Main Roads Western Australia

Minilya-Exmouth Road

Biological Survey

July 2016

Executive Summary

Introduction

Main Roads is proposing to upgrade various sections of the Minilya-Exmouth Road between SLK 0 to 211.75 and will require a number of material pits located along the Minilya-Exmouth Road to facilitate the upgrade works.

Main Roads commissioned GHD Pty Ltd to undertake a biological assessment of the potential areas of project works. The purpose of this assessment was to identify vegetation, flora and fauna values within the survey area to assist the final design of the project. The outcomes of the assessment will inform the environmental assessment and approvals process.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.5 and the assumptions and qualifications contained throughout the report.

Key Results

Flora and Vegetation

The survey area is comprised of 16 vegetation types which are generally equivalent to the mapped pre-European vegetation associations known from the local and regional area. All vegetation types are well represented with greater than 85% remaining at State, IBRA bioegion and IBRA sub-region scales.

The desktop assessment determined that the buffer of the Priority 1 PEC *Tussock grasslands or grassy tall or low shrublands of the Yarcowie Land System (Carnarvon Basin)* intersects survey areas 5, 6, 7 and 8 but vegetation types analogous with the PEC were not recorded during the survey.

Ephemeral drainage lines supporting riparian vegetation were recorded within survey areas 3, 10 and 11. This riparian vegetation was associated with Vegetation Type 2 (Creekline) and Vegetation Type 10 (Drainage Line).

Vegetation Type 4 (*Frankenia* flats) forms part of a coastal wetland within survey area 9. The Cape Range Subterranean Waterways (Nationally Important Wetland) was recorded within survey area 9. Vegetation Type 2 (Mosaic Plain) within survey area 9 may provide a buffer to this underground wetland.

Vegetation condition throughout the survey areas were generally consistent, with the exception of disturbed drainage lines, access tracks, fence lines, the road maintenance zone of the Minilya-Exmouth Road and borrow pits. Condition ranged from *Excellent* (Condition 2) to *Completely Degraded* (Condition 6). The majority of the survey areas were rated *Excellent* (Condition 2) (1,039 ha).

No conservation significant flora listed under the EPBC Act or WC Act was recorded from the survey areas, however three DPaW Priority listed flora species were recorded. In addition, the post-field Likelihood of Occurrence assessment survey concluded that two DPaW Priority listed flora taxa are likely or possible to occur.

Fauna and habitat

The habitats within the survey area are well represented within adjacent areas. Two Migratory EPBC Act listed conservation significant fauna species were recorded from survey area 11, including:

- Osprey (*Pandion haliaetus*)
- Rainbow Bee-eater (*Merops ornatus*).

The Osprey is considered to unlikely to utilise the habitat within the survey areas; however, foraging habitat for the Rainbow Bee-eater was present.

The post-field Likelihood of Occurrence assessment concluded that four fauna species of conservation significance species are likely to occur within the survey areas:

- Two EPBC Act listed fauna (Hermite Island Worm-lizard, Common Greenshank)
- One WC Act listed fauna (Peregine Falcon)
- One DPaW Priority fauna (Cape Range Stone Gecko).

Stygofauna

Groundwater of the Cape Range region supports a global hotspot for the occurrence of stygofauna; with 43 stygofaunal species belonging to twelve taxonomic groups. Approximately nine species are listed under the WC Act and are found within the Exmouth peninsula.

Matters of National Environmental Significance

Based on an assessment of the MNES, the following outcomes were recommended:

- Referral recommended
  - Significant fauna – *Aprasia rostrata* subsp. *rostrate* (Hermite Island Worm-lizard)

    The survey provided sufficient information to determine the presence of potentially suitable habitat within the survey area; however the survey could not determine the importance of this habitat for this species, nor eliminate the possibility of the the species utilising these habitats.
- Referral unlikely
  - Significant fauna – Migratory species *Merops ornatus* (Rainbow Bee-eater), *Pandion haliaestus* (Osprey) and *Tringa nebularia* (Common Greenshank)

    It was considered that these species are unlikely to rely on the habitats present within the survey area and clearing of habitat for the project is unlikely to significantly impact a population of this species. It is considered unlikely the project would require referral to the DotE for impacts on this species.

Table of Contents

1. Introduction....1
   - 1.1 Background....1
   - 1.2 Purpose of this report....1
   - 1.3 Survey area....1
   - 1.4 Scope of works....1
   - 1.5 Relevant legislation, conservation codes and background information....2
   - 1.6 Report limitations....2
   - 1.7 Report assumptions....3
2. Methodology....4
   - 2.1 Desktop Information Sources....4
   - 2.2 Field survey....4
   - 2.3 Desktop and Field Assessment Limitations and Assumptions....7
3. Desktop assessment....11
   - 3.1 Previous studies....11
   - 3.2 Physical environment....13
   - 3.3 Hydrology....15
   - 3.4 Land use....16
   - 3.5 Vegetation and flora....17
   - 3.6 Fauna species....22
4. Field Results....24
   - 4.1 Hydrology....24
   - 4.2 Vegetation....24
   - 4.3 Flora....35
   - 4.4 Fauna habitat....39
   - 4.5 Fauna species....49
5. Project values and approvals....52
   - 5.1 Key biological values....52
   - 5.2 Environmental approvals and referrals....55
6. References....57

Table Index

Table 1 Survey area 1
Table 2 Data recorded during the field survey 5
Table 3 Field Survey Limitations 8
Table 4 Land system description (Spencer and O'Brien 1998) 14
Table 5 DoW geographic data atlas query results (DoW 2015) 16
Table 6 Broadscale vegetation associations (Beard 1975; DAFWA 2015) 17
Table 7 Vegetation Associations extent and status 18
Table 8 NatureMap search results 20
Table 9 Introduced flora statistics 21
Table 10 *NatureMap* search results 22
Table 11 EPBC SPRAT threatened and migratory species 23
Table 12 Vegetation types recorded 25
Table 13 Extent of each vegetation condition rating within the survey areas 34
Table 14 Surveys areas flora statistics 35
Table 15 Other significant flora 38
Table 16 Weeds species recorded 38
Table 17 Fauna habitats 40
Table 18 Recorded fauna diversity 49
Table 19 Summary of likelihood of occurrence assessment for conservation significant fauna 50
Table 20 Biological values 53
Table 21 Assessment of the biological Matters of National Environmental Significance for the survey area 55
Table 22 Likelihood of Occurrence Assessment for conservation significant flora taxa 77
Table 23 Flora recorded from the survey area 83
Table 24 Likelihood of Occurrence assessment for conservation significant fauna species 154
Table 25 Recorded fauna during the field survey 166

Figure Index

Figure 1 Locality

Figure 2 Environmental Constraints

Figure 3 Vegetation types

Figure 4 Vegetation condition

Figure 5 Field Environmental Constraints

Appendices

Appendix A Conservation codes

Appendix B Database Searchess

Appendix C Flora Data

Appendix D Fauna Data

1. Introduction

1.1 Background

Main Roads Western Australia (Main Roads) has identified the need to upgrade the Minilya-Exmouth Road, as a result of an increase in traffic. The upgrade is required to improve safety and includes upgrading the road formation and culverts, seal widening and minor realignments at various locations between straight line kilometres (SLK) 0 and 211.75 (the project). To facilitate these works Main Roads also requires a number of material sources along the Minilya-Exmouth Road.

1.2 Purpose of this report

Main Roads commissioned GHD Pty Ltd (GHD) to undertake a biological assessment for the project. The purpose of this assessment was to identify vegetation, flora and fauna values within the survey area to assist in project design. The outcomes of the assessment will be used to inform the environmental assessment and approvals process.

1.3 Survey area

The survey area includes fives sections of road and six material pits situated along the Minilya-Exmouth Road. As part of the desktop assessment a predefined buffer of 20 kilometres (km) to each survey area was applied and defined as the study area. The details of each survey area and study area are provided in Table 1. The total survey area was 1922.7 hectares (ha), as defined by shapefiles provided by Main Roads.

Table 1 Survey area

Study area (includes 20 km buffer)	Survey area	Description	Size (ha)
Study area 1	Survey area 1	SLK 0 to 4 road	86.4
Study area 2	Survey area 2	SLK 7 material source	142.6
Study area 3	Survey area 3	SLK 24.5 material source	65.1
Study area 4	Survey area 4	SLK 25.4 material source	22.5
Study area 5	Survey area 5	SLK 116.3 material source	278.5
Study area 6	Survey area 6	SLK 118 material source	547.4
Study area 7	Survey area 7	SLK 128.5 material source	549.7
Study area 8	Survey area 8	SLK 130 to 135 road	106.6
Study area 9	Survey area 9	SLK 182 to 183.2 road	88.5
Study area 10	Survey area 10	SLK 202.1 to 204.4 road	26.0
Study area 11	Survey area 11	SLK 211 to 211.75 road	9.4
Total			**1922.7**

1.4 Scope of works

The scope of works, as detailed in the Main Roads Consultants Brief was to undertake a desktop assessment and biological survey. The following actions were completed to fulfil the scope:

- Complete a desktop assessment of the study areas prior to the field survey work to identify all biological values which may be in, or nearby, the survey area
- Identify and review any existing and relevant environmental reports

- Identify significant flora, fauna, soil, groundwater and surface water values and potential sensitivity to impact
- Identify pre-European vegetation type(s) using Beard mapping
- Conduct a field survey (to be done by an environmental specialist) to verify/ground-truth the desktop assessment findings
- Undertake vegetation condition mapping using Keighery (1994) and ecological community mapping
- Undertake relevant environmental constraints mapping using GIS mapping software (e.g. ArcMap)
- Assess the plant species diversity, density, composition, structure and weed cover within each survey area
- Assess all biological aspects likely to require referral of the project to the Environmental Protection Authority (EPA)
- Assess Matters of National Environmental Significance (MNES) and indicat whether potential impacts on MNES as protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are likely to require referral of the project to the Commonwealth Department of the Environment (DotE). Provide justification of decision as to whether referral to DotE is likely to be required. Ensure to reference relevant Commonwealth significant impact guidelines
- Determine the legislative context of environmental aspects required for the assessment
- Provide a concise report on the findings of the biological survey.

The biological survey methodology and reporting was undertaken with reference to the EPA Guidance Statements 51 and 56 (EPA 2004a; EPA 2004b).

1.5 Relevant legislation, conservation codes and background information

In Western Australia some ecological communities, flora and fauna are protected under both Federal and State Government legislation. In addition, regulatory authorities also provide a range of guidance and information on expected standards and protocols for environmental surveys.

An overview of key legislation and guidelines, conservation codes and background information relevant to this biological survey is provided in Appendix A.

1.6 Report limitations

This report has been prepared by GHD for Main Roads and may only be used and relied on by Main Roads for the purpose agreed between GHD and the as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Main Roads arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no

responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Main Roads and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.7 Report assumptions

This report has assessed the biological values within the survey area (Figures 1 and 2). Should the survey area change or be refined, further assessment may be required.

.

2. Methodology

2.1 Desktop Information Sources

Prior to the commencement of the field survey, a desktop assessment was undertaken to identity relevant environmental information pertaining to the study area. The search parameters used were a 20 km radius of a point within each survey area. This included a review of:

- The DotE Protected Matters Search Tool (PMST) to identify communities and species listed under the EPBC Act potentially occurring within the study area (DotE, 2015a) (Appendix B)
- The Department of Parks and Wildlife (DPaW) Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) database to determine the potential for TECs or PECs to be present within the study area
- The *NatureMap* database for flora and fauna species previously recorded within the study area (DPaW 2015c) (Appendix B)
- The DPaW Threatened (Rare) and Priority Flora (TPFL) database, the DPaW Threatened and Priority Fauna database, and the Western Australian (WA) Herbarium database for Threatened flora species listed under the *Wildlife Conservation Act 1950* (WC Act) and listed as Priority by the DPaW, previously recorded within the survey area
- Existing datasets including previous vegetation mapping of the survey area (Beard 1975), aerial photography, geology/soils and hydrology information to provide background information on the variability of the environment, likely vegetation units and fauna habitats and to identify areas with potential to contain TECs, PECs, and Threatened and Priority listed flora and fauna species

Note: The survey is restricted to terrestrial fauna and therefore, marine aquatic fauna species such as sharks, cetaceans, eels and seasnakes were omitted from the counts and will not be further assessed.

2.2 Field survey

2.2.1 Vegetation and flora

Ecologists Joshua Foster (Scientific Flora Collection Licence SL011358) and Steven Petts, (SL011359) completed a single-season vegetation and flora assessment of the survey areas from 11 to 19 October 2015. This vegetation and flora survey was undertaken with reference to the EPA Guidance Statement No. 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a).

The survey was undertaken to identify and describe the dominant vegetation units, assess vegetation condition and identify and record vascular flora taxa present at the time of survey. Additionally, searches for conservation significant communities and flora taxa identified in the desktop assessment were undertaken.

Data Collection

Field survey methods involved a combination of sampling quadrats located in identified vegetation units and traversing the survey area by foot and vehicle. Twenty-nine non-permenant quadrats were described throughout the survey areas.

Unmarked quadrats (measuring 30 x 30 metres (m) - area of 900m^2) were located within each identified vegetation type. Data recorded during the field survey is provided in Table 2.

Table 2 Data recorded during the field survey

Aspect	Measurement
Physical features	Aspect, soil attributes. Percentage surface cover by: rocks, logs and branches, leaf litter, bare ground.
Location of important features	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS) tool. All data was in MGA Zone 50.
Vegetation type	Vegetation types were described according to Muir (1977) and Aplin (1979) using the National Vegetation Inventory System (NVIS) data collection requirements (the Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003).
Vegetation Condition	Vegetation condition was assessed using the condition rating scale Keighery (1994).
Disturbance	Level and nature of disturbances (e.g. weed presence, fire — and time since last fire, impacts from grazing, exploration activities, etc.).
Flora	List of vascular flora taxa recorded in each vegetation type and within the survey area.

A flora inventory was compiled from taxa listed in described quadrats, releves, transects, and floristic records throughout the survey area in accordance with.

Vegetation types

Vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features and field data/observations.

Vegetation types were described based on structure, dominant taxa and cover characteristics as defined by quadrat data and field observations. A representative photograph of each vegetation type was also taken and is presented in Section 4.2.

Vegetation mapping has been undertaken at a suitable scale for the survey areas.

Vegetation condition

The vegetation condition of the site was assessed using the vegetation condition rating scale (Keighery 1994). The scale recognises the intactness of vegetation and consists of six rating levels as outlined in Appendix A.

All information and methodologies presented within this report predate the EPA and DPAW's (2015) Technical Guide- Flora and Vegetation Surveys for Environmental Impact Assessment, released in December 2015 after all surveys had been completed.

Flora identification and nomenclature

Species that were well known to the survey ecologists were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking.

Plant specimens collected during the field assessment were dried and processed in accordance with the requirements of the WA Herbarium. Flora identification was undertaken by the survey ecologist - Joshua Foster and plant species were identified by the use of local and regional flora keys and by comparison with the named species held at the Geraldton DPaW Herbarium.

Surveys for conservation significant flora

Prior to the field survey, information obtained from the desktop assessments (e.g. aerial photography, geology, soils and topography data, EPBC Act PMST, TPFL, *NatureMap* and the WAHERB database search results) was reviewed to determine conservation significant flora taxa potentially present within the survey area and locations. Additionally, ecological

information (e.g. habitat, associated flora taxa and phenology) was sourced from *FloraBase* (DPaW 2015d) and other relevant publications where available, to provide further details.

Potential habitat was searched by transect sampling and opportunistic sampling. Locations within the survey area with differing hydrology, fire or disturbance history to the surrounding areas were also searched where identified.

2.2.2 Fauna

Concurrent with the botanical survey, a fauna and habitat assessment of the survey area was undertaken by ecologists Joshua Foster and Steven Petts from 11 to 19 October 2015. The fauna assessment was undertaken with reference to the EPA Guidance Statement No. 56 Assessment of Environmental Factors for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b) and the DPaW and EPA's Technical Guide Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and Department of Environment and Conservation 2010).

The majority of the survey area was traversed on foot and by vehicle over the course of four days to identify and describe the dominant fauna habitat types and their condition, assess habitat connectivity, identify and record fauna species within the survey area. An assessment of the likelihood of conservation significant fauna and their habitats occurring within the survey areas was also undertaken.

Habitat assessment

A field data sheet was used to document the type, condition and extent of habitats within the survey area. The following information was collected for 13 habitat assessment quadrats:

- Habitat structure (e.g. vegetation type, presence/absence of structural layers such as ground cover and mid storey)
- Presence/absence of refuge including: density of ground covers, fallen timber (coarse woody debris) and rocks/boulder piles, and the type and extent of each refuge
- Presence/absence of waterways including type, extent and habitat quality within waterways
- Location of the habitat within the survey areas in comparison to the habitat within the surrounding landscape
- Current land use and disturbance history
- Identification and evaluation of key habitat features and types identified during the desktop assessment relevant to fauna of conservation significance
- A representative photograph of each habitat type.

Opportunistic fauna searches

- Opportunistic fauna searches were also conducted across the survey area. The majority of opportunistic searches were undertaken at habitat assessment locations and focussed on the following:
  - Searching the survey area for tracks, scats, bones, diggings and feeding areas for both native and feral fauna.
  - Searching through microhabitats including turning over rocks ground debris (e.g. leaf litter) and fallen trees for reptile and other small vertebrate fauna
  - Visual and aural surveys. This accounted for many bird species potentially utilising the survey areas. The *Michael Morcombe eGuide to Australian Birds* – phone application

(Morcombe 2014) and binoculars were used to assist visual observations. Pre-recorded calls from Morcombe (2014) were used to assist with aural identification of bird species.

Hermite Island Worm-lizard Survey

A survey for the Hermite Island Worm-lizard was undertaken within its preferred habitat type – Sand dunes. The survey involved raking through sand and leaf litter, and hand searches.

Camera trap survey

Motion sensor cameras (Reconyx-Hyperfire) were deployed for a period of at two nights within each of the survey areas 5, 6, 7 and 8. No motion sensor cameras were deployed within the remaining survey areas, due to time constraints and distances between survey areas and accommodation. Cameras were positioned in areas where activity (e.g. burrows, diggings and scat piles) was recorded. Cameras were baited with a peanut butter/oats and sardines mixture to attract fauna species, particularly carnivorous marsupials (e.g. Dasyuridae). For each camera location, the time and date the camera was deployed and recovered, a GPS coordinate and brief habitat description were recorded.

Data from the cameras was downloaded to a computer and analysed for the presence of animals following the field survey.

Fauna species identification

Identification of fauna species was made in the field using available field guides and electronic guides (e.g. Morcombe 2014). Where identification was not possible, photographs of specimens were collected to be later identified.

Nomenclature follows that used by the Western Australian Museum and the DPaW *NatureMap* database, as it is deemed to contain the most up-to-date species information for Western Australia, with the exception of birds, where Christidis and Boles (2008) was used.

2.3 Desktop and Field Assessment Limitations and Assumptions

The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual records of the species within the area. The records from the DPaW searches of threatened flora and fauna provide more accurate information for the general area. However, some records of collections, sightings or trappings cannot be dated and often misrepresent the current range of threatened species.

New Wildlife Conservation (Rare Flora) and Wildlife Conservation (Specially Protected Fauna) Notices were gazetted on 3 November 2015. The format of these Notices has been changed to align with the EPBC Act threatened species lists. To date information contained in publically available databases such as *NatureMap* does not reflect these newly gazetted Notices. This report has been updated to reflect the conservation status of flora and fauna listed in these Notices. However, the outputs of database searches contained in this report such as *NatureMap*, does not reflect the conservation status of flora and fauna listed in these Notices.

All information and methodologies presented within this report predates the EPA and DPAW's Technical Guide- Flora and Vegeation Surveys for Environmental Impact Assessment, December 2015.

There were no substantial limitations to the field survey as described in Table 3.

Table 3 Field Survey Limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information	Minor	Adequate information is available for the survey area, this includes: • Broad scale (1:1,000,000) mapping by Beard (1975) and digitised by Shepherd *et al.* (2002) • Regional biogeography (Desmond and Chant 2001, Kendrick and Mau 2002).
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not assessed as part of survey, although observations of invertebrate fauna were recorded.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Minor	The vegetation and flora survey was undertaken in Spring from 11 to 19 October, 2015. Flora species were generally identified with the exception of nine taxa which were only identified to genus level. It is likely that the survey under-recorded grass species (Poaceae) some of which had largely senesced at the time of survey. It is considered that a reasonably high number of the species likely to be present in the survey areas was recorded, due to the intensity of survey and high visibility of the differing vegetation types. The fauna survey was undertaken in in Spring from 11 to 19 October, 2015 and was a reconnaissance survey only. The fauna assessment sampled those species that can be easily seen, heard or have distinctive signs such as tracks, scats, diggings, etc. Many cryptic, e.g. invertebrate species, and nocturnal species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. Of the fauna species recorded during the survey, all species were identified to a species level. The fauna assessment was aimed at identifying habitat types and terrestrial vertebrate fauna utilising the survey area. No sampling for invertebrates or aquatic species occurred. Where terrestrial invertebrate fauna were recorded and mentioned in this report. However, this report is limited to an assessment of terrestrial vertebrate fauna, as the information available on the identification, distribution and conservation status of invertebrates is generally less extensive than that of vertebrate species.
Flora determination	Minor	Flora determination was undertaken by Joshua Foster in the field or material collected for later identification in the Geraldton herbarium or through online resources. The proportion of flora collected and identified was considered high, however nine flora taxa were identified to a genus level due to insufficient material such as flowers and fruit. .

Aspect	Constraint	Comment
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Minor	The majority of the Project Area was accessed on foot and vehicle. Information gained from the survey was extrapolated across those small sections of the survey area not accessed on foot during the field survey to assist with determining the vegetation and habitat types for the entire survey area.
Mapping reliability	Minor	The vegetation was mapped using aerial imagery obtained from Landgate, topographical features, vegetation mapping (Beard 1975) and field data. The distribution of non-permanent quadrats is considered adequate for the definition of vegetation within the survey areas. Data was recorded in the field using hand-held GPS tools, e.g. Garmin GPS. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ±10 m on average. Therefore, the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/season/cycle	Minor	The field survey was conducted from 11 to 19 October 2015 following average rainfall in Winter and above average rainfall in Autumn (Bureau of Meterology (BoM) 2015). During the field survey ecologists recorded a large number of annuals. Some flora species are only available for collection at certain times of the year and others are only identifiable at certain times (such as when they are flowering). Species that have a very low abundance in the area are more difficult to locate, due to the above factors. Flora composition changes over time, with flora species having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). Therefore, the results of future botanical surveys in this location may differ from the results of this survey. Complete flora and fauna surveys can require multiple surveys at different times of year and over a period of a number of years, to enable observation of all species present.
Disturbances (e.g. fire, flood, accidental human intervention)	Minor	Current disturbances recorded were cattle, recent tracks and introduced flora. Evidence of recent clearing activities within survey area 10. Much of the recent clearing was in vegetation on road edges that had been previously heavily disturbed.
Intensity (in retrospect, was the intensity adequate)	Nil	The vascular flora of the survey area was sampled with reference to EPA (2004a) and terrestrial fauna sampled with reference to EPA (2004b). The survey areas were sufficiently covered by the ecologists during the survey on foot and via vehicle.
Resources	Nil	Adequate resources were employed during the field survey. Nine person days were spent undertaking the survey using two ecologists.
Access restrictions	Nil	No access problems were encountered during the survey.

Aspect	Constraint	Comment
Experience levels	Nil	The ecologists who executed the survey were practitioners suitably qualified in their respective fields. Joshua Foster (Scientific Flora Collection licence SL011358), is a Principal Ecologist with over 12 years experience in undertaking ecological (flora and fauna) surveys within the Carnarvon region. Steven Petts, (SL011359), is an Ecologist with over five years experience in undertaking ecological surveys in the Carnarvon region.

3. Desktop assessment

This section describes the study areas' physical, biological aspects based on previous studies and desktop investigations.

3.1 Previous studies

GHD (2008) *Passing Lanes and Material Pit Minilya Exmouth Road Targeted Flora Survey. Unpublished Report*

A targeted flora assessment was undertaken at SLK 183.3–192, SLK 202.1–204.4 and at material pit SLK 205.1 to 206.1 along the Minilya-Exmouth Road.

- Fifteen vegetation types were recorded from the survey area
- One hundred and forty-five species from 88 genera and 37 families (137 native flora and eight introduced species) were recorded from the survey area
- One Priority 3 species, *Corchorus congener,* was recorded within material pit SLK 205.1 to 206.1 and at SLK 183.3-192 and SLK 202-204.4. Approximately five plants were recorded at material pit 205.1 to 206.1
- The proposed project was considered to be likely at variance with Clearing Principle C.

GHD (2011) *Minilya-Exmouth Road. Cardabia Station Fencing Project. Biological Survey*. Unpublished Report

A biological assessment was undertaken from Minilya-Exmouth Road SLK 68.64 to 114.97 for the proposed Cardabia Station fencing project.

- Two priority flora species were recorded from the survey area: *Acacia ryaniana* (Priority 2) and *Acacia startii* (Priority 3)
- Approximately 700 plants of *Acacia ryaniana* were recorded along Coral Bay Road from a number of locations
- Approximately 20 plants of *Acacia startii* were recorded from the survey area. These plants appear to inhabit previously disturbed areas
- A number of flora taxa exhibiting an extension of their known range were recorded from the survey area, including:
  - *Lobelia gibbosa* (630 km north of nearest record)
  - *Senna artemisioides* subsp. x *sturtii* (150 km north of nearest record)
  - *Sauropus trachyspermus* (165 km south west of nearest record)
  - *Yakirra australiensis* (65 km west of nearest record)
  - *Hakea lorea* (50 km south and west of nearest record)
  - *Anthobolus foveolatus* (240 km north of nearest record).

GHD (2012) Minilya-Exmouth Road Section Upgrades. Preliminary Environmental Impact Assessment. Unpublished Report

A Biological Assessment was undertaken at SLK 4-25, SLK 36.4-38.4, SLK 113-130, SLK 181-183.3, SLK 192-202.1 and SLK 204.4-411 along the Minilya-Exmouth Road.

- Six priority flora species were recorded from the survey area:

  - *Acacia alexandri* Priority 3
  - *Acanthocarpus rupestris* Priority 3
  - *Brachychiton obtusilobus* Priority 4
  - *Eremophila youngii subsp. lepidota* Priority 4
  - *Gymnanthera cunninghamii* Priority 3
  - *Tinospora esiangkara* Priority 2.
- One priority fauna species was recorded from the survey area – Australian Bustard (*Ardeotis australis* – Priority 4)
- The project was not found to be at variance with any of the Ten Clearing Principles.

GHD (2016) Strategic Material Areas Minilya-Exmouth Road SLK 54, 62-65, 175.1 and 205.5 Biological Survey. February 2016

A Biological Assessment was undertaken at four proposed strategic material areas at Minilya-Exmouth Road SLK 54, SLK 62-65, SLK 175.1 and SLK 205.5 with the following key outcomes:

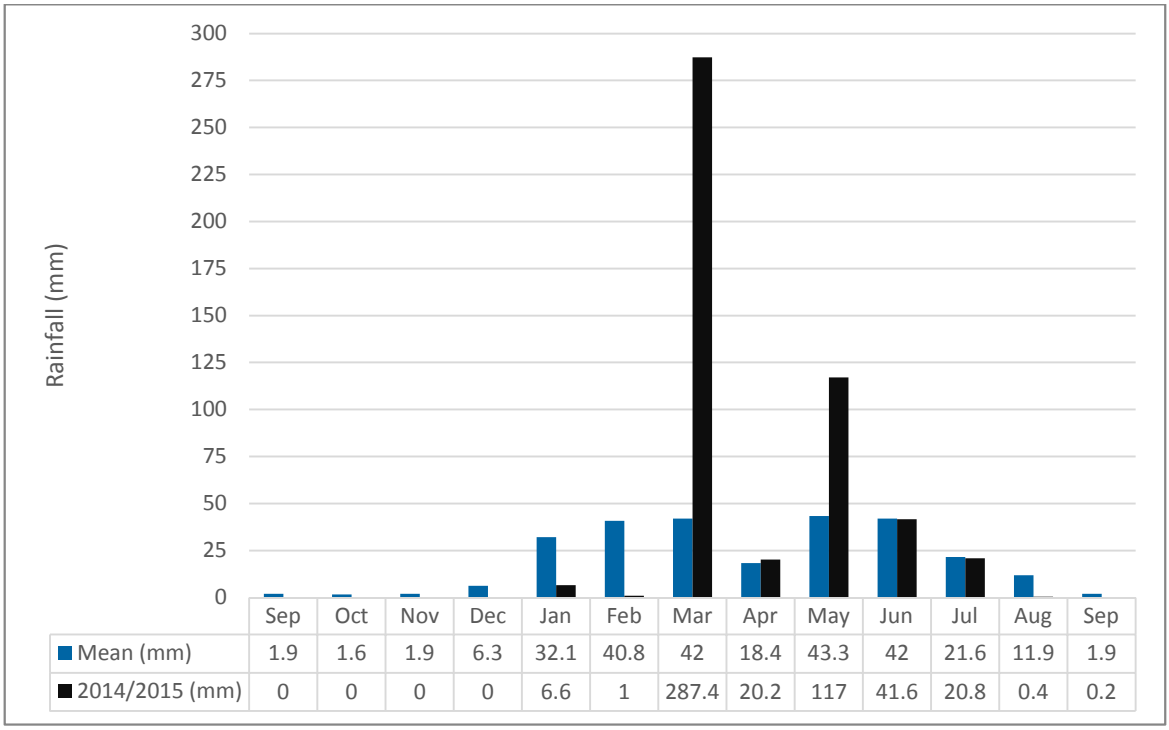
- Range extension Priority 1 Flora taxon – *Eremophila cuneata* at SLK 54
- Priority 3 flora taxon – *Acacia startii* at SLK 54 and SLK 62-65
- Potential habitat for Priority 2 – Cape Range Stone Gecko (*Diplodactylus capensis*)
- An Environmental Sensitive Area (ESA) intercepts SLK 205. This ESA is associated with a nationally important wetland - Cape Range Subterranean Waterways.
  - The vegetation type Mosaic Plain within the SLK 205.5 likely provides a buffer to this wetland. The creek lines forms the hyporheic zone of this wetland and it was recommended Main Roads avoids these areas.

3.2 Physical environment

3.2.1 Climate

The survey areas are located in the Shires of Carnarvon and Exmouth, which experience an arid climate with predominately winter rainfall (Kendrick and Mau 2002).

The closest BoM weather station that provides continuous reliable data to the Project Area is located at Learmonth Airport (Site Number 5007) (BoM 2015). In the three months proceding the field survey, rainfall recorded was 21.4 millimetres (mm) which is below the long term average of 35.4 mm over the same months (BoM 2015). However, rainfall recorded between March and May exceeded the mean monthly rainfall, with March recording 287.4 mm, well above the average of 42 mm. A comparison of the mean monthly rainfall from since 1907 and 2014/2015 annual rainfall proceding the field survey assessment is provided in Plate 1.



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean (mm)	1.9	1.6	1.9	6.3	32.1	40.8	42	18.4	43.3	42	21.6	11.9	1.9
2014/2015 (mm)	0	0	0	0	6.6	1	287.4	20.2	117	41.6	20.8	0.4	0.2

Plate 1 Rainfall statistics (BoM 2015)

3.2.2 Bioregion

The Interim Biogeographic Regionalisation of Australia (IBRA) divides the Australian continent into 89 biogeographic regions based on their climatic, faunal, vegetation, landform and geological features (Department of Sustainability, Environment, Water, Population and Communities 2012). All survey areas are located within the Carnarvon IBRA region.

Survey areas 1, 2 and 3

These survey areas are located within the Wooramel (CAR2) IBRA sub-region. The Wooramel Subregion is the southern and central parts of the Carnarvon Basin. This sub-region consists of alluvial plains associated with downstream sections and deltas of Gascoyne, Minilya and Wooramel Rivers (Kendrick and Mau 2002).

Survey areas 4, 5, 6, 7, 8, 9, 10 and 11

These survey areas are located within the Cape Range (CAR1) IBRA sub-region. The CAR1 consists of rugged tertiary limestone ranges and extensive areas of red Aeolian dunefield,

Quaternary coastal dunes and mud flats. The region typically comprises *Acacia* shrublands over *Triodia* on limestone and red dunefields (Desmond and Chant, 2001).

3.2.3 Geology

A search of the Department of Mines and Petroleum (DMP) Interactive Geological Map (DMP 2015) database indicates that Cza – Alluvial, shoreline and eolian deposits - is the principal underlying geology.

3.2.4 Land system

Land systems within the Carnarvon Basin region were mapped and described by Spencer and O'Brien (1998). A summary of location and description of the land systems is provided in Table 4 and mapped in Figure 2a.

Table 4 Land system description (Spencer and O'Brien 1998)

Land System	Description	Land Type	Location
Brown Land System	Sandy plains with sparse longitudinal dunes, supporting tall shrublands of acacias.	Sandplains and occasional dunes with grassy acacia shrublands.	Survey area 1
Delta Land System	Flood plains of the major rivers, supporting low shrublands of bluebush and saltbush, widely degraded and eroded.	Alluvial plains with halophytic shrublands.	Survey area 1
Trealla Land System	Elevated plains and marginal slopes with shallow soils over limestone, supporting moderately close tall acacia shrublands and minor areas of low shrublands of bluebush.	Calcrete plains with acacia shrublands.	Survey area 2
Donovan Land System	Gently sloping outwash plains and minor stony plains with alkaline loamy and clayey soils supporting tall shrublands of snakewood and other Acacia species and low shrublands of bluebush.	Alluvial plains with halophytic shrublands.	Survey area 3
Trealla Land System	Elevated plains and marginal slopes with shallow soils over limestone, supporting moderately close tall acacia shrublands and minor areas of low shrublands of bluebush.	Calcrete plains with acacia shrublands.	Survey area 3
Chargoo Land System	Flat saline alluvial plains subject to temporary inundation, characterised by numerous drainage depressions; low shrublands of saltbush and bluebush and tussock grasslands.	Alluvial plains with halophytic shrublands.	Survey areas 3 and 4
Cardabia Land System	Undulating sandy plains with linear dunes, minor limestone plains and low rises, supporting mainly soft spinifex hummock grasslands with scattered acacias and other shrubs.	Alluvial and sandy plains with soft spinifex grasslands.	Survey areas 5, 6, 7 and 8
Littoral Land System	Bare coastal mudflats with mangroves on seaward fringes, samphire flats, sandy islands, coastal dunes and	Coastal plains, cliffs, dunes, mudflats and	Survey area 9

Land System	Description	Land Type	Location
	beaches.	beaches; various vegetation.	
Learmonth Land System	Sandy outwash plains marginal to the Cape Range, supporting mainly soft spinifex hummock grasslands with scattered acacia shrubs.	Alluvial and sandy plains with soft spinifex grasslands.	Survey areas 9, 10 and 11

3.2.5 Acid sulfate soils

The Australian Soil Resource Information System (ASRIS) described the probability of acid sulfate soils occurring within the survey areas and indicates that there is an extremely low probability/low confidence of them occurring (ASRIS 2015).

3.3 Hydrology

3.3.1 Wetlands

A search of the EPBC Act PMST indicated that no Wetlands of International Importance (i.e. listed under the Ramsar Convention) occur within the survey areas. However, one Nationally Important Wetland intersects survey area 9 - Cape Range Subterranean Waterways (including the associated karst system) (Figure 2).

The Cape Range Subterranean Waterways includes “waterways, sinkholes, general groundwater and artificial wells (notably Billy, Five Mile, Javis, Kubara, Kudumurra, Milyering, Mowbowra, Pilgramunna, Tantabiddi and Tulki Wells, [-Tantabiddi] and Wobri Rockholes, Bundera Sinkhole and caves C-23, C-215, C-425, C-495) of the coastal plain and foothills of the Cape Range north of a line between Norwegian Bay and the Exmouth Gulf” (Department of Environment and Conservation (DEC) 2010). This area is described as follows:

“Rich entirely endemic stygofauna inhabits the system and is mostly a relictual Tethys Sea fauna. The affinities of many taxa lie with similar habitats in the Caribbean and Canary Islands. The fauna includes the Blind Gudgeon [(*Milyeringa veritas*)], the Blind Cave Eel [(*Ophisternon candidum*)], and the only southern hemisphere representatives of entire classes, orders, families and genera of crustaceans. Plant structural formations: Overlying areas support tussock grassland (*Triodia* spp.) and low shrubland” (DEC 2010). This wetland intercepts portions of survey area 9.

A further review of the EPBC Act PMST database indicates that survey area 3 is located approximately 6.5 km north east of, and survey areas 1, and 2, 18 km north east of, Lake MacLeod.

The desktop findings are presented in Figure 2.

3.3.2 Watercourses

No major watercourses intersect the survey areas. The closest major watercourse is the Lyndon River which is located within study area 4. A coastal waterline intercepts survey area 11. The Department of Water (DoW) identified a number of minor, non-ephemeral watercourses in and adjacent to the survey areas. A “Coastal Waterline” was identified within survey area 11 (DoW 2000).

3.3.3 Public Drinking Water Source

The hydrology and hydrogeology aspects proclaimed under the *Rights in Water and Irrigation Act 1914* (RIWI Act) within the survey areas are provided in Table 5.

Table 5 DoW geographic data atlas query results (DoW 2015)

Aspect	Detail	Result
RIWI Groundwater Areas	Groundwater areas proclaimed under the RIWI Act.	Survey areas 1, 2, 3, 4, 9, 10 and 11 - Gascoyne RIWI groundwater area. Survey areas 5, 6, 7 and 8 – Pilbara RIWI groundwater area.
Groundwater Sub-areas	Groundwater areas proclaimed under the RIWI Act.	Survey areas 1, 2, 3 and 4 – Zuytdorp/Ningaloo Survey areas 5, 6, 7 and 8 - Ashburton Survey area 9 – Exmouth South Survey area 10 – Exmouth Central Survey area 11 – Exmouth Town
RIWI Watercourses	Watercourses proclaimed under the RIWI Act.	The Project does not cross any RIWI watercourses.
RIWI Surface Water Area	Surface water areas proclaimed under the RIWI Act.	The Project is located within the Pilbara Surface Water Area.
Public Drinking Water Source Areas (PDWSA)	PDWSAs is a collective term used for the description of Water Reserves, Catchment Areas and Underground Pollution Control Areas declared (gazetted) under the provisions of the *Metropolitan Water Supply, Sewage and Drainage (MWSSD) Act 1909* or the *Country Area Water Supply (CAWS) Act 1947.*	The Project is not within a PDWSA.

3.4 Land use

3.4.1 Surrounding land use

The current land use within the survey areas includes pastoral leases, historical material extraction and access tracks. The surrounding land use includes the Minilya-Exmouth Road, Exmouth Airport, urban development and conservation areas.

3.4.2 Environmentally sensitive areas

Environmentally sensitive areas (ESAs) are subject to definition under Section 51B of the EP Act and may include areas requiring special management attention to protect important scenic values, fish and wildlife resources, historical and cultural values, and other natural systems or processes. The Department of Environment Regulation's (DER's) Clearing Permit System indicates that survey areas 9, 10 and 11 are located within an ESA (the Cape Range National Park and surrounds) as shown in Figure 2 (DER 2015c). The Cape Range National Park is located approximately 7 km from the survey areas and it is considered unlikely that it will be impacted by the proposed project.

3.4.3 Conservation areas

NatureMap indicates that the survey areas do not include any conservation areas. The nearest conservation area is the Cape Range National Park (DPaW 2015c).

3.5 Vegetation and flora

3.5.1 Vegetation mapping

Broad scale (1:1,000,000) pre-European vegetation association mapping of the Murchison region was completed by Beard (1975), which indicates that there are four associations present within the survey areas (Table 6).

Table 6 Broadscale vegetation associations (Beard 1975; DAFWA 2015)

Vegetation association	Description	Location
95	Hummock grasslands, shrub steppe; acacia & grevillea over *Triodia basedowii*	Survey area 1
117	Shrublands, snakewood scrub	Survey area 9
162	Hummock grasslands, grass steppe spinifex	Survey area 9
244	Low woodland; Acacia victoriae & snakewood	Survey area 4
264	Low woodland; Acacia victoriae & snakewood	Survey areas 1 and 2
345	Mosaic: Shrublands; *Acacia sclerosperma* & *A. victoriae* patchy scrub, barren/Succulent steppe; saltbush & bluebush	Survey areas 3 and 4
658	Shrublands; *Acacia sclerosperma* & snakewood scrub (also with some waterwood)	Survey area 4
662	Hummock grassland; shrub steppe; mixed acacia scrub & dwarf scrub with soft spinifex & *Triodia basedowii*	Survey areas 5, 6, 7, 8 and 9
663	Hummock grasslands, shrub steppe; waterwood over soft spinifex	Survey areas 10 and 11
678	Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* over hard spinifex	Survey areas 9

3.5.1 Conservation significant ecological communities

A search of the EPBC Act PMST database (DotE 2015a) did not identify any TECs within the study areas. The closest TEC – Cape Range Remipede Community, is located approximately 26 km west of survey area 9.

A search of the *NatureMap* database identified the buffer of one PEC (Priority 3) which intercepts survey areas 1 and 2 (DPaW 2015c). *Lake Macleod invertebrate assemblages* are associated with a saline aquatic community. This PEC is located approximately 6 km west of survey area 1, and is unlikely to be impacted by the proposed works.

Data sourced in 2015 from DPaW Threatened TEC and PEC spatial datasets (Figure 2) identified the buffer of one Priority 1 PEC which intercepts survey areas 5, 6, 7 and 8. This PEC is the *Tussock grasslands or grassy tall or low shrublands of the Yarcowie Land System - Carnarvon Basin*. This PEC is characterised by Gilgai soils derived from lower cretaceous benthonitic siltstone on nearly flat plains that support tussock grasslands or grassy tall or low shrublands. The Land System has a very restricted distribution (DPaW 2015b).

3.5.2 Vegetation extent and status

The broad-scale vegetation association mapping (Beard 1975) was adapted and digitised by Shepherd *et al.* (2002). The remaining extents of the pre-European vegetation associations have been determined by the State-wide calculations maintained by DPaW (Government of Western Australia (GoWA) 2015). As shown in Table 7 the remaining extent of the vegetation associations occurring within the survey areas is greater than 85% for all but two of them at the State, IBRA bioregion, IBRA sub-region and local government authority (LGA) levels.

Table 7 Vegetation Associations extent and status

Vegetation association	Scale	Pre-European extent (ha)	Current extent (ha)	% Current extent in all DPaW managed lands	% Remaining
IBRA region (Carnarvon (CAR))		8,382,890.36	8,360,803.35	11.61	99.74
IBRA subregion (Cape Range (CAR1))		2,368,970.05	2,356,438.10	15.43	99.47
IBRA subregion (Wooramel (CAR2))		6,013,920.31	6,004,363.27	10.10	99.84
95	State	1,224,626.57	1,223,593.74	3.65	99.92
	IBRA (CAR)	390,084.96	389,947.89	0	99.96
	IBRA Sub-region (CAR2)	332,277.22	332,140.15	0	99.96
	LGA (Shire of Carnarvon)	385,399.51	384,366.68	0.13	99.73
117	State	919,517.05	886,004.92	14.25	96.36
	IBRA (CAR)	12,424.35	10,907.99	27.48	87.80
	IBRA Sub-region (CAR1)	12,424.35	10,907.99	27.48	87.80
	LGA (Shire of Exmouth)	5,089.65	3,362.59	14.97	66.07
162	State	547,312.10	545,772.34	26.15	99.74
	IBRA (CAR)	218,936.66	217,754.85	27.48	99.46
	IBRA Sub-region (CAR1)	27,287.90	26,106.10	0	95.67
	LGA (Shire of Exmouth)	2,015.43	770.22	0	32.22
244	State	88,973.40	88973.40	0.04	100
	IBRA (CAR)	88,909.93	88,909.93	0.01	100
	IBRA Sub-region (CAR1)	88,868.39	88,868.39	0	100
	LGA (Shire of Carnarvon)	36,386.99	36,386.99	0.01	100
264	State	581,127.75	581,127.75	3.76	100
	IBRA (CAR)	503,681.76	503,677.32	3.47	100
	IBRA Sub-region (CAR2)	475,948.78	475,944.34	3.64	100
	LGA (Shire of Carnarvon)	218,234.12	218,229.69	4.54	100

Vegetation association	Scale	Pre-European extent (ha)	Current extent (ha)	% Current extent in all DPaW managed lands	% Remaining
345	State	57,166.10	57,166.10	0	100
	IBRA (CAR)	57,166.10	57,166.10	0	100
	IBRA Sub-region (CAR1)	33,982.39	33,982.39	0	100
	IBRA Sub-region (CAR2)	23,183.71	23,183.71	0	100
	LGA (Shire of Carnarvon)	57,166.10	57,166.10	0	100
658	State	200,281.99	200,281.99	22.05	100
	IBRA (CAR)	200,281.99	200,281.99	22.05	100
	IBRA Sub-region (CAR1)	133,266.87	133,266.87	33.14	100
	LGA (Shire of Carnarvon)	131,764.26	131,764.26	0	100
662	State	284,795.92	282,125.59	1.99	99.06
	IBRA (CAR)	282,709.68	281,679.33	1.84	99.64
	IBRA Sub-region (CAR1)	282,709.68	281,679.33	1.84	99.64
	LGA (Shire of Exmouth)	194,418.89	193,603.95	2.60	99.58
663	State	30,474.41	25,976.66	26.46	85.24
	IBRA (CAR)	29,068.26	25,866.32	26.19	88.94
	IBRA Sub-region (CAR1)	29,068.26	25,866.32	26.19	88.98
	LGA (Shire of Exmouth)	30,747.41	25,976.66	29.46	85.24
678	State	5,980.33	5,886.40	0	98.09
	IBRA (CAR)	5,980.33	5,886.40	0	98.09
	IBRA Sub-region (CAR1)	5,980.33	5,886.40	0	98.09
	LGA (Shire of Exmouth)	5,980.33	5,886.40	0	98.09

3.5.3 Flora diversity

A summary of the the *NatureMap* database (DPaW 2015c) search results for eash survey area is provided in and the data searches are provided in Appendix B.

.

Table 8 NatureMap search results

Study area 1 - Dominant Families	Number of taxa
Chenopodiaceae	16
Fabaceae	14
Poaceae	13
Total flora taxa	95
Study area 2 - Dominant Families	**Number of taxa**
Chenopodiaceae	17
Asteraceae	11
Fabaceae	11
Total flora taxa	63
Study area 3 - Dominant Families	**Number of taxa**
Fabaceae	16
Chenopodiaceae	12
Asteraceae	10
Total flora taxa	88
Study area 4 - Dominant Families	**Number of taxa**
Fabaceae	16
Chenopodiaceae	12
Asteraceae	10
Total flora taxa	84
Study area 5 – Dominant Families	**Number of taxa**
Fabaceae	15
Myrtaceae	7
Poaceae	7
Total flora taxa	171
Study area 6 – Dominant Families	**Number of taxa**
Fabaceae	13
Myrtaceae	7
Poaceae	7
Total flora taxa	65
Study area 7 – Dominant Families	**Number of taxa**
Fabaceae	17
Goodeniaceae	9
Asteraceae	7
Total flora taxa	60
Study area 8 – Dominant Families	**Number of taxa**
Fabaceae	21
Goodeniaceae	9
Malvaceae	9
Total flora taxa	80

Study area 9 – Dominant Families	Number of taxa
Fabaceae	31
Asteraceae	21
Myrtaceae	15
Total flora taxa	88
Study area 10 – Dominant Families	**Number of taxa**
Fabaceae	34
Asteraceae	21
Myrtaceae	14
Total flora taxa	162
Study area 11 – Dominant Families	**Number of taxa**
Fabaceae	54
Asteraceae	31
Chenopodiceae	23
Total flora taxa	428

3.5.1 Introduced flora species

A summary of the EPBC Act PMST (DotE 2015a) and *NatureMap* (DPaW 2015c) search results for introduced flora (weeds) is summarised in Table 9 and detailed in Appendix B.

Table 9 Introduced flora statistics

Location	EPBC	NatureMap
Survey area 1	1	4
Survey area 2	1	2
Survey area 3	1	2
Survey area 4	1	2
Survey area 5	2	2
Survey area 6	2	2
Survey area 7	2	4
Survey area 8	2	5
Survey area 9	1	6
Survey area 10	1	7
Survey area 11	1	14

3.5.2 Conservation significant flora taxa

A search of the EPBC Act PMST (DotE 2015a) indicated that two EPBC Act listed flora taxa are known or likely to occur within study area 2.

Desktop searches of the *NatureMap* database (DPaW 2015c) and the DPaW databases (20 km buffer) determined that no Threatened flora taxa declared under the WC Act have been previously recorded within the study areas. The searches indicate the following number of DPaW Priority taxa have been previously recorded within the study areas:

- Five study areas 1, 9
- Four in study areas 2, 3, 4
- One in study areas 5, 6, 7 and 8
- Seven in study area 10
- Fourteen in study area 11.

The databases search results are provided in Table 22, Appendix C and Figure 2.

3.6 Fauna species

3.6.1 Fauna diversity

A summary of the search results of the *NatureMap* database (DPaW 2015c) for each study area are provided in Table 10.

Table 10 *NatureMap* search results

Location	Amphibians	Birds	Mammals	Reptiles
Study area 1	7	93	-	19
Study area 2	-	65	-	19
Study area 3	1	54	1	27
Study area 4	1	54	1	27
Study area 5	-	36	2	55
Study area 6	-	34	1	46
Study area 7	-	41	1	51
Study area 8	-	43	4	53
Study area 9	4	88	22	51
Study area 10	3	81	15	46
Study area 11	4	127	11	76

3.6.2 Conservation significant fauna

Searches of the EPBC Act PMST and *NatureMap* database identified the presence/potential presence of threatened and migratory fauna species, and are provided in Appendix B. A summary of the search results is provided inTable 11.

Table 11 EPBC SPRAT threatened and migratory species

Location	Listed threatened and DPaW Priority species	Listed migratory species
Study area 1	1	8
Study area 2	2	9
Study area 3	1	9
Study area 4	1	9
Study area 5	7	12
Study area 6	8	21
Study area 7	4	10
Study area 8	4	9
Study area 9	6	12
Study area 10	10	17
Study area 11	3	25

Conservation significant fauna species are discussed further in Sections 4.5.2 and 4.5.3.

3.6.3 Stygofauna

Groundwater of the Cape Range region is a global hotspot for the occurrence of stygofauna; with 43 stygofaunal species belong to twelve taxonomic groups. Approximately nine species are listed under the WC Act and are found on the Exmouth peninsula. Limited stygofauna surveys indicate that the majority of species are restricted to the eastern side of the Cape Range but at present there are no sites considered of very high conservation significance. Groundwater studies of the limestone systems of the Cape Range and the coastal plain indicate that more than 300 caves are known to occur on the limestone system (Bennelongia 2008).

‘

4. Field Results

4.1 Hydrology

4.1.1 Ephemeral drainage lines

The field survey recorded a number of natural creek lines within survey areas 10 and 11. These findings are consistent with, the desktop results in Section 3.3.2. These creek lines had been modified, and were generally restricted to the edge of the existing road. They support riparian vegetation.

Drainage lines were recorded within survey areas 3 and 4. These drainage lines are degraded, and within survey area 3 were modified as a result of previous material extraction. The drainage line in survey area 3 forms part of the Lyndon River and supports riparian vegetation *(Eucalyptus victrix).* Survey area 4 does not support any riparian vegetation.

A floodplain was recorded within survey area 1, but does not support riparian vegetation. During periods of the flow it is likely that this floodplain forms a tributary of the Minilya River.

4.1.2 Wetlands

One wetland was recorded within survey area 9. This wetland is largely in good condition and is considered to support riparian vegetation, predominantly *Frankenia* species.

A claypan was recorded within survey area 2. It would likely be seasonally inundated following intensive rainfall periods. The claypan does not support any riparian vegetation.

Section 3.3.1 and Figure 2, identified the Cape Range Subterrean Waterways which intercepts survey area 9, it is likely that vegetation within the survey area 9 likely provides a buffer to this underground wetland.

4.2 Vegetation

4.2.1 Vegetation types

Sixteen vegetation types were delineated during the field survey using a combination of results from quadrat data assessment and interpretation of aerial photography (Table 12). One vegetation type was described as Cleared/Degraded.

The vegetation across the survey areas broadly varies between survey areas 9, 10 and 11, which comprise Mosaic vegetation type (vegetation type 1), to survey areas 5, 6, 7 and 8 which are characterised by Interdune vegetation type (vegetation type 7). Survey areas 3, 4 and 5 are dominated by Mixed Scrub on Stony Soils vegetation type (vegetation type 9) and survey area 2 is dominated by Tall Acacia Scrub. The Mixed Scrub on Rolling Dunes vegetation type dominates survey area 1.

The vegetation types recorded during the field survey have been mapped in Figure 3.

4.2.2 Vegetation extent and status

Vegetation within the survey areas is considered to be equivalent to the pre-European vegetation associations mapped in the local and regional area. The dominant vegetation type is the Interdune, which covers an extent of 1,288 ha.

Table 12 Vegetation types recorded

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
1	Mosaic	Mosaic of Scattered Low Trees of *Corymbia hamersleyana* over Mixed High to Low Open Shrubland of *Acacia bivenosa, A. synchronicia, Eremophila longifolia, Scaevola acacioides, S. tomentosa* sometimes over Closed Hummock Grassland of *Triodia basedowii* with Scattered Bunch Grass / Closed Bunch Grass of **Cenchrus ciliaris, Iseilema membranaceum* with Very Open Herbs of *Goodenia forrestii, Lobelia heterophylla.*		Survey areas 9, 10 and 11 (Q1, Q2, Q5, Q6, Q7)	Condition 3 to Condition 6 (*Very Good* to *Completely Degraded*)	663, 678, 117, 162 (>30% remaining)
2	Creek line	Scattered Low Trees of *Eucalyptus xerothermica* over Scattered Tall to Low Shrubs of *Acacia georgii, Scaevola cunninghamii, Adriana tomentosa* var. *tomentosa, Acacia coriacea* over Scattered Grass of *Eulalia aurea, *Cenchrus ciliaris, Eriachne helmsii* with Scattered Herbs in creek line.		Survey areas 10 and 11	Condition 4 to Condition 6 (*Good* to *Completely Degraded)*	663 (>90% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
3	Cleared/Degraded	Scattered Shrubs over Scattered Bunch Grass. Often contains plants associated with adjacent vegetation types. Typically contains the most number of weed species.		All survey areas	Condition 5 to Condition 6 (*Degraded* to *Completely Degraded)*	N/A
4	*Frankenia* flats	Low Open Heath of *Frankenia pauciflora, Mullerolimon salicorniaceum* with Very Open Hummock Grassland of *Triodia pungens* over Scattered Herbs on *Frankenia* flats.		Survey area 9 (Q3 and Q5)	Condition 3 to Condition 5 (*Very Good* to *Degraded)*	162 (>30% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
5	Pebbly Dune	High Open Shrubland of *Acacia coriacea, A. tetragonophylla, A. synchronicia* over Scattered Shrubs to Low Scattered Shrubs of **Aerva javanica, Sida fibulifera* over Hummock Grassland of *Triodia pungens* and Bunch Grassland of **Cenchrus ciliaris* over Scattered Herbs of *Rhynchosia minima* on a pebbly dune.		Survey area 9 (Q4)	Condition 5 (*Degraded)*	117, 162 (>30% remaining)
6	Dune	Scattered Shrubs to Low Scattered Shrubs of *A. tetragonophylla, A. coriacea, Senna artemisioides* subsp. *oligophylla* with Low Open Shrubland of *Pileanthus septentrionalis* over Hummock Grassland of *Triodia schinzii, Triodia basedowii* over Scattered Herbs on dune.		Survey areas 5, 6, 7, 8 (Q9, Q13, Q18)	Condition 2 to Condition 5-6 (*Excellent* to *Degraded-Completely Degraded)*	662 (>90% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
7	Interdune	Scattered Shurbs of *Acacia coriacea, A. spathulifolia, A. bivenosa, Hakea stenophylla, Eremophila miniata* sometime with Low Open Shrubland of *Dampiera incana, A. georgii, Thryptomene dampieri, Diplopeltis eriocarpa* over Hummock Grassland of *Triodia angusta* over Open Herbs of *Goodenia cusackiana, Ptilotus axillaris* between dunes on generally on flats / gentle slopes.		Survey areas 5, 6, 7, 8 (Q10, Q11, Q14, Q15, Q17, Q19, Q20)	Condition 2 to Condition 6 (*Excellent* to *Completely Degraded)*	662 (>90% remaining)
8	Calcareous Shield	Scattered Low Trees of *Ficus brachypoda* over Low Open Shrubland of **Aerva javanica, Solanum lasiophyllum, Ptilotus obovatus* over Open Bunch Grassland of **Cenchrus ciliaris* with Very Open Tussock Grassland of *Enneapogon caerulescens* and Very Open Hummock Grassland of *Triodia pungens* over Scattered Herbs over a calcareous shield.		Survey areas 5, 6, 7, (Q12, Q16, Q21)	Condition 2 to Condition 6 (*Excellent* to *Completely Degraded)*	662 (>90% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
9	Mixed Scrub on Stony Soils	Mixed Scrub of Scattered Tall Shrubs to Scattered Shrubs of *Acacia xiphophylla, A. cuspifolia, A. tetragonophylla* over Low Open Shrubland of *Eremophylla pterocarpa* subsp. *pterocarpa, Maireana polypterygia* over Very Open Mixed Grassland of *Enneaopogon caerulenscens, Aristida contorta, Cenchrus ciliaris, Eriachne pulchella* subsp. *dominii* over Scattered Herbs on stony soils.		Survey areas 3 and 4 (Q22, Q25)	Condition 3 to Condition 6 (*Very Good* to *Completely Degraded*)	345 (100% remaining)
10	Drainage Line	Low Open Woodland of *Acacia sericophylla* sometimes *Eucalyptus victrix* (survey area 4) over Open Shrubland of *Acacia sclerosperma* subsp. *sclerosperma, A. tetragonopylla, Alectryon oleifolius* over Closed Bunch Grassland of **Cenchrus ciliaris* over Scattered Herbs in drainage line.		Survey areas 3 and 4 (Q23)	Condition 3 to Condition 6 (*Very Good* to *Completely Degraded*	244 (>100% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
11	Plains	Scattered Tall Shrubs of *Acacia xiphophylla* over Scattered Shrubs to Low Shrubs of *Acacia tetragonophylla, Chenopodium gaudichaudium, Senna artemisioides* subsp. *oligophylla* with Low Open Shrubland of *Maireana polypterygia* over Open Bunch Grassland of **Cenchrus ciliaris* with Very Open Tussock Grassland of *Aristrida contorta, Dichanthium sericeum* over Scattered Herbs of *Ptilotus clementii, P. polystachyus, *Asphodelus fistulosus* on plains.		Survey area 3 (Q24)	Condition 3 to Condition 6 (*Very Good* to *Completely Degraded*	345 (100% remaining)
12	Chenopod Plains	Low Scattered Chenopod shrubs of *Tecticornia doleiformis*, *Maireana carnosa* over *Scattered Grass* of *Diachanthium sericeum* over Scattered Herbs of *Rhodanthe citrina* on plains.		Survey area 4	Condition 5 to Condition 5-6 (*Degraded* to *Degraded-Completely Degraded)*	345 (>90% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
13	Tall Acacia Scrub	Tall Acacia Scrub of *Acacia synchronicia, A. tetragonopylla, A. sclerosperma* with *Salsola australis, Scaevola tomentosa* over Bunch Grassland of **Cenchrus ciliaris* over Scattered Herbs.		Survey area 2 (Q26)	Condition 4 to Condition 6 (*Good* to *Completely Degraded)*	264 (>90% remaining)
14	Claypan	Scattered Shrubs of *Acacia tetragonophylla* over Low Scattered Shrubs of *Ptilotus polakii* subsp. *juxtus* and *Atriplex codonocarpa* over Scattered Tussock Grass of *Eragrostis dielsii* over Scattered Herbs on claypan.		Survey area 2	Condition 4 to Condition 5 (*Good* to *Degraded)*	264 (>90% remaining)

Number	Short description	Long description	Photo	Location and extent	Vegetation condition	Beard equivalent
15	Mixed Scrub on Rolling Dunes	Mixed Scrub of *Acacia synchronicia, A. sclerosperma* subsp. *sclerosperma, A. tetragonophylla* in High Open Shrubland over Scattered Shrubs of *Hakea priessii, Alectryon oleifolius* over Bunch Grassland of **Cenchrus ciliaris* with Scattered Herbs on rolling dunes.		Survey area 1 (Q28, Q29)	Condition 5 (*Degraded)*	95 (>60% remaining)
16	Floodplain	Scattered Low Trees of *Acacia tetragonophylla* over High Shrubland of *Acacia tetragonophylla, Hakea preissii, Scaevola acacioides* over Scattered Shrubs to Low Scattered Shrubs of *Acacia synchronicia, Aeschynomene indicata* over Bunch Grassland of **Cenchrus ciliaris, Sporobolus virginicus* over Scattered Herbs of *Stemodia viscosa, Alternanthera nodiflora.*		Survey area 1 (Q27)	Condition 5 (*Degraded)*	264 (>90% remaining)

4.2.1 Vegetation condition

Vegetation condition throughout the survey areas was generally consistent, with the majority of the survey areas rated as *Excellent* (Condition 2) (1,039 ha). The exceptions were disturbed drainage lines, access tracks, fence lines, the road maintenance zone of the Minilya-Exmouth Road and existing material pits. The better condition vegetation within the survey areas was recorded within the interdune and dune vegetation type in survey areas 5, 6, 7 and 8.

The time since a fire within the survey areas was determined to be long (>5 years) with no recently burnt areas observed. Burn scars were observed within survey areas 5, 6 and 7, but it was likely burnt longer than five years ago, based on the extent of vegetation regeneration.

Vegetation condition ratings determined during the field survey have been mapped in Figure 4 and detailed in Table 13.

Table 13 Extent of each vegetation condition rating within the survey areas

Vegetation condition rating (Keighery 1994)	Extent mapped (ha)											
	SA1	SA2	SA3	SA4	SA5	SA6	SA7	SA8	SA9	SA10	SA11	Total
Excellent (Condition 2)	-	-	-	-	6.3	494.1	473.1	72.1	-	-	-	**1,045.6**
Excellent to Very Good (Conditions 2-3)	-	-	-	-	-	-	-	21.2	-	-	-	**21.2**
Very Good (Condition 3)	-	-	23.2	-	259.2	-	7.6	-	1.4	-	-	**291.4**
Very Good to Good (Conditions 3-4)	-	-	-	-	-		-	-	2.8	-	-	**2.8**
Good (Condition 4)	-	1.3	-	-	6.8	45.2	60.1	-	-	-	6.5	**119.9**
Degraded (Condition 5)	75.8	130.8	19.8	16.2		-	-	-	60.6	20.2	0.4	**323.8**
Degraded to Completely Degraded (Conditions 5-6)	-	7.2	-	5.7	1.3	3.4	-	-	-	-	-	**17.6**
Completely Degraded (Condition 6)	10.6	3.3	2.3	0.6	4.7	4.7	8.9	13.3	21.1	5.8	2.5	**77.8**

4.2.2 Threatened and priority ecological communities

No ecological communities were recorded from the survey areas that are considered to represent examples of known TECs or PECs. Vegetation, soil and geological components identified within survey areas 5, 6, 7 and 8 were not consistent with the *Tussock grasslands or grassy tall or low shrublands of the Yarcowie Land System - Carnarvon Basin* as described by DPaW (2015b).

4.2.3 Other significant vegetation

Based on the guidelines in Guidance Statement 51 (EPA 2004a), the field survey did not identify vegetation that may be considered as 'other significant'.

4.3 Flora

4.3.1 Recorded flora diversity

The survey recorded 343 flora taxa (including subspecies and varieties) representing 57 families and 168 genera during the field survey. This total comprised 319 (93%) native taxa and 24 (7%) introduced taxa.

Dominant families recorded from the survey areas include:

- Fabaceae (Peas, Wattles) 62 taxa
- Asteraceae (Daisies) 30 taxa
- Chenopodiaceae (Samphires) 24 taxa
- Malvaceae (Hibiscus family) 24 taxa.

Dominant genera recorded from the survey areas include:

- *Acacia* 21 taxa
- *Eremophila* 13 taxa.

A breakdown of the recorded data is provided below (Table 14) and detailed in Appendix C.

Table 14 Surveys areas flora statistics

Survey areas	1	2	3	4	5	6	7	8	9	10	11
Number of taxa	79	34	73	42	118	130	91	103	92	77	98
Number of introduced species	2	2	6	1	4	8	5	4	14	5	6
Number of Priority flora	1	-	-	-	-	-	-	-	1	-	2
Number of noxious weeds	-	-	-	-	-	-	-	1	1	-	-
Other significant flora	-	-	-	-	3	2	1	2	1	-	1

4.3.2 Conservation significant flora

EPBC Act and WC Act

No conservation significant flora taxa listed under the EPBC Act or WC Act was recorded from the survey areas.

DPaW Priority listed flora

Three DPaW Priority Flora were recorded from the survey areas:

- *Acacia alexandri* (Priority 3)
- *Corchorus congener* (Priority 3)
- *Owenia acidula* (Priority 3).

Acacia alexandri

Acacia alexandri is a Priority 3, open or moderately dense, sometimes wispy shrub, which grows to a height of between 1.5 to 3 metres (m). This taxon has cream flowers between June and September. It occupies limestone associated with stony creeks and steep rocky slopes. *NatureMap* shows 38 records within Western Australia and all records are within the study areas.

Plate 2 *Acacia alexandri*

Twelve plants from six locations were recorded in survey area 11.

Corchorus congener

Corchorus congener is a Priority 3 plant, spreading shrub to 0.6 m. It has yellow flowers between April and November (DPaW 2015d) and occupies sand, red sandy loam with limestone on sand dunes and plains. *NatureMap* shows 25 records within Western Australia and seven records within the study areas (DPaW 2015c).

Plate 3 *Corchorus congener*

Two individual plants were recorded within suvey area 11.

Owenia acidula

Owenia acidula is a Priority 3 tree which grows to a height of between3 to 8 m. It flowers white to brown and sometimes cream (DPaW 2015d) and generally occurs in clay. *NatureMap* shows 18 records of this taxon within Western Australia and two within survey area 1 (DPaW 2015c).

Plate 4 *Owenia acidula*

Thirty plants of *Owenia acidula* from four locations were recorded within survey area 1 growing in Mixed Scrub on Rolling Dunes vegetation type. Two locations are known records, previously recorded by GHD (2009), and shown on the *NatureMap* database. At a number of locations a number of adult and juvenile plants were recorded.

4.3.3 Other significant flora

The flora species recorded during the field survey were assessed to determine whether any were regarded as other significant flora as defined by the EPA (2004a). Three species exhibiting an extension to their known range were recorded and are shown in Table 15.

Table 15 Other significant flora

Species	Nearest Record	Justification
**Passiflora foetida*	300 km South	The majority of the taxa are introduced species and have not been recorded within the Shire of Exmouth. These taxa were recorded well beyond their known range.
**Lactuca serriola*	300 km South	
**Avena sativa*	700 km South	
Lobelia gibbosa	630 km South	
**Salvia verbenaca*	650 km South	
Acacia saligna	430 km South	
Eremophila tietkensii	140 km South	

4.3.4 Introduced Flora

Twenty-two introduced flora were recorded from the field survey. One Weed of National Significance (WoNS) and declared pest (DP) was recorded, **Tamarix aphylla,* within survey area 9.

A summary of the introduced taxa recorded from the survey areas is provided in Table 16.

Table 16 Weeds species recorded

Genus	Species	Status
Aerva	*javanica*	*
Asphodelus	*fistulosus*	*
Avena	*sativa*	*RE 700 km North
Bidens	*bipinnata*	*
Cenchrus	*ciliaris*	*
Chenopodium	*murale*	*
Chloris	*barbata*	*
Citrullus	*lanatus*	*
Crotalaria	*incana subsp. incana*	*
Cynodon	*dactylon*	*
Eucalyptus	camaldulensis subsp. *obtusa*	+
Flaveria	*trinervia*	*
Lactuca	*serriola*	*RE 300 km N
Malvastrum	*americanum*	*
Momordica	*balsamma*	*
Passiflora	*foetida*	*RE 300 km N
Salvia	*verbenaca*	*RE 650 km N
Sigesbeckia	*orientalis*	*
Solanum	*nigrum*	*
Sonchus	*asper*	*
Sonchus	*oleraceus*	*
Tamarix	*aphylla*	*WoNS, DP
Vachellia	*farnesiana*	*

* introduced species; + planted; RE – range extension

4.3.5 Likelihood of Occurrence assessment

A post-survey Likelihood of Occurrence assessment was conducted for all conservation significant flora taxa identified in the desktop assessment. This assessment took into account previous records, habitat requirements, efficacy of the survey, intensity of the survey, flowering times and the cryptic nature of species.

This assessment concluded the following in relation to conservation significant flora:

- Three were recorded (Section 4.3.2)
- *Crinum flaccidum* (P2) is considered likely to occur
- *Tinospora esiangkara* (P2) is considered possible to occur.

4.4 Fauna habitat

4.4.1 Habitat connectivity and linkages

The habitat within the survey areas are well connected and part of a largely contiguous landscape. Existing barriers for movements of fauna is the Minilya-Exmouth Road and, to a lesser extent, access tracks and fence lines. The habitat within survey areas 3, 4, 9, 10 and 11 had minimal fauna habitat value and was impacted by the pastoral practices and the existing Minilya-Exmouth Road.

4.4.2 Habitat types

Fifteen fauna habitat types recorded during the field survey. These habitat types are closely aligned with the vegetation types described in Section 4.2.1. The habitat types recorded in the survey areas are described in Table 17.

Table 17 Fauna habitats

Description and location in survey areas	Indicative photo
Mosaic Plains **Location: Survey areas 9, 10 and 11** Survey area 9 – the habitat occurs in the lower elevated areas of the survey area and forms a broad floodplain. The habitat has varying levels of disturbances, with the vegetation within the vicinity of the road being impacted by clearing and weeds and vegetation away of the road being in generally good condition. The majority habitat is well connected. The Exmouth Airport/Military base adjoins the southern end of the survey area is present. The presence of dense groundcover provides refuge for reptiles (such as snakes, goannas and dragons) and small mammals such as *Notomy alexis* (The spinifex hopping mouse). The areas of clumped shrubs likely provide refuge for native birds. Survey area 10 the habitat is degraded, consisting of Acacias with a dense layer of buffel-grass dominating the understorey. This is an artefact of clearing associated within the power line easement and pastoral practices. This habitat provides limited resources to native fauna species with the exception of snakes, which are likely to utilise the area due to the dense understorey. Survey area 11 - the habitat is moderately structurally diverse, with some habitat consisting sometimes of scattered Eucalypts, Acacais and understorey of spinifex and sometimes buffel-grass. The Eucalypts are generally located near the creekline habitat type and typically 6 m high and 10 to 15 cm diametre breast height, with no hollows. The buffel-grass was recorded in areas of historical clearing and near exposed limestone rocky outcrops. Urban development is encroaching on the northern portion of this habitat, whilst remainder of the habitat was well connected. The presence of dense groundcover provides refuge for reptiles (such as snakes, goannas and dragon) and small mammals such as spinifex hopping mouse. In the areas of clump shrubs, these likely provide refuge for native birds.	

Description and location in survey areas	Indicative photo
Conservation Significant Fauna The habitat is part of a contiguous area of remnant vegetation extending through, and beyond, the survey area. This habitat provides dispersal /foraging habitat for the listed Migratory species *Merops ornata* (the Rainbow Bee-eater).	
Low Rocky Outcrop **Location: Survey area 11** The habitat is restricted to the open/elevated areas of the survey area. The outcrop is generally exposed, with some groundcover including buffel-grass and scattered spinifex. Bare ground is greater than 50% and consists of limestone rock plates, cobbles and gravel. In areas where there are obvious signs of weathering, small crevices provide suitable refuge for reptile species. The habitat occurs in an isolated patch of the Mosaic Plain within survey area 11. ***Conservation Significant Fauna*** The habitat is considered to be potential breeding and refuge for the Priority 2 species, *Diplodactylus capensis* (Cape Range Stone Gecko).	

Description and location in survey areas	Indicative photo
Creek line **Location: Survey areas 10 and 11** This habitat type shows signs of varying levels of disturbances both natural and human. The banks of the creekline appeared to be impacted by erosion from flood waters. Much of the limestone gravel present was likely imported to the area to mitigate the erosion of the river bed and is absent of vegetation. The banks consist of embedded limestone gravel. Plants of *Eucalyptus xerothermica* to 3 m are present along the banks, with Acacias in the middle storey. The Eucalypts lack any hollows. The groundcover consists of scattered native grasses and herbs, with occasional clumps of spinifex. The creekline is considered an important ecological corridor to other broader habitats within the local area and during periods of waterflow would provide a water source for fauna species. ***Conservation Significant Fauna*** This habitat provides dispersal/foraging habitat for the Rainbow Bee-eater. It may provide breeding opportunities for the Rainbow Bee-eater.	
Flats **Loation: Survey area 9** This habitat type occurs in the low lying section of survey area 9. The flat supports coastal wetland species of *Frankenia* on sandy soils. During periods of water inundation are is likely to provide habitat for many water bird species. In contrast, during periods of dry the habitat would provide habitat for ground dwelling bird species such as *Ardeotis australis* (the Australian Bustard), *Turnix velox* (Little Button-quail) and various wrens. ***Convervation significant fauna*** This habitat provides dispersal/foraging habitat for the Rainbow Bee-eater and Schedule 5/ Migratory species*Tringa nebularia* (Common Greenshank). Other marine and migratory fauna species may utilise the flats, but these species have a preference for samphire and clayey soils.	

Description and location in survey areas	Indicative photo
Pebbly Dune **Loation: Survey area 9** The pebbly dune fauna habitat type was recorded in an elevated portion of the survey area. This habitat type comprises buffel grass with emergent *Acacia* shrubs. The habitat type was largely degraded and provides limited habitat structure, with the groundcover comprising a sparse to moderate amount of leaf litter and wood debris. The pebbly dune is considered to have low fauna habitat value and is isolated within the survey area. Immediately adjactent to the habitat is a cleared area containing a memorial. ***Conservation significant fauna*** The habitat has low value and due to its degraded nature no conservation significant fauna are considered likely to utilise the habitat	
Dune System **Location: Survey areas 5, 6, 7 and 8** This habitat type comprises open Mixed Shrubland of scattered Acacias up to 1.5 m high over clumps of spinifex within pale red sands with minor clay. Bare ground is less than 30%. The presence of mostly sandy soils in this Spinifex steppe increases the presence of reptiles such as Leristas, whiptailed snakes and dragons, and marsupial species such as the Little Red Kaluta and Stripe-faced Dunnart. There is sparse wood and leaf litter; with the denser litter occurring around the base of shrubs on the dune. There are small, isolated patches of buffel grass near Acacia shrubs, which have resulted from cattle utilising the shade. ***Conservation significant fauna*** The dune systems are considered suitable habitat for *Aprasia rostrata* subsp. *rostrata* (the Hermite Island Worm-lizard) (Vulnerable, Schedule 3).	

Description and location in survey areas	Indicative photo
Calcareous Shield **Location: Survey areas 5, 6 and 7** This habitat type was recorded in survey areas 5, 6 and 7. The calcareous shields provide minimal habitat value for fauna species as they are impacted by the introduced fodder species (buffel grass), although the presence of loose rocks provides micro-habitat for reptile species. A number of geckos and dragons were recorded utilising the rocks. ***Conservation significant fauna*** The habitat has low value, and no conservation significant fauna are considered likely to utilise the habitat	
Mixed Scrub on Stony Slope **Location: Survey areas 3 and 4** This habitat type consists of scattered overstorey of *Ficus brachypoda* up to 4 m in height, with a sparse to moderately dense middle storey of *Pittosporum phillyreoides, Ptilotus* species and *Acacia coriacea.* The presence of moderately dense foliage within survey area 4 likely provides refuge for small birds. The goundcover consists of scattered spinifex and native tussock grasses. The habitat has obvious signs of historical clearing and cattle grazing, due to the presence of clumps of buffel grass and the sparse overstorey within survey area 3. Bare ground was greater than 20%, covered with surface gravel and cobbles, with evidence dragons and geckos utilising the area. ***Conservation significant fauna*** The habitat has low value, and no conservation significant fauna are considered likely to utilise the habitat	

Description and location in survey areas	Indicative photo
	
Drainage Line **Location: Survey area 1** This habitat type is degraded and has impacts from naturalised fodder species including buffel grass. It largely comprises of *Acacia* woodland, some low trees of *Eucalyptus victrix* over buffel grassland. There was evidence of cattle currently utilising this habitat type. The habitat generally lacks micro-habitats such as tree hollows, leaves, wood debris and fallen logs. This habitat type is likely to provide a wildlife corridor between other habitat types. The thick groundcover of buffel grass is likely to provide protection for reptiles and the trees would be used by aerial fauna. ***Conservation significant fauna*** The habitat has a relatively low value and due to its degraded nature no conservation significant fauna are considered likely to utilise the habitat.	

Description and location in survey areas	Indicative photo
Open Grass Plains with Emergent Acacia Shrubs **Location: Survey areas 2 and 3** This habitat type was recorded in a small area within survey areas 2 and 3. It largely comprises of buffel grass and some native tussock grasses with emergent *Acacia* species. The Open Grass Plains had evidence of grazing by cattle. The habitat is likely to provide connectivity to intact vegetation for large mammal species. ***Conservation significant fauna*** The habitat has low value and due to its degraded nature no conservation significant fauna are considered likely to utilise the habitat	
Chenopod Plains **Location: Survey area 3** This habitat type is degraded and there were obvious signs of overgrazing. The habitat is likely to provide connectivity to intact vegetation for large mammal species. ***Conservation significant fauna*** The habitat has low value and due its degraded nature no conservation significant fauna are considered likely to utilise the habitat.	

Description and location in survey areas	Indicative photo
Claypan **Location: Survey area 2** This habitat type was recorded in isolated areas along the northern boundary of survey area 2. The claypan was generally bare, with scattered *Acacia* shrubs up to 1.5 m high and low *Ptilotus* species on the fringes. Bare ground is greater than 60%. During seasonal periods of water inundation, this habitat would provide opportunities for waterbird species. However, during dry periods the area would provide connectivity for mammal species to larger patches of vegetation. ***Conservation significant fauna*** The habitat potentially has moderate value for waterbirds during wet periods, but is isolated, and because of this isolation it is likely to be only rarely utilised by migratory species.	
Scrub on Rolling Dune **Location: Survey area 1** This habitat type comprises scattered shrubs of *Acacia* up to 2 m in height and the groundcover is dominated by buffel grass. The buffel grass is a legacy of cattle grazing and historical clearing practices. Bare ground was less than 20% on deep pale red sands, and the area provides marginal refuge opportunities for some reptiles and small ground dwelling mammals. There was a sparse to moderate amount of leaf litter and wood debris. The leaf and wood litter generally occurs in small clumps at the base of the shrubs. ***Conservation significant fauna*** The habitat has low value and due its degraded nature no conservation significant fauna are considered likely to utilise the habitat.	

Description and location in survey areas	Indicative photo
Floodplain **Location: Survey area 1** The habitat occurs in the lower parts of the survey area and forms part of a broader floodplain beyond the survey area. The habitat has varying levels of disturbances, but is largely impacted by historical clearing and weeds. The habitat comprises of dense scrub of *Acacia* species, *Hakea preissii, Scaevola* species up to 4.5 m in height. The dense scrub provides foraging and breeding opportunities for native birds. The groundcover comprises thick buffel grass and scattered herbs. The thick groundcover also provides protection and suitable habitat for reptile species, including snakes and lizards. Bare ground was less than 10%, with some coarse gravel overlying cracked clay. There was a moderate amount of leaf litter and sparse amount of wood litter, generally confined to base of trees and shrub thickets. ***Conservation significant fauna*** The habitat has low to moderate value, and no conservation significant species are likely to solely utilise this habitat.	
Cleared/Degraded **Location: All survey areas** The highly modified areas include road maintenance zoness, borrow pits, old tracks and fence lines. These areas are generally open and cleared, thus providing limited habitat for fauna species. However, the depression in the landscape indicates that water pooling would occur following significant rainfall events and this would provide a water source for fauna species. The water source is located in an open environment, with limited vegetation and as a result fauna that utilise this area are likely exposed to predation and vehicle strikes.	

4.5 Fauna species

4.5.1 Fauna diversity

The field survey was generally limited to daylight hours with the exceptions being at survey areas 6, 7 and 8, where night time surveys were undertaken. Sixty-nine fauna species were recorded from the survey areas, including 43 birds, 11 mammals and 15 reptiles. Seven introduced fauna species were recorded including Cattle *(Bos taurus),* Sheep (*Ovis aries),* Red Fox (*Vulpes vulpes),* Cat (*Felis Catus),* Rabbit (*Oryctolagus cuniculus)* and House Mouse (*Mus musculus).* A summary of the number of fauna taxa recorded in each survey area is provided in Table 18 and a complete list in Appendix D.

Table 18 Recorded fauna diversity

Survey area	1	2	3	4	5	6	7	8	9	10	11
Birds	19	8	13	4	11	11	12	10	11	10	16
Mammals	4	2	4	-	3	3	5	3	4	1	2
Reptiles	1	-	2	-	4	7	6	4	1	-	-

4.5.2 Conservation significant fauna species

Two Migratory EPBC Act listed fauna species were recorded from survey area 11 during the field survey, including Osprey (*Pandion haliaetus)* and Rainbow Bee-eater (*Merops ornatus).* Both species were recorded flying over the survey area however the habitat within this area is unlikely to be important for these species.

4.5.3 Likelihood of Occurrence assessment of fauna

A Likelihood of Occurrence assessment of conservation significant fauna species potentially occurring in the survey areas was undertaken. This assessment is based on species biology, habitat requirements, the quality and availability of suitable habitat as determined during the field survey and records of the species in the survey areas and locality.

The search areas for the desktop investigations included 20 km buffer around the survey areas and included marine, riverine, coastal and estuarine habitats that are not present but are adjacent to survey areas 9, 10 and 11. Several of the conservation significant fauna species indicated in the searches will therefore not occur within the survey areas due to a lack of suitable habitat. Species specific searches of the *NatureMap* database with a buffer of 20 km were also conducted in order to gather information about the broader regional occurrence of species to further inform the Likelihood of Occurrence assessment.

The Likelihood of Occurrence assessment for the survey areas concluded that:

- Two conservation significant fauna species were present
- Four conservation significant fauna species are likely to occur
- 24 conservation significant fauna species are unlikely to occur
- 12 conservation significant fauna are highly unlikely to occur.

The parameters for the Likelihood of Occurrence assessment and the full Likelihood of Occurrence assessment are provided in Appendix D. A summary of the conservation significant fauna considered present or likely to occur is presented in Table 19.

Table 19 Summary of likelihood of occurrence assessment for conservation significant fauna

Species/ EPBC Act listing/ WC Act/ DPaW listing	Outcome of assessment
Aprasia rostrata subsp. *rostrata* – Hermite Island Worm-lizard (Vulnerable – EPBC Act; Schedule 3 – WC Act)	Likely - The Hermite Island Worm-lizard generally occupies red dunes covered by *Triodia* grassland. There is suitable habitat within survey areas 5, 6, 7 and 8 (see Plate 6). The habitat is associated with Vegetation Type 6 (Dune). The *NatureMap* database shows records immediately adjacent to survey areas 7 and 8. There are also records 5 km north of survey areas 5 and 6 (collection record year 2000) (DPaW 2015c)
Merops ornatus – Rainbow Bee-eater (Migratory – EPBC Act; Schedule 5 – WC Act)	Present - This species can inhabit a variety of habitat types and foraging habitat was present within the survey areas. These habitats adjoin larger, similar habitat areas within the local region. Only marginal breeding habitat was recorded within survey area 10 and 11, associated within the banks of the creekline. This species was recorded flying over survey area 11.
Pandion haliaetus – Osprey (Migratory – EPBC Act)	Present - The preferred habitat for this species is not present within the survey areas, however survey areas 9, 10 and 11 are situated near the coastline. This species is likely to fly over, and opportunistically utilise, portions of the habitat. Recorded flying over survey area 11.
Tringa nebularia – Common Greenshank (Migratory – EPBC Act; Schedule 5 – WC Act)	Likely – There is suitable habitat which this species may occasionally use within survey area 9; Frankenia flats vegetation type/habitat type. This habitat has varying levels of disturbances, generally associated with the Minilya-Exmouth Road and pastoral practices, with a small portion in better condition. This species is unlikely to rely upon this habitat, with nearby coastal estuarine habitat being more suitable.
Falco peregrinus – Peregrine Falcon (Schedule 6 – WC Act)	Likely – The Peregrine Falcon is considered to be a possible visitor to the survey areas, as it uses a variety of habitats. The habitats are, however, not suitable for breeding. The habitat is connected with similar habitat types within the local and regional landscape. There are no records within the survey areas and the nearest *NatureMap* record is just north of Exmouth, on the coastline (DPaW 2015c)
Diplodactylus capensis – Cape Range Stone Gecko (Priority 2 – DPaW Status)	Likely - there is suitable habitat in survey area 11 for this species (see Plate 7) and it has has been previously recorded 3 km west of the survey area (DPaW 2015c).

Plate 5 Potential habitat for the Hermite Island Worm-lizard

Plate 6 Potential habitat for the Cape Range Stone Gecko

5. Project values and approvals

5.1 Key biological values

This section provides preliminary environmental approvals and referrals advice based on the biological constraints identified within the survey area. As the project is in concept design there may be opportunities to avoid and minimise the potential impacts through design refinement. If the impacts can be avoided or minimised it may negate the need for environmental approvals or referral to Federal/State environmental agencies.

The key biological values identified for the survey area during the biological assessment are summarised in Table 20.

Table 20 Biological values

Survey area	Native vegetation	Conservation significant flora species	Fauna habitat	Conservation significant fauna species
Survey area 1	Approximately 74 hectares of native vegetation.	Approximately 13 plants of *Owenia acidula.* Likelihood assessment indicates one flora taxon is considered likely to occur.	The fauna habitats are well represented and connected with adjoining areas of contiguous remnant vegetation.	No conservation species recorded. The assessment identified the likely presence of habitat for two species of conservation significance: • Rainbow Bee-eater (Mi, S5) Peregrine Falcon (S6)
Survey area 2	Approximately 135 hectares of native vegetation.	None identified.	As above.	As above.
Survey area 3	Approximately 64 hectares of native vegetation. Degraded drainage line that forms part of the Lyndon River and supports riparian vegetation.	None identified	As above.	As above.
Survey area 4	Approximately 22 hectares of native vegetation.	None identified.	As above.	As above.
Survey area 5	Approximately 16 hectares of native vegetation.	None identified.	As above.	Sand dunes present which are considered suitable habitat for the Hermite Island Worm-lizard. The assessment identified the likely presence of habitat for four species of conservation significance: • Hermite Island Worm-lizard (Vu, S3) • Osprey (Mi, S5) • Rainbow Bee-eater (Mi, S5) • Peregrine Falcon (S6).
Survey area 6	Approximately 540 hectares of native vegetation.	None identified.	As above.	As above.

Survey area	Native vegetation	Conservation significant flora species	Fauna habitat	Conservation significant fauna species
Survey area 7	Approximately 540 hectares of native vegetation.	None identified.	As above.	As above.
Survey area 8	Approximately 92 hectares of native vegetation.	None identified.	As above.	As above.
Survey area 9	Approximately 65 hectares of native vegetation.	*Frakenia* flats supports riparian vegetation. Mosaic plains vegetation likely provides a buffer to the Cape Range Subterranean waterways. One WoNS and declared pest was recorded - **Tamarix aphyllus.*	As above.	The assessment identified the likely presence of habitat for four species of conservation significance: • Common Greenshank (Mi, S5) • Osprey (Mi, S5) • Rainbow Bee-eater (Mi, S5) • Peregrine Falcon (S6).
Survey area 10	Approximately 20 hectares of native vegetation.	No constraints identified.	As above.	The assessment identified the likely presence of habitat for three species of conservation significance: • Osprey (Mi, S5) • Rainbow Bee-eater (Mi, S5) • Peregrine Falcon (S6)
Survey area 11	Approximately seven hectares of native vegetation.	Approximately 12 plants of *Acacia alexandri* and *Conchorus congener* were recorded. Likelihood assessment indicates one flora taxon is considered likely to occur.	As above.	Suitable habitat for the Cape Range Stone Gecko (P2) was recorded (rocky limestone substrate). The assessment identified the likely presence of habitat for four species of conservation significance: • Osprey (Mi, S5) • Rainbow Bee-eater (Mi, S5) • Peregrine Falcon (S6) • Cape Range Stone Gecko (P2)

5.2 Environmental approvals and referrals

5.2.1 Federal approvals

Referral to the DotE under the EPBC Act is triggered if a proposed action has or potentially has a significant impact on any MNES. Table 21 shows an assessment of the survey areas against key biological MNES. A review of the Significant Impact Criteria guidelines (DotE 2015) was undertaken for each relevant MNES.

Table 21 Assessment of the biological Matters of National Environmental Significance for the survey area

Matter of National Environmental Significance	Present	Decision to refer
World Heritage Properties	None – nearest 10 km west of survey areas 9, 10 and 11.	Not applicable
National Heritage Properties	None – nearest 46 km west of survey areas 9, 10 and 11.	Not applicable
Ramsar Wetlands	None – nearest 846 km north of survey areas 9, 10 and 11.	Not applicable
Nationally Threatened Species and Ecological Communities	The Hermite Island Worm-lizard is considered likely to occur.	**Referral recommended** **Hermite Island Worm-lizard** The survey provided sufficient information to determine the presence of potentially suitable habitat within the survey area; however the survey could not determine the importance of this habitat for this species, nor eliminate the possibility of the the species utilising these habitats.
Listed Migratory Species	Two Migratory species recorded including – Osprey and Rainbow Bee-eater. The Common Greenshank is considered likely to occur.	**Referral unlikely** **Osprey** Preferred habitat not present, although species recorded flying over survey area and may opportunistically utilise portions of the habitat. There is suitable habitat within the greater study area and clearing of habitat for the project is unlikely to significantly impact a population of this species. **Rainbow Bee-eater** The Rainbow Bee-eater was considered likely to utilise the entire survey areas. This species utilises a wide-range of habitats and is likely to use the survey areas for foraging and dispersal. This species is widespread throughout Australia and occurs in a wide range of habitat types. The Rainbow Bee-eater is a reasonably common bird and there is suitable breeding and foraging habitat within the greater study area. The Rainbow Bee-eater is unlikely to rely on the habitats present within the survey area and clearing of habitat for the project is unlikely to significantly impact a population of this species.

Matter of National Environmental Significance	Present	Decision to refer
		Common Greenshank There is suitable habitat which this taxon occasionally within survey area 9, *Frankenia* flats vegetation type/habitat type. Much of this habitat is degraded with on a small portion in better condition.

5.2.2 State approvals

Environmental Protection Authority

In the absence of a broader environmental assessment, the majority of the likely biological impacts associated with the project are linked to native vegetation clearing and loss of fauna habitat. The potential impacts from the loss of native vegetation and loss of fauna habitat can be effectively assessed through the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. Therefore, with consideration of the biological values discussed in this report, it is considered unlikely that the project would require referral to the EPA under Section 38 of the EP Act.

Department of Environment Regulation

Main Roads has been granted a State-wide vegetation clearing permit (Clearing Permit CPS 818) which allows clearing of native vegetation for road projects and associated activities, except within ESAs.

The Federal and Western Australian Governments have entered into a bilateral agreement under the EPBC Act relating to environmental assessment (assessment bilateral agreement). Specifically, this agreement now includes the clearing permit assessment process under Part V Division 2 of the EP Act. Under the assessment bilateral agreement, if a native vegetation clearing permit is required and the clearing will have or is likely to have an impact on a MNES, the assessment of the clearing application including the potential impacts to the MNES can be conducted by the DER or DMP under delegation.

No flora species listed under the EPBC Act (MNES) or WC Act were recorded but three DPaW Priority listed flora were recorded within the survey areas. Two other Priority flora species were indicated as possible or likely to occur within the survey areas.

Two EPBC Act listed Migratory Marine species (the Rainbow Bee-eater and Osprey) were recorded flying over survey area 11.

A post-field Likelihood of Occurrence assessment concluded that two fauna species listed under both the EPBC Act and WC Act are likely to occur (*Aprasia rostrata* subsp. *rostrata* – Vulnerable; Schedule 3 and *Tringa nebularia*- Migratory, Marine; Schedule 5), one listed under the WC Act (*Falco peregrinus* – Peregrine Falcon – Schedule 6) and One DPaW Status Priority listed species was considered likely to occur (*Diplodactylus capensis* – Priority 2).

As such, any clearing permit application should assess the significance of any potential impacts of the proposed project on these species.

6. References

Aplin, T. (1979) The Flora. Chapter 3 *in* O'Brien, B.J. (ed.) (1979). *Environment and Science.* University of Western Australia Press.

Beard, JS (1975) *Pilbara, 1:1,000,000 vegetation series: explanatory notes to sheet 5: the vegetation of the Pilbara area.* University of Western Australia Press, Nedlands, WA.

Bennelongia Pty Ltd (2008) *Stygofauna Survey – Exmouth Cape Aquifer: Scope Document Describing Work Required to Determine Ecological Water Requirements for the Exmouth Cape Aquifer.* Prepared for the DoW. April 2008.

BoM (2015) *Climate Statistics for Australian Locations: Summary statistics for Learmonth* Airport Retrieved from: http://www.bom.gov.au/climate/averages/tables/cw_005007.shtml [Accessed 12 August 2015]

Christidis L. and W.E. Boles (2008). *Systematics and taxonomy of Australian Birds*. CSIRO Publishing.

Department of Environment and Conservation (2010) *Cape Range National Park. Management Plan 2010*. Retrieved from: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/cape-range-2010-print-and-web.pdf [23 July 2015]

Department of Sustainability, Environment, Water, Population and Communities (2012) *Interim Biogeographic Regionalisation for Australia, Version 7.* Retrieved from: https://www.environment.gov.au/system/files/pages/5b3d2d31-2355-4b60-820c-e370572b2520/files/bioregions-new.pdf [Accessed 21 July 2016]

DAFWA (2015) *Natural Resource Management, Shared Land Information Portal, as administered by Government of Western Australia*. Retrieved from: http://maps.agric.wa.gov.au/nrminfo/

DER (2015) *Clearing Permit System*. Retrieved from: https://cps.der.wa.gov.au/ [15 August 2015]

Desmond, A and Chant, A. (2001) *Carnarvon 2 (CAR2 – Wooramel Subregion).* Retrieved from: https://www.dpaw.wa.gov.au/images/documents/about/science/projects/waaudit/carnarvon02_p87-102.pdf [11 August 2015]

DMP (2015). *Interactive Geological Map (GeoVIEW.WA).* Retrieved from: http://warims.dmp.wa.gov.au/GeoView/Viewer.html?Viewer=GeoVIEW [12 August 2015]

DotE (2015a) Protected Matters Search Tool. Retrieved from: http://www.environment.gov.au/epbc/pmst/index.html [13 August 2015]

DotE (2015b) *SPRAT Profile Conservation significant fauna.* Retrieved from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl [15 August 2015]

DPaW (2015a) *Threatened Ecological Communities listt*. https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/threatened_ecological_communities_endorsed_by_the_minister_for_the_environment_june_2015.pdf [Accessed 10 August 2015]

DPaW (2015b) *Priority Ecological Communities for Western Australia*. Retrieved from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority_ecological_communities_list.pdf [Accessed 14 August 2015]

DPaW (2015c) *NatureMap: Mapping Western Australia's Biodiversity, Perth, Department of Environment and Conservation*. Retrieved from: https://naturemap.dpaw.wa.gov.au/ [Accessed 13 August 2015]

DPaW (2015d) *FloraBase: The Western Australian Flora. Department of Parks and Wildlife.* Retrieved from: https://florabase.dpaw.wa.gov.au/ [Accessed 13 August 2015]

DPaW (2012) *Species profile Black-flanked Rock-wallaby Petrogale lateralis.* Retrieved from: http://www.dpaw.wa.gov.au/images/documents/plants-animals/animals/animal_profiles/black-flanked-rock-wallaby_2012.pdf [Accessed 14 August 2015]

DoW (2015). Geographic Data Atlas. Retrieved from: http://www.water.wa.gov.au/idelve/dowdataext/index.jsp [Accessed 14 August 2015]

EPA (2004a) *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Impact Assessment in Western Australia*. Perth, Western Australia.

EPA (2004b) *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* Perth, Western Australia.

EPA and Department of Environment and Conservation (2010) *Technical Guide Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*.

ESCAVI (2003) *Australian Vegetation Attribute Manual. Version 6.* Retrieved from: https://www.environment.gov.au/system/files/pages/06613354-b8a0-4a0e-801e-65b118a89a2f/files/vegetation-attribute-manual-6.pdf [7 July 2016]

GoWA (2015). *Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full report)*, Current as of June 2015, Perth Western Australia, Department of Parks and Wildlife, retrieved July 2015 from: https://www2.landgate.wa.gov.au/web/guest/downloader [14 August 2015]

DAFWA (2015). *Biosecurity and Agriculture Management Act* 2007 Western Australian organism list. Retrieved from: https://www.agric.wa.gov.au/organisms [14 August 2015]

GHD (2008) *Passing Lanes and Material Pit Minilya Exmouth Road Targeted Flora Survey.* Unpublished Report for Main Roads .

GHD (2011) *Minilya-Exmouth Road. Cardabia Station Fencing Project. Biological Survey*. Unpublished Report for Main Roads.

GHD (2012) *Minilya-Exmouth Road Section Upgrades. Preliminary Environmental Impact Assessment.* Unpublished Report for Main Roads.

GHD (2016) *Strategic Material Areas Minilya-Exmouth Road SLK 54, 62-65, 175.1 and 205.5. Biological Survey.* Unpublished Report for Main Roads.

Keighery, B. (1994). *Bushland Plant Survey*. Wildflower Society of Western Australia (Inc.)., Nedlands WA.

Kendrick, P. and Mau, R. (2002) *Carnarvon 1 (CAR1 – Cape Range subregion).* Retrieved from: https://www.dpaw.wa.gov.au/images/documents/about/science/projects/waaudit/carnarvon01_p69-86.pdf [13 August 2015]

Morcombe, M. (2004) *Field Guide to Australian Birds*. Steve Parish Publishing, Brisbane.

Muir, B. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum, Suppl*. No. 3; Specht R.L. (1970).

Shepherd, D., Beeston, G. and Hopkins, A. (2002) *Native Vegetation in Western Australia – Extent, Type and Status, Resource Management Technical Report 249*, Perth, Department of Agriculture, Western Australia.

Spencer, G. and O'Brien, W. (1988) *Landsystems of the Carnarvon Basin, Western Australia. Yaringa-Byro.* Western Australia Department of Land and Surveys. Perth

Figures

Figure 1 Locality

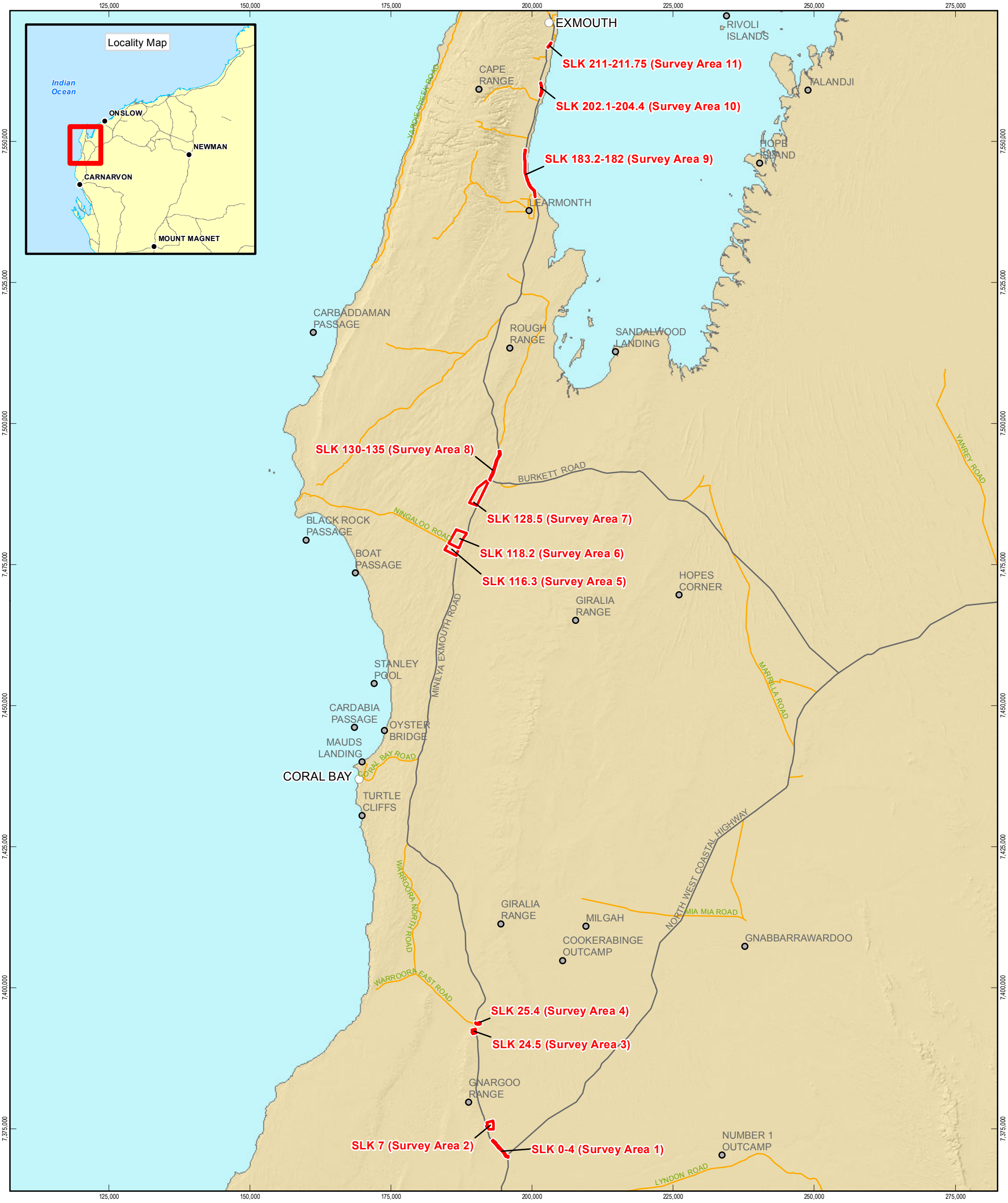
Figure 2 Environmental Constraints

Figure 2b Environmental Constraints –Yarcowie Land System

Figure 3 Vegetation types

Figure 4 Vegetation condition

Figure 5 Field Environmental Constraints



LEGEND

- Major Road
- Minor Road
- Survey Area

Paper Size A3

0 2.5 5 10 15 20 25

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Location

Job Number	61-32476
Revision	0
Date	05 Jul 2016

Figure 1

G:\61\32476\GIS\GIS\Maps\MXD\6132476_001_Rev0_Fig1Location.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Travellers Atlas 2004; GHD: Survey Area - 20150808 GA: Geodata Topo 250k Series III - 2006. Created by: RB & ML

160,000 175,000 190,000 205,000 220,000 235,000

7,560,000 7,545,000 7,530,000 7,515,000 7,500,000 7,485,000

EXMOUTH

SLK 211-211.75 (Survey Area 11)

SLK 202.1-204.4 (Survey Area 10)

EXMOUTH GULF

SLK 183.2-182 (Survey Area 9)

LEARMONTH

MINILYA EXMOUTH ROAD

SLK 130-135 (Survey Area 8)

NINGALOO

NINGALOO ROAD

SLK 128.5 (Survey Area 7)

SLK 118.2 (Survey Area 6)

SLK 116.3 (Survey Area 5)

160,000 175,000 190,000 205,000 220,000 235,000

LEGEND

- Locality

Threatened (Declared Rare) & Priority Flora

- (T) Threatened Rare Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa
- RE - Range Extension

Threatened and Priority Ecological Communities

- Critically Endangered
- Priority 1
- River
- Road
- DPaW Estate
- Survey Area
- Environmentally Sensitive Area

Paper Size A3

0 5 10 15

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Environmental Constraints

Job Number 61-32476
Revision 0
Date 05 Jul 2016

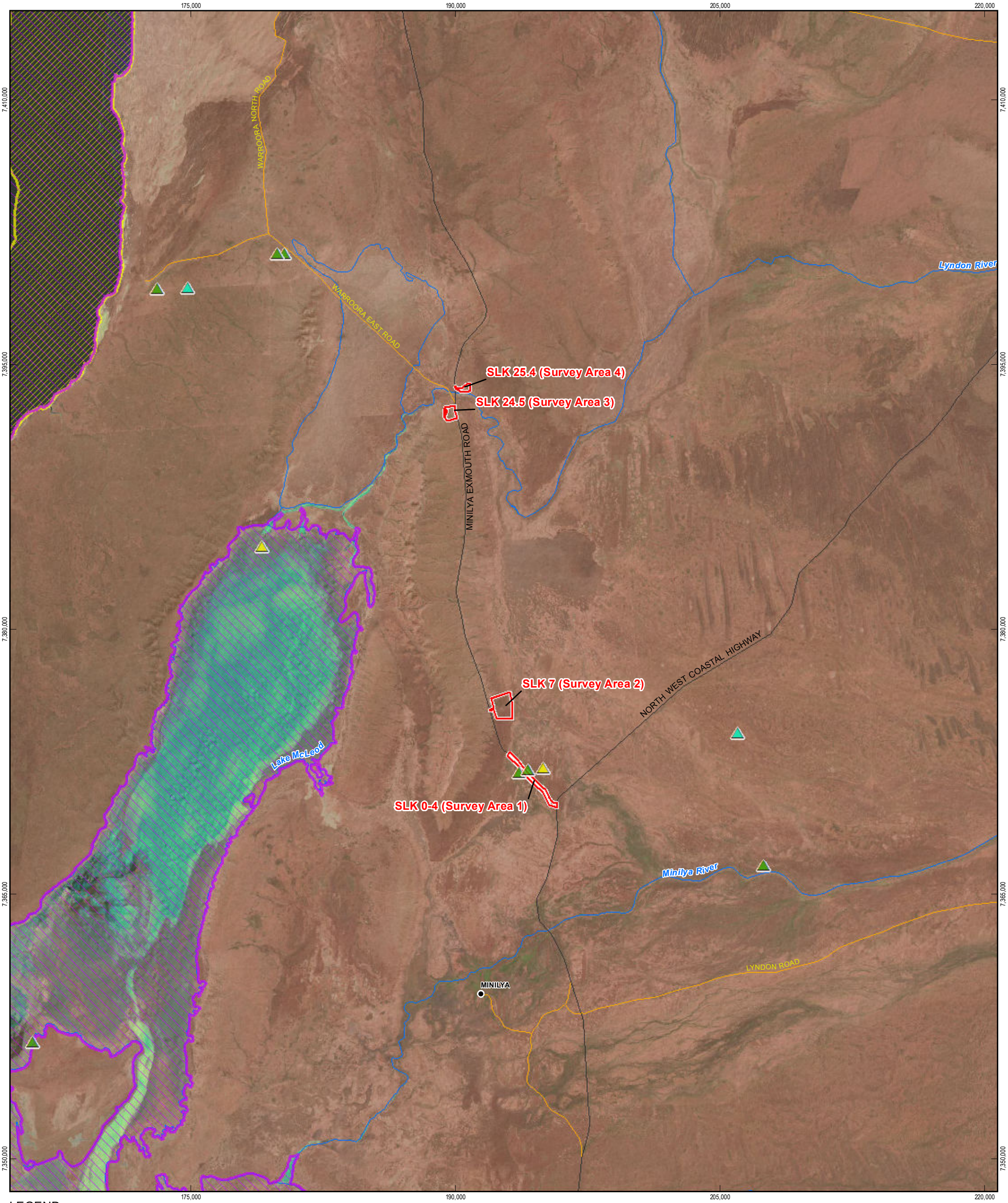
Sheet 1 of 2

Figure 2

G:\61\32476\GIS\GIS\Maps\MXD\6132476_002_Rev0_Fig2AEnviroConstraints.mxd

999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Geoscience Australia: Landsat Imagery, GeoData Topo 250k Series III; DER: Environmentally Sensitive Area - 20141008; DPaW: DPaW Estate - 20141008, Threatened (Declared Rare) and Priority Flora - 20151007; DoW: River - 20141008; GHD: Survey Area - 20150808, Significant Flora - 20140220 and 20131210. Created by: RB



LEGEND

- Locality

Threatened (Declared Rare) & Priority Flora

- (T) Threatened Rare Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa
- RE - Range Extension
- Major Road
- Minor Road
- River
- DPaW Estate
- Survey Area
- Environmentally Sensitive Area

Paper Size A3

0 2.5 5 7.5 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Environmental Constraints

Job Number	61-32476
Revision	0
Date	05 Jul 2016

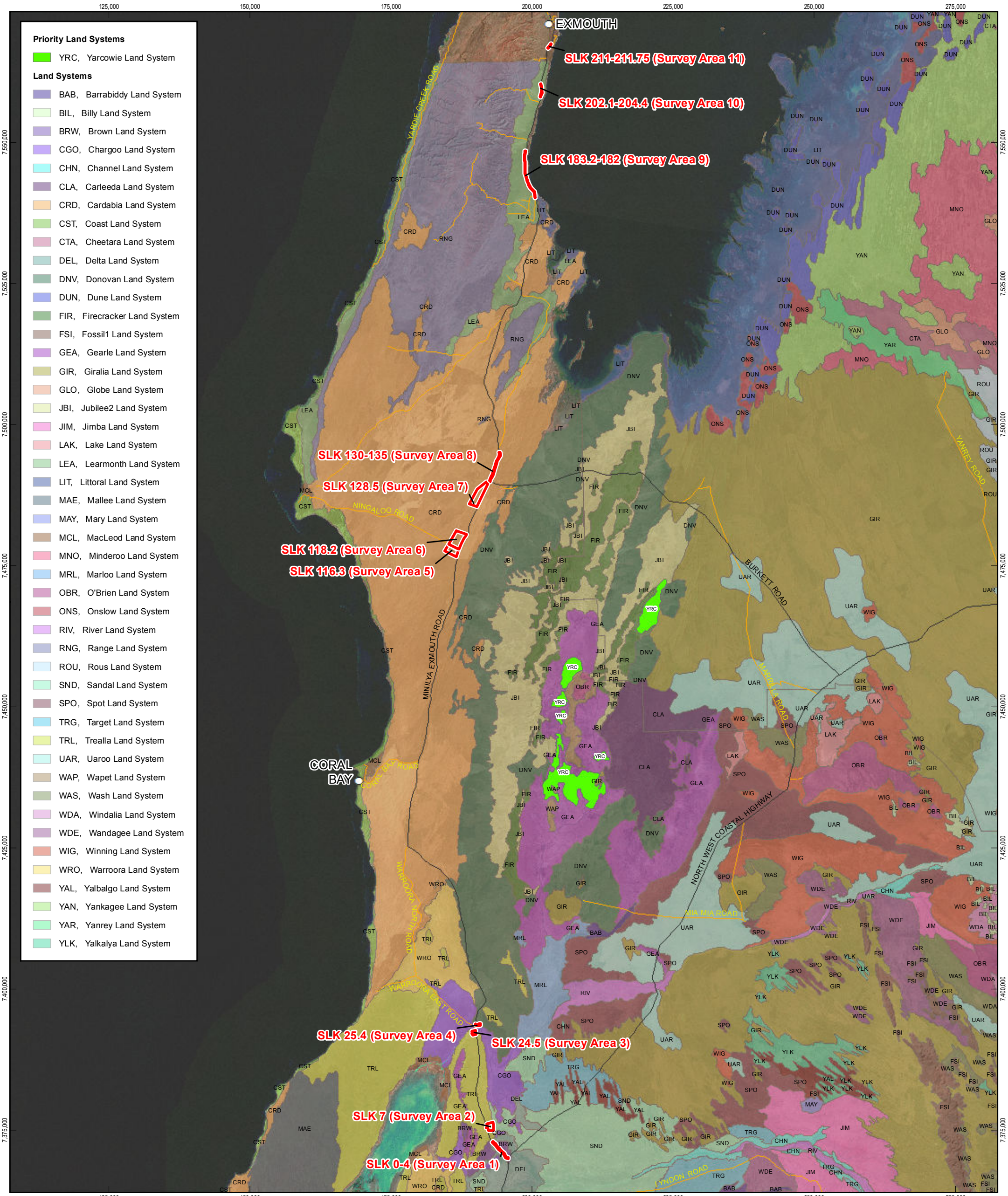
Sheet 2 of 2

Figure 2

G:\61\32476\GIS\GIS\Maps\MXD\6132476_002_Rev0_Fig2BEnviroConstraints.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Geoscience Australia: Landsat Imagery, GeoData Topo 250k Series III; DER: Environmentally Sensitive Area - 20141008; DPaW: DPaW Estate - 20141008, Threatened (Declared Rare) and Priority Flora - 20151007; DoW: River - 20141008; GHD: Survey Area - 20150808, Significant Flora - 20140220 and 20131210. Created by: RB



LEGEND

Major Road

Minor Road

Survey Area

Paper Size A3

0 2.5 5 10 15 20 25

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Job Number 61-32476
Revision 0
Date 05 Jul 2016

Environmental Constraints

Figure 2B

G:\61\32476\GIS\GIS\Maps\MXD\6132476_002_Rev0_Fig2BLandsystems.mxd

999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GHD: Survey Area - 20150808; DAFWA: Rangelands Land Systems: 20100908; GA: Landsat Imagery, Geodata Topo 250k Series III - 2006. Created by: ML

202,800 203,000 203,200 203,400

7,567,400 7,567,200 7,567,000 7,566,800 7,566,600

SLK 211-211.75
(Survey
Area 11)

MINILYA EXMOUTH RD

Q1

LEGEND

Quadrat
River
Road
Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3
0 40 80 120 160
Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 1

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA50_SheetsA-E.mxd
999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

LEGEND

- Quadrat
- River
- Road
- Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

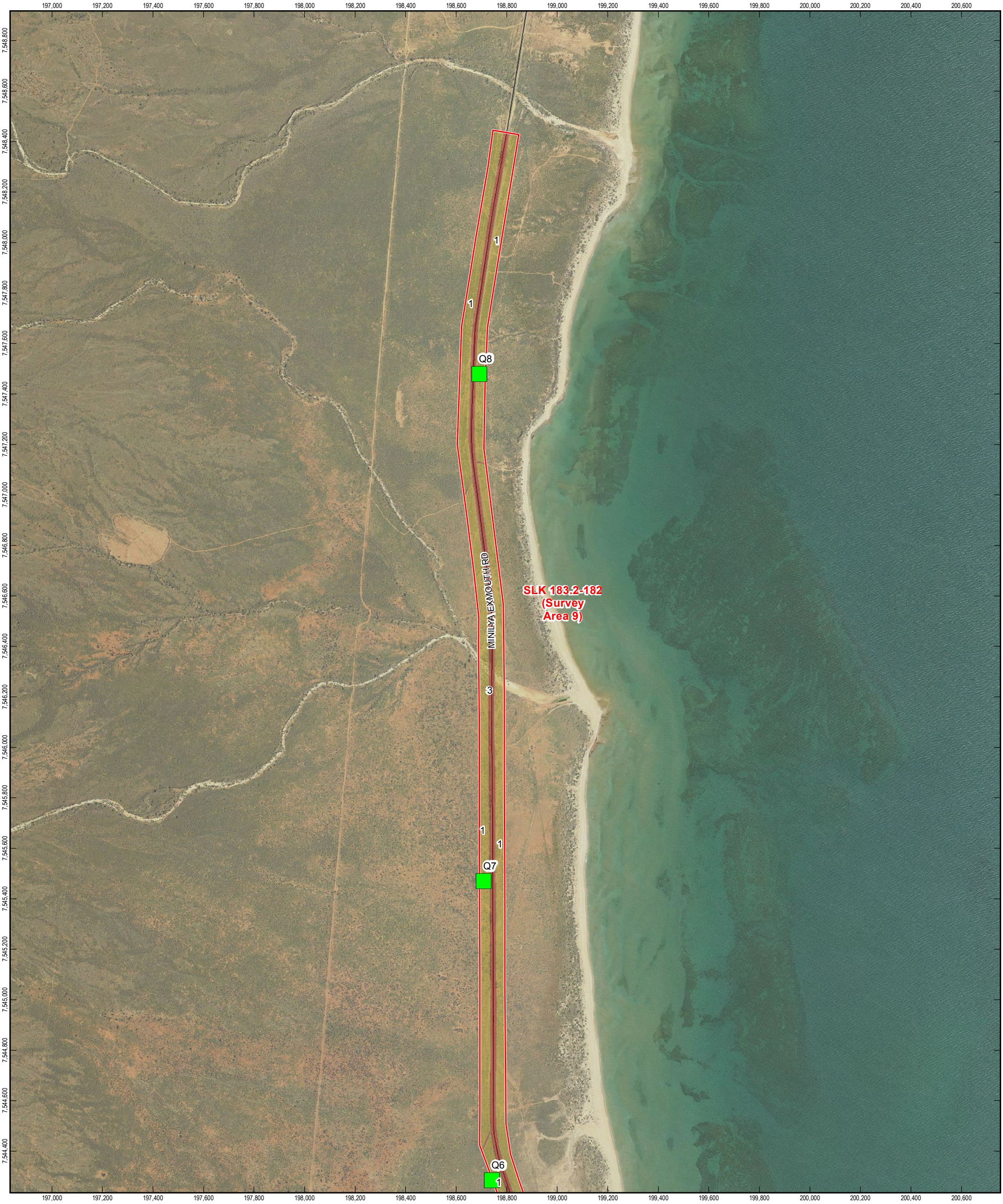
Job Number 61-32476
Revision 0
Date 22 Jul 2016

Sheet 2

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA50_SheetsA-E.mxd
999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML



LEGEND

- Quadrat
- River
- Road
- Survey Area

Vegetation Types

- 1 - Mosaic
- 2 - Creekline
- 3 - Cleared / Degraded
- 4 - Frankenia Flats
- 5 - Pebbly Dune
- 6 - Dune
- 7 - Interdune
- 8 - Calcareous Shield
- 9 - Mixed Scrub on Stony Slopes
- 10 - Drainage Line
- 11 - Plains
- 12 - Chenopod Plains
- 13 - Tall Acacia Scrub
- 14 - Claypan
- 15 - Mixed Scrub on Rolling Dunes
- 16 - Floodplain

Paper Size A3

0 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 3

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA50_SheetsA-E.mxd
999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

LEGEND

Quadrat
River
Road
Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 4

Figure 3

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

MINILYA EXMOUTH RD

SLK 130-135
(Survey
Area 8)

SLK 128.5
(Survey
Area 7)

BURKETT RD

Q9

Q10

Q11

LEGEND

Quadrat

River

Road

Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 5

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA50_SheetsA-E.mxd
999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

LEGEND

- Quadrat
- River
- Road
- Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 210 420 630 840

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 49

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 6

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA49_SheetsF-J.mxd

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

LEGEND

- Quadrat
- River
- Road
- Survey Area

Vegetation Types

- 1 - Mosaic
- 2 - Creekline
- 3 - Cleared / Degraded
- 4 - Frankenia Flats
- 5 - Pebbly Dune
- 6 - Dune
- 7 - Interdune
- 8 - Calcareous Shield
- 9 - Mixed Scrub on Stony Slopes
- 10 - Drainage Line
- 11 - Plains
- 12 - Chenopod Plains
- 13 - Tall Acacia Scrub
- 14 - Claypan
- 15 - Mixed Scrub on Rolling Dunes
- 16 - Floodplain

Paper Size A3

0 280 560 840 1,120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 49

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 7

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA49_SheetsF-J.mxd

999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au
Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

802,000 802,500 803,000 803,500

7,394,000 7,393,500 7,393,000 7,392,500 7,392,000

Lyndon River

MINILYA-EXMOUTH RD

SLK 25.4 (Survey Area 4)

SLK 24.5 (Survey Area 3)

Q25 Q24 Q22 Q23

9 12 10 3 11

LEGEND

Quadrat
River
Road
Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 49

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 8

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA49_SheetsF-J.mxd
999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

803,500 804,000 804,500 805,000 805,500

7,377,000 7,376,500 7,376,000 7,375,500 7,375,000 7,374,500

14 14 14 13 13 3 3 Q26 14

MINILYA-EXMOUTH RD

SLK 7
(Survey
Area 2)

LEGEND

Quadrat
River
Road
Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 110 220 330 440

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 49

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number 61-32476
Revision 0
Date 22 Jul 2016

Sheet 9

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA49_SheetsF-J.mxd
999 Hay Street, Perth WA 6004 Australia T 61 8 6222 8555 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

804,500 805,000 805,500 806,000 806,500 807,000 807,500

7,373,000 7,372,500 7,372,000 7,371,500 7,371,000 7,370,500 7,370,000 7,369,500

Q27
16
16
16
16
Q28
MINILYA EXMOUTH RD
SLK 0-4
(Survey
Area 1)
15
Q29
15
NORTH-WEST COASTAL HWY
3

LEGEND

Quadrat
River
Road
Survey Area

Vegetation Types

1 - Mosaic
2 - Creekline
3 - Cleared / Degraded
4 - Frankenia Flats
5 - Pebbly Dune
6 - Dune
7 - Interdune
8 - Calcareous Shield
9 - Mixed Scrub on Stony Slopes
10 - Drainage Line
11 - Plains
12 - Chenopod Plains
13 - Tall Acacia Scrub
14 - Claypan
15 - Mixed Scrub on Rolling Dunes
16 - Floodplain

Paper Size A3

0 170 340 510 680

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 49

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Type

Job Number	61-32476
Revision	0
Date	22 Jul 2016

Sheet 10

Figure 3

G:\61\32476\GIS\GIS\Maps\MXD\6132476_003_Rev0_Fig3_MGA49_SheetsF-J.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Type - 20160105: Quadrats - 20160301; MRWA: Road - 20141008. Created by: ML

203,000 203,500

7,567,500 7,567,500

7,567,000 7,567,000

4 4 4 6 4 5 5 5 4 4

SLK 211-211.75 (Survey Area 11)

MINILYA EXMOUTH RD

203,000 203,500

LEGEND

River
Road
Survey Area

Vegetation Condition

1 - *Pristine or Nearly So*
1-2 - *Excellent to Pristine*
2 - *Excellent*
2-3 - *Very Good to Excellent*
3 - *Very Good*
3-4 - *Good to Very Good*
4 - *Good*
4-5 - *Degraded to Good*
5 - *Degraded*
5-6 - *Competely Degraded to Degraded*
6 - *Completely Degraded*

Paper Size A3

0 40 80 120 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

Job Number	61-32476
Revision	0
Date	05 Jul 2016

Sheet 1

Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA50_SheetsA-E.mxd

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Survey Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

201,000 201,500 202,000 202,500

7,560,000 7,559,500 7,559,000 7,558,500 7,558,000

5 6

SLK 202.1-204.4
(Survey
Area 10)

MINILYA EXMOUTH RD

5 5

LEGEND

River
Road
Survey Area

Vegetation Condition

1 - *Pristine or Nearly So*
1-2 - *Excellent to Pristine*
2 - *Excellent*
2-3 - *Very Good to Excellent*
3 - *Very Good*
3-4 - *Good to Very Good*
4 - *Good*
4-5 - *Degraded to Good*
5 - *Degraded*
5-6 - *Competely Degraded to Degraded*
6 - *Completely Degraded*

Paper Size A3
0 110 220 330 440
Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA
powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

Job Number 61-32476
Revision 0
Date 05 Jul 2016

Sheet 2
Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA50_SheetsA-E.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Survey Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML

LEGEND

River
Road
Survey Area

Vegetation Condition

1 - *Pristine or Nearly So*
1-2 - *Excellent to Pristine*
2 - *Excellent*
2-3 - *Very Good to Excellent*
3 - *Very Good*
3-4 - *Good to Very Good*
4 - *Good*
4-5 - *Degraded to Good*
5 - *Degraded*
5-6 - *Competely Degraded to Degraded*
6 - *Completely Degraded*

Paper Size A3

0 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

Job Number 61-32476
Revision 0
Date 05 Jul 2016

Sheet 3

Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA50_SheetsA-E.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Survey Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML

LEGEND

River
Road
Survey Area

Vegetation Condition

1 - *Pristine or Nearly So*
1-2 - *Excellent to Pristine*
2 - *Excellent*
2-3 - *Very Good to Excellent*
3 - *Very Good*
3-4 - *Good to Very Good*
4 - *Good*
4-5 - *Degraded to Good*
5 - *Degraded*
5-6 - *Competely Degraded to Degraded*
6 - *Completely Degraded*

Paper Size A3
0 200 400 600 800
Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

GHD

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

Job Number	61-32476
Revision	0
Date	05 Jul 2016

Sheet 4

Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA50_SheetsA-E.mxd

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Survey Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

LEGEND

River
Road
Survey Area

Vegetation Condition

- 1 - *Pristine or Nearly So*
- 1-2 - *Excellent to Pristine*
- 2 - *Excellent*
- 2-3 - *Very Good to Excellent*
- 3 - *Very Good*
- 3-4 - *Good to Very Good*
- 4 - *Good*
- 4-5 - *Degraded to Good*
- 5 - *Degraded*
- 5-6 - *Competely Degraded to Degraded*
- 6 - *Completely Degraded*

Paper Size A3

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

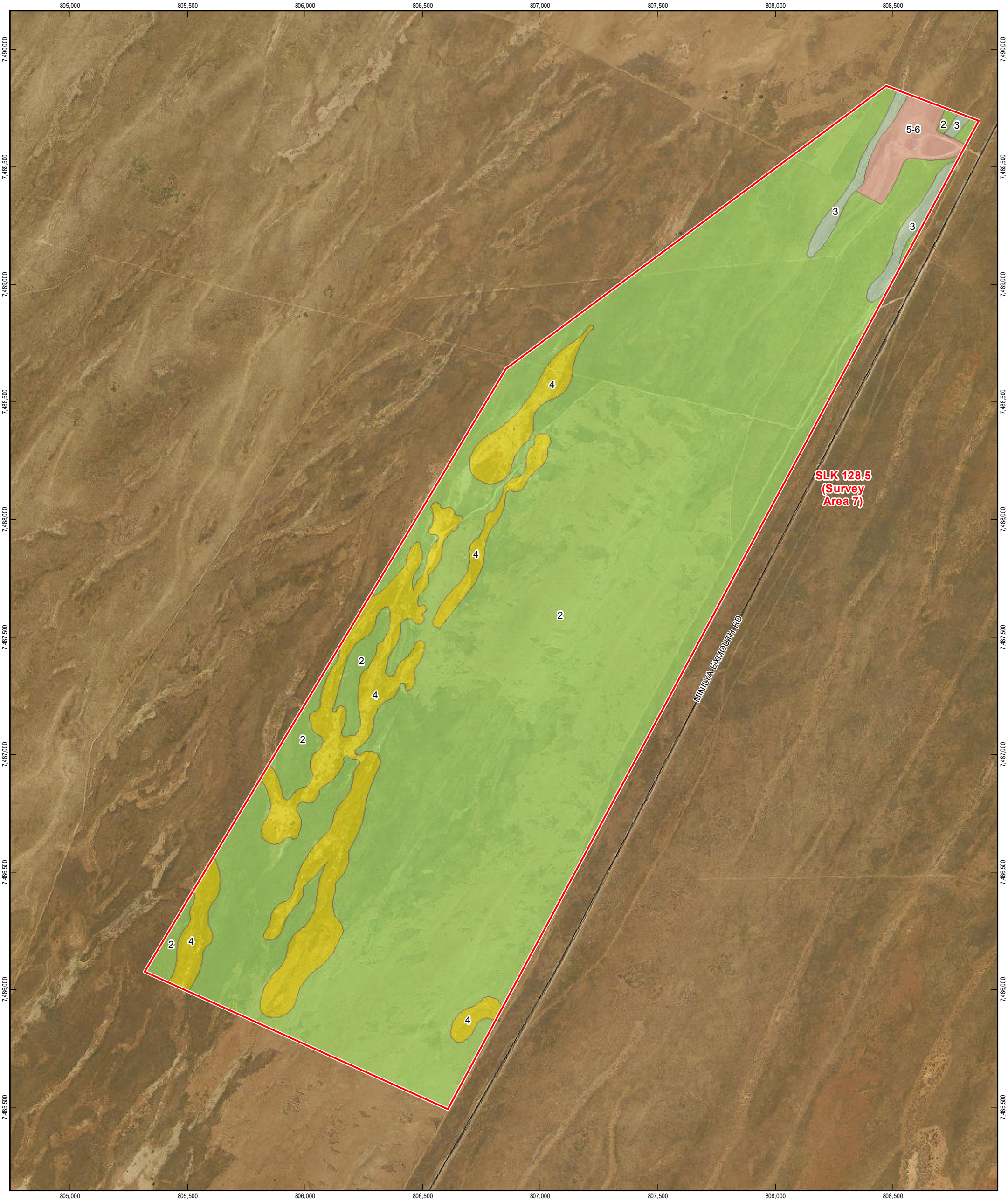
Job Number	61-32476
Revision	0
Date	05 Jul 2016

Sheet 5

Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA50_SheetsA-E.mxd
999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Imagery (Virtual Mosaic); DoW: River - 20141008; GHD: Survey Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML



LEGEND

River
Road
Survey Area

Vegetation Condition

- 1 - *Pristine or Nearly So*
- 1-2 - *Excellent to Pristine*
- 2 - *Excellent*
- 2-3 - *Very Good to Excellent*
- 3 - *Very Good*
- 3-4 - *Good to Very Good*
- 4 - *Good*
- 4-5 - *Degraded to Good*
- 5 - *Degraded*
- 5-6 - *Competely Degraded to Degraded*
- 6 - *Completely Degraded*

Paper Size A3

0 210 420 630 840

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Vegetation Condition

Job Number	61-32476
Revision	0
Date	05 Jul 2016

Sheet 6

Figure 4

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Virtual Mosaic - 20160108; DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML

LEGEND

- River
- Road
- Survey Area

Vegetation Condition

- 1 - *Pristine or Nearly So*
- 1-2 - *Excellent to Pristine*
- 2 - *Excellent*
- 2-3 - *Very Good to Excellent*
- 3 - *Very Good*
- 3-4 - *Good to Very Good*
- 4 - *Good*
- 4-5 - *Degraded to Good*
- 5 - *Degraded*
- 5-6 - *Competely Degraded to Degraded*
- 6 - *Completely Degraded*

Paper Size A3

0 280 560 840 1,120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
MRWA ETS BDS
Minilya Exmouth Biological Survey 2015

Job Number 61-32476
Revision 0
Date 05 Jul 2016

Sheet 7

Vegetation Condition

Figure 4

G:\61\32476\GIS\GIS\Maps\MXD\6132476_004_Rev0_Fig4_MGA49_SheetsF-J.mxd

999 Hay Street, Perth WA 6004 Australia **T** 61 8 6222 8555 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Landgate: Virtual Mosaic - 20160108; DoW: River - 20141008; GHD: Study Area - 20150808: Vegetation Condition - 20160105; MRWA: Road - 20141008. Created by: ML