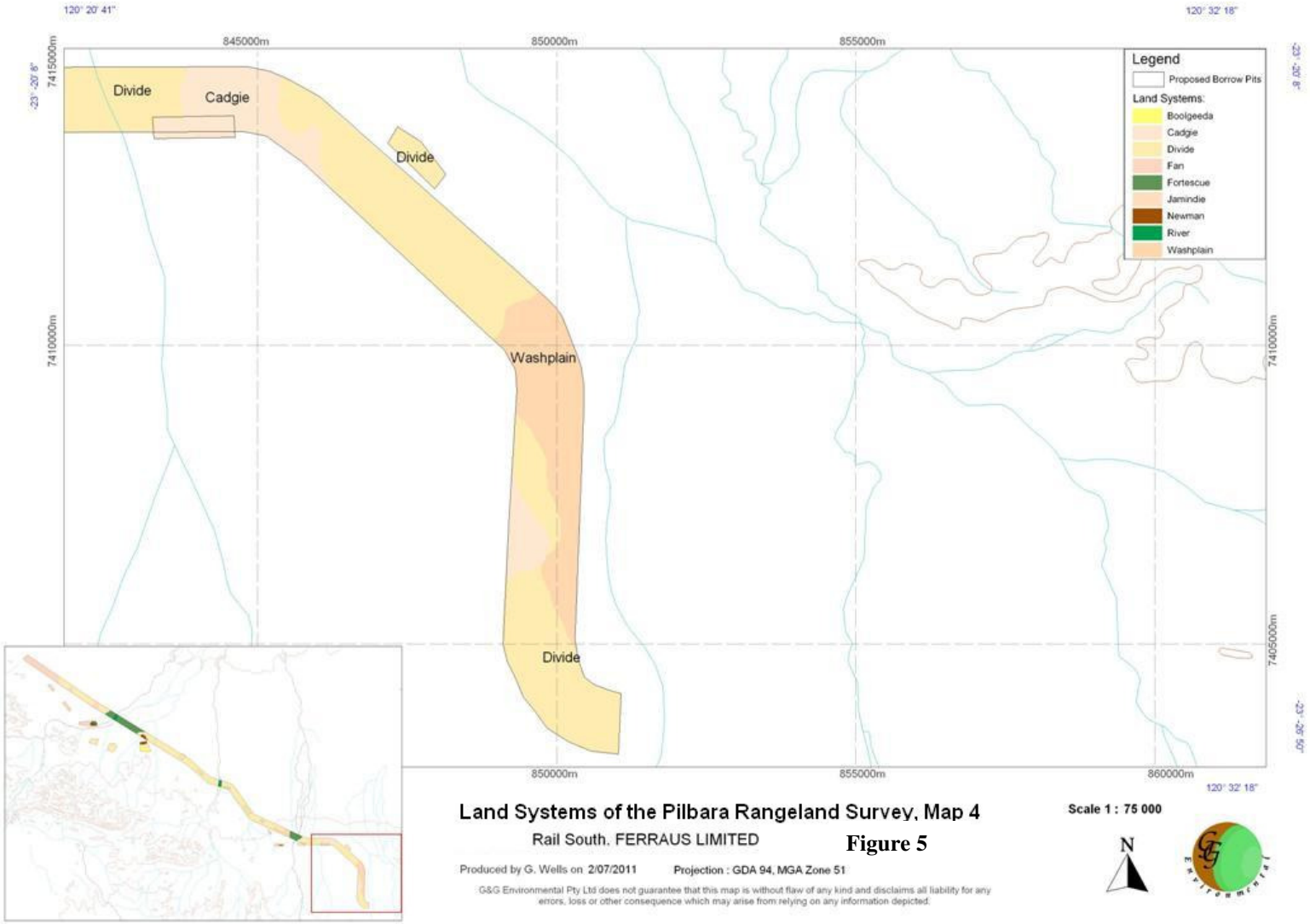
120° 21' 7"
825000m
830000m
835000m
840000m
7425000m
7420000m
7415000m
-23° 15' 9"
-23° 21' 51"
Legend
Proposed Borrow Pits
Land Systems:
Boolgeeda
Cadgie
Divide
Fan
Fortescue
Jamindie
Newman
River
Washplain
Divide
River
Divide
Divide
Washplain
Washplain
Fortescue
River
Jamindie
Newman
Cadgie
Land Systems of the Pilbara Rangeland Survey, Map 3
Rail South. FERRAUS LIMITED
Figure 5
Produced by G. Wells on 2/07/2011
Projection : GDA 94, MGA Zone 51
G&G Environmental Pty Ltd does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.
Scale 1 : 75 000
N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120° 32' 18"
845000m
850000m
855000m
860000m
7415000m
7410000m
7405000m
-23° 20' 8"
-23° 26' 50"
Divide
Cadgie
Divide
Washplain
Divide
Legend
Proposed Borrow Pits
Land Systems:
Boolgeeda
Cadgie
Divide
Fan
Fortescue
Jamindie
Newman
River
Washplain
Land Systems of the Pilbara Rangeland Survey, Map 4
Rail South. FERRAUS LIMITED
Figure 5
Produced by G. Wells on 2/07/2011
Projection : GDA 94, MGA Zone 51
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Scale 1 : 75 000
N

Table 3: Description of the land systems within the survey areas (Van Vreeswyk *et al* 2004).

Land System	Landforms	Geology	Vegetation
Adrian	Low rounded hills and rises, gently undulating stony plains	Tertiary silcrete, chert breccia and colluvium	Hard spinifex grasslands with sparse acacia shrubs and occasional eucalypts (HSPG) occur on stony soils of rounded hills and footslopes. Stony plains on red shallow loams have PHSG. Drainage lines support hummock grasslands and acacia shrubs on red shallow loams and include DAHW.
Boolgeeda	Stony lower slopes and plains below hill systems	Quaternary colluvium.	Hard and soft spinifex grasslands and mulga shrublands (HESG, HSPG, PHSG, PMSS) on hills and plains. Scattered to closed shrublands and woodlands on drainage floors and channels (GMUW, GMGW, DAHW).
Cadgie	Hardpan plains with thin sand cover and sandy banks.	Tertiary cemented colluvium and alluvium.	Mulga shrublands with soft and hard spinifex. Vegetation on the sandy plains and banks comprise three types HPMS, PMSS and SBAS. HPMS also occurs on the hardpan plains and drainage tracts with GMUW on the drainage foci.
Divide	Sandplains and occasional dunes.	Quaternary aeolian sand.	Shrubby hard Spinifex grasslands. Vegetation associations recorded include PMSS, SHSG and SSSG.
Fan	Washplains and gilgai.	Quaternary alluvium, minor colluvium and sand.	Shrubby hummock grasslands of *Triodia* spp. (hard spinifex) (SHSG) or scattered tall shrublands with *Acacia aneura* (mulga), *Senna* spp. and prominent ground layer of *Triodia* spp. (SBAS). Hummock grasslands of *Triodia* spp. (hard and soft spinifex) with scattered acacias and mallee eucalypts (PHSG, PSSG) or tall shrublands of *A. aneura* with low shrubs or hard spinifex understoreys (HPMS, PMSS). Very scattered to scattered tall shrublands of *A. aneura* and other acacias with sparse *Senna* and *Ptilotus* spp. low shrubs (HPMS, PSMS). Also *A. xiphophylla* (snakewood) tall shrublands with chenopod low shrubs (PSCS). Moderately close to close tall shrublands/woodlands of *A. aneura* with tussock grasses in ground layer (GMGW, GMUW). Tussock grasslands of *Eragrostis xerophila* (Roebourne Plains grass) and *E. setifolia* (neverfail) (ARPG). Scattered to moderately close tall shrublands with *A. aneura* and *A. xiphophylla*, tussock grasses in ground layer (DEGW, GMGW). Moderately close to close tall shrublands/woodlands of *A. xiphophylla, A.aneura* with tussock grasses (SSTS, GMGW).
Fortescue	Gently undulating shaly plains with isolated low hills.	Middle Proterozoic shale and minor dolerite, Quaternary colluvium and minor alluvium.	Low woodland of *Acacia aneura* (mulga) with low shrubs *Senna* and *Eremophila* spp., forbs and sparse annual grasses (SAES). Very scattered tall shrublands of *A. aneura* and other acacias, low shrubs *Senna* and *Eremophila* spp., forbs and sparse annual grasses (SAES). Very scattered woodlands/tall shrublands of *A. aneura* and other acacias, low shrubs *Senna* and *Eremophila* spp., forbs and sparse annual grasses (SAES). Depauperate shrublands with isolated or very scattered *A. aneura, A.* aff. *palustris, Senna* spp., *Eremophila* spp. and forbs (PSMS). Low very

			scattered shrublands of *Senna artemisioides* subsp. *oligophylla* (blood bush) with occasional *Eremophila* and *Acacia* spp., also *Rhagodia eremaea* (tall salt bush) and annual grasses. Drainage floors: very scattered to scattered low shrublands of *Halosarcia* spp. (samphire) (PSPS) or very scattered to scattered tall shrublands of *Acacia* spp. with understorey of numerous chenopod low shrubs, forbs and annual grasses (PMCS). Braided channels: moderately close to close fringing tall shrublands with *A. aneura, A. coriacea* (river jam), *A. sclerosperma* (limestone wattle) and *A. citrinoviridis* (black mulga), numerous low shrubs, forbs and annual grasses (DEAW).
Jamindie	Stony hardpan plains and rises.	Partly cemented Quaternary colluvium, alluvium and laterite; minor sedimentary rocks of Proterozoic age.	Groved mulga shrublands, occasionally with spinifex understorey (HESG, HSPG, PHSG, PMSS) on hills and plains. Scattered to closed shrublands and woodlands in groves and on drainage tracts and channels (GMUW, GMGW, DAHW, DEGW).
Marillana	Gravelly plains with large drainage foci and unchannelled drainage tracts.	Quaternary alluvium.	Hummock grassland of *Triodia wiseana* (hard spinifex) with very scattered to scattered *Acacia* and *Senna* spp. shrubs (CASG). Very scattered to scattered and somewhat clumpy tall shrublands of *Acacia xiphophylla* (snakewood) with undershrubs of *Maireana pyramidata* (sago bush), *M. triptera* (three winged bluebush), *M. georgei* (golden bluebush) and *Atriplex bunburyana* (silver saltbush) (PSCS). Scattered to close tall shrublands or woodlands of *Acacia aneura* with numerous undershrubs and patchy tussock grasses such as *Eragrostis setifolia* (neverfail) and *Chrysopogon fallax* (ribbon grass) (DEGW, GMUW). Close to closed tall shrublands or woodlands of *Acacia aneura* with numerous undershrubs and tussock grasses such as *Chrysopogon fallax* (DEGW, GMGW).
Newman	Rugged jaspilite plateaux, ridges and mountains.	Lower Proterozoic jaspilite, chert, siltstone, shale, dolomite and minor acid volcanic.	Hard spinifex grasslands. Vegetation on the plateaux's, mountains and hills includes HESG and HSPG. HESG and PHSG occur on the lower slopes with PHSG and PSSG on the stony plains. Vegetation of the drainage floors is more diverse with ASSG, DEGW, DAHW and DESG present.
River	Active floodplains and major rivers.	Quaternary alluvium.	Grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands. Vegetation is diverse with APBG, ASSG, AHSG, AEBG, DEGW, DESG and DAHW recorded for the floodplains and lower terraces. GMEW and AEBG occur in the channels, ASSG and PSSG on the sandy levees and sheets, PSSG, PHSG and DEGW on the stony plains and PHSG and PSSG on the upper terraces.
Urandy	Stony plains, alluvial plains and drainage lines.	Quaternary alluvium and colluvium.	Shrubby soft spinifex grasslands with PSSG on stony plains, ASSG on alluvial plains and DESG and DEGW in drainage zones and along channels.
Washplain	Hardpan plains	Quaternary partly cemented alluvium.	Groved mulga shrublands. Vegetation on hardpan plains comprises HPMS and LHAS with SAES and PMGS on stony plains, SSSG and SHSG on sandplains, GMGW in groves and DEAW and DEGW along the drainage tracts.

Table 4: Major vegetation groups and the area (Ha) they occupy in the Gascoyne and Pilbara bioregions (Source NLWRA 2001).

Major Vegetation Groups	Code	Gascoyne	Pilbara
Eucalypt woodlands	MVG5	4,584	150,424
Acacia forests and woodlands	MVG6	9,255,076	1,993,476
Casuarina forests and woodlands	MVG8	0	1,188
Acacia open woodlands	MVG13	74,400	18,384
Acacia shrublands	MVG16	5,752,440	377,107
Other shrublands	MVG17	666,940	4,668
Heath	MVG18	0	88
Tussock grasslands	MVG19	1,264	1,266,180
Hummock grasslands	MVG20	1,262,828	13,424,080
Grassland group	MVG21	12,560	283,796
Chenopod group	MVG22	794,620	95,920
Mangrove group	MVG23	250,616	203,220

Table 5: Summary of the major vegetation groups potentially present in the rail options and the status of each of the groups (Data Source NLWRA 2001).

Major Vegetation Group Code	Estimated area pre 1750 (km^2)	Present area (km^2)	% altered since 1750	Area protected (km^2)	% protected	Major disturbances and threats
MVG 5	1 362 263	892 920	~34.5%	72 589	~8%	Removed particularly in the agricultural zones of eastern and south-western Australia, altered fire regimes and impacts from invasive introduced plant species.
MVG 6	495 059	408 632	~17.5%	36 064	~8.8%	Extensively cleared for grazing and agriculture and modified by the grazing of cattle/sheep and feral animals, and increased macropod populations supported by water bores.
MVG 8	166 303	149 262	~10%	27 561	~18.5%	Modified by selective logging for timber, by sheep and\cattle grazing and altered fire regimes.
MVG 13	320 981	314 040	~2%	23 815	~7.6%	Clearing for pastoral activities, change in local drainage systems, increased grazing pressure by providing stock watering and the introduction and spread of feral animals and changes to fire regimes.
MVG 16	865 845	851 274	~1.7%	85 444	~10%	Clearing for pastoral activities, altered fire regimes and combined grazing of domestic stock feral and native animals.
MVG 17	157 530	123 464	~21.6%	23 136	~18.7%	Extensively cleared in the agricultural regions and in coastal areas adjoining major cities. In the arid zone, little of this group has been cleared but many areas have been subject to modification by grazing by domestic stock and feral herbivores.
MVG 18	9 256	8 071	~13%	3 562	~44.1%	Land clearing for urban development, recreational areas and mineral sand mining.
MVG 19	559 850	525 888	~6%	15 795	~3%	Extensively grazed and altered fire regimes.
MVG 20	1 368 861	1 367 973	~0.06%	135 637	~10%	Some grazing by domestic stock but primarily from feral herbivores, altered fire regimes.
MVG21	67 977	64 810	~4.7%	11 112	~17.1%	Different hydrological conditions, changes to fire regimes, impacts from feral animals and localised tourism.
MVG 22	447 239	436 801	~2.3%	55 143	~12.6%	Generally these communities have remained intact since European settlement.. Foremost among threats for coastal occurrences are infilling for urban areas, changes to tidal regimes and isolation from the estuary by roads and infrastructure.
MVG 23	9 664	9 325	~3.5%	3 08	~33.1%	Widespread clearing or infilling of mangroves and tidal mudflats has occurred in coastal areas near urban major centers for industrial uses or urban developments.

The vegetation within and surrounding the survey area was mapped by Beard (1975) and included:

- a_1Li - low continuous mulga woodland;
- a_1Lp - mulga trees in groves or patches;
- a_nSr.tHi - scattered shrubs over spinifex; and
- $e_{25}Srt_2$Hi - *Eucalyptus gamophylla* over spinifex.

For the ten land systems that occur within the rail corridor survey area, Van Vreeswyk *et al* (2004) defined a total of 31 'site types' (**Table 6**) which are described according to their land surface, dominant plant species and vegetation formation.

Table 6: Description of the site types of Van Vreeswyk *et al* 2004.

Site Type	Description
AEBG – Alluvial plain buffel grass grassland with eucalypt overstorey	Occurs on level floodplains, alluvial plains, levees and drainage tracts. A *Cenchrus ciliaris* tussock grassland with an overstorey of eucalypt trees, also a tall shrub layer and less frequently mid and low shrub layers. Dominant trees are *Eucalyptus camaldulensis* and *E. victrix* with *Atalaya hemiglauca*, *Hakea suberea* and *Bauhinia cunninghamii* common. Tall shrubs include *Acacia inaequilatera*, *A. sclerosperma* and *A. trachycarpa*. Common mid shrubs are *Carissa lanceolata*, *Rhagodia eremaea*, *Tephrosia rosea* and *Vachellia farnesiana*. Low shrubs are *Aerva javanica*, *Atriplex bunburyana*, *Cucumis maderaspatanus* and *Senna artemisioides* subsp. *oligophylla*. Perennial grasses are dominated by *Cenchrus ciliaris* with *Bothriochloa bladhii* subsp. *bladhii*, *Cenchrus setiger*, *Chrysopogon fallax*, *Eriachne benthamii* and *Triodia pungens* common.
AHSG - Alluvial plain hardpan spinifex grassland	Occurs widely on alluvial plains and drainage tracts usually with non-cracking, weakly saline, sand duplex and clay soils. A hummock grassland with up to 60% foliage cover, occasionally an *Acacia* mid and/or tall shrub layer. Tall shrubs include *Acacia ancistrocarpa*, *A. arida* and *A. inaequilatera*, mid and low shrubs are *Acacia bivenosa*, *A. stellaticeps*, *Corchorus walcotii*, *Hibiscus sturtii*, *Mollugo molluginea*, *Pluchea tetranthera* and *Sida rohlenae*. Perennial grasses *Triodia lanigera*, *T. longiceps*, *T. secunda* are dominant and *Aristida holathera* var. *holathera*, *Cenchrus ciliaris*, *Chrysopogon fallax* and *Triodia pungens* are common.
APBG - Alluvial plain buffel grass grassland	Occurs on level alluvial plains, flood plains, levees and drainage tracts. Occurs as Cenchrus *ciliaris* tussock grassland with a few shrubs and trees. Common trees are *Atalaya hemiglauca* and *Hakea lorea* subsp. *suberea*. Tall and mid shrubs include *Acacia inaequilatera*, *A. sclerosperma*, *A. victoriae*, *Carissa lanceolata* and *Vachellia farnesiana*. Common low shrubs are *Senna artemisioides* subsp. *oligophylla*, *Sida fibulifera*, *Solanum esuriale* and *Trianthema turgidifolia*. Perennial grasses are dominated by *Cenchrus ciliaris* with *Cenchrus setiger*, *Chrysopogon fallax*, *Eragrostis eriopoda*, *E. xerophila*, *Panicum decompositum* and *Triodia pungens* common.
ARPG – Alluvial plain Roebourne Plains grass grassland	Common on level plains with gilgai microrelief in cracking and/or saline clays. An *Eragrostis xerophila* tussock grassland usually with other minor grass species and occasionally with a poorly developed lower shrub stratum, larger shrubs and trees if present are typically isolated. *Acacia victoriae* is a common tall shrub; lower shrubs include *Indigofera trita, Neptunia dimorphantha, Senna artemisioides* subsp. *helmsii, Senna artemisioides* subsp. *oligophylla, S. hamersleyensis, Sida fibulifera,*

	Solanum lasiophyllum, Tephrosia clementii. The dominant perennial grass is *Eragrostis xerophila*, *Cenchrus ciliaris*, *Chrysopogon fallax*, *Eragrostis setifolia, Eriachne benthamii, Triodia pungens* are common.
ASSG - Alluvial plain soft spinifex grassland	Occurs widely on alluvial plains and drainage floors in sandy soils. A hummock grassland of *Triodia pungens* with mostly isolated to scattered shrubs and trees. Dominant trees are *Corymbia hamersleyana* and *Hakea lorea* subsp. *suberea*. Dominant tall and mid shrubs are *Acacia ancistrocarpa*, *A. inaequilatera* and *A. victoriae*. Low shrubs include *Acacia stellaticeps*, *Corchorus sidoides*, *Hibiscus sturtii*, *Indigofera monophylla*, *Mollugo molluginea*, *Pluchea tetranthera*, *Senna artemisioides* subsp. *oligophylla* and *Sida fibulifera*. Grasses are dominated by *Triodia pungens*; *Cenchrus ciliaris*, *Chrysopogon fallax* and *Eragrostis xerophila* are common.
CASG – calcrete spinifex grassland	Common on platforms and plains and plateaux of hill systems based on calcrete and limestone. A hummock grassland of *Triodia* species with occasional trees and isolated to scattered shrubs which may form a prominent strata. Dominant trees are *Corymbia hamersleyana* and *Eucalyptus leucophloia*. Common tall shrubs are *Acacia ancistrocarpa, A. inaequilatera*, *A. pyrifolia*, *Grevillea wickhamii* and *Hakea lorea*. Common mid-shrubs are *acacia bivenosa*, *A/ ligulata*, *A. victoriae*, *Senna glutinosa* and *Senna glutinosa* subsp. x *luerssenii*. Common low shrubs are *Corchorus sidoides*, *Evolvulus alsinoides*, *Heliotropium ovalifolium*, *Hibiscus sturtii*, *Indigofera monophylla*, *Ptilotus calostachyus, P. obovatus, Sida fibulifera, Senna artemisioides* subsp. *helmsii, Senna artemisioides* subsp. *oligophylla* and *Solanum lasiophyllum. Triodia wiseana* is the dominant perennial grass with *T. plurinervata*, *T. pungens*, *Cenchrus ciliaris* and *Paraneurachne muelleri* also common.
DAHW - Drainage acacia hummock grass shrubland/woodland	Occurs on narrow drainage floors and occasionally on groves on wash plains. An *Acacia* woodland or shrubland with hummock grass layer. Occasionally the hummock grassland is dominant with an overstorey of *Acacia* tall shrubs or trees. Dominant trees include *Acacia aneura*, and *Corymbia hamersleyana*. Common tall shrubs are *Acacia ancistrocarpa*, *A. citrinoviridus*, *A. holosericea*, *A. trachycarpa*, *A. tumida* and *Hakea lorea* subsp. *suberea*. Mid shrubs include *Acacia acradenia*, *A. atkinsiana*, *A bivenosa*, *Grevillea pyrifolia*, *G. wickhamii* and *Senna glutinosa* subsp. *glutinosa*. Low shrubs are *Corchorus sidoides*, *Evolvulus alsinoides*, *Goodenia stobbsiana*, *Hybanthus aurantiacus*, *Indigofera monophylla*, *Mollugo molluginea*, *Senna artemisioides* subsp.'s, *Sida fibulifera* and *Solanum lasiophyllum*. *Triodia pungens* is the dominant perennial grass with *Cenchrus ciliaris*, *Chrysopogon fallax*, *Paraneurachne muelleri* and *Triodia wiseana* common.
DEAW – Drainage eucalypt and acacia woodland/shrubland	Occurs on near level drainage tracts and floors, channelled or unchannelled up to 500m wide, occasionally wider. A eucalypt and/or *Acacia* woodland or tall shrubland with a low shrub layer but no perennial grass layer. Dominant trees are *Eucalyptus victrix* and *Acacia aneura*, *Hakea suberea* is common. Tall shrubs include *Acacia ancistrocarpa*, *A. sclerosperma* and *A. tumida*. Mid and low shrubs are *Muehlenbeckia florulenta*, *Chenopodium auricomum*, *Eremophila lanceolata*, *Indigofera monophylla*, *Cucumis maderaspatanus*, *Maireana villosa*, *Sida* spp., *Solanum lasiophyllum* and *Tephrosia bidwillii*. The perennial grass *Chrysopogon fallax* may also be present
DEGW - Drainage eucalypt and acacia grassy woodland/shrubland	Occurs mainly on narrow drainage floors but also wider drainage floors, floodplains, levees and on drainage foci such as claypans and swamps. An *Acacia* and/or eucalypt tall shrubland or woodland with a tussock grass layer. There is generally a mid and low shrub layer. Dominant trees are *Acacia aneura*, *A. coriacea*, *Corymbia aspera*, *C.*

	flavescens, *C. hamersleyana*, *Eucalyptus camaldulensis*, *E. victrix* with *Hakea suberea* also common. Tall and mid shrubs include *Acacia citrinoviridus*, *A. distans*, *A. inaequilatera*, *A. pyrifolia*, *A. trachycarpa*, *A. tetragonophylla*, *A. tumida*, *A. victoriae*, *Carissa lanceolata*, *Rhagodia eremaea* and *Vachellia farnesiana*. Low shrubs include *Eremophila forrestii*, *Indigofera monophylla*, *Maireana planifolia*, *M. villosa*, *Ptilotus obovatus*, *Senna artemisioides* subsp.'s, *Sida fibulifera*, *Solanum lasiophyllum* and *Tephrosia rosea*. Dominant perennial grasses are *Cenchrus ciliaris*, *Chrysopogon fallax* and *Eriachne benthamii* with *Eragrostis xerophila*, *Eulalia aurea*, *Themeda triandra* and *Triodia pungens* common.
DESG – Drainage spinifex grassland with eucalypt overstorey	Occurs on drainage tracts and floors. A hummock grassland with an overstorey of eucalypt trees typically with tall, mid and low shrub strata. Dominant trees are *Corymbia flavescens*, *C. hamersleyana*, *Eucalyptus camaldulensis*, *E. victrix* and *Hakea lorea* subsp. *suberea*. Common tall shrubs include *Acacia inaequilatera*, *A. pyrifolia* and *A. tumida*; mid shrubs are *Gossypium australe*, *G. robinsonii*, *Petalostylis labicheoides* and *Rhagodia eremaea*. Common low shrubs are *Corchorus* spp., *Bonamia erecta*, *Euphorbia australis*, *Indigofera monophylla* and *Ptilotus australasicus*. Perennial grasses are dominated by *Triodia* spp., particularly *T. pungens* with *Cenchrus ciliaris* and *Chrysopogon fallax* common.
GMEW – Gallery (riverbank and channel) melaleuca eucalypt woodland	Occurs along banks and channels of major rivers. A *Melaleuca argentea* or *Eucalyptus camaldulensis* woodland often with a tall shrub layer, infrequently mid or low shrub layers and a patchy layer of sedges or perennial grasses. Dominant trees are *Melaleuca argentea* or *Eucalyptus camaldulensis* with *Acacia coriacea*, *Atalaya hemiglauca*, *Ficus platypoda* and *Sesbania formosa* common. Tall shrubs include *Acacia holosericea*, *A. pyrifolia*, *A. trachycarpa*, *Melaleuca glomerata* and *M. linophylla*. Mid shrubs are *Capparis lasiantha*, *C. spinosa* and *Petalostylis labicheoides*. *Jasminum didymum* subsp. *lineare* is a common low shrub and common perennial grasses and sedges include *Cenchrus ciliaris*, *Cymbopogon procerus*, *Cyperus vaginatus*, *Eulalia aurea*, *Themeda triandra* and *Triodia pungens*.
GMGW - Grove mulga grassy woodland/shrubland	Occur as arcuate clumps of notably denser mulga shrubs and trees than surrounding vegetation with the long axes along the contour of slightly inclined wash plains and also as diffuse foci on drainage tracts. A moderately close to closed *Acacia* woodland with a tussock grass ground layer. Dominant trees include *Acacia aneura* and *A. catenulata*. *Hakea suberea* is a common tall shrub, mid and low shrubs include *Eremophila clarkei*, *E. forrestii*, *E. latrobei*, *E. lanceolata*, *Enchylaena tomentosa*, *Evolvulus alsinoides*, *Hibiscus sturtii*, *Maireana planifolia*, *M. villosa*, *Psydrax latifolia*, *Ptilotus obovatus*, *Sida fibulifera*, *Solanum ferocissimum* and *S. lasiophyllum*. Perennial grasses include *Chrysopogon fallax*, *Themeda triandra, Aristida latifolia*, *Digitaria ammophila*, *Eragrostis setifolia*, *E. xerophila*, *Eriachne benthamii* and *E. obtusa.*
GMUW - Grove mulga woodland/shrubland	Occurs on hardpan wash plains subject to sheet water flow as bands of dense vegetation separated by inter-grove plains supporting much sparser vegetation. Moderately close to closed *Acacia* woodland or tall shrubland. Dominant tree is most commonly *A. aneura* other trees include *A. pruinocarpa* and *Hakea lorea* subsp. *suburea*. Tall and mid shrubs *Acacia catenulata*, *Eremophila forrestii*, *E. latrobei*, *Psydrax latifolia*, *Rhagodia eremaea*, *Sida calyxhymenia* and *Stylobasium spathulatum*. Low shrubs include *Enchylaena tomentosa*, *Evolvulus alsinoides*, *Hibiscus burtonii*, *Maireana planifolia*, *M. villosa*, *Ptilotus obovatus*, *Senna artemisioides* subsp. x *sturtii*, *Sida fibulifera* and *Solanum*

	lasiophyllum. Perennial grasses include *Chrysopogon fallax* and *Monachather paradoxa*.
HESG - Hill eucalypt spinifex grassland	Occurs on hillslopes, footslopes and low rises. A hummock grassland of *Triodia* species with an overstorey of isolated to scattered eucalypts and isolated to scattered shrubs. Dominant trees include *Eucalyptus leucophloia*, *Corymbia hamersleyana* and *Acacia pruinocarpa.* Dominant tall shrubs *Grevillea wickhamii*, *Hakea lorea* subsp. *suberea*, *Acacia adoxa*, *A. tetragonophylla* and *A. maitlandii*. Dominant mid and low shrubs *Acacia atkinsiana*, *A. bivenosa*, *A. monticola*, *Senna glutinosa* and subsp.'s, *Acacia hilliana*, *Goodenia stobbsiana*, *Indigofera monophylla*, *Ptilotus calostachyus*, *P. obovatus*, *P. rotundifolius*, *Senna artemisioides* subsp. *oligophylla* and *Solanum lasiophyllum.* Dominant grasses *Triodia angusta*, *T. biflora*, *T. brizoides*, *T. concinna*, *T. plurinervata*, *T. pungens* and *T. wiseana*. *Themeda triandra* is also common.
HPMS - Hardpan plain mulga shrubland	Widely distributed, occurs on extensively broad plains overlying hardpan between erosional uplands and salt lake or river systems. A very scattered to scattered tall shrubland of mulga with well developed mid and low shrub layers, occasionally only a low shrub layer. Dominant trees include *Acacia aneura*, *A. pruinocarpa* and *Hakea lorea*; tall and mid-shrubs *Acacia tetragonophylla, A. wanyu*, *Eremophila fraseri*, *E. latrobei*, *Senna glutinosa* subsp.x *luerssenii*, *Psydrax latifolia*, *Rhagodia eremaea* and *Sida calyxhymenia*. Common low shrubs *Eremophila forrestii*, *E. margarethe*, *Hibiscus burtonii*, *Maireana tomentosa*, *M. villosa*, *Ptilotus obovatus*, *P. schwartzii*, *Senna artemisioides* subsp.'s, and *Solanum lasiophyllum* and common perennial grasses *Eriachne obtuse* and *Monachather paradoxa*.
HSPG - hill Spinifex grassland	Occurs on hillslopes, hill crests, footslopes, plateaux, ridges and low rises. A hummock grassland of *Triodia* species with isolated to scattered trees and shrubs. Common trees include *Corymbia hamersleyana* and *Eucalyptus leucophloia*. Dominant tall shrubs include *Acacia orthocarpa*, *Acacia inaequilatera*, *Grevillea wickhamii* and *Hakea lorea* subsp. *suberea*. Common mid-low shrubs are *Acacia bivenosa*, *Senna glutinosa* and subsp.'s, *Abutilon lepidum*, *Corchorus* spp., *Goodenia stobbsiana*, *Indigofera monophylla*, *Mollugo molluginea*, *Ptilotus calostachyus* and *Senna artemisioides* subsp *oligophylla*, *Tribulus platypterus* and *T. suberosus*. The most common perennial grasses include *Triodia pungens* and *T. wiseana* also *T. brizoides*, *T. lanigera*, *T. plurinervata*, *Cymbopogon ambiguous* and *Eriachne mucronata*.
LHAS - Lateritic hardpan plain acacia shrubland	Occurs on plains on hardpan with ironstone gravel or pebbles. An isolated to scattered tall acacia shrubland, commonly *Acacia aneura*, with well developed mid and low shrub layers. Dominant tall shrubs include *Acacia aneura*, *A. synchronicia* and *Hakea lorea* subsp. *suberea*. Mid and low shrubs include *Acacia wanyu, Senna glutinosa* subsp. x *luerssenii, Eremophila exilifolia, E. lanceolata, E. pensilis*, *Maireana planifolia*, *M. villosa*, *Ptilotus schwartzii* and *Senna* spp. Common perennial grasses are *Aristida holathera* var. *holathera* and *Triodia pungens*.
PAGS - Plain acacia cassia grassy shrubland	Occurs on gritty and stony plains and low rises typically in granitic terrain but also dolerite, sedimentary rocks and colluvium. A very scattered mixed shrubland with low, mid and tall shrub strata of *Acacia* , *Eremophila* and *Senna* species and a conspicuous understorey of *Aristida contorta* and/or *Enneapogon* spp. Annual grasses with *Aristida holathera* var. *holathera* a common perennial grass. Dominant tall shrubs include *Acacia aneura*, *A. tetragonophylla*, *A victoriae* and *Hakea lorea* subsp. *suberea*. Common mid and low shrubs are *Eremophila fraseri*, *E. latrobei*, *E. forrestii*, *E. margarethe*, *E. pensilis*, *Rhagodia eremaea*, *Senna* spp., *Evolvulus alsinoides*, *Indigofera monophylla*, *Maireana planifolia*, *M. villosa*, *Ptilotus obovatus*, *Sida*

	echinocarpa, *S. fibulifera, Solanum lasiophyllum* and *Tephrosia supina*. Perennial grasses include *Aristida holathera* var. *holathera*, *Chrysopogon fallax*, *Eragrostis eriopoda* and *Monachather paradoxa*.
PHSG - Plain hard Spinifex grassland	Occurs extensively on plains including stony, loamy, gravelly and gritty plains, also on footslopes and low rises. A hummock grassland of *Triodia* spp. with isolated to scattered to trees and shrubs. Common trees include *Corymbia hamersleyana, Eucalyptus leucophloia* and *Hakea lorea* subsp. *suberea*. Common tall shrubs include *Acacia ancistrocarpa*, *A. inaequilatera A. victoriae* and *Grevillea wickhamii*. Common mid and low shrubs include *Acacia bivenosa*, *A. stellaticeps*, *Senna glutinosa* and subsp.'s, *Corchorus* spp., *Mollugo molluginea*, *Solanum lasiophyllum* and *Ptilotus astrolasius*, *P. calostachyus*, *Indigofera monophylla*, *Senna artemisioides* subsp. *helmsii*, *Senna artemisioides* subsp. *oligophylla*, *Senna symonii* and *Sida echinocarpa.* Perennial grass cover frequently dominated by *Triodia wiseana* with *T. lanigera*, *T. longiceps*, *T. plurinervata*, *T. pungens*, *Paneurachne muelleri* and *Cenchrus ciliaris* also common.
PMCS - Plain mulga shrubland with chenopod low shrubs	Uncommon and occurs on plains including hardpan and saline plains and drainage tracts. A scattered tall *Acacia aneura* shrubland with a few mid shrubs and a low shrub layer dominated by chenopod shrubs. Tall shrubs are dominated by *Acacia aneura* with *A. tetragonophylla*, *A. victoriae* and *A. xiphophylla* common. *Senna glutinosa* subsp. x *luerssenii* is the dominant mid shrub with *Eremophila latrobei* and *Rhagodia eremaea* common. Low shrubs include *Enchylaena tomentosa*, *Eremophila forrestii*, *Maireana georgei*, *M. melanocoma*, *M. pyramidata*, *M. tomentosa*, *M. triptera*, *Ptilotus obovatus*, *Senna artemisioides* subsp.'s and *Solanum lasiophyllum.*
PMGS - Plain mosaic grassy shrubland	Uncommon and occurs on alluvial and stony plains that have a mosaic of gilgai and non-gilgai surfaces where typically the non-gilgai surface dominates but not always. A variably dense low shrubland of *Senna* and *Eremophila* species with a prominent but patchy ground layer of perennial grasses. *Acacia tetragonophylla* is a common tall shrub, mid shrubs include *Eremophila forrestii* and *Senna glutinosa* subsp. x *luerssenii*; low shrubs are *Eremophila cuneifolia*, *E. lanceolata*, *E. pantonii*, *Maireana planifolia*, *Sclerolaena deserticola*, *Senna* spp. And *Solanum lasiophyllum*. Perennial grasses include *Chrysopogon fallax* and *Eragrostis eriopoda.*
PMSS - Plain mulga Spinifex shrubland/grassland	Occurs on stony, loamy, gravelly and hardpan plains. A moderately closed *Acacia aneura* shrubland with a prominent to patchy ground layer of spinifex, or hummock grassland with a scattered overstorey of mulga and other shrubs. Common trees are *Acacia aneura*, *A. pruinocarpa* and *Corymbia hamersleyana.* Tall shrubs include *Acacia inaequilatera* and *Hakea lorea* subsp. *suberea* with mid shrubs *Acacia ancistrocarpa*, *A. bivenosa*, *Eremophila forrestii*, *E. latrobei*, *Rhagodia eremaea* and *Senna* spp. Low shrubs include *Hibiscus burtonii*, *Maireana planifolia*, *M. villosa*, *Ptilotus obovatus*, *Solanum lasiophyllum* and *Tribulus platypterus* with dominant grasses *Triodia pungens* and *Chrysopogon fallax.*
PSCS – plain snakewood shrubland with chenopod low shrubs	Occurs on stony, gravelly plains and alluvial plains. A mid or tall very scattered to scattered of *Acacia xiphophylla* with a patchy understorey of chenopod low shrubs, other low shrubs and a few perennial grasses. Dominant tall shrubs are *Acacia xiphophylla* with *A. tetragonophylla* and *A. victoriae* common. Common mid and low shrubs are *Atriplex bunburyana, Enchylaena tomentosa, Neptunia dimorphantha, Maireana georgei, M. pyramidata, M. tomentosa, M. triptera, Rhagodia eremaea* and *Senna glutinosa* subsp. x *luerssenii*. Common perennial grasses are *Cenchrus ciliaris, Enteropogon acicularis, Eragrostis*

	Xerophila and *Triodia pungens*.
PSMS – Plain sparse mulga shrubland	A common site type occurring on wash plains, hardpan, stony plains and low rises. A very scattered tall mulga shrubland with very sparse mid or low shrubs of which rarely form defined strata. Occasionally the low shrubs are dominant as a very scattered to scattered low shrubland. Common trees are *Acacia catenulata* and *A. pruinocarpa*. *Acacia aneura* is the dominant tall shrub with *A. tetragonophylla* and *Hakea lorea* common. Prominent mid and low shrubs are *Acacia marramamba, Eremophila caespitosa, E. fraseri, E. glutinosa, E. lanceolata, E. latrobei, Maireana convexa, M. georgei, M. villosa, Ptilotus obovatus, P. schwartzii, Rhagodia eremaea, Senna artemisioides* subsp. *helmsii* and *Solanum lasiophyllum.* Common perennial grasses are *Chrysopogon fallax* and *Eriachne mucronata*.
PSPS - plain samphire shrubland	Occurs on coastal areas and inland on areas associated with salt lakes and the Fortescue Marsh on highly saline plains and drainage tracts. A low shrubland of samphire with density there are no other shrub or tree layers. Occasionally there may be a perennial grass layer. Low shrubs are dominated by *Tecticornia* species including *T. halocnemoides* and *T. pterygosperma*. Common low shrubs are *Atriplex bunburyana*, *Eremophila spongiocarpa, Frankenia* spp., *Maireana amoena, M. tomentosa, Sclerolaena bicornis, Sida fibulifera* and *Solanum esuriale.* Common perennial grasses are *Cenchrus ciliaris, Eragrostis falcata*, *Panicum decompositum* and *Sporobolus virginicus.*
PSSG - Plain soft Spinifex grassland	Occurs extensively on stony, loamy and gritty plains. A hummock grassland of resinous *Triodia* grasses with isolated to moderately close trees and shrubs which may forma strata and are often *Acacia*. Common trees and include *Corymbia hamersleyana*, *Eucalyptus leucophloia*, *Acacia pruinocarpa*, *Grevillea wickhamii* and *Hakea lorea* subsp. *suberea*. Tall and mid shrubs include *Acacia ancistrocarpa*, *A. atkinsiana*, *A. inaequilatera*, *Senna glutinosa* and subsp.'s, *Bonamia rosea*, *Corchorus sidoides*, *C. walcotii*, *Euphorbia australis*, *Indigofera monophylla*, *Mollugo molluginea* , *Ptilotus australasicus*, *P. calostachyus, Solanum lasiophyllum*, *Tephrosia uniovulata* and *Senna artemisioides* subsp. *oligophylla*. Perennial grasses include *Triodia pungens*, *T. epactia*, *A. latifolia*, *Cenchrus ciliaris*, *Chrysopogon fallax*, *Eragrostis eriopoda* and *Paraneurachne muelleri*.
PXHS – Plain mixed halophyte shrubland	Occurs on level plains and drainage floors with abundant mantles of gravel or pebbles, typically in saline soils. A scattered to very scattered low shrubland of saltbush and bluebush with sparse perennial grasses. Common tall shrubs are *Acacia aneura*, *A victoriae* and *Hakea preisii*. Mid and low shrubs include *Atriplex bunburyana*, *Enchylaena tomentosa*, *Eremophila cuneifolia*, *E. maculate*, *Frankenia* spp., *Maireana carnosa* , *M. glomerifolia*, *M. planifolia*, *M. pyramidata*, *Senna artemisioides* subsp. *helmsii*, *Senna* sp. Meekatharra, *Solanum lasiophyllum* and *Streptoglossa cylindriceps*. Common grasses are *Enteropogon ramosus*, *Eragrostis eriopoda* and *E. xerophila.*
SAES - Stony plan acacia-eremophila-cassia shrubland	Common on stony plains and low rises and also occurs on stony hardpan plains, gravelly plains and occasionally hillslopes. A very scattered to scattered *Senna* and *Eremophila* low or mid-height shrubland with prominent tall *Acacia* shrubs seldom with trees or a perennial grass cover. Common tall shrubs include *Acacia pruinocarpa*, *A. aneura*, *A. tetragonophylla*, *A. victoriae* and *A. wanyu*. Mid and low shrubs include *Eremophila exilifolia*, *E. fraseri*, *E. cuneata*, *E. latrobei* , *Rhagodia eremaea*, *Senna glutinosa* subsp. x *luerssenii*, *Senna artemisioides* subsp.'s, *Sida calyxhymenia*, *Maireana georgei*, *M. tomentosa*, *M. triptera* , *Ptilotus obovatus*, *P. roei*, *P. schwartzii* and *Solanum*

	lasiophyllum. Perennial grasses are sparse but include *Eragrostis eriopoda*, *Triodia lanigera* and *T. wiseana*.
SBAS - Sandy bank acacia Spinifex shrubland	Occurs on deep sands on sand banks. A scattered to moderately closed *Acacia* shrubland with a hummock grass layer. Tall shrubs are dominated by *Acacia aneura* with *A. pruinocarpa* and *A sclerosperma* common. Mid shrubs include *Eremophila latrobei* and *Rhagodia eremaea*; low shrubs are *Abutilon otocarpum*, *Eremophila pensilis*, *Hibiscus burtonii*, *H. Sturtii*, *Maireana planifolia*, *M. villosa* and *Senna artemisioides* subsp. *helmsii*. Perennial grasses dominated by *Triodia basedowii*, *T. lanigera* and *T. pungens* with *Digitaria brownii* and *Eragrostis eriopoda* common.
SHSG - Sandplain hard spinifex grassland	Common on sandplains gravelly sandplains and dunes. Triodia hummock grassland with variable shrub layers. Common trees include *Allocasuarina decaisneana*, *Corymbia chippendalei*, *Eucalyptus gamophylla* and *Hakea lorea* subsp. *suberea*. Tall shrubs include *Acacia ancistrocarpa*, *A. inaequilatera* and *Grevillea eriostachya*. Mid and low shrubs include *Acacia stellaticeps*, *A. tumida*, *Bonamia rosea*, *Corchorus* spp., *Halgania* spp., *Indigofera monophylla*, *Ptilotus aphyllus*, *Scaevola parvifolia* subsp. *parvifolia* and *Sida cardiophylla*. Dominant grasses are *Triodia lanigera* and *T. pungens* with *Aristida holathera* var. *holathera, Eragrostis eriopoda* and *Paraneurachne muelleri* common.
SSSG - Sandplain soft spinifex grassland	Widespread on the deep sands of sandplains and dunes. Hummock grassland of *Triodia pungens*, *T. epactia* or *T. schinzii* with variable shrubs and occasional trees. Common trees include *Corymbia zygophylla*, *Bauhinia cunninghamii*, *Owenia reticulata*, *Acacia coriacea* and *Hakea lorea* subsp. *suberea*. Tall shrubs include *Acacia ancistrocarpa*, *A. holosericea*, *A. tumida*, *Grevillea pyramidalis* and *G. wickhamii*; mid shrubs are *Acacia inaequilatera*, *Carissa lanceolata* and *Sida pilbarensis*. *Acacia stellaticeps* is the dominant low shrub with *Bonamia eremaea*, *Corchorus walcotii*, *Dicrastylis* spp., *Evolvulus alsinoides*, *Indigofera monophylla*, *Mollugo molluginea*, *Ptilotus astrolasius*, *Scaevola parvifolia* subsp. *parvifolia* and *Solanum diversiflorum*. Perennial grasses include *Triodia pungens*¸ *T. epactia*, *T. schinzii*, *Aristida holathera* var. *holathera*, *Chrysopogon fallax*, *Eragrostis eriopoda*, *Eriachne obtuse* and *Paraneurachne muelleri*.

1.3.4 Threatened and Priority Flora, Threatened and Priority Ecological Communities, and Potentially Significant Taxon and Communities

The Department of Environment and Conservation define conservation codes for Western Australia on the FloraBase website (http://florabase.calm.wa.gov.au/conservationtaxa). Threatened Flora, Declared rare Flora – Extant are defined as 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 (Schedule 1 under the Wildlife Conservation Act 1950) (**Appendix A**).

Priority flora are taxa under consideration for declaration as Threatened but require further surveys or monitoring (**Appendix A**). Priorities 1, 2 or 3 are taxa not adequately surveyed to be listed under Schedule 1 or 2 and are ranked in order of priority for survey and evaluation of conservation status. Priority 4 are taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons. Conservation dependent species are Priority 5.

At the time of compiling this report Florabase (2011) listed a combined 61 T and Priority Flora for the Gascoyne bioregion. The list contained two T, *Pityrodia augustensis* (Lamiaceae) and *Thryptomene wittweri* (Myrtaceae) (**Appendix B**). The remaining species comprised sixteen P1, six P2, thirty three P3 and four P4 species. For the Pilbara bioregion 125 DRF and priority flora were reported on the Florabase website. There were two threatened species (*Lepidium catapycnon* and *Thryptomene wittweri*), 40 P1 taxa, 20 P2 taxa, 55 P3 taxa and 8 P4 taxa.

Pityrodia augustensis has been listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species has been recorded in the Fortescue Plains and Ashburton sub-regions. Naturemap (2011) lists 24 records for the species the closest of which lies several hundred kilometres from the survey area

Thryptomene wittweri is listed as vulnerable and has been recorded in the Fortescue Plains sub-region but not the Ashburton sub-region. Naturemap (2011) lists 14 records for the species the closest of which lies approximately 150 km from the survey area.

Lepidium catapycnon is listed as vulnerable and has been recorded in the Fortescue Plains sub-region. NatureMap (2011) lists 44 records for the species the closest of which occurs within 10 km of the northern end of the rail corridor.

Van Vreeswyk *et al* (2004) recorded seven priority taxa inhabiting the site types that may potentially occur in the survey area (**Table 7**)

Table 7: Priority species recorded by Van Vreeswyk *et al* (2004) in site types that occur in the survey area.

Species	Priority Code	Vegetation Associations
Acacia aphanoclada	P1	HSPG
Bulbostylis burbidgeae	P4	HSPG, PHSG, PSSG, SHSG, SSSG, AHSG, DAHW
Eremophila pilosa	P1	PSSG
Eremophila spongiocarpa	P1	PXHS
Josephinia sp Marandoo	P1	PAGS
Sida sp Barlee Range	P3	HSPG
Tephrosia bidwillii	P3	DEAW

Searches of the Department of Environment and Conservation (DEC) Threatened (Declared Rare Flora) database, the Threatened Ecological Communities database and the Western Australian Herbarium database identified a single DRF (*Lepidium catapycnon*), three P1 flora (*Brachyscome* sp. Wanna Munna Flats, *Eremophila pilosa*, *Eremophila spongiocarpa*), one P2 flora (*Stylidium weeliwolli*), six P3 flora (*Acacia subtiliformis*, *Amaranthus centralis*, *Atriplex flabelliformis*, *Crotalaria smithiana*, *Sida* sp. Barlee Range, *Themeda* sp. Hamersley Station) and two P4 flora (*Goodenia nuda*, *Rhynchosia bungarensis*) that could potentially occur in the survey area.

Selected plant communities have been listed as TECs under the EPBC Act (1999). In Western Australia, the Department of Environment and Conservation (DEC) describe four categories of TECs (Appendix B). None of the DEC listed TECs occur in the Gascoyne bioregion (ANRA 2010). One TEC has been named in the Pilbara bioregion under State legislation, *Themeda* grassland plains, dominated by *Themeda* (kangaroo grass) and many annual herbs and grasses. This vulnerable community has been

recorded on the *Brockman* land system on red calcareous clays at Hamersley Station (Van Vreeswyk *et al.*2004), more than 130 km west of the search area.

The DEC maintains a list of PEC's (DEC 2010). Category 1-3 PEC's are possible TEC's that do not meet survey criteria or that are not adequately defined. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as TECs. In addition, communities that have been proposed as TEC's by the Threatened Ecological Community Scientific Committee and that have not yet been classified as 'threatened' in Western Australia are listed as Priority 1 Ecological Communities as an interim measure. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5.

The Fortescue Marsh on Marillana and Roy Hill stations is a Priority 1 PEC (DEC 2010). The marsh is located to the north of the rail corridor survey area. No other listed PEC's occur in close proximity to the survey area.

There are three rare features in the Pil2 sub-region associated with the Fortescue River - the Millstream wetlands, the Millstream aquifer and the Fortescue Marshes. In addition, two refugia occur in the Pil2 sub-region, the Millstream wetlands and gorges of the Fortescue River in the Chichester ranges (Kendrick 2001). The northern end of the survey area occurs less than 10 km from the southern edge of the Fortescue Marsh and the FEPR southern rail corridor option crosses the Fortescue River.

Environmentally Sensitive Areas (ESAs) are declared under section 51A and 51B of the *Environmental Protection Act 1986*, and are thereby protected from native vegetation clearing exemptions that may otherwise apply. The Fortescue Marsh is a declared ESA and no other ESA's occur within close proximity to the survey area.

Plant taxon may be considered locally or regionally significant for numerous reasons (EPA 2004) including:

- a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
- relic status;
- being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range;
- the presence of restricted subspecies, varieties or naturally occurring hybrids;
- local endemism/a restricted distribution; and
- being poorly reserved.

Plant communities or assemblages may also be considered locally or regionally significant for similar reasons (EPA 2004) including:

- scarcity;
- unusual species;
- novel combinations of species;
- a role as a refuge;
- a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- being representative of the range of a unit (particularly, a good local and/or regional example of a unit in "prime" habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range; and
- a restricted distribution.

1.3.5 Weeds and Declared Plant Species

A combined 109 weed species are recorded on Florabase (2011) for the Gascoyne and Pilbara bioregions (**Appendix C**). Seven of the species recorded for the Pilbara bioregion are a Declared Plant for the Shire of East Pilbara under the *Agriculture and Related Resources Protection Act 1976* namely; *Calotropis procera*, *Opuntia stricta*, *Opuntia stricta* var. *stricta*, *Parkinsonia aculeata*, *Prosopis glandulosa* x *velutina*, *Prosopis pallida* and *Ziziphus mauritiana*. Five other species; *Argemone ochroleuca*, *Argemone ochroleuca* subsp. *ochroleuca*, *Datura leichhardtii*, *Emex australis* and *Heliotropium europaeum* are Declared Plants for other regions of Western Australia. None of the species recorded for the Gascoyne bioregion are a declared plant for the survey area.

2.0 METHODS

2.1 BACKGROUND RESEARCH

For the review of Previous Botanical Surveys for FEPR Northern Section Desktop Survey Mattiske (2007), Mattiske (2008), Van Vreeswyk *et al* (2004) and Biota (2004) reports were reviewed to identify the types of vegetation recorded on different landforms, to note any flora and vegetation of conservation significance including T and priority flora and suitable habitat for the species likely to occur within the survey area, to identify potential weed species, and to compile a list of plant species and vegetation types defined by earlier surveys. Mattiske (2007) and Biota (2004) conducted flora surveys in the Fortescue River valley 40 km North of the northern section of the rail corridor option. Mattiske (2008) conducted a flora survey of the Hopes Down 4 Mine and Village camp area situated approximately 50 km to the south-west of the northern rail corridor. Van Vreeswyk *et al* (2004) described vegetation in terms of general landform features, geology, geomorphology and vegetation in the Pilbara. In addition, a comprehensive list of species within the corridor was compiled from NatureMap (2011) utilising the 'line' search feature for a 10 km buffer.

For FEPR Southern Section Corridor Option (and Associated Borrow Pits Option 6) three further reports (Ecologia 2007, Ecologia 2009 and G&G Environmental 2011) documenting previous vegetation surveys at the FerrAus Pilbara Project (FPP) were also reviewed to supplement background information on the existing vegetation assemblages within the FPP.

Searches of the DEC's *Threatened (Declared Rare) Flora* database, the *Western Australian Herbarium Specimen* database and the *Declared Rare and Priority Flora List* were conducted in the area defined by a 10 km buffer around the line between the points 22° 30' 51" S, 119° 07' 23" E and 23° 37' 34" S, 120° 43' 22" E encompassing both the southern and northern corridor options.

The locations of T and priority flora obtained by the searches were overlayed over a map of the rail corridor to identify populations previously recorded within close proximity of the survey area.

The botanical surveys and lists of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) available from the Department of Environment and Conservation (DEC) website (www.dec.wa.gov.au) were reviewed to identify whether vegetation communities of conservation significance were previously recorded in the vicinity of the corridor options. The EPBC search tool was also used to determine national scale TEC listed under the EPBC Act.

SLIP Enabler (2011) was utilised to search for conservation estate areas (eg. national parks, regional parks) for the Pilbara bioregion in combination with maps from Van Vreeswyk *et al.* (2004) to identify whether any of the land systems present in the corridor were represented in a conservation estate and to locate potential Environmentally Sensitive Areas (ESAs).

Habitat for each T and priority flora that may potentially occur within the rail corridor option both recorded on FloraBase (2011) and within the reviewed reports was compared to vegetation/habitat defined for the corridor. The taxon was considered to potentially occur within the survey area if suitable habitat for the species was present.

The location of Threatened and priority flora from the search of the DEC databases was overlayed over the survey areas to locate previously recorded conservation significant flora.

The conservation status, brief description, habitat preference, flowering season and images (where available) of T and Priority Flora, either recorded at the FPP in previous surveys, or identified as potentially occurring within the FPP from database searches were compiled utilising FloraBase (2011). A hard copy of the information was printed as a 'field guide'.

A list of weed species recorded within the vicinity of the corridor was derived from NatureMap (2011) and from species recorded in the reviewed reports. Habitat for each of the species was compared to vegetation/habitat mapped within the corridor. The taxon was considered to potentially occur within the corridor if suitable habitat for the species was present.

2.2 VEGETATION SURVEYS

The same methods were applied to the Rail Borrow Pit Options Northern Section (Level 1 Survey) and FEPR Southern Section Corridor Option and Associated Borrow Pit Options (Level 2) with the

addition of a second season survey for the FEPR Southern Section Corridor Option and Associated Borrow Pits in autumn 2011.

2.2.1 Reconnaissance

A detailed survey that involved multiple site visits in differing seasons (including one in the main flowering season), replication of survey plots in vegetation types and greater coverage and displacement of plots over the target area was conducted. Field surveys were conducted by Dr Grace Wells and Dr Grant Wells from G&G Environmental (**Table 7**).

Table 7: Field survey schedule.

Survey Area	Dates
Rail Borrow Pit Options Northern Section	23rd – 27th November 2010
FEPR Southern Section Corridor Option and Associated Borrow Pits Option 6	9th -10th October 2010 18th – 22nd October 2010
FEPR Southern Section Corridor Option and Associated Borrow Pits Option 6	24th-31st March 2011

Quadrat-based sampling of vegetation was undertaken in areas selected in accordance with the methods applied previously to map flora and vegetation in the Pilbara bioregion (Biota 2004, Outback Ecology 2006, Ecologia 2007, 2009, G&G Environmental 2006, 2007a, b, 2008, 2009a, b). During the initial survey sites were chosen on the basis of topography, interpretation and ground truthing of Google Earth images, previously mapped vegetation types, and field observations of vegetation structure, floristics and condition. The sites chosen for the consecutive surveys were based on the vegetation mapping carried out following the first phase of the survey. In addition, surveys were conducted where changes in the vegetation were identified during the on ground survey.

Sampling of the vegetation was conducted in 50 m x 50 m quadrats that included cover values of all present species, description of topography, vegetation based on NVIS (2003) and condition scale of Keighery (1994) (**Table 8**). In accordance with EPA (2004), where possible, quadrat surveys were conducted in at least two different locations within each of the vegetation types.

Table 8: Data recorded in quadrat surveys.

Data	Details
Location	The coordinates of the quadrat were recorded in GDA 94 projection utilising a hand-held Garmin GPS.
Vegetation Description	A broad description utilising the structural formation and height classes based on NVIS (2003) (**Appendix D**). The vegetation was described to association level (**Appendix E**) with the dominant growth form, height and cover of species from the traditional three strata, upper, mid and ground, recorded. The vegetation was also compared to the descriptions of Ecologia 2007, 2009). When the dominant species in each stratum matched a description the vegetation code from the prior survey was recorded in the data set.
Landform	A brief description of landform, eg. creek, undulating plain, hill slope.
Soil Type	A broad description of surface soil type and rocks, eg. red sand with ironstone.
Disturbance History	A brief description of any observed disturbance including a visual estimate of time since last fire, weed invasions, soil disturbance and animal grazing.
Vegetation Condition	A condition rating for the vegetation was assigned utilising the condition scale of Keighery (1994).
Species List	The name of every species present in the quadrat. Where species were located that were unknown to the staff conducting the survey, a specimen was collected and pressed for later identification. All such specimens were later identified utilising Florabase (2011), and by comparison to specimens at the WA state reference herbarium. Plants were named according to the nomenclature of Florabase (2011), DEC (http://florabase.calm.wa.gov.au).
Foliage Cover	A visual estimate of the canopy cover of each species present was recorded as was the total vegetation cover, cover of shrubs and trees >2m tall, cover of shrubs <2m, total grass cover and total herb cover
Photograph	A digital colour photograph of the vegetation within each quadrat

Targeted searches for T and priority flora were conducted in and around quadrat survey locations and where landform and vegetation resembled the brief habitat description for the species in the compiled field guide.

2.2.2 Vegetation Type Definition, Mapping and Flora Assessment

Vegetation sub-formations were defined from clusters of quadrats on a dendrogram in the statistical ordination tests, UPGMA Cluster Analysis (PATN™) based on perennial species composition and cover values, the description, species composition, individual species cover values and photographs of each of the field sites.

The vegetation types defined in the current survey were compared with the data from surveys previously conducted at the FPP (Ecologia 2007, 2009 and G&G Environmental 2011). Where the dominant species (highest cover values for each of the canopy levels) of vegetation types defined for the current survey congruent with those of previous surveys, and numerous other species were also common to both, the vegetation was named in accordance with the earlier survey.

The defined vegetation sub-formations were mapped utilising Map Info Professional version 8.5 by plotting boundaries visible on aerial photos, contour lines and changes in the vegetation recorded on GPS during the survey.

The broad description of the vegetation sub-formations defined for the rail corridor were compared to the description of the major vegetation groups of NLWRA (2001), the mapped vegetation of Beard (1975) and regional site types recorded for the landsystems of the area of Van Vreeswyk *et al.* (2004) to provide an indication of the potential local and regional conservation significance of the vegetation in the survey areas. Where landform and the broad vegetation description were congruent and numerous of the species recorded were common a sub formation of the current survey was considered to resemble the broader site type of Van Vreeswyk *et al* (2004). The conservation status of the site type was then ascertained from Van Vreeswyk *et al* (2004) to provide an indication of whether the sub-formation defined for the current survey resembled a broadly distributed or restricted site type and whether the site type is represented in conservation reserves or unallocated crown land (UCL).

A species list for the current survey was compiled from the survey quadrat data and opportunistic collections while traversing the area (to target species that occur within the survey area but outside the quadrats surveyed).

The current conservation status of each of the species in the species list was determined from Florabase (2011). The mapped range of each species was consulted on NatureMap (2011) and Florabase (2011) to determine whether the survey areas represented a range extension for any of the recorded species.

2.2.3 Assessment of the Potential Conservation Significance of the Land Systems and Vegetation of the Survey areas

Utilising MapInfo software (version 8.5) the area of each of the land systems of Van Vreeswyk *et al* (2004) that occurred within the rail corridor was determined. This value was then used to ascertain what proportion of each of the land system occurred in the corridor. In a similar fashion, the proportion of each of the vegetation types defined for the rail corridor was also ascertained.

The occurrence of flora and vegetation of either listed conservation significance (EPBC or DEC databases) or potentially locally or regionally significant taxa or vegetation within the disturbance footprint was also examined.

2.3 LIMITATIONS OF THE SURVEY

EPA (2004) includes a list of potential limitations of terrestrial flora and vegetation surveys, each of which is addressed for the current survey (**Table 10**).

Table 10: Flora survey constraints and their relevance to the survey.

Aspect	Constraint	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material)	No	The land systems and vegetation of the survey area have been mapped by Van Vreeswyk *et al.*(2004) and three prior flora and vegetation surveys undertaken for the FerrAus Pilbara Project were available (Ecologia 2007, 2009 and G&G Environmental 2011).
The scope (i.e. what life forms, etc., were sampled)	No	The scope of the survey was prepared in accordance to EPA (2004) and to that of previous surveys conducted for public environmental reviews and environmental impact assessments in the Pilbara (Biota 2004, Outback Ecology 2006, Ecologia 2007, 2009, G&G Environmental 2006, 2007a, b, 2008, 2009a, b).
Proportion of flora collected and identified (based on sampling, timing and intensity)	No	The surveys identified a combined total of 350 taxa from 46 families and 150 genera from 134 quadrat surveys in an area of ~130 km^2. These figures compare favourably with other surveys conducted in the Pilbara bioregion. Of the taxa recorded 104 (29.7%) were annual species indicating surveys were conducted at appropriate times.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	No	Survey areas were carefully selected utilising existing vegetation maps and aerial photo's to ensure all apparent different vegetation types were sampled.
Mapping reliability	No	As with all surveys of this nature the map of vegetation was extrapolated utilising aerial photos and some inaccuracies in the depiction of the vegetation boundaries may be expected to occur. However, given the intensity of the ground survey, marking of vegetation boundaries by GPS and the effort expended outlining vegetation boundaries visible from aerial photo's it is considered that the vegetation maps have been prepared to a satisfactory level of accuracy.
Timing, weather, season, cycle	No	Rainfall prior to the surveys in October/November 2010 and March 2011 were well above average and over this period a high number of annual species (104) were recorded. In March 2011 quadrat surveys were conducted at the majority of sites surveyed in 2010 to record annual species and confirm the identity of perennial grasses which had abundant inflorescences.
Disturbances (fire, flood, accidental human intervention etc.)	No	The survey area occurs on an active pastoral lease and some areas have been impacted (e.g. access tracks, fence lines, wells). However, the majority of the survey area appeared in excellent to pristine condition. The majority of the survey area had not been burnt for an estimated 5-10 years. A few areas had been burnt more recently, estimated 1-2 years, and diversity in these areas due to a flush of ephemeral species was frequently higher than more mature stands of the same vegetation type. It is considered that disturbance in the survey area did not limit the survey; on the contrary, it assisted in identifying the plant diversity of the area.
Intensity (in retrospect, was the intensity adequate)	No	A total of 134 quadrats were surveyed for an area of ~130 Km^2, this sampling intensity is high in comparison to previous flora surveys in the Pilbara bioregion.
Resources	No	It is considered that the resources for the current survey were satisfactory given the quality and amount of background material available, intensive use of botanical databases and the period and intensity of the field survey by highly qualified and experienced personnel.
Access problems	No	The survey areas were large and, as such, the entirety of the areas was not traversed. While vehicle access to some sections was unavailable this was overcome by undertaking long treks by foot.
Experience levels (e.g. degree of expertise in plant identification to taxon)	No	All work, including background, reconnaissance, data analysis and report preparation has been conducted by Dr Grace Wells and Dr Grant Wells of G&G Environmental Pty Ltd. These personnel share in excess of 25 years experience undertaking botanical surveys and research of the Western Australia flora. Where plant

		taxa are unknown specimens are collected for identification utilising the combined resources of the Florabase and NatureMap databases, taxonomical texts and through comparison to specimens at the state herbarium. Any taxa not identified by this process are lodged with the herbarium Collections Manager to be identified by taxonomic specialists.

3.0 RESULTS

3.1 DESKTOP VEGETATION AND FLORA ASSESSMENT OF THE NORTHERN RAIL ALIGNMENT OPTION

3.1.1 Land Systems

Out of seven land systems of Van Vreeswyk *et al* (2004) present within the FEPR northern section rail corridor option (**Figure 4**), only two (Newman and Fortescue) occur in a conservation estate .The Newman, Fortescue, Divide and Urandy land systems have been recorded on UCL. Three land systems Adrian, Fan and Marillana) are not present in either conservation estate or UCL.

Less than 2% of the land systems are found in the northern rail corridor option with three of them occupying less that 1% (**Table 11**).

Table 11: Proportion of land systems in the FEPR northern section rail corridor and borrow pit options.

Land System	Total Area (km^2)	% Pilbara Survey Area	Area in Corridor Options (km^2)	% in Corridor Options
Adrian	235	0.1	3.03	1.29
Divide	5293	2.9	8.04	0.15
Fan	1482	0.8	26.69	1.80
Fortescue	504	0.3	2.15	0.43
Marillana	419	0.2	5.55	1.32
Newman	14580	8.0	0.73	0.005
Urandy	1311	0.7	7.87	0.60

3.1.2 Vegetation

Van Vreeswyk *et al* (2004) recorded 18 site types on seven land systems within the FEPR northern section comprising seven *Triodia* spp. hummock grasslands, eight *Acacia* woodlands or shrublands, one *Melaleuca* and *Eucalyptus* woodland associated with riparian zones, a single tussock *(Eragrostis xerophila*) grassland and one *Senna* and *Eremophila* shrubland **Table 12**. The *Triodia* hummock grasslands were recorded on hillslopes, hill crests, footslopes, plateaux, ridges, low rises, alluvial plains and drainage floors in sandy soils, stony, loamy, gravelly and gritty plains, and sandy plains and sand dunes. *Acacia* and *Eucalyptus* woodlands were recorded on alluvial plains, levees and on drainage foci such as claypans and swamps and along banks and channels of major creeks and rivers. The vegetation of hardpan plains comprised *Acacia* shrublands with tussock grasses, the tussock grassland and the sparse *Senna* and *Eremophila* shrublands.

Mattiske (2007) defined and mapped four vegetation units associated with the Newman land system comprising three units associated with creeks and drainage lines (1, 2 and 8) and one unit (17) on

ranges, hills and hillslopes: The vegetation of the creeks and drainage lines comprised *Acacia* and/or *Eucalyptus* woodlands and *Acacia* shrublands, a *Triodia* hummock grassland on the hills. The vegetation map of Mattiske (2007) also showed the *Adrian* land system, dominated by *Triodia* hummock grassland (17) present extensively on the *Newman* land system.

Mattiske (2008) defined and mapped four *Triodia* hummock grasslands on the hills and hill slopes of the Newman land system.

The *Triodia* hummock grassland on hills and hill slopes and *Acacia* and/or *Eucalyptus* woodlands along drainage lines of Mattiske (2007 and 2008) are consistent with the site types defined for similar landforms by Van Vreeswyk *et al* (2004). .

In summary, the vegetation of the FEPR northern section is likely to comprise the following:

- *Triodia* hummock grasslands on stony rises and rocky hills;
- *Triodia* hummock grasslands on sandy plains and sand dunes;
- *Acacia* and/or *Eucalyptus* woodlands along creek lines and drainage foci and on alluvial plains; and
- *Acacia* woodlands and shrublands, tussock grasslands and sparse shrublands on hardpan plains.

Table 12: Vegetation that may potentially occur in the FEPR northern section.

Source	Code	Site Type Description
Van Vreeswyk *et al* (2004)	ARPG	An *Eragrostis xerophila* tussock grassland usually with other minor grass species and occasionally with a poorly developed lower shrub stratum, larger shrubs and trees if present are typically isolated.
Van Vreeswyk *et al* (2004)	ASSG	A hummock grassland of *Triodia pungens* with mostly isolated to scattered shrubs and trees.
Van Vreeswyk *et al* (2004)	DEGW	An *Acacia* and/or eucalypt tall shrubland or woodland with a tussock grass layer. There is generally a mid and low shrub layer.
Van Vreeswyk *et al* (2004)	GMEW	A *Melaleuca argentea* or *Eucalyptus camaldulensis* woodland often with a tall shrub layer, infrequently mid or low shrub layers and a patchy layer of sedges or perennial grasses.
Van Vreeswyk *et al* (2004)	GMGW	A moderately close to closed *Acacia* woodland with a tussock grass ground layer.
Van Vreeswyk *et al* (2004)	GMUW	Moderately close to closed *Acacia* woodland or tall shrubland.
Van Vreeswyk *et al* (2004)	HESG	A hummock grassland of *Triodia* species with an overstorey of isolated to scattered eucalypts and isolated to scattered shrubs.
Van Vreeswyk *et al* (2004)	HPMS	A very scattered to scattered tall shrubland of mulga with well developed mid and low shrub layers, occasionally only a low shrub layer.
Van Vreeswyk *et al* (2004)	HSPG	A hummock grassland of *Triodia* species with isolated to scattered trees and shrubs.
Van Vreeswyk *et al* (2004)	PHSG	A hummock grassland of *Triodia* spp. with isolated to scattered to trees and shrubs.
Van Vreeswyk *et al* (2004)	PMGS	A variably dense low shrubland of *Senna* and *Eremophila* species with a prominent but patchy ground layer of perennial grasses.
Van Vreeswyk *et al* (2004)	PMSS	A moderately closed *Acacia aneura* shrubland with a prominent to patchy ground layer of spinifex, or hummock grassland with a scattered overstorey of mulga and other shrubs.
Van Vreeswyk *et al* (2004)	PSCS	A mid or tall very scattered to scattered of *Acacia xiphophylla* with a patchy understorey of chenopod low shrubs, other low shrubs and a few perennial grasses.
Van Vreeswyk *et al* (2004)	PSMS	A very scattered tall mulga shrubland with very sparse mid or low shrubs of which rarely form defined strata. Occasionally the low shrubs are dominant as a very scattered to scattered low shrubland.
Van Vreeswyk *et al* (2004)	PSSG	A hummock grassland of resinous *Triodia* grasses with isolated to moderately close trees and shrubs which may forma strata and are often *Acacia*.
Van Vreeswyk *et al* (2004)	SBAS	A scattered to moderately closed *Acacia* shrubland with a hummock grass layer.
Van Vreeswyk *et al* (2004)	SHSG	Triodia hummock grassland with variable shrub layers.

Van Vreeswyk *et al* (2004)	SSSG	Hummock grassland of *Triodia pungens*, *T. epactia* or *T. schinzii* with variable shrubs and occasional trees.
Mattiske (2007)	1	Open Woodland *of Eucalyptus victrix, Eucalyptus camaldulensis* var. *obtusa* with pockets of *Acacia coriacea* subsp. *pendens* over *Grevillea wickhamii* subsp. *aprica, Petalostylis labicheoides, Acacia tumida* over *Triodia longiceps, Chrysopogon fallax, Themeda triandra* and *Aristida* species.
Mattiske (2007)	2	Low Woodland to Low Open Forest of *Acacia aneura* var. *aneura, Acacia citrinoviridis, Acacia pruinocarpa* over *Acacia tetragonophylla* and *Psydrax latifolia* over *Chrysopogon fallax, Stemodia viscosa, Blumea tenella, Themeda triandra* and species of *Triodia* and *Aristida.*
Mattiske (2007)	8	Closed Scrub to Tall Shrubland of *Acacia pruinocarpa*, *Acacia tumida, Acacia ancistrocarpa, Acacia maitlandii, Acacia kempeana, Acacia tetragonophylla* with occasional *Eucalyptus gamophylla* and *Corymbia deserticola* over *Triodia epactia, Themeda triandra* and *Aristida* species.
Mattiske (2007)	17	Hummock Grassland of *Triodia basedowii* with pockets of *Triodia epactia* and *Triodia lanigera* with emergent patches of *Eucalyptus leucophloia, Corymbia deserticola* over *Acacia ancistrocarpa, Acacia pyrifolia, Hakea lorea* subsp. *lorea* over *Goodenia stobbsiana* and mixed *Senna* and *Ptilotus* species.
Mattiske (2008)	S1	Hummock Grassland of *Triodia epactia* with pockets of *Triodia basedowii* and *Triodia pungens* with emergent *Corymbia hamersleyana*, *Eucalyptus gamophylla*, *Eucalyptus leucophloia* over *Acacia aneura* var. *aneura, Acacia pruinocarpa, Acacia rhodophloia, Codonocarpus cotinifolius, Psydrax latifolia* and *Grevillea berryana* over *Acacia adoxa* var. *adoxa, Acacia arida, Acacia tenuissima, Acacia tetragonophylla, Acacia bivenosa, Acacia distans, Acacia hilliana, Eremophila latrobei* and *Eremophila forrestii* subsp. *forrestii* over range of annual species on gravely soils on lower slopes.
Mattiske (2008)	S2	Hummock Grassland of *Triodia basedowii, Triodia* aff. *wiseana and Triodia epactia* with emergent *Acacia pruinocarpa, Acacia inaequilatera, Corymbia deserticola* subsp. *deserticola, Corymbia hamersleyana, Eucalyptus leucophloia* and *Eucalyptus gamophylla* over *Eremophila latrobei, Acacia adoxa* var. *adoxa, Acacia arida, Acacia bivenosa, Eremophila exilifolia, Acacia spondylophylla, Acacia ancistrocarpa, Acacia bivenosa, Acacia inaequilatera, Acacia hilliana, Indigofera monophylla* and a range of annual species on gravelly soils on mid and upper slopes of small ranges.
Mattiske (2008)	S3	Hummock Grassland of *Triodia wiseana* with emergent *Eucalyptus leucophloia, Corymbia hamersleyana* over *Acacia adoxa* var. *adoxa, Acacia hilliana, Acacia marramamba, Codonocarpus cotinifolius*, *Indigofera monophylla*, *Hakea lorea* subsp. *lorea* over *Goodenia*

		stobbsiana and mixed *Senna* and *Ptilotus* species on gravelly soils on mid and upper slopes of ranges.
Mattiske (2008)	S4	Hummock Grassland of *Triodia basedowii* and *Triodia pungens* with emergent *Eucalyptus leucophloia, Hakea lorea* subsp. *lorea, Grevillea wickhamii, Acacia ancistrocarpa, Acacia bivenosa, Acacia inaequilatera* over a range of annual species on low hills and ranges

3.1.3 Potentially Locally Significant Communities

The PSSG site type of Van Vreeswyk *et al* (2004) identified as potentially existing in the FEPR northern section was exclusive habitat for the priority 1 species, *Eremophila pilosa* and may therefore be considered potentially locally significant. PSSG comprises a *Triodia* hummock grassland and occurs extensively on gritty plains.

Mattiske (2008) identified seven vegetation types that may potentially be locally significant as they represent habitat for a number of priority flora. These vegetation types included two of the spinifex grasslands associated with the Newman land system (found in the FEPR northern section) and five vegetation units comprised of two *Acacia aneura* woodlands found on flat plains, two Eucalypt woodlands that form the riparian vegetation of creeks and a *Triodia* hummock grassland recorded on calcareous flat plains.

Mattiske (2007) also considered five vegetation communities to be locally significant as they were habitat for priority flora: Each of the communities was an *Acacia* woodland or shrubland and included vegetation type 2 recorded on the Newman land system.

The DEC Clearing Permit Decision Report provides the following statements regarding clearing of vegetation:

a. Native vegetation should not be cleared if it comprises a high level of biological diversity;

b. Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;

c. Native vegetation should not be cleared if it includes , or is necessary for the continued existence of rare flora;

d. Native vegetation should not be cleared if it comprises the whole part or a part of, or is necessary for the maintenance of a threatened ecological community;

e. Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared;

f. Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland;

g. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation;

h. Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation areas;

i. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; and

j. Native vegetation should not be cleared if clearing the vegetations likely to cause, or exacerbate, the incidence or intensity of flooding.

Clearing of vegetation at the FEPR northern section may only be at variance with statement f of the DEC Clearing Permit Decision Report. The corridor option crosses a number of creek systems and therefore may impact upon vegetation associated with a watercourse. 3.1.2 Flora

A list of 313 species derived for the FEPR northern rail option from the NatureMap (2011) line search, dominant species from the site types of the land systems from Van Vreeswyk *et al* (2004) and report reviews (**Appendix F**) represent 44 families and 125 genera. The most prominent families were Fabaceae, Poaceae, Malvaceae, Amaranthaceae, Chenopodiaceae, Myrtaceae, Asteraceae, Scrophulariaceae, Goodeniaceae, Convolvulaceae and Boraginaceae. These families also represented a high proportion of taxa recorded in flora surveys conducted in the Pilbara and Gascoyne bioregions (**Table 13).**

None of the records of the priority flora occur within the FEPR northern section (**Figure 6**). However, the DEC databases search, flora survey reviews and NatureMap (2011) identified 33 flora of conservation significance recorded within 100 km of the rail corridor option (**Table 14**). Of these, 16 taxa were considered unlikely to occur within the FEPR northern section corridor option as there is little suitable habitat. The probability of two species occurring in the survey area could not be determined as there was no description of habitat for the species provided on Florabase (2011). A suitable habitat exists within the survey area for 15 species comprising five P1, two P2, seven P3 and one P4.

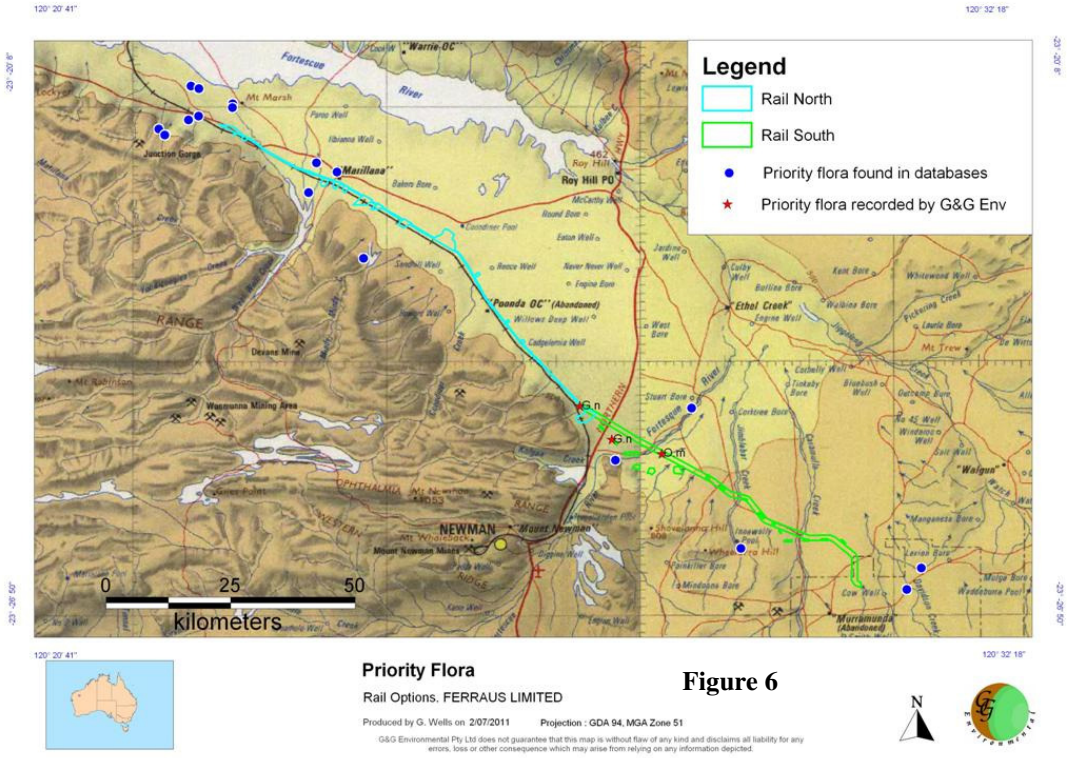


Figure 6

The desktop review identified 21 introduced flora that may potentially occur within the FEPR northern section rail corridor option (**Table 15**). None of the species are a declared plant under the *Agriculture and Related Resources Protection Act 1976* for the survey area.

Table 13: Dominant families and the proportion of the total number of species recorded for flora surveys in Western Australia.

	Biota 2004	Mattiske 2005/Biota 2005	G&G Environmental 2011	Desktop Survey
AMARANTHACEAE	39	36	18	24
ASTERACEAE	36	39	33	17
BORAGINACEAE	20	9	13	5
CONVOLVULACEAE	26	13	14	6
CHENOPODIACEAE	43	21	23	21
FABACEAE	165	143	95	60
GOODENIACEAE	26	20	22	14
MALVACEAE	31	77	49	22
MYRTACEAE	17	18	13	14
POACEAE	121	34	70	57
SCROPHULARIACEAE	11	16	18	14
% Species Recorded	70.2	68.8	76.3	81.2

Table 14: Priority species recorded in the vicinity of the rail corridor option and the probability that they may be present within the survey area based on habitat preference.

Species	Code	Source	Habitat	Probability
Lepidium catapycnon	**T**	DEC Database Search	Skeletal soils. Hillsides.	Unlikely
Acacia aphanoclada	**P1**	Van Vreeswyk *et al* 2004	Skeletal stony soils. Rocky hills, ridges and rises	Unlikely
Aristida jerichoensis var. *subspinulifera*	**P1**	DEC Database Search	Hardpan plains.	Possible
Brunonia sp. Long hairs	**P1**	DEC Database Search	Along creeklines	Possible
Eremophila pilosa	**P1**	Van Vreeswyk *et al* 2004, DEC Database search, Biota 2004	Red sand plain	Possible
Eremophila spongiocarpa	**P1**	DEC Database Search, Mattiske 2005	Weakly saline alluvial plain on margins of marsh.	Unlikely
Helichrysum oligochaetum	**P1**	Mattiske 2007	Red clay. Alluvial plains.	Possible
Myriocephalus scalpellus	**P1**	Mattiske 2005	Clay. Depression on flood plain.	Possible
Nicotiana heterantha	**P1**	Mattiske 2005, Mattiske 2007	Black clay. Seasonally wet flats.	Unlikely
Triodia triticoides	**P1**	DEC Database Search	Rocky sandstone & limestone hillslopes.	Unlikely
Brachyscome sp. Wanna Munna Flats	**P2**	DEC Database Search	Red soils. Creeks and Groves.	Possible
Stylidium weeliwolli	**P2**	DEC Database Search	Gritty sand soil, sandy clay. Edge of watercourses.	Possible
Acacia subtiliformis	**P3**	DEC Database Search	On rocky calcrete plateau.	Unlikely
Amaranthus centralis	**P3**	DEC Database Search	NA	
Atriplex flabelliformis	**P3**	DEC Database Search	Clay loam, loam. Saline flats or marshes.	Unlikely
Crotalaria smithiana	**P3**	DEC Database Search	Regeneration site on floodplain.	Possible
Eremophila magnifica subsp. *velutina*	**P3**	DEC Database Search	Skeletal soils over ironstone. Summits.	Unlikely
Eucalyptus histophylla	**P3**	DEC Database Search	Sandy loam on granite or laterite. Granite outcrops.	Unlikely
Goodenia lyrata	**P3**	DEC Database Search	Red sandy loam. Near claypan.	Possible
Goodenia nuda	**P3**	DEC Database Search, Biota 2004	Red Clay Loam. Flat plains, crab hole and Groves.	Possible
Goodenia purpurascens	**P3**	Mattiske 2008	Clay, mud. Swamps & seasonally wet depressions.	Unlikely
Goodenia sp. East Pilbara	**P3**	DEC Database Search, Mattiske 2008	Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.	Possible
Gymnanthera cunninghamii	**P3**	Mattiske 2008	Sandy soils.	Possible
Nicotiana umbratica	**P3**	DEC Database Search	Shallow soils. Rocky outcrops.	Unlikely

Rhagodia sp. Hamersley	**P3**	Mattiske 2008	NA	
Rostellularia adscendens var. *latifolia*	**P3**	Mattiske 2005	Ironstone soils. Near creeks, rocky hills.	Possible
Sida sp. Barlee Range	**P3**	Van Vreeswyk *et al* 2004	Skeletal red soils pockets. Steep slopes.	Unlikely
Themeda sp. Hamersley Station	**P3**	DEC Database Search, Mattiske 2005, 2007, 2008, Biota 2004	Red clay. Clay pan, grass plain.	Possible
Acacia bromilowiana	**P4**	DEC Database Search	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.	Unlikely
Bulbostylis burbidgeae	**P4**	Van Vreeswyk *et al* 2004	Granitic soils. Granite outcrops, cliff bases.	Unlikely
Eremophila youngii subsp. *lepidota*	**P4**	Mattiske 2005, 2008	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.	Possible
Myriophyllum balladoniense	**P4**	DEC Database Search	Semi-permanent rock pools on granite outcrops.	Unlikely
Rhynchosia bungarensis	**P4**	DEC Database Search	Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.	Unlikely

Table 15: Weed species that may occur in the FEPR northern section rail corridor option. NA – no habitat description provided on Florabase (2011).

FAMILY	SPECIES	HABITAT
AMARANTHACEAE	*Aerva javanica*	Often on sandy soils. Along drainage lines.
AMARANTHACEAE	*Alternanthera pungens*	Amongst tall trees, grassland; in sand, loam, clay; occupying edges of creeklines, road verges, farmlands; growing in cropland, in lawns, in disturbed natural vegetation.
ASTERACEAE	*Bidens bipinnata*	Alluvium, clay, loam over sandstone, limestone. Along rivers & creeks, coastal areas, rocky hillsides.
ASTERACEAE	*Bidens pilosa*	Peaty clay, sandy loam, alluvium. Along drainage lines, lateritic screes.
ASTERACEAE	*Flaveria trinervia*	NA
ASTERACEAE	*Sigesbeckia orientalis*	Loamy soils over limestone or granite. Rocky gullies, limestone ranges, creek beds.
ASTERACEAE	*Sonchus oleraceus*	Variety of soils. Weed of waste places & disturbed ground.
CUCURBITACEAE	*Citrullus colocynthis*	Sandy, rocky, stony loam, clay soils, wet soils. In disturbed areas, floodplains
CUCURBITACEAE	*Cucumis melo* subsp. *agrestis*	NA
FABACEAE	*Vachellia farnesiana*	Stony sandy, clay or loam soils, gravel. Low-lying areas, river and creek banks, disturbed sites.
MALVACEAE	*Malvastrum americanum*	Orange/red/yellow sands, gritty alluvial sand, black/brown clay, alluvial cracking clays, limestone, calcrete. Stony ridges and hillsides, floodplains, along drainage lines.
PAPAVERACEAE	*Argemone ochroleuca* subsp. *ochroleuca*	Red/white/grey sand, red-brown clay loam. Creek edges, riverbanks, roadsides.
POACEAE	*Cenchrus ciliaris*	White, red or brown sand, stony red loam, black cracking clay.
POACEAE	*Cenchrus setiger*	Brown sands, red loam, pindan soils. Sand dunes, plains, rangelands, stony hillsides, floodplains.
POACEAE	*Chloris barbata*	White or red sand, loam, black clay. Sand dunes, river levees.
POACEAE	*Chloris virgata*	Clay, sand. Sand dunes.
POACEAE	*Echinochloa colona*	Black sand, black clay. Near watercourses and swamps.
POACEAE	*Setaria verticillata*	Sand, clay, loam
POLYGONACEAE	*Acetosa vesicaria*	Sandy alluvial soils, gravelly ironstone soils. Along roadsides, in disturbed areas.
PORTULACACEAE	*Portulaca oleracea*	Clay loam, sand. Often disturbed sites.
ZYGOPHYLLACEAE	*Tribulus terrestris*	Often on sandy soils. Waste places.

3.2 RAIL BORROW PIT OPTIONS NORTHERN SECTION (LEVEL 1 SURVEY)

3.2.1 Vegetation

A total of 38 sites were surveyed in the 30 borrow pits of the FEPR northern section rail corridor option in November 2010. 17 vegetation sub-formations (**Figure 7 and Table 16**) were defined from the dendogram generated by PATN analysis (**Figure 8**), site descriptions and site photographs. Three of the sub-formations,1c, 1e and 2a closely resemble those recorded in previous surveys (Ecologia 2007, 2009 and G&G Environmental 2011) and were named accordingly. The remaining sub-formations do not fit previous descriptions and were regarded as previously undescribed vegetation types.

The number of sub-formations recorded for the borrow pit options is comparatively high in respect to some of the previous surveys in the Pilbara and Gascoyne bioregions, (**Table 17**). The survey of the borrow pit options represents 'spot' surveys along a long distance corridor that encompasses numerous habitats and land systems located between two significant hill ranges (Chichester and Hamersley) with numerous drainage channels. A similar number of vegetation units were previously recorded in long distance linear corridors in the Pilbara bioregion by Biota (2004) and G&G Environmental (2008).

The majority of the vegetation sub-formations defined for the rail corridor fit broad descriptions of the nationally recognised major vegetation groups. Five may be broadly classed as *Triodia* hummock grasslands (1c, 1g, 9g, 2a and 10a), ten as *Acacia* woodlands or shrublands (1e, 9a, 9b, 9c, 9d, 9e, 9f, 9h, 9k and 4d) and one (3c) as a Eucalypt woodland (although *Corymbia* woodland in the current survey).

Hummock grasslands were recorded on flat sand plains, flat clay/loam plains, rocky hills and sand dunes. The *Acacia* woodlands occurred on flat sand plains, flat clay/loam plains and in groves. The *Corymbia* woodland was present as riparian vegetation along a minor creek system. Sub-formation (5b) occurred in a low depression in a flat clay/loam plain that is likely seasonally inundated and was virtually devoid of vegetation.

Regionally, the majority of the vegetation sub-formations resemble three of the vegetation communities mapped by Beard (1975), namely, a_1Lp - mulga trees in groves or patches; a_nSr.tHi - scattered shrubs over spinifex; and $e_{25}Srt_2$Hi - *Eucalyptus gamophylla* over spinifex. Large areas of the mulga community occur throughout the Gascoyne bioregion and extend up through the Fortescue valley in the Pilbara bioregion. Similarly, large areas of the *Eucalyptus gamophylla* community extend through the Fortescue valley and the eastern Gascoyne. The scattered shrubs over spinifex are restricted to the north-east of the Gascoyne bioregion but cover an extensive area of the Little Sandy Desert. Each of the vegetation sub-formations defined for the borrow pit options (**Table 16**) also resemble the regional site types defined by Van Vreeswyk *et al.* (2004).

The sub-formation 1c recorded on red sand plains, 10a recorded on red sand dunes and 9g recorded on a flat clay/loam plains are synonymous with the $e_{25}Srt_2$Hi - *Eucalyptus gamophylla* over spinifex community mapped by Beard (1975) and resemble the SHSG site type of Van Vreeswyk *et al.* (2004)

common on sandplain, gravelly sandplain and dunes. The SHSG site type occurs at Rudall River National Park and extensively on UCL.

Vegetation sub-formation 1e was recorded in groves on flat red sand plains and resembles the widespread GMGW site type of Van Vreeswyk *et al.* (2004) found on wash plains and drainage tracts. GMGW is favoured by domestic stock and is important habitat for native fauna. It has been recorded at Karijini National Park and occurs on UCL.

The vegetation sub-formation 2a recorded in the current survey on a low rocky hill resembles the HSPG site type of Van Vreeswyk *et al.* (2004). HSPG was recorded on hills, ridges and footslopes, is represented in conservation reserves including Karijin National Park and Meentheena pastoral lease, and occurs extensively on UCL.

Vegetation subformation 1g was recorded on red sand plains and resembles the ASSG site type found widely on alluvial plains and drainage floors in sandy soils and has been recorded at the Cane River Nature Reserve, the Meentheena pastoral lease and on UCL.

The vegetation sub-formation 3c recorded on the banks of a minor creek, resembles the DAHW site type found on narrow drainage floors and occasionally as groves on washplains. The DAHW is well represented in conservation reserves including Karijini National Park and Meentheena pastoral lease and is common on UCL.

Vegetation sub-formation 4d recorded on a flat plain resembles the PMCS site type. PMCS occurs on plains and drainage tracts. It is a minor site type in the Pilbara survey area but has been previously described in the Murchison, Sandstone- Yalgoo-Paynes Find and north-eastern Goldfields and is represented in Karijini National Park.

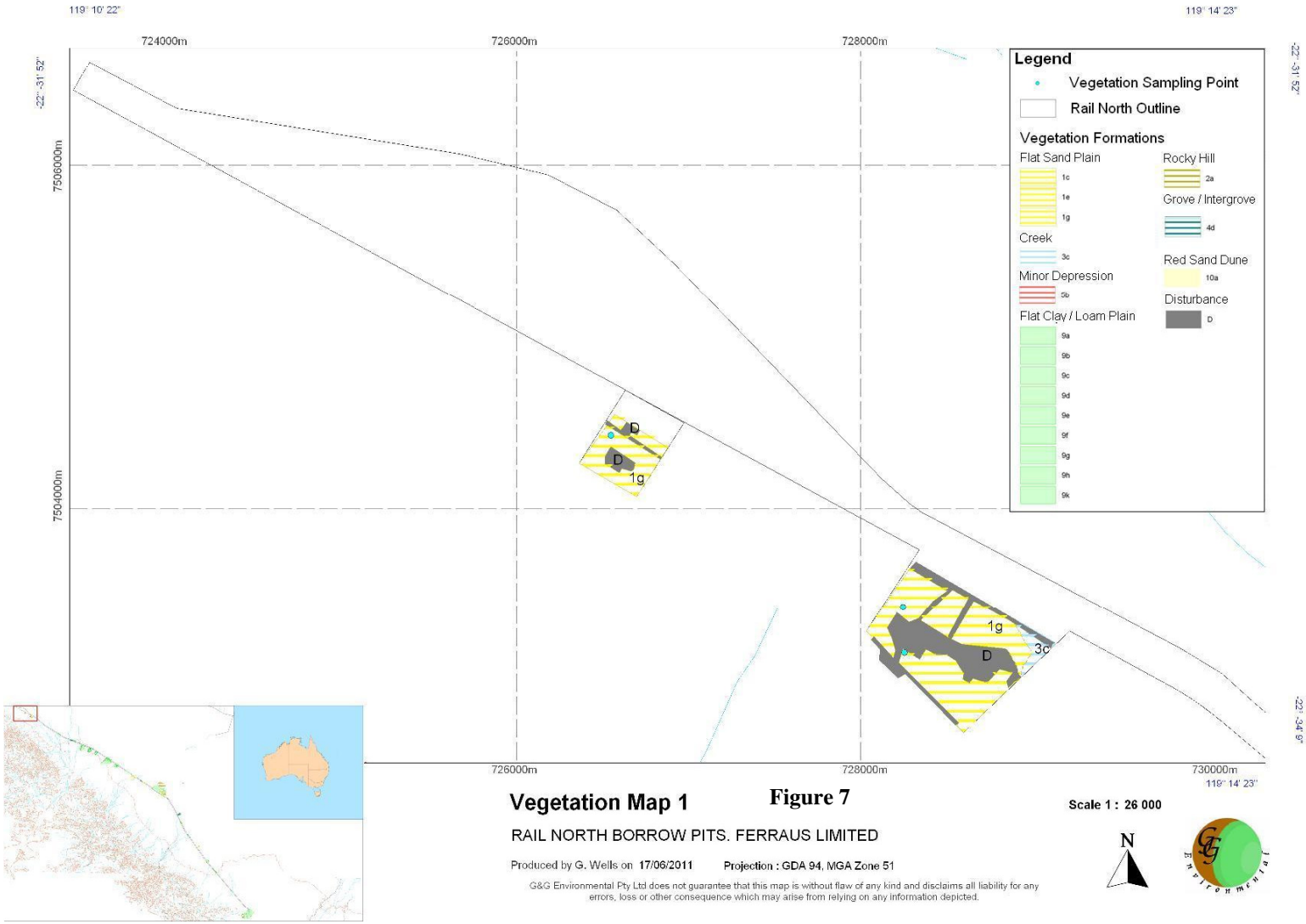
Vegetation sub-formations 9a, 9b and 9f are similar differing slightly in the composition of the mid-shrub layer and were recorded on flat clay/loam plains. Each of the sub-formations resemble the PMSS site type recorded on stony, loamy, gravelly and hardpan plains and is well represented in conservation reserves including Karijini National Park and also occurs on UCL.

Vegetation sub-formations 9c and 9d are similar with the 9c sub-formation having a greater diversity of *Acacia* tree species. Both sub-formations resemble the SAES site type common on stony plains, low rises, hardpan plains, gravelly plains and occasionally hillslopes. SAES is poorly represented in nature reserves of the Pilbara but is widespread in the Eremaea zone and is represented in the Wanjarri Nature Reserve.

Vegetation sub-formation 9e resembles the PSCS site type that occurs on stony, gravelly and alluvial plains. PSCS is represented in Karijini National Park and Cane River Nature Reserve.

Vegetation sub-formation 9k resembles the PXHS site type that occurs on level plains and in drainage floors. PXHS is found in patches in the south-eastern Pilbara but rarely more than a few kilometres in extent. It is considerably more wide spread in southern Rangelands and has been previously recorded in the Murchison River catchment and north-eastern Goldfields.

The 9h sub-formation resembles the LHAS site type found on hardpan plains with ironstone gravel or pebbles. LHAS has been recorded in four land systems in the Pilbara but is not represented in the conservation estate or on UCL.



Vegetation Map 1

Figure 7

RAIL NORTH BORROW PITS. FERRAUS LIMITED

Produced by G. Wells on **17/06/2011** **Projection : GDA 94, MGA Zone 51**

Scale 1 : 26 000

N

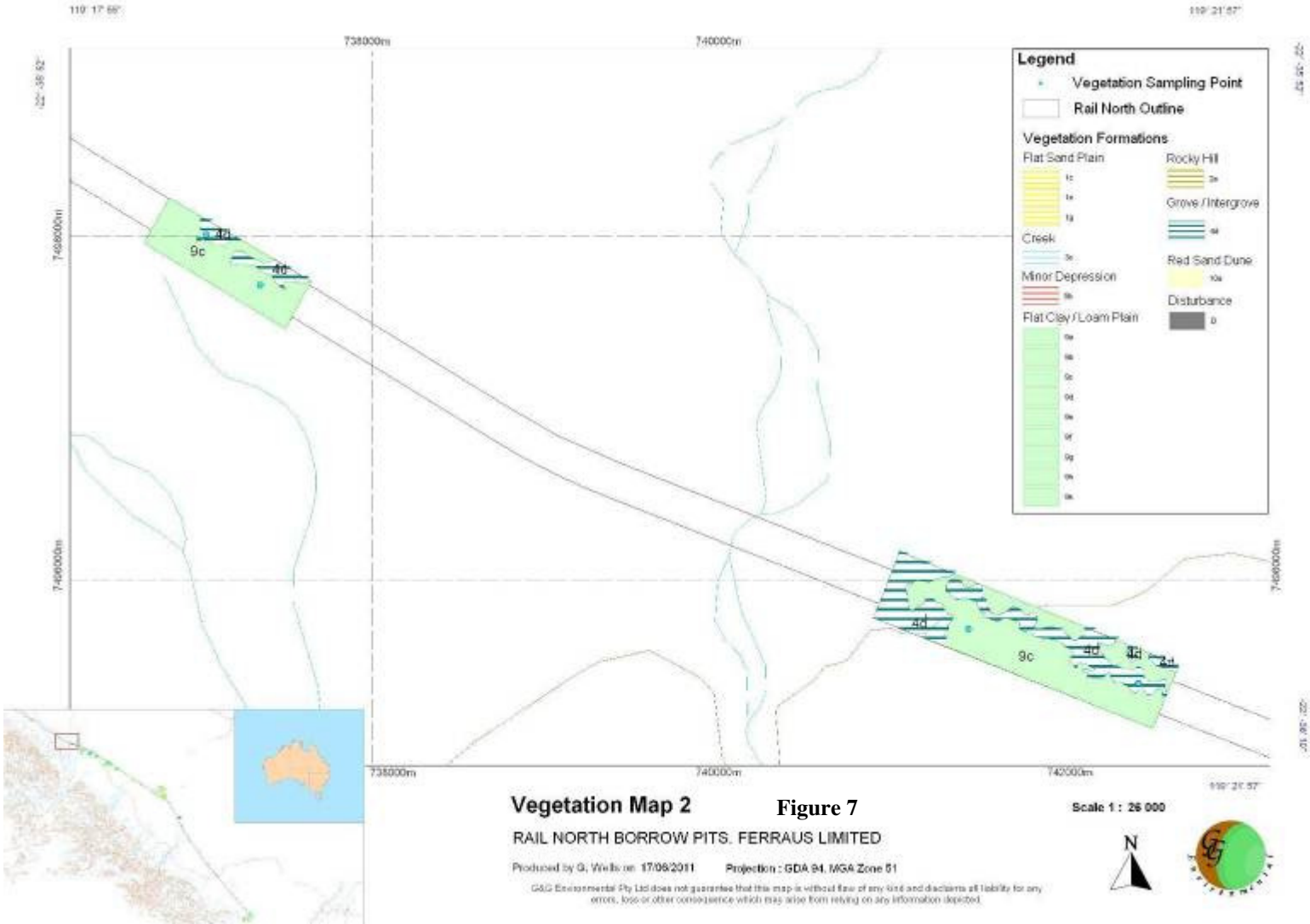
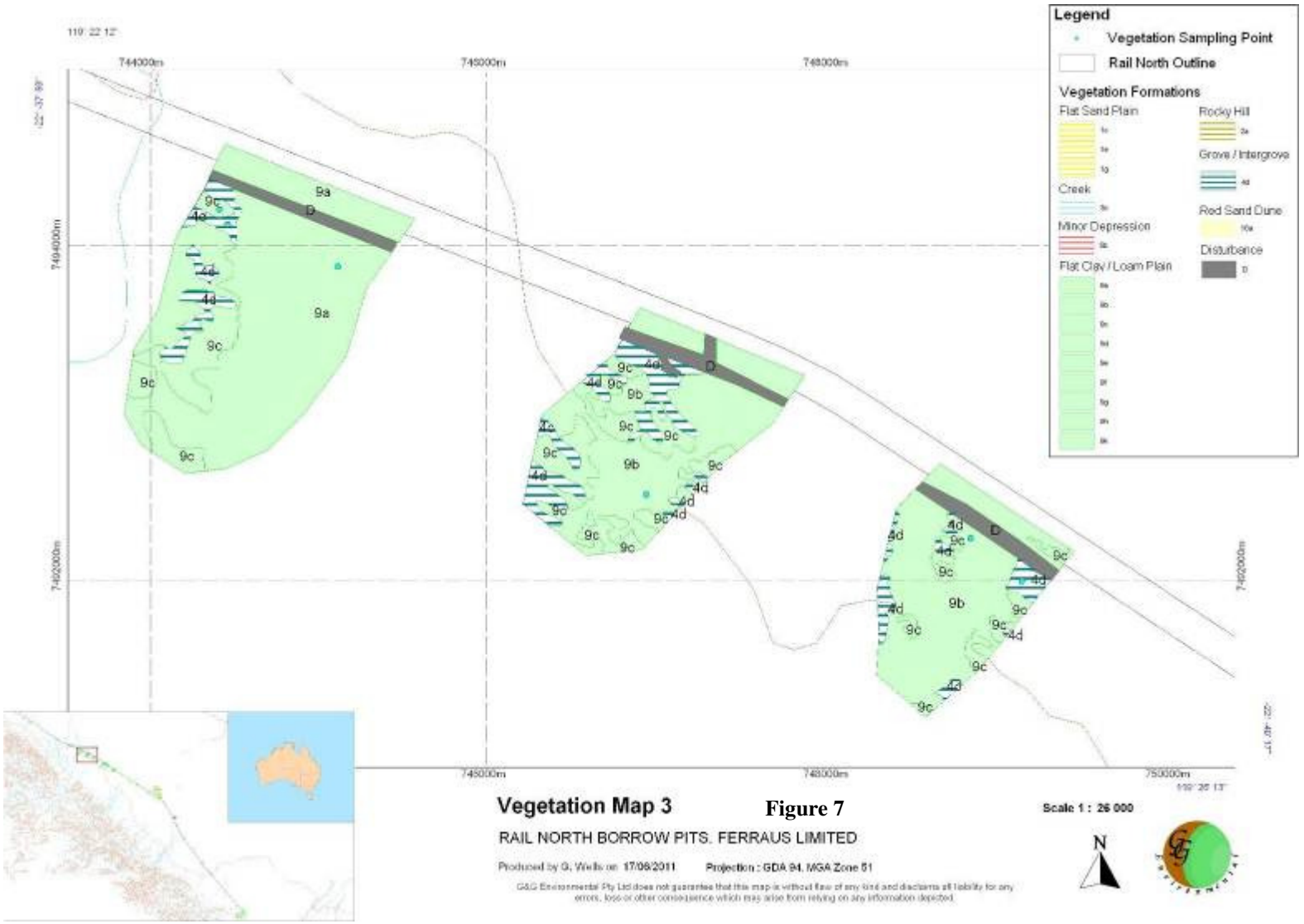

Legend
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
738000m
740000m
742000m
9c
4d
Vegetation Map 2
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
N

Figure 7



Vegetation Map 3 **Figure 7**

RAIL NORTH BORROW PITS. FERRAUS LIMITED

Produced by G. Wells on 17/08/2011 Projection : GDA 94, MGA Zone 51

Scale 1 : 25 000

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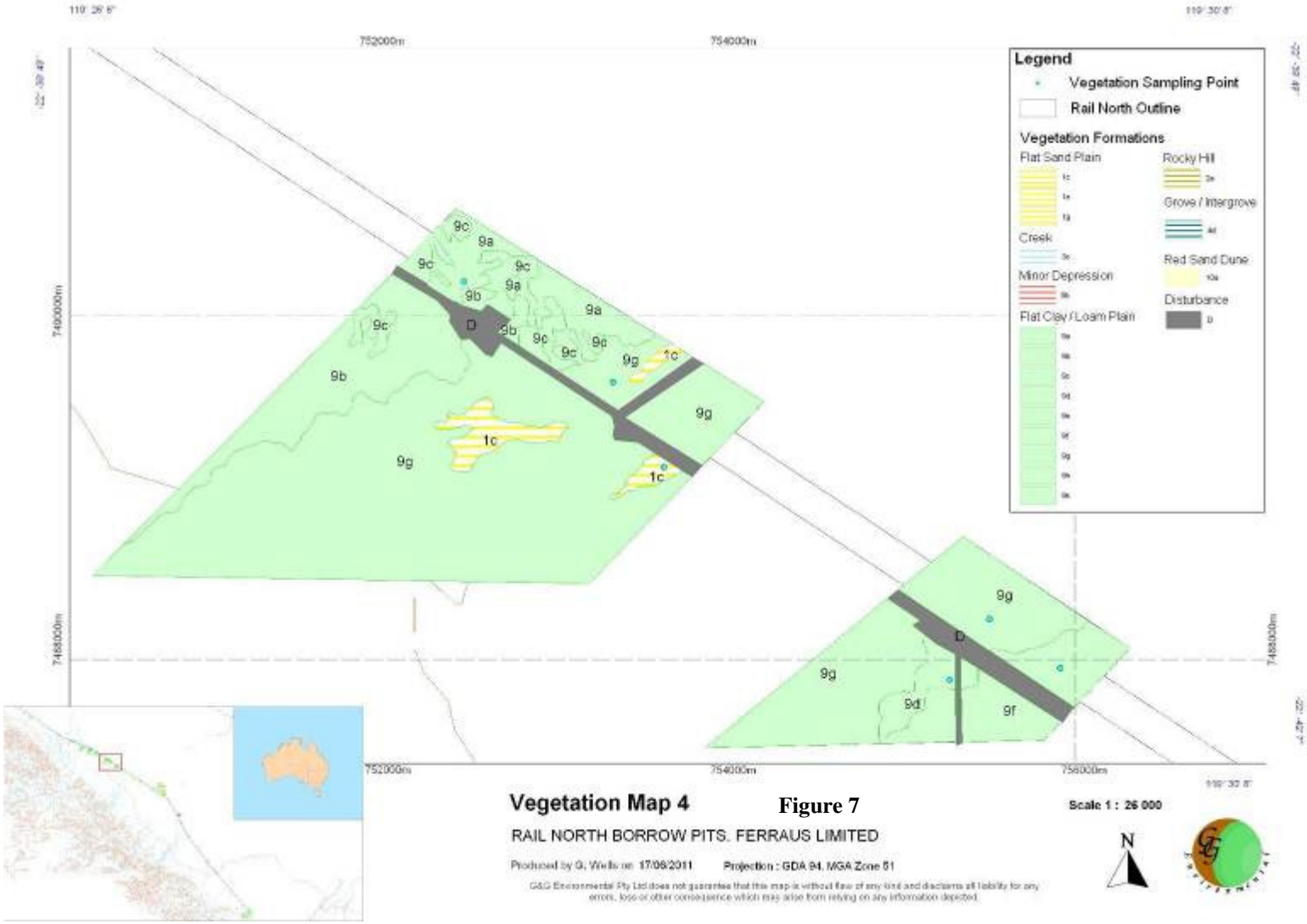
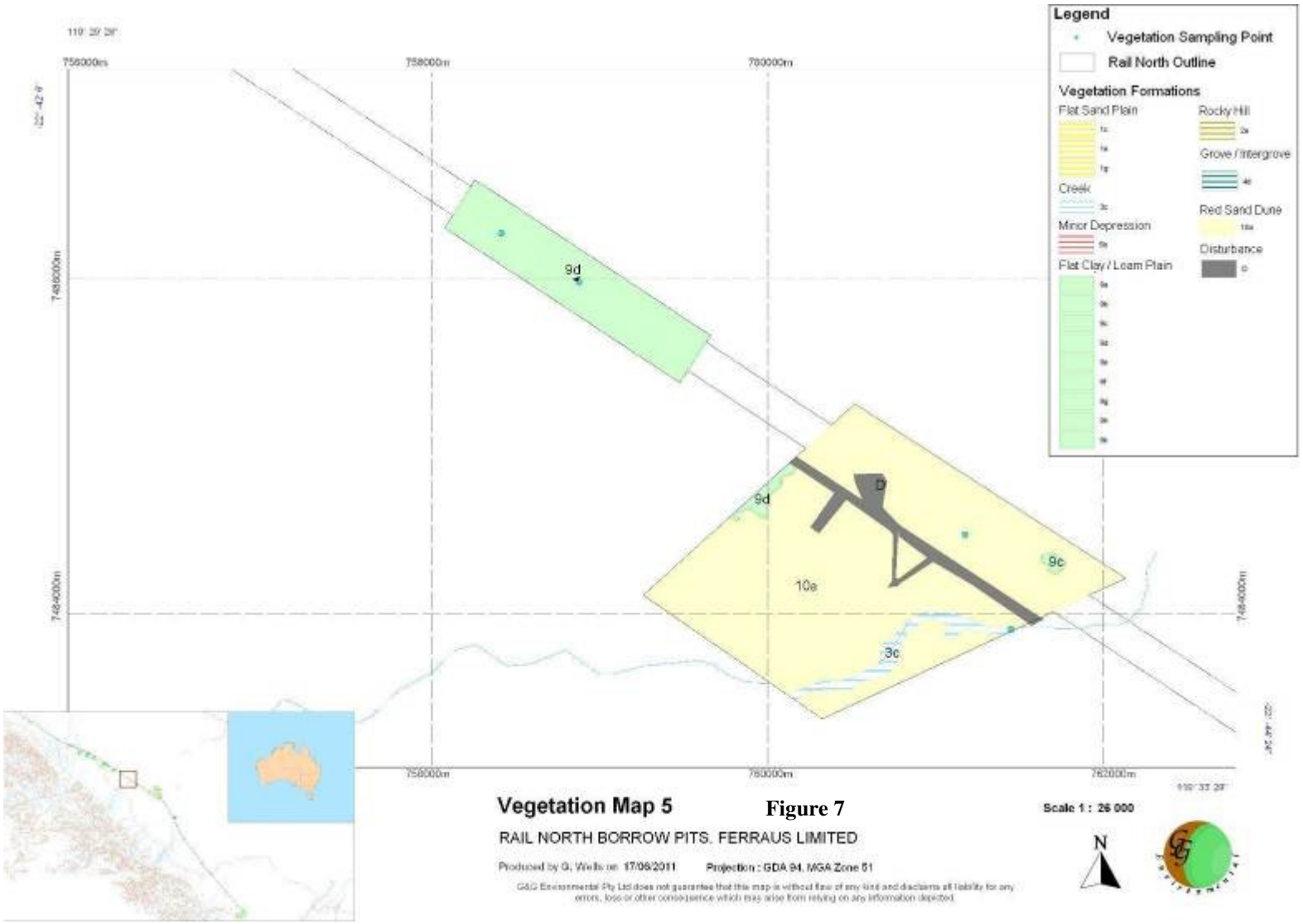

752000m
754000m
756000m
7490000m
7488000m
Legend
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
9c
9a
9b
9g
1c
9d
9f
D
Vegetation Map 4
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
N

Figure 7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Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
9d
9d
9c
10a
3c
758000m
760000m
762000m
748000m
748400m
Vegetation Map 5
Figure 7
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
N

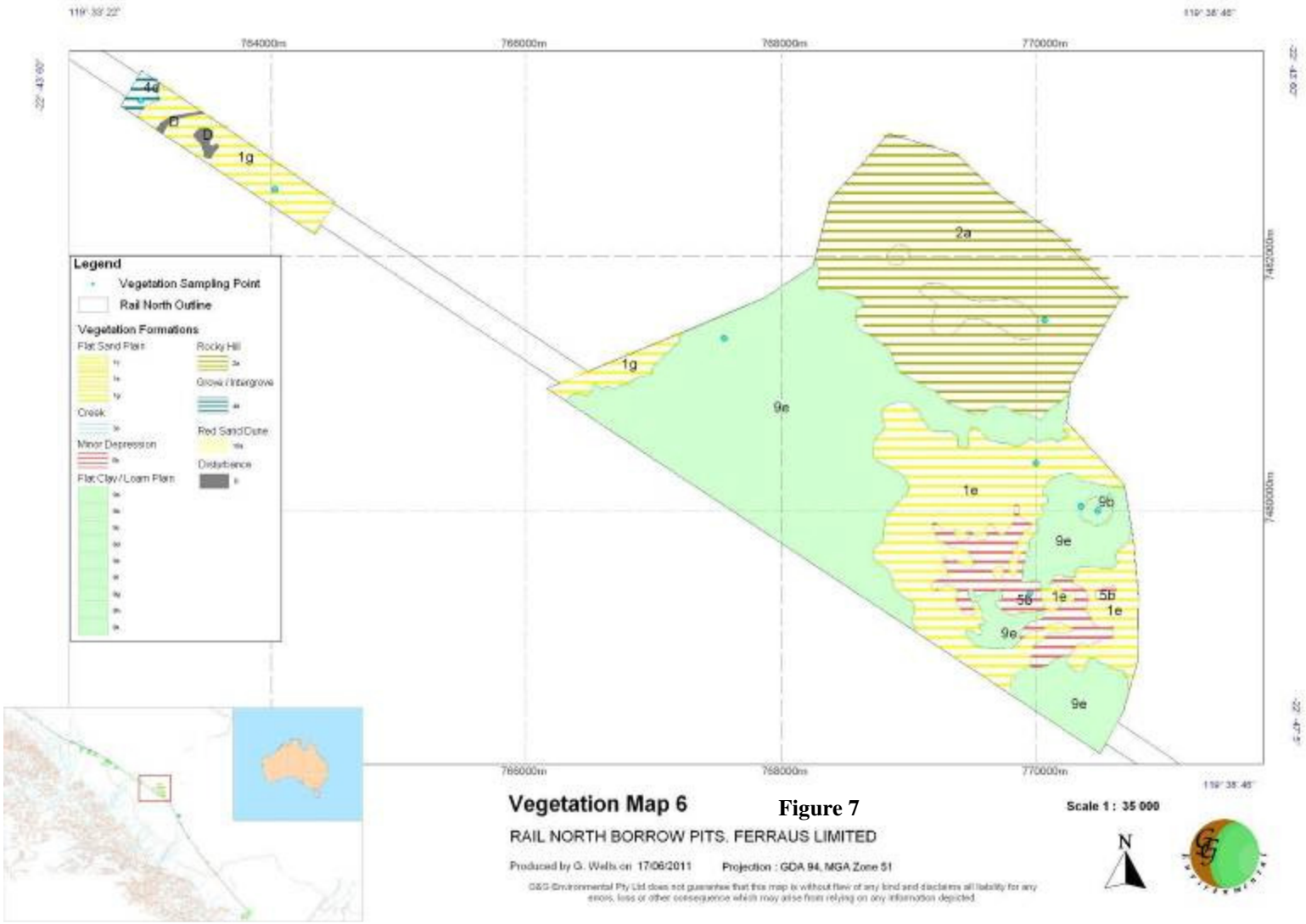
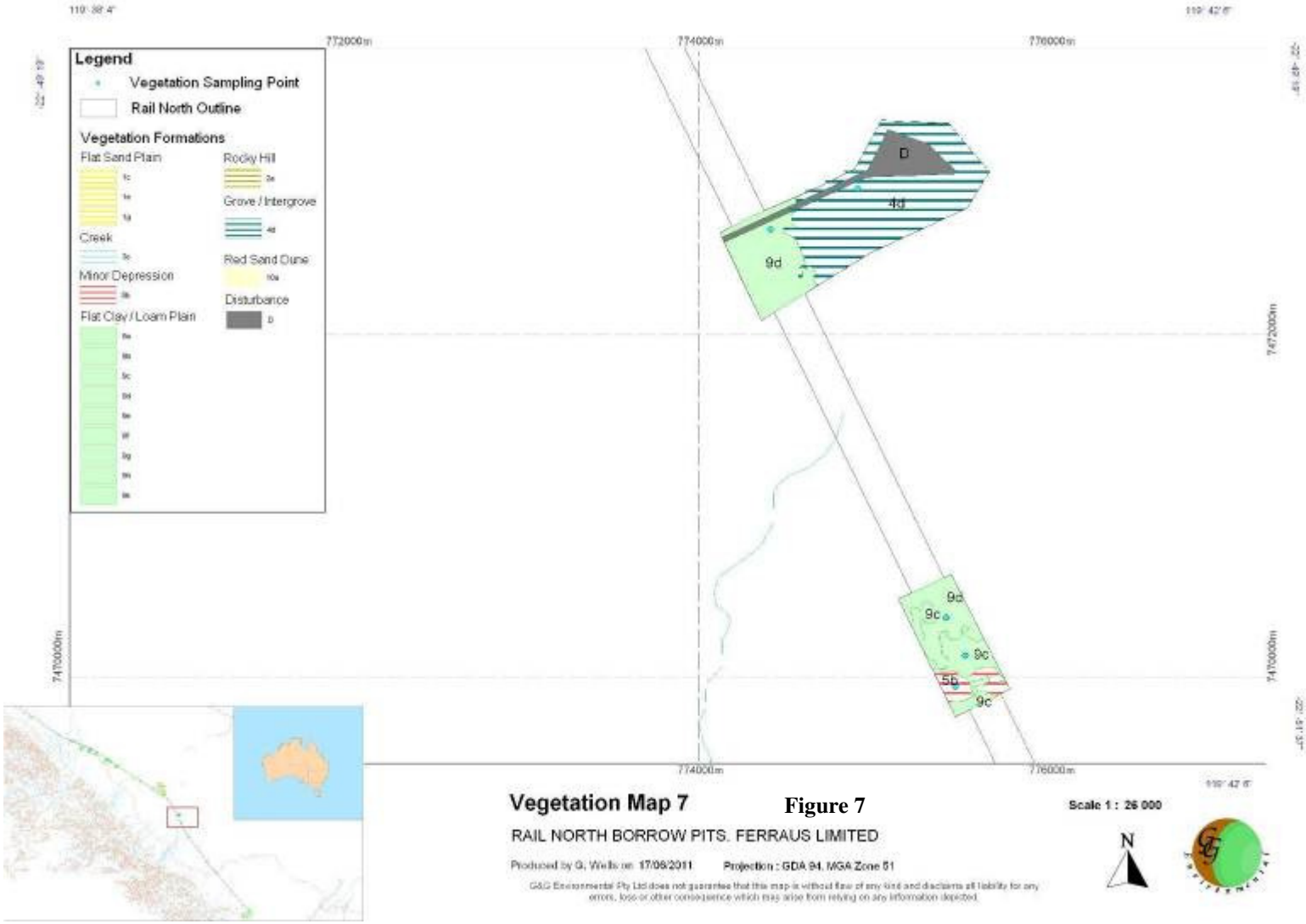

764000m
766000m
768000m
770000m
7482000m
7480000m
1g
2a
9e
1e
9b
5b
Legend
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Creek
Red Sand/Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
Vegetation Map 6
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/06/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 35 000
N

Figure 7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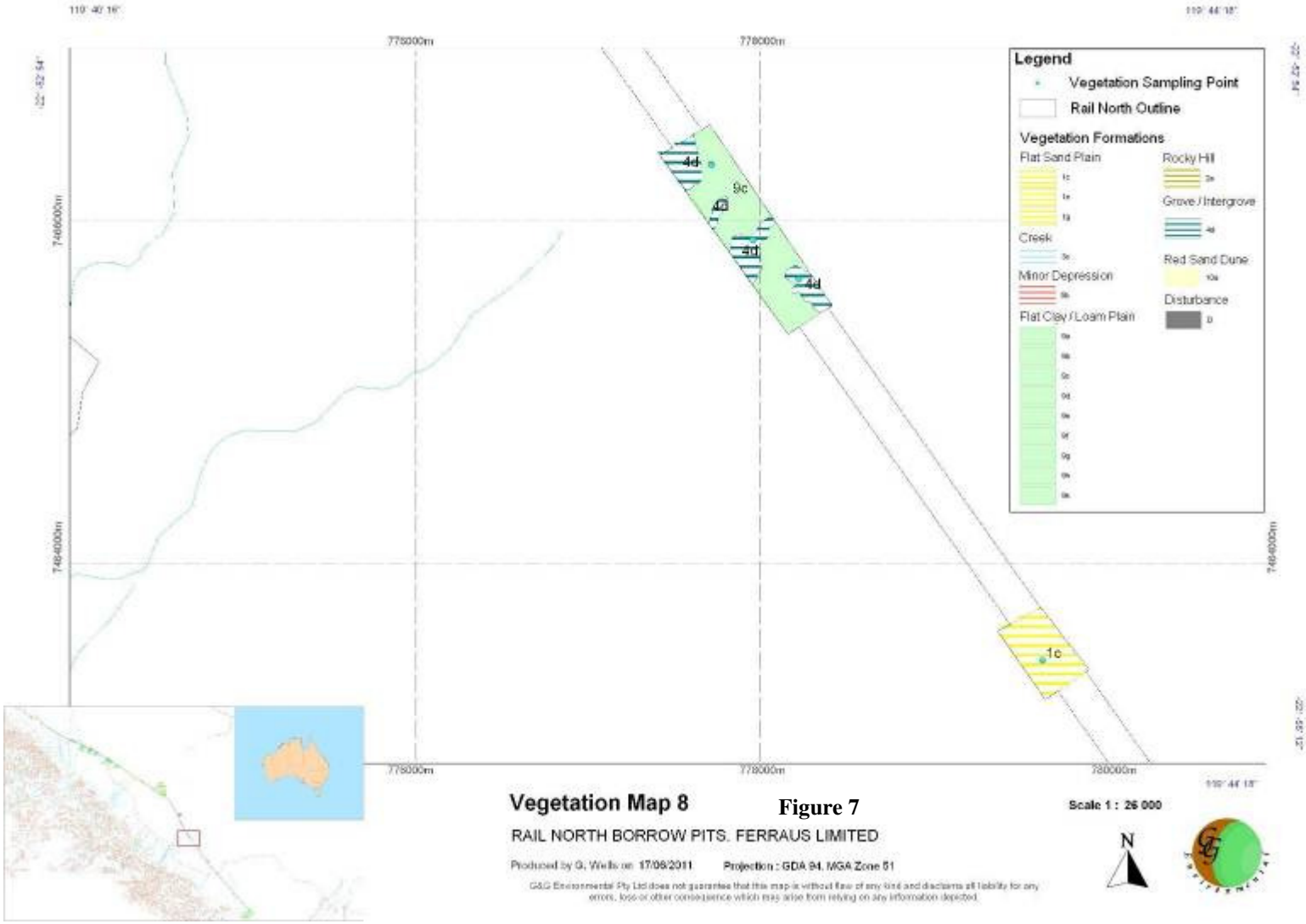
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
772000m
774000m
776000m
7472000m
7470000m
D
4d
9d
9c
5b
Vegetation Map 7
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
N

Figure 7


778000m
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780000m
7486000m
7484000m
Legend
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
4d
9c
1c
Vegetation Map 8
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
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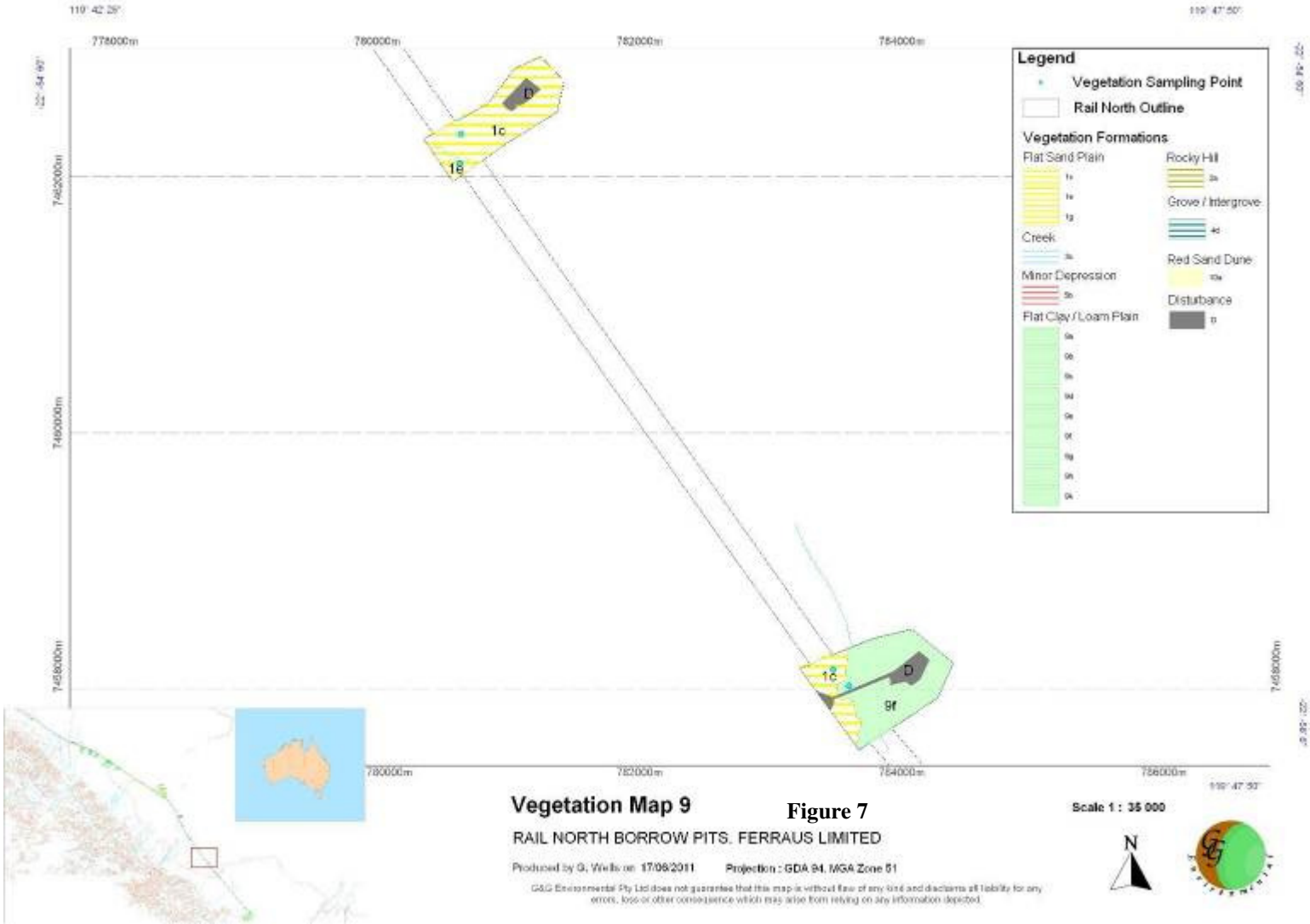
Figure 7



Vegetation Map 9

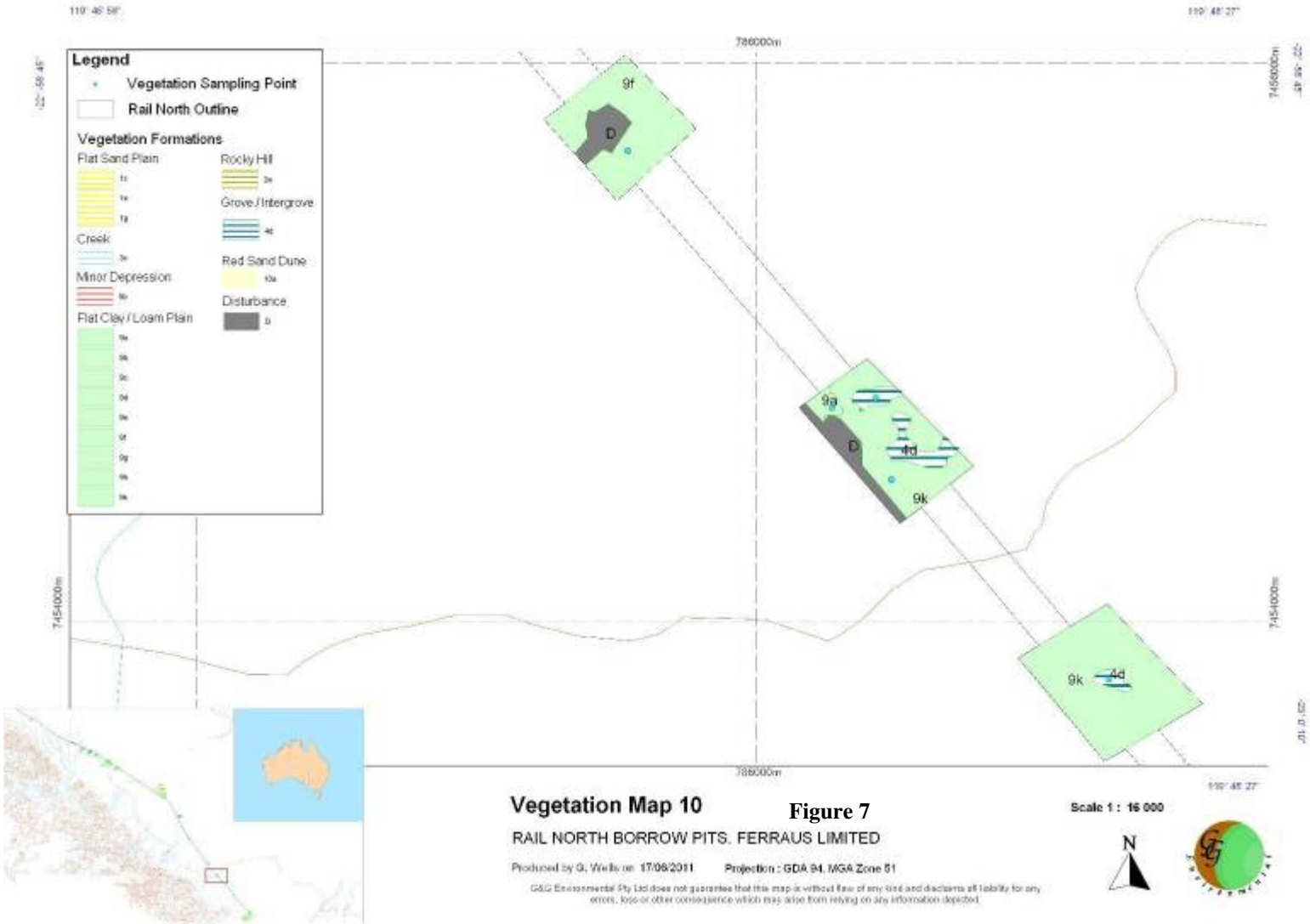
Figure 7

RAIL NORTH BORROW PITS. FERRAUS LIMITED

Produced by G. Wells on 17/08/2011 Projection : GDA 94, MGA Zone 51

Scale 1 : 35 000

N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Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
786000m
745400m
9f
D
9a
4d
9k
Vegetation Map 10
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 16 000
N

Figure 7

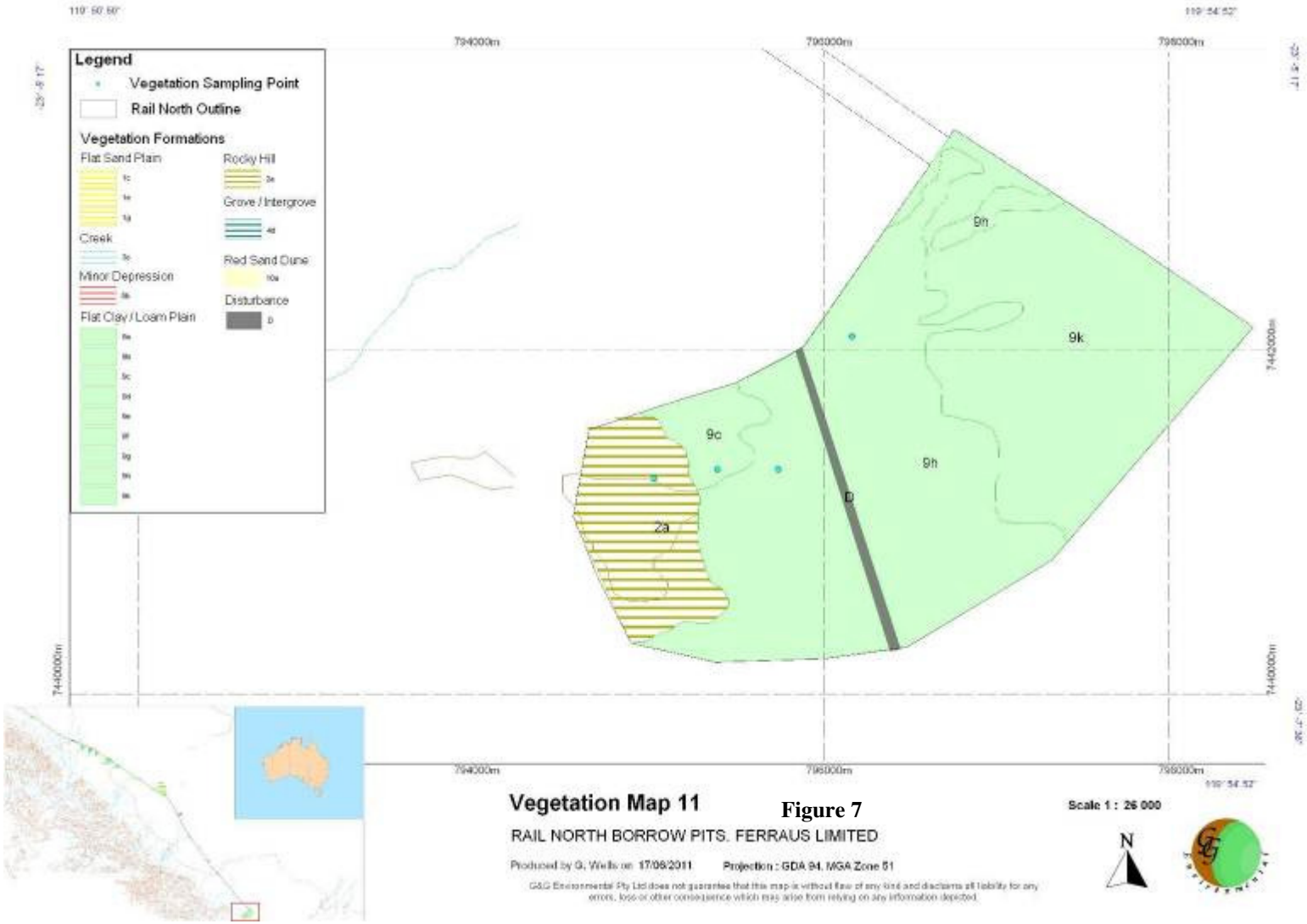

Legend
Vegetation Sampling Point
Rail North Outline
Vegetation Formations
Flat Sand Plain
Rocky Hill
Grove / Intergrove
Creek
Red Sand Dune
Minor Depression
Disturbance
Flat Clay / Loam Plain
794000m
796000m
798000m
7442000m
7440000m
9m
9k
9c
9h
D
2a
Vegetation Map 11
RAIL NORTH BORROW PITS. FERRAUS LIMITED
Produced by G. Wells on 17/08/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 25 000
N

Figure 7

Table 16: Vegetation sub-formations recorded during surveys and examples of sites where units were described.

Vegetation Description	Frequently Recorded Species	Photograph
Flat Sand Plain		
1c - *Eucalyptus gamophylla* low open mallee woodland, over isolated mid to tall *Acacia* species and *Hakea chordophylla* shrubs in *Triodia basedowii* mid-hummock grassland.	Trees– *Eucalyptus gamophylla*, *Acacia pruinocarpa* Mid/Tall Shrubs - *Acacia dictyophleba*, *A. ligulata*, *A. trudgeniana*, *Hakea chordophylla* Low Shrubs – *Scaevola parvifolia* Grasses – *Triodia basedowii*	
1e - *Acacia aneura* low open woodland to low woodland/tall shrubland, over isolated mid *Eremophila* and *Senna* species shrubs over isolated low *Sida* species shrubs over low mixed grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura*, *A. pruinocarpa* and *A. sibirica* Mid Shrubs –*Eremophila forrestii*, *E. jucunda*, *Senna artemisioides* subsp. *helmsii*, *S. glaucifolia* and *Solanum phlomoides* Low Shrubs –*Sida fibulifera*, *Sida platycalyx* Grasses –*Eragrostis eriopoda Eulalia aurea* and *Triodia basedowii.*	

1g - Isolated low *Corymbia hamersleyana* trees over isolated low *Acacia aneura* trees to open low *A. aneura* woodland over mixed mid *Acacia* spp. shrubs over isolated *Aristida inaequiglumis* and *Triodia basedowii* hummock grasses to low *Triodia basedowii* hummock grassland.	Trees – *Acacia aneura* and *Corymbia hamersleyana* Mid Shrubs – *Acacia ancistrocarpa*, *A. dictyophleba*, *A. synchronicia*, *A. trudgeniana* and *Hakea lorea* Grasses – *Aristida inaequiglumis* and *Triodia basedowii*	
Rocky Hills		
2a - Isolated low mixed trees over isolated low to mid shrubs to open mixed shrubland in *Triodia wiseana* low hummock grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura, Grevillea berryana* Mid Shrubs – *Acacia maitlandii*, *A. marramamba*, *Eremophila latrobei* subsp. *latrobei* and *Senna glutinosa* varieties. Low Shrubs – *Eremophila exilifolia*, *E. jucunda* and *Keraudrenia velutina* Grasses – *Eragrostis eriopoda*, *Eriachne mucronata* and *Triodia wiseana*	
Rivers / Creeks		

3c - A low *Corymbia hamersleyana* woodland over a low to mid *Acacia sclerosperma* and *Corchorus parviflorus* shrubland over a mid *Triodia pungens* and *Cenchrus ciliaris* tussock grassland.	Trees – *Acacia pruinocarpa*, *Corymbia candida* subsp. *dipsodes* and *Corymbia hamersleyana* Low/Mid Shrubs – *Acacia sclerosperma*, *Atalaya hemiglauca* and *Corchorus parviflorus* Grasses – *Cenchrus ciliaris* and *Triodia pungens*	
Grove / Intergrove		
4d - Low *Acacia aneura* open forest to forest over isolated low *Acacia aneura* shrubs over isolated low mixed tussock hummock grasses.	Trees – *Acacia aneura*, *A. pruinocarpa* and *Corymbia candida* subsp. *dipsodes* Mid/Tall Shrubs – *Acacia aneura*, *A. tetragonophylla* and *Psydrax latifolia* Low Shrubs – *Enchylaena tomentosa* and *Maireana planifolia* Grasses – *Chrysopogon fallax* and *Triodia pungens*	
Minor Depression		

5b - Isolated clumps of *Sclerolaena densiflora* low shrubs and *Cenchrus ciliaris* low tussocks.	Low Shrubs - *Sclerolaena densiflora* Grasses - *Cenchrus ciliaris*	
Flat Clay/Loam Plain		
9a - Low isolated *Acacia aneura* and *A. pruinocarpa* trees to low open forest over isolated *A. ancistrocarpa* mid shrubs to shrubland in an open to closed *Triodia basedowii* and/or *T. pungens* hummock grassland	Trees - *Acacia aneura* and *A. pruinocarpa* Mid Shrubs – *Acacia ancistrocarpa*, *Acacia tetragonophylla*, *Hakea lorea* and *Psydrax latifolia* Low Shrubs – *Salsola australis*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Grasses – *Cymbopogon obtectus*, *Triodia basedowii* and *T. pungens*	

9b - Low *Acacia aneura* and *A. pruinocarpa* open woodland to woodland over isolated mid to tall *A. tetragonophylla*, *Anthobolus leptomerioides* and *Petalostylis labicheoides* shrubs in a low open to closed *Triodia basedowii* hummock grassland.	Trees – *Acacia aneura* and *A. pruinocarpa* Mid/Tall Shrubs – *Acacia ancistrocarpa*, *A. tetragonophylla*, *Anthobolus leptomerioides*, *Hakea chordophylla* and *Petalostylis labicheoides* Low Shrubs – *Eremophila forrestii*, *Kennedia prorepens*, *Ptilotus obovatus* and *Sida fibulifera* Grasses – *Aristida contorta*, *A. inaequiglumis* and *Triodia basedowii*	
9c - Tall sparse *Acacia synchronicia* shrubland to low open woodland over isolated *Senna artemisioides* subsp. *helmsii* mid shrubs over isolated low *Sida platycalyx* and *Salsola australis* shrubs over bare ground to isolated low tussock grasses.	Trees – *Acacia aneura* and *A. synchronicia* Mid/Tall Shrubs – *Acacia synchronicia*, *Senna artemisioides* subsp. *helmsii* Low Shrubs – *Salsola australis*, *Sida platycalyx*, and *Solanum lasiophyllum* Grasses – *Aristida contorta*, *Cenchrus ciliaris* and *Enneapogon caerulescens*	

9d - Low isolated *Acacia aneura*, *A. pruinocarpa* and *A. synchronicia* trees to low woodland over isolated tall *A. synchronicia* and *A. tetragonophylla* shrubs to shrubland over isolated low shrubs over isolated low mixed tussock and hummock grasses.	Trees - *Acacia aneura*, *A. pruinocarpa* and *A. synchronicia* Mid/Tall Shrubs - *Acacia synchronicia* and *A. tetragonophylla* Low Shrubs – *Ptilotus obovatus*, *Salsola australis* and *Solanum lasiophyllum* Grasses – *Cenchrus ciliaris* and *Triodia pungens*	
9e - Isolated clumps of low *Acacia aneura* trees over mid to tall *A. synchronicia* and *A. xiphophylla* shrubs over isolated clumps to low open *Eremophila cuneifolia* and *Maireana triptera* shrubland.	Trees – *Acacia aneura* Tall Shrubs – *Acacia synchronicia* and *A. xiphophylla* Low Shrubs – *Eremophila cuneifolia* and *Maireana triptera* Grasses – *Cenchrus ciliaris*	

9f - Low *Acacia aneura* and *Corymbia hamersleyana* woodland to low open forest over isolated mid *Acacia* spp. shrubs over isolated grasses to *Triodia pungens* hummock grassland.	Trees - *Acacia aneura* and *Corymbia hamersleyana* Mid Shrubs – *Acacia citrinoviridus* and *A. tetragonophylla* Low Shrubs – *Salsola australis* Grasses – *Chrysopogon fallax* and *Triodia pungens*	
9g - Isolated low *Corymbia hamersleyana* trees over isolated low to low open *Eucalyptus gamophylla* mallee woodland over isolated low to mid mixed *Acacia* shrubs in a *Triodia basedowii* and *T. pungens* hummock grassland.	Trees/Mallee – *Corymbia hamersleyana* and *Eucalyptus gamophylla* Mid Shrubs – *Acacia ancistrocarpa*, *A. bivenosa* and *A. trudgeniana* Grasses – *Triodia basedowii* and *T. pungens*	
9h - Isolated low *Acacia aneura* and *A. pruinocarpa* trees to low woodland over isolated mid to tall *Acacia* and *Senna* shrubs over isolated low shrubs to low open *Sida platycalyx* and *Solanum lasiophyllum* shrubland over isolated low tussock grasses.	Trees - *Acacia aneura* and *A. pruinocarpa* Mid/Tall Shrubs – *Acacia synchronicia*, *A. tetragonophylla*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs - *Eremophila lanceolata, Hibiscus burtonii, Sida platycalyx* and *Solanum lasiophyllum* Grasses – *Aristida inaequiglumis*, *Cymbopogon obtectus*, *Eragrostis eriopoda* and *Eulalia aurea*	

9k - Isolated mixed *Acacia* species low trees over isolated mid *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* shrubs over isolated mixed low chenopod shrubs and herbs with isolated tussock grasses.	Trees – *acacia paraneura*, *A. pruinocarpa* and *A. synchronicia* Mid Shrubs - *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs – *Eremophila lanceolata*, *Maireana villosa*, *Salsola tragus*, *Sclerolaena cornishiana*, *S. tetragona* and *Sida platycalyx* Grasses – *Aristida contorta*, *Enneapogon robustissimus*, *Eragrostis cumingii* and *E. pergracilis*	
Red Sand Dune		
10a - Low *Eucalyptus gamophylla* open mallee woodland in an *Acacia sclerosperma* tall shrubland over isolated low *Petalostylis cassioides* shrubs in low *Triodia pungens* hummock grassland.	Tree/Mallee – *Eucalyptus gamophylla* Mid/Tall Shrubs – *Acacia sclerosperma* and *A. ligulata* Low Shrubs – *Petalostylis cassioides* and *Ptilotus obovatus* Grasses – *Triodia pungens*	

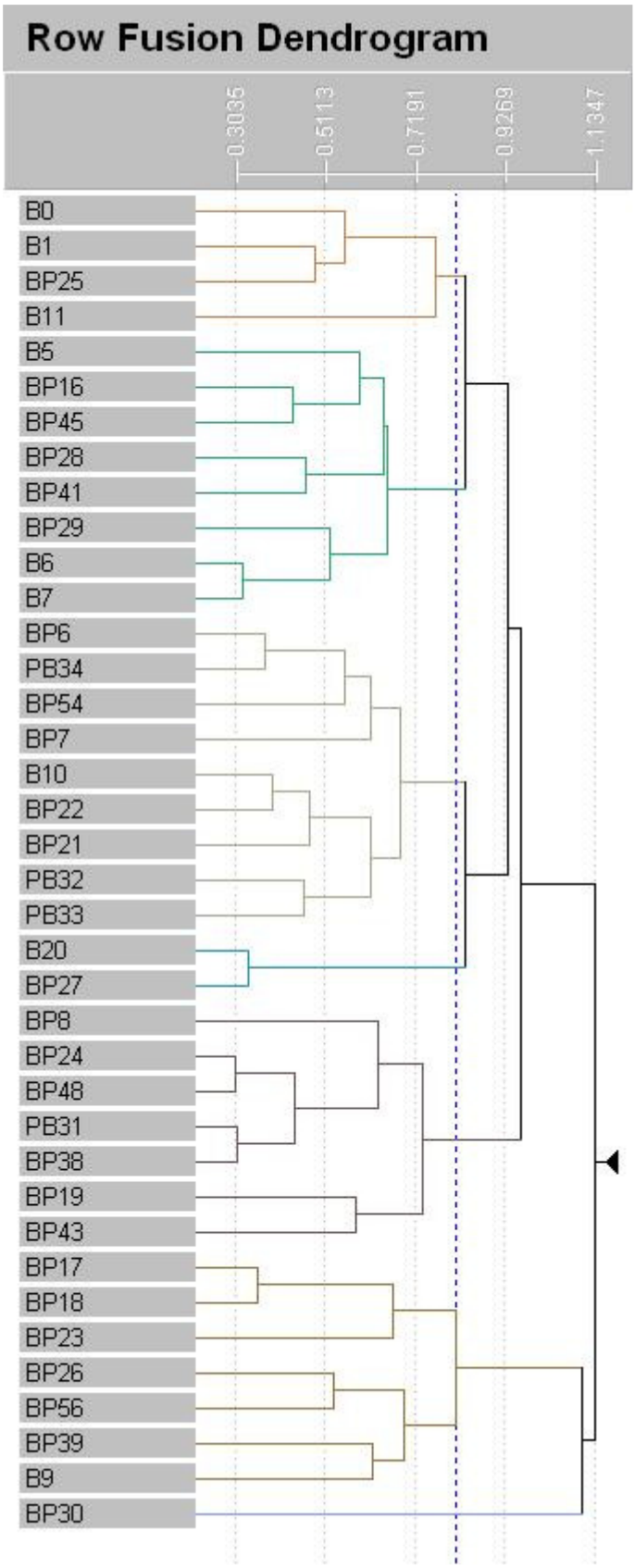


Figure 8: Dendogram of quadrat survey sites for the current survey of the FEPR northern section borrow pit options.

Table 17: Comparison of floristic data from the borrow pit options level 1 survey with previous flora surveys conducted in the Gascoyne and Pilbara bioregions.

Survey	Area	Vegetation Types	Taxa	Families	Genera
Van Vreeswyk *et al.* (2004)	~181723 km^2	44	1137	98	348
Mattiske (2005)	~250 km^2	18	234	41	106
Biota (2004)	>500 km^2	122	762	69	218
G&G Environmental (2008)	~18km^2	81	213	45	106
G&G Environmental (2011)	~160 km^2	19	482	48	165
Borrow Pit Options	~37 km^2	17	120	28	65

3.2.2 Vegetation Condition

A total of 17 areas were mapped as disturbed within the borrow pit options of the FEPR northern section and included historic borrow pits and rail infrastructure for the BHP Billiton Iron Ore Mainline. The natural vegetation in these areas had been completely cleared.

The condition of the vegetation in the survey sites ranged from good to pristine. Approximately 5% of sites were in good condition. 7.7% very good, 48.7 excellent and the remaining 38.5% were pristine. The sites recorded to be in good and very god condition occurred adjacent to borrow pits and the vegetation had been severely impacted by evident vehicle movement. Disturbance in the areas recorded as excellent included grazing and vehicle tracks.

3.2.3 Flora

A total of 120 taxa recorded in the quadrat surveys comprised 93 perennial and 27 annual species representing 28 families and 65 genera. The most prominent families were the Fabaceae (37 taxa), Poaceae (15), and Malvaceae (10). The Chenopodiaceae (9), Amaranthaceae (7), Scrophulariaceae (7) and Myrtaceae (6) were also well represented. The most prominent genera included *Acacia* (20), *Senna* (9), *Eremophila* (7) and *Ptilotus* (6). The identity of a *Triodia* species could not be identified to species level due to absence of reproductive structures at the time of survey. General morphology of the species and leaf length closely resembled *Triodia biflora*.

The dominant families and the number of taxa recorded at the borrow pit options compares favourably with other flora surveys in the adjacent Pilbara bioregion (**Table 17**) with the number of taxa recorded per km^2 in the current survey area frequently higher.

Acacia aneura varieties and *A. pruinocarpa* were the most widespread trees in the borrow pit options with *Corymbia hamersleyana*, *C. candida* subsp. *dipsodes*, *Eucalyptus gamophylla* and *Hakea lorea* subsp. *lorea* also common. Widespread mid to tall shrubs included *Acacia ancistrocarpa*, *A. tetragonophylla*, *Psydrax latifolia*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla*. Common low shrubs included *Maireana planifolia*, *Ptilotus obovatus*, *Salsola australis*, *Sida fibulifera*, *Sida platycalyx* and *Solanum lasiophyllum*. The most widely distributed perennial grasses included spinifex (*Triodia basedowii* and *T. pungens*) and tussock grasses including *Aristida inaequiglumis* and *Cymbopogon obtectus*. Common annual herbs included *Boerhavia coccinea*,

Evolvulus alsinoides var. *villosicalyx*, *Gomphrena kanisii*, *Goodenia prostrata*, *Ptilotus helipteroides* and *Trianthema glossostigma*.

3.2.3.1 Species Range Extensions and Declared Rare/Priority Flora

Review of the distribution of each of the recorded species on NatureMap (2011) and Florabase (2011) identified apparent range extensions for 3 species (**Table 18**).

Table 18: Description of species apparent range extensions based on the location of the survey area and the mapped range for each species (NatureMap 2011Florabase 2011).

SPECIES	RANGE EXTENSION DETAILS
Atalaya hemiglauca	A small south-eastern extension of the mapped range.
Cullen leucanthum	A small south-eastern extension of the mapped range.
Senna ferraria	A substantial eastern extension of the mapped range.

Atalaya hemiglauca was recorded in two quadrats, one in riparian vegetation of a creek in sub-formation 3c and the other in *Acacia* woodland on a flat clay loam plain in sub-formation 9d. *Cullen leucanthum* was recorded at a single location on a flat sand plain in *Acacia* woodland vegetation sub-formation 1e. *Senna ferraria* was recorded at a single location on a flat clay/loam plain in *Acacia* woodland sub-formation 9d.

No T or priority flora were recorded in the borrow pit options during the survey and no records from the search of the DEC database occur within the survey areas (**Figure 6**).

Three introduced flora were recorded in the borrow pit options, *Cenchrus ciliaris*, *Malvastrum americanum* and *Portulaca oleracea*. *Cenchrus ciliaris* was the most widespread being recorded in 12 of the quadrat surveys in various vegetation assemblages and habitats. *Malvastrum americanum* was recorded in a single quadrat in riparian vegetation of a minor creek. *Portulaca oleracea* was only recorded on a flat plain in a red clay/loam soil.

Each of the introduced species have wide distributions across Western Australia (Florabase 2011, Naturemap 2011) and none is a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*.

3.2.4 Potential Conservation Significance of the Land Systems and Vegetation of the Survey Areas

Each of the seven land systems that occur in the FEPR northern section occur within the borrow pit options (**Figure 4**). The borrow pit options occurred primarily on the Divide and Fan land systems (**Figure 4**). Each of the Adrian, Marillana and Newman systems were recorded at a single location within the borrow pit options, the Fortescue land system comprised a small proportion of two borrow pit options and the Urandy land system occurred at three borrow pit options.

Only two (Newman and Fortescue) occur in a conservation estate. The Newman, Fortescue, Divide and Urandy land systems have been recorded on UCL. Three land systems, Adrian, Fan and Marillana are not present in either conservation estate or UCL.

In excess of 1% of the Adrian, Marillana and Fan land systems occurred within the borrow pit options (**Table 11**) and each of these land systems represent less than 1% of the Pilbara Rangeland survey area. It may be considered that the borrow pit options have a high conservation value for these land systems.

Less than 1% of the remaining land systems occur within the borrow pit options and it may therefore be considered that the borrow pit options represent a low conservation value for these land systems.

Vegetation sub-formation 10a was recorded at a single location in the borrow pit options, all other sub-formations occurred in at least two locations (**Table 19**). Sub-formation 4d and 9c were the most widely distributed and accounted for just under 10% of the total area. Sub-formations 2a, 9e and 9g covered the greatest area accounting for in excess of 35%. Sub-formation 3c (riparian vegetation of a minor creek) represented the lowest proportion of the area.

Table 19: Area of vegetation sub formations and degraded areas in the Borrow Pit Options of the Northern Rail alignment.

Vegetation Sub formation	No. Locations in Borrow Pit Options	Total Area in Borrow Pit Options (km^2)	% Borrow Pit Options
1c	6	0.81	2.20
1e	5	2.15	5.84
1g	4	1.07	2.91
2a	2	4.07	11.06
3c	2	0.11	0.30
4d	33	1.45	3.94
5b	3	0.63	1.71
9a	6	1.68	4.57
9b	7	2.16	5.87
9c	41	2.14	5.82
9d	6	1.00	2.72
9e	4	4.93	13.40
9f	3	0.98	2.66
9g	5	3.97	10.79
9h	2	3.19	8.67
9k	3	2.64	7.17
10a	1	2.38	6.47
D	17	1.44	3.91

3.3 FEPR SOUTHERN SECTION RAIL CORRIDOR OPTION – LEVEL 2

3.3.1 Vegetation

A total of 96 quadrat surveys were conducted for the FEPR southern rail corridor and borrow pit options. 51 sites were assessed during the initial survey in 2010. 45 quadrats were surveyed in 2011 with repeat observations taken at 16 of the sites. 41 vegetation sub-formations occurring on nine broad landforms (**Figure 9 and Table 20**) were defined from the dendrogram generated by PATN analysis (**Figure 10**), site descriptions and site photographs.

The number of sub-formations is comparatively high in respect to some of the previous surveys in the Pilbara bioregion (**Table 21**) but is commensurate with long distance linear corridors surveyed in the Pilbara bioregion by Biota (2004) and G&G Environmental (2008) The surveys of long distance corridors typically result in a higher number of vegetation types as they intersect a greater number of habitats.

Eight of the sub-formations defined by the current survey, including five for flat sandplains closely resemble those recorded in previous surveys conducted for the FPP by Ecologia (2007, 2009) and G&G Environmental (2011) and were named accordingly. A further seven sub-formations were defined on flat sand plains within the rail corridor. Typically the dominant stratum of the sandplain vegetation associations was *Triodia* hummock grassland with the exception of sub-formation 11 which was a *Eulalia aurea* tussock grassland.

Of two sub-formations defined for rocky hills one was also recorded at the FPP. . While the prominent stratum of the sub-formation defined for the southern rail corridor was also a *Triodia wiseana* hummock grassland the composition of the associated shrubs differed.

Four sub-formations defined for the riparian vegetation of creeks and rivers in the southern rail corridor differed from that recorded at the FPP. The differences highlight the diversity of riparian vegetation in the region.

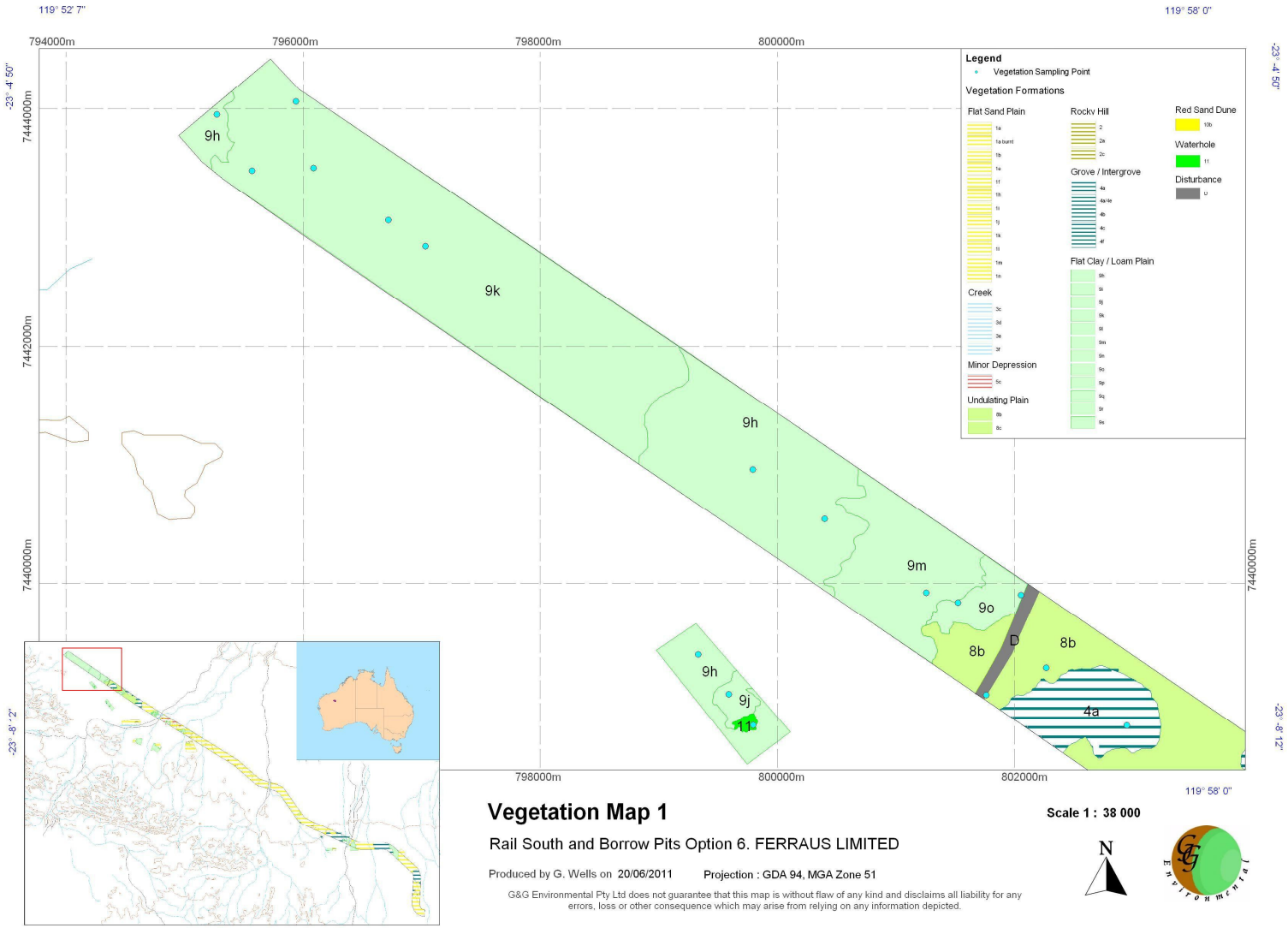
Two sub-formations recorded for Grove/Inter Grove vegetation at the FPP were recorded in the rail corridor along with a further three sub-formations defined during the current survey.

One new sub-formation was defined for minor depressions with neither of those recorded at the FPP occurring in the rail corridor. Similarly two new sub-formations were defined for undulating plains with none of those recorded for the FPP occurring in the rail corridor.

The remaining sub-formations were recorded on landforms not present at the FPP. Twelve were defined for flat clay/loam plains, one for red sand dunes and one occurred on the periphery of a permanent waterhole in a flat clay/loam plain.

The vegetation sub-formations defined for the FEPR southern rail corridor and borrow pit options (**Table 20**) fit the broad descriptions of the nationally recognised major vegetation groups (**Table 22**). Hummock grasslands were recorded on flat sand plains, flat clay/loam plains, undulating plains and rocky hills and hill slopes. *Acacia* forests and open woodlands were recorded on flat sandplains and in groves. *Acacia* shrublands occurred on flat sandplain, flat clay/loam plains and in riparian vegetation of one minor creek. Other shrublands were recorded in a minor depression on a flat clay/loam plain and on undulating plain. A tussock grassland (*Eulalia aurea* grassland in the current survey) was recorded on flat sand plain. Eucalypt woodlands occurred in riparian vegetation of creeklines and rivers, on the banks of a permanent waterhole and on flat clay/loam plains. A mixed grassland was recorded on a red sand dune.

Regionally the majority of the vegetation sub-formations resemble three of the vegetation communities mapped by Beard (1975), namely, a_1Lp - mulga trees in groves or patches; a_nSr.tHi - scattered shrubs over spinifex; and $e_{25}Srt_2$Hi - *Eucalyptus gamophylla* over spinifex. Large areas of the mulga community occur throughout the Gascoyne bioregion and extend up through the Fortescue valley in the Pilbara bioregion. Similarly, large areas of the *Eucalyptus gamophylla* community extend through the Fortescue valley and the eastern Gascoyne. The scattered shrubs over spinifex are restricted to the north-east of the Gascoyne bioregion but cover an extensive area of the Little Sandy Desert.

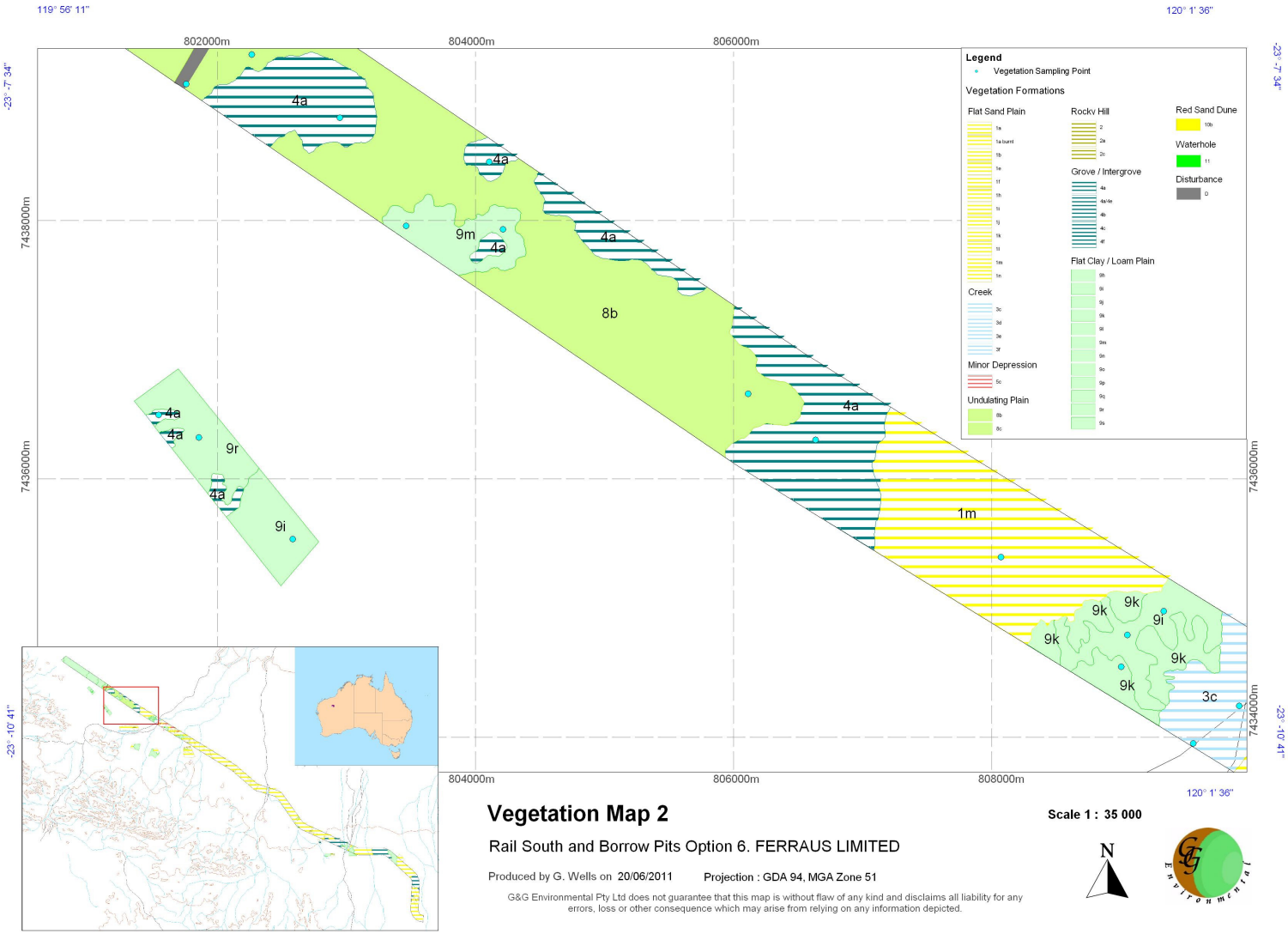


Vegetation Map 1

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 38 000

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51

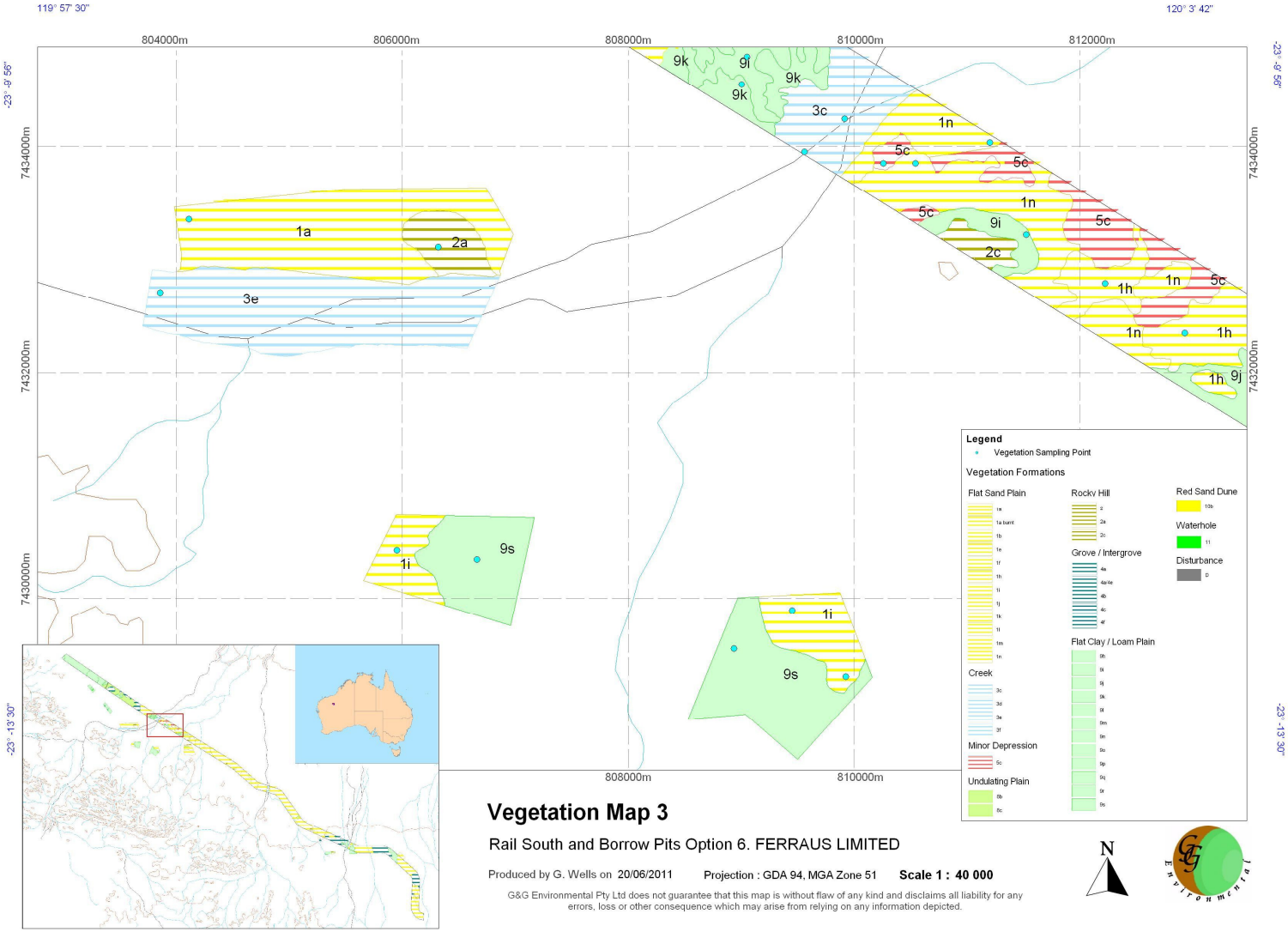


Vegetation Map 2

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 35 000

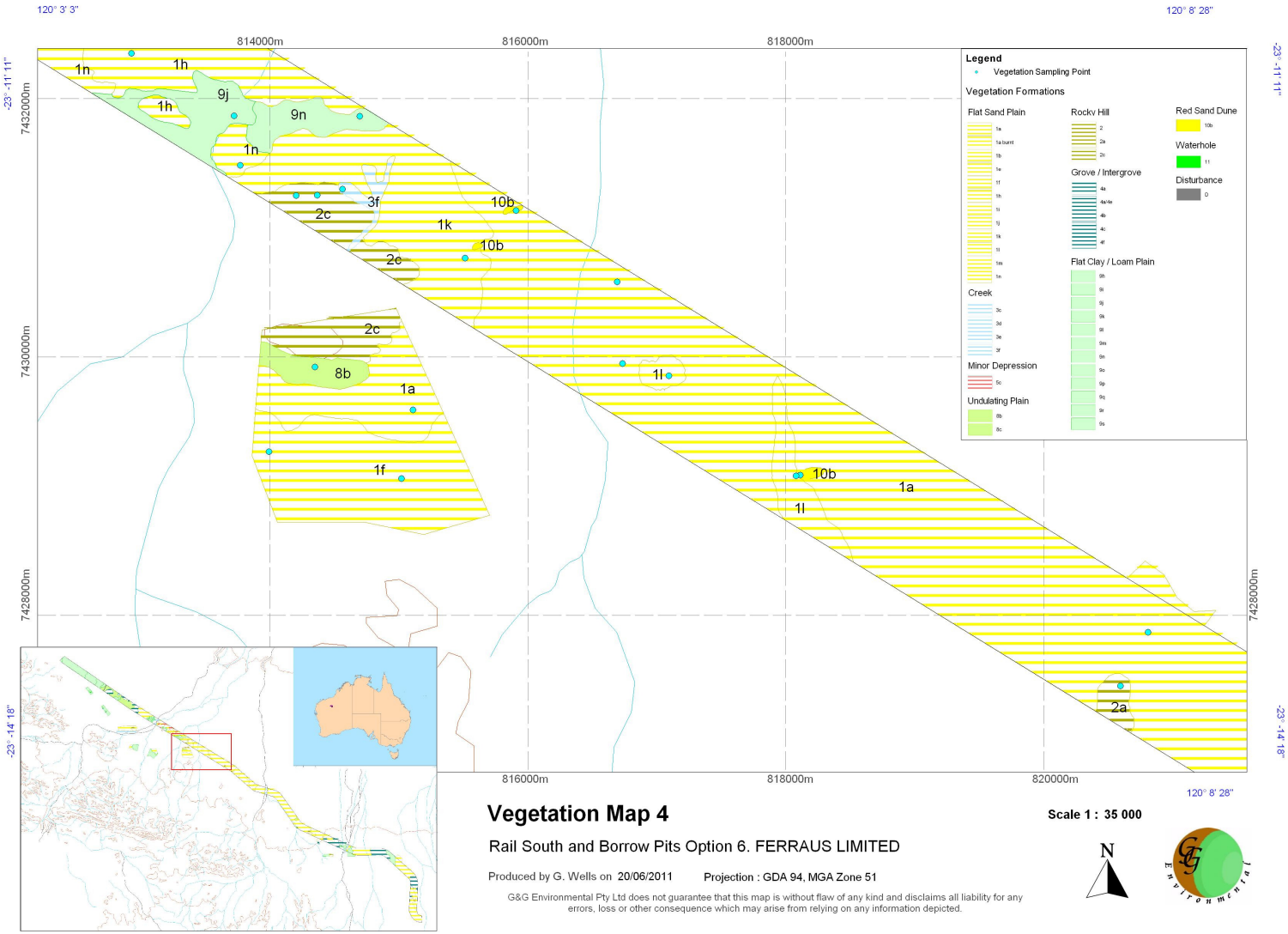
Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51



Vegetation Map 3

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51 **Scale 1 : 40 000**

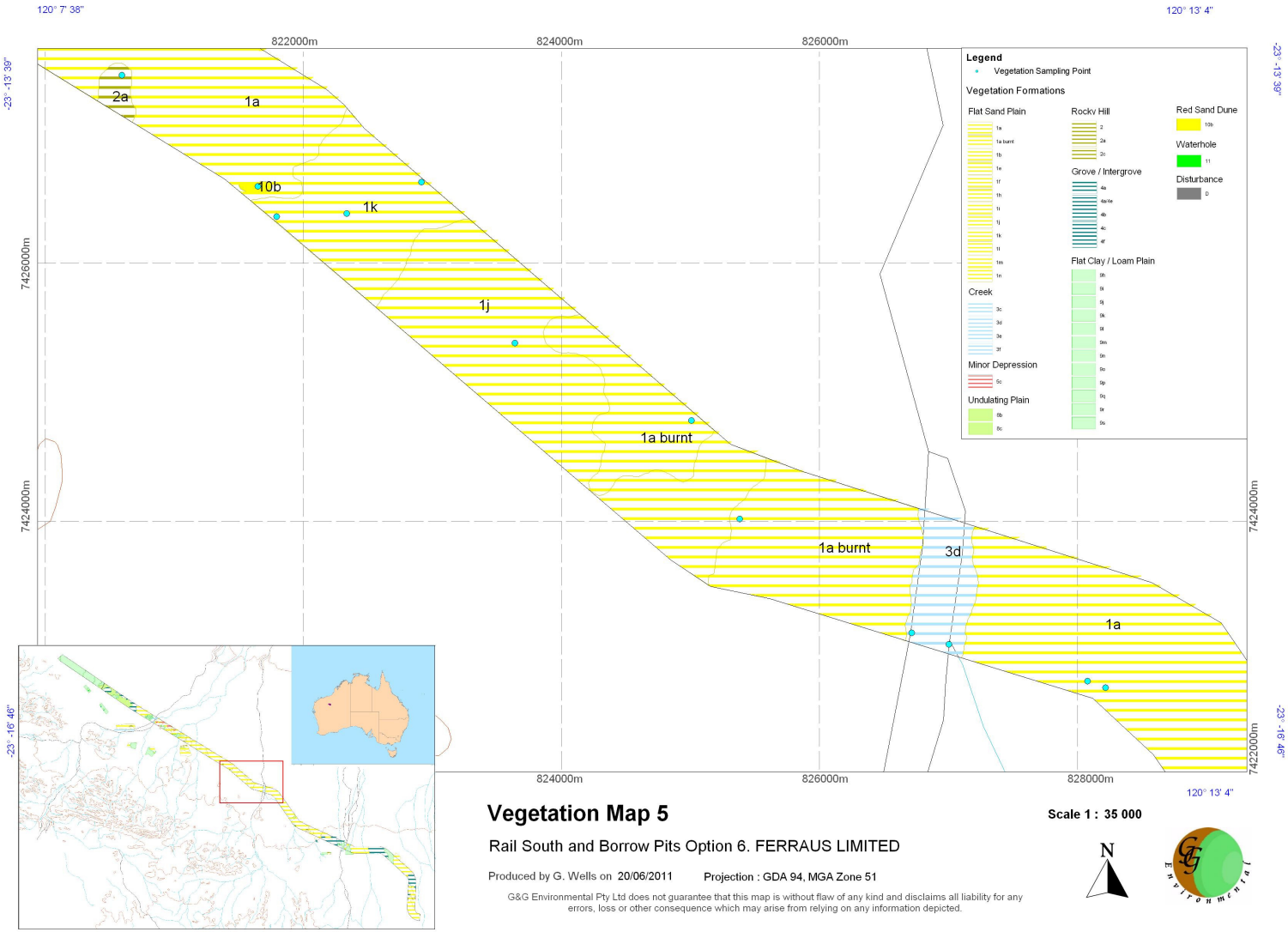


Vegetation Map 4

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 35 000

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51

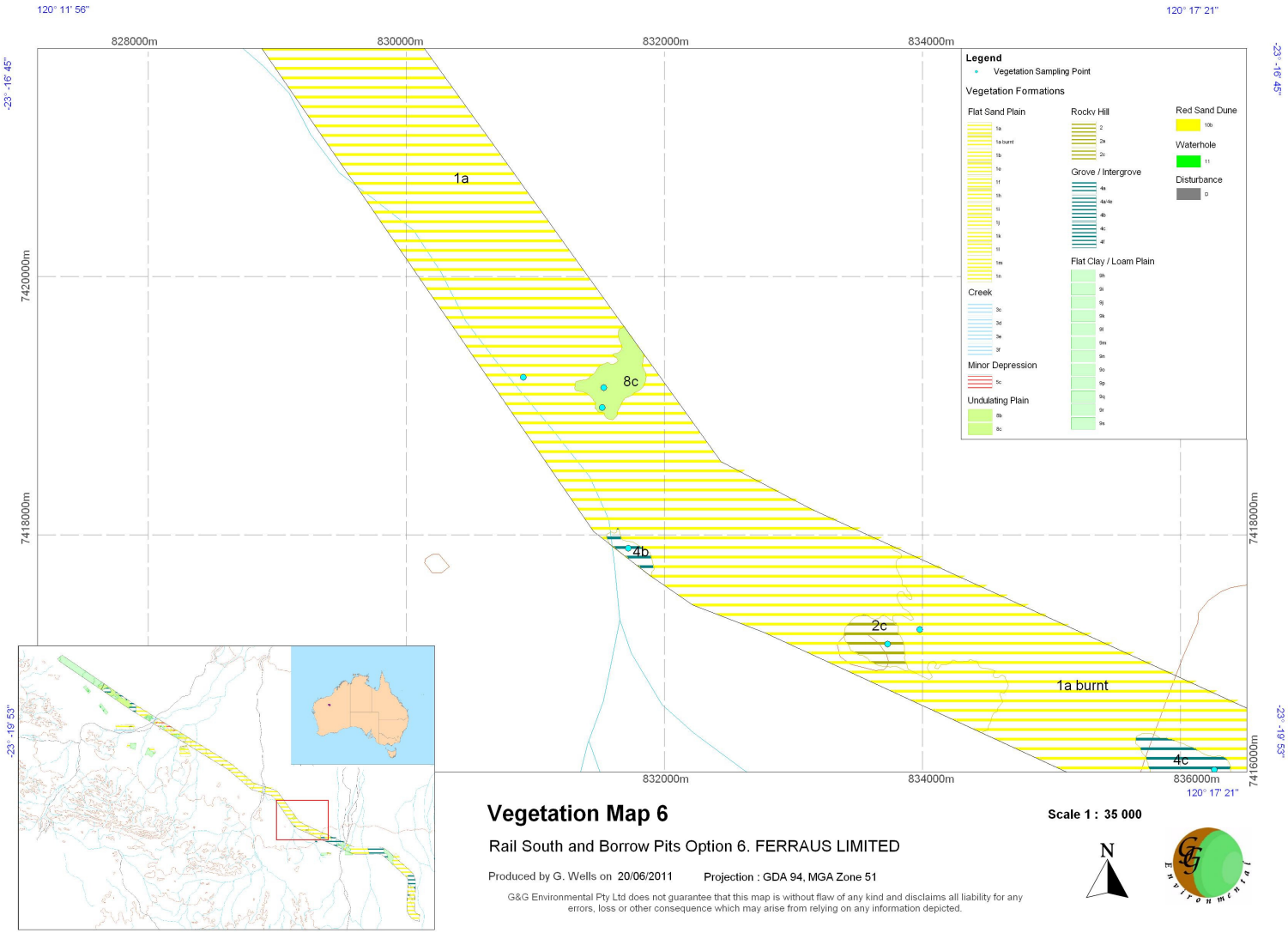


Vegetation Map 5

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 35 000

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51

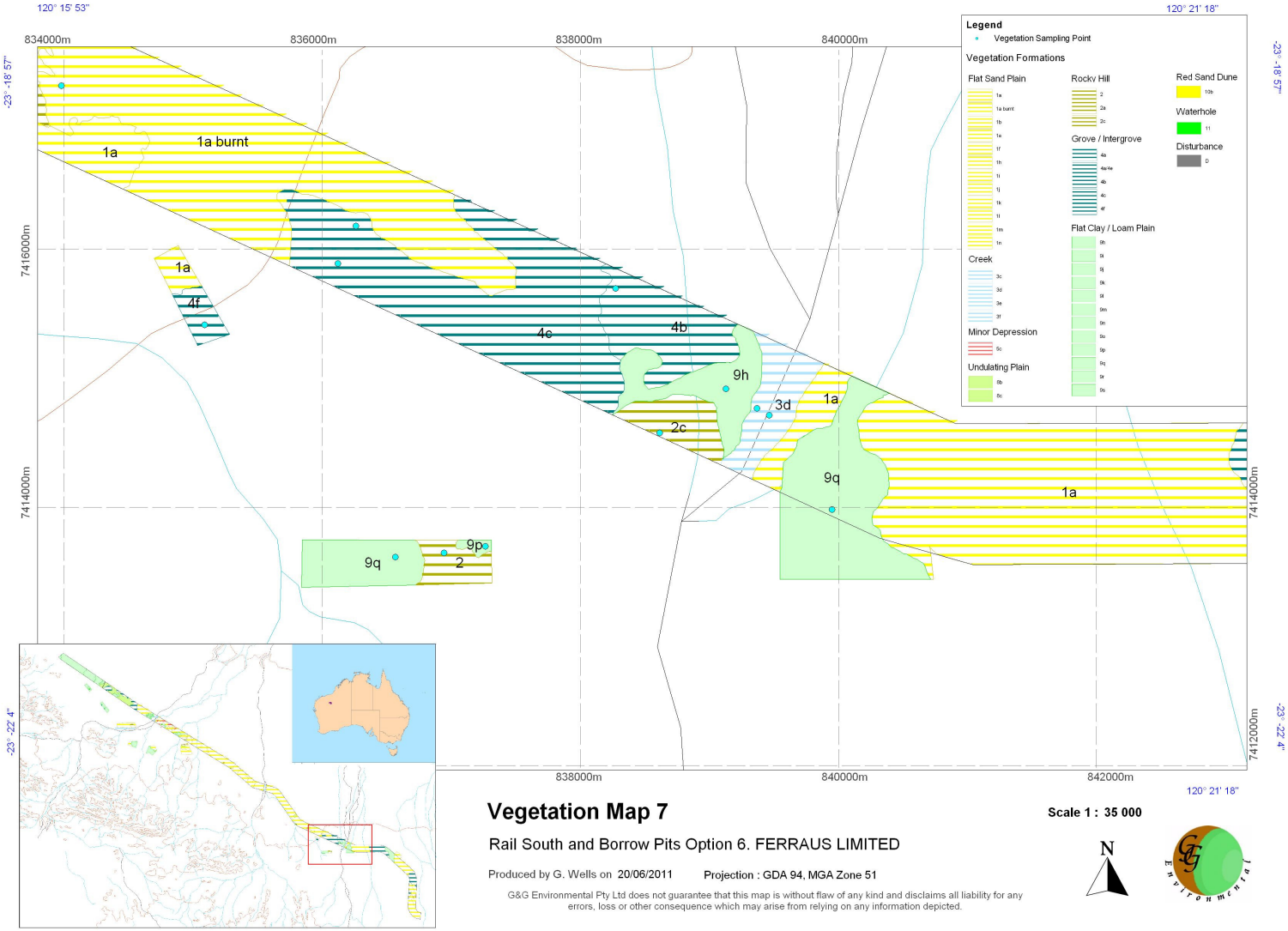


Vegetation Map 6

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 35 000

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51

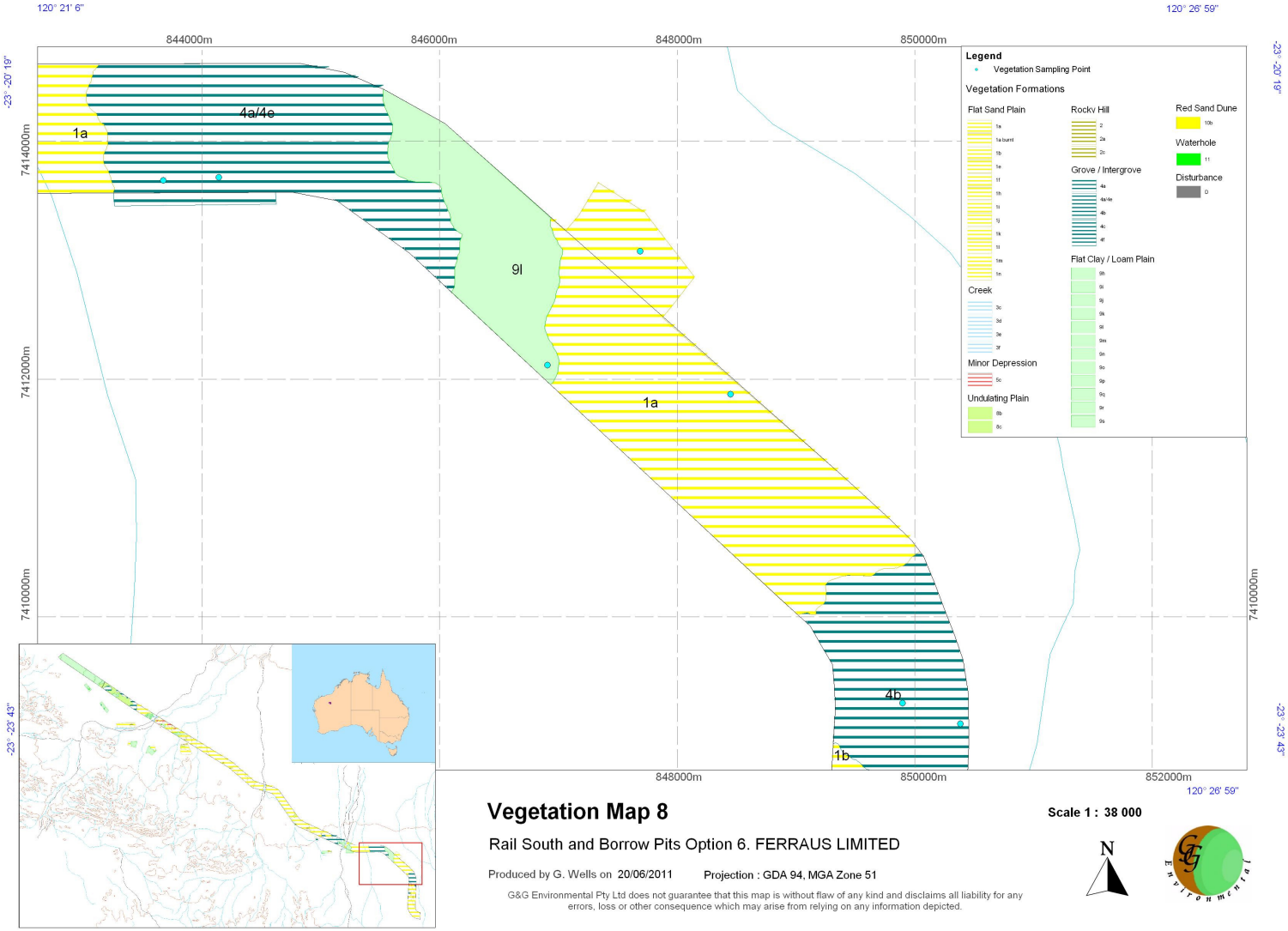


Vegetation Map 7

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Scale 1 : 35 000

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51



Vegetation Map 8

Rail South and Borrow Pits Option 6. FERRAUS LIMITED

Produced by G. Wells on 20/06/2011 Projection : GDA 94, MGA Zone 51

Scale 1 : 38 000

N

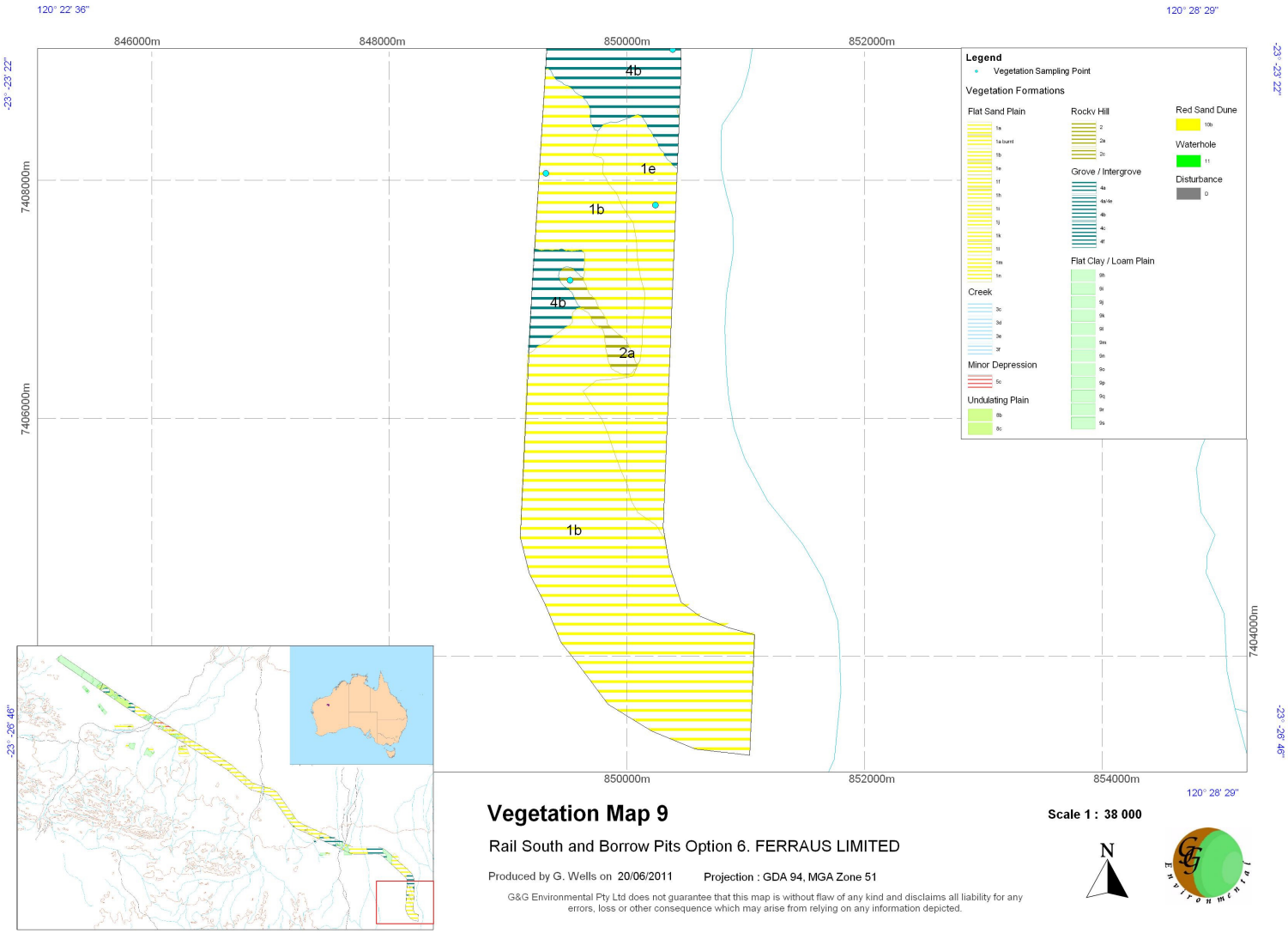

120° 22' 36"
120° 28' 29"
846000m
848000m
850000m
852000m
854000m
-23° 23' 22"
-23° 26' 46"
7408000m
7406000m
7404000m
4b
1e
1b
4b
2a
1b
Legend
Vegetation Sampling Point
Vegetation Formations
Flat Sand Plain
Rocky Hill
Red Sand Dune
Waterhole
Disturbance
Grove / Intergrove
Flat Clay / Loam Plain
Creek
Minor Depression
Undulating Plain
Vegetation Map 9
Rail South and Borrow Pits Option 6. FERRAUS LIMITED
Produced by G. Wells on 20/06/2011
Projection : GDA 94, MGA Zone 51
Scale 1 : 38 000
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Table 20: Vegetation sub-formations recorded during surveys and examples of sites where units were described.

Vegetation Description	Frequently Recorded Species	Photograph
Flat Sand Plain		
1a: Mixed *Acacia*, *Corymbia* and *Hakea* species scattered low trees or shrubs, over low to mid isolated shrubs to open shrubland over mid *Triodia basedowii* hummock grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura*, *Corymbia hamersleyana*, *Hakea chordophylla* and *H. lorea* subsp. *lorea* Mid Shrubs – *Acacia ancistrocarpa*, *A. dictyophleba*, *A. ligulata*, *A. tenuissima*, *A. trudgeniana* Low Shrubs – *Bonamia rosea*, *Halgania solanacea*, *Kennedia prorepens*, *Keraudrenia velutina* and *Leptosema chambersii* Grasses – *Triodia basedowii*, *T. schinzii* and *Paraneurachne muelleri*	
1a burnt: Isolated tall *Acacia* and *Hakea* species shrubs over a low mixed species shrubland in open low *Triodia basedowii* hummock grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura*, *Hakea chordophylla* and *H. lorea* subsp. *lorea* Mid Shrubs – *A. dictyophleba*, *A. trudgeniana* Low Shrubs –*Halgania solanacea*, *Keraudrenia velutina*, *Leptosema chambersii* and *Rulingia loxophylla* Grasses – *Triodia basedowii* and *T. schinzii.*	

1b: Isolated low trees to open low *Acacia aneura* woodland over isolated shrubs to open *Acacia*, *Eremophila* and *Senna* species low to mid shrubland over low to mid mixed grassland.	Trees/Tall Shrubs – *Acacia aneura* varieties, *A. distans*, *A. pruinocarpa*, *Hakea chordophylla* and *H. lorea* subsp. *lorea* Mid Shrubs – *Acacia sclerosperma*, *A. tenuissima*, *Eremophila fraseri*, *E. forrestii*, *Senna artemisioides* subsp. *helmsii* and *Senna glaucifolia* Low Shrubs –*Halgania solanacea*, *Solanum lasiophyllum* Grasses – *Aristida inaequiglumis*, *Cymbopogon obtectus*, *Eulalia aurea*, *Paraneurachne muelleri* and *Triodia basedowii.*	
1e - *Acacia aneura* low open woodland to low woodland/tall shrubland, over isolated mid *Eremophila* and *Senna* species shrubs over isolated low *Sida* species shrubs over low mixed grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura*, *A. pruinocarpa* and *A. sibirica* Mid Shrubs –*Eremophila forrestii*, *E. jucunda*, *Senna artemisioides* subsp. *helmsii*, *S. glaucifolia* and *Solanum phlomoides* Low Shrubs –*Sida fibulifera*, *Sida platycalyx* Grasses –*Eragrostis eriopoda Eulalia aurea* and *Triodia basedowii.*	
1f - Isolated *Acacia pruinocarpa* low trees and isolated tall mixed *Acacia* shrubs in an open low *Triodia basedowii* hummock grassland.	Trees –*A. pruinocarpa* Tall Shrubs –*Acacia aneura* var. *aneura, A. kempeana* and *A. tenuissima* Grasses –*Triodia basedowii.*	

1h - Isolated low *Acacia aneura*, *Corymbia candid* subsp. *dipsodes* and *C. hamersleyana* trees over isolated mid to tall mixed *Acacia* shrubs to open shrubland over isolated low mixed shrubs in a low *Triodia pungens* hummock grassland with large patches of mid *Eulalia aurea* tussock grassland in depressions.	Trees – *Acacia aneura*, *Corymbia candid* subsp. *dipsodes* and *C. hamersleyana* Mid Shrubs – *Acacia ancistrocarpa*, *A. dictyophleba*, *A. tetragonophylla*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs – *Bonamia rosea*, *Dicrastylis cordifolia*, *Euphorbia boophthona*, *Sida fibulifera* and *Solanum lasiophyllum* Grasses – *Aristida inaequiglumis*, *Chrysopogon fallax*, *Eulalia aurea* and *Triodia pungens*.	
1i - Isolated low *Corymbia candida* subsp. *dipsodes* and *C. hamersleyana* low trees over a mid to tall *Acacia ancistrocarpa* and *A. tenuissima* open shrubland over isolated low *Eremophila fraseri* shrubs in mixed low *Aristida holathera, Triodia. basedowii* and *T pungens* hummock tussock grassland.	Trees - *Acacia pruinocarpa*, *Corymbia candid* subsp. *dipsodes* and *C. hamersleyana* Mid/Tall Shrubs – *Acacia ancistrocarpa* and *A. tenuissima* Low Shrubs – *Eremophila fraseri*, *Psydrax latifolia*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Grasses – *Aristida holathera*, *Triodia basedowii* and *T. pungens*	
1j - Isolated low *Hakea lorea* trees over isolated tall *Acacia tenuissima* shrubs over a low mixed sparse shrubland in low open *Triodia basedowii* hummock grassland.	Trees – *Hakea lorea* Tall Shrubs – *Acacia dictyophleba* and *A. tenuissima* Low Shrubs – *Bonamia rosea*, *Diplopeltis stuartii*, *Halgania erecta*, *Newcastelia hexarrhena* and *Scaevola parvifolia* Grasses – *Triodia basedowii* and *T. schinzii*	

1k - Isolated low *Corymbia hamersleyana* trees over isolated mid to tall *Acacia*, *Grevillea* and *Hakea* shrubs over isolated low mixed shrubs to sparse low shrubland over a *Triodia basedowii* and *T. schinzii* hummock grassland.	Trees – *Corymbia hamersleyana* and *Hakea lorea* Mid/Tall Shrubs – *Acacia dictyophleba*, *A. tenuissima*, *Grevillea juncifolia* and *Hakea chordophylla* Low Shrubs – *Bonamia rosea*, *Rulingia loxophylla*, *Scaevola parvifolia* and *Solanum centrale* Grasses – *Aristida contorta*, *Amphipogon caricinus*, *Triodia basedowii* and *T. schinzii*	
1l - Isolated low *Corymbia* species trees over isolated low to mid mixed shrubs over isolated low *Eulalia aurea* tussocks to low tussock grassland.	Trees – *Corymbia candida* subsp. *dipsodes* and *C. hamersleyana* Mid Shrubs – *Acacia tenuissima* and *Hakea lorea* Low Shrubs – *Bonamia rosea*, *Dicrastylis cordifolia* and *Kennedia prorepens* Grasses – *Aristida contorta*, *Cymbopogon obtectus*, *Eragrostis eriopoda*, *Eriachne aristidae*, *Eulalia aurea*, *Paraneurachne muelleri* and *Triodia basedowii*	
1m - Isolated low *Acacia pruinocarpa* trees over a tall sparse *Acacia sclerosperma* and *A. tenuissima* shrubland over isolated mid *Senna artemisioides* subsp. *oligophylla* and *S. glutinosa* subsp. *pruinosa* shrubs over isolated mixed low shrubs over a low *Triodia basedowii* hummock grassland.	Trees – *Acacia pruinocarpa* Tall Shrubs – *Acacia sclerosperma* and *A. tenuissima* Mid Shrubs – *Hakea chordophylla*, *Senna artemisioides* subsp. *oligophylla* and *S. glutinosa* subsp. *pruinosa* Low Shrubs – *Eremophila jucunda*, *Ptilotus astrolasius* and *Senna notabilis* Grasses – *Eragrostis eriopoda*, *Triodia basedowii* and *Urochloa holosericea*	

1n - Isolated mid to tall *Acacia dictyophleba* and *A. sclerosperma* shrubs to open tall shrubland over isolated low *Senna artemisioides* subsp. *oligophylla* and *S. notabilis* shrubs over a mixed low open tussock and *Triodia basedowii* hummock grassland.	Trees – *Corymbia hamersleyana* Mid/Tall Shrubs – *Acacia dictyophleba* and *A. sclerosperma* Low Shrubs – *Abutilon leucopetalum*, *Corchorus sidoides*, *Senna artemisioides* subsp. *oligophylla* and *S. notabilis* Grasses – *Aristida contorta*, *Eragrostis eriopoda*, *Paraneurachne muelleri* and *Triodia basedowii*	
Rocky Hills		
2a - Isolated low mixed trees over isolated low to mid shrubs to open mixed shrubland in *Triodia wiseana* low hummock grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura, Grevillea berryana* Mid Shrubs – *Acacia maitlandii*, *A. marramamba*, *Eremophila latrobei* subsp. *latrobei* and *Senna glutinosa* varieties. Low Shrubs – *Eremophila exilifolia*, *E. jucunda* and *Keraudrenia velutina* Grasses – *Eragrostis eriopoda*, *Eriachne mucronata* and *Triodia wiseana*	

2c - Isolated mixed tall *Acacia* species shrubs over isolated *Senna glutinosa* subsp. *pruinosa* mid shrubs over isolated mixed low shrubs to low sparse shrubland over *Triodia wiseana* hummock grassland.	Tall Shrubs – *Acacia pruinocarpa* and *A. trudgeniana* Mid Shrubs – *Grevillea juncifolia*, *Ptilotus rotundifolius*, *Senna glutinosa* subsp. *pruinosa* and *Tribulus suberosus* Low Shrubs – *Acacia hilliana*, *Eremophila cuneifolia* and *Ptilotus calostachyus* Grasses – *Aristida contorta* and *Triodia wiseana*	
Rivers / Creeks		
3c - A low *Corymbia hamersleyana* woodland over a low to mid *Acacia sclerosperma* and *Corchorus parviflorus* shrubland over a mid *Triodia pungens* and *Cenchrus ciliaris* tussock grassland.	Trees – *Acacia pruinocarpa*, *Corymbia candida* subsp. *dipsodes* and *Corymbia hamersleyana* Low/Mid Shrubs – *Acacia sclerosperma*, *Atalaya hemiglauca* and *Corchorus parviflorus* Grasses – *Cenchrus ciliaris* and *Triodia pungens*	

3d - Low to mid isolated *Eucalyptus camaldulensis* trees to open woodland over a low *Acacia citrinoviridus* and *A. coriacea* subsp. *pendens* woodland over a sparse to open tall *Acacia citrinoviridus*, *A. pyrifolia* and *Melaleuca glomerata* open shrubland over mixed isolated shrubs in a mixed tussock to *Cenchrus ciliaris* low to mid tussock grassland with isolated sedges.	Trees – *Acacia citrinoviridus*, *A. coriacea* subsp. *pendens*, *A. pruinocarpa* and *Eucalyptus camaldulensis* Tall Shrubs – *Acacia citrinoviridus*, *A. pruinocarpa*, *A. sclerosperma* and *Melaleuca glomerata* Low/Mid Shrubs – *Corchorus sidoides* subsp. *sidoides*, *Euphorbia boophthona*, *Senna artemisioides* subsp. *helmsii* and *Tephrosia rosea* Grasses – *Cenchrus ciliaris*, *Chrysopogon fallax*, *Eulalia aurea* and *Themeda triandra* Sedges – *Cyperus vaginatus*	
3e - Isolated mid *Eucalyptus camaldulensis* trees over isolated to open low *Acacia citrinoviridus* woodland over isolated mixed tall and low shrubs in a mixed low to mid tussock and *Triodia pungens* hummock grassland.	Trees -*Acacia citrinoviridus*, *A. coriacea* subsp. *pendens* and *Eucalyptus camaldulensis* Low/Tall shrubs – *Acacia pyrifolia*, *Corchorus sidoides* subsp. *sidoides* and *Solanum lasiophyllum* Grasses – *Cenchrus ciliaris* and *Triodia pungens*	
3f - Isolated low *Acacia citrinoviridis* and *Corymbia hamersleyana* trees over a mid to tall *Acacia ancistrocarpa* shrubland over isolated mixed low shrubs in *Triodia basedowii* hummock grassland.	Trees – *Acacia citrinoviridus* and *Corymbia hamersleyana* Mid/Tall Shrubs – *Acacia ancistrocarpa*, *A. bivenosa*, *Eremophila longifolia* and *Santalum lanceolatum* Low Shrubs – *Bonamia rosea*, *Corchorus sidoides* subsp. *sidoides*, *Halgania solanacea* and *Hybanthus aurantiacus* Grasses – *Aristida inaequiglumis*, *Paraneurachne muelleri* and *Triodia basedowii*	

Grove / Intergrove		
4a –Low open mixed *Acacia* species woodland over isolated mixed low to mid shrubs in open *Triodia basedowii* hummock grassland.	Trees/Tall Shrubs – *Acacia aneura* var. *aneura, A. distans* and *A. paraneura* Low/Mid Shrubs – *Eremophila forrestii*, *E. jucunda*, *Hibiscus burtonii*, *Psydrax latifolia* and *Sida fibulifera* Grasses – *Eragrostis eriopoda*, *Triodia basedowii*	
4b –Low *Acacia aneura* woodland over isolated clumps of low *Eremophila lanceolata* shrubs in low open mixed tussock grassland	Trees/Tall Shrubs – *Acacia aneura* var. *aneura* Low/Mid Shrubs – *Eremophila lanceolata*, *Senna artemisioides* subsp. *helmsii*, *S. glaucifolia*, *Sida platycalyx* Grasses – *Aristida inaequiglumis*, *Cymbopogon obtectus*, *Eulalia aurea* and *Monachather paradoxa*	

4d - Low *Acacia aneura* open forest to forest over isolated low *Acacia aneura* shrubs over isolated low mixed tussock hummock grasses.	Trees – *Acacia aneura*, *A. pruinocarpa* and *Corymbia candida* subsp. *dipsodes* Mid/Tall Shrubs – *Acacia aneura*, *A. tetragonophylla* and *Psydrax latifolia* Low Shrubs – *Enchylaena tomentosa* and *Maireana planifolia* Grasses – *Chrysopogon fallax* and *Triodia pungens*	
4e - Isolated low *Acacia aneura* trees over a sparse mid to tall *Acacia xiphophylla* shrubland over isolated mixed mid shrubs over isolated low *Ptilotus obovatus* shrubs over bare ground.	Trees – *Acacia aneura* and *a. pruinocarpa* Mid Shrubs – *Acacia xiphophylla* and *Eremophila fraseri* Low Shrubs – *Enchylaena tomentosa*, *Eremophila margarethae* and *Ptilotus obovatus*	
4f - A mid *Acacia aneura* var. *pilbarana* open forest over isolated low *Corymbia candida subsp. dipsodes* trees over tall *A. distans* shrubs over isolated mixed low to mid shrubs in an open low *Chrysopogon fallax* tussock grassland.	Trees – *Acacia aneura* var. *pilbarana* and *Corymbia candida* subsp. *dipsodes* Mid/Tall Shrubs – *Acacia distans*, *Eremophila latrobei* subsp. *filiformis*, *Hakea chordophylla* and *Psydrax latifolia* Low Shrubs – *Eremophila lanceolata*, *Hibiscus burtonii*, *Ptilotus obovatus* and *Sida platycalyx* Grasses – *Chrysopogon fallax* and *Eragrostis eriopoda*	

Minor Depression		
5c - A sparse mid *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* shrubland over isolated low mixed shrubs over isolated low *Triodia pungens* hummock grasses.	Mid Shrubs – *Acacia dictyophleba*, *Senna artemisioides* subsp. *helmsii*, *S. artemisioides* subsp. *oligophylla* and *Senna sericea* Low Shrubs – *Eremophila lanceolata*, *Hibiscus burtonii* and *Sclerolaena cornishiana* Grasses – *Eragrostis eriopoda* and *Triodia pungens*	
Undulating Plain		
8b - Isolated low *Acacia pruinocarpa* trees over patches of low *Eucalyptus gamophylla* open mallee woodland over isolated mid to tall *Grevillea juncifolia*, *Psydrax latifolia* and *Senna* species shrubs in a low to mid *Triodia basedowii* hummock grassland.	Trees/Mallee – *Acacia pruinocarpa* and *Eucalyptus gamophylla* Mid/Tall Shrubs – *Grevillea juncifolia*, *Psydrax latifolia*, *Senna artemisioides* subsp. *helmsii* and *S. glutinosa* Low Shrubs – *Ptilotus obovatus* and *Solanum lasiophyllum* Grasses – *Triodia basedowii*	

8c - Isolated mixed low *Acacia* species trees over a low sparse *Eremophila cuneifolia, Ptilotus obovatus* and *Senna artemisioides* subsp. *helmsii* shrubland over isolated low mixed tussock and *Triodia basedowii* hummock grasses.	Trees – *Acacia aneura* Mid/Tall Shrubs – *Acacia synchronicia*, *A. tenuissima* and *A. tetragonophylla* Low Shrubs - *Eremophila cuneifolia, Ptilotus obovatus* and *Senna artemisioides* subsp. *helmsii* Grasses – *Aristida contorta*, *Cymbopogon ambiguus*, *Eragrostis xerophila* and *Triodia basedowii*	
Flat Clay/Loam Plain		
9h - Isolated low *Acacia aneura* and *A. pruinocarpa* trees to low woodland over isolated mid to tall *Acacia* and *Senna* shrubs over isolated low shrubs to low open *Sida platycalyx* and *Solanum lasiophyllum* shrubland over isolated low tussock grasses.	Trees - *Acacia aneura* and *A. pruinocarpa* Mid/Tall Shrubs – *Acacia synchronicia*, *A. tetragonophylla*, *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs - *Eremophila lanceolata, Hibiscus burtonii, Sida platycalyx* and *Solanum lasiophyllum* Grasses – *Aristida inaequiglumis*, *Cymbopogon obtectus*, *Eragrostis eriopoda* and *Eulalia aurea*	

9i - Isolated *Corymbia hamersleyana* trees over isolated low *Acacia aneura* trees to low open woodland over isolated mid *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* shrubs over isolated low mixed shrubs over isolated low mixed tussock grasses.	Trees - *Acacia aneura*, *A. pruinocarpa* and *Corymbia hamersleyana* Mid Shrubs – *Acacia tetragonophylla, Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs – *Abutilon leucopetalum*, *Eremophila lanceolata*, *Gomphrena kanisii*, *Sida fibulifera*, *Sida platycalyx* and *Solanum lasiophyllum* Grasses – *Aristida contorta*, *A. inaequiglumis*, *Enneapogon robustissimus* and *Triodia basedowii*	
9j - Isolated low *Acacia aneura* trees to open low woodland over isolated tall *Acacia aneura* and *A. tetragonophylla* shrubs to *Acacia aneura* scrub over isolated *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* shrubs over isolated low *Sida platycalyx* and *Solanum lasiophyllum* shrubs over isolated mixed low tussocks.	Trees – *Acacia aneura* Tall Shrubs – *Acacia aneura* and *A. tetragonophylla* Mid Shrubs – *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs – *Euphorbia boophthona*, *Sida platycalyx* and *Solanum lasiophyllum* Grasses – *Aristida contorta, Chrysopogon fallax* and *Triodia schinzii*	
9k - Isolated mixed *Acacia* species low trees over isolated mid *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* shrubs over isolated mixed low chenopod shrubs and herbs with isolated tussock grasses.	Trees – *acacia paraneura*, *A. pruinocarpa* and *A. synchronicia* Mid Shrubs - *Senna artemisioides* subsp. *helmsii* and *S. artemisioides* subsp. *oligophylla* Low Shrubs – *Eremophila lanceolata*, *Maireana villosa*, *Salsola tragus*, *Sclerolaena cornishiana*, *S. tetragona* and *Sida platycalyx* Grasses – *Aristida contorta*, *Enneapogon robustissimus*, *Eragrostis cumingii* and *E. pergracilis*	

9l - Isolated low *Acacia aneura* and *Corymbia hamersleyana* trees over isolated clumps of mid to tall *Acacia ancistrocarpa* and *A. aneura* shrubs over isolated low mixed shrubs in a mid *Triodia basedowii* hummock grassland.	Trees - *Acacia aneura* and *Corymbia hamersleyana* Mid/Tall Shrubs – *Acacia aneura*, *A. ancistrocarpa* and *Hakea chordophylla* Low Shrubs – *Hybanthus aurantiacus*, *Kennedia prorepens* and *Solanum lasiophyllum* Grasses – *Triodia basedowii*	
9m - Isolated low *Acacia aneura* and *A. pruinocarpa* trees over open mid to tall *A. ancistrocarpa* and *A. tenuissima* shrubland over isolated mixed low shrubs in an *Aristida inaequiglumis* and *Triodia basedowii* low tussock/hummock grassland.	Trees - *Acacia aneura* and *A. pruinocarpa* Mid/Tall shrubs – *Acacia ancistrocarpa*, *a. tenuissima*, *Eremophila forrestii*, *Hakea lorea* and *Psydrax latifolia* Low Shrubs – *Corchorus sidoides*, *Euphorbia boophthona*, *Hibiscus burtonii*, *Scaevola parvifolia*, *Sida platycalyx* and *Solanum lasiophyllum* Grasses - *Aristida contorta, A. inaequiglumis, Cymbopogon obtectus, Paraneurachne muelleri* and *Triodia basedowii*	

9n - Isolated low *Acacia distans* and *Corymbia hamersleyana* trees over a sparse mid *Acacia ancistrocarpa* and *A. tenuissima* shrubland over isolated mixed low shrubs in a low open mixed tussock grassland.	Trees - *Acacia distans* and *Corymbia hamersleyana* Mid Shrubs - *Acacia ancistrocarpa*, *A. tenuissima* and *Senna artemisioi8des* subsp. *helmsii* Low Shrubs – *Abutilon leucopetalum*, *Hibiscus brachychlaenus* and *Sclerolaena cornishiana* Grasses – *Aristida inaequiglumis*, *Eragrostis eriopoda* and *Paraneurachne muelleri*	
9o - Isolated low mallee trees to open low mallee woodland over sparse to open mid to tall mixed *Acacia* shrubland over isolated mixed shrubs in a low *Aristida inaequiglumis* and *Triodia basedowii* open tussock/hummock grassland.	Trees/Mallee – *Eucalyptus gamophylla* Mid/Tall shrubs – *Acacia ancistrocarpa*, *A. bivenosa*, *A. dictyophleba* and *A. tenuissima* Low Shrubs – *Rulingia loxophylla*, *Senna notabilis*, *Sida cardiophylla* and *Solanum lasiophyllum* Grasses – *Aristida inaequiglumis*, *Cymbopogon obtectus*, *Paraneurachne muelleri* and *Triodia basedowii*	

9p - A low mixed *Acacia* species open woodland over a sparse low *Eremophila forrestii* and *Ptilotus obovatus* shrubland over isolated low *Triodia basedowii* hummock grasses.	Trees – *Acacia aneura*, *A. distans* and *A. sibirica* Low Shrubs - *Eremophila forrestii* and *Ptilotus obovatus* Grasses – *Triodia basedowii*	
9q - A low *Acacia aneura* and *A. pruinocarpa* woodland over a sparse mid to tall mixed shrubland over isolated low shrubs in a low *Triodia basedowii* hummock grassland.	Trees – *Acacia aneura* and *A. pruinocarpa* Mid/Tall Shrubs – *Acacia ancistrocarpa*, *Eremophila forrestii*, *Hakea lorea*, *Psydrax latifolia*, *Senna artemisioides* subsp. *helmsii* Low Shrubs – *Senna glaucifolia* and *Solanum lasiophyllum* Grasses – *Triodia basedowii*	

9r - Isolated low *Acacia aneura* var. *pilbarana* and *A. paraneura* trees over a tall *A. tenuissima* shrubland over mixed isolated low shrubs and tussock grasses.	Trees - *Acacia aneura* var. *pilbarana* and *A. paraneura* Tall Shrubs – *Acacia tenuissima* and *A. tetragonophylla* Low Shrubs – *Anthobolus leptomerioides*, *Dodonaea petiolaris* and *Solanum lasiophyllum* Grasses – *Eragrostis eriopoda* and *Paraneurachne muelleri*	
9s - Low *Corymbia hamersleyana* and *Eucalyptus gamophylla* woodland over a mid to tall open *Acacia ancistrocarpa* and *A. bivenosa* shrubland in a low closed *Triodia pungens* and *T. wiseana* hummock grassland.	Tree/Mallee - *Corymbia hamersleyana* and *Eucalyptus gamophylla* Mid/Tall Shrubs - *Acacia ancistrocarpa*, *A. bivenosa* and *Hakea chordophylla* Low Shrubs – *Kennedia prorepens, Scaevola parvifolia* and *Sida platycalyx* Grasses – *Triodia pungens* and *T. wiseana*	
Red Sand Dune		

10b - Isolated mid to tall *Acacia dictyophleba*, *A. sclerosperma* and *Clerodendrum floribundum* shrubs over isolated low *Leiocarpa semiclava* subsp. *semiclava* and *Scaevola parvifolia* shrubs in a *Aristida contorta*, *Paractaenum refractum*, *Triodia basedowii* and *T. schinzii* low open tussock/hummock grassland.	Mid/Tall shrubs – *Acacia dictyophleba*, *A. sclerosperma*, *A. tenuissima*, *Eremophila longifolia* and *Clerodendrum floribundum* Low Shrubs – *Bonamia rosea*, *Hibiscus brachychlaenus*, *Leiocarpa semiclava* subsp. *semiclava* and *Scaevola parvifolia* Grasses – *Eragrostis eriopoda*, *Paractaenum refractum*, *Triodia basedowii* and *T. schinzii*	
Waterhole		
11 - A mid *Corymbia candida* subsp. *dipsodes* woodland over a tall mixed *Acacia* species shrubland over a low mixed herb land.	Trees – *Corymbia candida* subsp. *dipsodes* Tall Shrubs – *Acacia aneura*, *A. citrinoviridus*, *A. pruinocarpa*, *A. sclerosperma* and *A. tetragonophylla* Herbs – *Centipeda minima* subsp. *macrocephala*, *Indigofera colutea* and *Neptunia dimorphantha* Grasses -	

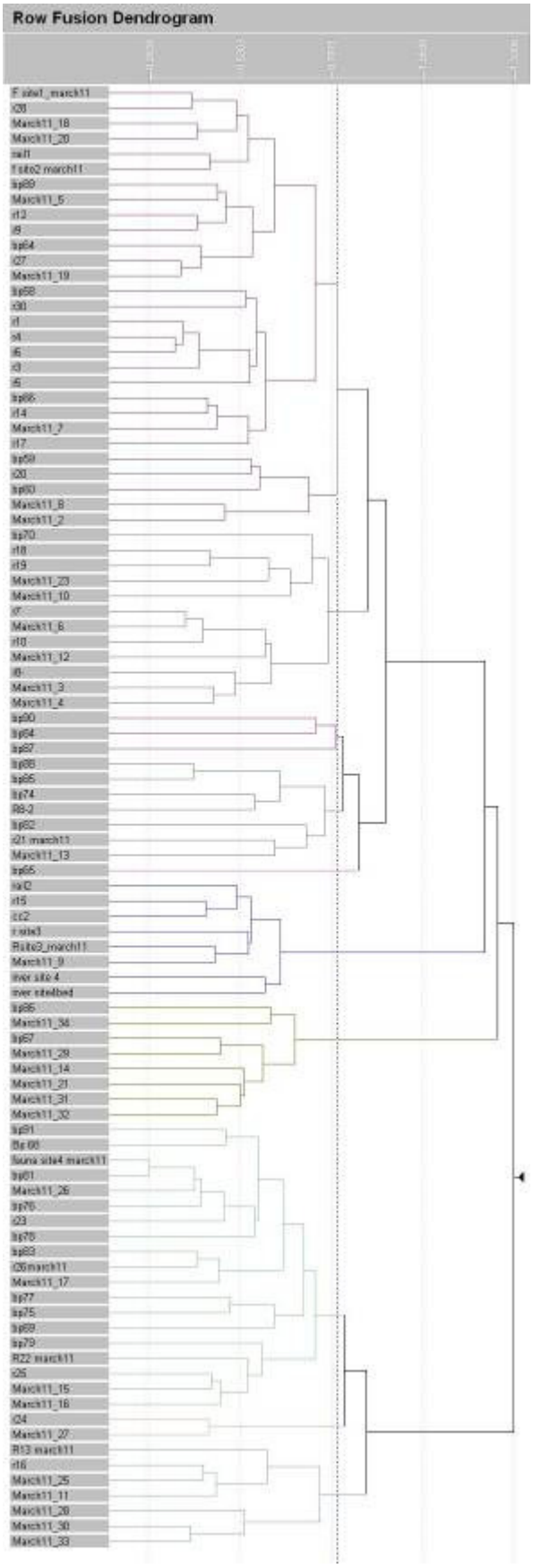

Figure 10: Dendogram of quadrat survey sites for the current survey of the FEPR southern section corridor and borrow pit options.

Table 21: Comparison of floristic data from the current survey with previous flora surveys conducted in the Gascoyne and Pilbara bioregions.

Survey	Area	Vegetation Types	Taxa	Families	Genera
Van Vreeswyk *et al.* (2004)	~181723 km^2	44	1137	98	348
Mattiske (2005)	~250 km^2	18	234	41	106
Biota (2004)	>500 km^2	122	762	69	218
G&G Environmental (2008)	~18km^2	81	213	45	106
G&G Environmental (2011)	~160 km^2	19	482	48	165
Rail Corridor	~89km^2	41	340	46	147

Table 22: Classification of vegetation sub-formations according to the major vegetation groups of Australia.

Vegetation Sub-formations	Major Vegetation Group
1a, 1a burnt, 1f, 1j, 1k, 2a, 2c, 8b, 9l	Hummock Grasslands
1e, 4d, 4f	*Acacia* forests and woodlands
1b, 4a, 4b, 4c, 9h, 9j, 9p, 9q	*Acacia* open woodlands
1h, 1i, 1n, 3f, 9k, 9l, 9m, 9n, 9r	*Acacia* shrublands
5c, 8c	Other shrublands
3c, 3d, 3e, 9o, 9s, 11	Eucalypt woodlands
1l	Tussock grasslands
10b	Grasslands

The majority of the sub-formations also resembled the regional site types of Van Vreeswyk *et al.* (2004). The 1a vegetation sub-formation was recorded on red sandplains and resembles the SSSG and SHSG site types both of which were described as common and widespread on red sandplains and are important habitat for a wide range of fauna dependent on *Triodia* grasses for food or shelter. SHSG occurs at the Rudall River National Park and extensively on UCL. SSSG occurs at the Cane River Nature Reserve and has been recorded on UCL. Large patches of the 1a sub-formation had been burnt in recent years and at the time of monitoring numerous short-lived; fire ephemeral shrubs formed a low regrowth shrubland. Over the course of a few seasons (in the absence of further fire) these areas are expected to mature and resemble the 1a sub-formation.

Vegetation sub-formation 1b was recorded on red sandplains and resembled the widespread PSSG site type. PSSG occurs extensively on stony, loamy and gritty plains, is common on UCL and occurs in nature reserves including Karijini and Millstream-Chichester National Parks, Cane River Nature Reserve and Meentheena pastoral lease.

Vegetation sub-formation 1e was recorded in groves on flat red sandplains and resembles the widespread GMGW site type recorded on washplains and drainage tracts. GMGW is favoured by domestic stock and is important habitat for native fauna. It has been recorded at Karijini National Park and occurs on UCL.

The vegetation sub-formation 1f occurring on flat loamy plains and sub-formation 9q recorded on flat clay/loam plains floristically resemble the PMSS site type described as widespread on stony plains, loamy plains and hardpan plains and is well represented in conservation reserves including Karijini National Park and UCL.

Vegetation sub-formations 1h and 1i resembled the ASSG site type that occurs widely on alluvial plains and drainage floors in sandy soils and has been recorded at the Cane River Nature Reserve, the Meentheena pastoral lease and on UCL.

Vegetation sub-formations 1j, 1k, 1m and 1n resemble the SBAS site type that occurs on deep sands on sand banks. SBAS is a distinct site type and changes abruptly to other site types on plains. It is not represented in the conservation estate or on UCL.

Vegetation sub-formation 1l was recorded in a slight depression in a red sandplain and resembled the DEGW site type that occurs mainly on narrow drainage floors but also on drainage foci. DEGW is described as widespread and was recorded at Karijini National Park, Cane River Nature Reserve, Meentheena pastoral lease and on UCL.

Vegetation sub-formations 2a and 2c recorded on low rocky hills resemble the HSPG site type. HSPG was recorded on hills, ridges and footslopes and is represented in conservation reserves including Karijin National Park and Meentheena pastoral lease and occurs extensively on UCL.

Vegetation sub-formation 3c occurred on the banks of a minor creek, sub-formation 4a was recorded in a grove and sub-formations 9n and 9s were recorded on a flat clay/loam plain. These sub-formations resemble the DAHW site type recorded on narrow drainage floors and occasionally as groves on washplains and is well represented in conservation reserves including Karijini National Park and Meentheena pastoral lease and is common on UCL.

Vegetation sub-formations 3d and 3e occurred along the same river system and differed primarily due to an infestation of the weed species *Cenchrus ciliaris*. These sub-formations resemble the GMEW site type recorded on the banks of rivers and occurs at the Karijini and Millstream-Chichester National Parks. It is well represented on UCL.

Vegetation sub-formation 3f resembled the DEGW site type that is widespread and was recorded at Karijini National Park, Cane River Nature Reserve, Meentheena pastoral lease and on UCL.

Vegetation sub-formation 4b and 4f recorded in groves resemble the GMUW site type recorded on hardpan washplains as bands of dense vegetation separated by inter-grove plains supporting much sparser vegetation. GMUW is represented at Karijini National Park and was recorded at a few locations on UCL. Van Vreeswyk *et al* (2004) note that this site type is important habitat for both native animals and favoured by domestic stock, and will degrade if overland sheet flow to the grove is disrupted.

Vegetation sub-formation 4d recorded on a flat plain resembles the PMCS site type. PMCS occurs on plains and drainage tracts. It is a minor site type in the Pilbara survey area but has been previously described in the Murchison, Sandstone- Yalgoo-Paynes Find and north-eastern Goldfields survey areas, and is represented in Karijini National Park.

Vegetation sub-formation 4e recorded on flat plains in a mosaic with sub-formation 4a resembles the PSCS site type that occurs on stony, gravelly plains and alluvial plains. PSCS is represented in Karijini National Park and Cane River Nature Reserve.

Vegetation sub-formation 5c recorded in a depression in a flat plain resembles the ARPG site type common on level plains with gilgai microrelief in cracking and/or saline clays. ARPG was recorded on UCL and is known to occur in the conservation estate.

Vegetation sub-formation 8b and 8c recorded on undulating plains resembled the SHSG site type common on sandplains, gravelly sandplains and dunes. It occurs at Rudall River National Park and extensively on UCL.

The 9h sub-formation resembles the LHAS site type that occurs on plains on hardpan with ironstone gravel or pebbles. LHAS has been recorded on four land systems in the Pilbara but is not represented in the conservation estate or on UCL.

Vegetation sub-formations 9i, 9j and 9k resemble the PXHS site type that occurs on level plains and drainage floors. PXHS is a site type found in patches in the south-eastern Pilbara but rarely over areas more than a few kilometres in extent. It is considerably more extensive in southern Rangelands and has previously been recorded in the Murchison River catchment and north-eastern Goldfields.

Vegetation sub-formations 9l, 9m resemble the AHSG site type that occurs widely on alluvial plains and drainage tracts usually with non-cracking, weakly saline, sand duplex and clay soils. AHSG was recorded at the Cane River Nature Reserve, Meentheena pastoral lease and on UCL.

The 9o sub-formation recorded on flat clay/loam plain floristically resembles the SHSG site type recorded on sand plain. SHSG occurs at the Rudall River National Park and extensively on UCL.

Vegetation sub-formation 9q resembles the PMSS site type described as widespread on stony plains, loamy plains and hardpan plains and is well represented in conservation reserves including Karijini National Park. It also occurs on UCL.

Vegetation sub-formation 9r recorded on flat clay/loam plains resembles the PSMS site type that is common on wash plains, hardpan, stony plains and low rises. PSMS is represented in the Karijini National Park and on UCL.

Sub-formation 10b recorded on isolated red sand dunes and sub-formation 11 recorded on the banks of a permanent waterhole do not resembled any of the site types described by Van Vreeswyk *et al* (2004).

3.3.2 Vegetation Condition

The majority (95.9%) of the vegetation in the FEPR southern rail corridor and borrow pit options was considered to be in pristine or excellent condition (71.9% and 24.0% respectively). Condition in four (4.1%) survey quadrats was recorded as very good. An area where the corridor option intercepts the Newman to Nullagine road was mapped as disturbed.

Disturbance from grazing/trampling of vegetation by stock, vehicle access tracks, exploration drill pads and drill lines were the primary causes of vegetation attaining an excellent rather than pristine rating. High density weed infestations, the presence of multiple vehicle tracks and intensive overgrazing reduced condition to very good.

3.3.3 Flora

A total of 340 taxa recorded in the quadrat surveys (**Appendix G**) comprised 236 perennial and 104 annual species. The identity of seven species could only be identified to genus level due to absence of reproductive structures at the time of the surveys. The genera closely resemble common unthreatened species.

The 340 taxa represent 46 families and 147 genera. The most prominent families were the Fabaceae (63 taxa), Poaceae (45), Malvaceae (29), Asteraceae (23) and Amaranthaceae (21). The Goodeniaceae (17), Chenopodiaceae (13), Scrophulariaceae (12), Convolvulaceae (10) and Myrtaceae (10) were also well represented. The most prominent genera included *Acacia* (31), *Ptilotus* (16), *Eremophila* (12), *Senna* (12), *Goodenia* (11) and *Sida* (11). *Heliotropium* (6), *Solanum* (6), *Euphorbia* (5) and *Tribulus* (5) were also well represented.

The dominant families recorded within the southern rail corridor were also dominant in flora surveys conducted in the adjacent Pilbara bioregion and the FPP (**Table 23**).The number of taxa (**Table 22**) compares favourably with other flora surveys in the Gascoyne and Pilbara bioregion. The number of taxa recorded per km^2 of survey area is higher than in prior surveys in the Pilbara bioregion and similar to that recorded at the associated FPP. *Acacia aneura* varieties, *A. pruinocarpa*, *Corymbia hamersleyana* and *Hakea lorea* subsp. *lorea* were the most widespread trees within the rail corridor. Widespread mid to tall shrubs included *Acacia ancistrocarpa*, *A. dictyophleba*, *A. tenuissima*, *A. tetragonophylla*, *Eremophila forrestii* subsp. *forrestii*, *Psydrax latifolia*, *Senna artemisioides* subsp. *helmsii*, *S. artemisioides* subsp. *oligophylla* and *S. glutinosa* subsp. *pruinosa*. Common low shrubs included *Bonamia rosea*, *Dicrastylis cordifolia*, *Eremophila lanceolata*, *Halgania solanacea*, *Hibiscus burtonii*, *Maireana planifolia*, *Ptilotus obovatus*, *Scaevola parvifolia* subsp. *Pilbarae*, *Senna notabilis*, *Sida fibulifera*, *S. platycalyx*, and *Solanum lasiophyllum*. The most widely distributed perennial grasses included spinifex (*Triodia basedowii*) and tussock grasses including *Aristida inaequiglumis*, *Chrysopogon fallax*, *Cymbopogon obtectus*, *Eragrostis eriopoda*, *Eulalia aurea* and *Paraneurachne muelleri*. The annual grasses *Aristida contorta*, *Enneapogon pallidus* and *Eriachne aristidae* were widespread following seasonal rainfall. Common herbs included *Boerhavia coccinea*, *Duperreya commixta*, *Euphorbia boophthona*, *Evolvulus alsinoides* var. *villosicalyx*, *Gomphrena kanisii*, *Goodenia triodiophila*, *Polycarpaea corymbosa*, *Ptilotus exaltatus*, *P. polystachyus*, *Sclerolaena cornishiana* and *Trichodesma zeylanicum*.

Table 23: Dominant families and the proportion of the total number of species recorded for flora surveys in Western Australia.

	Biota 2004	Mattiske 2005/Biota 2005	G&G Environmental 2011	Rail Corridor
AMARANTHACEAE	39	36	18	21
ASTERACEAE	36	39	33	23
BORAGINACEAE	20	9	13	9
CONVOLVULACEAE	26	13	14	10
CHENOPODIACEAE	43	21	23	13
FABACEAE	165	143	95	63
GOODENIACEAE	26	20	22	17
MALVACEAE	31	77	49	29
MYRTACEAE	17	18	13	10
POACEAE	121	34	70	45
SCROPHULARIACEAE	11	16	18	12
% Species Recorded	70.2	68.8	76.3	74.0

3.3.3.1 Species Range Extensions

Review of the distribution of each of the species recorded in the rail corridor on NatureMap (2011) and Florabase (2011) identified apparent range extensions for 14 species (**Table 24**). Each of the species were recorded in habitats and soil types that match descriptions on FloraBase (2011).

Atalaya hemiglauca was recorded at a single location in riparian vegetation of a large river in vegetation sub-formation 3d. *Cullen leucanthum* at a single location in riparian vegetation of Jimblebar creek also in sub-formation 3d. *Enneapogon pallidus* in 25 quadrat surveys in a variety of habitats and vegetation types including mulga groves, crabhole claypans, flat plains, hill slopes and riparian vegetation of rivers and creeks in sub-formations 4a, 4b, 8c, 9h, 9o and 9i. *Fimbristylis simulans* in four quadrats all of which occurred on the slopes of low rocky hills (sub-formations 2a and 2c). *Gossypium robinsonii* at one location, riparian vegetation of Jimblebar creek (3d). *Heliotropium heteranthum* at four locations in clay soils in a mulga grove, a crabhole claypan and two floodplains in sub-formation 9h. *Indigofera hirsuta* at a single location on the slope of a low rocky rise in sub-formation 8b. *Oldenlandia corymbosa* at one location in clay soil on a flat plain. *Oldenlandia pterospora* on two small red sand dunes (10b). *Operculina aequisepala* at a single location in a loamy clay soil on a flat plain (9h). *Polygala arvensis* at a single location in red loamy sand on a flat plain (9h). *Senna ferraria* in one quadrat growing in red loamy clay on a flat plain (9h). *Sida* sp. articulation below in one quadrat, one on a rocky outcrop in *Triodia wiseana* hummock grassland (2a). *Triumfetta ramosa* at one location in riparian vegetation of Jimblebar creek (3d).

Identifications of range extensions for flora are a common occurrence of surveys conducted for environmental impact assessment. For example, range extensions for 10 species (Mattiske 2008), 9 species (Biota 2004) and 8 species (Mattiske 2005) were identified in surveys conducted in the Pilbara bioregion. These range extensions reflect the increased knowledge of the flora that arises from comprehensive ground surveys conducted in greenfield areas. The rail corridor is situated in a greenfields area to the south-east of operating mines in the Pilbara bioregion. The position of the

survey area accounts for the majority of the range extensions which are small south-east extensions of the mapped range.

3.3.2.3 Declared Rare/Priority Flora

No T were recorded in the rail corridor survey area two priority flora were recorded, *Olearia mucronata* (P3) and *Goodenia nuda* (P4) (**Figure 6**). NatureMap (2011) lists 17 records for *Olearia mucronata* with a distribution that extends from the Pilbara bioregion to the Murchison. The survey area lies within the mapped range of the species. A solitary plant was recorded at a single location in vegetation sub-formation 9i on a flat clay/loam plain.

NatureMap (2011) lists 42 records for *Goodenia nuda* with a distribution that extends across the Pilbara bioregion and into the Gascoyne and Little Sandy Desert bioregions. The survey area lies within the mapped range of the species. Solitary plants were recorded at two locations one in a mulga grove (vegetation subformation 4a) and the other on a flat clay/loam plain in vegetation 9h.

Table 24: Description of apparent range extensions for species based on the location of the survey area and the mapped range for each species provided on NatureMap (2011) and Florabase (2011).

SPECIES	RANGE EXTENSION DETAILS
Atalaya hemiglauca	A small south-eastern extension of the mapped range.
Cullen leucanthum	A small south-eastern extension of the mapped range.
Enneapogon pallidus	A small south-eastern extension of the mapped range.
Fimbristylis simulans	A small south-eastern extension of the mapped range.
Gossypium robinsonii	A small south-eastern extension of the mapped range.
Heliotropium heteranthum	A small south-eastern extension of the mapped range.
Indigofera hirsuta	A small south-eastern extension of the mapped range.
Oldenlandia corymbosa	A large south-western extension of the mapped range, previously not recorded in the Gascoyne or Pilbara bioregions.
Oldenlandia pterospora	A small south-western extension of the mapped range.
Operculina aequisepala	A small south-eastern extension of the mapped range.
Polygala arvensis	A large south-western extension of the mapped range, previously not recorded in the Gascoyne or Pilbara bioregions.
Senna ferraria	A substantial eastern extension of the mapped range.
Sida sp. articulation below	A substantial southern extension of the mapped range.
Triumfetta ramosa	A substantial south-eastern extension of the mapped range.

Five introduced flora were recorded in the rail corridor survey area, *Bidens bipinnata*, *Cenchrus ciliaris*, *Malvastrum americanum*, *Portulaca oleracea* and *Sonchus oleraceus*. *Bidens bipinnata* in seven quadrats, all of which were in groves or riparian vegetation. *Cenchrus ciliaris* in 13 quadrats on the slopes of low hills, flat floodplains, groves and riparian vegetation. This species was the dominant grass at five locations and these large infestations resulted in the condition rating of the vegetation to be downgraded from pristine to excellent or very good. *Malvastrum americanum* was recorded in four quadrats, two in riparian vegetation, one adjacent a waterhole and one in a mulga grove. At the waterhole the species was present t such densities that the condition of the vegetation was downgraded from pristine to very good. *Portulaca oleracea* was the most widespread introduced species recorded in almost half (46.9%) of the quadrat surveys in various vegetation assemblages and habitats. The species was rarely present in large densities and as such condition of the vegetation at most of the sites was still recorded as pristine. A small number of plants of *Sonchus oleraceus* were recorded at a single location in a mulga grove.

Distribution maps (Florabase 2011) and Naturemap 2011) identify that each of the introduced species have been previously recorded in the Gascoyne and Pilbara bioregions and have wide distributions across Western Australia. None of the species is a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*.

3.3.4 Assessment of the Potential Conservation Significance of the Land Systems and Vegetation of the Survey Areas

The FEPR southern rail corridor option intercepts nine land systems (**Figure 5, Table 25**). Less than one tenth of a percent of the Boolgeeda, Jamindie, Newman and River land systems occur within the corridor option and it is therefore considered that it has little conservation value for these systems.

The Cadgie, Fan and Washplain land systems comprised less than 1% of the Pilbara rangeland survey and over half a percent of each of these restricted systems occurs within the corridor option. Also, approximately 1% of the more widely distributed Divide land system occurs in the corridor option. It is may be considered that the southern rail corridor option has a moderate conservation value for these land systems.

In excess of 1.5% of the Fortescue land system which comprises only 0.3% of the Pilbara rangeland survey area occurs within the area. It may be considered that the corridor option therefore has a high conservation value for this restricted land system.

Table 25: Proportion of land systems in the Rail Corridor.

Land System	Total Area (km^2)	% Pilbara Survey Area	Area in Rail Corridor (km^2)	% in Rail Corridor
Boolgeeda	7748	4.3	0.96	0.01
Cadgie	495	0.3	3.57	0.72
Divide	5293	2.9	52.72	1.00
Fan	1482	0.8	10.70	0.72
Fortescue	504	0.3	7.87	1.56
Jamindie	2074	1.1	0.42	0.02
Newman	14580	8.0	1.42	0.01
River	4088	2.3	1.09	0.03
Washplain	917	0.5	6.26	0.68

Vegetation in the southern corridor option was dominated by flat sandplain, flat clay/loam plain, groves and undulating plain communities which accounted for in excess of 92% of the survey area.

Vegetation sub-formation 10b was recorded at four locations on small red sand dunes and occupied just 0.067km^2 or 0.08% of the survey area (**Table 26**) with five species , *Clerodendrum floribundum*, *Leiocarpa semiclava* subsp. *semiclava*, *Oldenlandia pterospora*, *Paractaenum refractum* and *Ptilotus latifolius* not recorded elsewhere in the survey area These sand dunes also represent a south-western range extension for *Oldenlandia pterospora*.

Vegetation sub-formation 11 occurred at one location and represents just 0.02% of the survey area. This sub-formation surrounded a permanent water hole that represents an important water resource for both native animals and domestic stock.

A further 16 sub-formations were recorded at a single location although three of these (1e, 1f and 2) were also recorded either in the northern rail corridor options and/or the FPP.

Table 26: Area of vegetation sub formations and degraded areas in the FEPR Southern Section and Borrow Pit Options.

Vegetation Sub formation	No. Locations in Rail Corridor and Borrow Pit Options	Total Area in Rail Corridor and Borrow Pit Options (**km^2**)	% Rail Corridor and Borrow Pit Options
1a	8	27.61	31.10
1a burnt	3	4.98	5.61
1b	2	4.64	5.23
1e	1	1.33	1.50
1f	1	1.25	1.41
1h	3	1.22	1.37
1i	2	0.81	0.91
1j	1	3.2	3.60
1k	2	2.3	2.59
1l	2	0.34	0.38
1m	1	1.96	2.21
1n	5	1.75	1.97
2	1	0.16	0.18
2a	3	0.56	0.63
2c	6	1.16	1.31
3c	1	0.77	0.87
3d	2	0.83	0.93
3e	1	1.91	2.15
3f	1	0.08	0.09
4a	8	2.24	2.52
4b	4	2.93	3.30
4d	1	1.95	2.20
4a/4e	1	3.19	3.59
4f	1	0.11	0.12
5c	5	0.86	0.97
8b	3	4.13	4.65
8c	1	0.18	0.20
9h	4	2.90	3.27
9i	3	0.96	1.08
9j	2	0.44	0.50
9k	6	4.89	5.51
9l	1	1.51	1.70
9m	2	1.47	1.66
9n	1	0.24	0.27
9o	1	0.26	0.29
9p	1	0.02	0.02
9q	2	1.34	1.51
9r	1	0.39	0.44
9s	2	1.7	1.91
10b	4	0.07	0.08
11	1	0.02	0.02
D	1	0.1	0.11

4.0 DISCUSSION

A comprehensive assessment of the flora and vegetation has been completed for the FerrAus Pilbara Project FEPR rail corridor and borrow pit options. 134 sites across the ~130km^2 survey area were assessed during three field periods conducted over two different seasons (October 2010, November 2010 and March 2011). The aims of the surveys was to record the vascular plant species present, search for and describe populations of plants of conservation significance and populations of exotic plant species (weeds), to define and map vegetation types present and assess their potential local and regional significance, and to record the condition of vegetation in the survey area.

The combined surveys recorded 351 plant taxa of which approximately 30% were annual species recorded following both winter and summer rainfall. The high number of taxa recorded, the intensity and timing of the survey effort by experienced field botanists, are evidence that the flora of the FPP has been adequately surveyed. With the review of both regional and localised previous botanical surveys, adherence to the methodology of the EPA guidelines for flora surveys and adoption of the National Vegetation Inventory System (NVIS 2003) to describe vegetation it is considered that adequate resources were utilised to define and assess the conservation significance of the vegetation defined. As some of the vegetation boundaries were drawn from apparent changes in the vegetation from aerial photographs some inaccuracies in the depiction of the boundaries may be expected.

4.1 DESKTOP SURVEY OF THE FEPR NORTHERN CORRIDOR OPTION

4.1.1 Land Systems

In excess of 1% of the Adrian, Fan and Marillana land systems occur within the northern corridor option none of which are represented in the conservation estate or on UCL. The corridor option may therefore be considered to represent a moderate to high conservation value for these land systems particularly the Adrian and Marillana systems restricted to the Fortescue valley. The Fortescue land system is also restricted in total area and distribution and therefore may be considered to have moderate conservation value. The remaining land systems cover a substantially larger area and as only a small proportion of each occur in the corridor option it may be considered to have a low conservation level.

4.1.2 Vegetation

A review of the vegetation types recorded for the land systems present in the FEPR northern rail corridor option identified several vegetation types that may be expected to occur, namely:

- *Triodia* hummock grasslands on stony rises and rocky hills;
- *Triodia* hummock grasslands on sandy plains and sand dunes;
- *Acacia* and/or *Eucalyptus* woodlands along creek lines and drainage foci and on alluvial plains; and
- *Acacia* woodlands and shrublands, tussock grasslands and sparse shrublands on hardpan plains.

No Threatened ecological Community, Priority Ecological community or Environmentally Sensitive areas were recorded for the survey area. Priority flora have been recorded in *Acacia* woodlands, *Triodia* hummock grasslands and riparian vegetation in flora surveys conducted in close proximity to the northern corridor option. In accordance to government guidelines vegetation that represents habitat for priority flora may be considered locally significant.

The DEC Clearing Permit Decision Report states that "native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland". Several creeks traverse the northern rail corridor option and clearing of the riparian vegetation of these creeks would be at variance with the DEC Clearing Permit Decision Report statement.

4.1.3 Flora

A list of 313 taxa representing 44 families and 125 genera that may potentially occur in the FEPR northern rail corridor was dominated by plant families and genera that are characteristic of the Pilbara bioregion.

A total of 33 flora of conservation significance were recorded within a 100 km distance of the northern corridor option but none within the survey area despite a significant activity in the region during the surveying, construction and operation of the BHP Billiton Iron Ore Mainline. The records include one T species, *Lepidium catapycnon* but there is no suitable habitat in the survey area described for the species. Review of the habitat for each of the priority species indicated that suitable habitat for 15 taxa comprised of five P1, two P2, seven P3 and one P4 may potentially occur in the survey area.

Given the number of priority species for which suitable habitat is likely to occur is possible that some populations still could be found. However, the possibility of significant populations of any priority flora occurring within the survey area is low.

Suitable habitat for 21 introduced species (weeds) recorded within 100 km of the survey area is likely to occur within the rail corridor option. None of the weed species are a declared plant under the *Agriculture and Related Resources Protection Act 1976* for the survey area. It is considered highly likely that common weed species of the region, e.g. *Aerva javanicum*, *Cenchrus ciliaris* , *Malvastrum americanum* and *Portulaca oleracea* will occur in the corridor option due to the presence of both suitable habitat and disturbance to the natural vegetation resulting from the construction and operation of the BHP Billiton Iron Ore Mainline. It is recommended that strict weed hygiene measures therefore be applied during any consequent construction and operation of a rail system in the corridor option.

4.2 RAIL BORROW PIT OPTIONS NORTHERN SECTION (LEVEL 1 SURVEY)

4.2.1 Land Systems

The borrow pit options were considered to be potentially of moderate to high conservation value for the Adrian and Marillana land systems as in excess of 1% of their known area occurred in the survey area. Both of the land systems were recorded in a single borrow pit and it is recommended that other borrow pit options be utilised in order to limit impacts to the restricted land systems.

4.2.2 Vegetation

A total of 17 vegetation types were defined for the borrow pit options to the level of sub-formation of the NVIS 2003. None of the sub-formations resembled a TEC of national or regional significance, a PEC or ESA and each resembled vegetation types previously mapped that are common and widespread. It is therefore considered that none of the sub-formations represent regionally significant vegetation.

Biota (2004) considered vegetation on sand dunes in the Hamersley Ranges and Fortescue Plains regions to be potentially locally significant due to the fragile nature of the system and scarcity of habitat. Vegetation sub-formations 10a of the current survey also inhabited red sand dunes with a restricted/scarce distribution and may therefore be considered potentially locally significant.

Vegetation sub-formation 5b did not closely resemble the regional vegetation types of prior surveys. However, this sub-formation was comprised of isolated common grasses and herbs and it is not considered that disturbance to this vegetation would significantly impact on the floral diversity of the region or immediate locality.

Vegetation sub-formation 3c was riparian vegetation of two minor creeks and represented a very small total area and proportion of the borrow pit options. The survey area also appears to represent a small range extension for *Atalaya hemiglauca* which was recorded in this sub-formation. In accordance to government guidelines the 3c sub-formation may be considered potentially locally significant as it represents habitat for a species at the limit of it's known range, has limited area and distribution. Clearing of this vegetation would also be at variance with the condition of the DEC Clearing Permit Decision Report. It is recommended that disturbance to this vegetation sub-formation be avoided and minimised wherever possible.

Vegetation condition in the borrow pit options was excellent to pristine for the most part, however several disturbed areas were also mapped. Many of the disturbed areas were previously utilised borrow pits, presumably for construction and maintenance of the BHP Billiton Iron Ore Mainline. It is recommended that where possible borrow options containing disturbed areas be utilised in preference to undisturbed options during any subsequent construction and maintenance of a rail corridor.

4.2.3 Flora

No T or priority flora were recorded in the borrow pit options and this concurs with the indication from the desktop survey that there is a low probability of significant populations of priority flora occurring within the survey area.

Review of the distribution of each of the species recorded in the borrow pit options identified range extensions for three species. In accordance with government guidelines (EPA2004) these species may be considered potentially locally significant as they represent recent increases to the known range of the taxa. All of the species were recorded in vegetation sub-formations that resemble widespread communities which are typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally

well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape.

Three introduced flora were recorded in the borrow pit options, *Cenchrus ciliaris*, *Malvastrum americanum* and *Portulaca oleracea.* None are a declared plant under the *Agriculture and Related Resources Protection Act 1976* and all are common weed species of the Pilbara and Gascoyne regions. As the weeds were recorded in areas proposed as borrow pits for the construction of a rail corridor it is recommended that strict weed hygiene practices be employed during any subsequent construction to minimise the potential of spreading the weeds.

4.3 FEPR SOUTHERN SECTION RAIL CORRIDOR OPTION – LEVEL 2

4.3.1 Land Systems

The southern rail corridor was considered to potentially represent moderate conservation value for the Cadgie, Fan, Divide and Washplain land systems due to the proportion of each of the systems occurring in the rail corridor option and associated borrow pits. As the total area is far larger than the disturbance by construction of a rail corridor, it is unlikely that it would significantly impact on the regional value of these land systems. However, it is recommended that disturbance to each of these land systems be minimised.

A small borrow pit option was comprised almost entirely of the Cadgie land system. It is recommended that other borrow pit options be used in preference to this area to reduce impacts to this restricted land system.

4.3.2 Vegetation

A total of 41 vegetation types were defined for the FEPR southern section rail corridor and associated borrow pit options to the level of sub-formation of the NVIS 2003. None of the sub-formations resembled a TEC of national or regional significance, a PEC or ESA. The majority of the sub-formations resembled vegetation types previously mapped that are common and widespread and were therefore not considered to represent regionally or locally significant vegetation.

Biota (2004) considered vegetation on sand dunes in the Hamersley Ranges and Fortescue Plains regions to be potentially locally significant due to the fragile nature of the system and scarcity of habitat. Vegetation sub-formations 10b of the current survey also inhabited red sand dunes with a restricted/scarce distribution. Furthermore, this sub-formation represents the limits of the range of one species and comprises a novel combination of species not recorded elsewhere in the survey area and consequently did not resemble previously recorded vegetation types. For these reasons this vegetation may be considered potentially locally significant and it is recommended that disturbance to these dunes be avoided.

Vegetation sub-formation 11 occurred at a single location within the survey area and did not resemble previously described vegetation. The sub-formation surrounded a permanent waterhole and appears to provide a valuable refuge to both native animals and domestic stock. It is recommended that disturbance to this sub-formation and the waterhole be avoided.

Vegetation sub-formations 2a, 2c, 3d and 9h are a habitat for several species with an extension to the known distribution range. These sub-formations represent *Triodia* hummock grassland, *Acacia* open woodland and riparian vegetation that were also identified by Mattiske (2008). In accordance to government guidelines the sub-formations may be considered potentially locally significant. However, each of these sub-formations resembled vegetation recorded in regional surveys and it is likely that they occur in the broader landscape.

Vegetation sub-formation 9h, 4a and 9l represented habitat for the priority 4 species *Goodenia nuda*, and priority 3 species *Olearia mucronata*. These sub-formations may be considered potentially locally significant as they represent habitat for conservation significant species.

4.3.3 Flora

Two priority flora were recorded within the rail corridor, *Olearia mucronata* (P3), *Goodenia nuda* (P4). The vegetation in which each of the priority species were recorded at the FPP resemble widespread communities typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape. It is recommended that site personnel be familiarised with the priority flora to facilitate reporting of further sightings and minimise the potential for disturbance to populations.

Review of the distribution of the species identified range extensions for 14 species. In accordance with government guidelines (EPA2004) these species may be considered potentially locally significant as they represent recent increases to the known range of the taxa. With the exception of one species (*Oldenlandia pterospora* in vegetation sub-formation 10b) each of the species was recorded in vegetation sub-formations that resemble widespread communities which are typical of the Pilbara and Gascoyne regions (Ecologia 2007) and are generally well represented in the surrounding area (Ecologia 2009). This indicates that suitable habitat for each of the species occurs not only within the survey areas but also in the broader landscape.

Five introduced taxa were recorded in the FEPR southern rail corridor option, *Bidens bipinnata*, *Cenchrus ciliaris*, *Malvastrum americanum*, *Portulaca oleracea* and *Sonchus oleraceus*. None of the species are a declared plant and all have broad distributions in Western Australia and have been previously recorded in the Gascoyne and Pilbara bioregions.

Portulaca oleracea was the most widespread species and was recorded in almost half of the quadrat surveys in a variety of habitat types and vegetation communities. The remaining species were typically recorded in riparian and /or grove/intergrove vegetation with Cenchrus ciliaris also recorded on the lower slopes of a few low rocky hills. Large infestations of Cenchrus ciliaris in riparian vegetation where it dominated the grass stratum reduced the condition of the vegetation to very good, Despite the widespread distribution of Portulaca oleracea and the Cenchrus ciliaris infestations at a few locations, in general, the level of weed infestation within the southern rail corridor was considered low.

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APPENDIX A – DEFINITIONS OF DECLARED RARE FLORA, PRIORITY FLORA, THREATENED ECOLOGICAL COMMUNITIES AND PRIORITY ECOLOGICAL COMMUNITIES

Source: http://florabase.calm.wa.gov.au, April 2011

Code	Definition
T	**T- Threatened Flora** 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. Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria: ▪ CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild ▪ EN: Endangered – considered to be facing a very high risk of extinction in the wild ▪ VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
P1	**Priority One - Poorly Known Taxa** Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two - Poorly Known Taxa** Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three - Poorly Known Taxa** Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	**Priority Four - Rare Taxa** (a) **Rare.** Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. (b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

P5	**Priority Five - Conservation Dependent Species** Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

Reference: - English (2003).

TEC Classification	Status	Definition
Presumed Totally Destroyed	X	Community is unlikely to be able to be rehabilitated.
Critically Endangered	R	There are immediate threats throughout its range.
Endangered	E	Threatened throughout most of its range in the near future.
Vulnerable	V	Vulnerable to threatening processes/may move into higher threat category.

PEC Categories	Definition
Priority One: Poorly-known ecological communities	Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two: Poorly-known ecological communities	Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority Three: Poorly known ecological communities	(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.	(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five: Conservation Dependent ecological communities	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX B - PRIORITY SPECIES LISTS FOR THE GASCOYNE AND PILBARA BIOREGIONS OF WESTERN AUSTRALIA

Source: http://florabase.calm.wa.gov.au, June 2011

GASCOYNE BIOREGION

FAMILY	Species	Priority Code
Lamiaceae	*Pityrodia augustensis*	T
Myrtaceae	*Thryptomene wittweri*	T
Amaranthaceae	*Ptilotus chrysocomus*	1
	Ptilotus mitchellii	1
Asteraceae	*Calocephalus beardii*	1
	Helichrysum oligochaetum	1
	Rhodanthe sphaerocephala	1
Euphorbiaceae	*Euphorbia sarcostemmoides*	1
Fabaceae	*Acacia wilcoxii*	1
Goodeniaceae	*Selliera radicans*	1
Myrtaceae	*Aluta quadrata*	1
	Eucalyptus semota	1
Scrophulariaceae	*Eremophila appressa*	1
	Eremophila arguta	1
	Eremophila humilis	1
	Eremophila prolata	1
	Eremophila rhegos	1
	Eremophila warnesii	1
Asteraceae	*Rhodanthe frenchii*	2
Cyperaceae	*Schoenus* sp. Kalbarri	2
Fabaceae	*Gompholobium karijini*	2
	Senna sp. Barlee Range	2
Frankeniaceae	*Frankenia confusa*	2
Goodeniaceae	*Goodenia virgata*	2
Stylidiaceae	*Stylidium weeliwolli*	2
Aizoaceae	*Gunniopsis propinqua*	3
	Tetragonia coronata	3
Amaranthaceae	*Ptilotus crosslandii*	3
	Ptilotus lazaridis	3
Chenopodiaceae	*Maireana murrayana*	3
	Maireana prosthecochaeta	3
Colchicaceae	*Wurmbea saccata*	3
Fabaceae	*Acacia atopa*	3
	Acacia speckii	3
Frankeniaceae	*Frankenia glomerata*	3
Lamiaceae	*Dicrastylis linearifolia*	3
	Hemigenia tysonii	3
Malvaceae	*Lawrencia* sp. Anna Plains	3
	Sida sp. Barlee Range	3
	Triumfetta echinata	3
Myrtaceae	*Calytrix praecipua*	3
	Homalocalyx echinulatus	3
Phyllanthaceae	*Sauropus ramosissimus*	3
Poaceae	*Sporobolus blakei*	3

FAMILY	Species	Priority Code
Proteaceae	*Grevillea subterlineata*	3
Restionaceae	*Lepidobolus densus*	3
Scrophulariaceae	*Eremophila campanulata*	3
	Eremophila coacta	3
	Eremophila flaccida subsp. *attenuata*	3
	Eremophila gracillima	3
	Eremophila lanata	3
	Eremophila magnifica subsp. *velutina*	3
	Eremophila micrantha	3
	Eremophila obliquisepala	3
	Eremophila petrophila subsp. *densa*	3
	Eremophila rigens	3
	Eremophila rigida	3
Scrophulariaceae	*Eremophila shonae* subsp. *diffusa*	3
Amaranthaceae	*Ptilotus trichocephalus*	4
Goodeniaceae	*Goodenia berringbinensis*	4
Scrophulariaceae	*Eremophila pungens*	4
	Eremophila youngii subsp. lepidota	4

PILBARA BIOREGION

Family	Species	Category
Brassicaceae	*Lepidium catapycnon*	T
Myrtaceae	*Thryptomene wittweri*	T
Aizoaceae	*Gunniopsis* sp. Fortescue	1
Amaranthaceae	*Ptilotus appendiculatus* var. *minor*	1
Asteraceae	*Brachyscome* sp. Wanna Munna Flats	1
	Calotis squamigera	1
	Genus sp. Hamersley Range hilltops	1
	Helichrysum oligochaetum	1
	Myriocephalus nudus	1
	Myriocephalus scalpellus	1
	Rhodanthe ascendens	1
Boraginaceae	*Heliotropium muticum*	1
	Heliotropium parviantrum	1
Brassicaceae	*Lepidium amelum*	1
Chenopodiaceae	*Atriplex spinulosa*	1
Cyperaceae	*Fimbristylis* sp. Shay Gap	1
Elaeocarpaceae	*Tetratheca fordiana*	1
Euphorbiaceae	*Euphorbia parvicaruncula*	1
Fabaceae	*Acacia aphanoclada*	1
	Acacia cyperophylla var. *omearana*	1
	Acacia leeuweniana	1
	Desmodium pullenii	1
	Rothia indica subsp. *australis*	1
	Senna sp. Millstream	1
	Tephrosia rosea var. *venulosa*	1
Goodeniaceae	*Brunonia* sp. Long hairs	1
	Goodenia pallida	1
Malvaceae	*Abutilon uncinatum*	1
Myrtaceae	*Aluta quadrata*	1
	Eucalyptus lucens	1
Pedaliaceae	*Josephinia* sp. Marandoo	1

Family	Species	Category
Phrymaceae	*Peplidium* sp. fortescue marsh	1
Plantaginaceae	*Stemodia* sp. Battle Hill	1
Poaceae	*Aristida jerichoensis* var. *subspinulifera*	1
	Bothriochloa decipiens var. *cloncurrensis*	1
	Eragrostis sp. Mt Robinson	1
Scrophulariaceae	*Eremophila pilosa*	1
	Eremophila sp. Snowy Mountain	1
	Eremophila sp. West Angelas	1
	Eremophila spongiocarpa	1
Solanaceae	*Nicotiana heterantha*	1
Zygophyllaceae	*Tribulus minutus*	1
Acanthaceae	*Dicladanthera glabra*	2
Amaranthaceae	*Gomphrena cucullata*	2
	Gomphrena pusilla	2
Asteraceae	*Pilbara trudgenii*	2
	Vittadinia pustulata	2
Cyperaceae	*Cladium procerum*	2
Euphorbiaceae	*Euphorbia clementii*	2
	Euphorbia sp. Mt Bruce flats	2
Fabaceae	*Gompholobium karijini*	2
	Indigofera ixocarpa	2
	Isotropis parviflora	2
	Vigna sp. central	2
Goodeniaceae	*Scaevola* sp. Hamersley Range basalts	2
Lamiaceae	*Spartothamnella puberula*	2
Poaceae	*Aristida calycina* R.Br. var. *calycina*	2
	Aristida lazaridis	2
	Paspalidium retiglume	2
Pteridaceae	*Adiantum capillus-veneris*	2
Scrophulariaceae	*Eremophila forrestii* subsp. Pingandy	2
Stylidiaceae	*Stylidium weeliwolli*	2
Acanthaceae	*Rostellularia adscendens* var. *latifolia*	3
Amaranthaceae	*Gomphrena leptophylla*	3
Asclepiadaceae	*Gymnanthera cunninghamii*	3
Asteraceae	*Calotis latiuscula*	3
	Iotasperma sessilifolium	3
	Olearia mucronata	3
Boraginaceae	*Heliotropium murinum*	3
Celastraceae	*Stackhousia clementii*	3
Chenopodiaceae	*Atriplex flabelliformis*	3
	Atriplex lindleyi subsp. *conduplicata*	3
	Rhagodia sp. Hamersley	3
Combretaceae	*Terminalia supranitifolia*	3
Convolvulaceae	*Polymeria distigma*	3
Cyperaceae	*Fimbristylis sieberiana*	3
	Fuirena incrassate	3
	Schoenus punctatus	3
Euphorbiaceae	*Euphorbia stevenii*	3
Fabaceae	*Acacia daweana*	3
	Acacia effusa	3
	Acacia fecunda	3
	Acacia glaucocaesia	3
	Acacia levata	3

Family	Species	Category
Fabaceae	*Acacia* sp. Riddell Beach	3
	Crotalaria smithiana	3
	Glycine falcata	3
	Indigofera ammobia	3
	Indigofera gilesii Peter G.Wilson & Rowe subsp. *gilesii*	3
	Indigofera sp. Bungaroo Creek	3
	Swainsona sp. Hamersley Station	3
	Tephrosia bidwillii	3
Goodeniaceae	*Dampiera anonyma*	3
	Dampiera atriplicina	3
	Dampiera metallorum	3
	Goodenia lyrata	3
	Goodenia sp. East Pilbara	3
Malvaceae	*Corchorus congener*	3
	Sida sp. Barlee Range	3
	Triumfetta echinata	3
Meliaceae	*Owenia acidula*	3
Phyllanthaceae	*Phyllanthus aridus*	3
Poaceae	*Astrebla lappacea*	3
	Eragrostis crateriformis	3
	Eragrostis lanicaulis	3
	Eriochloa fatmensis	3
	Themeda sp. Hamersley Station	3
	Triodia sp. Mt Ella	3
	Whiteochloa capillipes	3
Rubiaceae	*Oldenlandia* sp. Hamersley Station	3
Rutaceae	*Geijera salicifolia*	3
Scrophulariaceae	*Eremophila coacta*	3
	Eremophila forrestii subsp. *viridis*	3
	Eremophila magnifica subsp. *velutina*	3
	Eremophila shonae subsp. *diffusa*	3
Solanaceae	*Nicotiana umbratica*	3
Thelypteridaceae	*Ampelopteris prolifera*	3
Amaranthaceae	*Ptilotus mollis*	4
	Ptilotus trichocephalus	4
Arecaceae	*Livistona alfredii*	4
Cyperaceae	*Bulbostylis burbidgeae*	4
Fabaceae	*Rhynchosia bungarensis*	4
Goodeniaceae	*Goodenia nuda*	4
Scrophulariaceae	*Eremophila magnifica* Chinnock subsp. *magnifica*	4
	Eremophila youngii subsp. *lepidota*	4

APPENDIX C – WEED SPECIES LIST FOR THE PILBARA BIOREGION OF WESTERN AUSTRALIA

Source: http://florabase.calm.wa.gov.au, November 2010

TAXA	Pilbara	Gascoyne
Acanthospermum hispidum	x	
Acetosa vesicaria	x	x
Aerva javanica	x	x
Agave americana	x	
Alternanthera pungens	x	
Amaranthus viridis	x	
Anagallis arvensis		x
Anagallis arvensis var. *caerulea*		x
Andropogon gayanus	x	
*Argemone ochroleuca**	x	x
Argemone ochroleuca ssp. *ochroleuca*	x	x
Arundo donax	x	x
Asclepias curassavica	x	x
Asphodelus fistulosus	x	
Bidens bipinnata	x	
Bidens pilosa	x	
*Calotropis procera**	x	
Catharanthus roseus	x	
Cenchrus biflorus	x	
*Cenchrus ciliaris**	x	x
Cenchrus echinatus	x	
Cenchrus setigerus	x	
Centaurium erythraea		x
Chenopodium murale	x	x
Chloris barbata	x	
Chloris virgata	x	
Citrullus colocynthis	x	x
Citrullus lanatus	x	x
Clitoria ternatea	x	
Coccinia grandis	x	
Conyza bonariensis	x	
Crotalaria juncea	x	
Cucumis melo	x	x
Cucumis melo ssp. *agrestis*	x	x
Cucumis myriocarpus	x	
Cuscuta planiflora		x
Cyclospermum leptophyllum	x	
Cynodon dactylon	x	x

TAXA	Pilbara	Gascoyne
Cyperus involucratus	x	
Cyperus rotundus	x	
*Datura leichhardtii**	x	x
*Datura metel**	x	
Desmodium scorpiurus	x	
Digitaria ciliaris	x	
Digitaria sanguinalis	x	
Echinochloa colona	x	
Emex australis		x
Eragrostis cilianensis		x
Eragrostis curvula		x
Eragrostis pilosa	x	
Gomphrena celosioides	x	
Gossypium hirsutum	x	
Heliotropium europaeum		x
Indigofera oblongifolia	x	
Indigofera sessiliflora	x	
Ipomoea indica		x
Jatropha gossypifolia	x	
Lactuca saligna	x	
Lactuca serriola	x	
Lamarckia aurea	x	
Lepidium africanum		x
Lepidium didymum	x	x
Leptochloa fusca ssp. *uninervia*	x	
Leucaena leucocephala	x	
Lolium multiflorum		x
Lycium ferocissimum		x
Malva parviflora		x
Malvastrum americanum	x	x
Malvastrum coromandelianum	x	
Melochia pyramidata	x	
Merremia dissecta	x	
Moringa oleifera	x	
*Opuntia stricta**	x	
Oxalis corniculata	x	
*Parkinsonia aculeata**	x	
Paspalum fasciculatum	x	
Passiflora foetida	x	
Passiflora foetida var. *hispida*	x	
Pennisetum setaceum	x	
Persicaria lapathifolia	x	
Phoenix dactylifera	x	

TAXA	Pilbara	Gascoyne
Phyla nodiflora var. *nodiflora*	x	
Physalis angulata	x	
Polypogon monspeliensis	x	x
Portulaca oleracea	x	x
*Prosopis glandulosa x velutina**	x	
Pseudognaphalium luteo-album	x	
Pupalia lappacea	x	
Ricinus communis	x	
Salvinia molesta	x	
Senna occidentalis	x	
Setaria italica	x	
Setaria sphacelata	x	
Setaria verticillata	x	x
Sigesbeckia orientalis	x	
Sisymbrium erysimoides		x
Sisymbrium irio		x
Sisymbrium orientale	x	x
Solanum nigrum	x	x
Solidago canadensis	x	
Sonchus oleraceus	x	x
Stylosanthes guianensis	x	
Stylosanthes hamata	x	
Tamarindus indica	x	
Trianthema portulacastrum	x	
Tribulus terrestris		x
Urospermum picroides		x
Washingtonia filifera	x	
*Ziziphus mauritiana**	x	

APPENDIX D – VEGETATION STRUCTUAL CLASSES (NVIS 2003)

Height Classes

Height		*Growth Form*				
Height Class	**Height Range (m)**	tree, vine (M & U), palm (single-stemmed)	shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)	tree mallee, mallee shrub	tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)	bryophyte, lichen, seagrass, aquatic
8	**>30**	tall	NA	NA	NA	NA
7	**10-30**	mid	NA	tall	NA	NA
6	**<10**	low	NA	mid	NA	NA
5	**<3**	NA	NA	low	NA	NA
4	**>2**	NA	tall	NA	tall	NA
3	**1-2**	NA	mid	NA	tall	NA
2	**0.5-1**	NA	low	NA	mid	tall
1	**<0.5**	NA	low	NA	low	low

Structural Formation Classes

Growth Form	**Height Ranges (m)**	**Structural Formation Classes**					
Foliage cover% (Cover#)		**70-100% (5)**	**30-70% (4)**	**10-30% (3)**	**<10% (2)**	**0-5% (1)**	**≈0% (N)**
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns
bryophyte	<0.5	closed bryophyteland	bryophyteland	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines
aquatic	0-0.5,<1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics
seagrass	0-0.5,<1	closed seagrass bed	seagrassbed	open seagrassbed	sparse seagrassbed	isolated seagrasses	isolated clumps of seagrasses

APPENDIX E - NATIONAL VEGETATION INFORMATION SYSTEM INFORMATION HIERARCHY.

Hierarchical level	Description	National Vegetation Information System structural/floristic components required
I	Class	Dominant growth form of the ecologically dominant stratum.
II	Structural formation	Dominant growth form, cover and height of the ecologically dominant stratum
III	Broad floristic formation	Dominant growth form, cover and height of the ecologically dominant stratum
IV	Sub- formation	Dominant growth form, cover, height and broad floristic code usually dominant genus and family of the three traditional strata (i.e. upper, mid and ground)
V	Association	Dominant growth form, height, cover and species (three species) of the three traditional strata (i.e. upper, mid and ground).
VI	Sub-association	Dominant growth form, height, cover and species (five species) of all layers/strata.

APPENDIX F – SPECIES LIST FOR THE FEPR NORTHERN RAIL CORRIDOR OPTION

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Acanthaceae	*Rostellularia adscendens* var. *latifolia* **P3**			**x**
Aizoaceae	*Trianthema pilosa*		**x**	
	Trianthema triquetra		**x**	
Amaranthaceae	*Aerva javanica**			**x**
	Alternanthera nodiflora		**x**	
	*Alternanthera pungens**			**x**
	Gomphrena canescens	x	x	
	Ptilotus aervoides	x	x	
	Ptilotus aphyllus		x	
	Ptilotus astrolasius		x	
	Ptilotus auriculifolius		x	
	Ptilotus australasicus		x	
	Ptilotus calostachyus	x	x	
	Ptilotus carinatus		x	
	Ptilotus exaltatus		x	
	Ptilotus gardneri		x	
	Ptilotus gomphrenoides	x		
	Ptilotus gomphrenoides var. *conglomeratus*	x		
	Ptilotus gaudichaudii		x	
	Ptilotus gomphrenoides		x	
	Ptilotus helipteroides	x	x	
	Ptilotus macrocephalus		x	
	Ptilotus obovatus		x	
	Ptilotus polystachyus	x	x	
	Ptilotus roei		x	
	Ptilotus rotundifolius		x	
	Ptilotus schwartzii		x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Apocynaceae	*Carissa lanceolata*		x	
	Gymnanthera cunninghamii **P3**			x
Araliaceae	*Trachymene oleracea* subsp. *oleracea*	x		
Asteraceae	*Bidens bipinnata**		x	
	*Bidens pilosa**			x
	Brachyscome iberidifolia	x		
	Brachyscome sp. Wanna Munna Flats **P2**	x		
	Calotis plumulifera	x		
	Flaveria trinervia	x		
	Helichrysum oligochaetum **P1**			x
	Myriocephalus scalpellus **P1**			x
	Olearia xerophila	x		
	Pluchea tetranthera		x	
	Pterocaulon sphacelatum		x	
	Rhodanthe charsleyae	x	x	
	*Sigesbeckia orientalis**			x
	*Sonchus oleraceus**			x
	Streptoglossa bubakii		x	
	Streptoglossa macrocephala	x		
	Streptoglossa odora		x	
Boraginaceae	*Heliotropium cunninghamii*	x		
	Heliotropium heteranthum	x		
	Heliotropium inexplicitum	x		
	Heliotropium tenuifolium	x		
	Trichodesma zeylanicum var. *zeylanicum*	x	x	
Brassicaceae	*Lepidium catapycnon* **T**	x		
	Lepidium echinatum	x		
	Lepidium muelleri-ferdinandii	x		

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Brassicaceae	*Lepidium oxytrichum*	x		
	Stenopetalum anfractum	x		
Campanulaceae	*Lobelia arnhemiaca*	x		
Capparaceae	*Capparis lasiantha*		x	
	Capparis spinosa		x	
Casuarinaceae	*Allocasuarina decaisneana*		x	
Chenopodiaceae	*Atriplex codonocarpa*		x	
	Dysphania rhadinostachya		x	
	Dysphania rhadinostachya subsp. *inflata*	x		
	Enchylaena tomentosa		x	
	Maireana convexa		x	
	Maireana georgei	x	x	
	Maireana melanocoma	x		
	Maireana planifolia	x	x	
	Maireana pyramidata		x	
	Maireana tomentosa		x	
	Maireana triptera		x	
	Maireana villosa		x	
	Rhagodia eremaea	x	x	
	Salsola australis	x		
	Salsola tragus		x	
	Sclerolaena cornishiana	x		
	Sclerolaena costata	x		
	Sclerolaena cuneata		x	
	Sclerolaena densiflora	x	x	
	Sclerolaena deserticola		x	
	Sclerolaena diacantha	x		
Cleomaceae	*Cleome viscosa*	x	x	
Convolvulaceae	*Bonamia erecta*	x	x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Convolvulaceae	*Bonamia eremeae*		x	
	Bonamia rosea		x	
	Convolvulus clementii	x		
	Evolvulus alsinoides var. *villosicalyx*		x	
	Ipomoea muelleri		x	
Cucurbitaceae	*Citrullus colocynthis**			x
	Cucumis maderaspatanus		x	
	Cucumis melo subsp. *agrestis**			x
Cyperaceae	*Cyperus cunninghamii*	x		
	Eleocharis geniculata	x		
Euphorbiaceae	*Euphorbia alsiniflora*		x	
	Euphorbia australis	x	x	
	Euphorbia boophthona	x	x	
	Euphorbia tannensis subsp. *eremophila*	x		
Fabaceae	*Acacia adoxa*		x	
	Acacia ancistrocarpa	x	x	
	Acacia ancistrocarpa x *citrinoviridis*	x		
	Acacia aneura		x	
	Acacia aneura var. *pilbarana*	x		
	Acacia aptaneura	x		
	Acacia atkinsiana		x	
	Acacia bivenosa		x	
	Acacia catenulata		x	
	Acacia citrinoviridis	x	x	
	Acacia coriacea		x	
	Acacia dictyophleba	x		
	Acacia holosericea		x	
	Acacia inaequilatera		x	
	Acacia maitlandii		x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Fabaceae	*Acacia marramamba*		x	
	Acacia monticola		x	
	Acacia orthocarpa		x	
	Acacia pachyacra	x		
	Acacia pruinocarpa	x		
	Acacia pyrifolia		x	
	Acacia sclerosperma subsp. *sclerosperma*		x	
	Acacia stellaticeps		x	
	Acacia synchronicia	x		
	Acacia tetragonophylla		x	
	Acacia trachycarpa		x	
	Acacia tumida		x	
	Acacia xiphophylla		x	
	Acacia victoriae		x	
	Acacia wanyu	x	x	
	Bauhinia cunninghamii		x	
	Cullen leucanthum	x		
	Cullen pogonocarpum		x	
	Crotalaria smithiana **P3**	x		
	Desmodium campylocaulon		x	
	Indigofera colutea		x	
	Indigofera monophylla	x		
	Indigofera trita		x	
	Neptunia dimorphantha		x	
	Petalostylis cassioides	x		
	Petalostylis labicheoides		x	
	Rhynchosia minima		x	
	Senna artemisioides subsp. *helmsii*		x	
	Senna artemisioides subsp. *oligophylla*		x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Fabaceae	*Senna artemisioides* subsp. x *sturtii*		x	
	Senna glutinosa		x	
	Senna glutinosa subsp. *pruinosa*		x	
	Senna glutinosa subsp. x *luerssenii*	x	x	
	Senna hamersleyensis		x	
	Senna notabilis	x	x	
	Senna symonii		x	
	Sesbania formosa		x	
	Swainsona formosa		x	
	Swainsona kingii	x		
	Tephrosia clementii		x	
	Tephrosia densa	x		
	Tephrosia rosea		x	
	Tephrosia uniovulata		x	
	Tephrosia sp. Bungaroo Creek	x		
	*Vachellia farnesiana**	x	x	x
Goodeniaceae	*Brunonia* sp. Long hairs **P1**	x		
Goodeniaceae	*Dampiera candicans*	x		
	Goodenia armitiana	x		
	Goodenia lamprosperma	x	x	
	Goodenia lyrata **P3**	x		
	Goodenia microptera		x	
	Goodenia nuda **P3**	x		
	Goodenia prostrata		x	
	Goodenia sp. East Pilbara **P3**			
	Goodenia stobbsiana	x	x	
	Goodenia vilmoriniae	x		
	Scaevola parvifolia subsp. *parvifolia*		x	
	Scaevola parvifolia subsp. *pilbarae*	x		

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Goodeniaceae	*Velleia connata*	x		
Haloragaceae	*Gonocarpus ephemerus*	x		
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*	x		
	Dicrastylis cordifolia	x		
	Newcastelia hexarrhena	x		
Loranthaceae	*Amyema fitzgeraldii*	x		
Malvaceae	*Abutilon lepidum*	x	x	
	Abutilon otocarpum		x	
	Corchorus crozophorifolius		x	
	Corchorus laniflorus		x	
	Corchorus tectus	x		
	Corchorus tridens	x		
	Corchorus walcottii		x	
	Gossypium australe		x	
	Gossypium robinsonii		x	
	Hibiscus burtonii		x	
	Hibiscus sturtii		x	
	*Malvastrum americanum**		x	x
	Sida arenicola	x		
	Sida calyxhmyenia		x	
	Sida cardiophylla		x	
	Sida echinocarpa		x	
	Sida fibulifera	x		
	Sida pilbarensis		x	
	Sida platycalyx	x		
	Triumfetta leptacantha	x		
	Triumfetta maconochieana	x		
	Waltheria indica	x		
Meliaceae	*Owenia reticulata*		x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Molluginaceae	*Mollugo molluginea*	x	x	
Moraceae	*Ficus platypoda*	x	x	
Myrtaceae	*Corymbia apsera*		x	
	Corymbia chippendalei		x	
	Corymbia flavescens		x	
	Corymbia hamersleyana		x	
	Corymbia zygophylla		x	
	Eucalyptus camaldulensis		x	
	Eucalyptus gamophylla	x	x	
	Eucalyptus leucophloia		x	
	Eucalyptus trivalva	x		
	Eucalyptus victrix		x	
	Eucalyptus xerothermica	x		
	Melaleuca argentea		x	
	Melaleuca glomerata		x	
	Melaleuca linophylla		x	
Oleaceae	*Jasminum didymum* subsp. *lineare*		x	
Orobanchaceae	*Striga squamigera*	x		
Papaveraceae	*Argemone ochroleuca* subsp. *ochroleuca**			x
Plantaginaceae	*Stemodia grossa*		x	
Poaceae	*Aristida contorta*	x	x	
	Aristida holathera var. *holathera*		x	
	Aristida jerichoensis var. *subspinulifera* **P1**	x		
	Aristida latifolia		x	
	Astrebla pectinata		x	
	Brachyachne convergens		x	
	Brachyachne prostrata		x	
	*Cenchrus ciliaris**		x	x
	Cenchrus setiger			x

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Poaceae	*Chloris barbata**			x
	*Chloris virgata**			x
	Chrysopogon fallax		x	
	Cymbopogon ambiguus		x	
	Cymbopogon procerus		x	
	Dactyloctenium radulans	x		
	Dichanthium sericeum		x	
	Digitaria ammophila		x	
	Digitaria brownii	x	x	
	Enneapogon avenaceus	x		
	Enneapogon caerulescens	x	x	
	Enneapogon cylindricus		x	
	Enneapogon polyphyllus	x	x	
	Enteropogon acicularis		x	
	Eragrostis cumingii		x	
	Eragrostis eriopoda		x	
	Eragrostis olida	x		
	Eragrostis pergracilis		x	
	Eragrostis setifolia		x	
	Eragrostis xerophila		x	
	Eriachne aristidea	x	x	
	Eriachne benthamii	x	x	
	Eriachne mucronata		x	
	Eriachne obtusa		x	
	Eriachne pulchella		x	
	Eriachne tenuiculmis	x		
	Monochather paradoxa		x	
	Paraneurachne muelleri		x	
	Paspalidium clementii		x	

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Poaceae	*Setaria verticillata**			x
	Sporobolus australasicus	x	x	
	Themeda sp. Hamersley Station **P3**	x		x
	Themeda triandra	x	x	
	Tragus australianus	x		
	Triodia basedowii	x	x	
	Triodia biflora			
	Triodia brizoides		x	
	Triodia bitextura	x		
	Triodia epactia		x	
	Triodia lanigera		x	
	Triodia longiceps		x	
	Triodia plurinervata		x	
	Triodia pungens	x	x	
	Triodia schinzii	x	x	
	Triodia wiseana		x	
	Triodia sp. Shovelanna Hill	x		
	Triraphis mollis	x		
	Yakirra australiensis		x	
Polygonaceae	*Acetosa vesicaria**			x
Portulacaceae	*Portulaca oleracea**		x	x
Proteaceae	*Grevillea eriostachya*		x	
	Grevillea pyramidalis subsp. *leucadendron*	x	x	
	Grevillea wickhamii subsp. *hispidula*		x	
	Hakea lorea subsp. *lorea*		x	
Pteridaceae	*Cheilanthes austrotenuifolia*		x	
Rubiaceae	*Psydrax latifolia*		x	
	Psydra suaveolens		x	
Santalaceae	*Santalum lanceolatum*	x		

FAMILY	Species	NatureMap 2011/DEC Database	Van Vreeswyk *et al* 2004	Survey Reviews
Santalaceae	*Santalum spicatum*	x		
Sapindaceae	*Atalaya hemiglauca*		x	
	Diplopeltis stuartii var. *stuartii*	x		
Scrophulariaceae	*Eremophila caespitosa*		x	
	Eremophila clarkei		x	
	Eremophila cuneifolia		x	
	Eremophila forrestii subsp. *forrestii*		x	
	Eremophila fraseri		x	
	Eremophila glutinosa		x	
	Eremophila lanceolata		x	
	Eremophila latrobei subsp. *latrobei*		x	
	Eremophila longifolia	x		
	Eremophila margarethae		x	
	Eremophila pantonii		x	
	Eremophila pensilis		x	
	Eremophila pilosa **P1**	x		
	Eremophila youngii subsp. *lepidota* **P4**			x
Solanaceae	*Solanum diversiflorum*		x	
	Solanum ferocissimum		x	
	Solanum horridum		x	
	Solanum lasiophyllum	x	x	
Stylidiaceae	*Stylidium weeliwolli* **P2**	x		
Surianaceae	*Stylobasium spathulatum*	x	x	
Zygophyllaceae	*Tribulus platypterus*		x	
	Tribulus suberosus		x	
	*Tribulus terrestris**	x		

APPENDIX G –SPECIES LIST FOR THE RAIL CORRIDOR SURVEY AREA

FAMILY	SPECIES	North	South
AIZOACEAE	*Trianthema glossostigma*	x	x
	Trianthema pilosa		x
	Trianthema triquetra		x
AMARANTHACEAE	*Alternanthera angustifolia*		x
	Alternanthera nana		x
	Amaranthus cuspidifolius		x
	Gomphrena affinis		x
	Gomphrena kanisii	x	x
	Ptilotus aervoides		x
	Ptilotus aphyllus		x
	Ptilotus astrolasius	x	x
	Ptilotus axillaris		x
	Ptilotus calostachyus	x	x
	Ptilotus exaltatus	x	x
	Ptilotus gaudichaudii var. *gaudichaudii*		x
	Ptilotus gomphrenoides	x	x
	Ptilotus helipteroides	x	x
	Ptilotus latifolius		x
	Ptilotus macrocephalus		x
	Ptilotus obovatus		x
	Ptilotus polystachyus	x	x
	Ptilotus roei		x
	Ptilotus rotundifolius		x
	Ptilotus schwartzii		x
APOCYNACEAE	*Carissa lanceolata*	x	
	Rhyncharrhena linearis		x
ARALIACEAE	*Trachymene oleracea*		x
ASTERACEAE	*Bidens bipinnata**		x
	Brachyscome ciliocarpa		x
	Calocephalus francisii		x
	Calocephalus knappii		x
	Calotis plumulifera		x
	Centipeda minima subsp. *macrocephala*		x
	Chrysocephalum apiculatum		x
	Chrysocephalum eremaeum		x
	Chrysocephalum pterochaetum		x
	Chrysocephalum sp.		x
	Leiocarpa semicalva subsp. *semicalva*		x
	Myriocephalus rudallii		x
	Olearia mucronata		x
	Pluchea dentex		x

FAMILY	SPECIES		
ASTERACEAE	*Pluchea dunlopii*		x
	Pluchea tetranthera		x
	Pterocaulon serrulatum		x
	Pterocaulon sphacelatum		x
	Rhodanthe floribunda	x	x
	Rhodanthe propinqua		x
	*Sonchus oleraceus**		x
	Streptoglossa bubakii		x
	Streptoglossa macrocephala		x
BORAGINACEAE	*Halgania erecta*		x
	Halgania solanacea	x	x
	Heliotropium conocarpum		x
	Heliotropium diversifolium		x
	Heliotropium heteranthum		x
	Heliotropium inexplicitum		x
	Heliotropium tanythrix		x
	Heliotropium tenuifolium		x
	Trichodesma zeylanicum	x	x
BRASSICACEAE	*Lepidium echinatum*	x	x
	Lepidium phlebopetalum		x
	Stenopetalum nutans		x
	Stenopetalum pedicellare		x
CAMPANULACEAE	*Wahlenbergia tumidifructa*		x
CAPPARACEAE	*Capparis lasiantha*	x	x
CARYOPHYLLACEAE	*Polycarpaea corymbosa*		x
	Polycarpaea longiflora		x
CELASTRACEAE	*Macgregoria racemigera*		x
CHENOPODIACEAE	*Dysphania glomulifera*		x
	Dysphania kalpari	x	x
	Dysphania melanocarpa		x
	Enchylaena tomentosa	x	x
	Maireana eriosphaera		x
	Maireana georgei		x
	Maireana planifolia	x	x
	Maireana triptera	x	
	Maireana villosa	x	x
	Rhagodia eremaea	x	x
	Salsola australis	x	x
	Salsola tragus		x
	Sclerolaena cornishiana	x	x
	Sclerolaena densiflora	x	
	Sclerolaena tetragona		x
CLEOMACEAE	*Cleome oxalidea*		x
	Cleome viscosa	x	x
CONVOLVULACEAE	*Bonamia media*		x

FAMILY	SPECIES		
CONVOLVULACEAE	*Bonamia rosea*	x	x
	Convolvulus angustissimus subsp. *angustissimus*		x
	Duperreya commixta	x	x
	Evolvulus alsinoides var. *decumbens*		x
	Evolvulus alsinoides var. villosicalyx	x	x
	Ipomoea calobra		x
	Ipomoea muelleri		x
	Ipomoea pes-caprae		x
	Operculina aequisepala		x
CUCURBITACEAE	*Cucumis maderaspatanus*	x	x
CYPERACEAE	*Bulbostylis barbata*		x
	Bulbostylis turbinata		x
	Cyperus iria		x
	Cyperus vaginatus		x
	Fimbristylis dichotoma		x
	Fimbristylis simulans		x
EUPHORBIACEAE	*Euphorbia alsiniflora*		x
	Euphorbia australis		x
	Euphorbia boophthona		x
	Euphorbia coghlanii		x
	Euphorbia drummondii		x
FABACEAE	*Acacia adoxa* var. *adoxa*	x	
	Acacia adsurgens	x	x
	Acacia ancistrocarpa	x	x
	Acacia aneura	x	x
	Acacia aneura var. *pilbarana*		x
	Acacia aneura var. *aneura*	x	x
	Acacia aneura var. *macrocarpa*		x
	Acacia bivenosa	x	x
	Acacia citrinoviridis	x	x
	Acacia coriacea		x
	Acacia coriacea subsp. *pendens*	x	x
	Acacia dictyophleba	x	x
	Acacia distans	x	x
	Acacia hilliana	x	x
	Acacia kempeana		x
	Acacia ligulata	x	x
	Acacia maitlandii		x
	Acacia marramamba		x
	Acacia monticola	x	
	Acacia pachyacra		x
	Acacia paraneura		x
	Acacia pruinocarpa	x	x
	Acacia pyrifolia		x
	Acacia rhodophloia		x

FAMILY	SPECIES		
FABACEAE	*Acacia sclerosperma* subsp. *sclerosperma*	x	x
	Acacia sibilans		x
	Acacia sibirica		x
	Acacia synchronicia	x	x
	Acacia tenuissima	x	x
	Acacia tetragonophylla	x	x
	Acacia trudgeniana	x	x
	Acacia ? tumida var. *pilbarensis*		x
	Acacia wanyu	x	x
	Acacia xiphophylla		x
	Corchorus tridens		x
	Cullen leucanthum	x	x
	Glycine canescens		x
	Gompholobium polyzygum	x	
	Indigofera colutea		x
	Indigofera georgei		x
	Indigofera hirsuta		x
	Indigofera monophylla	x	x
	Isotropis atropurpurea		x
	Isotropis forrestii		x
	Jacksonia aculeata		x
	Kennedia prorepens	x	x
	Leptosema chambersii		x
	Mirbelia viminalis		x
	Neptunia dimorphantha		x
	Petalostylis cassioides	x	x
	Petalostylis labicheoides	x	x
	Rhynchosia minima	x	x
	Senna artemisioides		x
	Senna artemisioides subsp. *helmsii*	x	x
	Senna artemisioides subsp. *oligophylla*	x	x
	Senna ferraria	x	x
	Senna glaucifolia	x	x
	Senna glutinosa	x	x
	Senna glutinosa subsp. *chatelainiana*	x	x
	Senna glutinosa subsp. *pruinosa*	x	x
	Senna glutinosa subsp. x *luerssenii*		x
	Senna notabilis	x	x
	Senna sericea		x
	Senna symonii		x
	Senna venusta	x	
	Sesbania cannabina		x
	Tephrosia clementii		x
	Tephrosia rosea		x
	Tephrosia supina	x	x

FAMILY	SPECIES		
GOODENIACEAE	*Brunonia australis*		x
	Dampiera candicans		x
	Dampiera cinerea		x
	Goodenia armitiana		x
	Goodenia lamprosperma		x
	Goodenia microptera		x
	Goodenia muelleriana		x
	Goodenia nuda		x
	Goodenia prostrata	x	x
	Goodenia ramelii		x
	Goodenia sp.		x
	Goodenia stobbsiana		x
	Goodenia triodiophila		x
	Goodenia vilmoriniae		x
	Scaevola amblyanthera var. *centralis*		x
	Scaevola parvifolia subsp. *pilbarae*	x	x
	Scaevola spinescens		x
GYROSTEMONACEAE	*Codonocarpus cotinifolius*		x
	Gyrostemon tepperi		x
HALORAGACEAE	*Haloragis gossei var. gossei*		x
LAMIACEAE	*Clerodendrum floribundum*		x
	Dicrastylis cordifolia	x	x
	Newcastelia hexarrhena		x
	Spartothamnella teucriiflora		x
LAURACEAE	*Cassytha* sp.		x
	Cassytha racemosa		x
LORANTHACEAE	*Amyema hilliana*	x	x
MALVACEAE	*Abutilon fraseri*		x
	Abutilon lepidium		x
	Abutilon leucopetalum		x
	Abutilon macrum		x
	Corchorus parviflorus	x	
	Corchorus sidoides subsp. *sidoides*	x	x
	Gossypium australe		x
	Gossypium robinsonii		x
	Hibiscus brachychlaenus		x
	Hibiscus burtonii	x	x
	Hibiscus sturtii var. *campylochlamys*		x
	Hibiscus sturtii var. *truncatus*	x	x
	Keraudrenia nephrosperma	x	x
	Keraudrenia velutina		x
	*Malvastrum americanum**	x	x
	Rulingia loxophylla		x
	Rulingia luteifolia		x
	Sida arenicola		x

FAMILY	SPECIES		
MALVACEAE	*Sida arsiniata*		x
	Sida calyxhmyenia	x	x
	Sida cardiophylla	x	x
	Sida clementii		x
	Sida echinocarpa		x
	Sida fibulifera	x	x
	Sida platycalyx	x	x
	Sida sp. articulation below		x
	Sida sp. golden calyces glabrous		x
	Sida sp. tiny glabrous fruits		x
	Triumfetta ramosa		x
	Waltheria indica		x
MOLLUGINACEAE	*Mollugo molluginea*		x
MYRTACEAE	*Calytrix carinata*	x	x
	Corymbia candida subsp. *dipsodes*	x	x
	Corymbia deserticola subsp. *deserticola*	x	x
	Corymbia hamersleyana	x	x
	Corymbia opaca		x
	Eucalyptus camaldulensis		x
	Eucalyptus gamophylla	x	x
	Eucalyptus leucophloia	x	x
	Eucalyptus sp. (sterile low white bark mallee)		x
	Melaleuca glomerata		x
NYCTAGINACEAE	*Boerhavia coccinea*		x
	Boerhavia repleta		x
OROBANCHACEAE	*Striga squamigera*		x
PHRYMACEAE	*Peplidium muelleri*		x
PHYLLANTHACEAE	*Phyllanthus erwinii*		x
	Phyllanthus maderaspatensis		x
PLANTAGINACEAE	*Stemodia grossa*	x	x
POACEAE	*Acrachne racemosa*		x
	Amphipogon caricinus	x	x
	Aristida contorta	x	x
	Aristida holathera		x
	Aristida inaequiglumis	x	x
	Brachyachne prostrata		x
	*Cenchrus ciliaris**	x	x
	Chrysopogon fallax	x	x
	Cymbopogon ambiguus		x
	Cymbopogon obtectus	x	x
	Dactyloctenium radulans	x	x
	Dicanthium sericeum ? subsp. *humilis*		x
	Digitaria ammophila		x
	Enneapogon caerulescens	x	x
	Enneapogon pallidus		x

FAMILY	SPECIES		
POACEAE	*Enteropogon ramosus*		x
	Eragrostis cumingii		x
	Eragrostis eriopoda	x	x
	Eragrostis pergracilis		x
	Eragrostis tenellula		x
	Eragrostis xerophila		x
	Eriachne aristidea		x
	Eriachne flaccida		x
	Eriachne mucronata	x	x
	Eriachne pulchella		x
	Eulalia aurea	x	x
	Iseilema membranaceum		x
	Leptochloa digitata		x
	Monachather paradoxus		x
	Paractaenum refractum		x
	Paraneurachne muelleri	x	x
	Paspalidium rarum		x
	Perotis rara		x
	Setaria surgens		x
	Sorghum plumosum		x
	Sporobolus actinocladus		x
	Sporobolus australasicus		x
	Themeda triandra		x
	Tragus australianus		x
	Triodia basedowii	x	x
	Triodia ? biflora	x	
	Triodia pungens	x	x
	Triodia schinzii		x
	Triodia wiseana		x
	Urochloa holosericea subsp. *velutina*		x
	Yakirra australiense		x
POLYGALACEAE	*Polygala arvensis*		x
	Polygala isingii		x
PORTULACACEAE	*Calandrinia balonensis*		x
	Calandrinia ptychosperma		x
	Portulaca conspicua		x
	Portulaca intraterranea		x
	Portulaca filifolia		x
	*Portulaca oleracea**	x	x
	Portulaca pilosa		x
PROTEACEAE	*Grevillea berryana*		x
	Grevillea juncifolia	x	x
	Grevillea wickhamii subsp. *hispidula*	x	x
	Hakea lorea subsp. *lorea*	x	x
PTERIDACEAE	*Cheilanthes sieberi*		x

FAMILY	SPECIES		
RUBIACEAE	*Oldenlandia corymbosa*		x
	Oldenlandia pterospora		x
	Psydrax latifolia	x	x
	Psydrax suaveolens		x
SANTALACEAE	*Anthobolus leptomerioides*	x	x
	Santalum lanceolatum		x
	Santalum spicatum		x
SAPINDACEAE	*Atalaya hemiglauca*	x	x
	Diplopeltis stuartii		x
	Dodonaea coriacea		x
	Dodonaea petiolaris	x	x
SCROPHULARIACEAE	*Eremophila cuneifolia*	x	x
	Eremophila exilifolia	x	x
	Eremophila forrestii subsp. *forrestii*	x	x
	Eremophila fraseri		x
	Eremophila jucunda		x
	Eremophila lanceolata	x	x
	Eremophila latrobei subsp. *filiformis*	x	x
	Eremophila latrobei subsp. *glabra*		x
	Eremophila latrobei subsp. *latrobei*	x	x
	Eremophila longifolia	x	x
	Eremophila margarethae		x
	Eremophila youngii		x
SOLANACEAE	*Nicotiana rosulata* subsp. *rosulata*		x
	Solanum centrale		x
	Solanum ellipticum		x
	Solanum esuriale	x	x
	Solanum ferocissimum		x
	Solanum lasiophyllum	x	x
	Solanum phlomoides		x
STYLIDIACEAE	*Stylidium ? adenophorum*		x
SURIANACEAE	*Stylobasium spathulatum*	x	x
VIOLACEAE	*Hybanthus aurantiacus*	x	x
ZYGOPHYLLACEAE	*Tribulopis angustifolia*		x
	Tribulus astrocarpus		x
	Tribulus cistoides		x
	Tribulus macrocarpus		x
	Tribulus occidentalis		x
	Tribulus suberosus		x