Main Roads Western Australia

MAIN ROADS
Western Australia

Karratha - Tom Price Road, Karratha to Nanutarra-Munjina Rd Section

Consultative Environmental Review

(Assessment No. 1244)

Volume 1

January 2003

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Appendices (Volume 2 – Available on Request)

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

Main Roads Western Australia proposes to construct a sealed, 2 lane road between the North West Coastal Highway near Karratha and the Nanutarra-Munjina road near Tom Price. The route will primarily follow the existing Pilbara Rail Company railway access road between these points.

In accordance with the Environmental Protection Act, a CER has been prepared which describes this proposal and its likely effects on the environment. The CER is available for a public review period of 8 weeks from 6 January 2003, closing on 3 March 2003.

Comments from government agencies and from the public will assist the EPA to preparean assessment report in which it will make recommendations to government. If you are able to, the EPA would welcome electronic submissions in particular, emailed to the project assessment officer or via the EPA's Website (see address below).

Where to get copies of this document

Printed copies of this document may be obtained free from :

Major Projects Directorate
Main Roads Western Australia,
PO Box 6202,
EAST PERTH WA 6892
Attn: Dinky Goble-Garratt
Ph: 93234905

Copies may also be obtained from www.mainroads.wa.gov.au

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the CER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind.

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the CER
- if you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name,
- address,
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: 3 March 2003

The EPA prefers submissions to be sent in electronically. You can either e-mail the submission to the project officer at the following address:

hans.jacob@environ.wa.gov.au

OR

use the submission form on the EPA's website:

www.epa.gov.au/submissions.asp and click on the EIA Assessment Submission option

OR

if you do not have access to e-mail then please post your submission to:

The Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842

Attention: **Mr Hans Jacob**

Main Roads Western Australia

Karratha to Tom Price Road
(between Karratha and the Nanutarra-Munjina Road)

EXECUTIVE SUMMARY

INTRODUCTION

Main Roads Western Australia (MRWA) proposes to design and construct a connecting road between Karratha and Tom Price in the west Pilbara. This Consultative Environmental Review (CER) describes the receiving environment, the impacts of the proposal, and management actions to minimise any adverse impacts as required under Part IV of the Environmental Protection (EP) Act 1986.

The Project, Objectives, Delivery and Timing

The proposal covered by this CER is for the design and construction of the section of the new road from the North West Coastal Highway near Karratha to the junction of the Nanutarra-Munjina Road (approximately 24 kilometres north of Tom Price). The proposed route, options considered, and relevant features and landmarks are shown in Figures A (north and south). The road is planned as a two lane (one in each direction), undivided, sealed carriageway. Construction will include all associated infrastructure such as:

- Road drainage;
- cross drainage (culverts, floodways and bridges);
- new railway level crossings;
- stopping bays and rest areas;
- guard rails and fencing, and
- connections to existing public and private roads.

The impacts and management considered in the CER also cover:

- sourcing of material for construction of embankments (fill);
- sourcing of material to provide an appropriate base for the sealing of the road (basecourse material), and
- sourcing of water for construction purposes.

The key characteristics are set out in the table below.

Table of Key Characteristics of the Proposed Development

Element	Description (Estimates)
Road length	245 km in total with approximately 40km being constructed along the existing Roebourne-Wittenoom Road.
Predicted traffic flow	130 vehicles per day north of Millstream 60 vehicles per day south of Millstream (by 2020)
Road pavement design	Design speed, 110kph 9 metre formation 7 metre bitumen seal
Bridges and floodways	Up to 9 bridges across major watercourses and railway lines. Construction of culverts and low level floodways as required at all other waterways.
Drainage structures	Cutoff drains, offshroot drains and table drains as appropriate to protect the road and maintain hydrological processes.
Road reserve fencing	Approximately 200 kilometres of stock fencing will be erected.
Railway level crossings (new)	4
Parking bays and/or rest areas	Parking bays (no facilities) will be constructed approximately every 20 kilometres; Two rest areas (with facilities) are planned.
Connections to existing roads.	At North West Coastal Highway, Roebourne Wittenoom Road (2), Millstream-Yaraloola Road, Mt Bruce Road and Nanutarra-Munjina Road. Also junctions for rail access roads and station roads.
Footprint	An area of approximately 875 hectares will need to be cleared for construction of the road and associated material pits
Material pits and associated temporary access tracks.	Basecourse pits will be located approximately every 10 km dependent upon the availability of suitable materials. Fill material pits will be needed approximately every 1km through flat terrain. The use of fill material pits in hilly country will be minimised by aiming for a balance of earthworks design (cut to fill).
Water for construction.	Water required for construction and dust management will be sourced from the existing Water Corporation supply, from existing bores and potentially from new sources for the southern section.

The project has been developed over a number of years in consultation with a steering committee in order to address:

- the current indirect public road connections between the coastal communities of Dampier, Karratha and Roebourne and the inland towns of Tom Price and Paraburdoo;
- the periodic closures of the public roads due to flooding or non-trafficability of the unsealed surfaces;

DAMPIER
KARRATHA
WICKHAM
ROEBOURNE
COASTAL
NORTH
WEST
DAMPIER TO PARABURDOO
RAILWAY
River
RAILWAY
River
East Harding
HIGHWAY
Nickol
Harding Dam
Lake Poongkaliyarra
Pinnacle Well
YANNERY HILLS
ROBE RIVER
River
Harding
AS
Western Creek Crossing
AS
CHIRCHESTER RANGE
Harding River Crossing
Python Pool
MILLSTREAM-CHICHESTER NATIONAL PARK
EXISTING LEVEL CROSSING
CAMP CURLEWIS
BAROWANNA HILL
ROEBOURNE
MILLSTREAM TURNOFF
TO WITTENOOM ROAD
Fortescue
Crossing Pool
Deep Reach Pool
MILLSTREAM PUIMPING STATION
River
Kan, Cree

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WI FILE No.	MRWA JOB No.
WI010232	17/231
APPROVED	
DATE	

The partners in Western Infrastructure are BSD Consultants, Brownie Gilchrist and Evans Pty Ltd and SMEC Australia Pty Ltd

- PREFERRED ALIGNMENT
- OPTION A
- OPTION B
- OPTION C
- ALTERNATIVE 1
- ALTERNATIVE 2
- ALTERNATIVE 2A
- ALTERNATIVE 3
- NATIONAL PARK BOUNDARY
- SURFACE & GROUNDWATER CATCHMENT BOUNDARY
- PROPOSED BRIDGE OVER CREEK
- PROPOSED FLOODWAY (MAJOR)
- * LEVEL CROSSING (NEW)
- EXISTING RAILWAY LINE
- ^^ MOUNTAINOUS TERRAIN
- THEMEDA GRASSLAND (THREATENED ECOLOGICAL COMMUNITY)
- AS POSSIBLY SIGNIFICANT ABORIGINAL HERITAGE SITE

FIGURE A (NORTH)

1:300000

0 10 20 30Km

Kanjenjie Creek

AS

Cowcumba Creek

Wallyinya Pool

ROEBOURNE TO WITTENOOM ROAD

Fortescue

Ballyeerina Creek

Fortescue River Crossing

DAMPIER TO PARABURDOO RAILWAY

River

CAMP ANDERSON

Weelerurra Creek

Weelamurra Creek Crossing

HAMERLSEY RANGE

HAMERSLEY STATION HOMESTEAD

Barnett Creek

Caves Creek

ROAD

Fortescue River

KARIJINI NATIONAL PARK

BROCK MAN RAILWAY

MUNJIRIA TO MARANDOO

South

NANUTARRA

RAILWAY

Barnett Creek

TOM PRICE

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FIGURE A (SOUTH)

1:300000

0 10 20 30Km

- a high accident rate on the more direct (private) Pilbara Rail Company railway access road;
- high road user costs associated with property damage and slow travel speeds;
- poor access to the inland National Parks including the visitor centre at Millstream, and the Chichester Ranges, and
- the need to promote the industrial diversification of the inland Pilbara towns.

The project is planned for delivery in a number of stages. The northern 90 kilometres (approximately) is planned for completion in late 2006. Final design for this stage will commence as soon as environmental approval has been granted. Delivery will be through an alliance contract between MRWA and one or more public sector partners.

Final design and construction of the remaining 155 kilometres (approximately) will follow after 2006, with the exact timing dependant on funding.

Environmental Assessment Process

The project was referred to the Environment Protection Authority (EPA) through a Notice of Intent in 1999. The EPA subsequently set a level of assessment for the project as a Consultative Environmental Review (CER) (Assessment Number 1244). Although the CER level of assessment is no longer used in the environmental assessment process, it has been agreed by the EPA that this level will remain for the duration of this project approval process, but with an extended review period to conform with existing Public Environmental Review standards.

The guidelines for the project were issued in August 1999 based on the environmental factors considered to be relevant to the project. A copy of the guidelines is included in Attachment A.

EXISTING ENVIRONMENT

Climate and Landform

The Pilbara is a semi-arid region characterised by high temperatures, low and variable rainfall and high evaporation. Temperature ranges are generally greater in inland districts away from the moderating effects of the onshore winds common to the coastal districts.

Between October and April, the temperature throughout the region exceeds 32^{0}C almost every day. During the winter months, this falls to around 25.^{0}C. Peak rainfalls occur in the warmer months as a result of monsoonal thunderstorm activity and tropical cyclones. This far south the monsoonal activity is sporadic and uncertain and this, combined with tropical cyclones means that rainfall is highly variable, but can be very high at the extremes.

The topography of the area is heavily governed by the underlying geology, the majority of which is extremely ancient and very hard. The landforms that the proposed road will traverse can be divided into broad units which are defined as:

- Flat plain, between North West Coastal Highway and the Chichester Range, and featuring occasional low hills or outcropping rock formations;

- Foothills and ranges of the Chichester and Hamersley Ranges, which rise to approximately 350m and 580 m respectively in the road corridor areas and consist of highly dissected, weathered plateau remnants.
- The Fortescue River valley which is a wide, relatively flat valley incorporating numerous creeks and drainage lines as part of the Fortescue River system; and
- The eastern outwash plain of the Hamersley Range, which is dominated by very low alluvial ridges with scattered outcrops.

Groundwater and Surface Hydrology

Significant groundwater supplies can be found with relative ease in the alluvium and colluvium found in the low lying areas of the coastal plain, Fortescue River valley and the upper reaches of Weelumurra Creek to the south of Hamersley Station. Information from the Water and Rivers Commission indicates that depths to water in these bores range from around 4m to 37m.

The Millstream borefield, on the Fortescue River, and some 13km south-west of the road/rail corridor, supplies water to the towns of Karratha and Dampier and to industry on the Burrup Peninsula. These water rich surface deposits can be somewhat ephemeral because over time the water will gradually drain in the direction of the river valley and will be dependent upon the infrequent rains for supply. The Millstream borefield and surrounding area is encompassed by a water reserve and associated Priority 1 and Priority 2 Groundwater Protection Areas.

Surface drainage features on the coastal plain in the immediate vicinity of the proposed road tend to be sporadic and shallow. As the landscape becomes more undulating towards the Chichester Ranges, watercourses are well defined and often rocky. Western Creek and the Harding River and their tributaries form the main drainage features. These rivers are formed in alluvial loams and gravels and are stable. Through the Chichester Ranges the rugged topography leads to deep river gorges with steep rocky channels.

Between the Chichester and Hamersley Ranges, all surface drainage is directed to the Fortescue River across a wide plain. Flows tend westwards across the proposed road alignment. At the southern end of the plain, the braided channels of Weelumurra Creek run parallel to the road before joining the Fortescue River.

Through the Hamersley Ranges, the rugged topography leads to small catchments drained by numerous, small channels. All drainage feeds into Weelumurra Creek, which runs along the proposed alignment.

South of the Hamersley Ranges, the country is flat to undulating. Drainage may be in the form of sheet flow in places, with much aligned parallel to the proposed road alignment.

Flora

A total of 287 species were recorded within the proposed road corridors during the field investigations. These were dominated by a small number of families with the majority being in the Mimosaceae (wattles), Poaceae (grasses), Papilionaceae (peas), Malvaceae (*Abutilon, Sida* and *Hibiscus* genera) and Amaranthaceae (mulla mullas). The field investigation was constrained by the seasonal conditions. In the northern half of the study area, there had been very little rain for some 12-15 months and the ground was extremely dry. Many of the ephemeral plants and grasses were either not present or only present as dried remnants with no fruiting material or other identifying features. Although some representative ephemeral species were found in drainage

lines and damper areas in the southern part of the study area, their presence was not recorded in other areas where they would likely normally occur. Further botanical survey of the Abydos Plains area (northern 45 kilometres) will be undertaken at a seasonally more favourable time in order to confirm the composition of the annual flora in this area.

The Department of Conservation and Land Management (DCLM) Declared Rare and Priority Flora database indicates that there are some twenty species which have been recorded from localities possibly within a one kilometre corridor on both sides of the existing Pilbara Rail Company access road, or that are found in habitats the same as, or similar to habitats within the one kilometre road corridor study area. However, none are Declared Rare Flora.

Two of the listed Priority species were collected during the field investigations. These were the grass species *Ischaemum albovillosum* (Priority 2) and *Themeda* sp. Hamersley Station (Priority 3). The former was found near to the North West Coastal Highway in the area of Option B1 and the latter south of the Hamersley Range as a dominant in the Threatened Ecological Community (*Themeda* grassland).

Only a small number of weed species were recorded during the field survey. Other, very detailed and long-term studies in the area have also indicated low numbers of weed species. Of the four weed species recorded the most prolific by far is *Cenchrus ciliaris* (buffel grass) which is widespread along the road/rail corridor. It is likely that this species was introduced to stabilise the railway embankments as it appears to be primarily in that area and closely adjacent for much of the route. It is also apparent in some of the small creeklines where looser, sandy soils are present. Outbreaks of *Rumex vesicarius* (Ruby Dock) are known from along the road corridor in the past.

No listed Declared weeds were observed during the field investigations. However, consultation with DCLM indicates that the Declared weed *Argemone mexicana* (Mexican poppy) may be present in many of the local creeks.

Vegetation

All the areas of the proposed alignments and options for the Karratha to Tom Price Road fall within the Fortescue Botanical District (Pilbara region) as defined by Beard (1975), with the proposed road alignments lying within the Abydos Plain, Chichester Plateau, Fortescue Valley and Hamersley Plateau subdivisions.

Abydos Plain (approximately 40 - 45 km)

The vegetation communities of the Abydos Plain area are influenced by the parent geological material of the area, which is Quaternary alluvium near the coast and Archaean granite further inland. Spinifex (*Triodia* species) associations with scattered shrubs (mostly *Acacia* species) or small trees (*Hakea lorea, Grevillea wickhamii*) dominate the granite areas and small rises of the plain.

Watercourses may support trees of *Eucalyptus camaldulensis* or *Melaleuca leucadendron* but are generally lined by a diverse shrub assemblage.

There are also areas of extensive grass plains on the Abydos Plain where finer grained alluvia have been deposited, particularly those derived from the weathering of basic rocks. These communities consist of open plains of grass (dominated by two or three species) or of mixed grass and Spinifex with scattered individuals of *Acacia inaequilatera.*

Chichester Plateau and Range (approximately 35 – 40 km)

The vegetation of the Chichester Plateau, is characterised by an *Acacia pyrifolia/A. inaequilatera – Triodia pungens*) association with scattered individuals of *Hakea lorea* and *Senna* species on the hard alkaline red soils of the high plains. Mixed grassland with scattered shrubs is found on the clay soils of lower areas

Higher areas of rocky, rugged slopes (which are basaltic in nature) are mostly vegetated with Snappy Gum (*Eucalyptus leucophloia*) over *Triodia pungens*, with mixed Acacias over *Triodia pungens*) on the lower slopes. A large number of other small trees are found scattered as individuals or small cumps on rocky slope areas of the Chichester Plateau and Range.

Drainage lines, which incise the plateau and flow seasonally through the rocky outcrop areas, are dominated by *Eucalyptus camaldulensis* over *Acacia ampliceps, A. coriacea, A. trachycarpa, Melaleuca linophylla, M. glomerata, Sesbania cannabina* and *S. formosa.* The tree species, *Terminalia canescens* and *Flueggea virosa* subsp. *melanthesoides* are also found in many of the creeks and drainage lines through the Chichester Plateau, as well as being present on the higher rocky outcrops of the plateau.

Fortescue River and Valley (approximately 85 – 90 km)

The Fortescue River and valley are located between the high points of the Chichester and Hamersley Ranges and Plateaux. The soil types found in the valley are predominantly Quaternary alluvial and colluvial deposits. The sand plain areas of the Fortescue Valley are mostly vegetated with Acacia shrubs of various species (*A. ancistrocarpa, A. acradenia, A. inaequilatera* and *A. tumida/colei*) over Spinifex (*Triodia pungens* and/or *T. wiseana*).

Major drainage lines are wide and support River Gums (*Eucalyptus camaldulensis*) over Paperbarks (*Melaleuca glomerata* and *M. linophylla*) over small shrubs, herbs and grass species. The smaller drainage channels have scattered trees of *E. camaldulensis* and/or *E. victrix* (Coolibah) over a denser cover of the wattle species *Acacia citrinoviridis* with a mixture of small shrubs, herb and grass species in the understorey.

Hamersley Plateau and Range to the intersection with the Nanutarra – Wittenoom Road (approximately 70 – 75 km)

The vegetation of the ranges is characteristically the association of *Eucalyptus leucophloia* and *Corymbia hamersleyana* over Spinifex (*Triodia wiseana*). Small trees of *Eucalyptus gamophylla* and *Corymbia deserticola* are also present. The principal shrub species found on these areas are mostly of the *Acacia* genus; *A. inaequilatera, A. dictyophleba, A. monticola, A. tumida/colei, A. ancistrocarpa, A. pachyacra/tenuissima, A. adoxa, A. synchronicia* and *A. acradenia.*

Most of the valley plains carry the Mulga formation (*Acacia aneura*) as low woodland. Some of the widest and flattest of them develop open grassland. The Mulga is usually associated with another *Acacia* species, *Acacia pruinocarpa,* which attains tree stature to about four to five (4 - 5) metres. Some other small tree and shrub species found growing in these alluvial soils characterised by Mulga woodlands are; *Acacia xiphophylla* (in localised small patches only), *A. tetragonophylla, Psydrax latifolia, Eremophila fraseri, E. latrobei, E. longifolia* and *Grevillea stenobotrya.*

An area of grassland, which dominates the plain around Hamersley Station, is dominated by *Themeda* sp. (Hamersley Station), and is listed by the Department of Conservation and Land Management as a Threatened Ecological Community (TEC).

The major and minor drainage lines are vegetated with principally the same species, but in varying proportions depending on the width and depth of the channels and the area they incise. The main tree species recorded in areas with seasonally flowing water are; *Corymbia hamersleyana, Eucalyptus camaldulensis, E. victrix,* over the shrub species *Gossypium robinsonii, G. australe, Acacia farnesiana,* and the grass species *Cymbopogon ambiguus* and *Cenchrus ciliaris.*

Apart from the Threatened Ecological Community (see below) all of the vegetation communities found along the road alignment corridors are well represented in the local and broader regions.

Threatened Ecological Community

The preferred road alignment traverses a known Threatened Ecological Community (TEC) south of the Hamersley Range (see Figure A, south) on the Hamersley Station flats.

This vegetation type occupies an area of grassland plains, which are dominated by the perennial grass species *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) pn. There are also various other species of trees, shrubs, herbs and grasses found growing on the clay soils of this vegetation community. The vegetation community is listed as a vulnerable (Category A) TEC by the Department of Conservation and Land Management (DCLM) but is not listed for the purposes of the Commonwealth *Environmental Protection and Biodiversity Conservation Act* (2000). DCLM records indicate that this community covers approximately 34,600 hectares.

Fauna

The Project Area has a rich vertebrate fauna, with the Fortescue plain landform supporting more species than other landform units, but the rocky hills of the Chichester and Hamersley Ranges having more species with restricted distributions. The Mulga woodlands of the Southern plains support a number of species that are at the northern or north-western limit of their range.

A total of 105 animal species were recorded during the field survey. The numbers of each category that could be expected to occur, compared to those that were recorded, are shown in the table below.

Table of Fauna Groups – Expected Versus Observed

	No. of species potentially found in the survey area	No. of species recorded in May, 2002
Fish	7	2
Amphibians	9	3
Reptiles	96	25
Birds	137	64
Mammals	41	11
TOTAL	290	105

With the exception of fish (confined to watercourses) and frogs, the Fortescue plain has the highest species richness within each taxonomic group, although the rocky hills and to some extent the Southern plains support species with restricted distributions.

All the fish species require permanent water, with refuge pools in the upper tributaries of the main river systems being important for them, and they disperse widely when water levels are high.

All the frog species observed or expected depend upon wetlands for breeding, but none is of conservation significance.

The bird fauna is very rich across all landform units, with a number of species likely to be restricted to particular landforms. The major watercourses are important not only for waterbirds, but because many birds make use of eucalypt woodlands and other vegetation types that grow along the watercourses.

The expected fauna of the area includes species of fish (Fortescue Grunter), reptiles (the Pilbara Olive Python, the Skinks *Notoscincus butleri* and *Lerista quadrivincula)*, birds (Peregrine Falcon, Australian Bustard and Flock Bronzewing), and mammals (Long-tailed Dunnart, Spectacled Hare-Wallaby, Ghost Bat, Orange Leaf-nose Bat and Pebble-mound Mouse) that are of conservation significance, with most of these present or expected to be present in the rocky hills and/or the Fortescue plain. Major watercourses and associated fringing vegetation are also important.

While the fauna survey and general fauna assessment do not address invertebrates, two species appear on the DCLM list of threatened species. These are the odonates (dragonflies and damselflies) *Antipodogomphus hodgkini* and *Nososcticta pilbara*. Both are probably restricted to the larger pools in the area, such as around Millstream, and the extent of their usage of small and seasonal pools such as those within the Project Area is unknown.

Of the species discussed above, only the Olive Python was observed during the field investigations.

Aboriginal Heritage

The broad scale nature of the environmental studies with the final alignment for the road yet to be confirmed, determined, that a constraints assessment of known information on Aboriginal Heritage would be carried out at this stage of the planning. A more detailed survey will be carried out once an environmentally preferred alignment had been identified.

Sixteen previously recorded archaeological sites within 1 kilometre of the study area were found to be registered with the Department of Indigenous Affairs. The majority of these are likely to be of low significance due to being of small size, having a low number of artefacts, lack of lithic variety, lack of stratigraphic potential and disturbance from water. Based on the available information in the register, four sites were considered to be of some significance, due to their size and their location along watercourses. Following a field investigation and therefore further clarification of the areas potentially impacted, a further 19 newly discovered sites have been added to the known archaeological sites.

The Ethnographic investigation of the project area included an assessment of the existing literature, determination of the Native Title claims which cover the area, and, a period of consultation with claimants in the field. The desktop investigation indicates that there are four Native Title claims which cover the project area. Due to the reliance on water sources in the arid Pilbara, the majority of aboriginal usage sites are along watercourses, and particularly on permanent or semi-permanent pools. In non-riverine environments, permanent or semi-permanent rock-holes or other water catchment places are important and often known only to members of family groups. Thirty sites of ethnographic significance have been recorded within or close to the proposed road corridor. The areas of the proposed corridors which are most at risk of intersecting ethnographic sites are:

- Within the vicinity of the Harding River;
- Between the Millstream turnoff and Camp Curlewis;
- In the Weelumurra Creek area of the Hamersley Range; and
- In the vicinity of the Hamersley Station homestead.

Adjoining Landuse

The proposed road corridor runs primarily through, or adjacent to, pastoral leaseholdings except when within the National Park. For much of the route it is close to the Pilbara Rail Company's Dampier to Paraburdoo railway lease. Where the new alignment coincides with the existing Roebourne-Wittenoom Road, the Shire of Ashburton manages the land.

Millstream-Chichester National Park

The Millstream-Chichester National Park is a major area of natural heritage through which the proposed road passes. With the exception of facilities at Millstream and Python Pool there are no formalised areas of visitor access or use in the Park. A Management Plan is currently being prepared for the Park. This Plan takes the proposed new road into account in terms of the potential indirect effects of greater visitor numbers but does not specify any particular management measures for the road.

The park is listed in the Australian Heritage Commission register with separate entries for the two constituent parks which were formerly separate entities.

Chichester Range National Park (1977 boundary), Millstream WA

Class: Natural

Legal Status: Registered (21/03/1978)

Database Number: 010127

File Number: 5/08/204/0001

Statement of Significance: Panoramic scenery, including Python Pool and Pyramid Hill. (The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.) The Commission has determined that this place has Indigenous values of National Estate significance. The Commission is currently consulting with relevant Indigenous communities about the amount of information to be placed on public record.

Millstream National Park (1977 boundary), Millstream WA

Class: Natural

Legal Status: Registered (21/03/1978)

Database Number: 010128

File Number: 5/08/204/0002

Statement of Significance: Biologically and scenically unique. Wide range of flora and fauna. Water from aquifer in reserve used in coastal towns. Preservation of fine stands of cadjeput. Oasis with an arid area of dry spinifex. (The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.)

Water Reserves

The road corridor crosses two designated Water Reserves both of which include Priority 1 Water Source Protection areas (see Figure A). These areas are the Harding Dam and the Millstream Water Reserve.

Pastoral Leaseholdings

The proposed road potentially impacts four pastoral leaseholdings. These are Karratha, Mt Welcome, Coolawanya and Hamersley Stations. The only station homestead or other buildings within or close to the corridor is Hamersley Station homestead, which is within 1km west of the Dampier to Paraburdoo railway.

Other Adjoining Landuses

Other landuses within, or being accessed off, the road alignment corridor include three mines, two permanent construction camps and a range of infrastructure.

These are:

- Radio Hill mine – approximately 24km south of the North West Coastal Highway;
- Muni Muni mine in the Yannery Hills;
- New construction camp and airstrip;
- Four microwave towers and masts;
- Water pipelines and power lines, and
- Various landing strips in use or abandoned.

PUBLIC CONSULTATION AND STAKEHOLDER SUPPORT

A range of key stakeholders were contacted and provided responses as part of the early planning for the project (GB Hill, 1998). These included;

State Government Departments and Authorities	Aboriginal Interests
The Water Corporation	ATSIC
The Department of Minerals and Energy	Karijini Aboriginal Corporation
The Ministry for Planning	Youngaleena Aboriginal Community
The Department of Transport	Wakathuni Aboriginal Community
Department of Resource Development	Gurrama
Pilbara Development Commission	Ngaluma-Injubandi Native Title Claimant Group

Western Australian Road Transport Association	**Heritage and Environmental Groups**
National Parks and Nature Conservation Authority	The National Trust of Australia
Department of Conservation and Land Management	LEAF of Hedland
Waters and Rivers Commission	Conservation Council of WA
Department of Environmental Protection	Pilbara Environmental Group
Aboriginal Affairs Department	Nickol Bay Naturalist Club
Heritage Council of WA	

Local Government Authorities	**Pastoral Leaseholders**
Shire of Roebourne	Mt Welcome Station
Shire of Ashburton	Hamersley Station
	Coolawanyah Station
Mining and Commercial Operations	
Hamersley Iron Operations	**Others**
Pilbara Rail Company Pty Ltd	Combined Tourist Association
Robe River Mining Company and North Ltd	Mount Florence Association
Titan Resources	Norman Moore (member for the Mining and Pastoral Region)
Tom Price Business Association	

In addition the following stakeholders were contacted but provided no response.

Agriculture Western Australia, Museum of Western Australia, Hooley Station, Karratha Station, Pyramid Station, Warambie Station, Yalleen Station, Kaipa (Torres Strait Islanders and Aboriginal Corporation), Ngurawaana Aboriginal Community, Dampier Archipelago Preservation Association, Karratha Chamber of Commerce, West Pilbara Land Council, Dampier Community Association.

From this initial consultation, the following factors were found to be of high importance:

1. The preferred start/end should be Karratha.
2. The road network should not be expanded more than necessary.
3. The new road should make use of existing roads and maximise multiple use corridors, especially through National Parks and water supply catchment areas.
4. Environmental concerns regarding the Harding River Catchment Area and the potential for spillages and unauthorised entry. WRC strongly opposed the route options in close proximity to Harding Dam and running parallel to major tributaries draining to the dam.
5. The new road should provide a sealed access to Harding Dam.
6. Concern that the new route might bypass Tom Price and that every possible action should be taken to assist the continued development and prosperity of the town.
7. Concern that additional crossings of the Fortescue River would create unmanageable drainage effects on the river.
8. Better access to various properties along the route.

During ongoing planning and the preparation of this environmental review, both specialist stakeholders (such as the Department of Conservation and Land Management, the Shires of Ashburton and Roebourne, and the Pilbara Rail Company) and the general public have been consulted and kept informed of progress of the concept design, through the steering committee, public displays and direct contact.

Manned information displays have been presented at Tom Price, Karratha and Dampier. Written and verbal opinions collected at these displays indicated that 46% preferred one of the options which followed the Pilbara Rail Company railway line closely, however, 38% didn't mind which route was constructed as long as the road was built.

ENVIRONMENTAL RISKS AND IMPACTS, AND PROPOSED MANAGEMENT

The major environmental and related issues that became apparent during the surveys and preparation of the environmental review relate to the position of the alignment through the National Park, impacts at river crossings and on the Threatened Ecological Community, and the potential for disturbance of Aboriginal Heritage sites.

National Park

Direct impacts on the National Park include those associated with the road construction such as clearing of native vegetation for both the alignment and for material pits, and the excavation of cuttings and construction of embankments to provide a safe alignment for the road. All of these activities lead to visual impacts which are hard to avoid. It must be remembered however, that the corridor chosen for the road alignment already carries other infrastructure (water pipeline, powerlines, communication towers, and various service roads), and that it is also the route for a future duplication of the railway.

It is for this reason that the Environmental Protection Authority has previously advised that future infrastructure should as far as is practicable be located within one kilometre of the Dampier to Paraburdoo railway. For the greater part of the route, the proposed alignment complies with this parameter. Deviations further from the railway are only proposed where the rugged terrain of the Chichester Ranges, or difficult river crossings provide significant physical constraints, and where staying closer to the railway may potentially create more negative impacts than the proposed alignment.

An indirect impact on the National Park is considered to be the potential for increased visitor numbers which the new sealed road will provide. Increases in visitor numbers could have unwelcome impacts on fragile vegetation and on pools in the river systems. Conversely, improved access also allows for easier management at the existing facilities, and may prove beneficial in fire management throughout the park. Consultation with the Department of Conservation and Land Management has resulted in a decision not to fence the road reserve through the National Park. Main Roads will cede management of all areas outside of the immediate road formation to DCLM.

River Crossings

There are four major river crossings along the preferred alignment at Western Creek, the Harding River, the Fortescue River and Weelumurra Creek as well as numerous smaller tributaries. Waterways structures will be designed to comply with requirements set by the Water and Rivers Commission for backwaters and downstream velocities. Design will also include scour protection techniques selected on environmental and aesthetic principles. All design parameters are

quantified in the waterways analysis and report, which will be carried out during final design. These parameters are auditable through the proposed commitments and management plan for the project.

Construction impacts at the waterways crossings include clearing of riparian vegetation that is of significance to fauna. All clearing for construction will be restricted to that needed for safe construction of the road, and will generally be no more than the footprint of the works. Rehabilitation of all disturbed areas outside of the safety clear zones along the road will be given priority as the construction work is completed.

Threatened Ecological Community

The impact on the Threatened Ecological Community (*Themeda* grassland on Hamersley Station) will be through clearing of approximately 17.5 hectares over a distance of some seven kilometres out of an estimated total extent regionally of some 34 600 hectares. Clearing will be tightly controlled through this area. It is likely that the grassland will regenerate in disturbed areas alongside the road, and fencing of the road reserve will provide protection from grazing for a small portion of the community.

The table below summarises the risks, impacts and management strategies for all of the factors deemed relevant to the proposal in the Environmental Protection Authority Guidelines for the environmental review.

FACTOR	RISKS & IMPACTS	MANAGEMENT STRATEGIES
Biophysical		
Soils and Landforms	Increased wind and water erosion on areas cleared of vegetation	Appropriate design, careful construction and rapid rehabilitation of disturbed areas
Biodiversity including: • Terrestrial Flora and Vegetation • System 8 • Declared Rare and Priority Flora • Threatened Ecological Communities • Spread of weeds • Regionally significant fauna • Specially protected (Threatened) fauna	• Extensive clearing, but no known loss of plant or animal species, or reduction of any vegetation type below 30% of pre-clearing extent • Traverse of the Millstream Chichester National Park for a distance of approx. 55 km • Clearing of Threatened Ecological Community • Potential spread of weeds • Loss of or changes to fauna habitat, possible increases in road kills with increase traffic, disturbance associated with additional human activity	• Development and implementation of detailed Vegetation Protection and Rehabilitation Management Plan to address design issues, clearing controls, construction work practices, rehabilitation and fencing of the road reserve • Co-operation with DCLM on management of long-term impacts on the National Park
Rivers	Clearing of riparian vegetation, disturbance to river beds and banks	Preparation of a Surface Drainage Management Plan to address design issues, clearing controls, construction work practices and rehabilitation
Flood management	Alteration to river flows, upstream flooding and/or downstream drainage shadows	Design and construct all drainage structures to maintain hydrological processes. Document in Surface Drainage Management Plan

FACTOR	RISKS & IMPACTS	MANAGEMENT STRATEGIES
Pollution Management		
Air quality	No noticeable risks or impacts expected	No specific management strategy required
Surface water quality	Risks are: • Acute contamination from accidental spillage • Cumulative impacts from stormwater runoff • Increased human activity	Undertake post-construction consultation with Water and Rivers Commission to develop spill response strategy
Groundwater quality	Very minor risk of contamination	Undertake post-construction consultation with Water and Rivers Commission to develop spill response strategy
Particulate/dust emissions during construction	Traffic safety on railway access road and health and safety of workers	Dust management to be included in Construction Management Plan
Noise	No noise sensitive premises near alignment	No specific management strategy required
Hazardous goods	Risks associated with fuel, lubricant and construction material storage	Handling and storage of hazardous materials to be included in Construction Management Plan
Social Surroundings		
Consideration of alternative route alignments	Within the constraints imposed by topography, other existing and proposed infrastructure, design for safety and cost, the environmental impacts are minimised through adoption of the preferred alignment	
Visual amenity	Clearing for, and construction of the road will add another element to the visual impacts through the Nation Park	Appropriate design, careful construction and rapid rehabilitation of disturbed areas to limit visual impacts consistent with the recommendations of the Visual Assessment in Appendix A.
Aboriginal culture and heritage	Some risk of disturbance Aboriginal Heritage sites, especially near major water sources	• Conduct detailed field surveys of the alignment when it is confirmed • Consult with traditional spokespeople and Native Title claimants • If required, seek Section 18 clearance under the Aboriginal Heritage Act
Other heritage	No significant issues identified	No specific management strategies required

PROPONENT COMMITMENTS

Summary of Environmental Commitments – Design and Construction of Karratha to Tom Price Road

No.	Issue	Action/Commitment	Objective	Phase	Advice
1.	Further Flora and Vegetation Survey	1. Carry out an additional flora and vegetation survey on the Abydos Plain section of the alignment at a seasonal time when the annual flora can be recorded. The standard and timing of the survey will be to the satisfaction of DCLM. 2. Assess any impacts of the preferred alignment in the light of the new survey results. 3. Report results of the survey to DCLM and EPA.	Add to the flora and vegetation survey information to record as complete a baseline survey as is possible, and minimise environmental impacts To determine the presence of rare, priority and significant flora on the Abydos Plain.	Prior to commencement of works	DCLM
2.	Surface Drainage Management Plan	Prepare a Surface Drainage Management Plan which includes the following elements: 1. Confirmation of design requirements (waterways report) for all major waterways; 2. Protection of embankments and waterway banks and beds; 3. Protection of riparian vegetation; 4. Details for monitoring of waterway integrity and erosion risks during and following construction; 5. Management and remediation of any impacts found during monitoring; and 6. Measurement and evaluation of environmental performance.	To maintain existing drainage patterns and prevent soil erosion and sedimentation caused by construction activity or new waterways structures.	Prior to commencement of construction.	WRC

No.	Issue	Action/Commitment	Objective	Phase	Advice
3.	Surface Drainage Management Plan	Implement Surface Drainage Management Plan	To maintain existing drainage patterns and prevent soil erosion and sedimentation caused by construction activity or new waterways structures	Design, construction, post-construction.	WRC
4.	Vegetation Protection and Rehabilitation Management Plan	Prepare a Vegetation Protection and Rehabilitation Management Plan to include the following elements: 1. Design and construction strategies which minimise loss of native vegetation and fauna habitat; 2. Treatment of the Threatened Ecological Community which includes fencing of the road reserve; 3. Protection of rare or significant flora; 4. Treatment of riparian zones; 5. Treatment of material pits; 6. A detailed rehabilitation strategy which includes topsoil and weed management, brushing and seeding; 7. Monitoring measures for ensuring that vegetation is protected and replaced; and 8. Measurement and evaluation of environmental performance.	Prevent loss of vegetation beyond the footprint of the works, and minimise potential indirect effects on vegetation. Rehabilitate impacted areas to replace lost vegetation.	Prior to commencement of construction.	DCLM
5.	Vegetation Protection and Rehabilitation Management Plan	Implement the Vegetation Protection and Rehabilitation Management Plan	Prevent loss of vegetation beyond the footprint of the works, and minimise potential indirect effects on vegetation. Rehabilitate impacted areas to replace lost vegetation.	Construction and post-construction	DCLM

No.	Issue	Action/Commitment	Objective	Phase	Advice
6.	National Park Plan.	Prepare a plan which addresses impacts in the Millstream-Chichester National Park which includes as elements: 1. Design of appropriate interpretive signage and rest bays to promote understanding of Park values and protection of flora and fauna 2. Design to minimise the ecological and visual impact of the road through: a. Minimising cut and fill through the Park; b. Confining the width of the construction corridor through the Park to an average of 40 metres; c. Best practice design of batters in cut and fill areas to provide stable landforms which blend in with the surrounding contours; and d. Reducing vegetation clearing through forward planning and sensitive design. 3. Long term management of the road reserve through the Park; and 4. Measurement and evaluation of environmental performance.	Minimise the impacts of the new road through the Millstream-Chichester National Park.	Design	DCLM
7.	National Park Plan.	Implement the National Park Plan.	Minimise the impacts of the new road through the Millstream-Chichester National Park.	Design, construction and post-construction.	DCLM

No.	Issue	Action/Commitment	Objective	Phase	Advice
8.	Aboriginal Heritage Management Plan	Prepare an Aboriginal Heritage Management Plan that incorporates the following elements (in compliance with the *Aboriginal Heritage Act* (1972)): 1. A strategy for further Aboriginal heritage assessment and consultation during the final design of the road; 2. Details of commitments and conditions for design and construction activities to avoid impacts on significant sites.	Protect and preserve Aboriginal cultural heritage within the area influenced by the roadworks.	Prior to commencement of works.	Department of Indigenous Affairs (DIA).
9.	Aboriginal Heritage Management Plan	Implement the Aboriginal Heritage Management Plan	Protect and preserve Aboriginal cultural heritage within the area influenced by the roadworks.	Design and construction	DIA
10.	Construction Management Plan	Prepare a Construction Management Plan to address: 1. Management of Construction Camps; 2. Noise, dust and other construction nuisance; 3. Transport, storage and use of hazardous materials.	Ensure that environmentally and socially acceptable standards are established and maintained during construction works	Prior to commencement of works	DCLM, Local Authorities
11.	Construction Management Plan	Implement the Construction Management Plan	Ensure that environmentally and socially acceptable standards are established and maintained during construction works	Construction, post construction	DCLM, Local Authorities

CONCLUSIONS

This environmental review includes the outcomes of investigations on flora and fauna, hydrology and groundwater, visual assessment, Aboriginal and European heritage and other social issues. Consideration of four northern route options and four alternative route sections through the Millstream Chichester National Park have led to the identification of the preferred alignment due to its:

- Reduced requirement for earthworks and consequent loss of vegetation;
- Increased safety because of fewer road-rail level crossings; and
- Proximity and access to existing infrastructure which avoids duplication of infrastructure corridors.

The impact of the preferred alignment through the Park will be determined by the care that is taken in design and construction of the works with regard to river and creek crossings and cut and fill across and along steep valleys. All opportunities will be taken to minimise the road footprint in these areas. This will reduce the effects on flora and fauna and local hydrology as well as the visual impact of the works.

The provision of a sealed road from Karratha to Tom Price will undoubtedly increase visitor numbers to the Park. However, due to the remoteness of the area from major population centres the increase in numbers is unlikely to be large. The visitors are, however, likely to be focussed in a small number of areas within the Park. None of these areas closely adjoins the proposed road.

The preferred alignment will not have any significant, unmanageable, impacts on the pastoral areas outside the park. When put into the scale of the landscape, and coupled with the fact that, for most of the options, the road will parallel an existing transport and services corridor, the potential impacts of the road construction and use are proportionately small.

Approximately 875 ha of vegetation will be affected by the proposal (including borrow pits). An analysis of the regional distribution of the communities affected has shown that they are all widespread across the study area and beyond, and only a small proportion of each type is affected.

The greatest impact is to the Threatened Ecological Community (TEC) on Hamersley Station. However, only a small portion (in the order of 17.5 ha or less than half of one percent) of the total estimated extent of this community will be lost due to the road construction. Minor re-alignments of the road will not provide an opportunity to avoid this community as it covers some 34,600 ha. Some protection of the TEC will be provided by the establishment of a wide road reserve which will be fenced and thus protect some of this community from stock grazing.

There will be a minor visual impact due to the construction of the new, sealed road, particularly through parts of the Chichester and Hamersley Ranges. However, careful design will aim to minimise the changes to the landscape through reducing cut and fill requirements. Batter shaping and rehabilitation works will re-contour the land to fit the surrounding environment and replace vegetation lost during roadworks.

The design and construction of river and creek crossings has the potential to impact the hydrology and associated riverine ecosystems. Although rainfall events are spasmodic, there is potential for flooding and backwater and scour effects due to heavy downpours and the capacity of some areas for runoff. Careful design of bridges, floodways, culverts and off-road drainage will be required to minimise the risks of the above impacts and ongoing monitoring will be carried out to ensure that unforseen impacts are quickly managed. Main Roads has undertaken successful design of many

such bridges and river crossing structures in the Pilbara, Kimberley and Gascoyne Regions. All design calculations will be verified by Department of Environmental Protection/Water and Rivers Commission prior to completion of the final design.

Operational Risks

Given appropriate design, the use of standard and proven construction techniques and suitable rehabilitation, it is not considered that there will be any significant or on-going impacts as a result of the road development. In the dry environment of the region, scars from vegetation and topsoil clearing can be long-lasting and it is important that appropriate management of these factors for both the road and borrow areas is undertaken. Main Roads has carried out successful rehabilitation in highly sensitive, arid regions such as the Karijini National Park, Shark Bay World Heritage Area and on the Coral Bay Road.

The new road will traverse two Priority 1 Water Source Protection areas – the Harding Dam catchment and the Millstream catchment. Risks to water supplies at the Millstream pumping area and the Harding Dam are negligible due to the distance of the road to these sources and the calculated likelihood of crashes involving hazardous material spills. The risks are not large enough to warrant any special road design for capturing possible spills prior to their entering a waterway and there is a high chance that any such spills can be successfully cleaned up if they pose a threat.

There is a small likelihood that the provision of a sealed road through the Chichester and Hamersley Ranges will increase the risk of road kills of the threatened species, the Pilbara Olive Python. This species and its habitat are widespread throughout the ranges but it is not thought to occur in large numbers. Main Roads will use opportunities for signage and information through the ranges to educate road-users as to the significance of this species.

None of the issues investigated in this report would require that the project be referred to Environment Australia under the *EPBC Act 1999*. The Threatened Ecological Community is not listed under that Act and although two listed migratory birds and a threatened reptile potentially use the area, the risks to these species are seen as negligible because their habitats are widely distributed.

Benefits of the Road

The provision of a sealed, public road between Karratha and Tom Price will provide many benefits for industry in the region and for the associated population. Currently, traffic between the two towns takes a public route via the Roebourne - Wittenoom Road, and the Nanutarra-Munjina road or a private road which was specifically designed as a rail access route and not for high-speed, mixed traffic. There are significant risks on the existing roads due to dust and poor horizontal and vertical design and a new, sealed road, designed for traffic to 110kph will significantly reduce these risks.

The alignment of the road will also considerably improve access to the Millstream-Chichester National Park. This Park is currently not easily accessible to tourists and there are opportunities to increase visitor usage and allow travellers to experience the rugged Chichester Ranges and its associated rivers and pools in greater comfort. The road has the potential to become a spectacular tourist route, opening up the Pilbara and allowing better access to the National Parks and to the mining and industry in the inland areas.

1. Introduction

1.1 The Project

Access between Karratha/Dampier and Roebourne (coastal communities) and Tom Price/Paraburdoo on the public road system is at present via the Roebourne – Wittenoom Road, the Nanutarra – Munjina Road and the Tom Price Spur Road. However, historical traffic data shows that most vehicles commuting between Karratha and Tom Price use the shorter Pilbara Rail Company's Dampier to Paraburdoo railway access road rather than the public roads.

Roads 2020, developed by Main Roads Western Australia and local government authorities (Government of Western Australia, 1997), and the Pilbara Regional Transport Strategy, developed by the Department of Transport, recognise that there is a requirement for a more direct link between Karratha and inland communities such as Tom Price and Paraburdoo.

The completed road will ultimately provide a sealed link between the coastal and inland communities of the central Pilbara that will best meet the needs of all stakeholders.

The project is therefore to construct a new sealed, 2-lane, road consisting of:

- A new 93km section from the North West Coastal Highway (NWCH) near Karratha to about 20km north of the Millstream turn-off on the existing Roebourne – Wittenoom Road (Section 2). In addition to the preferred concept alignment, there are three options joining the NWCH near Karratha, two alternatives at the railway crossing area and two in the Chichester Range near the Harding River which were considered.
- A 46km section in common with the existing Roebourne – Wittenoom Road (Section 3); and
- A 109km section from Wallyinya Pool (on the existing Roebourne – Wittenoom Road) to the Nanutarra – Munjina Road (Section 4) adjacent to the existing Pilbara Rail Company railway.

These sections, including options and alternatives are shown in Figures A (North and South)

This study does not include:

- The 23km section from the Nanutarra – Munjina Road to Tom Price. A level of assessment has previously been set by the EPA for this section, and the project is currently under construction.

The preliminary design of the road indicates the requirement for a range of construction elements. The exact numbers and dimensions of these will be available at the final design stage. Specific elements of the proposal are shown in Table 1.

Table 1 Key Characteristics of the Proposed Development

Element	Description (Estimates)
Road length	245 km in total with approximately 40km being constructed along the existing Roebourne-Wittenoom Road.
Predicted traffic flow	130 vehicles per day north of Millstream 60 vehicles per day south of Millstream (by 2020)
Road pavement design	Design speed, 110kph 9 metre formation 7 metre bitumen seal
Bridges and floodways	Up to 9 bridges across major watercourses and railway lines. Construction of culverts and low level floodways as required at all other waterways.
Drainage structures	Cutoff drains, offshroot drains and table drains as appropriate to protect the road and maintain hydrological processes.
Road reserve fencing	Approximately 200 kilometres of stock fencing will be erected.
Railway level crossings (new)	4
Parking bays and/or rest areas	Parking bays (no facilities) will be constructed approximately every 20 kilometres; Two rest areas (with facilities) are planned.
Connections to existing roads.	At North West Coastal Highway, Roebourne Wittenoom Road (2), Millstream-Yaraloola Road, Mt Bruce Road and Nanutarra-Munjina Road. Also junctions for rail access roads and station roads.
Footprint	An area of approximately 875 hectares will need to be cleared for construction of the road and associated material pits
Material pits and associated temporary access tracks.	Basecourse pits will be located approximately every 10 kms dependent upon the availability of suitable materials. Fill material pits will be needed approximately every 1km through flat terrain. The use of fill material pits in hilly country will be minimised by aiming for a balance of earthworks design (cut to fill).
Water for construction.	Water required for construction and dust management will be sourced from the existing Water Corporation supply, from existing bores and potentially from new sources for the southern section.

1.1.1 The Need for the Project

The project has been developed in consultation with a steering committee since 1996. The steering committee comprises of Main Roads WA, the Pilbara Development Commission, Department of Planning and Infrastructure, Department of Minerals and Petroleum Resources, the Water and Rivers Commission, Shires of Roebourne and Ashburton, Department of Conservation and Land Management, Western Australian Tourism Commission, Robe River Pty Ltd and Hamersley Iron Pty Ltd (now represented as the Pilbara Rail Company). The steering committee identified the main drivers for the project to be:

- safety concerns due to the high accident rate on the Pilbara Rail Company access road;
- long closure periods experienced on unsealed roads between Karratha and Tom Price, particularly after significant rain events;
- low level serviceability flood crossings on the existing unsealed roads;
- high road user costs associated with property damage, road conditions and slow travel speeds;
- poor access to national parks; and
- that the road is essential to broadening the industrial and tourism base supporting the inland Pilbara towns.

1.2 Project Delivery and Timing

At present is planned to deliver the project in numerical order.

Stage 2 is the section from North West Coastal Highway to Camp Curlewis. Camp Curlewis is located approximately 95 km south of Karratha at the intersection of the Roebourne Wittenoom Road and the Pilbara Rail Company railway. This section is scheduled for construction between late 2003 and late 2006.

Stage 3 is the section of the Roebourne Wittenoom Road between Camp Curlewis and Wallyinya Pool located approx 46 km south. This section will be constructed after 2006, the actual timing being subject to the availability of funding.

Stage 4 is from Wallyinya Pool to the Nanutarra Munjina Road along the existing railway which is approximately 109km in length. This section will be constructed after 2006, subject to the availability of funding.

1.3 Objectives of this Study

This study aims to define and describe an optimal 1 km wide corridor in which the final road alignment will be located, as well as locations outside this corridor, which may be utilised as borrow pits. There is a need for flexibility within the corridor to accommodate potential Aboriginal heritage and geotechnical constraints, as well as allowing for minimisation of other environmental impacts (cut and fill requirements, optimising the approaches to watercourses).

The objectives of this study are to:

- prepare a public review document which will allow the public to assess the impacts and benefits of the proposal in accordance with the requirements of the Environmental Protection Act (1986);
- guide decisions on a suitable alignment, and to
- inform the final design process.

The study has included the collection of all necessary information to enable the key environmental issues to be addressed.

1.4 The Level of Assessment

The project was referred to the Environment Protection Authority (EPA) through a Notice of Intent in 1999. The EPA subsequently set a level of assessment for the project as a Consultative

Environmental Review (CER) (Assessment Number 1244). Although the CER level of assessment is no longer used in the environmental assessment process, it has been agreed by the EPA that this level will remain for the duration of this project approval process, but with an extended review period to conform with existing Public Environmental Review standards.

The guidelines for the project were issued in August 1999 based on the environmental factors considered to be relevant to the project. These guidelines were reviewed prior to undertaking the studies included in this review, and are considered to still be relevant. A copy of the guidelines is included in Attachment A.

At the conclusion of the public review period, the EPA provides all submissions, and any other issues which the EPA considers need clarification to the proponent. These submissions and issues must be addressed by the proponent. In responding to the issues raised, the proponent may amend the proposal and modify the management commitments. The EPA then finalises its assessment report which includes a copy of the issues raised, and the proponent's response.

Under Section 44 of the Environmental Protection Act, the EPA is required to report to the Minister for the Environment and Heritage on the environmental factors relevant to the proposal, conditions and procedures to which any implementation of the proposal should be subject, and recommendations that it sees fit.

1.5 Study Outputs

Results of the study are reported in two volumes:

- Volume 1 which is the Consultative Environmental Review; and
- Volume 2 which contains the technical reports on hydrology, Aboriginal Heritage, flora and fauna, and visual assessment, vegetation and aboriginal sites mapping, public information sheets, as well as plans of the preferred alignment and options overlaid on 1:100 000 topographic maps.

2. Options for Providing a Road from Karratha to Tom Price

2.1 Historical Route Planning

GB Hill Consulting Engineers completed the Karratha – Tom Price Planning Study: Recommended Route, in 1997. A map of the routes considered in this study is shown below in Figure B.

The following criteria were used as the basis for a multi criteria assessment for selection of the most acceptable route corridor.

1. Karratha to be the end/start point;
2. The road network should not be expanded more than necessary;
3. Maximum use to be made of multiple purpose transport and infrastructure corridors (especially in the National Park and Water Catchment Areas)
4. Any route option in close proximity to Harding Dam or running parallel to major tributaries close to the dam to be given low priority due to concern voiced by the Water and Rivers Commission (WRC).

From the criteria mentioned above a range of alternative road corridors were considered within two major link sectors. The following summarises why particular road corridor alternatives (Figure B) for each link were rejected.

Link 1 – Karratha/Roebourne to Curlewis

- The yellow option was discounted because it did not end at Karratha, was opposed by the WRC and did not service the Harding Dam;
- The dashed yellow option was discounted because is did not end at Karratha, and it created a new road alignment and transport corridor, which was opposed by the WRC;
- The orange and dashed orange and dashed blue options were discounted because they create a new road and transport corridor and were opposed by the WRC.

Link 2 – Curlewis to Half Way Point (where the Roebourne-Wittenoom Road heads east from the Pilbara Rail Company railway).

The green option was selected over the orange option because the existing Roebourne – Wittenoom Road alignment resulted in no expansion of the road network and maintained the multiple use corridor through the National Park. It was also considered and recommended that the existing transport corridor is the better of the two routes as it provides a balance between WRC and DCLM objectives. These objectives were, respectively, to minimise the risk on Priority 1 water catchment areas and to keep new infrastructure close to existing infrastructure within the National Park.

Link 3 – Half Way Point to Tom Price

(Only some of the options for this link are relevant to this CER, as Stage 1 of the Karratha-Tom Price Road, between Tom Price and the Nanutarra-Munjina Road, has been separately assessed.)

- The northern section of the orange route was discounted on the basis of the lack of opportunity to widen the existing Pilbara Rail Company rail crossing of the Fortescue River

to include a road. Further, the orange route provided indirect access to link the homesteads to the sealed roads and would require the construction of spur roads

- The yellow option along the Nanutarra - Munjina Road from the intersection of the Dampier to Paraburdoo railway and via the Tom Price Spur was also discounted due to length, cost and no response from stakeholders as being their preferred route.
- The blue option from the Dampier to Paraburdoo rail across to the existing Tom Price North Road was discounted because it did not satisfy the 'expanded network' and 'multiple use corridors' criteria. Also the costs and lengths of construction were calculated compared to the railway option. The costs were the same, however, the travel distance was 25km longer.

2.1.1 Preferred Option – Preliminary Study

Based on the multi criteria and benefit costs analyses GB Hill (1997), suggested that the following were the preferred options for the alignment.

Link 1

The recommended route in 1997 for Link 1 was via the Harding Dam. This option was seen to benefit tourism and the local residents in the region by providing a sealed road to Harding Dam which was considered to be high priority.

Link 2

The recommended route in 1997 was via the existing Roebourne-Wittenoom Road (green option).

Link 3

The preferred alignment for Link 3 was via the Pilbara Rail Company (Hamersley Iron) transport corridor. This option benefited tourism and the local residents in the region by providing the shortest route, which was considered to be a high priority.

2.2 Recent Route Planning and Concept Design

2.2.1 Route Options for Approach into Karratha

Following the GB Hill report, a concept design was prepared and discussed with stakeholders. In order to avoid the immediate catchment area of the Harding Dam, the road concept stopped 5 km short of the dam to return towards the Pilbara Rail Company railway. The cost estimate for this route proved to be far higher than expected, and Main Roads was asked by the Steering Committee to investigate additional options. As a result, four options (preferred, A, B, and C) were considered for the northern end of the project (approach to Karratha, see Figure A (North)).

The **preferred** alignment corridor follows the Dampier to Paraburdoo railway line on the eastern side from North West Coastal Highway to where it crosses to the western side just north of the Millstream-Chichester National Park boundary.

Option A follows the water pipeline from North West Coastal Highway to within approx 5km of the Harding Dam (outside of the immediate catchment area), where it then heads back toward the Dampier to Paraburdoo railway near Yannery Hills.

KARRATHA-TOM PRICE ROAD STUDY AREA & PRELIMINARY ROUTE OPTIONS

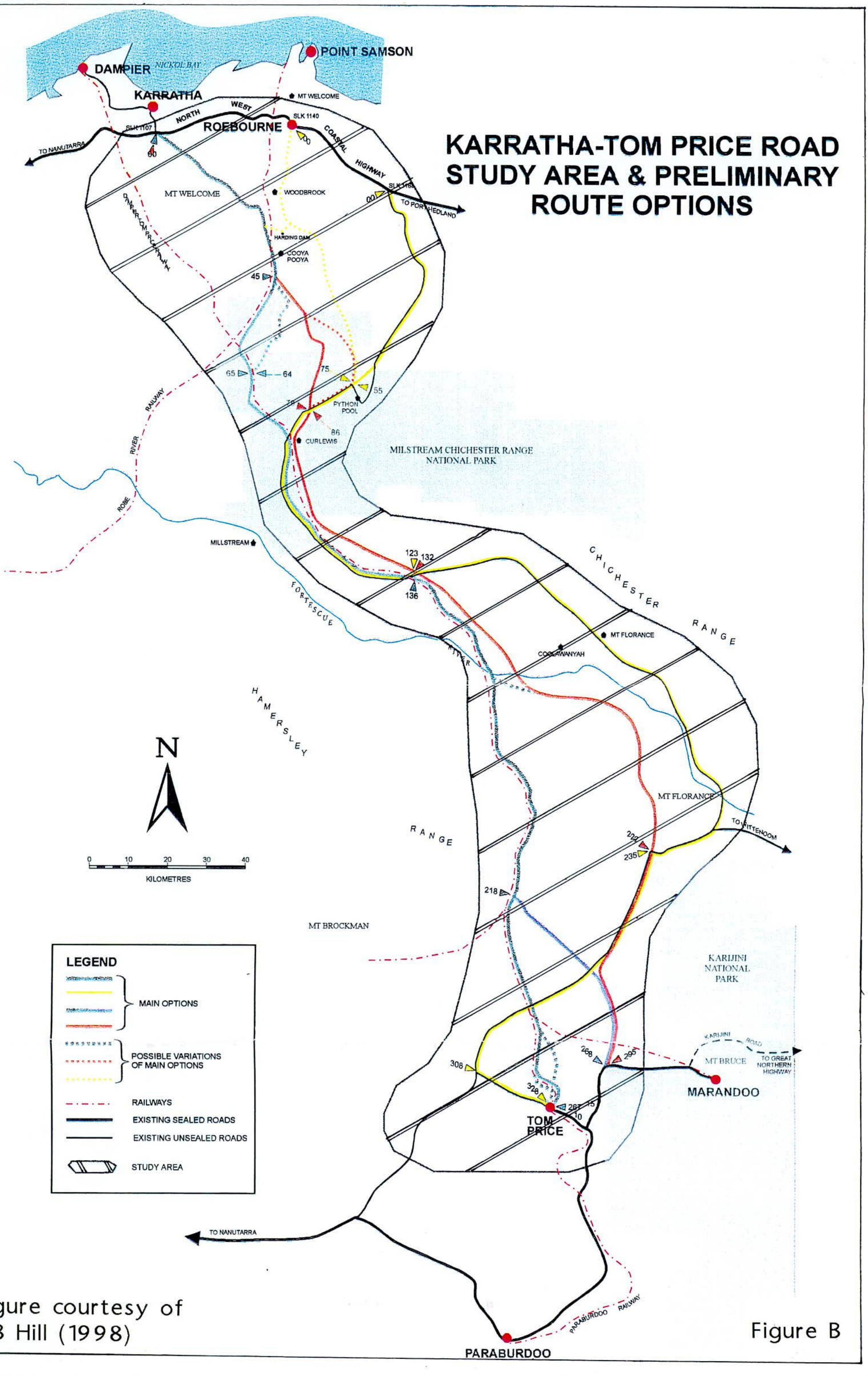

Figure courtesy of GB Hill (1998)

Figure B

Option B follows the Dampier to Paraburdoo railway on the western side from North West Coastal Highway to the National Park boundary where it crosses the railway to join the preferred alignment.

Option C is a more direct link to Karratha. This option starts just east of the main entry to Karratha off North West Coastal Highway and heads almost due southwards to the Dampier to Paraburdoo railway.

2.2.2 Study of Alternative Routes in Millstream-Chichester National Park

In the Millstream-Chichester National Park four alternatives (Figure A, North) have been examined in order to minimise environmental disturbance and construction costs. These alternatives are in the railway flyover and Harding River areas.

Two alternatives were considered for the railway flyover area. The preferred alignment corridor is largely on the eastern side of the railway, with Alternative 1 being on the west.

Alternatives 2, 2a and 3 provide options through, or around, the steep valleys associated with the Harding River and also consider the constraints provided by existing and proposed rail alignments, the existing water pipeline, and various bridges.

Alternative 2 follows higher ground to the east of the main Harding River channel and rejoins the preferred alignment in the southern foothills of the Chichester Range. It runs close to a watershed, and thus minimises cut and fill impacts on watercourses.

Alternative 2a is a link between Alternative 2 and the preferred alignment, which enables a floodway crossing of the Harding River.

Alternative 3 provides an alignment that keeps within 1 km of the railway.

Immediately north of the intersection of the Roebourne to Wittenoom Road and the Dampier to Paraburdoo railway two possible alignments are under consideration.

2.2.3 Decisions on Options and Alternatives

Detailed assessment of the alternatives was undertaken during field investigations and a multi-criteria analysis carried out to define the preferred alignment. These details are given in 6.2.19 and summarised below.

Options into Karratha

Option A was eliminated from consideration because:

- the compromise provided by not traversing the catchment of the Harding Dam resulted in no additional access to the dam for recreational purposes;
- the longer distance meant additional disturbance and cost, and
- station property is affected by severance.
- These factors result in the multi-criteria analysis indicating that, of the four options, this option gives the poorest performance both economically and socially.

Option B is similar to the preferred alignment, but on the western side of the Pilbara Rail Company railway instead of the east until it joins with the preferred alignment south of the Yannery River. This alignment does not provide an optimal link with other roads at the North West Coastal Highway. There are few differences in the potential impacts of these two options with the exception of possible impacts on an Aboriginal site for Option B.

Option C provides a slightly more direct route to Karratha, but is not as direct to Dampier and the Burrup Peninsula. Its major disadvantage is that it crosses Mt Welcome and Karratha Stations and could impact significantly on station management through dividing grazing areas and hindering access to watering points.

Millstream-Chichester National Park Alternatives

Within the National Park **Alternative 1** was not chosen because the Department of Conservation and Land Management had concerns about a new road route through an area to the west of the railway that is relatively undisturbed and which is not otherwise impacted by infrastructure. In addition, this alignment would potentially result in two additional railway crossings.

Alternative 2 was rejected primarily due its distance from existing infrastructure and the consequent disturbance of undisturbed areas and visual implications. In addition the northernmost section requires significant earthworks where the alignment climbs from the river to higher ground, with the associated extra costs.

Alternative 2a provides a short link from Alternative 2 to the preferred alignment and has advantages such as crossing the Harding River at right angles. Additional distance from the existing rail bridges over the river allow this alternative to cross the river via a floodway rather than a bridge. However, it is a slightly more expensive option and also does not provide optimum access to existing infrastructure.

Alternative 3 is the least acceptable of the alternatives and has been rejected due to higher potential impacts on the Harding River, because of the potential for disturbance of Aboriginal heritage sites, and as a result of engineering constraints. Construction would require extensive disturbance to a major valley, and would require moving the Millstream water pipeline. Moving the pipeline would possibly require additional clearing, both for construction and for new access tracks. This alternative is both expensive and has implications for service provision during relocation of the pipeline.

Immediately north of the Roebourne to Wittenoom Road (**Camp Curlewis**), two possible alignments are put forward. The Preferred (2) alignment has been developed in order to avoid a new level crossing of the Dampier to Paraburdoo line in hilly terrain. This route links directly to the existing Roebourne to Wittenoom Road and crosses the railway at an existing level crossing. As far as disturbance and environmental impacts are concerned, the two possible alignments are similar.

During the environmental assessment and review of the proposed West Angelus railway line, the EPA determined that any new rail proposal was to be developed to sit within a nominal one kilometre wide transport and infrastructure corridor. The Dampier to Paraburdoo railway and access road and Water Corporation pipeline are already in this corridor. Discussions with various decision-making authorities have indicated that this is also the approach they would wish the road proposal to follow.

During route investigations and costing Main Roads found that there were significant difficulties in staying within the nominal one kilometre corridor at all times. These difficulties relate primarily to

the requirements for earthworks in steep valley areas adjacent to Harding River and Western Creek, and the need for river crossings at particular sites. Alternatives outside the one kilometre corridor may offer a reduction in damaging earthworks, and less direct or indirect impact on watercourses.

Recent discussion with the EPA has indicated that, notwithstanding previous advice, the EPA would consider an alignment which deviates more than one kilometre from the existing Dampier to Paraburdoo railway, provided that the alignment under consideration could be shown to have environmental, social and economic benefits over alignments which conform with the one kilometre limit. MRWA has thus examined alternatives within the National Park which extend outside of the nominal 1kilometre corridor.

The **preferred alignment** corridor (Figure A, North & South) has been chosen primarily because of its proximity to the existing railway, within the constraints that are present due to river crossings and steep valleys. It also does not require substantial movement of existing infrastructure, which minimises disturbance and environmental impacts, and reduces the overall cost of the project.

The preferred route corridor is generally one kilometre wide and is centred on the preferred road alignment. The final alignment of the road within this corridor will be dependent on detailed design, and in particular on final aboriginal heritage investigations.

3. Existing Environment

3.1 Physical Environment

3.1.1 Meteorology and Climate

The Pilbara is a semi-arid region characterised by high temperatures, low and variable rainfall and high evaporation. Temperature ranges are generally greater in inland districts away from the moderating effects of the onshore winds common to the coastal districts.

Between October and April, the temperature throughout the region exceeds 32^0C almost every day. During the winter months, this figure falls to around $25.^0$C (Bureau of Meteorology, 2002).

Peak rainfalls occur in the warmer months as a result of monsoonal thunderstorm activity and tropical cyclones. This far south the monsoonal activity is sporadic and uncertain and this, combined with tropical cyclones means that rainfall is highly variable, but can be very high at the extremes. This has lead to vast riverine drainage systems that are dry for many years and, to the casual observer, appear to be excessively large for the apparent rainfall.

3.1.2 Geology

The coastal plain around Karratha comprises extremely ancient Granite Greenstone terrain overlain by sheets of alluvium and colluvium material washed from the hills to the south and west by the numerous creeks.

These hills comprise the foothills of the Chichester Range, which is formed of the relatively younger materials of the Mount Bruce supergroup which lies unconformably on the underlying Archaean Rocks. The Mount Bruce Supergroup essentially comprises a mix of volcanic material, banded iron formations and other sediments (shales and dolomites), the latter of which are softer than the banded iron formations and tend to form the plains and lower lying areas, whilst the volcanic material forms ridges. The Fortescue Valley follows the line of some of these softer materials for considerable distances.

To the south of the Fortescue, the Hamersley Range is mainly composed of variably hard, fine-grained rocks; jaspilite, shale and dolomite, with the escarpment capped by the very hard Brockman Iron Formation. Where the outcrop is mainly of jaspilite and dolomite the land consists of ranges, steep hills and steeply dissected pediments, with narrow, winding valley plains. Softer rocks are found in the area of the Hamersley Station homestead. These softer rocks form a low-lying area which is overlain by significant deposits of alluvium and colluvium.

3.1.3 Topography and Landform

The topography of the area is heavily governed by the underlying geology, the majority of which is extremely ancient and very hard.

The landforms which the proposed road will traverse can be divided into broad units which are defined as:

- Flat plain, between Karratha and the Chichester Range, and incorporating occasional low hills or outcropping rock formations;

- Foothills and ranges of the Chichester and Hamersley Ranges, which rise to approximately 350m and 580 m respectively in the road corridor areas and consist of highly dissected, weathered plateau remnants.
- The Fortescue River valley which is a wide, relatively flat valley incorporating numerous creeks and drainage lines which are part of the Fortescue River system; and
- The eastern outwash plain of the Hamersley Range, which is dominated by very low alluvial ridges with scattered outcrops.

3.1.4 Visual Quality

A separate visual quality assessment was undertaken as part of this study and is found in Volume 2.

The visual assessment identified 6 visual character units as shown in Table 2. These visual character units show a strong correlation with the topography and regional geology and a number of potential design and management actions were identified to reduce the visual impact of the road and provide access to views and lookouts (see Sections 6.2.11 and 6.2.21.

Table 2 - Visual Character Units

Visual Character Unit	Extent	General Character
1	North-West Highway to Yannery Hills	broad open flatlands
2	Millstream Chichester National Park	undulating to steep, with incised valleys
3	South of Millstream Chichester National Park to Fortescue	broad open flatlands
4	South of Fortescue to Hamersley Ranges	flat becoming undulating
5	Hamersley Ranges	rugged with deeply incised gorges
6	Hamersley Ranges to Tom Price	broad open flatlands

3.1.5 Groundwater Flow Systems

Significant groundwater supplies can be found with relative ease in the alluvium and colluvium found in the low lying areas of the coastal plain, Fortescue River valley and the upper reaches of Weelumurra Creek to the south of Hamersley Station. These areas are dotted with station bores indicating that useful water supplies have been found. The high permeability of this geologically recent material offers easy returns on drilling and, in the correct locations, it is unlikely that the local station leaseholders have ever been required to search in other rocks for their water. Information from the Water and Rivers Commission indicates that depths to water in these bores range from around 4m to 37m.

The Millstream borefield, on the Fortescue River, and some 13km south-west of the road/rail corridor, supplies water to the towns of Karratha and Dampier and to industry on the Burrup Peninsula.

These water rich surface deposits can be ephemeral in some places because over time the water will gradually drain in the direction of the river valley and will be dependent upon the infrequent rains for supply. Therefore, water cannot always be guaranteed when drilling in these formations unless drilling in the deeper deposits. All of these water resources are unconfined and the high permeability presents some concern regarding the possibility of accidental spillage on the proposed

road. However the vast areas involved suggest that any spill would be relatively insignificant given that cleanup of fuel-contaminated soil can be easily carried out on the roadside using proven techniques.

The underlying Mt Bruce Supergroup contains a number of deposits capable of bearing water, however the indurated nature of these materials indicates that these are unlikely to ever represent significant water resources.

The Millstream borefield and surrounding area is encompassed currently by a water reserve and associated Priority 1 and Priority 2 groundwater source protection areas. Priority 1 (P1) source protection areas are defined to ensure that there is no degradation of the water source and are declared over land where the provision of the highest quality public drinking water is the prime beneficial land use. P1 areas are managed in accordance with the principle of risk avoidance. Priority 2 (P2) source protection areas are defined to ensure that there is no increased risk of pollution to the water source. P2 areas are declared over land where low intensity development, such as rural, already exists and are managed in accordance with the principle of risk minimisation (Water and Rivers Commission, 1999a).

3.1.6 Surface water

Drainage Patterns and Catchments

A hydrological assessment of the alignment options was undertaken and is found in Volume 2. This assessment focussed on:

- identifying the catchment zones;
- recording the existing condition of the waterways, floodways and associated vegetation; and
- examining any impacts from the existing culverts and embankments of the Dampier to Paraburdoo railway.

The hydrological assessment was simplified by using the concept of drainage areas, where catchment boundaries were rationalised, and 'like' catchments were grouped. Drainage characterisation was used to limit the catchment assessment to just 26 drainage areas over the alignment.

A full description of each drainage area is provided in the Field Summary Sheets in Volume 2.

From the North West Coastal Highway heading south, the landscape is flat for some 45 kilometres with sporadic, shallow drainage lines. The existing railway line is serviced by a number of relief culverts.

The landscape becomes more undulating after these 45 kilometres as the route approaches the Harding River. Watercourses are well defined, most having a channel bed armoured by rock deposits and vegetated with scattered mature eucalypts. The watercourses are formed in alluvial red loams with gravel and are stable. Hillsides are rocky and set back from the rail corridor. The Harding River catchment is protected by its declaration as a Priority 1 source protection area as it flows into the Harding Dam, some 35 km north of the road corridor.

South of the Harding River the landscape changes to 'gorge' country in the Chichester Ranges, where the existing railway passes through several large cuttings. Steep rocky channels are formed on the hillsides that abut the proposed route.

Moving south of the Chichester Ranges the terrain varies from hilly to quite flat and back to undulating again. Over the flat terrain there are only sporadic drainage lines with few culvert structures on the exiting railway line, and limited need for cross drainage on the road. Channels are formed in alluvial clay loams and appear stable. South of the Portland River the catchments are broken into a series of small but defined watersheds in gently rolling hills.

The Fortescue River plain is generally flat, with drainage lines tending to be small but defined. The railway service road dips in and out of floodways along this section at regular intervals, especially immediately north of the proposed crossing of the main Fortescue River channel. Drainage is perpendicular to the road. Channels are typically free from sediment other than rock debris.

South of the proposed Fortescue River crossing the proposed route continues across the river plain close to the exiting railway. The main drainage here is northwards towards the Fortescue (i.e. predominantly parallel to the railway and the proposed road.

Through the Hamersley Ranges the landscape varies between gently undulating hills and rugged eroded hillsides immediately abutting the rail corridor. Hillsides are rocky and sparsely vegetated. Catchments tend to be small, with upper catchments on rocky slopes and defined channels being formed in the shallow red alluvial loams near the base of hillsides. Watercourses tend to be armoured with rock debris, and are stable with good fringing vegetation. Weelumurra Creek and its tributaries pass close to the proposed alignment as they head northwards to join the Fortescue River.

South of the Hamersley Ranges is undulating country forming a transition onto the flat lands further south. Drainage is varied but in the flatter areas would tend to act as sheet flows, connected by a large network of small drainage lines.

The southernmost section of the route, is very flat. Drainage tends to act as sheet flows and much appears to run parallel to the road alignment. Relief culverting has been provided sporadically below the existing railway line to accommodate cross flows.

Implications for Drainage Management

No identified surface water management issue represents a significant impediment to any of the route alignments. The key hydrological issues and potential impacts have been summarised in Table 3 together with options for their management, which are further described below.

Generally the catchments have defined drainage lines so that a combination of culverts and low level floodways can be used to minimise the effects of the road on the hydrologic regime, both in terms of flooding upstream and erosion downstream of the road.

The stable condition of the existing watercourses should aid construction and ongoing maintenance of drainage infrastructure. Sedimentation was not identified as a problem in channels and culverts over the surveyed alignment. In-situ rock deposits can be used to armour channels downstream of floodways. Best practice in culvert and floodway design as identified in the Austroads (1994) Waterway Design manual and incorporating recent experience in major road construction through similar country in Karijini National Park will be implemented.

Areas where sheet flows predominate are at the southern end of the alignment and within the Fortescue floodplain. These are areas where the alignment may potentially intercept sheet flows, and therefore potentially create runoff shadows. The landscape immediately south of the Hamersley Ranges is flat and the drainage is likely to be a combination of sheet flows and minor drainage lines. Sufficient relief culverting will be required to retain the hydrologic regime which supports the existing grasslands. The Fortescue floodplain has a hydrologic regime generally

governed by sheet flows, but these are parallel to the direction of the road alignment and therefore will not be impacted.

Mulga woodland is present in significant stands through the Hamersley Ranges. The catchments here are typically rocky with defined watercourses and watersheds. Confirmation on a small scale of the need for relief culverting will be undertaken during the design phase of the project.

Table 3 Summary of Potential Environmental and Engineering Drainage Impacts

Management Issue	Hotspot / potentially at risk	Discussion
Watercourse Erosion	None currently No evidence of significant channel erosion as a result of the existing rail or road structures. This is both true for large rivers to small tributaries.	Erosion is most likely to occur in areas of turbulent flow in channels formed on mixed alluvial clay loam and gravel soils. Such sites were inspected downstream of floodways and bridges but in general the channel banks and beds were stable, likely due to the low channel grades and therefore low velocities. In steeper hillside catchments the landscape is often rocky limiting the volumes of erodable material. Channels over much of the alignment have a bed armoured with deposited rock or are incised to a partly cemented clay pan, reducing the potential for erosion.
Sedimentation	None of the bridge, rail or road culvert infrastructure inspected was compromised by deposited sediment. Only Western Creek and Cowcumba (Middle) Creek were recorded as having significant coarse-sand / gravel bed loads. Both also had associated rock debris loads.	Drainage lines identified as being at risk to sedimentation were the relief culverts in very flat landscapes, such as those immediately south of the Hamersley Ranges. Site inspection confirmed, however, that the sheet flows generated in these catchments did not appear to carry significant sediment load, and the drainage structures remained clear of debris.
Floods	There was little evidence of recent flood flows over the route. Larger creeklines Cowcumba Ck, and Harding River had evidence of flows to over 2 metres depth, with flood debris scattered in trees.	The presence of stands of eucalyptus in the main channels of most of the larger creeks indicated that any recent flood activity was not sufficiently large to remove the vegetation.
Infrastructure Damage	Site inspection showed very little damage to drainage infrastructure, culverts, floodways and bridges.	Damage limited to minor scouring on the downstream toe of several floodways. All of the culvert groups were in working condition. It is assumed regular maintenance is undertaken on the Hamersley access road floodways.
Dependent Vegetation	Scattered individual Mulga were recorded on the Fortescue River plain and south of the Hamersley Ranges. Stands of Mulga woodland were identified through the Hamersley Ranges. The Threatened Ecological Community *Themeda* Grassland immediately south of the Hamersley Ranges.	The drainage areas where sheet flows predominate and 'runoff shadows' are most likely to be formed by road/rail embankments do not support existing Mulga stands, only individual trees. For drainage areas in the Hamersley Range, which support Mulga stands, the drainage lines are incised, and 'runoff shadows' are not likely to be an issue. Drainage assessment at a micro scale may need to be considered for individual stands These grassland areas are generally flat, and sheet flows and small drainage lines are likely to be significant in maintaining the viability of the vegetation. Sufficient relief culverting will be required to maintain the hydrological regime.

Management Issue	Hotspot / potentially at risk	Discussion
Maintenance of Hydrologic Regimes	Existing drainage practices on roads and railway appear to have satisfactorily maintained the hydrologic regime across each of the landscape types.	Consultation with the botanists confirmed that no vegetation types currently display signs of water stress as a result of drainage shadow due to existing infrastructure.

3.2 Biological Environment

A biological survey of the proposed road corridor and alternative alignments was carried out over three weeks in May/June 2002. The vegetation and flora assessment included aerial photograph interpretation and ground truthing, a traverse of the alignments, detailed recording and collection at 68, 50m x 50m survey plots and opportunistic flora collection. The fauna assessment included trapping, targeted searching and opportunistic recording for all expected species, including fish and other freshwater vertebrates.

At the time of the surveys there had been no significant rain in the northern half of the project area for over a year. Conditions were very dry with much of the herbaceous vegetation being dead or in a poor state. Ephemeral vegetation was still present on some of the creeklines but higher areas were depauperate with regard to annuals. The southern half of the project area had had more recent rain and was in relatively good condition with most species likely to occur being present and identifiable. The dry conditions also limited fauna collections, particularly of mammal and reptile species.

3.2.1 Previous Botanical Assessments of the area

There have been some detailed botanical assessments, by others, which have overlapped sections of the road proposal area. The most comprehensive of these has been an unpublished report (Trudgen, 1999) on the proposed West Angeles mine, which includes assessments of various road and rail options and a number of mine lease areas. That survey was carried out over two years and included a detailed consideration of Priority species and other significant species.

Another study has been carried out by *ecologia* Consultants for the section of National Park which was added to link the Chichester and Millstream areas.

Flora lists from these studies have resulted in a flora list for the Millstream-Chichester National Park (unpublished) which contains 559 species.

3.2.2 Vegetation

A detailed vegetation survey was undertaken in May/June, 2002 and a full report is included in Volume 2.

All the areas of the proposed alignments and options for the Karratha to Tom Price Road fall within the Fortescue Botanical District (Pilbara region) as defined by Beard (1975). Beard then further divides this Botanical District into nine subdivisions, with the proposed road alignments lying within the Abydos Plain, Chichester Plateau, Fortescue Valley and Hamersley Plateau subdivisions.

Abydos Plain (approximately 40 - 45 km of road length)

The proposed road alignment corridors start in the Abydos Plain at the North West Coastal Highway.

The vegetation communities of the Abydos Plain area are influenced by the parent geological material of the area, which is Quaternary alluvium near the coast and Archaean granite further inland (Beard, 1975). According to Beard, the predominant community of the granite plain is shrub steppe of the *Acacia pyrifolia/inaequilatera – Triodia pungens* association. This association forms a hummock grass cover dotted with widely spaced shrubs, with some other *Triodia* species (*T. wiseana* and *T. lanigera*) dominating on stony ground, calcrete and other soil types. The principal medium to large shrub species, which were recorded as present in this vegetation community are *Acacia inaequilatera, A. bivenosa, A. pyrifolia* and *Hakea lorea.* Other shrub species found on this granite plain area, are *Corchorus, Cullen* and *Triumfetta* species, *Grevillea wickhamii,* and *Senna* species.

The granite plain is broken by numerous stony rises, low hills, basic dykes, large granite outcrops and small ranges of hard, resistant Archaean rocks (Beard, 1975). These stony rises and rocky outcrops are mostly only vegetated with two or three species of Spinifex (*Triodia pungens/ T. wiseana/ T. longiceps* or *T. angusta*) due to the shallowness of the soil. A few shrubs and small trees are also found on the granite outcrops. These are *Ficus brachypoda, Flueggea virosa* subsp. *melanthesoides, Acacia maitlandii, A. inaequilatera, A. tenuissima* and species of *Corchorus* and *Triumfetta.* The basic dykes are exposed patches of dark red-brown bare boulders, with no vegetation on the summits and very little on the slopes. Where there is any plant cover present (only seen on the lower slopes), it is usually only Spinifex (*Triodia wiseana* and/or *T. pungens*).

There are a number of watercourses on the Abydos Plain, including both major channels and minor drainage lines, which incise the plain and provide distinct vegetation communities and habitats. The banks of major creeks and rivers are vegetated with relatively large trees of *Eucalyptus camaldulensis,* occasional *E. victrix* and smaller ones of *Melaleuca leucadendra.* Shrub species found in these channels are *Acacia ampliceps, A. coriacea, Gossypium robinsonii, Hibiscus panduriformis* and *Triumfetta appendiculata.* Minor creek beds and drainage lines are often colonised by *Terminalia canescens, Eucalyptus camaldulensis, Acacia acradenia, A. ampliceps, Cullen leucanthum, Hibiscus panduriformis,* and *Senna* species. The dominant native species present in the understorey stratum of the major and minor river and creek channels are the grass species *Cymbopogon ambiguus* and the sedge species *Cyperus vaginatus.* The introduced grass species *Cenchrus ciliaris* (Buffel Grass) is present in high numbers along the banks of most of the major and minor channels, and is also present in areas of disturbance such as roadsides, along the railway line and in heavily grazed areas.

There are also areas of extensive grass plains on the Abydos Plain where finer grained alluvia have been deposited, particularly those derived from the weathering of basic rocks. These communities consist of open plains of grass (dominated by two or three species) or of mixed grass and Spinifex with scattered individuals of *Acacia inaequilatera* (Beard, 1975). The principal Spinifex species present are *Triodia wiseana* and/or *T. pungens,* with the main grass species recorded being *Aristida ? contorta, Eragrostis* sp., *Themeda triandra* and the introduced species, *Cenchrus ciliaris.* Most of the grass species present on these grass plain areas were not identifiable to species level due to the lack of reproductive material. The time of year that the survey was undertaken was not opportune due to the fact that very little rain had fallen in the area in the past 12 – 14 months. None of the grass hummocks and tussocks were in flower and most of them had been grazed by kangaroos and/or livestock, or were in a state of aestivation.

Chichester Plateau and Range (approximately 35 – 40 km of road length).

The vegetation of the Chichester Plateau, is described by Beard (1975) as principally *Acacia pyrifolia/A. inaequilatera – Triodia* species (mostly *T. pungens*) steppe, with scattered individuals of *Hakea lorea* and *Senna* species on the hard alkaline red soils of the high plains. Grass savannah (of mixed grass species) is found on the clay soils, which occur mainly on the lower portions with scattered individuals of *Acacia* and *Senna* species. Valley areas of stony clay soils have *Acacia xiphophylla* (Snakewood) as the dominant tree/shrub species, and the areas of stony ridges on the plain are vegetated with Snappy Gum (*Eucalyptus leucophloia*) over *Triodia* species (*T. pungens* and *T. wiseana*).

Higher areas of rocky, rugged slopes (which are basaltic in nature) are mostly vegetated with Snappy Gum (*Eucalyptus leucophloia*) over Spinifex (Snappy Gum over Spinifex steppe) on the higher rocky slopes and summits, with *Acacia* shrubland (dominated by *Acacia inaequilatera/A. pyrifolia* and *A. maitlandii,* with individuals of *A. arida* and *A. adoxa*) over Spinifex (*Triodia pungens*) on the lower slopes, with scattered individuals of *Corymbia hamersleyana* (Bloodwood) through the areas. The tree species *Brachychiton acuminatus, Ficus brachypoda, Flueggea virosa* subsp. *melanthesoides, Terminalia canescens,* and *Pittosporum phylliraeoides* are also found growing on rocky slope areas of the Chichester Plateau and Range. Drainage lines, which incise the plateau and flow seasonally through the rocky outcrop areas, are vegetated with a different suite of species. The dominant species are *Eucalyptus camaldulensis* over *Acacia ampliceps, A. coriacea, A. trachycarpa, Melaleuca linophylla, M. glomerata, Sesbania cannabina* and *S. formosa,* the grass species *Cymbopogon ambiguus* and *Paraneurachne muelleri,* the sedge species *Cyperus vaginatus,* the herbs *Stemodia grossa* and *Cleome viscosa* and the introduced grass species *Cenchrus ciliaris.* The tree species, *Terminalia canescens* and *Flueggea virosa* subsp. *melanthesoides* are also found in many of the creeks and drainage lines through the Chichester Plateau, as well as being present on the higher rocky outcrops of the plateau.

Fortescue River and Valley (approximately 85 – 90 km of road length)

The Fortescue River and the valley it follows are located between the high points of the Chichester and Hamersley Ranges and Plateaux. The soil types found in the valley are Quaternary alluvial and colluvial deposits, and sand plains overlying the Tertiary Oakover formation (limestone and calcareous gravels) and chert breccia, which are exposed locally (Beard, 1975).

The sand plain areas of the Fortescue Valley are mostly vegetated with *Acacia* shrubs of various species (*A. ancistrocarpa, A. acradenia, A. inaequilatera* and *A. tumida/colei*) over

Spinifex (*Triodia pungens* and/or *T. wiseana*), with scattered individuals of *Corymbia hamersleyana, Eucalyptus gamophylla, Hakea lorea* and small shrubs of the *Triumfetta, Corchorus, Hibiscus, Senna* and *Sida* genera. Annual, small perennial and climber species that are present in these areas include; *Indigofera monophylla, Jasminum didymum* subsp. *lineare,* various *Ptilotus* species, *Polycarpaea longiflora, Rhynchosia minima,* and *Trichodesma zeylanicum.* Outwash areas between the sand plain areas and the river valley have almost the same species as listed for the sand plain areas, with the addition of the two species Snakewood (*Acacia xiphophylla*) and Berrigan (*Eremophila longifolia*) recorded in these areas. Both these areas had the presence of the introduced grass species, *Cenchrus ciliaris,* recorded.

The plain areas of the Fortescue Valley are mostly vegetated with a mixture of *Acacia* species, the most commonly seen species being *Acacia aneura* (Mulga), *A. pruinocarpa* (Gidgee), *A. dictyophleba, A. bivenosa, A. tumida/colei, A. xiphophylla, A. tetragonophylla, A. monticola, A. maitlandii, A. rhodophloia* and *A. synchronicia.* The tree species, *Eucalyptus gamophylla, Codonocarpus cotinifolius* and *Corymbia hamersleyana* are scattered through the *Acacia*

shrubland, as are the shrub species *Dodonaea coriacea, Grevillea wickhamii, Hakea lorea* and *Petalostylis labicheoides.*

The most common smaller shrubs recorded as occurring with the above species in the *Acacia* shrubland are; *Corchorus* sp., *Capparis lasiantha, Triumfetta chaetocarpa, Senna notabilis, S. glutinosa, Indigofera monophylla, Trichodesma zeylanicum, Gossypium australe, Dampiera candicans, Cullen* sp. (*C ? lachnostachys*), *Sida/Hibiscus* sp., *Goodenia stobbsiana* and various annual and perennial *Ptilotus* species. The understorey stratum is vegetated with hummocks of Spinifex (*Triodia pungens, T ? epactia* and *T. wiseana* identified, but other species of *Triodia* may also be present), the grass species *Aristida inaequiglumis/latifolia, Themeda triandra, Paraneurachne muelleri* and the introduced *Cenchrus ciliaris.* It is likely that there are a few more grass species than these mentioned, but due to the fact that very little rain had fallen through the surveyed area, and there is grazing of the area by cattle and kangaroos, many of the species present were not distinguishable as individuals and were not able to be identified to species level.

Drainage lines, rivers and creeks flowing through this area are vegetated with a number of species, the principal species being *Eucalyptus camaldulensis, Acacia citrinoviridis, A. farnesiana, A. tumida/colei, Atalaya hemiglauca, Carissa lanceolata, Corymbia hamersleyana, Melaleuca glomerata, Sesbania cannabina, Stylobasium spathulatum, Petalostylis labicheoides,* and the herbaceous species *Stemodia grossa, Cleome viscosa* and *Aeschynomene indica.* The most common grass species found in these drainage line areas are *Cymbopogon ambiguus, Chrysopogon fallax, Eragrostis tenellula, Eriachne benthamii, Eulalia aurea,* and the introduced species *Cenchrus ciliaris.* The major drainage lines are wider and have a greater cover of River Gums (*Eucalyptus camaldulensis*) over Paperbarks (*Melaleuca glomerata* and *M. linophylla*) over small shrubs, herbs and grass species. The smaller drainage channels have scattered trees of *E. camaldulensis* and/or *E. victrix* (Coolibah) over a denser cover of the wattle species *Acacia citrinoviridis* with a mixture of small shrubs, herb and grass species in the understorey stratum.

Hamersley Plateau and Range to the intersection with the Nanutarra – Wittenoom Road (approximately 70 – 75 km of road length).

The Hamersley Range is mainly composed of the hard, fine-grained rocks; jaspilite, shale and dolomite, with the escarpment capped by the very hard Brockman Iron Formation (Beard, 1990). Where the outcrop is mainly of jaspilite and dolomite the country consists of ranges, steep hills and steeply dissected pediments, with narrow, winding valley plains. The soils are frequently stony and shallow, with some areas of ferruginous duricrust. Wider alluvial plains occur locally, where the principal soils are in part deep, earthy loams, with small areas of neutral red earths, in part deep cracking clays and earthy clays (Beard, 1975).

There are three main vegetation communities found in the Hamersley Plateau and Range. These are:

- the community associated with the rugged slope and summit areas of the escarpment;
- the vegetation community associated with the valley plains; and
- the riparian vegetation found in the major and minor drainage lines which cut through the area.

Each of these main vegetation communities can then be divided into more specific vegetation associations which are related to position in the landscape, underlying geology, soil type and water availability.

The vegetation of the ranges is characteristically the tree steppe association of *Eucalyptus leucophloia* and *Corymbia hamersleyana* over Spinifex (*Triodia wiseana*). Small trees of

Eucalyptus gamophylla and *Corymbia deserticola* are also present. The principal shrub species found on these areas are mostly of the *Acacia* genus; *A. inaequilatera, A. dictyophleba, A. monticola, A. tumida/colei, A. ancistrocarpa, A. pachyacra/tenuissima, A. adoxa, A. synchronicia* and *A. acradenia.* Other shrub species present are *Hakea lorea, Grevillea wickhamii* and two or three species of *Senna.* The most common groundcover species present here is Spinifex (*Triodia wiseana,* but other species may also be present) with another main grass species present (*Aristida inaequiglumis/latifolia*). Small shrubs of the Tiliaceae (*Triumfetta* and *Corchorus* species) and Malvaceae families (*Hibiscus/Abutilon* and *Sida* species) are common as are the pea species *Tephrosia rosea* and *Gompholobium polyzygum.*

Most of the valley plains carry the Mulga formation (*Acacia aneura*) as low woodland. Some of the widest and flattest of them develop open grassland (Beard, 1975). The Mulga is usually associated with another *Acacia* species, *Acacia pruinocarpa,* which attains tree stature to about four to five (4 - 5) metres. Some other small tree and shrub species found growing in these alluvial soils characterised by Mulga woodlands were; *Acacia xiphophylla* (in localised small patches only), *A. tetragonophylla, Psydrax latifolia, Eremophila fraseri, E. latrobei, E. longifolia, Grevillea stenobotrya, Senna* species and scattered individuals of *Acacia farnesiana, A. bivenosa, A. ancistrocarpa, Hakea lorea* and *Solanum lasiophyllum/phlomoides* over Spinifex and a variety of herb species.

An area of grassland dominating part of the valley plain around Hamersley Station, is listed by the Department of Conservation and Land Management (DCLM) as a Threatened Ecological Community (TEC) due to the fact that it is a rare vegetation association. This community is dominated by the species *Themeda* sp. Hamersley Station and is associated with cracking clay soils. Other species are *Eucalyptus xerothermica, E. victrix, Eremophila longifolia, Hakea lorea, Acacia farnesiana, A. synchronicia, A. pruinocarpa, Senna notabilis, Gossypium australe, Capparis spinosa, Codonocarpus cotinifolius,* and a number of small shrubs and perennial and annual species. A number of other grass species were also recorded from these cracking clay soils in the 'Themeda grassland'. These were *Aristida inaequiglumis/latifolia, ?Astrebla pectinata, Cymbopogon ambiguus, Eragrostis setifolia* and *Chrysopogon fallax.*

The major and minor drainage lines are vegetated with principally the same species, but in varying proportions depending on the width and depth of the channels and the area they incise. The main tree species recorded in areas with seasonally flowing water are; *Corymbia hamersleyana, Eucalyptus camaldulensis, E. victrix,* over the shrub species *Gossypium robinsonii, G. australe, Acacia farnesiana,* and the grass species *Cymbopogon ambiguus* and *Cenchrus ciliaris,* the herb species *Operculina aequisepala, Senecio magnificus* and *Stemodia grossa,* and the creeper *Vigna lanceolata.*

Beard (1975) also lists another type of vegetation association specific to basalt hills areas. This occurs mainly around Mount Tom Price, and is referred to as 'mulga and spinifex'. This was seen only at the Tom Price end of the road where it intersects with the Nanutarra – Wittenoom road, and there were also a number of examples of this vegetation association on the Nanutarra – Wittenoom road heading to Tom Price. It is not strictly a plant community type, but rather a mosaic of *Acacia aneura* low woodland and *A. inaequilatera – Triodia* shrub steppe, with intermediate mixtures. At the one extreme, on the more alluvial soils, is pure mulga with *Acacia aneura, A. pruinocarpa,* patches of *A. xiphophylla, Senna* species, *Eremophila* species and a ground layer of ephemerals. The first transitional stage is for *Triodia pungens* to add itself to the ground layer. Going upslope as the ground becomes more stony this changes to *Triodia basedowii,* the mulga thins out and *Acacia inaequilatera* comes in with its associates *Grevillea wickhamii / G. striata/ G. pyramidalis* and *Hakea lorea.* In some of the steepest and stoniest places, *Eucalyptus leucophloia* over *Triodia wiseana* replaces the *A. inaequilatera* shrub steppe over Spinifex.

3.2.3 Regional Significance of the Vegetation Communities

Apart from the Threatened Ecological Community (see Section 4.2.6 below) it is apparent that the vegetation communities found along the road alignment corridors are well represented in the local and broader regions. Beards (1975) vegetation map indicates that there are 18 broad vegetation types along the road alignment. The total amount of each vegetation type that the road corridor traverses and the percentage of each type that is protected in conservation reserves is summarised in Table 4 below. This information has been derived from details on vegetation communities and their representation in conservation reserves given in Hopkins *et al.* (1996).

Table 4 Regional Significance and Protection of Vegetation Communities

Vegetation Type	Area (ha)	% in Conservation Reserve
Abydos Plain		
Hummock grasslands, shrub steppe; *Acacia inaequilatera* (Kanji) over Spinifex (*Triodia pungens*)	3 920 687	0.3 to 0.4
Hummock grasslands, grass steppe of *T. pungens*	871 476	12.1 – 12.2
Hummock grasslands, grass steppe of *T. wiseana*	495 694	17.4
Hummock grasslands, grass steppe of *T. pungens* and *T. wiseana*	436 174	1.1
Perennial tussock grass species and Spinifex	45 763	0
Chichester Range		
A. inaequilatera (Kanji) over *T. pungens* and *T. wiseana*	1 718 087	11.2
Snappy Gum (*E. leucophloia*) over Spinifex (*T. wiseana*)	2 633 332	9.2
Snakewood over *T. pungens*	39 943	0
Snakewood over *T. basedowii*	47 623	1.4
Snakewood over *T. pungens* and *T. wiseana*	593 926	0
Major River Systems		
Coolibah woodland	35 834	0
River Gum woodland	102 286	0.2
River Gum – Coolibah woodland	35 845	3
Low woodland of *Melaleuca* paperbarks	90 696	27.3 – 28.2
Hamersley Ranges		
Mulga low woodland	24 252 102	2.7
Mulga associated with Snakewood	684 727	0
Open low woodland of Mulga	311 829	0
Mulga occurring as sparsely scattered groups.	6 952 783	0.3

From this table it can be seen that, although not all vegetation communities are represented in conservation reserves, all are relatively well represented in other areas.

3.2.4 Threatened Ecological Communities

The preferred road alignment traverses a known Threatened Ecological Community (TEC) south of the Hamersley Range (see Figure A, south) on the Hamersley Station flats (TEC no. 50, DCLM, 2002).

This vegetation type occupies an area of grassland plains, which are dominated by the perennial grass species *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) pn. There are also various other species of trees, shrubs, herbs and grasses found growing on the clay soils of this vegetation community. The vegetation community is listed as a vulnerable (Category A) TEC by the Department of Conservation and Land Management (DCLM) but is not listed for the purposes of the Commonwealth *Environmental Protection and Biodiversity Conservation Act* (2000).

A "Vulnerable, Category A" community is defined as:

'An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

A*) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated."* (DCLM).

DCLM records indicate that this community covers approximately 34,600 hectares.

Currently, the community is bisected by the existing Pilbara Rail Company railway line and access road, as well as a power line and its access track. A number of station tracks and bores are also present within the grassland and the area is grazed by cattle and has been recently partly burnt.

3.2.5 Flora

A total of 287 species were recorded within the proposed road corridors during the field investigations. These were dominated by a small number of families with the majority being in the Mimosaceae (wattles), Poaceae (grasses), Papilionaceae (peas), Malvaceae (*Abutilon, Sida* and *Hibiscus* genera) and Amaranthaceae (mulla mullas). The field investigation was constrained by the seasonal conditions. In the northern half of the study area, there had been very little rain for some 12-15 months and the ground was extremely dry. Many of the ephemeral plants and grasses were either not present or only present as dried remnants with no fruiting material or other identifying features. Although some representative ephemeral species were found in drainage lines and damper areas in the southern part of the study area their presence was not recorded in other areas where they would likely normally occur.

The flora list by families is as follows:

Table 5 Flora Species by Family

FAMILY	Number of Genera	Number of Species	% of Total Species
Poaceae	14	36	12.5 %
Mimosaceae	3	28	9.8 %
Papilionaceae	16	28	9.8 %
Malvaceae	5	22	7.7 %
Amaranthaceae	5	19	6.6 %
Myrtaceae	3	11	3.8 %
Convolvulaceae	7	11	3.8 %
Asteraceae	8	10	3.5 %
Goodeniaceae	3	10	3.5 %
Myoporaceae	1	8	2.8 %
Chenopodiaceae	6	8	2.8 %
Euphorbiaceae	5	8	2.8 %
Caesalpiniaceae	2	8	2.8 %
Tiliaceae	2	7	2.4 %

Flora of Conservation Significance

The Department of Conservation and Land Management (DCLM) Declared Rare and Priority Flora database was searched for species of conservation significance in the areas between Karratha and Tom Price, so that all records potentially within any zone of future impacts from proposed construction works would be listed. From the list provided there were some twenty species which have been recorded from localities possibly within a one kilometre corridor on both sides of the existing Pilbara Rail Company access road, or that are found in habitats the same as, or similar to habitats within the one kilometre road corridor study area. Of these twenty species three are trees (including a palm), three are shrubs, 12 are herbaceous species or grasses, one is a climber and one is a sedge.

No Declared Rare Flora has been recorded for the area and only two of the species of conservation significance are Priority 1. The full list and description of these species is given in Volume 2.

Two of the listed Priority species were collected during the field investigations. These were the grass species *Ischaemum albovillosum* (Priority 2) and *Themeda* sp. Hamersley Station (Priority 3). The former was found near to the North West Coastal Highway in the area of Option B1 and the latter south of the Hamersley Range as a dominant in the Threatened Ecological Community (*Themeda* grassland).

Weeds

Only a small number of weed species were recorded during the field survey. Other, very detailed and long-term studies in the area (Trudgen, 1999) have also indicated low numbers of weed species. This maybe indicative of the remoteness of the location and also the harsh conditions, which do not favour introduced species.

Of the four weed species recorded the most prolific by far is *Cenchrus ciliaris* (buffel grass) which is widespread along the road/rail corridor. It is likely that this species was introduced to stabilise the railway embankments as it appears to be primarily in that area and closely adjacent for much of the route. It is also apparent in some of the small creeklines where looser, sandy soils are present.

Acacia farnesiana (mimosa bush) was recorded at a number of sites on the Fortescue plain and in the Hamersley Range. This species is believed to have been introduced to Australia prior to European settlement (Hussey *et al.*, 1997). It is a widespread weed of roadsides, creeks, rivers and disturbed flood plains and can displace native shrubs.

Aerva javanica (Kapok bush) is a common weed of disturbed areas in the Pilbara and Kimberley. It was found in small populations at a number of sites along the Pilbara Rail Company access road and railway.

Malvastrum americanum is a weed of river and creek margins and beds in many arid zone habitats. It was found prolifically in some roadside drains from the Fortescue River southwards, but may be more widespread as conditions were probably unsuitable for growth in the northern areas.

Declared Weeds

No listed Declared weeds (Agriculture WA, 2002) were observed during the field investigations. DCLM (S. van Leeuwen, pers. comm.) indicated that the Declared weed *Argemone mexicana* (Mexican poppy) was present in many creek beds. This weed is widespread in the Pilbara in sandy creek beds but never attains large numbers and does not cause a threat to water flows or other vegetation.

Serious Pest Plants

Consultation with DCLM (S. Van Leeuwen, pers. comm.) indicated that outbreaks of Ruby Dock had been recorded at two locations along the road corridor. One, near the junction of the Robe River and Hamersley Iron railways and within the National Park, was being eradicated as part of the commitments for the railway duplication in that area. A second patch was known to be in the Hamersley Range at Weelumurra Creek but was not observed during this survey.

3.2.6 Fauna

The Project Area has a rich vertebrate fauna, with the Fortescue plain landform supporting more species than other landform units, but the rocky hills of the Chichester and Hamersley Ranges having more species with restricted distributions. The Mulga woodlands of the Southern plains support a number of species that are at the northern or north-western limit of their range.

Survey Area Definition

A detailed fauna assessment was undertaken by M.J. & A.R. Bamford Consulting Ecologists and the report is found in Volume 2.

The aims of this review and survey were to:

- produce a list of vertebrate fauna of the Project Area;
- identify species of conservation significance that are or may be present;
- identify significant or sensitive habitats and locations on the site; and
- identify potential impacts and make management recommendations to minimise these impacts.

The study area for the field survey consisted of a long, narrow region that for the most part followed the existing railway and access road between Tom Price and Karratha/Dampier. From the north, this area crosses the Abydos Plain, Chichester Range (in the Chichester/Millstream National Park), and the broad plains of the Fortescue River valley, the Hamersley Range and plains of low relief south of the Hamersley Range. Major watercourses are crossed in the Chichester and Hamersley Ranges, while the Fortescue River is crossed in the Fortescue River valley. For the purposes of this study, these features were assigned to 5 landform units: Abydos Plain, rocky hills (Chichester and Hamersley Ranges), Fortescue plain, Southern plain (south of the Hamersley Range) and major watercourses.

The field survey was carried out from the 21st to 30th May 2002 and while the whole route was traversed, studies focussed on the Fortescue plain. The Fortescue plain includes the Fortescue River and its many tributaries. There is a higher use of the area by fauna due to the water sources and the consequent denser vegetation within the zone. This allowed details on the presence and abundance of fauna in this landform unit to be collected, while species lists for all landform units were produced based on the literature review and supplemented by opportunistic observations.

Results of Field Survey

A total of 105 animal species were recorded during the field survey. The numbers of each category that could be expected to occur, compared to those that were recorded, are shown in Table 6 below. Late autumn and otherwise dry conditions had a significant impact on the numbers of reptile and mammal species recorded. For reptiles, however, long-term studies have shown that it can take months of fieldwork to recover 75% of expected species.

Table 6 Fauna Groups – Expected Versus Observed

	No. of species potentially found in the survey area	No. of species recorded in May, 2002
Fish	7	2
Amphibians	9	3
Reptiles	96	25
Birds	137	64
Mammals	41	11
TOTAL	290	105

With the exception of fish (confined to watercourses) and frogs, the Fortescue plain has the highest species richness within each taxonomic group, although the rocky hills and to some extent the Southern plains support species with restricted distributions.

All the fish species require permanent water, with refuge pools in the upper tributaries of the main river systems being important for them, and they disperse widely when water levels are high.

All the frog species observed or expected depend upon wetlands for breeding, but none is of conservation significance.

The bird fauna is very rich across all landform units, with a number of species likely to be restricted to particular landforms. The major watercourses are important not only for waterbirds, but because many birds make use of eucalypt woodlands and other vegetation types that grow along the watercourses.

Species of Conservation Significance

The expected fauna of the area includes species of fish, reptiles, birds and mammals that are of conservation significance, with most of these present or expected to be present in the rocky hills and/or the Fortescue plain. Major watercourses and associated fringing vegetation are also important.

The following species of conservation significance were identified as being potentially present in the survey area:

Fish

- The Fortescue Grunter is of national conservation significance, being listed as Priority 4 by DCLM. It has a limited distribution, being confined to the Fortescue catchment.

Reptiles

- The Pilbara Olive Python *Morelia olivacea barroni* is listed as Vulnerable under the WA Wildlife Conservation Act and the EPBC Act and a single specimen was found in the Chichester Range (Table 6) at 507 365 E, 7 646 576 N. This was close to a watercourse in habitat typical for the species, and the Pilbara Olive Python is likely to be present wherever there are watercourses in the Chichester and Hamersley Ranges, and on the Fortescue plain. There are records of the Pilbara Olive Python in the WA Museum and DCLM threatened fauna lists.
- The skink *Notoscincus butleri* (Priority 4 according to DCLM) is known only from near Karratha on the Abydos Plain and appears on both the WA Museum and DCLM lists.
- The skink *Lerista quadrivincula* (Priority 1 according to DCLM) is known from a single specimen collected on the Abydos Plain near Karratha. It is listed by both the WA Museum and DCLM.

Birds

- Peregrine Falcon (Other Specially Protected Fauna under the WA Wildlife Conservation Act but Least Concern according to Garnett and Crowley 2000). If present in the Project Area, the Peregrine Falcon is likely to forage widely but nesting sites, most likely on cliffs, would be significant. Suitable nest sites may be present particularly where the Project Area passes through the Chichester Range. There is a record of this species in the area on the DCLM threatened fauna list.
- Australian Bustard (Near-Threatened according to Garnett and Crowley 2000). Most likely to occur on the Abydos Plain and Fortescue plain. There are records of this species in the area on the WA Museum and DCLM threatened fauna list.
- Flock Bronzewing (Near-Threatened according to Garnett and Crowley 2000). Historically known from the Pilbara, especially around waterholes on sandplains, but the species has declined and is now recorded only as a vagrant in the region (Johnstone and Storr 1998). If ever still present in the Project Area, it could occur anywhere except in the rocky hills. The record of this species in the WA Museum list for the area is probably based on old observations.

Mammals

- Long-tailed Dunnart (Priority 4 according to DCLM). This species has an apparently disjunct distribution from the Pilbara and across parts of inland Western Australia and the rocky hills of the Project Area appear suitable for it. Although not recorded, it is important to realise that trapping, even for extensive periods, cannot guarantee the capture of a species, especially in arid environments where levels of abundance can vary annually. There are records of this species in the area on the WA Museum and DCLM fauna list.
- Spectacled Hare-Wallaby (Priority 3 according to DCLM). According to DCLM's threatened fauna database, there was a record of this species on the Fortescue plain in 1979, but none subsequently. Therefore, the species may still be present within or close to the Project Area. Very extensive fires that remove the mosaic of burnt and unburnt spinifex have been implicated in the decline of a number of mammal species such as hare-wallabies (Burbidge and McKenzie 1989).
- Ghost Bat (Priority 4 according to DCLM). Known from the general area of the Chichester and Hamersley Ranges and probably forages widely over adjacent landforms. There are records of this species in the area in the WA Museum and DCLM lists, as recently as 1998.
- Orange Leaf-nose Bat (Vulnerable under the WA Wildlife Conservation Act). Known from the general area of the Chichester and Hamersley Ranges, where it roosts in deep caves and mine-shafts. There are records of this species in the area in the WA Museum and DCLM lists.
- Pebble-mound Mouse (Priority 4 according to DCLM). The distinctive mounds of this species were searched for in the gravelly foothills of the Chichester and Hamersley Ranges, which are the most likely habitat for the species. No active mounds were found, but an old mound was located on the southern foothills of the Chichester Range, overlooking the Fortescue plain, at 512 519 E, 7 637 180 N. There are records of this species in the area in the WA Museum and DCLM lists, including from the Millstream-Chichester National Park.

Invertebrates

- While the fauna survey and general fauna assessment do not address invertebrates, two species appear on the DCLM list of threatened species. These are the odonates (dragonflies and damselflies) *Antipodogomphus hodgkini* and *Nososticta pilbara*. Both are probably restricted to the larger pools in the area, such as around Millstream, and the extent of their usage of small and seasonal pools such as those within the Project Area is unknown.

Of the species discussed above, only the Olive Python was observed during the field investigations.

4. Social Environment

4.1 Natural Heritage

4.1.1 Millstream-Chichester National Park

The Millstream-Chichester National Park is a major area of natural heritage through which the proposed road will traverse. However, there are currently no formalised areas of visitor access or use either along the Pilbara Rail Company railway access road or the section of the Roebourne Wittenoom Road which runs within the Park boundaries. The Millstream access road, off the Pilbara Rail Company railway access road, forms the southern boundary of the Park and intersects the proposed road corridor but Millstream itself is some 13km from the proposed road. The only other area of the Park which has visitor facilities is at Python Pool, some 20km from the proposed road.

A Management Plan is currently being prepared for the Park. This Plan takes the proposed new road into account in terms of the potential indirect effects of greater visitor numbers but does not specify any particular management measures for the road (Claire Anthony DCLM, pers. comm.).

DCLM Information

The following statement is taken from the DCLM web site on National Parks.

"Most of the 200,000 hectare Millstream-Chichester National Park is a landscape of rolling hills, spectacular escarpments and winding tree-lined watercourses.

The Chichester Range rises sharply from the coastal plain and includes rocky peaks, tranquil gorges, and hidden rock pools such as Python Pool. Scattered white-barked gums and spiky spinifex clumps cover the stony plateau, which gradually slopes down to the bed of the Fortescue River.

In the midst of this landscape is the remarkable oasis of Millstream, where fresh water springs from an aquifer to create the lushly tropical Chinderwarriner Pool. Paperbark and palm trees surround this deep pool on the Fortescue River.

The park's shady camping areas near deep pools at Crossing Pool and Deep Reach attract tourists and locals all year round, but winter is the best time to visit. The cool season between May and August, experiences little rain, with day time temperatures around 26° Celsius.

The area has an interesting cultural history. It has long been a focal point for the Yinjibarndi people and was an active pastoral station for more than 100 years. Previously two separate parks, the area was expanded into one park in 1982, and it has significant natural, recreational and cultural values.

The broad area of land straddling the Fortescue River, from the Hamersley Range through to the Chichester escarpment is the homeland of the Yinjibarndi people. Ngarrari (Millstream) was an important camp site for inter-tribal meetings. Visitors camped beside Chinderwarriner Pool, where they feasted on fresh fish and edible plant roots, harvested wood for spears and collected rocks for ritual purposes. Today the Yinjibarndi people maintain close ties with their land and have been trained and employed as rangers and contract workers.

Millstream was named in 1861 by the explorer F T Gregory, who reported its favourable grazing prospects. The pastoral lease, first taken up in 1865 changed hands several times before Les Gordon assumed management of the property in 1923. In its heyday the station covered more than 400,000 hectares and ran 55,000 sheep. The homestead which now houses the visitor centre, was built in 1919 and was home to the Gordon family until 1964.

Plants and Animals

Plants flower after rain, when blankets of mulla-mulla and Sturt pea cover the landscape. The soft yellow flowers of the wattles and the orange cockroach bush provide a dramatic contrast to the hard red earth. Generally, the winter months, from June to August, is the best time to see the Pilbara wildflowers.

Plants more typical of the tropical north grow near permanent water pools. Of special interest is the Millstream palm, with its fanned, greyish-green leaves and smooth bark. Exotic date palms and cotton palms introduced by pioneers have now spread throughout the Millstream Delta.

The common kangaroo of the rocky country is the euro and on the plains you can see red kangaroos. Black flying foxes are easily seen at Millstream and a variety of birds can be seen during the cooler hours of the day, especially near water. Fourteen species of dragonfly and damselfly have been recorded in the Millstream wetlands."

Australian Heritage Commission Register

The Australian Heritage Commission register is relatively old for these areas, citing both the Chichester Range National Park and the Millstream National Park as separate parks. The following statements are taken from the Australian Heritage Commission database.

"Chichester Range National Park (1977 boundary), Millstream WA

Class: *Natural*
Legal Status: *Registered (21/03/1978)*
Database Number: *010127*
File Number: *5/08/204/0001*

Statement of Significance : *Panoramic scenery, including Python Pool and Pyramid Hill.*
(The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.)
The Commission has determined that this place has Indigenous values of National Estate significance. The Commission is currently consulting with relevant Indigenous communities about the amount of information to be placed on public record.

Description : *Situated in western part of Chichester Range. Tableland dissected by headwaters of Harding, George and Sherlock Rivers. Escarpment on northern edge gives way to coastal plain. Hills covered by spinifex grassland, while watercourses contain trees and shrubs. The euro is common.*

Condition and Integrity :

Location : *About 150,609ha, Roebourne - Wittenoom Road, 5km north-east of Millstream and 45km south of Roebourne, comprising Reserve A 30071."*

"Millstream National Park (1977 boundary), Millstream WA

Class: *Natural*
Legal Status: *Registered (21/03/1978)*
Database Number: *010128*
File Number: *5/08/204/0002*

Statement of Significance : *Biologically and scenically unique. Wide range of flora and fauna. Water from aquifer in reserve used in coastal towns. Preservation of fine stands of cadjeput. Oasis with an arid area of dry spinifex.*
(The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.)

Description : *Of an oasis nature, the place has a large calcrete aquifer on part of the Fortescue Plain extending across the Fortescue River upstream from Gregory Gorge. Overflow from the aquifer supplies a fast running stream and four permanent pools, (which overflow one into another). Rich in fauna having a colony of flying foxes, a variety of birds (108 species), nine species of fish and twenty-nine of dragon and damsel-flies. The Millstream palm is a particularly outstanding plant.*

Condition and Integrity : *Endangered by possible dam construction.*

Location : *About 435ha, Yarraloola Road, 2km north-east of Millstream and 80km south of Roebourne on Fortescue River above Gregory Gorge, comprising Reserve A 24392."*

Proposed Additions to the National Park

A new section of National Park is proposed (DCLM, P Moore, pers. comm.). This area is known as the 'Fish Pool' section and extends the park to the east of the Pilbara Rail Company railway line from the Millstream access road and then north of the Roebourne-Wittenoom Road where it leaves the railway line and heads east (see Figure A). The proposed new park section will be on the opposite side of the railway line from the proposed preferred road alignment.

4.1.2 Geo-heritage

There is clearly a strong link in this region between the geology, the visual quality and the biota. These combined with isolation add up to a strong wilderness experience. The geology of this region is not under threat by man except at specific mining locations. However, it is worth reiterating the key geological values of this region.

The Archaean rocks surrounding Karratha are so old that Lyall's Law (the present is the key to the past) is not tenable. Many of the geological environments have no direct corollary today and therefore the nature of the processes that formed these rocks is subject to considerable extrapolation. These rocks speak of the formation of the continental masses as the earths crust was forming.

The Mount Bruce super group rocks are considerably younger than the Archaean Rocks, but are nevertheless very old in geological terms. Remarkably these almost appear like a smear overlain on the older continental block. These rocks were formed at a time when the atmosphere was being changed from a reducing atmosphere to an oxidising one by the photosynthetic action of algae in the oceans. As this change occurred, iron, dissolved in the oceans, precipitated out and formed the banded iron formations.

Overlying these geologically ancient rocks are the alluvial and colluvial recent deposits. These are important because they carry the water that makes the Millstream pools and water resource area.

Overall, the geo-heritage of this region is significant. However, the majority of this is unlikely to be affected by human activity except on a massive scale.

4.2 Aboriginal Heritage

The broad scale nature of the environmental studies does not fit well with detailed aboriginal studies. The requirement of a 1 km wide corridor was requested by DCLM in order to allow for assessment of alternatives that might be required to avoid areas of environmental significance. However, such a broad area with multiple possible alignments along such a length of proposed road cannot be covered by the detailed archaeological and ethnographic assessments required under the *Aboriginal Heritage Act (1972).*

Therefore it was determined that a constraints assessment of known information would be required, whilst accepting that a more detailed survey would be carried out once an environmentally preferred alignment had been identified.

Preliminary assessments of known archaeological and ethnographic sites within the corridor have been undertaken, with some field assessment for verification of sites, consultation with Aboriginal claimants and identification of other potential areas of interest.

4.2.1 Archaeological Investigation

A constraints assessment was undertaken by Quartermaine Consultants. The work has been undertaken in two phases, firstly as a desktop assessment, and secondly with a broad field investigation, targeting areas of likely significance along the road alignment corridors.

The results of the desktop assessment and preliminary results of the field investigation are summarised below.

Previously Recorded Sites of Significance

In their search of the aboriginal register, Quartermaine found 48 previously recorded sites within 5 kilometres of the study area, with 16 within 1 kilometre and 10 on the opposite side of the railway line. The general location of sites within or close to the 1 kilometre road corridor is shown in Figures in Volume 2. Quartermaine Consultants identified that the majority of these are likely to be of low significance due to being of small size, having a low number of artefacts, lack of lithic variety, lack of stratigraphic potential and disturbance from water. Based on the available information in the register, four sites were considered to be of some significance, due to their size and their location along watercourses. These are indicated separately.

Results of Field Investigation

Following a field investigation and therefore further clarification of the areas potentially impacted, a further 2 previously recorded, and 19 newly discovered sites have been added to the known archaeological sites.

4.2.2 Ethnographic Investigation

Rory O'Connor has carried out the Ethnographic investigation of the project area. The investigation has included an assessment of the existing literature and his own knowledge of the area from previous studies, discussion of the Native Title claims which cover the area, and, a period of consultation with claimants in the field.

Native Title Claims

The desktop investigation indicates that there are four Native Title claims which cover the project area. Two of these are essentially a subset of an earlier claim but all have been registered and are awaiting the outcomes of the Native Title Tribunal process. As there has been some conflict between groups and changes in boundaries and claimant sub-groups, the outcome of the Federal Court decisions on traditional ownership are likely to be challenged and therefore ownership will not be resolved for some time.

Ethnographic Sites

Due to the reliance on water sources in the arid Pilbara, the majority of aboriginal usage sites were along watercourses, and particularly on permanent or semi-permanent pools. In non-riverine environments, permanent or semi-permanent rock-holes or other water catchment places were important and often known only to members of family groups.

Thirty sites of ethnographic significance have been recorded within or close to the proposed road corridor. Of these, seven are on the opposite side of the Pilbara Rail Company railway from the proposed road and one is likely to be considerably to the east of the road alignment. There are some twelve sites which have been recorded by O'Connor but are not yet on the Department of Indigenous Affairs sites register. They have been identified as being significant to local people in previous reports within the area.

The areas of the proposed corridors which are most at risk of intersecting ethnographic sites are :

- Within the vicinity of the Harding River;
- Between the Millstream turnoff and Camp Curlewis;
- In the Weelumurra Creek area of the Hamersley Range; and
- In the vicinity of the Hamersley Station homestead.

There are no sites recorded for any of the Options between North West Coastal Highway and the northern boundary of the Millstream-Chichester National Park.

Consultation

Detailed consultation with all Native Title claimants and other relevant aboriginal stakeholders is being undertaken.

4.3 Post Settlement Heritage Assessment

The register of the National Estate and the Western Australian Heritage Council databases were investigated for registered or nominated heritage sites. These databases identify a number of heritage homesteads, geological sites, indigenous sites and natural heritage sites in the general vicinity. However none fall within the 1 km search area of this project or will be indirectly affected.

A bore and tank site named 'Bottom Bore' was mentioned by the Karratha Tourist Board as being an identified historic location. This site is not mentioned on any official registers. The bore is located approximately 16 km south of the North West Coastal Highway and immediately to the west of the Pilbara Rail Company railway access road.

4.4 Adjoining Landuse and Tenure

The proposed road corridor(s) run primarily through, or adjacent to, pastoral leaseholdings except when within the National Park. Where adjoining the Pilbara Rail Company railway, the corridor is essentially outside the 80m railway lease and within the adjoining pastoral lease or National Park. Where the corridor runs along the existing Roebourne-Wittenoom Road the land is managed by the Shire of Ashburton.

4.4.1 Water Reserves

The road corridor crosses two designated Water Reserves both of which include Priority 1 Water Source Protection areas (see Figure A). These areas are the Harding Dam and the Millstream Water Reserve, which are under the jurisdiction of the Water and Rivers Commission and Water Corporation in order to protect drinking water sources.

The Priority 1 water catchment area for the Harding Dam covers the proposed road corridor from near the northern boundary of the Millstream-Chichester National Park to near the junction with the Roebourne-Wittenoom Road at Camp Curlewis.

Within the Millstream Water Reserve, the proposed road intersects the catchment from a few kilometres south of Camp Curlewis right through to the end of the project. Within this catchment area the Priority 1 zone covers the area from near Camp Curlewis south to a point approximately 10 km south of where the Roebourne-Wittenoom Road leaves the Pilbara Rail Company railway line. Beyond this area to the end of the project the land is designated as a Priority 2 Water Source Protection Area.

4.4.2 Pastoral Leaseholdings

Four pastoral leaseholdings are potentially impacted by the proposed road. These are Karratha, Mt Welcome, Coolawanya and Hamersley Stations. The only station homestead or other buildings within or close to the corridor is Hamersley Station homestead, which is within 1km west of the Pilbara Rail Company railway. This homestead is already subject to impacts from traffic along the Pilbara Rail Company access road but may have increased impacts due to increased road use.

The road corridor adjoins the Pilbara Rail Company railway along the majority of the proposed route and therefore severance issues with regard to station paddocks and access tracks will not be increased by the new road. However, Option C (see Figure A) takes an entirely new path through Karratha and Mt Welcome stations which would sever paddocks and potentially limit stock access to water points.

4.4.3 Other Adjoining Landuses

Other landuses within, or being accessed off, the road alignment corridor include three mines, two permanent construction camps and a range of infrastructure.

These are:

- Radio Hill mine – approximately 24km south of the North West Coastal Highway.
- Muni Muni mine in the Yannery Hills.
- Camp Curlewis – currently unused construction camp that is in the process of being decommissioned and rehabilitated.
- Camp Anderson – currently unused construction camp that is in the process of being decommissioned and rehabilitated.
- New constructions camp and airstrip.
- Four microwave towers and masts.
- Water pipelines and power lines.
- Various landing strips in use or abandoned.

At the time of survey a large temporary construction camp was in use near the Millstream turnoff but outside the National Park on the eastern side of the railway line. Facilities for the camp include a new airstrip, which runs adjacent to the Roebourne-Wittenoom Road.

5. Consultation

5.1 Stakeholder Consultation

5.1.1 Planning Study

A range of key stakeholders were contacted and provided responses as part of the planning study (GB Hill, 1998). These included;

State Government Departments and Authorities	**Aboriginal Interests**
The Water Corporation	ATSIC
The Department of Minerals and Energy	Karijini Aboriginal Corporation
The Ministry for Planning	Youngaleena Aboriginal Community
The Department of Transport	Wakathuni Aboriginal Community
Department of Resource Development	Gurrama
Pilbara Development Commission	Ngaluma-Injubandi Native Title Claimant Group
Western Australian Road Transport Association	**Heritage and Environmental Groups**
National Parks and Nature Conservation Authority	The National Trust of Australia
Department of Conservation and Land Management	LEAF of Hedland
Waters and Rivers Commission	Conservation Council of WA
Department of Environmental Protection	Pilbara Environmental Group
Aboriginal Affairs Department	Nickol Bay Naturalist Club
Heritage Council of WA	
Local Government Authorities	**Pastoral Leaseholders**
Shire of Roebourne	Mt Welcome Station
Shire of Ashburton	Hamersley Station
	Coolawanyah Station
Mining and Commercial Operations	**Others**
Hamersley Iron Operations	Combined Tourist Association
Pilbara Rail Company Pty Ltd	Mount Florence Association
Robe River Mining Company and North Ltd	Norman Moore (member for the Mining and Pastoral Region)
Titan Resources	
Tom Price Business Association	

In addition the following stakeholders were contacted but provided no response.

Agriculture Western Australia, Museum of Western Australia, Hooley Station, Karratha Station, Pyramid Station, Warambie Station, Yalleen Station, Kaipa (Torres Strait Islanders and Aboriginal Corporation), Ngurawaana Aboriginal Community, Dampier Archipelago Preservation Association, Karratha Chamber of Commerce, West Pilbara Land Council, Dampier Community Association.

G B Hill (1998) received a range of responses from stakeholders and these were categorised in levels of importance as follows:

- High importance relates to issues that were raised by multiple stakeholders or were considered as non-negotiable.
- Medium importance issues were significant issues that affected all route options and would therefore need to be managed rather than avoided.
- Low importance issues were issues that were peripheral to the study and/or were common to all alignments.

With this framework in mind the following issues were identified and categorised;

High Importance

1) The preferred start/end should be Karratha.
2) The road network should not be expanded more than necessary.
3) The new road should make use of existing roads and maximise multiple use corridors, especially through National Parks and water supply catchment areas.
4) Environmental concerns regarding the Harding River Catchment Area and the potential for spillages and unauthorised entry. WRC strongly opposed the route options in close proximity to Harding Dam and running parallel to major tributaries draining to the dam.
5) The new road should provide a sealed access to Harding Dam.
6) Concern that the new route might bypass Tom Price and that every possible action should be taken to assist the continued development and prosperity of the town.
7) Concern that additional crossings of the Fortescue River would create unmanageable drainage effects on the river.
8) Better access to various properties along the route.

Medium Importance

1) The link should not be a major heavy haulage route. (The link is already recognised as a major transport link for local heavy haulage).
2) The road should link as many communities, population centres, tourist attractions, major infrastructure assets and mines as possible.
3) Consideration should be given to the proposed rail alignment for the West Angelas Iron Ore Project.
4) Heritage Sites should be avoided wherever possible.
5) Management of additional impacts on natural resources needs to be considered.

Low Importance

1) Disruption to services.
2) Funding to be examined at the earliest stage and community advised of possible timing.

A more detailed record of the stakeholder responses is given in Volume 2.

5.1.2 Ongoing Consultation

The road alignment development process has been progressed by a Steering Committee since 1996. The Steering Committee involves the major stakeholders for the project and is made up of:

- Main Roads WA;
- Department of Mineral and Petroleum Resources;
- Pilbara Development Commission;

- Department of Planning and Infrastructure;
- Water and Rivers Commission (since 2002);
- Shires of Roebourne and Ashburton,
- Department of Conservation and Land Management (DCLM);
- WA Tourism Commission, and
- Robe River Pty Ltd and Hamersley Iron Pty Ltd (now Pilbara Rail Company).

The Steering Committee has remained fully informed about the road alignment options and progress of investigations and preliminary road design

5.1.3 Consultation of Stakeholders by Specialists

Specialists working on this document have separately contacted some of the listed stakeholders relevant to their area of investigation. The consultation undertaken is outlined below.

Biological Assessment

This has involved direct, and ongoing, consultation with the Karratha office of DCLM. Discussion has assisted the direction of the field investigations with regard to areas of significance, potential for Priority species and particular weeds.

With regard to fauna, DCLM was initially consulted (P. Kendrick) in order to get an agreed methodology for the fauna assessment programme and also to agree areas of fauna survey focus.

Further discussion has occurred regarding the potential need for a post 'wet season' survey for flora and fauna. The outcome of this is that DCLM will require a further survey for flora for the northern section (approximately 100 km) of the route. This survey will be carried out following good rains in the area. No further survey for fauna was required (P. Morse, pers. comm.).

Visual Assessment and European Heritage

The visual assessment report has been based on initial discussions with DCLM, the Shire of Roebourne and the Tourism Association. This focussed particularly on tourism issues for the National Park and also considered aesthetic issues and opportunities.

Water Catchments and Water Management

Main Roads has undertaken consultation with Water and Rivers Commission (WRC) with regard to the suitability of the original concept alignment (Option A) which improved access to the Harding River dam. This option was subsequently rejected by the Steering Committee due to cost implications.

Further consultation has occurred with the WRC (now as part of DEP/WRC) to access water depth information for bores in the vicinity of the proposed road.

Aboriginal Heritage

The Department of Indigenous Affairs (previously Aboriginal Affairs Department) was contacted to obtain the most up to date lists of archaeological and ethnographic sites for the project area. Consultation with relevant Native Title groups is ongoing and includes personal discussions with the spokespeople for the groups and visits to the project area to discuss issues of concern.

5.2 Public Information and Consultation

MRWA, has been providing information to the public in the Pilbara for the Karratha to Tom Price Road project. As part of this public consultation process, MRWA has produced two 'Project Update' brochures which include information on Stage 2 of the overall project (North West Coastal Highway to Curlewis). The 'Project Update' brochures are provided in Volume 2.

Public information displays were also held in Dampier and Karratha in September 2002 for Stage 2 of the overall development. The display times were advertised in the local newspaper and on a pamphlet that was distributed to all mailing addresses in Dampier, Karratha, Roebourne, Wickham and Tom Price.

The information display consisted of maps of the various options and staff actively polled people for their preference for the road alignment options into Karratha. Of people who inspected the display some declined to comment. Others expressed the opinion that they didn't mind what option was constructed or 'didn't care as long as the road is built'. The results of the polling are shown in Table 7.

Table 7 Results from Public Information Display and Polling

Location	Date	Time	Option			Don't Care	No Comment	Total
			A	B1, B2	C			
Dampier	Thursday Sept 5	4pm – 8pm	0	8	1	11	9	29
Karratha City	Friday Sept 6	10am – 3pm	0	10	3	7	21	41
Karratha City	Saturday Sept 7	10am – 3pm	4	10	1	5	43	63
		Total	**4**	**28**	**5**	**23**	**73**	**133**
			7%	**46%**	**8%**	**38%**		

A total of 60 people expressed an opinion over the three days. Of these, 28 people (46%) preferred options B1 or B2. However, 38% didn't mind which route was constructed as long as the road was built.

Since this public consultation, there have been minor changes to the locations and numbering of Options and Alternatives considered. These are very unlikely to have changed the outcome of the public polling as the fundamental routes have not changed.

5.3 Outcome of Consultation

As a result of all consultation carried out, Option B2 was developed as the preferred route for the northern portion of the road (subject to environmental assessment). This minimises the risks to water catchment areas, uses an existing transport route and has reduced cost implications. Within the National Park, alternatives were further developed (see Sections 2.4 and 6.2.19) based on the requirement for a constrained, 1km corridor, and for minimising impacts on riverine environments.

With regard to the environmental investigations along the preferred route corridor and alternatives, a further survey of the northern part of the route will be carried out following good rains in the area.

6. Environmental Factors Relevant to the Proposal

6.1 Project Description

The new Karratha-Tom Price Road will provide a two lane bitumen road from the North West Coastal Highway near Karratha to the Nanutarra – Munjina Road near Tom Price. The road will be an all weather road but is likely to be un-trafficable following extreme rain event periods.

The preferred alignment for the road is approximately 250km long and will traverse the Chichester and Hamersley Ranges and the Fortescue flood plain. It generally follows the Dampier to Tom Price railway, now operated by the Pilbara Rail Company, but has some minor deviations away from the railway line due to road design constraints through the ranges and to avoid riverine and other environmentally significant sites. Approximately 55 km of the road will traverse the Millstream-Chichester National Park.

6.2 Potentially Significant Issues (EPA Assessment)

The following environmental factors have been highlighted by the EPA (Assessment No 1244) as needing consideration during the preparation of the CER document. These factors were prepared in 1999 and since then the focus for environmental documentation for proposed works has been to only consider in detail those factors which are of particular significance. This document will therefore still list all the factors raised for the project but will only provide detail for those where it is considered that there is a real and reasonably significant risk of detrimental impact on the factor.

6.2.1 Biodiversity

EPA Objective *– To maintain the biodiversity, meaning the different plants and animals and ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.*

Potential Impacts and Risks

Due to the extensive and relatively intact nature of many of the ecosystems in this area of the Pilbara it is not considered that loss of biodiversity is a significant issue. The EPA Position Statement No. 2, *Environmental Protection of Native Vegetation in Western Australia* (EPA, 2000) lists the elements that it will take into account when assessing impacts on biodiversity. In addressing these elements it can be stated that there will be no known loss of any plant or animal species as a consequence of the construction and use of the road and that no vegetation types would be reduced to below the 'threshold level' of 30% of their pre-clearing extent.

It is assumed that, because the plant communities are not considered to be under particular threat, and the road alignment will not impact a significant proportion of any one community, that the associated resident fauna will also not be significantly impacted (see also factors 8 and 9 below). Discussions with DCLM (S. van Leeuwen, pers. comm.) have indicated that, apart from the Threatened Ecological Community (see Section 6.2.5 below) there are no communities of particular significance along the route.

Although the road project is large, it is set in a region that has not been cleared for agriculture and therefore there is no requirement to retain particular, representative, vegetation types or links within the project area. However, the fencing of the new road reserve into a 100m corridor (outside of the National Park) will create an opportunity to prevent grazing in representative strips of all vegetation types encountered.

Management Strategies

- *Outside of the Millstream-Chichester National Park, the road reserve will be fenced to a width of 100m to prevent stock access to the road. This will protect a representative strip of vegetation.*

See also 6.2.2 and 6.2.4, 6.2.5 and 6.2.7 below.

6.2.2 Terrestrial Flora and Vegetation Communities

EPA Objective *– Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.*

Potential Impacts and Risks

The flora and vegetation communities of the proposed alignment corridor and options, as well as the potential materials pits, were examined and mapped. Most of the vegetation communities are widespread across the study area and beyond, and only a small proportion of each type encountered will be directly or indirectly impacted by the road works (see Section 2.4, Table 4.) Although, due to the length of the proposed road, some 875 ha will be directly affected (including borrow pits) no one vegetation type will be affected more significantly than any other. This is because of the 'ribbon' nature of the works and that the level of disturbance is relative to the size of the vegetation communities. That is, although creekline communities make up a proportionately smaller percentage of the vegetation types encountered, the road generally only intersects them for a very short distance.

The productivity of the vegetation communities is unlikely to be detrimentally impacted by the construction and operation of the road. Current productivity is determined by climate and inherently infertile soils (on the rocky uplands at least). It is also affected by seasonal conditions, drainage patterns, grazing (native and introduced animals) and fire regimes. The only potential changes to these as a result of the road could be due to drainage alterations and increased fires. Drainage changes can be managed through careful road design and no significant risks have been identified (see Section 3.6.2, Hydrology). Although there are some areas of mulga woodland in the southern part of the route alignment the road will mostly run parallel to the surface drainage which does not pose a threat to the communities. Further, detailed assessment of the risk to mulga communities will be carried out at the final design stage to ensure that drainage shadows are not created.

The possibility of fires is constantly present in the Pilbara due to lightning strike, campfire escapes and fires deliberately lit in order to 'refresh' grasslands. The Pilbara plant communities are mostly adapted to (and even dependent upon) regular fires and it is unlikely that the provision of a bitumen road will increase the possibility of fires such that they are a risk to vegetation. In fact, as travellers will move through the area more quickly due to the improved road they will be less likely to stop to light campfires. The potential increase in tourists may increase the risk of camp fire escape but this is a longer term management and education issue which can be minimised by fire bans or by providing appropriate stopping areas. The risk of campfire escape remains for the area, whether or not a new road is provided.

Management Strategies (see also 6.2.5)

- *Develop and implement A Vegetation Protection and Rehabilitation Management Plan;*
- *Undertake detailed design to minimise vegetation clearing through steepening batters where possible;*
- *Design river crossings to minimise the loss of riparian vegetation;*

- *If required, design and implement drainage techniques that have been proven to be effective in similar road projects in the Pilbara to protect Mulga communities; and*
- *Ensure that no vegetation is cleared unnecessarily or otherwise damaged during construction.*

6.2.3 System 8 (Millstream Chichester National Park)

***EPA Objective** – Ensure the conservation values of System 8 recommended areas are not compromised. Ensure the regionally significant flora and fauna communities in System 8 are adequately protected.*

Potential Impacts and Risks

The only System 8 area impacted by the proposed road is the Millstream-Chichester National Park. An additional area, adjoining the southern portion of Millstream Chichester National Park, is proposed to be added to the Park. This is known as the 'Fish Pool' area (see Figure A).

The road will traverse approximately 55 km of the current national park and will be adjacent to around 27 km of the proposed new 'Fish Pool' section to the south. The total loss of native vegetation within the existing section of the National Park due to the road construction could be a maximum of 220 ha, based on an average disturbance width of 40m. There is some potential for wider bands of disturbance due to cut and fill requirements through steep sections of the ranges but the final road design will aim to minimise this. Disturbance widths in relatively flat sections of the Park should not be more than 20m.

There were four alternative route options through the section of the National Park between Western Creek and the southern edge of the Chichester Range. These alternatives were chosen to provide opportunities for reducing impacts on the environment and because of the constraints through some sections due to the existing and proposed railways (see Section 2.3). Further discussion on these alternatives and their potential environmental impacts occurs at Section 6.2.19.

There are no significant flora or vegetation communities impacted by the road corridor within the Millstream-Chichester National Park (DCLM, S. van Leeuwen, pers. comm.). Although some communities are less well represented within the Park than others (e.g. riverine vegetation) none are considered to be regionally significant. The discussion on alternatives through the Park focuses on the requirement to minimise impacts to the riverine vegetation.

Potential Social Impacts

The new road will improve access to the National Park although there are currently no formal camping areas adjoining any part of the route. The only formal camping areas are at Millstream and Python Pool and there are no other access roads, lookouts or picnic areas along the current Pilbara Rail Company access road. The construction of a sealed road will increase visitor pressures on the National Park and may result in DCLM providing camping or picnic areas at particular locations. There are opportunities to more effectively use the park through the placement of lookouts or rest areas but these must be carefully planned and designed to avoid detrimental impacts.

Given the size and inaccessibility of most of the Park the opportunities for providing better access and viewing points along the existing railway/road corridor are likely to outweigh the risks of increased visitor numbers. The preferred alignment provides the best direct access to the riverine environments which are likely to be the most visited parts of this area. However, other alternative will still provide opportunities for accessing the rivers without the road having a direct impact on

them. The use of the river pools for passive recreation will depend upon whether DCLM decides that they should be more available and whether there are funds to provide well controlled access roads and other facilities.

Management Strategies

- *Main Roads will consult with DCLM to ensure appropriate interpretive signage and rest bays are available to promote understanding of Park values.*
- *Main Roads will consult with DCLM regarding long-term management of the road reserve through the National Park.*
- *Road design will focus on minimising the footprint of the road and blending the road contours with the surrounding landscape.*

6.2.4 Declared Rare and Priority Flora

EPA Objective *– Protect Declared rare and Priority Flora within the provisions of the Wildlife Protection Act 1950.*

Potential Impacts and Risks

There are a limited number of Declared Rare and Priority species recorded for the Pilbara Region. This is a function of the relative intactness of much of the vegetation but also partly due to the relative lack of study of the area and its flora.

No Declared Rare species have been recorded as occurring within the vicinity of the proposed road area and none were observed during the field investigation.

Twenty Priority species are recorded or potentially found in the general area and two of these were recorded during the current study. *Themeda sp.* Hamersley Station pn (P3) is a grass species which is a dominant in the grassland Threatened Ecological Community (TEC, see 6.2.5 below) and the second species recorded was *Ishaemum albovillosum* (P2) which was found on the Abydos Plain in the northern part of the route. There is some debate as to whether *Themeda* sp. Hamersley Station will be recognised as a separate species, and if not, it will revert to *Themeda australis*, which is a very widespread and common grass species. Neither of these species is considered to be threatened in the long term by the location of the proposed road.

No other species of particular significance were recorded during the field investigation and subsequent WA Herbarium analysis of specimens.

Management Strategies

- *Road design within the Threatened Ecological Community will focus on minimising the footprint of the works; and*
- *Road construction will be carried out such that there will be no damage to flora outside the immediate works area. This will be ensured through protective measures such as temporary fencing, education of staff and location of all stockpile and parking areas outside of the TEC zone.*

6.2.5 Threatened Ecological Communities

EPA Objective *– Protect any ecological communities listed as threatened on lists maintained by Environment Australia or the Department of Conservation and Land Management.*

Potential Impacts and Risks

The proposed preferred alignment traverses the *Themeda* grassland Threatened Ecological Community (TEC) no. 50 on Hamersley Station. This grassland is listed on DCLM's database as covering some 34,600 hectares. The area is currently crossed by the Pilbara Rail Company railway and associated road and powerline and is also heavily grazed by cattle. Parts of the area have recently been burnt.

Disturbance due to the proposed road would involve an area of a maximum of 17.5 ha, calculated using a 25m wide corridor over a distance of approximately 7 km. It is likely that the grassland would easily rehabilitate in disturbed areas alongside the road as grass species have numerous seeds which germinate well in soil which has been loosened. The provision of a fenced road reserve of at least 100m width will provide protection for a small portion of this community, complementing the strip which is protected from grazing within the fenced railway reserve. There are no plans by DCLM to protect other areas of the community from stock grazing (S. van Leeuwen, DCLM, pers. comm.).

This TEC is not listed under the *Commonwealth Environmental Protection and Biodiversity Act 1999*, and is therefore not a trigger for referring the proposal to Environment Australia.

Management Strategies

- *Road design within the Threatened Ecological Community will focus on minimising the footprint of the works; and*
- *Road construction will be carried out such that there will be no damage to vegetation outside the immediate wórks area. This will be ensured through protective measures such as temporary fencing, education of staff and location of all stockpile and parking areas outside of the TEC zone.*
- *Main Roads will provide a fenced road reserve within the area of the TEC, which, in conjunction with the fenced rail reserve will protect a 200m strip of this vegetation from stock grazing.*

6.2.6 Weeds

EPA Objective – *Protect the existing vegetation from invasion by weeds species (particularly Ruby Dock).*

Potential Impacts and Risks

Very few weed species were observed during the field investigations. Previous, longer term studies over all seasons have also indicated that weeds are not a significant part of the flora in this area. Buffel grass (*Cenchrus ciliaris*) is the most prolific weed species along the route but it is most evident along the railway embankments and existing road edges.

No Ruby Dock was found during the survey although it has been recorded previously at two locations near to the alignments.

Standard weed management techniques with particular focus on the areas where Ruby Dock has been previously located will be sufficient to reduce the risks of weed spread to an acceptable level. Such practices include minimising movement of soil along the road construction, ensuring vehicles and plant are clean on arrival at the works and ensuring that topsoil from any areas containing Ruby Dock is not disturbed or moved offsite.

Management Strategies

- *Main Roads will develop and implement weed management protocols as part of the Vegetation Protection and Rehabilitation Management Plan for the project. Weed management will incorporate actions such as : ensuring vehicles and equipment are free of soil and vegetative material when they start on the project, minimising the movement of soil and vegetation along the road alignment and, marking off and preventing any access to any known areas infested with Ruby Dock.*

6.2.7 Regionally Significant and Specially Protected (Threatened) Fauna

EPA Objectives *– Maintain the abundance, species diversity, geographic distribution and productivity of terrestrial and aquatic fauna. Protect Threatened fauna and Priority fauna species and their habitats consistent with the provisions of the Wildlife Conservation Act 1950.*

Potential Impacts and Risks

A fauna survey was carried out for the entire route, including intensive trapping in the area of the Fortescue river plains. The trapping programme and locations of traps were discussed and agreed with DCLM in Karratha prior to being undertaken.

A number of listed and threatened species may potentially occur in the road survey area. However, only one specimen of one threatened species, the Pilbara Olive Python (see Section 3.4.3), was recorded during the survey. This species is listed as Vulnerable under the Wildlife Conservation Act and the EPBC Act. The Rainbow bee-eater, a listed migratory species under the EPBC Act was recorded in the Chichester Ranges but is expected to be widespread.

The Pilbara Olive Python is widespread but scattered in the Pilbara. It is likely to be present wherever there are watercourses in the Chichester and Hamersley Ranges, and on the Fortescue plain.

The following potential impacts upon fauna, particularly with reference to species of conservation significance, were identified:

- Loss of habitat, likely to be most significant with habitats that are poorly represented in the region, such as those associated with watercourses;
- Alterations to flow along watercourses and through Mulga woodland;
- Alternations to quality of flow along watercourses (for fish and amphibian species);
- Increased numbers of road kills, particularly significant for species such as the Pilbara Olive Python;
- Changes in fire frequency, increases in abundance of introduced predators and increased levels of disturbance associated with increased human activity in the area.

Considered on a regional basis the loss of habitat at watercourses will be relatively small as the road design will avoid these areas where possible. Where crossings are required the impact will be minimised. The potential for road kills of some reptiles is increased with a bitumen road as reptiles can favour these areas because of the warmth absorbed and re-radiated by the black surface. There is little that can be done to mitigate against loss of reptiles on road surfaces. Education through interpretive information in the National Park, could help to make road-users aware of the potential for reptiles, and particularly the Olive Python, on the road.

Management Strategies

- *Consult with DCLM regarding educational signage to highlight the significance of the Pilbara Olive Python;*
- *Ensure that construction crews are aware of the significance of the Pilbara Olive Python and will avoid impacts on all fauna throughout the project.*

6.2.8 Rivers

EPA Objective *– Maintain the integrity and functions of the environmental values of the rivers. Ensure riparian vegetation on substantial streamlines is adequately protected.*

Potential Impacts and Risks

The road alignment will cross a number of major rivers including Western Creek and the Harding and Fortescue Rivers. In addition to these there are numerous tributaries and smaller river and creek systems within the landscape. Most of these have very limited, and sometimes non-existent, riparian vegetation due to the constraints of water availability. The river and creek systems appear to be in generally good condition with little obvious impact from erosion or sedimentation and only minor, localised, impacts from the embankments and culverts of the Pilbara Rail Company railway.

The risks to rivers crossed by the new road can potentially involve flow constriction or alteration, loss of riparian vegetation, sedimentation due to roadworks and the effects of backwaters and scouring due to poorly designed bridges or culverts.

All of these risks can be adequately dealt with through thorough flow investigations, modelling and subsequent bridge and culvert design and management. Some of the larger crossings will involve floodways which will not constrict flows and therefore reduce the risks of scour and backwaters.

One of the major objectives in developing and choosing alternative alignments within the Millstream Chichester National Park has been to minimise the amount of road that runs parallel to the major watercourses. This has the outcome of reducing both direct and indirect impacts on rivers and riparian vegetation and is considered to be an important consideration in the road design.

In order to ensure the appropriate design of bridges, floodways and culverts, all quantification and assumptions or measurements used in calculations will be discussed with Water and Rivers Commission officers during final design. All parameters will be documented in the Surface Drainage Management Plan and will therefore be auditable.

Management Strategies

- *A Surface Drainage Management Plan will be developed and implemented.*

The management plan will include the following elements:

- *Quantification of waterways final design requirements;*
- *Protection of river and creek bank;*
- *minimisation of backwater and scour potential;*
- *Monitoring of waterway integrity and erosion risks during and following construction;*
- *Remediation of any impacts found during monitoring.*

6.2.9 Flood Management

EPA Objective *– Maintain the integrity and function of the floodways.*

Potential Impacts and Risks

As mentioned above localised flood management can be adequately dealt with by thorough assessment of river flows and flood-prone areas, followed by hydraulic modelling and appropriate design.

The many river and creek crossings will be engineered to best suit the local hydrology. Hydrological modelling and crossing design will be undertaken to ensure the potential for backwater flooding and/or scour and siltation is minimised.

Nine bridges are likely to be required – with two major bridges at the Harding and Fortescue Rivers. Other crossings will be serviced by floodways or culverts.

The construction of a new road over the Fortescue plain is unlikely to exacerbate any broadscale flood risk. The road will run parallel to the Pilbara Rail Company railway which already presents an embankment which can collect water flows. On the Fortescue plain, however, the railway and road will run predominantly parallel to the main Fortescue channel and this will not prevent floodwaters from this river from taking their major course downstream.

Management Strategies

- *Hydraulic modelling will be undertaken in order to develop the final design of bridges and floodways;*
- *Bridges will be designed to accommodate a 100 year flood level; and*
- *Bridges and floodways will be designed so as not to add to the risks of flooding within the Fortescue valley.*

6.2.10 Soil

EPA Objective *– Ensure that clearing does not result in land degradation.*

Potential Impacts and Risks

An estimated 875 ha (3.5 ha per kilometre of new road) will need to be cleared for the proposed roadworks over the total length. This amount is estimated using an average clearing width of around 40m in hilly areas and an average of 25m in other areas and includes all requirements for basecourse and borrow pits as well as access tracks to the pits. The breakdown of clearing requirements is as follows :

- Road alignment and drains 700 ha
- Basecourse pits 38 ha
- Borrow pits 62 ha
- Access tracks to pits 75 ha

The total amount of clearing will depend upon the final, detailed, alignment of the road in some areas but could pose a risk to soil stability in steep areas. The areas most at risk will be in the Chichester and Hamersley Ranges due to the cut and fill required traverse the hills. Careful design and management of embankments will be required in order to minimise the risks of land degradation in localised areas adjoining the road.

Most land along the preferred alignment is in relatively good condition with regard to excessive grazing and consequent wind and water erosion of soils. The northern half of the project area has been subject to an extended dry period but grazing pressure appears to be low and soils appear relatively stable.

It is unlikely that the construction of the road through pastoral areas will result in soil degradation. Suitable design of drainage and minimisation of clearing, with appropriate rehabilitation, should be sufficient to ensure that soil condition is retained or improved. Out of the estimated 875 ha of clearing for the works approximately 375 will be rehabilitated through contouring, topsoil replacement and brushing with cleared vegetation. Of the remaining areas, some 175 ha will be sealed and the remainder will form road shoulders and batters which will be permanently maintained. The road reserve will be fenced following completion of works and this will prevent grazing by sheep and cattle and therefore improve rehabilitation success. Further details on rehabilitation and on the impacts of borrow areas are found in Sections 6.2.11 and 6.2.20 respectively.

Management Strategies

- *A Vegetation Protection and Rehabilitation Management Plan will be developed and implemented;*
- *The Plan will detail construction requirements to minimise the risk of soil degradation through minimising clearing, avoiding soil windrows which may lead to water erosion and wetting soil during construction to reduce the risk of wind erosion.*

6.2.11 Rehabilitation, Landforms and Visual Amenity

EPA Objective *– Establish stable, sustainable landforms consistent with the surroundings. Ensure the area adjacent to the project is not unduly affected by the proposal.*

Potential Impacts and Risks

As in 6.2.10 above, the stability of landforms is an issue within the parts of the Chichester and Hamersley Ranges where the road construction will require considerable areas of cut and fill to provide suitable driving grades. Careful design and construction of embankments and batter slopes and drainage will be required to ensure that landforms are sustainable and that they fit in with the surrounding landforms.

It is likely that considerable blasting will be required to construct the road through the hard rocks of the ranges. Aligning the road through hard rock areas has advantages in that it can minimise the amount of land required due to steep batters but also involves some risks of non-target damage due to blasting. Rock, both loose and embedded, is an integral part of the landscape over most of the ranges and can be used both to armour drainage lines and rehabilitate road batters.

There will be numerous borrow and basecourse pits adjacent to the road alignment. Due to the undulating topography in many areas some of these are likely to be visible from the new road, at least until they have been fully rehabilitated. Careful pit siting and management will be undertaken to minimise the potential for viewing the pits from the immediate road area but many are likely to still be visible.

As there are very few opportunities for viewing the road from areas off the road itself, there will be little potential visual impact to existing users of the area. At present there are no tourist lookouts or other easily accessible high points either within the National Park or through the Hamersley Ranges which would have views marred by the location of the proposed road.

Management Strategies

- *Design the road cuttings to blend with the surrounding landforms;*
- *Develop and implement a Vegetation Protection and Rehabilitation Management Plan which will detail the elements of, and actions for, roadside and pit rehabilitation. The rehabilitation section will be based on Main Roads 'Flora Care' Manual and will include:*
- *Correct storage and re-use of topsoil on road edges and borrow pits and access tracks;*
- *Stripping and re-use of vegetative material on road edges and borrow pits;*
- *Shaping and ripping of areas to be rehabilitated to ensure water retention and reduce erosion.*
- *Locate and design parking bays and rest areas to maximise opportunities for views to the ranges or other features;*

6.2.12 Air Quality

EPA Objective *– Ensure that gaseous emissions do not adversely affect the environment or health, welfare and amenity of nearby land users by meeting the statutory requirements of the Environmental Protection Act 1986 and acceptable standards.*

Potential Impacts and Risks

The existing air quality in the region is likely to be almost pristine due to the very low numbers of vehicles that would cause emissions. There would be particulate matter in the air due to dust at some times of the year but as no significant soil erosion was observed this is not likely to be significant. Following the construction of the new road dust will be considerably reduced in the vicinity of the road due to the change of surface from unsealed to sealed. This will improve the visual impact on, and health of, the adjacent roadside vegetation.

The potential increase of traffic on the route as a result of the new road will make a negligible difference to the air quality of the area and to nearby land users due to the very low numbers of vehicles and lack of sensitive receptors.

Management Strategies

No particular management strategies proposed.

6.2.13 Surface Water Quality – Contamination with pollutants in road runoff.

EPA Objective *– Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) and the NHMRC/ARMCANZ Australian Drinking Water Guidelines-National Water Quality Management Strategy.*

Potential Impacts and Risks

The proposed road has been recognised in the Harding Dam Water Source Protection Plan (Water and Rivers Commission, 1999) as being of a low likelihood of causing pollution to the dam. The identified risks from the road are:

- Acute contamination from traffic accidents causing spills;
- Cumulative impacts from stormwater runoff; and
- Increased access to the catchment and reservoir.

The road alignment crosses Western Creek and the Harding River which ultimately feed into the Harding Dam as well as small tributaries which feed the Fortescue River near to the Millstream pumping area. The Harding Dam is around 30km downstream of the proposed crossing of the Western Creek and some 35km from the Harding River crossing but the proposed road is within the Priority 1 catchment area for Harding Dam. The waterways which the road crosses are ephemeral watercourses with some permanent pools, however, and the risks of pollution to the dam from either road spills or other pollutants are considered to be minimal.

The proposed road would be approximately 12km at its closest point to the Millstream pumping station. It crosses two minor tributaries of Dawson's Creek, which flow into the Millstream area but again, these are small ephemeral creeks and the risks of pollution to the pools at Millstream are very small.

A quantitative risk assessment (see below) indicated that the risk of a spill of a hazardous load in sensitive sections of the proposed road would be very low. Calculations have been based on crash rates for the Pilbara in general and then using statistics for the percentages of hazardous loads and major crashes.

For the Harding River catchment there is a maximum length of 20 km of proposed road from which a large spillage could potentially reach the river system. For this distance the risk of a significant spill from a crash is once in every 144 years. These risk levels do not justify any specific spill control aspects in the road design.

For the Fortescue plains area, a section of around 90 km, the risk of a spill of a hazardous load is around one in every 32 years. This is over a long section and the chances of a spill reaching a sensitive water receptor are very small as there are few major drainage lines across the catchment and these would have to be flowing for hazardous materials to be transported to sensitive areas.

RISK ASSESSMENT FOR HAZARDOUS LOADS

The widest catchment that the road crosses is the Fortescue River Catchment which is approximately 90km across.

Main Roads report an unclassified crash rate of 0.8734 crashes per million kilometres travelled. In country situations approximately 25% of crashes lead to a requirement for medical attention, hospitalisation or led to a fatality (Office of Road Safety, 2000). It is reasonable to assume that these crashes would be sufficient to lead to vehicle damage sufficient to cause some loss of load.

A typical road mix indicates that approximately 10% of vehicles are heavy goods vehicles and one third of these would be placarded loads (MRWA, classified counts for North-West area, unpublished).

Main Roads indicate that 130 vehicles per day will travel the proposed road, giving a total of 130 x 90 = 11700 vehicle kilometres travelled per day or 4.2705 million kilometres travelled per year for the section of road on the Fortescue Plain.

This will lead to 4.2705 * 0.8732 = 3.73 crashes per year.

Ten percent of these crashes will involve a heavy goods vehicle giving a crash frequency of 0.373 crashes per year. Of these 25% will be sufficient to lead to a loss of load giving 0.093 crashes per year where some loss of load might occur.

However only one third of these vehicles will contain hazardous goods giving a final crash frequency for the potential loss of all or part of a hazardous load of 0.031 crashes per year or 1 crash every 32 years.
This frequency is sufficiently low and the manner in which it is derived is sufficiently tenuous that specific control measures should not be required. However, any spill would require immediate response and remediation of contaminated material.

For comparison the same figures give a hazardous goods spill crash frequency of 1 in 144 years for the 20 km stretch across the Harding river catchment

Management Strategies

- *Roadside drainage design will incorporate "best practice" initiatives, and be finalised in consultation with the Water and Rivers Commission.*

6.2.14 Groundwater Quality – Contamination with pollutants from road runoff.

EPA Objective - *Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) and the NHMRC/ARMCANZ Australian Drinking Water Guidelines-National Water Quality Management Strategy.*

Potential Impacts and Risks

The proposed road corridor crosses the Priority 1 and 2 Water Catchment areas for the Millstream Water Reserve. The Millstream Water Reserve Water Source Protection Plan (Water and Rivers Commission, 1999) identifies transport of diesel along the Pilbara Rail Company railway as being of low likelihood and low impact of contaminating the groundwater source. Given the volumes of fuel that are transported along the railway as compared that those that are likely to be transported on the road the risk of spillages and groundwater pollution from the road are even lower. There has been detailed consultation with the Water and Rivers Commission (WRC) regarding the potential risks to ground and surface water supplies. A letter from WRC in December 1997 indicated that they are satisfied that the proposed road would pose no significant threat to water resources. However, it was noted that some joint-agency contingency planning may be required in order to rapidly clean up any spills which might threaten the water resources.

Management Strategies

- *Post-construction consultation with Water and Rivers will be undertaken to consider the requirement for, and development of, a spill response strategy.*

6.2.15 Particulate/dust emissions during construction.

EPA Objective *– Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems in accordance with EPA Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites.*

Potential Impacts and Risks

The Hamersley Station homestead and associated buildings are the only permanent dust-sensitive premises near to the proposed road corridor. Standard dust suppression techniques will be used during the construction of the works to reduce dust in this area and also to reduce risk to road workers and road users.

Management Strategies

- *Dust management will be undertaken to reduce dust nuisance for road users and the Hamersley Station homestead. Dust management will require constant wetting down of construction materials, stockpiles and the unsealed road surfaces used during constuction. These issues will be addressed in a Construction Management Plan.*

6.2.16 Noise

***EPA Objective** – Ensure noise impacts emanating from the road construction activities comply with statutory requirements and acceptable (and appropriate) standards.*

Potential Impacts and Risks

As above, the Hamersley Station homestead and associated buildings are the only permanent noise-sensitive premises near to the proposed road corridor. Plant and equipment used on the works will comply with standard noise level requirements and negotiations regarding working out of standard hours will be undertaken when work is near the station homestead.

Due to the low traffic levels predicted for the southern part of the Karratha to Tom Price road (60 vehicles per day) traffic noise levels are not considered an issue.

Management Strategies

- *Possible noise nuisance to the Hamersley Station homestead and actions to prevent inappropriate timing and use of machinery near the homestead will be addressed in a Construction Management Plan.*

6.2.17 Construction Camps

***EPA Objective** – Ensure the impacts arising from the establishment of new or use of existing construction camps comply with statutory requirements and acceptable (and appropriate) standards.*

Potential Impacts and Risks

There have previously been two permanent construction camps present along the Pilbara Rail Company railway access road (Camp Curlewis and Camp Anderson) but these have been decommissioned and will not be available for crews on this project. Accommodation is available at Karratha or Tom Price and can be used for part of the project but other, temporary camps will need to be established. These camps will be designed and managed to minimise the impacts on surrounding vegetation, fauna and waterways as well as to adequately cater for disposal of waste.

Management Strategies

The following management issues will be addressed in a Construction Management Plan:

- *Siting of the camps will be negotiated with leaseholders and Aboriginal claimants;*
- *Sites will be chosen to eliminate or minimise the need for clearing;*
- *The camp will comply with all Shire requirements for rubbish disposal and hygiene;*
- *Vehicle servicing areas at the camp will comply with Australian Standards for fuel storage and management;*
- *Adequate fire breaks and fire prevention measures will be implemented; and*
- *Following completion of the works the camp area will be fully rehabilitated to conform with the landform and vegetation of the surrounding area.*

No construction camps will be established within the National Park.

Table 9b – Comparison of Alternatives within the National Park (Harding River)

Option/Alternative	Preferred Alignment	Alt. 2	Alt. 2a	Alt. 3
Issue/Aspect		**Rating**		
Tourism benefits (visual interest)	4	4	3	3
Risks to riverine environments	3	3	3	1
Risks to surface water	3	3	3	2
Risks to Aboriginal Heritage sites	3	4	4	2
Distance from existing linear infrastructure	4	2	2	4
Access to existing infrastructure	4	2	2	3
Requirements for earthworks	4	2	3	1
Other engineering constraints (e.g. moving infrastructure)	3	3	3	1
Safety	4	3	4	2
Cost	3	3	3	4
TOTAL	**35**	**29**	**30**	**23**

Rating is on a scale of 1 to 5 where 1 is the least acceptable.

Table 9c Comparison of Alternatives within the National Park (Camp Curlewis)

	Preferred	Preferred (2)
Issue/Aspect	**Rating**	
Risks to riverine environments	3	4
Risks to surface water	3	3
Risks to Aboriginal Heritage sites	4	4
Distance from existing linear infrastructure	3	3
Access to existing infrastructure	4	4
Requirements for earthworks	3	3
Other engineering constraints (e.g. moving infrastructure) and structures	3	4
Safety (level crossings, grades, fill embankments, etc.)	3	3
Cost	3	4
TOTAL	**29**	**32**

Rating is on a scale of 1 to 5 where 1 is the least acceptable.

Option A was eliminated from consideration because the Water and Rivers Commission indicated that they were concerned that a road in proximity to Harding Dam would unacceptably increase risks of pollution in a water catchment area. Main Roads have concurred with this request because their multi-criteria analysis indicates that, of the four options, this option gives the poorest performance both economically and socially.

Option B is similar to the preferred alignment, but on the western side of the Pilbara Rail Company railway instead of the east until it joins with the preferred alignment south of the Yannery River. There are few differences in the potential impacts of these two options but Option B has the potential to impact on an Aboriginal site.

Option C provides a slightly more direct route to Karratha, but is not as direct to Dampier and the Burrup Peninsula. Its major disadvantage is that it crosses Mt Welcome and Karratha Stations and would sever paddocks and access to water supplies.

In addition to the above limitations Options A and C increase the road network without significant justification. That is, they create a new route where there is currently no route.

Within the National Park the Alternatives were developed and considered to provide options which were feasible from an engineering constraints viewpoint and which minimised the impacts on the Western Creek and Harding River.

Alternative 1, crosses the railway line north of the major river zones and therefore has the opportunity to remain further from the rivers until it rejoins the preferred alignment at the Harding River. Although it has advantages with regards to riverine impacts it is not DCLM's preferred Alternative as it takes the road out into an area that has not been previously impacted by infrastructure and which is not within the 1 km development corridor. It also has the disadvantage of requiring a new level crossing which reduces its desirability from a safety and cost consideration.

Alternative 2 commences where Alternative 1 joins the preferred alignment and then heads well away from the existing infrastructure and onto the major plateau area before dropping down to the foothills and plain area, crossing the existing railway and access road and rejoining the preferred option 4 km north of the Roebourne – Wittenoom Road. This option does not traverse up any large gullies. However, it has disadvantages in being a considerable distance from the existing infrastructure and having an increased requirement for earthworks.

Alternative 2a coincides with Alternative 2 for approximately 3 kms then runs along a small valley for 1.5 km to rejoin the preferred alignment. This alternative is included because it provides a good right-angled crossing of the Harding River (as for Alternative 2), but avoids the problems associated with steep grades on the southern part of Alternative 2. It also stays closer to the rail corridor.

Alternative 3 has significant potential environmental disadvantages in its proximity to sections of the Harding River and the fact that its traverse along a deep valley which will require considerable amounts of cut and fill and the subsequently larger footprint that this will entail. This area has particularly steep slopes which will mean that large areas of vegetation, including the narrow valley floor, are likely to be covered. There are also risks to drainage in this area because runoff from heavy rain will be constrained in a narrow area close to the road. The earthworks in this valley area could be very complex and the requirement for moving existing infrastructure may make the costs significantly higher than for other alternatives.

Immediately north of the Roebourne to Wittenoom Road (Camp Curlewis), two possible alignments are put forward. The Preferred (2) alignment has been developed in order to avoid a new level crossing of the Dampier to Paraburdoo line in hilly terrain. This route links directly to the existing Roebourne to Wittenoom Road and crosses the railway at an existing level crossing. As far as disturbance and environmental impacts are concerned, the two possible alignments are similar.

The **preferred alignment** has been defined in order to avoid as many of the constraints as possible and to take key stakeholder concerns into consideration. The preferred alignment is east of the Pilbara Rail Company railway and is almost entirely within 1 km of the existing infrastructure.

Because of this, however, it has slightly greater potential impacts on the riverine environment and consequent water quality. The preferred alignment stays close to the existing railway wherever landforms allow but deviates away from it in the southern part if the Chichester Range where the steepness of the land would result in unacceptable cut and fill and difficulties with drainage.

In comparing the alternatives above it is important to note that most of the vegetation types encountered are widespread and common and there are no known threatened or priority plant species which will be impacted by any of them. However, proximity to the major river lines provides a greater risk of pollution for those rivers and associated permanent pools and may also remove some of the immediate fringing vegetation. Cut and fill requirements, and therefore land requirements also differ between the routes, with the preferred alignment potentially having the least impact.

6.2.20 Location of Construction Materials

EPA Objective – *To minimise the potential for disturbance of environmentally sensitive areas during extraction of construction materials.*

Potential Impacts and Risks

The construction of the road will require many borrow and basecourse pits. Basecourse pits are required to gain coarser material for the base of the road structure. Approximately 3000m^3 of basecourse material is required for every kilometre of road. The size and location of the pits will therefore vary dependent upon the location of suitable materials and the constraints to avoid any areas of significance. Overall, however, basecourse pits would require clearing of approximately 38 ha of land as well as land for access tracks to the pits. The amount of land for access tracks will depend on the size, and therefore number, of the pits established.

Borrow pits provide materials for the near-surface and for road shoulders and a more even quality of material is required. All borrow pits will be located within the proposed 1 km road alignment corridor. The total area of land cleared for borrow pits could be up to 62 ha, with extra land for access tracks.

A number of potential borrow pit areas were examined during the field investigations. At the northern end of the route some of these are off the North West Coastal Highway. Of the 18 existing pits and pit sites that were examined by Golder Associates (2002) for suitable material, seven have been used previously and their use for this project would involve re-opening or expansion. The remainder were in areas which had not been accessed before and their locations are not fully detailed for the purposes of a biological assessment. However, as all will be within the road alignment corridor they have been covered by the current vegetation assessment of that area.

Eight of the proposed pits are within the National Park and of these seven are new areas with no existing access. The total area of potential borrow within the National Park could be 6 ha. Borrow pit locations within the Park will be negotiated with DCLM. No pits will be sited within the area of the Threatened Ecological Community on Hamersley Station.

No flora of significance was recorded in the potential borrow pit areas that were examined and the general lack of significant flora in the area would make the presence of such flora in other pit areas unlikely. Other risks to borrow pit establishment and use relate to drainage collection and re-direction, weed introduction, and visual impacts. These can generally be managed using standard techniques and will be subject to established Main Roads procedures.

Management Strategies

- *Borrow pits will be located to minimise clearing and visual impacts;*
- *No pits will be located in, or immediately adjacent to watercourses;*
- *Borrow pit locations within the National Park will be negotiated with DCLM;*
- *No borrow pits will be sited within the Threatened Ecological Community vegetation;*
- *Borrow pit rehabilitation will be designed and implemented under the guidance of the Vegetation Protection and Rehabilitation Management Plan to be produced prior to the commencement of works;*
- *Borrow pit siting and rehabilitation will follow Main Roads internal guidelines for borrow pit management.*

6.2.21 Visual Amenity

EPA Objective *– Ensure visual amenity of the area is not unduly affected by the proposal, the establishment of the road and operation of pits used to provide construction material.*

Potential Impacts and Risks

The visually significant areas of the route are generally considered to be the areas in and around the Chichester and Hamersley Ranges. Other areas are flat and relatively featureless and may provide limited interest to the traveller. Within the ranges there are numerous view sheds, both to the surrounding hills and creeklines and also to the railway. The railway is an extensive industrial feature and the trains on it are also a source of interest.

Within those areas which are relatively flat and featureless, where a lack of relief and vegetation allows for long sightlines, the proposed road may not be readily absorbed into the landscape. The contrast between the black tarmac and the red-brown soil will also be highly visible in these areas. Conversely, the amount of cut and fill required in these locations may be minimal, thus reducing the visual intrusion of the proposed roadworks.

Through those areas where there is distinct relief, the cut and fill of the proposed road may be significant. The topography, however, will conceal the new road from view in some areas and may prevent long-distance sightlines from the road itself.

As noted in Section 6.2.11 above, there are very few opportunities for viewing the road from areas off the road itself and there will little potential visual impact as a result of its construction. At present there are no tourist lookouts or other easily accessible high points within the National Park or other areas which would have views marred by the location of the proposed road

Consultation with WRC has indicated that they have some concerns that the road will add an extra, unwanted, line through the National Park when viewed from the air and when added to the existing railways, access road, pipeline and powerlines. This was one of the initial aspects which required Main Roads to align the new road within 1 km of the existing road/rail corridor within the Park.

Careful design and construction of cut and fill areas and shaping of batters will assist in reducing the visual impact of the road through the ranges. Similar roads, through areas of Karijini National Park, have created spectacular viewing opportunities through steep sections and have opened up vistas that would otherwise not be seen. On balance, it is considered that the positive visual experience afforded to visitors will outweigh any negative impacts in the Chichester and Hamersley Ranges.

Standard techniques will be used to ensure that there are no direct sight lines to borrow areas. This may involve varying pit locations and providing curved access roads. Detailed rehabilitation plans will be prepared where pits are to be closed after the completion of the works.

Management Strategies

Management strategies indicated for Section 6.2.11 and 6.2.20 above will be used to minimise negative visual impact as a result of the road project.

6.2.22 Aboriginal Heritage and Culture

EPA Objective *– Ensure the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.*

Potential Impacts and Risks

The preliminary surveys identified a number of registered archaeological and ethnographic Aboriginal sites in the vicinity of the preferred alignment. The exact locations of these are difficult to determine from the register, because they are deliberately obscured to avoid vandalism. Before a final reserve can be established a formal field survey will be undertaken in conformance with the requirements of the *Aboriginal Heritage Act* (1972). It is entirely possible that, during the final design stage, the survey will identify other sites of concern and therefore Main Roads may need to modify the alignment and introduce management measures to avoid disturbance. Where this is not possible due to site constraints Main Roads will seek a section 18 clearance. However, it is important to note that Main Roads policy on Aboriginal heritage sites is to avoid impacts wherever possible and only seek a clearance to disturb as a last resort. Registered sites along the Harding River and adjacent areas may be found to be incompatible with the construction of the road on the preferred alignment. If this is the case, the alternative alignments already indicated will be re-considered or a minor alignment change made to avoid them.

It is also noted that this alignment runs through an area of overlapping Native Title claims. All claimants will be consulted during the detailed investigation phase and will have an opportunity to provide input into the road alignment and management of any potential impacts to sites.

Management Strategies

- *Once the preferred alignment corridor has been approved, detailed Aboriginal heritage and ethnographic consultation will be undertaken to identify any previously unknown heritage sites and understand the requirements of the Aboriginal custodians;*
- *Main Roads will avoid areas of aboriginal heritage wherever a viable alternative is available;*
- *It if is not possible to avoid sites, Main Roads will seek a Section 18 clearance under the Aboriginal Heritage Act (1972).*

6.3 Other Issues Identified

As a result of discussions with stakeholders and field investigations one other potential issue was identified.

6.3.1 Access to Karratha and Severance

A potential social issue relates to the options for access at the northern end of the route, i.e. where the road intersects North West Coastal Highway in relation to Karratha and the potential this has for severance of pastoral lease holdings.

The preferred option has a significant advantage over Options A and C in that it travels along the existing rail corridor in this area and does not sever paddocks in the adjoining leaseholdings of Karratha Station and Mt Welcome Station.

7. Management of Environmental Impacts

Many of the identified potential environmental impacts of the preferred route can be managed using standard and proven design and construction techniques. The construction techniques will not be detailed in this document but will be provided in a Construction Environmental Management Plan.

7.1 Preferred Road Alignment

The preferred alignment at the northern end of the route has been chosen to minimise the risks of significant impact, particularly with regard to social , landform and Aboriginal heritage issues. This alignment prevents severance within Karratha and Mt Welcome Stations and does not intersect any known Aboriginal sites. Because it parallels the railway line it has the potential to reduce barrier and road kill effects on fauna. As most of the land is flat the road footprint can be kept to a minimum.

Within the National Park, the route choice has greater constraints due to topography, rivers and existing infrastructure. Tables 9a, 9b and 9c (in Section 6.2.19) indicate that, environmentally, the preferred alignment is the most suitable due to its proximity to the existing infrastructure corridor and its reduced requirement for earthworks.. Other benefits of the preferred alignment include a reduction in the requirement for level crossings (with the consequent safety and cost improvements) and access to existing infrastructure.

7.2 Design Issues

Minor alignment options and detailed design can minimise the severity of some impacts. The following are considered to be the most significant issues for which the risks can be reduced by careful design.

7.2.1 Water Catchment/Hydrology

- Main Roads will undertake an assessment of major watercourses to ensure that surface and subsurface supplies to downstream water supplies are not affected by compaction for the road construction.
- Main Roads will undertake design of floodways and bridges to minimise potential for flooding and to avoid scour and erosion problems.
- Detailed design of drainage will take into account existing surface flows and will minimise impacts on sheet flow and avoid the creation of drainage shadows.

7.2.2 Vegetation and Flora

- Main Roads will undertake detailed design to minimise vegetation clearing.
- Design of river crossings will be focussed on minimising loss of riparian vegetation.
- The road and drainage footprint through the Threatened Ecological Community will be minimised. The road reserve (100m) will be fenced to protect the grassland from stock grazing.

- The position and design of pull off/rest areas with be determined in consultation with DCLM to avoid especially fire sensitive habitats or other environmentally significant features.

7.2.3 Fauna

- Creeklines are the main refuge for fauna and Main Roads will take extra care to minimise habitat loss in these areas.
- Appropriate fauna signs will be erected on the road to regularly remind motorists of the need to be aware of fauna crossing the road.

7.2.4 Impacts on Millstream – Chichester National Park

- Main Roads will consult with DCLM to ensure appropriate interpretive signage and rest bays are available to promote understanding of the Park values.
- The ecological and visual impact of the road will be minimised by:
  - Minimising cut and fill through the Park;
  - Best practice design of batters in cut and fill areas to provide stable landforms which blend in with the surrounding contours; and
  - Reducing vegetation clearing through forward planning and sensitive design.
- Main Roads will consult with DCLM regarding long-term management of the road reserve through the National park.

7.2.5 Social Issues

Severance from water supply may be an issue in areas where the road moves away from the railway alignment. Main Roads will consult with station owners and ensure this is resolved. Ongoing discussion with station owners will be undertaken to ensure that there are no adverse impacts to stock, station tracks, fences or other infrastructure along the road alignment during, or as a result of, construction.

7.2.6 Aboriginal Heritage

The aboriginal heritage assessment will be finalised when a 200m wide corridor is determined and Main Roads will avoid areas of aboriginal heritage wherever a viable alternative is available.

If it is not possible to avoid sites, Main Roads will seek a Section 18 clearance under the Aboriginal Heritage Act (1972).

7.3 Construction Impacts

Careful construction of the works can make a significant difference to the physical impact on the vegetation and fauna and the success of rehabilitation. There are minor risks to waterways due to fuel spillage and inappropriate storage of materials but apart from this and vegetation loss most other potential impacts from construction are temporary.

Management of construction impacts will focus on minimising the footprint of the works, preventing off-site disturbance, securing fuels and hazardous chemicals and providing effective rehabilitation. Rehabilitation will include reshaping and revegetation of borrow and basecourse pits, access tracks, materials storage locations and camp sites.

The details of construction management will be developed in a series of Management Plans. These plans will be prepared by Main Roads prior to the commencement of work on site. All management actions will be based on guidelines previously developed by Main Roads for specific environmental management aspects and which have proved to be successful in the Pilbara. Input to management for the project will be sought from DCLM and the WRC, The Main Roads Environmental Management Manual details strategies and guidelines for a range of environmental issues including :

- Borrow pit design and management (Main Roads Operational Group Circular 32 ' Gravel Extraction for Road Works'.);
- Rehabilitation (Main Roads, 'Roadside Flora Care, 1997'); and
- Drainage management;

Successful management of environmental issues in the Pilbara or other arid environments is represented by works on Karijini Drive through the Karijini National Park, on the Useless Loop Road upgrade in the Shark Bay World Heritage Area and in various upgrades of the Great Northern Highway and the Coral Bay Road.

Issue-specific plans will include:

- Surface Drainage Management Plan;
- Vegetation Protection and Rehabilitation Management Plan;
- Plan for Management of Issues in the Millstream-Chichester National Park;
- Aboriginal Heritage Management Plan, and
- Construction Management Plan

7.4 Post Construction Monitoring

The potential for post-construction impacts will be determined by the quality of the design and construction of the works. The aim of design and construction will be to have minimal impacts on the adjoining environment once the road has been completed. The main risk of on-going impacts lies with erosion due to road and embankment runoff. Monitoring will be carried out to examine these potential effects, as well as examining the impacts on river and creek banks and their vegetation and other vegetation which may be impacted by the road embankments or drainage systems.

Monitoring will occur following the first major rains after construction and then annually for three years. Any detrimental impacts will be remedied and action taken to prevent those impacts from occurring again.

Rehabilitation of roadsides and embankments, materials sites, side tracks and borrow areas will also be regularly monitored. Monitoring will focus on ensuring that disturbed areas are stabilised and that re-establishment of local native species occurs as soon as possible, within seasonal constraints. Completion criteria will be developed for the rehabilitation works and will consider soil stability, plant density and species mix, weed infestation and visual impact.

Table 10 - Summary of Environmental Commitments – Design and Construction of Karratha to Tom Price Road

No.	Issue	Action/Commitment	Objective	Phase	Advice
1.	Further Flora and Vegetation Survey	1. Carry out an additional flora and vegetation survey on the Abydos Plain section of the alignment at a seasonal time when the annual flora can be recorded. The standard and timing of the survey will be to the satisfaction of DCLM. 2. Assess any impacts of the preferred alignment in the light of the new survey results. 3. Report results of the survey to DCLM and EPA.	Add to the flora and vegetation survey information to record as complete a baseline survey as is possible, and minimise environmental impacts To determine the presence of rare, priority and significant flora on the Abydos Plain.	Prior to commencement of works	DCLM
2.	Surface Drainage Management Plan	Prepare a Surface Drainage Management Plan which includes the following elements: 1. Confirmation of design requirements (waterways report) for all major waterways; 2. Protection of embankments and waterway banks and beds; 3. Protection of riparian vegetation; 4. Details for monitoring of waterway integrity and erosion risks during and following construction; 5. Management and remediation of any impacts found during monitoring; and 6. Measurement and evaluation of environmental performance.	To maintain existing drainage patterns and prevent soil erosion and sedimentation caused by construction activity or new waterways structures.	Prior to commencement of construction.	WRC

No.	Issue	Action/Commitment	Objective	Phase	Advice
3.	Surface Drainage Management Plan	Implement Surface Drainage Management Plan	To maintain existing drainage patterns and prevent soil erosion and sedimentation caused by construction activity or new waterways structures.	Design, construction, post-construction.	/WRC
4.	Vegetation Protection and Rehabilitation Management Plan	Prepare a Vegetation Protection and Rehabilitation Management Plan to include the following elements: 1. Design and construction strategies which minimise loss of native vegetation and fauna habitat; 2. Treatment of the Threatened Ecological Community which includes fencing of the road reserve; 3. Protection of rare or significant flora; 4. Treatment of riparian zones; 5. Treatment of material pits; 6. A detailed rehabilitation strategy which includes topsoil and weed management, brushing and seeding; 7. Monitoring measures for ensuring that vegetation is protected and replaced; and 8. Measurement and evaluation of environmental performance.	Prevent loss of vegetation beyond the footprint of the works, and minimise potential indirect effects on vegetation. Rehabilitate impacted areas to replace lost vegetation.	Prior to commencement of construction.	DCLM
5.	Vegetation Protection and Rehabilitation Management Plan	Implement the Vegetation Protection and Rehabilitation Management Plan	Prevent loss of vegetation beyond the footprint of the works, and minimise potential indirect effects on vegetation. Rehabilitate impacted areas to replace lost vegetation.	Construction and post-construction	DCLM

No.	Issue	Action/Commitment	Objective	Phase	Advice
6.	National Park Plan.	Prepare a plan which addresses impacts in the Millstream-Chichester National Park which includes as elements: 1. Design of appropriate interpretive signage and rest bays to promote understanding of Park values and protection of flora and fauna 2. Design to minimise the ecological and visual impact of the road through: • Minimising cut and fill through the Park; • Confining the width of the construction corridor through the Park to an average of 40 metres; • Best practice design of batters in cut and fill areas to provide stable landforms which blend in with the surrounding contours; and • Reducing vegetation clearing through forward planning and sensitive design. 3. Long term management of the road reserve through the Park; and 4. Measurement and evaluation of environmental performance.	Minimise the impacts of the new road through the Millstream-Chichester National Park.	Design	DCLM
7.	National Park Plan.	Implement the National Park Plan.	Minimise the impacts of the new road through the Millstream-Chichester National Park.	Design, construction and post-construction.	DCLM

No.	Issue	Action/Commitment	Objective	Phase	Advice
8.	Aboriginal Heritage Management Plan	Prepare an Aboriginal Heritage Management Plan that incorporates the following elements (in compliance with the *Aboriginal Heritage Act* (1972)): 1. A strategy for further Aboriginal heritage assessment and consultation during the final design of the road; 2. Details of commitments and conditions for design and construction activities to avoid impacts on significant sites.	Protect and preserve Aboriginal cultural heritage within the area influenced by the roadworks.	Prior to commencement of works.	Department of Indigenous Affairs (DIA).
9.	Aboriginal Heritage Management Plan	Implement the Aboriginal Heritage Management Plan	Protect and preserve Aboriginal cultural heritage within the area influenced by the roadworks.	Design and construction	DIA
10.	Construction Management Plan	Prepare a Construction Management Plan to address: 1. Management of Construction Camps; 2. Noise, dust and other construction nuisance; 3. Transport, storage and use of hazardous materials.	Ensure that environmentally and socially acceptable standards are established and maintained during construction works	Prior to commencement of works	DCLM, Local Authorities
11.	Construction Management Plan	Implement the Construction Management Plan	Ensure that environmentally and socially acceptable standards are established and maintained during construction works	Construction, post construction	DCLM, Local Authorities

8. Summary and Conclusions

The construction of a sealed, public road between Karratha and Tom Price will be carried out in four stages. The first stage is currently under construction between the Nanutarra-Munjina Road and Tom Price and the second will commence in 2003. The Stage 2 works will provide a two-lane, 110kph speed road between the North West Coastal Highway and the Roebourne Wittenoom Road, and will traverse the Millstream-Chichester National Park. The completion of Stages 3 and 4 will be dependent upon available funding.

The development of the road has been progressed by a Steering Committee since 1996. This Committee has involved a number of major stakeholders who have considered the requirements of the road and the potential significant impacts. Following referral of the project to the DEP it was required that a Consultative Environmental Review (CER) be carried out to consider route options for the road, assess the potential environmental impacts of the routes and provide design and management recommendations.

This CER document includes the outcomes of investigations on flora and fauna, hydrology and groundwater, visual assessment, Aboriginal and European heritage and other social issues.

Consideration of four northern route options and four alternative route sections through the Millstream Chichester National Park have led to the identification of the preferred alignment due to its:

- Reduced requirement for earthworks and consequent loss of vegetation;
- Increased safety due to reduced level crossings; and
- Proximity and access to existing infrastructure.

The impact of the preferred alignment through the Park will be determined by the care that is taken in design and construction of the works with regard to river and creek crossings and cut and fill across and along steep valleys. All opportunities will be taken to minimise the road footprint in these areas. This will reduce the effects on flora and fauna and local hydrology as well as the visual impact of the works.

Project Impacts

The preferred alignment will not have any significant, unmanageable, impacts on the surrounding environment. When put into the scale of the landscape, and coupled with the fact that, for most of the options, the road would parallel an existing transport and services corridor, the potential impacts of the road construction and use are relatively minor. The most significant aspects relate to the construction of the road in the Millstream-Chichester National Park and the fact that the alignment traverses a Threatened Ecological Community (TEC) on Hamersley Station. However, the permanent loss of vegetation in these areas represents only a small fraction of the whole areas of these vegetation types and does not put any communities or flora species at risk of extinction or in a higher threat category. The TEC is currently not protected in a reserve but is listed as Vulnerable on the State register. Only a tiny fraction (approximately 17.5 ha or half of one percent) of the area of this community will be lost due to the road construction. Minor re-alignments of the road will not provide an opportunity to avoid this community as it covers some 34,600 ha. Protection of part of the TEC can be enhanced through the establishment of a wide road reserve which will be fenced and will therefore protect some of it from stock grazing.

The provision of a sealed road from Karratha to Tom Price will undoubtedly increase visitor numbers to the Park. However, due to the remoteness of the area from major population centres the increase in numbers is unlikely to be large. The visitors are, however, likely to be focussed in a small number of areas within the Park. None of these areas closely adjoins the proposed road. There will be a minor visual impact due to the construction of the new, sealed road, particularly through parts of the Chichester and Hamersley Ranges. However, careful design will aim to minimise the changes to the landscape through batter shaping, and rehabilitation works will re-contour the land to fit the surrounding environment and replace vegetation lost during roadworks.

The design and construction of river and creek crossings has the potential to impact the hydrology and associated riverine ecosystems. Although rainfall events are spasmodic, there is potential for flooding and backwater and scour effects due to heavy downpours and the capacity of some areas for runoff. Careful design of bridges, floodways, culverts and off-road drainage will be required to minimise the risks of the above impacts and ongoing monitoring will be carried out to ensure that unforseen impacts are quickly managed. Main Roads has undertaken successful design of many such bridges and river crossing structures in the Pilbara, Kimberley and Gascoyne Regions. All design calculations will be verified by Department of Environmental Protection/Water and Rivers Commission prior to final design.

Given appropriate design, the use of standard and proven construction techniques and suitable rehabilitation it is not considered that there will be any significant or on-going impacts as a result of the road development. In the dry environment of the region, scars from vegetation and topsoil clearing can be long-lasting and it is important that appropriate management of these factors for both the road and borrow areas is undertaken. Main Roads has carried out successful rehabilitation in highly sensitive, arid regions such as the Karijini National Park, Shark Bay World Heritage Area and on the Coral Bay Road.

Operational Risks

The new road will traverse two Priority 1 Water Source Protection areas – the Harding Dam catchment and the Millstream catchment. Risks to water supplies at the Millstream pumping area and the Harding Dam are negligible due to the distance of the road to these sources and the calculated likelihood of crashes involving hazardous material spills. The risks are not large enough to warrant any special road design for capturing possible spills prior to their entering a waterway and there is a high chance that any such spills can be successfully cleaned up if they pose a threat.

There is a small likelihood that the provision of a sealed road through the Chichester and Hamersley Ranges will increase the risk of road kills of the threatened species, the Pilbara Olive Python. This species is widespread throughout the ranges but not thought to occur in large numbers and may preferentially use the bitumen road to bask on. Main Roads will use opportunities for signage and information through the ranges to educate road-users as to the significance of this species.

None of the issues investigated in this report would require that the project be referred to Environment Australia under the *EPBC Act 1999*. The Threatened Ecological Community is not listed under that Act and although two listed migratory birds and a threatened reptile potentially use the area, the risks to these species are seen as negligible.

Benefits of the Road

The provision of a sealed, public road between Karratha and Tom Price will provide many benefits for industry in the region and for the associated population. Currently, traffic between the two towns takes a public route via Roebourne, and the Nanutarra-Munjina road or a private road which

was specifically designed as a rail access route and not for high-speed, mixed traffic. There are significant risks on the existing roads due to dust and poor horizontal and vertical design and a new, sealed road, designed for traffic to 110kph will significantly reduce these risks.

The alignment of the road will also considerably improve access to the Millstream-Chichester National Park. This Park is currently not easily accessible to tourists and there are opportunities to increase visitor usage and allow travellers to experience the rugged Chichester Ranges and its associated rivers and pools in greater comfort. The road has the potential to become a spectacular tourist route, opening up the Pilbara and allowing better access to Karijini National Park and to the mining and industry within the region.

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Attachment A

Environmental Protection Authority Guidelines

2. Environmental factors/issues relevant to this proposal

These factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA expects to address these factors in its report to the Minister for the Environment.

The EPA expects the proponent to take due care in ensuring that any other relevant environmental factors which may be of interest to the public are addressed.

At this preliminary stage, the Environmental Protection Authority (EPA) believes the relevant environmental factors, objectives and work required is as detailed in the table below:

CONTENT		SCOPE OF WORK	
Factor	**Site specific factor**	**Preliminary EPA objective**	**Work required for the environmental review in addition to generic requirements (see Part B of Guidelines)**
BIOPHYSICAL			
Biodiversity	Ecosystems	To maintain biological diversity, meaning the different plants and animals and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.	1. Describe the existing levels of biological diversity. 2. Discuss the potential direct and indirect impacts of the proposal on the existing environment. 3. Document proposed management measures (if any) which will be implemented to ensure biological diversity is maintained. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Terrestrial Flora	Vegetation communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	1. Assess and document the abundance, diversity, distribution and productivity of the existing vegetation communities. 2. Discuss the potential direct and indirect impacts of the proposal on the existing environment. 3. Discuss the proposed management measures (if any) which will be implemented to ensure the abundance, diversity distribution and productivity of the vegetation communities are maintained. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
	System 8	• Ensure that the conservation values of System 8 recommended areas are not compromised. • Ensure that regionally significant flora and vegetation communities in System 8 are adequately protected.	1. Identify and discuss the potential direct and indirect impacts on System 8 Recommendations (Millstream and Chichester Range National Parks), including excisions/additions and management implications (additional tourists etc). Discuss visual amenity/landscape issues (see factor below) with specific reference to the National Park.. 2. Discuss the proposed management measures which will be implemented to ensure the values of System 8 areas are not compromised. 3. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
	Declared Rare and Priority and other significant Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950.	1. Assess and document the presence of Declared Rare and Priority flora species that may be affected by the proposal. Identify other species of significance that may be impacted by the proposal and discuss the reason for their conservation significance. These species may include undescribed taxa, new records for the region, species of taxa that are endemic to the region or range, or species confined to specific sites of limited occurrence in the region. 2. Discuss the potential direct and indirect impacts of the proposal on the flora. 3. Discuss the proposed management measures (if any) which will be implemented to ensure any Declared Rare, Priority and other significant flora is protected. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Terrestrial Fauna	Regionally Significant Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial and aquatic fauna.	1. Assess and document the presence of terrestrial fauna, that may be affected by the proposal. 2. Discuss the potential direct and indirect impacts of the proposal on the fauna. 3. Discuss the proposed management measures (if any) which will be implemented to ensure the EPA's objective is met. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.

CONTENT		SCOPE OF WORK	
Factor	**Site specific factor**	**Preliminary EPA objective**	**Work required for the environmental review in addition to generic requirements (see Part B of Guidelines)**
	Specially Protected (Threatened) Fauna	Protect Threatened Fauna and Priority Fauna species and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950.*	1. Assess and document the presence of Declared Rare and Priority fauna species and their habitats. 2. Discuss the potential direct and indirect impacts of the proposal on the flora. 3. Discuss proposed management measures (if any) which will be implemented to ensure these species and their habitats are protected. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Wetlands	Rivers	Maintain the integrity, functions and environmental values of rivers. Ensure riparian vegetation on substantial streamlines is adequately protected.	1. Describe the existing condition of the river/s, watercourses and riparian vegetation that may be affected by the proposal. 2. Discuss the potential direct and indirect impacts of the proposal. 3. Discuss the proposed management measures (if any) which will be implemented to ensure the integrity, function and environmental values of the river/s is maintained. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
	Flood management	Maintain the integrity and function of the floodway.	1. Describe the existing condition of the floodway/s that may be affected by the proposal and assess and document the flooding characteristics of the floodway/s. 2. Discuss the likely direct and indirect impacts of the proposal on the floodway/s. 3. Discuss the proposed management measures (if any) which will be implemented to ensure the integrity and function of the floodway/s is maintained. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Land	Soil	Ensure that clearing is minimised and does not result in land degradation.	1. Describe the existing soil types and conditions along the proposed route. 2. Discuss the direct and indirect potential impacts of the proposal on these soils. 3. Discuss the proposed management measures which will be implemented to ensure that clearing does not result in land degradation.
	Rehabilitation, landforms visual amenity.	Establish stable, sustainable landforms consistent with the surroundings. Ensure the area adjacent to the project is not unduly affected by the proposal.	1. Describe the existing landforms. 2. Discuss the potential direct and indirect impacts of the proposal on those landforms. 3. Discuss the proposed management measures which will be implemented to ensure that stable, sustainable landforms consistent with the surroundings, adequate rehabilitation and acceptable visual amenity of the landforms are achieved. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
POLLUTION MANAGEMENT			
Air	Gases	Ensure that gaseous emissions do not adversely affect the environment or health, welfare and amenity of nearby land users by meeting the statutory requirements (including Section 51 of the *Environmental Protection Act 1986*) and acceptable standards. Ensure consistency with the *Ambient Air Quality NEPM 1998* so that gaseous emissions, both individually and cumulatively, meet appropriate criteria and do not cause environmental or human health problems; and discharge of gaseous emissions is minimised.	1. Describe the existing air environment based on established criteria, agreed with the DEP. 2. Discuss the likely direct and indirect impacts of the proposal on the existing air environment. 3. Discuss the proposed management measures which will be implemented to ensure that gaseous emissions do not adversely affect the environment or health, welfare and amenity of nearby land user. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.

CONTENT		SCOPE OF WORK	
Factor	**Site specific factor**	**Preliminary EPA objective**	**Work required for the environmental review in addition to generic requirements (see Part B of Guidelines)**
Water	Surface Water quality - Contamination with pollutants in road runoff	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) and the NHMRC / ARMCANZ Australian Drinking Water Guidelines - National Water Quality Management Strategy. • Ensure that the beneficial uses of groundwater can be maintained, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993). • Maintain the quality of surface water so that existing and potential uses, including ecosystem maintenance, are protected.	1. Assess and document the existing surface water and its catchment, particularly the Priority 1 Water Catchment Area (Harding Dam). 2. Discuss the likely direct and indirect impacts of the proposal on the surface water and the catchment. 3. Discuss the proposed management measures which will be implemented to ensure that the existing and potential uses of the surface water and catchment, including ecosystem maintenance, are protected. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
	Ground Water quality - Contamination with pollutants in road runoff	Maintain or improve the quality of ground water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) and the NHMRC / ARMCANZ Australian Drinking Water Guidelines - National Water Quality Management Strategy. • Ensure that the beneficial uses of groundwater can be maintained, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993). • Maintain the quality of ground water so that existing and potential uses, including ecosystem maintenance, are protected.	1. Assess and document the existing ground water and its catchment, particularly the Priority 1 Water Catchment Area (Millstream Water Reserve). 2. Discuss the likely direct and indirect impacts of the proposal on the ground water and the catchment. 3. Discuss the proposed management measures which will be implemented to ensure that the existing and potential uses of the ground water and catchment, including ecosystem maintenance, are protected. This should include how compliance with the priority protection objectives for any Public Drinking Water Source Areas will be demonstrated. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
SOCIAL SURROUNDINGS			
Aesthetic	Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal .	1. Describe and assess the existing visual amenity and landscape character/s of the area in which the proposal will be located. 2. Discuss the potential visual impacts of the proposal on the visual amenity and landscape character/s of the area. 3. Discuss the management measures (if any) which will ensure specific criteria required by CALM is met and the visual amenity of the area is not unduly affected. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Landscape		To maintain the integrity, environmental and aesthetic values of landscape.	1. Describe the integrity, environmental and aesthetic values of the landscape in terms of its landscape character/s. 2. Discuss the management measures (if any) which will ensure the integrity, and environmental and aesthetic values of the landscape are maintained. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.
Culture and Heritage	Heritage	Comply with statutory requirements in relation to areas of cultural or historical significance. Ensure that cultural and heritage values are protected.	1. Assess and document places and items of cultural or historical significance. 2. Discuss the potential impacts of the proposal on those places and items. 3. Discuss management measures (if any) which will ensure that cultural and heritage values are protected. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.

	Aboriginal culture and heritage	i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and ii) Ensure that changes to the biological and physical environmental resulting from the project do not adversely affect cultural associations with the area.	1. Assess and document sites of Aboriginal archaeological and ethnographic significance. 2. Discuss the potential impacts of the proposal on those sites. 3. Discuss and the management measures (if any) which will ensure the proposal complies with the requirements of the *Aboriginal Heritage Act 1972* and that cultural associations in the area are not adversely affected by the proposal. 4. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.

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