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Petroleum and Minerals Industries in the Northwest Marine Region

A Report to the Department of the Environment, Water, Heritage and the Arts.

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Abstract:

The most economically significant industries dependent on the Northwest Marine Region for exploration, production or export are the petroleum and minerals sectors. To assist in understanding the nature and extent of these industries, the Australian Government Department of the Environment and Water Resources (the Department) has contracted International Risk Consultants Pty Ltd. to advise it on the anticipated expansion of the petroleum and mineral exporting industries in the Northwest and related shipping, port and other marine infrastructure needs. The Department is interested to understand the potential implications for the marine environment of industry expansion so as to be able to better meet the information and referrals assessment needs of industry, while protecting the ecological health and conservation values of the Northwest Marine Region.

The project outcomes will be used by the Department to support development of the Northwest Marine Bioregional Plan, including preliminary design work for candidate Marine Protected Areas. The report:

• briefly describes the current scale, volumes, economic values and locations of production of petroleum and minerals in the Region;

• assesses the likely expansion of the petroleum and minerals exporting industries in and adjacent to the Region over the next two decades, including location, volumes and value of production and the factors affecting the anticipated expansion;

• assesses the marine infrastructure (ports, pipelines, shipping) required to service the industries' anticipated expansion; and

• identifies the types and scale of potential impacts industry expansion may have on the marine environment (potential impacts which the Department have identified may arise from, amongst other things, seismic surveys, off-shore petroleum production and associated marine and coastal infrastructure, increased shipping movements, increases in size of vessels and associated dredging, ballast water exchange and port development and expansion).

Country:

Western Australia

Contents

ABBREVIATIONS

API	American Petroleum Institute gravity scale
APPEA	Australian Petroleum Production and Exploration Association
AQIS	Australian Quarantine Inspection Service
BFPL	Burrup Fertilisers
BHPB	BHP Billiton
CALM	Department of Conservation and Land Management, Government of Western Australia, now DEC
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBGP	Dampier to Bunbury Gas Pipeline
DEC	Department of Environment and Conservation,
DITR	Department of Industry, Resources and Technology, Commonwealth
DOIR	Department of Industry and Resources, Government of Western Australia
DPA	Dampier Port Authority
DPI	Department of Planning and Infrastructure, Government of Western Australia
EPBC	Environment Protection and Biodiversity Conservation
FPSO	Floating Production, Storage and Offloading (vessel)
FSO	Floating Storage and Offloading (vessel)
GGT	Goldfields Gas Transmission
HBI	Hot Briquetted Iron
HI	Hamersley Iron
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IRC	International Risk Consultants Pty Ltd
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
MEG	Monoethylene Glycol
MOU	Memorandum Of Understanding
MPA	Marine Protected Area
NES	National Environmental Significance
NORM	Naturally Occurring Radioactive Minerals/Material

NT	Northern Territory
NWBM	Non-Water Based Mud
NWS	North West Shelf
NWSV	North West Shelf Venture
PFW	Produced Formation Water
SBM	Synthetic Based Mud
SBSJV	Shark Bay Salt Joint Venture
TBT	Tributyltin
The Department	Australian Government Department of the Environment and Water Resources
WA	Western Australia
WBM	Water Based Mud

UNITS

bbl	Barrels
Bt	Billion tonnes
in	Inch
km	Kilometer
mm	Milimeter
mmpa	Millimetres per annum
Mt	Metric tonne
Mtpa	Metric tonnes per annum
nm	nautical mile
tpa	Tonnes per annum
tph	Tonnes per hour

EXECUTIVE SUMMARY

The most economically significant industries dependent on the Northwest Marine Region are those related to the exploration, production or export of petroleum (crude oil, liquefied natural gas (LNG), liquefied petroleum gas (LPG), domestic gas and condensate) and minerals (metals, mineral sands, diamonds, coal and salt). To assist in understanding the nature and extent of these industries, the Department has contracted International Risk Consultants (IRC) to advise it on the anticipated expansion of the petroleum and mineral exporting industries in the Northwest and related shipping, port and other marine infrastructure needs. The Department is interested to understand the potential implications for the marine environment of industry expansion so as to be able to better meet the information and referrals assessment needs of industry, while protecting the ecological health and conservation values of the Northwest Marine Region.

The Northwest Marine Bioregional Plan is currently in its first stage, which is development of a Bioregional Profile. A key component of the Profile is describing the region's ecosystems, heritage values and human uses. Gaining a better understanding of the human uses in the Region and their characteristics is essential in ensuring that any conservation measures that might be contemplated in developing the Bioregional Marine Plan are designed to minimise their potential effects on industries and communities whilst still achieving conservation objectives.

This document presents the anticipated petroleum and minerals industries expansion and reviews the environmental impacts of potential petroleum and mining developments in the Northwest Marine Bioregion as defined The Australian Government Department of the Environment and Water Resources (the Department) under Section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Minerals Industry

Production of other key mineral commodities during 2005-06 included 11.5 million tonnes of alumina, 161 tonnes of gold, 191 000 tonnes of nickel and 244 million tonnes of iron ore (DITR 2006a). The sector is experiencing rapid growth and projections indicate that sector output is likely to grow by 50-75% over the next decade (Chamber of Minerals and Energy, 2005).

Currently, there are five operating iron ore export ports in the Northwest Marine Bioregion are Port Hedland, Cape Preston, Cape Lambert and Dampier.

WA accounts for 93 % of Australia's salt production with centres in Dampier, Onslow and Shark Bay.

The Petroleum Sector

The Northwest Marine Region is the major region for the production of petroleum products (crude oil, liquefied natural gas (LNG), liquefied petroleum gas (LPG), domestic gas and condensate) with over 70% of crude oil and condensate production. The Northwest Marine Bioregion also accounts for over 90% of current Australian gas reserves.

In 2005-06 the total value of WA petroleum sales was $15.2b. This was a 23% increase over 2004-05 in spite of an overall decline in production as existing fields mature. The major contributor was crude oil sales (43.3%) followed by LNG (30.3%), condensate (18.1%), natural gas (4.6%) and LPG (3.7%).

LNG output from Western Australia could triple over the next 10 to 15 years to 150 million tonnes per annum. Growth in output was over 20% since 2005 and Western Australia holds an estimated 140 trillion cubic feet of gas reserves. The major LNG projects under development are summarised in Section 5.

The existing petroleum infrastructure and typical onshore and offshore facilities are presented and discussed in Section 4. There are currently five onshore oil and gas production facilities located adjacent to the Northwest Marine Region. These are the Woodside Energy operated Karratha Gas Plant on the Burrup Peninsula (Dampier), the BHP Billiton operated Turbridgi Gas Plant to the south-west of Onslow, and the island based facilities on Barrow, Thevenard and Varanus islands.

There are currently nine Floating Production, Storage and Offloading (FPSO) facilities and two production platforms with offloading facilities operating in the Northwest marine region.

The primary focus of petroleum exploration has been the offshore northern Carnarvon basin, where field development and infrastructure continue to grow. Planning is underway for 20 new petroleum projects involving a minimum $22 billion investment over the next few years. Most of the future oil developments come from Exmouth Sub-basin fields and contain heavy oil. The current boom in the liquefied natural gas (LNG) market underpins a number of LNG developments, and it is expected that industry will apply to develop other LNG projects in the near future. The majority of these oil and LNG developments are expected to come on stream during the coming decade. The likely expansion of the petroleum industries in and adjacent to the Northwest Marine Bioregion is summarised in section 5.

The northern Carnarvon basin at present is by far the largest producing basin in Western Australia with 97% of WA's oil and gas production. Western Australian sedimentary basins currently hold more than 80% of Australia's discovered natural gas resources. The number of developed and producing fields has almost doubled over the past decade. Currently there are 67 producing fields.

A peak in oil production is expected around 2008-09 mainly attributable to the development of heavy oilfields in the Exmouth Sub-basin), though there is a sharp decline after this point. Between 2010 and 2020, condensate production from gas condensate fields will play a key role in maintaining WA liquid hydrocarbon production in the future. Since condensate production comes principally from LNG developments, the forecast decline in condensate production is much slower than the decline in oil production. Future gas production is committed to upcoming LNG projects.

The majority of WA's new oil developments are located in the Exmouth Sub-basin. These include a series of significant discoveries, namely, Enfield, Vincent, Pyrenees, Stybarrow and Laverda, which contain more than 48 GL (300 MMbbl) of heavy crude reserves. These fields

are expected to come on stream before the end of this decade and their combined initial production is estimated at nearly 40 000 kL/d (250 000 bbl/d).

The development of these fields represents a number of technical challenges. The oil in these fields is heavy (17–22° API), has relatively high viscosity (7–11 cp), and some of these fields have thin oil legs. As such, their production would decline very rapidly. These fields are situated close to an environmentally sensitive area: the Ningaloo Marine Park, which requires additional precautions in the development process.

Example projects presented are:

- Stybarrow-Eskdale Development (Operator, BHP Billiton)
- Pyrenees Development (Operator, BHP Billiton)
- Vincent Development (Operator, Woodside Energy)

WA's North West Shelf has estimated natural gas resources of more than 3168 Gm^3 (130 Tcf). Australia is strategically located to supply LNG throughout the Asia Pacific region with LNG exports playing an increasingly important role in the Western Australian energy scene.

In the next decade several significant gas discoveries such as Greater Gorgon, Jansz-Io, and Scott Reef-Brecknock, each in excess of 560 Gm^3 (20 Tcf), will be bought on stream supplying export LNG. These forthcoming developments include fields that were regarded as stranded gas when they were discovered 20 to 30 years ago.

While some of these gasfields contain significant condensate reserves, producing this condensate would depend on the timeframe of the LNG contracts. Fields with a low condensate-gas ratio (CGR), ie. less than 56 m^3/Mm^3 (10 bbl/MMscf), such as Gorgon, Jansz-Io, and Scarborough, would not have a significant contribution to condensate production. However, for Ichthys, with a CGR of over 280 m^3/Mm^3 (50 bbl/MMscf), and Brecknock fields, which are expected to have a combined daily condensate production of 12.7 ML/d (80 000 bbl/d) sustainable for more than 20 years, the contribution is much more significant.

Example projects presented are:

- Angel Development (Operator, Woodside Energy)
- Gorgon Development (Operator, Chevron)
- Jansz-Io Development (Operator, ExxonMobil)
- Pluto Development (Operator, Woodside Energy)
- Scarborough Development (Operator, ExxonMobil)
- Brecknock / Brecknock South and Scott Reef Development (Operator, Woodside Energy)
- Ichthys Field Development (Operator, INPEX)
- Perseus-over-North Rankin / Perseus-over-Goodwyn (Operator, Woodside)

- Goodwyn Western Flank Development (Operator, Woodside)

Currently uptake of Australia's offshore petroleum exploration permits is at an all time record high with over 300 permits in operation. Indications are that this increase is likely to continue the new exploration areas for 2007 the Northwest Bioregion are shown in Figure 5.2.

Giant gas fields continue to be found in the Carnarvon Basin. Chevron's Chandon gas discovery, located west of ExxonMobil's giant Jansz field and Woodside's Pluto gas discovery demonstrate that there are still significant hydrocarbon discoveries in Australia's offshore waters, and that the Carnarvon Basin is a world class hydrocarbon province.

Marine Infrastructure

Within the NW marine region there are three port authorities (Broome, Dampier and Port Hedland) which are autonomous bodies operating under the *Port Authorities Act 1999* and reporting to the Minister for Planning and Infrastructure. The existing ports in the North West Marine Bioregion are: Port of Dampier, Port Hedland, Port of Broome, Port Walcott (Cape Lambert), Yampi Sound (Cockatoo Island), Koolan Island, Onslow (Airlie Island and Thevenard Island), Carnarvon (Cape Cuvier and Useless Loop), Wyndham, Derby, Varanus Island and Barrow Island.

An overview of the oil and gas trunklines connections between offshore facilities (NWS) including , size, length and summary notes is provided in Section 6.2

On both a global and national scale the NWS ports, in particular Dampier and Port Hedland, handle a large tonnage of mineral and gas exports. Other export cargoes include salt, manganese, feldspar, chromite and copper.

Presented are the major shipping routes in the NWS region and the distribution of types of vessel in the Northwest Region subregions during 2004 and 2006.

Section 6 presents an overview of the currently planned future and proposed ports and presents a generalised assessment of the main environmental aspects, values and sensitivities. Activties related to ongoing maintenance dredging and port expansion are presented for Dampier, Port Hedland, Cape Lambert/ Port Walcott , Ronsard Island, Cape Preston, Maret Island, Quandong Point

There are a number of activities common to both mining and petroleum exploration and exploitation that may result in potential impacts to the marine environment. The typical environmental hazards associated with petroleum and mining activities are discussed in Section 7.

1 INTRODUCTION

1.1 Background

The Australian Government Department of the Environment and Water Resources (the Department) has commenced Marine Bioregional Planning in the Northwest Marine Bioregion (see Figure 1.1 below) under Section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

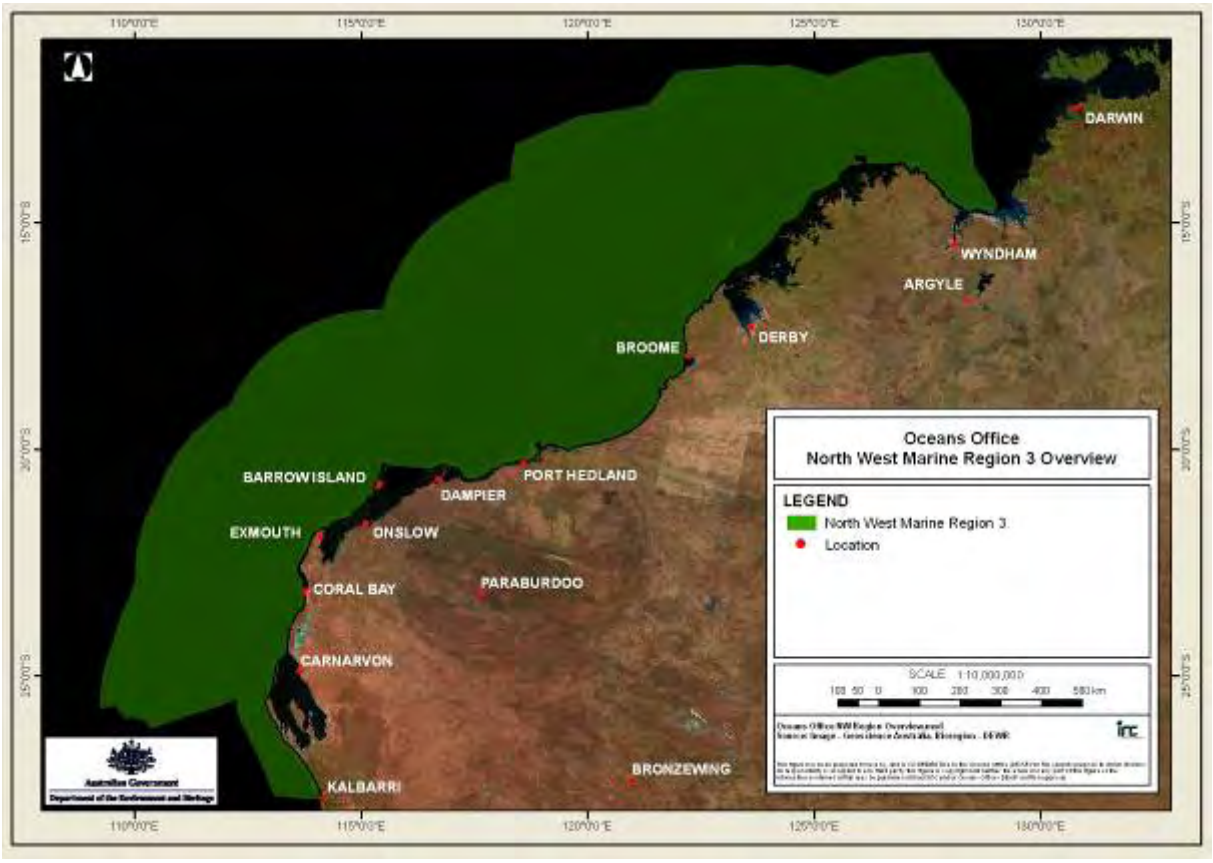


Figure 1.1 The Northwest Marine Bioregion

The Northwest Marine Bioregional Plan aims to:

- describe the region's key habitats, species, natural processes, human uses and benefits and threats to the long-term ecological sustainability of the region;
- assist in developing programs and policies to enhance the conservation of marine biodiversity and heritage values of the region;
- give details about the various statutory obligations under the EPBC Act that apply in the region and describe the conservation measures in place, such as those relating to recovery planning for threatened species;

- establish a network of representative marine protected areas (MPAs) in the Region; and
- provide industry with greater certainty about the Australian Government's conservation priorities in the Region, which will assist in streamlining referrals processes under the EPBC Act.

The Northwest Marine Bioregional Plan is currently in its first stage, which is development of a Bioregional Profile. A key component of the Profile is describing the region's ecosystems, heritage values and human uses. Gaining a better understanding of the human uses in the Region and their characteristics is essential in ensuring that any conservation measures that might be contemplated in developing the Bioregional Marine Plan are designed to minimise their potential effects on industries and communities.

1.2 Scope

The most economically significant industries dependent on the Northwest Marine Region are those related to the exploration, production or export of petroleum (crude oil, liquefied natural gas (LNG), liquefied petroleum gas (LPG), domestic gas and condensate) and minerals (metals, mineral sands, diamonds, coal and salt). To assist in understanding the nature and extent of these industries, the Department has contracted International Risk Consultants (IRC) to advise it on the anticipated expansion of the petroleum and mineral exporting industries in the Northwest and related shipping, port and other marine infrastructure needs. The Department is interested to understand the potential implications for the marine environment of industry expansion so as to be able to better meet the information and referrals assessment needs of industry, while protecting the ecological health and conservation values of the Northwest Marine Region.

1.3 Objectives

The project outcomes will be used by the Department to support development of the Northwest Marine Bioregional Plan, including preliminary design work for candidate Marine Protected Areas. The report:

- briefly describes the current scale, volumes, economic values and locations of production of petroleum and minerals in the Region;
- assesses the likely expansion of the petroleum and minerals exporting industries in and adjacent to the Region over the next two decades, including location, volumes and value of production and the factors affecting the anticipated expansion;
- assesses the marine infrastructure (ports, pipelines, shipping) required to service the industries' anticipated expansion; and
- identifies the types and scale of potential impacts industry expansion may have on the marine environment (potential impacts which the Department have identified may arise from, amongst other things, seismic surveys, off-shore petroleum production and

associated marine and coastal infrastructure, increased shipping movements, increases in size of vessels and associated dredging, ballast water exchange and port development and expansion).

1.4 Assessment Guidelines and Assumptions

In consultation with the Department, IRC developed a set of guidelines and assumptions which are used in this assessment. The assessment presented in this report is based on the following guidelines and assumptions, which may influence extend of developments in the region:

- No change in government policy however future changes in government policy may be expected on areas such as Uranium mining, marine parks, domestic supply arrangements;
- Economic factors to remain at the current level however it is anticipated that prices and demand for oil, gas, iron ore will rise;
- Resource availability however there will be limits to workforce available, availability of drill rigs, dredging and installation vessels, etc. Increased constraints on the availability of suitably skilled workers and infrastructure is likely to push production costs up and potentially affect economic viability of projects (or at least returns on capital) and lengthen timeframes in bringing projects to fruition;
- Current quoted life/production expectations are correct however improved exploration techniques enhance the estimated reserves;
- Technology to remain at same level however in future technological developments are may make it possible to develop resources previously considered inaccessible or too costly to pursue;
- Only known prospects considered. The assessment covers know resource provinces only however there may be future exploration successes outside these provinces;
- Only considering companies currently operating in the region however an increased number of foreign companies are interested in the Northwest Marine Bioregion, bringing in capital that will increase drive for developments;
- Production not significantly affected by natural disasters however global climate changes may have an affect on the meteorologic and oceanographic characteristics of Northwest Marine Bioregion;
- Hydrocarbons remain as primary energy resource; and
- Exclude war, terrorist attacks and acts of god.

It should also be noted that only potential impacts to the marine environment are included in this assessment.

1.5 Consultation

In producing the report, IRC liaised with relevant industry stakeholders such as the Western Australian Department of Industry and Resources (DoIR) and the Australian Petroleum Production and Exploration Association (APASA) and operating companies in the Northwest Region.

To gather information on future operations in the Northwest Marine Bioregion IRC developed an online questionnaire. The questionnaire was aimed at gaining a better understanding of the petroleum and minerals sectors in the region and the likely nature of the sectors future interactions with the marine environment.

Note: It is not the Department's intention to include detailed or specific information on individual companies in the Bioregional Profile or subsequent products of the planning process. Were information on individual companies collected through the questionnaire to be included in planning publications, this would only occur with the expressed approval of the organisations involved.

1.6 IRC

IRC is an independent consultancy providing a variety of services to the mining, oil and gas exploration, production and financial industries. IRC's methods and tools have been developed to enable rapid, confident decision making, and to recognise the key decision criteria necessary to minimise risk and maximise value. IRC has an overall objective of assisting our clients improve their performance and increase the value of their assets. This is achieved by improving:

- safety performance through reducing the risk/cost associated with injury/fatality;
- environmental performance through reducing environmental damage and clean up costs; and
- production performance through optimising production uptime and availability of facilities and supply chains.

2 THE NORTHWEST MARINE REGION

2.1 Bioregion Overview

The Northwest Marine Region covers more than 1.07 million square kilometres of water under Commonwealth jurisdiction between Kalbarri and the Northern Territory (NT)/Western Australian (WA) border. The Region is divided into 8 provincial bioregional units under the Integrated Coastal and Marine Regionalisation of Australia (IMCRAv.4).

The area is characterised by an extensive continental shelf in the north as well as deeper in-shore environments. The Northwest provides some of the best examples of tropical and arid-zone mangroves in the world, and reefs of great diversity and productivity are found in-shore (in the south) and along the edge of the continental shelf.

The very narrow shelf of the Ningaloo Reef regions contributes to a unique deep water environment, located close to shore and supporting an abundant concentration of marine life including migrating whale sharks and dolphins. Surface waters in this part of the region are unusually productive.

North of North West Cape the broad shelf environment encompasses a series of off-shore islands and structures including the Barrow-Montebello-Lowendal complex of islands. Tsunamis and cyclones are major natural disturbances affecting this part of the region. Offshore are the headwaters of the Leeuwin Current, while surface waters, with relatively low productivity, are strongly influenced by the Indo-Pacific throughflow. Sub-surface waters, by contrast, are much more productive and responsible for a rich diversity of sponges and animals inhabiting the shelf floor.

As part of the Marine Bioregional Planning process, a Regional Profile will be developed by the Department describing the region's key habitats, species, natural processes, heritage values and human uses. A key outcome of marine bioregional planning will be the identification of marine protected areas (MPAs) as part of the National Representative System of MPAs and to complement the Ningaloo, Mermaid and Ashmore-Cartier MPAs already in the region. The process for identifying MPAs in the Northwest Marine Region will be outlined in detail in the Northwest Regional Profile. The Northwest Regional Profile will be completed in mid 2008. The draft Northwest Marine Bioregional Plan is intended to be completed twelve months after the release of the Regional Profile. The Department is committed to targeted and effective stakeholder consultation throughout the planning process.

Further information regarding the Region and the planning process is available from the Department's website.

3 THE MINERALS INDUSTRY

Production of other key mineral commodities during 2005-06 included 11.5 million tonnes of alumina, 161 tonnes of gold, 191 000 tonnes of nickel and 244 million tonnes of iron ore (DITR 2006a). The sector is experiencing rapid growth and projections indicate that sector output is likely to grow by 50-75% over the next decade (Chamber of Minerals and Energy, 2005).

3.1 Iron Ore

Currently, there are five operating iron ore export ports in the Northwest Marine Bioregion.

3.1.1 Port Hedland

Port Hedland is the major centre for the iron ore industry in WA and one of the largest mineral ports in the world.

The new BHP Billiton iron ore expansion project plans to extend the port from 70 Mtpa to 100 Mtpa and include a fourth shipping berth and iron ore processing and stockpiling facilities at Finucane Island, and rail upgrades (a new multi-user rail line).

BHP Billiton's Boodarie Iron Plant is WA's only iron ore secondary processing facility. The plant has four production trains, each with four reactors, which use reformed natural gas to change the ore's composition.

A below-harbour tunnel from BHP Billiton's Nelson Point handling facility was constructed primarily to convey Newman fines to Finucane Island and on to the Boodarie Iron plant. A conveyor in the tunnel and overland carries ore to the plant and the then hot briquetted iron (HBI) product back to Finucane Island for shiploading and export. A transmission line links Pilbara Energy's power station to the Boodarie Iron facility. A buried gas pipeline transports the feedstock gas (i.e. the reducing agent) from the power station to the HBI plant. The HBI plant has been decommissioned in 2003 (DOIR 2007).

3.1.2 Cape Preston

The Cape Preston Iron Ore Project has a deposit of over 1 billion tonnes of proven magnetite iron ore and an initial mine life of 25 years, at a production capacity of 12 million tonnes per annum of product (6 Mtpa of concentrate and 6 Mtpa of pellets).

Operated by CP Mining Management, a wholly owned subsidiary of CITIC Pacific Ltd created to manage this project.

All production will be exported, mostly to China. The project is greenfields (new development in an undeveloped location) and due to its remote location, will require the development of infrastructure.

Project development includes construction of production facilities, a port and materials handling facilities, a gas pipeline, a 25 km overland conveyor, a power station and water desalination plant and accommodation infrastructure (CPM 2007).

Austeel Pty Ltd plans to mine iron ore from the George Palmer Orebody on a pastoral lease about 25 km south of Cape Preston. Their plan is to mine 13.8 Mtpa of pellet iron and 4.7 Mtpa of direct reduced iron/hot briquetted iron. Products will be exported via a new port to be built at Cape Preston and Preston Island. Subsidiary components of the proposal include waste dumps, tailings storage facility, stockpiles, water desalination plant, power station and distribution network, onsite accommodation, a 25 km long transport corridor (for a conveyor and/or road) and a causeway from mainland Cape Preston to the port facility off Preston Island. Main shareholder is Mineralogy Pty. Ltd., who hold the mining leases over the George Palmer iron ore deposit, port facilities and infrastructure and has granted rights to Austeel to use part of its tenements for the development and operation of the project.

3.1.3 Cape Lambert

Port Walcott, in Cape Lambert, is owned and operated by Robe River Iron Associates, managed and maintained by Pilbara Iron (Rio Tinto). The port has a service wharf and an ore wharf (one of the deepest, longest and highest in Australia). The ore wharf is 2.8 km long, 30 m high and has two ship loaders servicing three berths. The port has facilities for train dumping, primary and secondary crushing and screening, ore stock piling and blending, and ship loading. The ship loading capacity is currently 55-57 Mtpa and further expansions are underway to expand its capacity to 80 Mtpa. Expansions will allow a concurrent berthing of four very large bulk carriers, replacement of original shiploader, an additional reclaimer in the stockyard, rail infrastructure, and the wharf will be extended 256 m to accommodate the new extension.

The Cape Lambert Iron Ore Project is located 10 km from Cape Lambert's iron ore port with direct connection to nearby infrastructure. Owned by Cape Lambert Iron Ore Ltd. it has a deposit of 2.5 billion tonnes (1.4 Bt indicated resource and 1.1 Bt inferred resource). The project is expected to be in production in late 2009, with production expected to be between 5 and 7 Mtpa. (Cape Lambert 2007 and Rio Tinto 2007).

3.1.4 Dampier

Dampier's port facilities are Hamersley Iron operated and wholly owned by Rio Tinto (Pilbara Iron) and located at Hampton Harbour and Mermaid Strait.

The port has two stock-handling yards and ship-loading terminals: Parker Point and East Intercourse Island. Dredging is planned to increase ship size and berthing and handling capacity.

The port facilities are set to expand from 74 Mtpa to 95 Mtpa. Expansion activities are mainly focused on Parker Point, with some minor works on East Intercourse Island, including

additional dust control measures. Expansion activities at Parker Point will include (Hamersley Iron 2007):

- dredging around Parker Point and channels;
- creation of a seawall and some land reclamation;
- new stockpile stackers and a new reclaimer;
- new rotary car dumper and rail track;
- new screen house;
- installation of new shiploader;
- extension of existing ship wharf to accommodate additional ship berths;
- modification to existing stockpiles; and
- relocation of bulk stockpiles.

Hematite mining and port facility owned and operated by Mount Gibson Iron (Aztec Resources Ltd.), located in Yampi Sound, off the northern Kimberly coast of WA.

Almost 70 Mt of high grade iron ore was mined from Koolan Island by BHP Billiton from 1959 to 1993. After take over by Mount Gibson Iron, production at Koolan Island recommenced in early 2007 with the first shipment achieved in June 2007 and it is forecast to produce up to 4 Mtpa of hematite when it reaches its targeted production rate in 2009.

Koolan Island iron ore is very high quality and low in impurities.

3.2 Salt

WA accounts for 93 % of Australia's salt production. The majority of operations are owned by Dampier Salt Ltd., with operations in Dampier, Karratha and Lake McLeod. Smaller operations in the NW are owned by Onslow Salt Pty. Ltd., in Onslow and Shark Bay Salt Joint Venture at Useless Loop.

3.2.1 Dampier

Dampier Salt Ltd., (Dampier Salt) is the world's largest exporter of high quality bulk solar salt, with current exports at approximately 3.5 Mtpa. Dampier Salt is owned and operated by Rio Tinto Minerals. Dampier Salt operations are located at Hampton Harbour and Mermaid Strait through a wharf for bulk export at Mistaken Island, which is connected to the mainland via a causeway. Dedicated stockpiling facilities are located at Mistaken Island and the port of Port Hedland.

Salt is produced from seawater at Dampier and Port Hedland. Seawater flows into a series of ponds and evaporation results in the water becoming progressively more concentrated and then pumped into crystallisers at a rate of approximately 300 mmpa (Dampier Salt

2007). Approximately once a year the crystallisers are harvested and a total of approximately 4 Mtpa of salt is harvested for cleaning before export.

Salt from Lake McLeod is from a natural salt-rich aquifer which lies below the surface of the lake. The same processes for crystallisation, harvesting, cleaning and stockpiling are used, but salt from Lake McLeod is shipped from dedicated facilities at Cape Cuvier. Current export is approximately 2.8 Mtpa.

Gypsum is also mined at Lake McLeod using a floating dredge and shipped from Cape Cuvier.

3.2.2 Onslow

Onslow Salt Pty. Ltd., is 92 % owned by Japanese company Mitsui & Co., Ltd.

Salt is collected via a process similar to that used by Dampier Salt. The ship loader is located on a platform positioned at the end of the jetty at the Onslow Port, which extends approximately 1.5 km out from shore. Approximately 2.5 Mtpa of salt is exported from Onslow.

3.2.3 Shark Bay

Shark Bay Salt Joint Venture (SBSJV) at Useless Loop is operated by Mitsui & Co., Ltd., currently produces 1.3 Mt of salt per year and has a planned capacity of 1.4 Mt per year.

SBSJV exports the purest grade salt in the world from its Useless Loop solar salt mine.

There is a proposal to dredge the existing shipping channel in Freycinet Estuary. The channel is used to transport salt from the ship loading facility at Slope Island.

3.3 Other (Ammonia, base metals)

Burrup Fertilisers Pty. Ltd. has recently constructed a liquid ammonia plant on the Burrup Peninsula, near Karratha. Production started in April 2206 and the first export shipment was made from the Dampier Port in June 2006. Current production capacity is 760 000 tpa and is one of the world's largest ammonia production facilities (Burrup Fertilisers 2007).

Ammonia is derived from natural gas and the liquid ammonia is transported via an export pipeline through the Burrup East West Services corridor and exported from the recently constructed Dampier Bulk Liquids Berth.

4 THE PETROLEUM SECTOR: CURRENT OPERATIONS & INFRASTRUCTURE

4.1 Introduction

The Northwest Marine Region is the major region for the production of petroleum products (crude oil, liquefied natural gas (LNG), liquefied petroleum gas (LPG), domestic gas and condensate) with over 70% of crude oil and condensate production. The Northwest Marine Bioregion also accounts for over 90% of current Australian gas reserves.

In 2005-06 the total value of WA petroleum sales was $15.2b. This was a 23% increase over 2004-05 in spite of an overall decline in production as existing fields mature. The major contributor was crude oil sales (43.3%) followed by LNG (30.3%), condensate (18.1%), natural gas (4.6%) and LPG (3.7%) (DOIR 2007).

LNG output from Western Australia could triple over the next 10 to 15 years to 150 million tonnes per annum. Growth in output was over 20% since 2005 and Western Australia holds an estimated 140 trillion cubic feet of gas reserves. The major LNG projects under development are summarised in Section 5.

Typical onshore and offshore facilities are presented in Figure 4.1 and Figure 4.2 respectively.

The North West Shelf areal subdivisions, distribution of exploration wells and location of key wells are presented in Figure 4.3.

The major hydrocarbon field locations and regional bathymetry map of the North West Shelf are presented in Figure 4.4.

The existing petroleum infrastructure is presented in Figure 4.5 to Figure 4.7.

4.2 Major Onshore Production Facilities

There are currently five onshore oil and gas production facilities located adjacent to the Northwest Marine Region. These are the Woodside Energy operated Karratha Gas Plant on the Burrup Peninsula (Dampier), the BHP Billiton operated Turbridgi Gas Plant to the south-west of Onslow, and the island based facilities on Barrow, Thevenard and Varanus islands.

4.2.1 Karratha Gas Plant

The Woodside Energy operated Karratha Gas Plant (Figure 4.1) located on the Burrup Peninsula (Dampier) produces domestic gas for WA markets and LNG, LPG and condensate for export. The Karratha Gas Plant is currently the only facility operating in WA producing LNG, LPG and condensate for export.

The gas and condensate is supplied from three offshore production facilities – the North Rankin A and Goodwyn A platforms and the Cossack Pioneer Floating Production, Storage and Offloading (FPSO) facility approximately 130 km north of the Karratha Gas Plant. After initial processing on the offshore facilities the gas and condensate is transported by two sub-sea pipelines to the Karratha Gas Plant.

Woodside Energy currently exports approximately 12.5 million tonnes of LNG primarily to Japan but also to other markets such as South Korea and China. Sales are governed by long term contractual requirements with limited spot sales made. Production capacity was most recently increased in 2004 with the start-up of the fourth LNG production train with a capacity of 4.2 million tonnes per annum. The LNG, predominantly a mixture of methane and ethane, is transported at atmospheric pressure and -162^0 C in specially designed cryogenic bulk carriers, typically 120,000 to 135,000 m^3 capacity. Currently, LNG exports involve 160 to 180 cargo movements per annum.

Figure 4.1 The Woodside Karratha Gas Plant (Source: Woodside)

LPG exports from the Karratha Gas Plant are currently approximately 1.5 million tonnes per annum shipped to Japan. LPG production involves the individual separation and storage of propane and butane hydrocarbons. Shipping is via specially designed refrigerated carriers with separate holds for the propane and butane that is stored at -43^0 C (propane) and -1^0 C (butane).

Condensate exports from the Karratha Gas Plant in 2006 were 3.3 million tonnes which is sold into markets in both Asia and America. Condensate is a light (highly volatile) crude oil (API 60^{o}) comprised predominantly of five to ten chain hydrocarbons (Woodside 2007).

4.2.2 Tubridgi Gas Plant

The Tubridgi gas processing facility can receive gas via a submarine pipeline from Thevenard Island and the Griffin Venture offshore field. The processed gas is fed into the WA domestic gas market via the Dampier to Bunbury Gas Pipeline (DBGP). Up to 40 TJ/d of sales gas is metered and into the DBGP via a 250 mm, 90 km pipeline lateral and on-sold into the domestic gas market.

4.2.3 Barrow Island

The Barrow island oilfield was discovered in 1964 and commenced production in 1967. While the field had an initial life expectancy of 30 years, current production expectation extends out to 2019 (55 years). Currently, there are 474 oil production wells producing 6 500 bbl/day from eight oil producing formations (DOIR 2003, World Oil 2007 and Santos 2007).

Processed oil is stored in five 200 000 bbl tanks, then transported via a 10 km long, 508 mm diameter sub-sea pipeline connected to an offshore mooring system and then loaded into tankers.

The facilities currently also receive oil and gas from other producers in the area.

4.2.4 Thevenard Island

Production commenced in 1989 and currently the facilities receive oil and gas from five fields. Current oil production is 3 000 bbl/day and gas production is (Santos 2007).

Processed crude oil is stored in tanks prior to tanker loading via a 7 km long, 602 mm diameter sub-sea pipeline connected to an offshore mooring system.

Processed gas is transported via a 44 km long, 610 mm diameter export line which extends from Thevenard Island to the mainland via the Roller and Skate monopods, then overland to the Tubridgi facilities where the bulk of gas is then transported via the onshore Tubridgi pipeline and the DBGP to the Mondara Gas Field in the Perth Basin.

4.2.5 Varanus Island

The Varanus island facilities process oil and gas from a number of adjacent fields and operate under an infrastructure sharing agreement between the Harriet Joint Venture and East Spar Joint Venture. Production commenced in 1986.

Process oil is stored in three 225 000 bbl tanks and is exported via a 3.5 km long, 762 mm diameter sub-sea pipeline connected to a tanker mooring facility. Gas production at East Spar is 114 mmscf/day and condensate is 6 000 bbl/day.

The process gas is exported via one of two 100 km long (324 and 406 mm diameter) sub-sea pipelines connecting to the DBGP and Goldfields Gas Transmission (GGT) pipeline.

Condensate is stored in tanks on the island before being loaded into tankers and then exported (Apache 2007).

4.3 Major Offshore Production Facilities

There are currently 9 Floating Production, Storage and Offloading (FPSO, typical example show in Figure 4.2) facilities and two production platforms with offloading facilities operating in the Northwest marine region.

FPSO's are selected typically as economic options for smaller and/or deeper oil reserves with lower gas to oil ratios with relatively shorter production outlooks. FPSO's may be permanently moored at the location or have the ability to disconnect from the turret to avoid a pending cyclone threat or for maintenance requirements.

Typically each FPSO will have a number of sub-sea production wells tied back to sub-sea manifold/s that are connected via a riser system and turret connection to the FPSO. For some fields the gas and oil may require the installation of sub-sea pumps to enable extraction at commercially viable rates. Crude oil is offloaded via flexible export lines to tankers temporally moored behind the FPSO.

Figure 4.2 The Woodside Nganhurra FPSO on location at Enfield (Source: Woodside)

Gas associated with the extracted oil is separated and either exported via a pipeline to an offshore facility or, in the absence of export capability, is compressed and re-injected via a dedicated re-injection well. A portion of the gas can also used as a power source for the facilities.

Operating fields typically face declining production output as they mature. For example the combined decline in production from the Harriet, Griffin, Woolybutt, Legendre and Wanaea

fields was 20MMbbl in 2005-06 or approximately 25% of total crude oil production from the previous year. This was partly compensated for by new projects starting production in 2005-06. Production is therefore a product of the number of operating fields and production profile for each field for the period.

Table 4.1 Current Floating Production, Storage and Offloading Facilities (FPSOs)

Facility	Operator	Field Discovered	First Production	Field Depth (m)	Onboard Storage bbl	API
Challis FPSO	Coogee Resources	1983	1989	120	880,000	40
Cossack- Pioneer FPSO	Woodside Energy	1989	1995	80	1,150,000	
Elang/Kakatua FPSO [1)]	ConocoPhillips	1994	1998	90	750,000	56
Enfield FPSO	Woodside Energy	1998	2006	400-550	900,000	22
Griffin FPSO	BHP Billiton	1989	1994	~600	820,000	
Jabiru FPSO	Coogee Resources	1984	1986	120	1,055,00	40
Lamininaria-Corillina FPSO	Woodside Energy	1994	1999	390	1,400,000	58
Legendre Production Platform & FSO	Woodside Energy	1968	2001	60	900,000	43
Mutineer-Exeter FPSO	Santos	1997	2005	150	930,000	43
Stag Production Platform & FSO	Apache Energy	1993	1998	47	700,000	19
Wandoo Production Platform	Vermillion Oil & Gas Australia	1991	1993	55	400,000	19
Woollybutt FPSO	Eni Australia	1997	2003	550	580,000	49

1) This facility is just outside the Northwest Marine Bioregion.

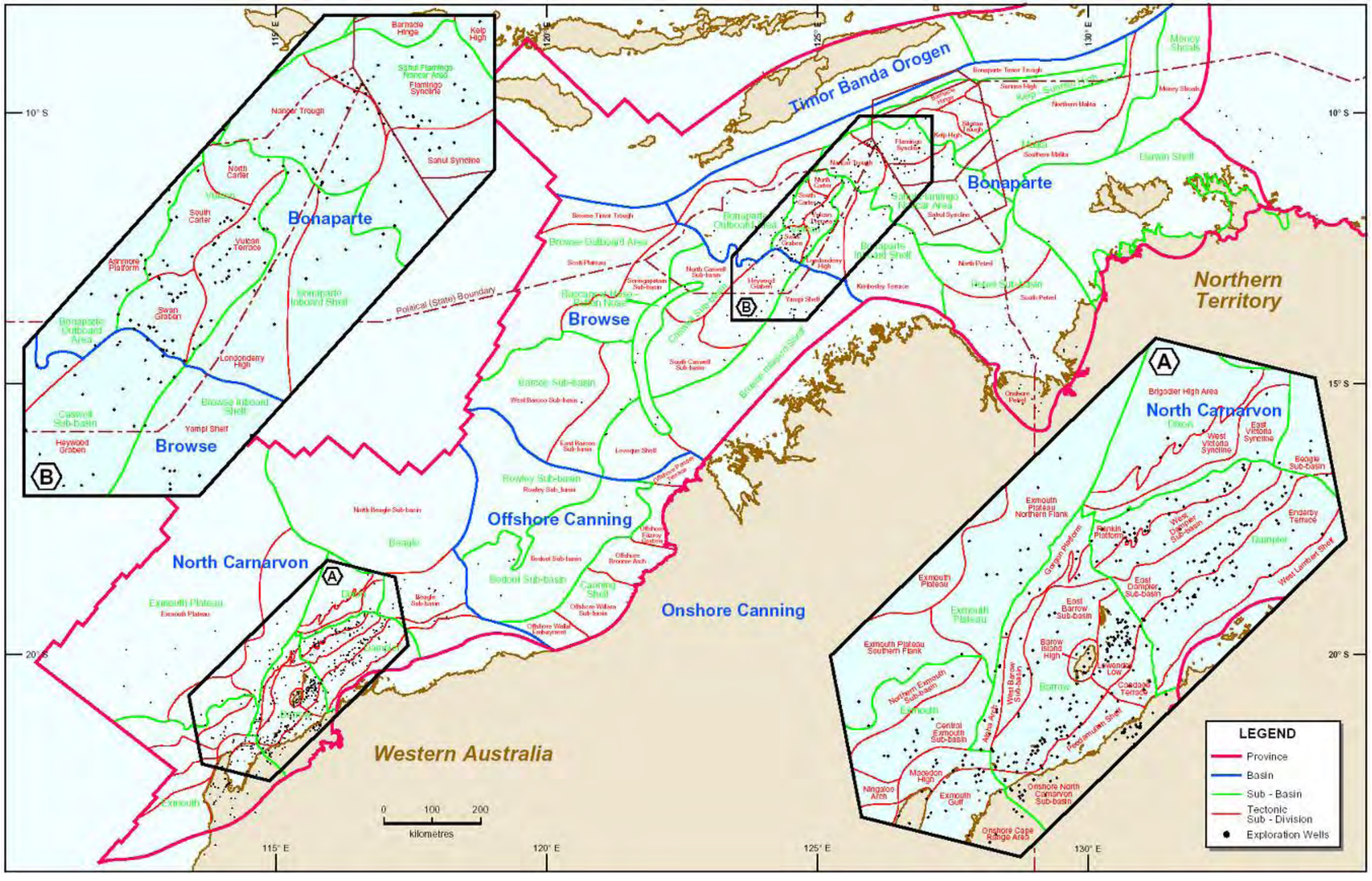


Figure 4.3 North West Shelf Areal Subdivisions, Distribution of Exploration Wells and Location of Key Wells (source: http://www.searchanddiscovery.net)

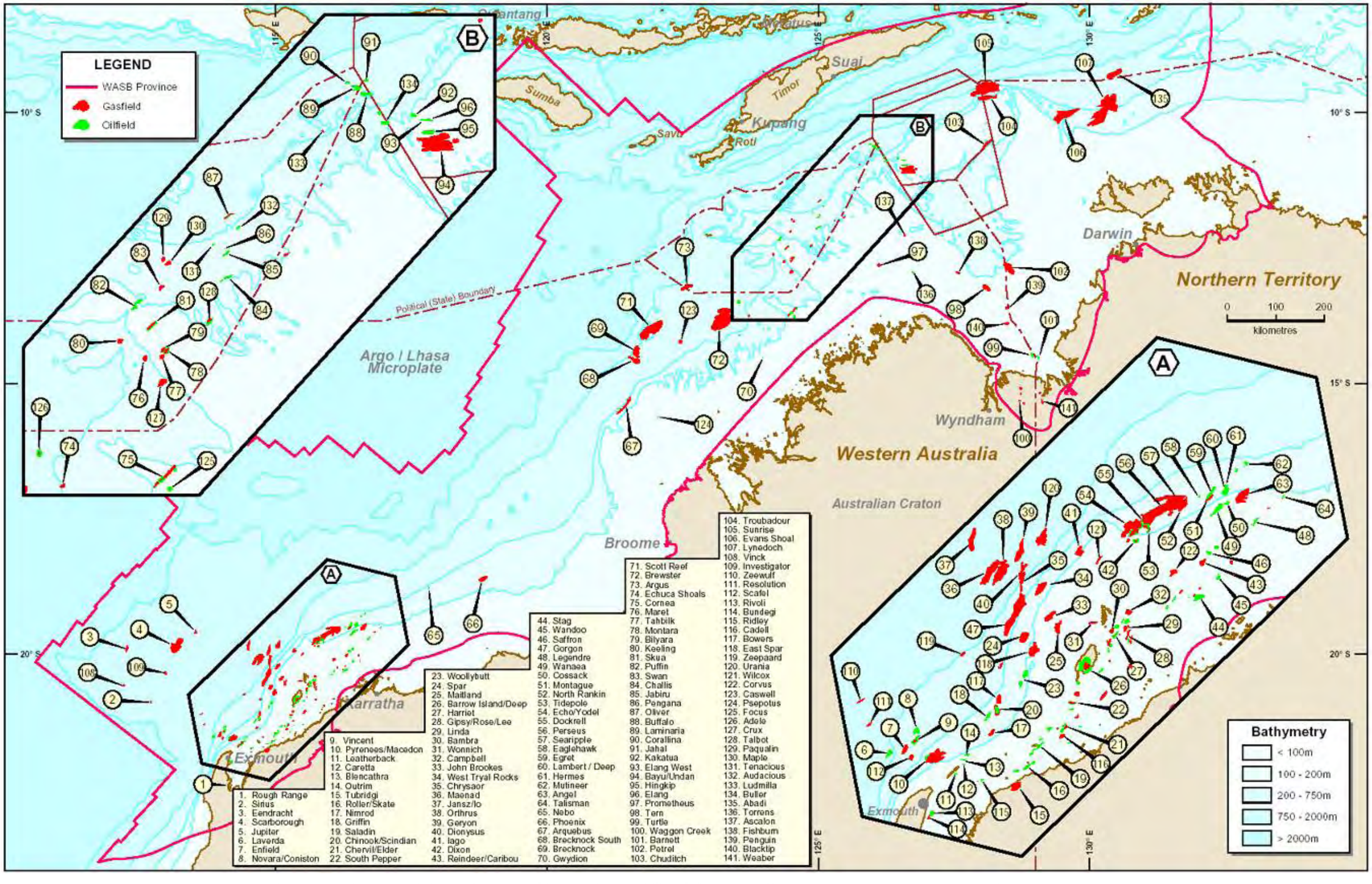


Figure 4.4 Major Hydrocarbon Field Locations and Regional Bathymetry Map of the North West Shelf. (source: http://www.searchanddiscovery.net)

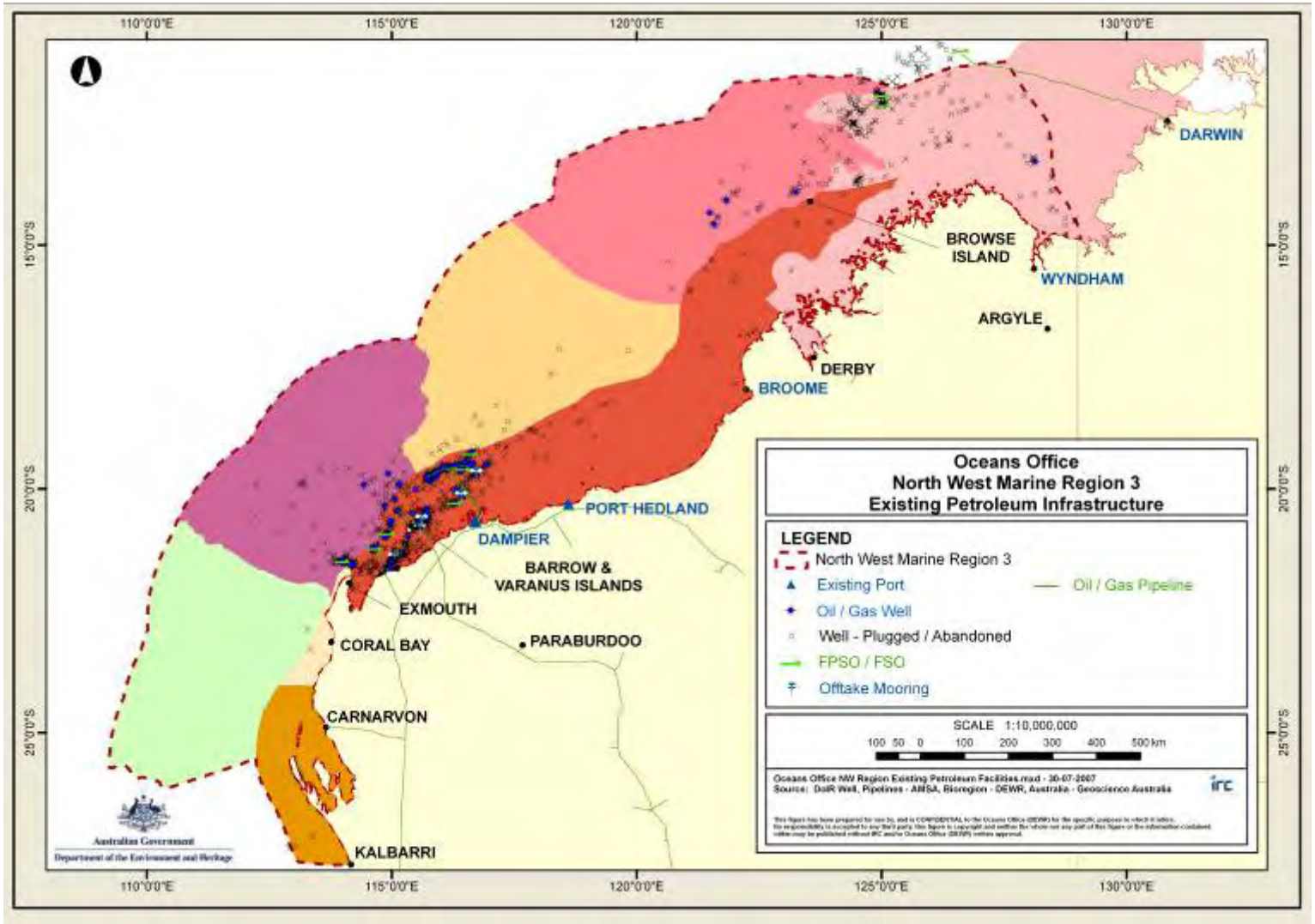


Figure 4.5 Existing Petroleum Infrastructure

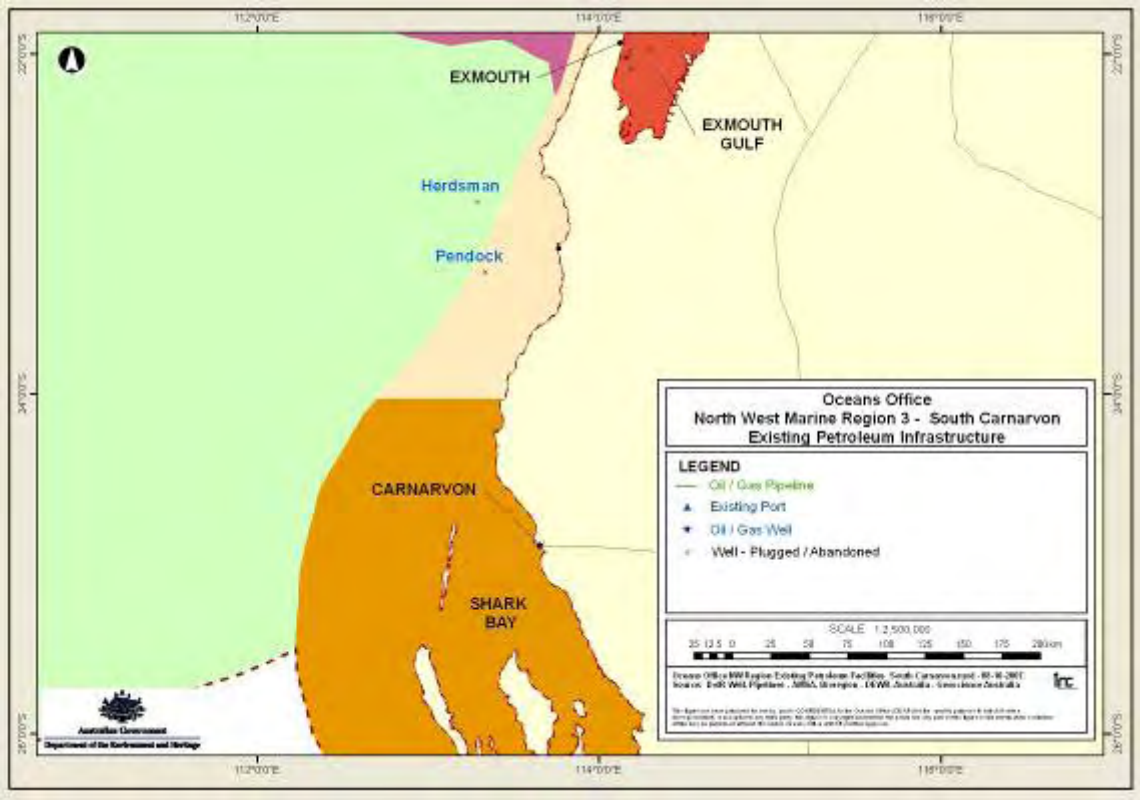


Figure 4.6 Existing Petroleum Infrastructure – South Carnarvon

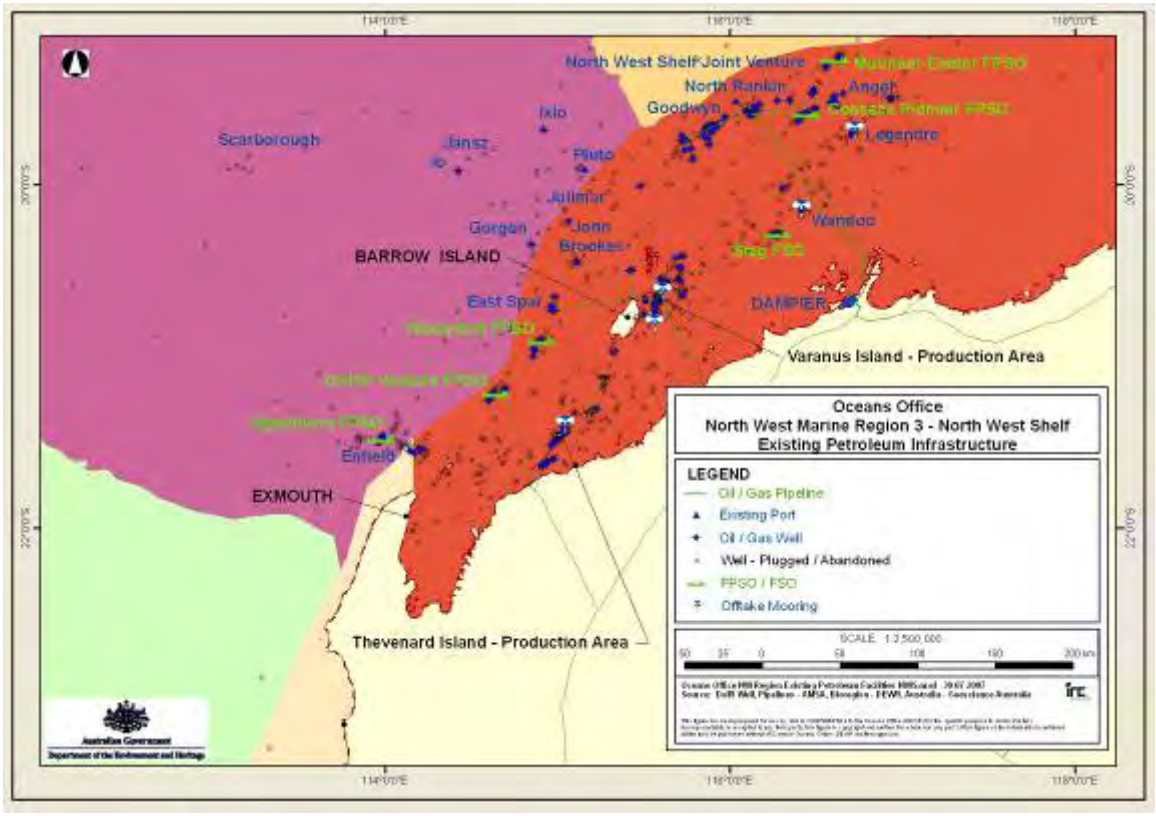


Figure 4.7 Existing Petroleum Infrastructure – North West Shelf

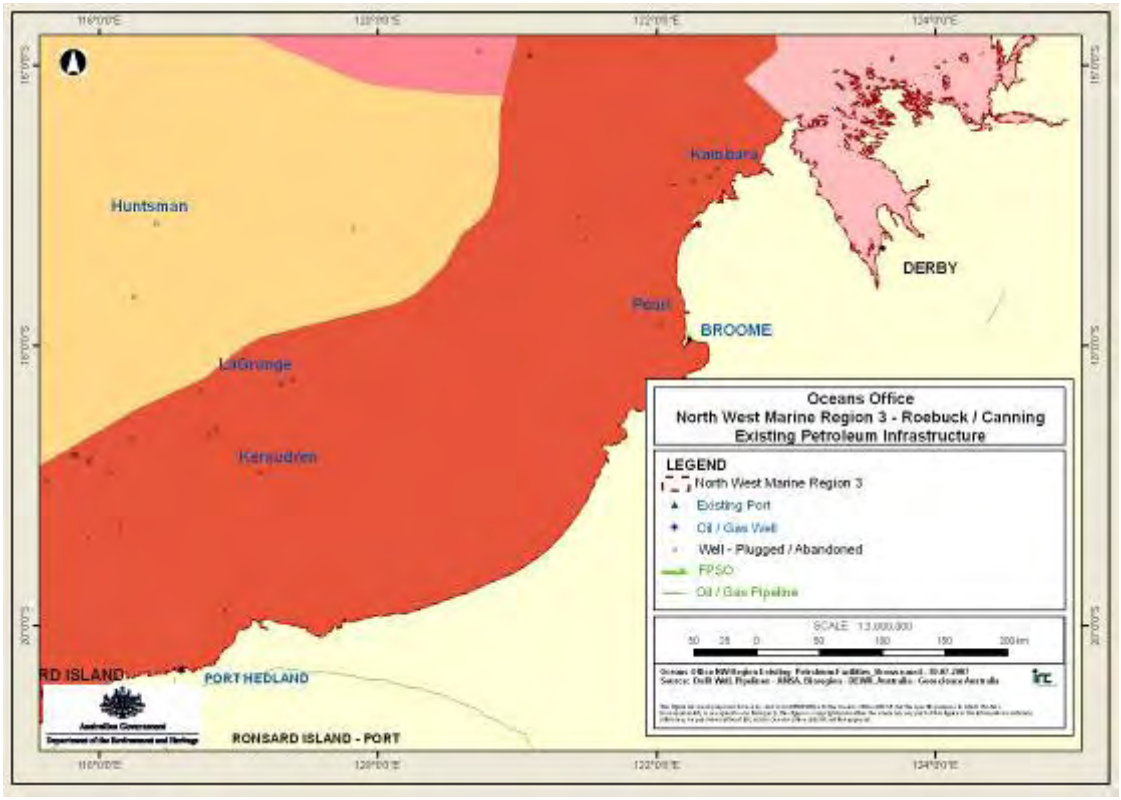


Figure 4.8 Existing Petroleum Infrastructure – Roebuck / Canning Basin

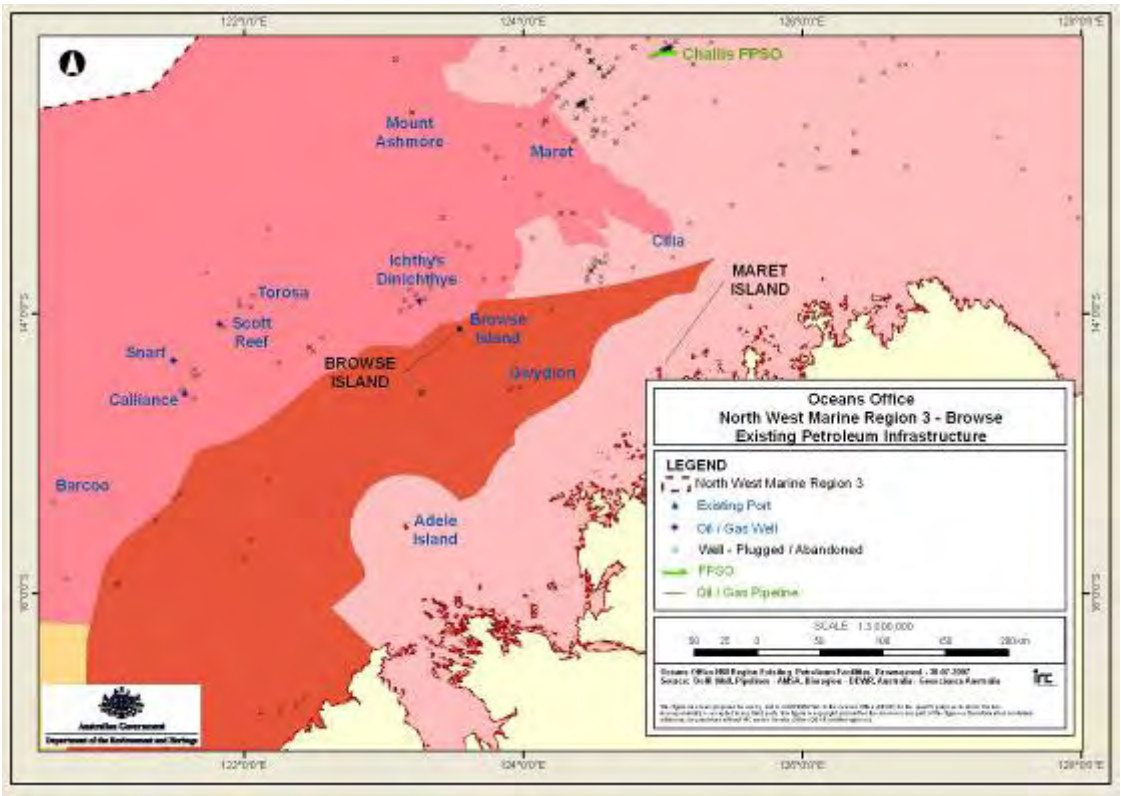


Figure 4.9 Existing Petroleum Infrastructure – Browse Basin

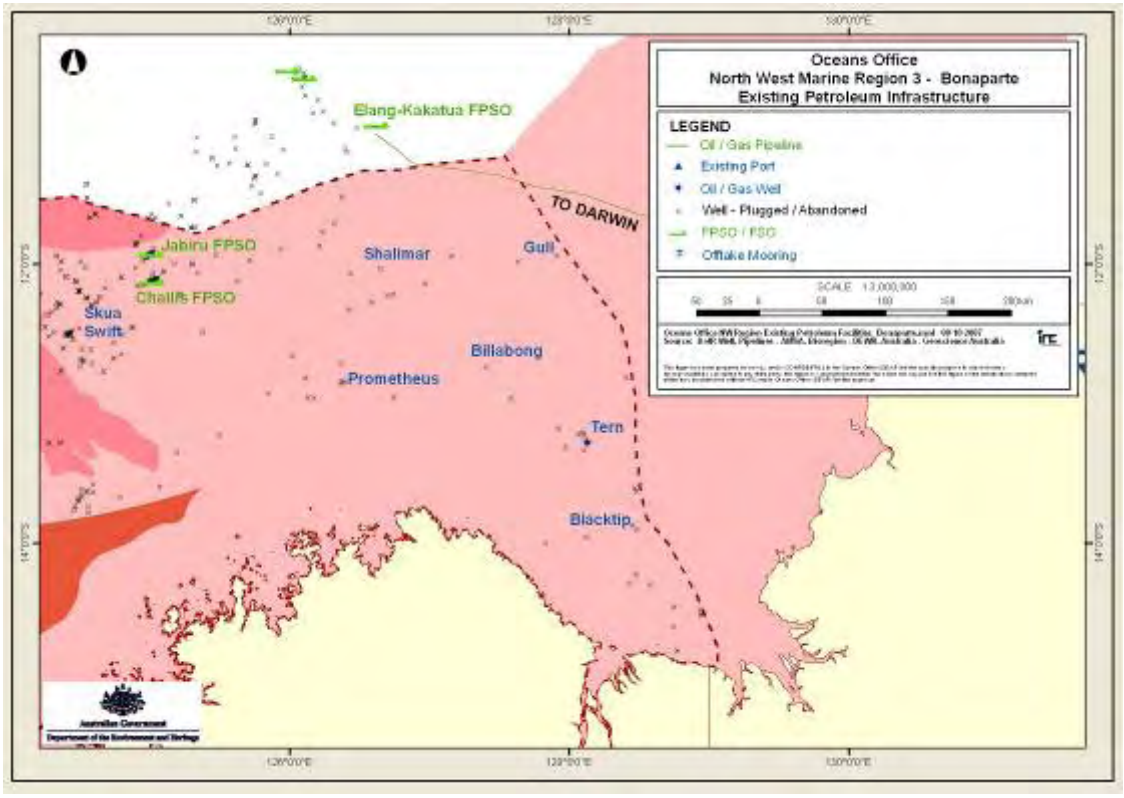


Figure 4.10 Existing Petroleum Infrastructure – Bonaparte Basin

5 THE PETROLEUM SECTOR: ANTICIPATED EXPANSION

The primary focus of petroleum exploration has been the offshore northern Carnarvon basin, where field development and infrastructure continue to grow. Planning is underway for 20 new petroleum projects involving a minimum $22 billion investment over the next few years. Most of the future oil developments come from Exmouth Sub-basin fields and contain heavy oil. The current boom in the liquefied natural gas (LNG) market underpins a number of LNG developments, and it is expected that industry will apply to develop other LNG projects in the near future. The majority of these oil and LNG developments are expected to come on stream during the coming decade.

The likely expansion of the petroleum industries in and adjacent to the Northwest Marine Bioregion is summarised in Table 5.1 and Figure 5.1 presents an overview of the currently planned future and proposed petroleum infrastructure Table 5.4 and Table 5.5 zoom in on the North West Shelf and the Browse basin and present a generalised assessment of the main environmental aspects, values and sensitivities.

5.1 Production and Reserves

The northern Carnarvon basin at present is by far the largest producing basin in Western Australia with 97% of WA's oil and gas production. Western Australian sedimentary basins currently hold more than 80% of Australia's discovered natural gas resources. The number of developed and producing fields has almost doubled over the past decade. Currently there are 67 producing fields.

A peak in oil production is expected around 2008-09 mainly attributable to the development of heavy oilfields in the Exmouth Sub-basin), though there is a sharp decline after this point. Between 2010 and 2020, condensate production from gas condensate fields will play a key role in maintaining WA liquid hydrocarbon production in the future. Since condensate production comes principally from LNG developments, the forecast decline in condensate production is much slower than the decline in oil production. Future gas production is committed to upcoming LNG projects.

Table 5.1 Summary Petroleum Projects in the Northwest Bioregion

Facility	Operator	Status	Construction Period	Operational Period	Decommissioning Period	Basin	IMCRA Region
Existing							
Challis FPSO	Coogee Resources	Operational	1989			Bonaparte	Northwest Shelf Transition
Cossack- Pioneer FPSO	Woodside Energy	Operational	1995	1995 - 2020	2020 - 2030	Carnarvon	Northwest Shelf Province
Elang/Kakatua FPSO	ConocoPhillips Petroleum	Operational	1998			Bonaparte	Outside of IMCRA Region.-
Enfield FPSO (Nganhurra)	Woodside Energy	Operational	2006	2006 - 2026	2026 - 2036	Carnarvon	Northwest Shelf Province
Griffin FPSO	BHP Billiton	Operational	1989	1994	2014 - 2024	Carnarvon	Northwest Shelf Province
Jabiru FPSO	Coogee Resources	Operational	1984	1986	2006 - 2016	Bonaparte	Northwest Shelf Transition
Lamininaria-Corallina FPSO	Woodside Energy	Operational	1994	1999	2019 - 2029	Bonaparte	Northwest Shelf Transition
Legendre Production Platform & FSO*	Woodside Energy	Operational	1968	2001	2021 - 2031	Carnarvon	Northwest Shelf Province
Mutineer-Exeter FPSO	Santos	Operational	1997	2005	2025 - 2038	Carnarvon	Northwest Shelf Province
Stag Production Platform & FSO	Apache Energy	Operational	1993	1998	2018 - 2028	Carnarvon	Northwest Shelf Province
Wandoo Production Platform	Vermillion Oil & Gas Australia	Operational	1991	1993	2013 - 2023	Carnarvon	Northwest Shelf Province
Woollybutt FPSO (Four Vanguard)	Eni Australia	Operational	1997	2003 -	2023 - 2033	Carnarvon	Northwest Shelf Province
Wandoo	Vermillion Oi & Gas Australia	Operational	2003	2003 - 2020	2020 - 2030	Carnarvon	Northwest Shelf Province
Future							
Stybarrow FPSO (MV16)	Coogee Resources	Commissioning	2005 - 2007	2007 - 2017	2017 - 2027	Carnarvon	Northwest Province
Pyrenees FPSO	Woodside Energy	Construction	2006 - 2010	2010 - 2035	2035 - 2045	Carnarvon	Northwest Province
Vincent FPSO (Ellen Maersk)	Woodside Energy	Construction	2006 - 2008	2008 - 2015/2028	2015/2028 - 2038	Carnarvon	Northwest Province
Montara FPSO	Coogee Resources	Planning	2007 - 2009	2009 -	2029 - 2039	Browse	Northwest Shelf Transition
Pluto	Woodside Energy	Planning	2005 - 2010	2010 -	2030 - 2040	Carnarvon	Northwest Province

Facility	Operator	Status	Construction Period	Operational Period	Decommissioning Period	Basin	IMCRA Region
Angel	Woodside Energy	Construction	2005 - 2008	2008 -	2028 - 2038	Carnarvon	Northwest Shelf Province
Scarborough & Onslow LNG Plant (onshore)	BHP Billiton Petroleum	Planning	2003 -2011	2011 -	2031 -2041	Carnarvon	Northwest Province
Browse - Ichthys	Inpex	Planning	2006 - 2012	2012 -	2032 - 2042	Browse	Timor Province
Gorgon	Chevron	Planning	2006 - 2010	2010 -	2030 – 2040	Carnarvon	Northwest Province
Browse - Scott Reef, Brecknock, Snarf, Torosa, Calliance	Woodside Energy	Planning	2007 - 2011	2011/2014 -	2031/2034 – 2041/2044	Browse	Timor Province
Van Gogh and FPSO (MT Kudam)	Apache Energy	Planning/ Construction	2007 - 2009	2009 -	2029 – 2039	Carnarvon	Northwest Province
Tern, Petrel	Santos	Planning	1969 -			Bonaparte	Northwest Shelf Transition
Blacktip	Eni	Planning/ Construction	-2009	2009 -	2029 – 2039	Bonaparte	Northwest Shelf Transition
Io, Jansz	ExxonMobil	Planning/ Construction	1999 -	20 years		Carnarvon	Northwest Province
Reindeer	Apache Energy	Planning/ Construction	1997 -			Carnarvon	Northwest Shelf Province
Julimar	Apache Energy	Planning/ Construction	2007 -			Carnarvon	Northwest Province

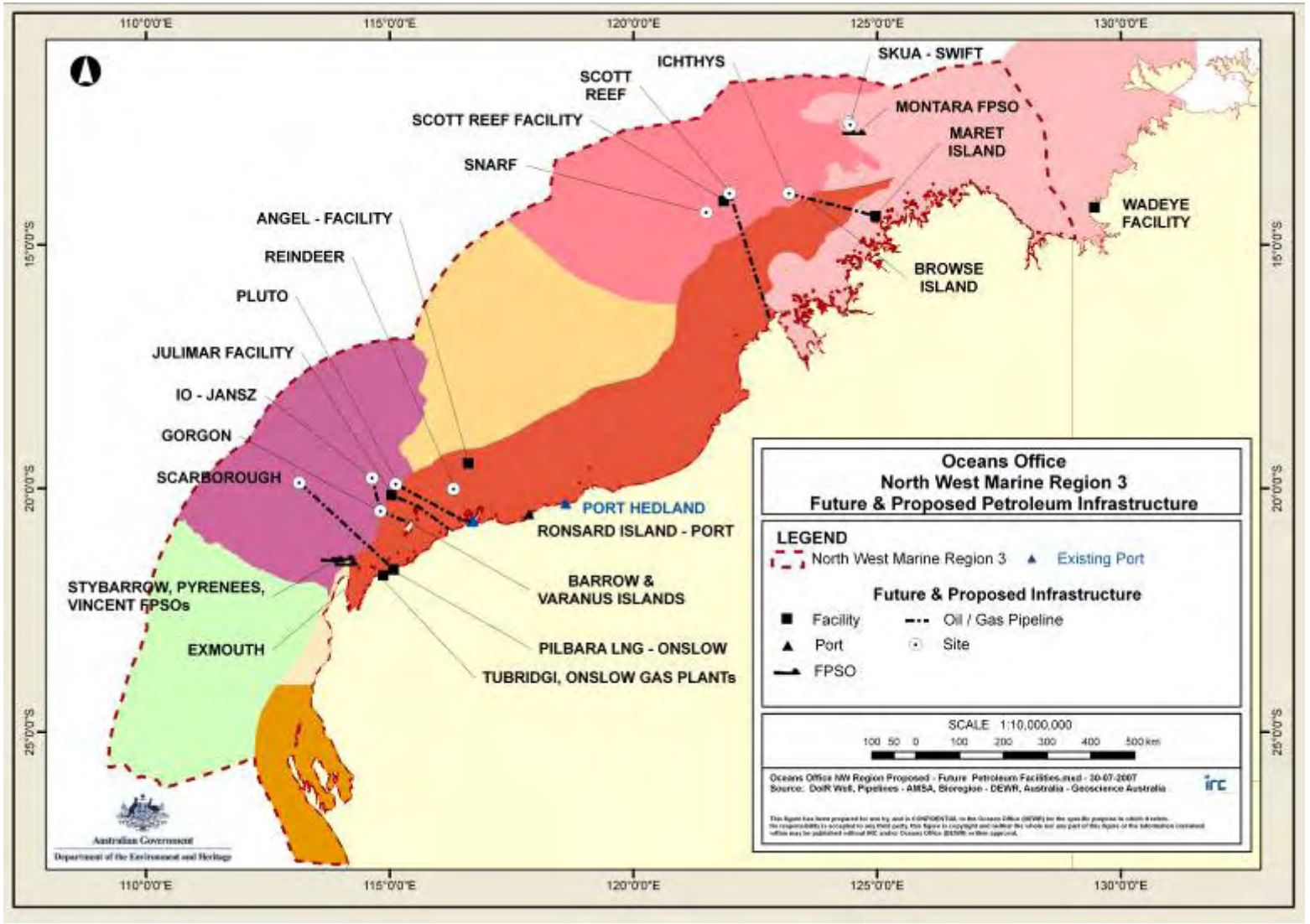


Figure 5.1 Future and Proposed Petroleum Infrastructure – Overview

5.2 Future Oil Developments

The majority of WA's new oil developments are located in the Exmouth Sub-basin. These include a series of significant discoveries, namely, Enfield, Vincent, Pyrenees, Stybarrow and Laverda, which contain more than 48 GL (300 MMbbl) of heavy crude reserves. These fields are expected to come on stream before the end of this decade and their combined initial production is estimated at nearly 40 000 kL/d (250 000 bbl/d).

The development of these fields represents a number of technical challenges. The oil in these fields is heavy (17–22° API), has relatively high viscosity (7–11 cp), and some of these fields have thin oil legs. As such, their production would decline very rapidly. These fields are situated close to an environmentally sensitive area: the Ningaloo Marine Park, which requires additional precautions in the development process.

5.2.1 Stybarrow-Eskdale Development (Operator, BHP Billiton)

The Stybarrow oilfield is located in WA-255-P (2) in the Exmouth Sub-basin, approximately 65 km from Exmouth. Stybarrow is a joint venture with Woodside Energy Limited.

At a water depth of 825 metres, this will be by far the deepest oilfield development ever undertaken in Australia. The Eskdale oil- and gasfield is situated 12 km northwest of Stybarrow in the same permit block. Mean recoverable oil reserves are estimated at 14.3 GL (90 MMbbl) of oil.

The proposed development includes a Floating Production Storage and Offloading (FPSO) facility. First production is expected in the first quarter of 2008 with an estimated economic life of about 10 years.

5.2.2 Pyrenees Development (Operator, BHP Billiton)

BHP Billiton has announced its intention to develop the Pyrenees cluster of oilfields (Ravensworth, Crosby, Stickle and Harrison). These fields are situated in the Exmouth Sub-basin about 45 km northwest of Exmouth, in water depths of approximately 200 metres. Potential recoverable oil reserves are estimated at 47.7 GL (300 MMbbl) of oil equivalent.

Subsea wells will be connected to a FPSO facility. It is planned that first oil will be produced from these fields in late 2008. The expected field life is 20 to 25 years.

5.2.3 Vincent Development (Operator, Woodside Energy)

The Vincent oilfield is located in Production Licence WA-28-L and Exploration Permit WA-271-P, about 50 km northwest of Exmouth. The water depth is about 350 metres.

Woodside is the operator (60%) on behalf of its joint venture partner Mitsui E&P Australia Pty Ltd (40%).

With estimated recoverable reserves of around 11.4 GL (72 MMbbl), first oil is targeted for 2008. Field life is estimated at 10 to 20 years.

5.3 Future Gas and Gas Condensate Developments

WA's North West Shelf has estimated natural gas resources of more than 3168 Gm^3 (130 Tcf). Australia is strategically located to supply LNG throughout the Asia Pacific region with LNG exports playing an increasingly important role in the Western Australian energy scene.

In the next decade several significant gas discoveries such as Greater Gorgon, Jansz-Io, and Scott Reef-Brecknock, each in excess of 560 Gm^3 (20 Tcf), will be bought on stream supplying export LNG. These forthcoming developments include fields that were regarded as stranded gas when they were discovered 20 to 30 years ago.

While some of these gasfields contain significant condensate reserves, producing this condensate would depend on the timeframe of the LNG contracts. Fields with a low condensate-gas ratio (CGR), ie. less than 56 m^3/Mm^3 (10 bbl/MMscf), such as Gorgon, Jansz-Io, and Scarborough, would not have a significant contribution to condensate production. However, for Ichthys, with a CGR of over 280 m^3/Mm^3 (50 bbl/MMscf), and Brecknock fields, which are expected to have a combined daily condensate production of 12.7 ML/d (80 000 bbl/d) sustainable for more than 20 years, the contribution is much more significant.

5.3.1 Angel Development (Operator, Woodside Energy)

The Angel gas-condensate field is located approximately 53 km east-northeast of the North Rankin A platform (NRA) and some 123 km northwest of the onshore gas plant at Dampier in 80 metres of water. The field lies entirely within Production Licence WA-3-L. Woodside Energy Ltd operates the Angel field on behalf of the North West Shelf Joint Venture (made up of Shell Development (Australia) Pty Ltd, BHP Petroleum (North West Shelf) Pty Ltd, BP Developments Australia Pty Ltd, Chevron Australia Pty Ltd, Japan Australia LNG (MIMI) Pty Ltd, and Woodside Energy Ltd, each having a one-sixth share).

Development includes the installation of a platform based production infrastructure with a design life of 20 years, which may facilitate future, phased development of satellite fields. The field is expected to come on stream by the third quarter 2008.

5.3.2 Gorgon Development (Operator, Chevron)

The Gorgon gasfield is situated 130 km off the northwest coast of WA and 65 km from Barrow Island. The Gorgon gasfield has certified proven hydrocarbon gas reserves of around 280 Gm3 (10 Tcf). The field is jointly owned by Chevron (50%), Shell (25%), and ExxonMobil (25%).

The field development concept consists of sub-sea wells arranged in several production centres over the field, tied back to gas processing facilities on Barrow Island via a 70 km pipeline. A gas connection will be installed from Barrow Island either to the mainland direct or to the existing offshore network some time in the future, thereby allowing Gorgon gas to be sold into the domestic market.

The Gorgon Joint Venture is committed to the responsible management of greenhouse gas emissions and plans to inject Gorgon CO2 into a saline aquifer under Barrow Island. The Gorgon project is envisaged to come into operation in 2010 with two 5 million tonnes per annum LNG trains on Barrow Island.

5.3.3 Jansz-Io Development (Operator, ExxonMobil)

The Jansz-Io field extends across the WA-18-R, WA-25-R and WA-26-R retention leases. WA-18-R covers the central and northwestern part of the field and is operated by ExxonMobil (with a 50% equity), with the remaining interest being held by Chevron Australia Ltd. WA-25-R and WA-26-R are operated by Chevron (50%) on behalf of a joint venture that also includes ExxonMobil (25%), BP Exploration (Alpha) Ltd (12.5%) and Shell (12.5%). ExxonMobil, as the operator of the Jansz-Io development project, intends to develop the Jansz-Io resource in a cooperative development linked to the Gorgon Development Project. Both the Gorgon field development and the LNG plant construction will be operated by Chevron.

A framework Agreement was reached in May 2005 between some of the companies having equities in the Greater Gorgon – Jansz area (Chevron, ExxonMobil and Shell). The Joint Venture participants have agreed to align their equity interests in individual licences in the Greater Gorgon area.

The development scheme proposed by the operator is based on gas production for more than 40 years with an average annual rate of 210 Mm3/d (740 MMscf/d). It is estimated that the field will produce at a plateau rate for approximately 20 years. The field is expected to come on stream by 2012.

5.3.4 Pluto Development (Operator, Woodside Energy)

The Pluto field is located in permit WA-350-P (100% Woodside), about 185 km northwest of Dampier. Pre-drill assessment suggests that the Pluto prospect could contain about 70.7 Gm3 (2.5 Tcf) of gas.

Woodside plans to have the project on stream by late 2010. As sole owner of the Pluto field, Woodside is eager to build a five to seven million tonnes per year project to boost its direct share of the world LNG trade.

5.3.5 Scarborough Development (Operator, ExxonMobil)

The Scarborough gas field is located in around 900 metres of water and about 280 km offshore, with probable reserves of approximately 226 Gm3 (8 Tcf) of gas. ExxonMobil announced in May 2006 that it is now interested in assessing the potential development. Joint venture partner BHPB is also conducting a pre-feasibility study to assess the viability of providing Scarborough gas to its proposed Pilbara LNG plant near Onslow.

5.3.6 Brecknock, Snarf and Scott Reef Development (Operator, Woodside Energy)

Woodside's extensive gas reserves in the Browse Basin, off WA's Kimberley coast, have the potential to create a major gas production hub for Australia. Combined, the fields represent a substantial undeveloped gas and condensate resource. Woodside is considering at least four development concepts for Browse. One of them involves working with the other owners in the Pluto area to look at taking their gas through the Burrup LNG Park and/ or the North West Shelf LNG plant (Woodside 2007a).

The initial development concept for Woodside's Browse project involves offshore facilities and from one to three LNG processing trains with the capacity to process about 7 to 14 million tonnes a year. Browse could also supply natural gas to Australian markets. The first LNG cargo from Browse could be delivered by 2014.

The Browse LNG development will also commercialise the Torosa, Brecknock and Calliance gas fields, and possibly other nearby resources, which together are expected to contain up to 20 trillion cubic feet of gas and 300 MM bbls of condensate.

Woodside plans two appraisal wells on Torosa in 2007, plus an exploration well on the Snarf prospect. A seismic shoot over the southern part of Torosa is also planned this year. Engineering studies continue in pursuit of a development concept.

If both Pluto and Browse are developed as hoped, Woodside's LNG production could rise fivefold by the middle of the next decade, making it one of the world's single biggest suppliers.

5.3.7 Ichthys Field Development (Operator, INPEX)

INPEX Browse Ltd, had a 100% interest in Exploration Permit WA-285-P and Total has recently signed an agreement to acquire a 24% interest. Project start up is expected in the next five to eight years.

5.4 North West Shelf Expansion

Following the approval for a 5th LNG train, the North West Shelf Venture is now progressing a number of offshore projects to meet gas supply requirements. Some of the projects under consideration are:

5.4.1 Perseus-over-North Rankin / Perseus-over-Goodwyn (Operator, Woodside)

Woodside Energy Ltd operates the Perseus field on behalf of the Northwest Shelf Joint Venture Participants. The Perseus field, located in WA-1-L in 130 metres of water, is currently developed by three 'Big Bore' wells drilled from the North Rankin (NRA) facility located approximately 135 km offshore from Dampier in the northwest of Western Australia. Three further 'Big Bore' wells were being drilled in 2006 from the NRA platform ('Perseus-

over-North Rankin'). Future phases will include further platform wells and gas compression on the NRA platform.

The subsea development in the southern and western parts of the Perseus field, with gas exported via the Goodwyn (GWA) facility, has a planned startup date of early 2007. This two-stage component of the development, which includes the Searipple accumulation, is known as 'Perseus over Goodwyn' and involves new wells and a new trunkline to GWA. Work started in 2004 and is scheduled for completion in 2007. Perseus has an expected ultimate recovery of 280 Gm3 (10 Tcf) of gas.

5.4.2 Goodwyn Western Flank Development (Operator, Woodside)

The Goodwyn gasfield is located 23 km southwest of North Rankin field. The phased development of Goodwyn satellite gas and oil accumulations includes Goodwyn South, Dockrell, Keast, Echo-Yodel, Sculptor-Rankin, Tidepole, and Wilcox. Development will most likely consist of subsea developments tied back to the GWA platform. Approximate start up is 2008–2011.

5.5 Future Exploration Activities

Currently uptake of Australia's offshore petroleum exploration permits is at an all time record high with over 300 permits in operation. Indications are that this increase is likely to continue with an additional thirteen areas being awarded in the Northwest Bioregion during July 2007. Each year the Australian Government releases new opportunities for offshore petroleum exploration. This annual release of offshore acreage is part of Australia's Offshore Petroleum Strategy, and all areas are available through a work program bidding system (PESA 2006). The new exploration areas for 2007 the Northwest Bioregion are shown in Figure 5.2.

Giant gas fields continue to be found in the Carnarvon Basin. Chevron's Chandon gas discovery, located west of ExxonMobil's giant Jansz field and Woodside's Pluto gas discovery demonstrate that there are still significant hydrocarbon discoveries in Australia's offshore waters, and that the Carnarvon Basin is a world class hydrocarbon province.

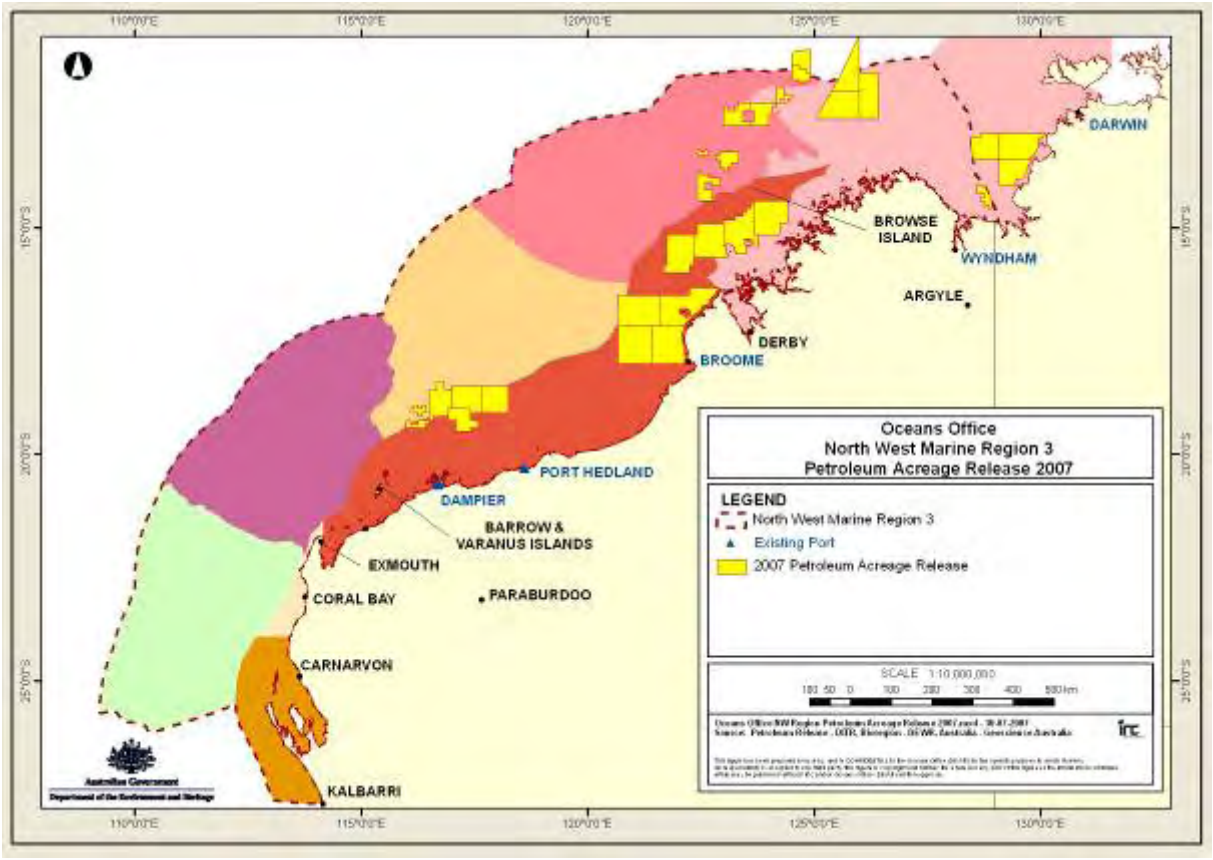


Figure 5.2 2007 Petroleum Acreage Releases

Typical amount of seismic data acquisition activity in the Northwest Region is summarised in Table 5.2 table below.

Table 5.2 Seismic data acquisition activities during 2006 in the Northwest Bioregion

2006 Seismic by Basin		
Basin Name	**2D (km)**	**3D (sq/km)**
Browse	1157	39
Carnarvon	0	12497

Typical annual drilling activity in the Northwest Region is presented in Table 5.3 below.

Table 5.3 Drilling activities during 2006 in the Northwest Bioregion

Basin Name	New	Extension	Development	Total
Carnarvon	29	10	23	62
Canning	2	0	0	2
Bonaparte	1	0	0	1
Browse	0	4	0	4
Total	**32**	**14**	**23**	**69**

Table 5.4 Future and Proposed Petroleum Related Infrastructure – North West Shelf

ASPECTS MATRIX **S**: An aspect of small magnitude **L**: An aspect of large magnitude	Physical presence	Seabed disturbance	Noise / vibration	Atmospheric emissions	Light emissions	Liquid waste disposal	Solid waste disposal	Discharges	Suspended solids	Energy usage	Introduced marine pests	Leaks or spills	Vessel Interference
APPRAISAL													
Vessel Operations			S	S	S	S	S	S		S	L	L	L
Exploration Surveys			L	S	S	S	S	S		S	L	S	L
Well Drilling and Testing	S	S	S	L	S	S	S	L	S	S	L	L	L
CONSTRUCTION													
Vessel Operations			S	S	S	S	S	S		S	L	L	L
Well Drilling and Testing	S	L	S	L	S	S	S	L	L	S	L	L	L
Dredging and Rock Dumping		L	S	S	S	S	S	S	L	S	L	S	L
Subsea Infrastructure	S	L	S					S				S	
Processing Facility	L	S	S	S	S	S	S	S		S	S	S	S
COMMISSIONING & OPERATIONS													
Subsea Systems						S		S				S	
Processing Facility	L	S	S	L	L	S	S	S		S		S	
Vessel Operations			S	S	S	S	S				L	L	L
Well Work-over and Dev. Drilling	S	L	S	L	S	S	S	L	L		L	L	L
DECOMMISSIONING & ABANDONMENT													
Vessels Operations			S	S	S	S	S				L	L	L
Subsea Infrastructure	S	L	S				L		S				
Plant and Infrastructure Removal	S	L	S				L		S				
Site Rehabilitation	S	L	S				L		S				

ENVIRONMENTAL VALUE / SENSITIVITY [Low (**L**); Medium (**M**); High(**H**)]					
Physical		**Biological**		**Socio-Economic**	
Seabed Quality	**M**	Marine Habitats	**M**	Marine Traffic	**M**
Water Quality	**M**	Marine Fauna	**H**	Fisheries.	**M**
Air Quality	**H**	Marine Flora	**L**	Heritage	**L**

Matters of National Environmental Significance	
World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Significance (Ramsar Sites):	None
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	32
Migratory Species:	37
Other Matters Protected by the EPBC Act	
Commonwealth Lands:	2
Commonwealth Heritage Places:	2
Places on the Register of the National Estate (RNE):	52
Listed Marine Species:	79
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves:	1
State and Territory Reserves:	36
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

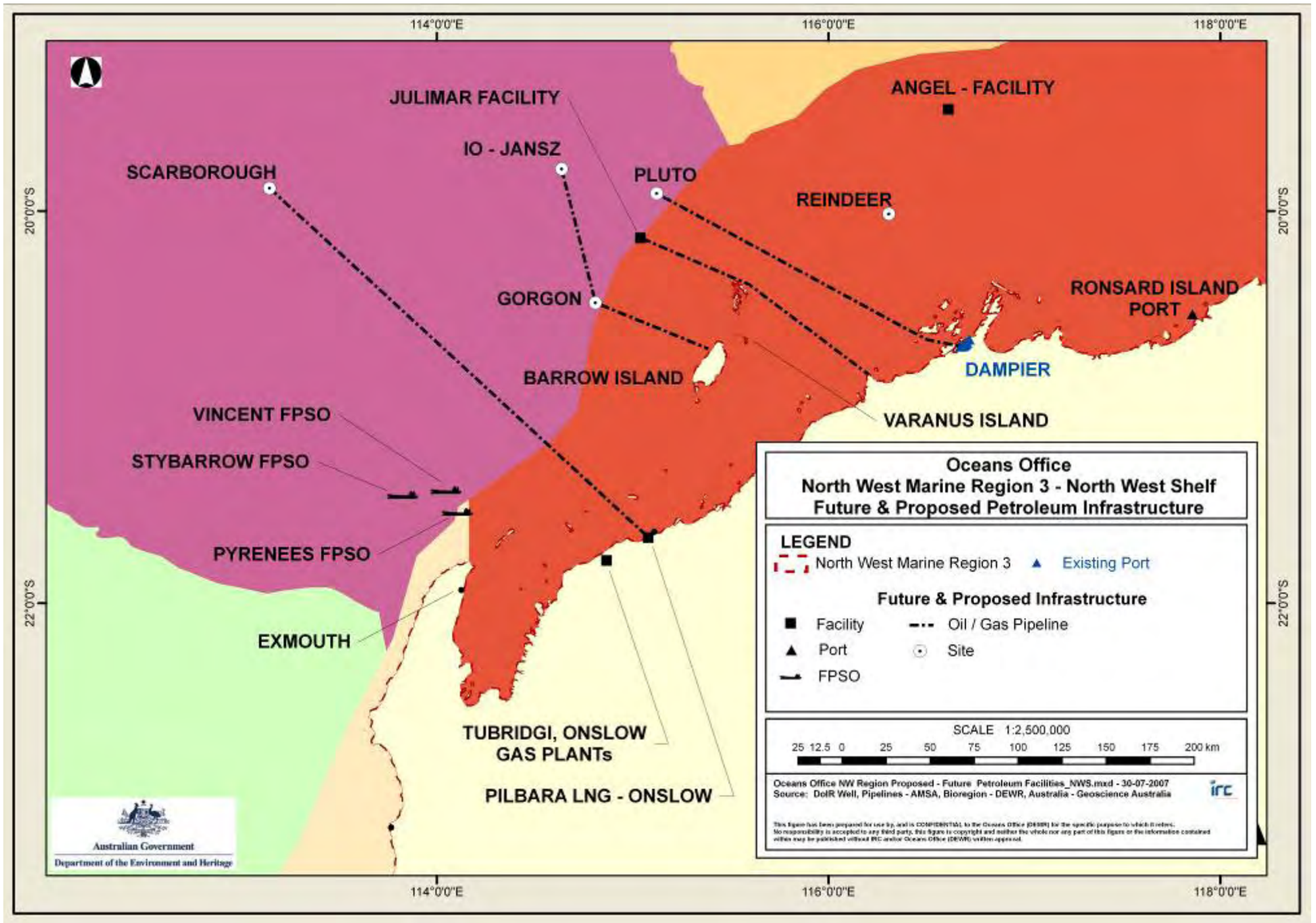


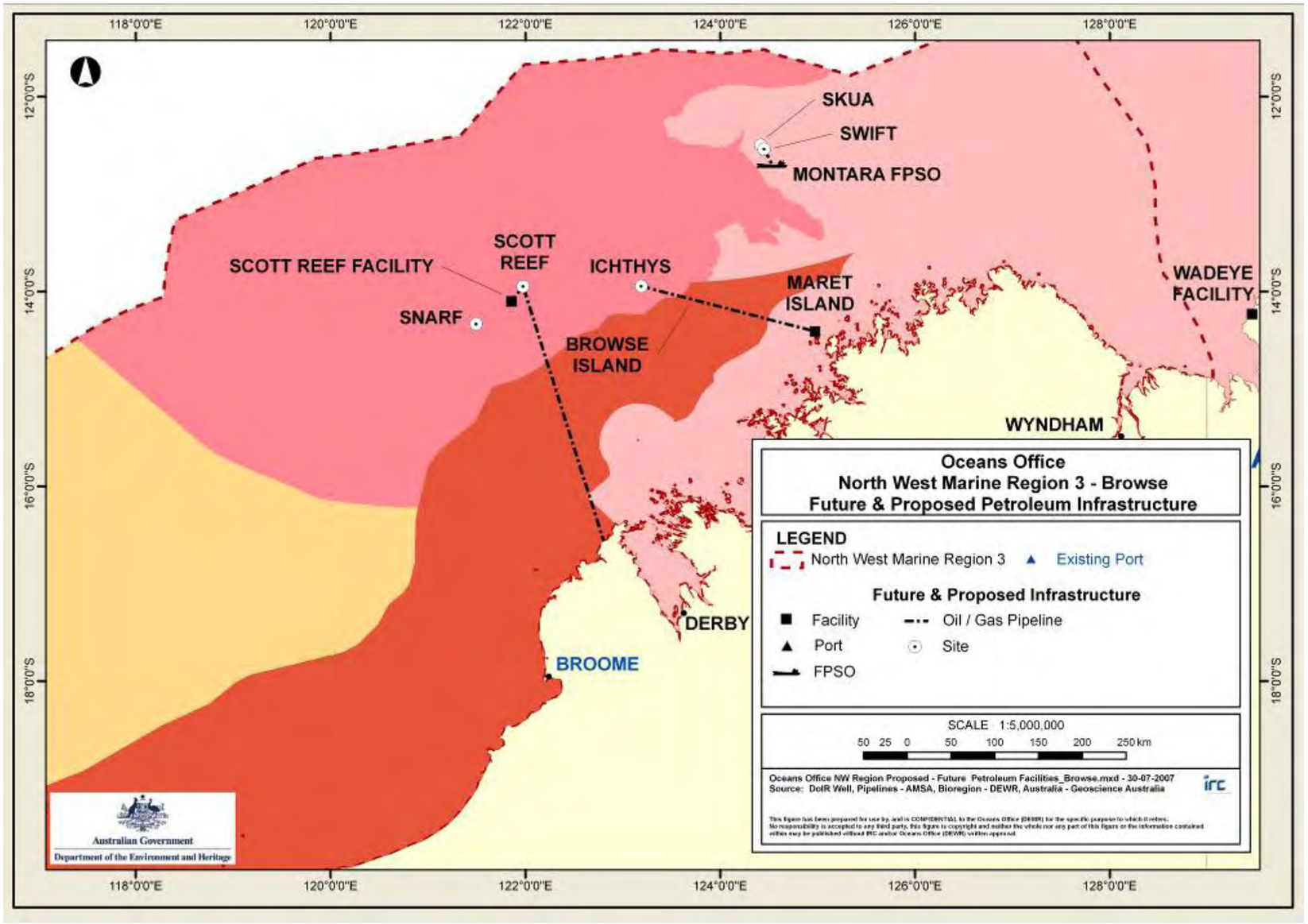
Table 5.5 Future and Proposed Petroleum Related Infrastructure – Browse Basin

ASPECTS MATRIX **S**: An aspect of small magnitude **L**: An aspect of large magnitude	Physical presence	Seabed disturbance	Noise / vibration	Atmospheric emissions	Light emissions	Liquid waste disposal	Solid waste disposal	Discharges	Suspended solids	Energy usage	Introduced marine pests	Leaks or spills	Vessel Interference
APPRAISAL													
Vessel Operations			S	S	S	S	S	S		S	L	L	L
Exploration Surveys			L	S	S	S	S	S		S	L	S	L
Well Drilling and Testing	S	S	S	L	S	S	S	L	S	S	L	L	L
CONSTRUCTION													
Vessel Operations			S	S	S	S	S	S		S	L	L	L
Well Drilling and Testing	S	L	S	L	S	S	S	L	L	S	L	L	L
Dredging and Rock Dumping		L	S	S	S	S	S	S	L	S	L	S	L
Subsea Infrastructure	S	L	S					S				S	
Processing Facility	L	S	S	S	S	S	S	S		S	S	S	S
COMMISSIONING & OPERATIONS													
Subsea Systems			S			S		S				S	
Processing Facility	L	S	S	L	L	S	S	S		S		S	
Vessel Operations			S	S	S	S	S				L	L	L
Well Work-over and Dev. Drilling	S	L	S	L	S	S	S	L	L		L	L	L
DECOMMISSIONING & ABANDONMENT													
Vessels Operations			S	S	S	S	S				L	L	L
Subsea Infrastructure	S	L	S				L		S				
Plant and Infrastructure Removal	S	L	S				L		S				
Site Rehabilitation	S	L	S				L		S				

ENVIRONMENTAL VALUE / SENSITIVITY [Low (**L**); Medium (**M**); High(**H**)]

Physical		Biological		Socio-Economic	
Seabed Quality	M	Marine Habitats	M	Marine Traffic	M
Water Quality	M	Marine Fauna	H	Fisheries.	M
Air Quality	H	Marine Flora	L	Heritage	L

Matters of National Environmental Significance	
World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance (Ramsar Sites):	5
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	29
Migratory Species:	71
Other Matters Protected by the EPBC Act	
Commonwealth Lands:	2
Commonwealth Heritage Places:	4
Places on the Register of the National Estate (RNE):	50
Listed Marine Species:	117
Whales and Other Cetaceans:	26
Critical Habitats:	None
Commonwealth Reserves:	2
State and Territory Reserves:	25
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None



6 MARINE INFRASTRUCTURE

6.1 Ports

Within the NW marine region there are three port authorities (Broome, Dampier and Port Hedland) which are autonomous bodies operating under the *Port Authorities Act 1999* and reporting to the Minister for Planning and Infrastructure. The Port Authority's functions, as required by the Act can be summarised as (sections 30 (1) a to f):

- *To facilitate trade within and through the port for future growth and development of the port;*
- *To undertake or arrange for activities that will encourage and facilitate the development of trade and commence generally for the economic benefit of the State through the use of the port and related facilities;*
- *To control business and other activities in the port or in connection with the operation of the port;*
- *To be responsible for the safe and efficient operation of the port;*
- *To be responsible for the maintenance and preservation of vested property and other property held by it; and*
- *To protect the environment of the port and minimise the impact of port activities on that environment.*

The ports of Dampier and Port Hedland are the major export centres for iron ore and salt. In addition, Dampier is also a major centre for the export of LNG, LPG and condensate.

Dredging is an ongoing activity that is required to maintain ports and for new port and channel projects. Port Hedland undergoes maintenance dredging of its port area and the shipping channel every three to four years with the dredge spoil containing silt and sand dumped offshore under a Commonwealth permit. Several projects to extend the current shipping berths and deepen the channel are proposed over the next few years with some spoil being dumped on land and some at sea (DPA 2006).

A shallow trench some 100 km long was dredged by Woodside for its trunkline, and Hamersley Iron and Dampier Salt dredged their shipping channel to deepen it by about 0.5 m. Both projects involved spoil being dumped offshore (CSIRO 2002).

Figure 6.1 presents the existing ports in the North West Marine Bioregion.

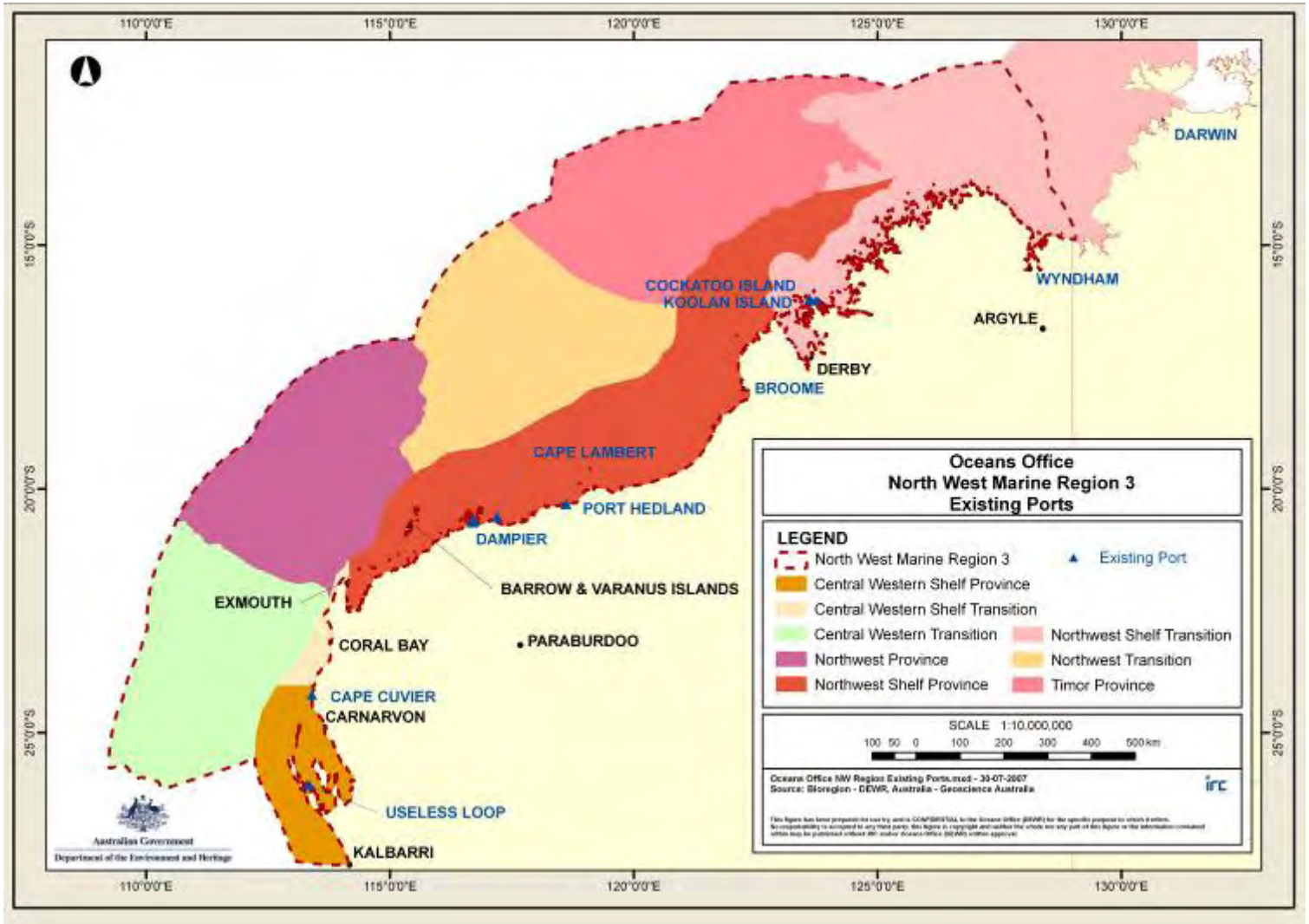


Figure 6.1 Existing Ports in the North West Marine Bioregion

6.1.1 The Port of Dampier

Dampier's port facilities are owned by Hamersley Iron and operated by Pilbara Iron (a Rio Tinto Group subsidiary). There are five major stakeholders currently involved with the operations at the Port of Dampier: the Dampier Port Authority (DPA), Dampier Salt Ltd (Dampier Salt), Hamersley Iron, North West Shelf Venture and Burrup Fertilisers.

DPA facilities are located in King Bay and Mermaid Sound. They include the Dampier Cargo Wharf, Berge Ramp, Heavy Load Out Facility and the Dampier Bulk Liquids Berth.

Dampier Salt operations are located at Hampton Harbour and Mermaid Stait through a wharf for bulk export at Mistaken Island. Dampier Salt's 14 710 ha state lease maintains 112 km of levees and causeways.

Hamersley Iron (HI) operations are located at Hampton Harbour and Mermaid Strait with wharf facilities for bulk iron ore export located at Parker Point and East Intercourse Island, and connected to the mainland via a causeway. HI's operations involve maintaining their shipping channels, management of their vessels and operations of a power station south of Parker Point.

The North West Shelf Venture (NWSV) operations are located at Wittnell Bay and King Bay and are operated by Woodside. Wittnell Bay has a wharf for LNG export and a second wharf for LPG and condensate export, and an onshore LNG plant. King Bay has a supply base and a wharf to service offshore facilities and fuels storage tanks. Another part of Woodside's key operations in the area is shipping channel maintenance and towage service.

Burrup Fertilisers (BFPL) produce anhydrous ammonia which is transported from the Burrup Industrial Estate via an export pipeline through the Burrup East West Services Corridor and is exported from the Port of Dampier's Bulk Liquids Berth (DPA 2007 and 2007a).

Table 6.1 show that total cargo movement in the port is dominated by iron ore (almost 80 %), followed by LNG, salt, condensate, LPG, ammonia and general cargo.

Table 6.1 Current 2007 / 2008 Financial Year (To Date) Statistics

Exports			Imports			Total Cargo		
Iron Ore	79.95	%	Petroleum:	74.65	%	Iron Ore	78.49	%
Salt	3.85	%	General Inwards:	25.35	%	Salt	3.82	%
Condensate	2.51	%				Condensate	2.49	%
LNG	12.72	%				LNG	12.63	%
LPG	1.36	%				LPG	1.35	%
Ammonia	0.28	%				Ammonia	0.28	%
General Out	0.22	%				General	0.40	%

Source: http://www.dpa.wa.gov.au/cargo_statistics.asp

A total of approximately 109.5 Mtpa of cargo are exported from the Port of Dampier and 606 326 tpa of cargo are imported (DPA 2007).

6.1.2 Port Hedland

The Port of Port Hedland (Figure 6.2) is owned and operated by the Port Hedland Port Authority. Iron Ore and Salt are the major trade products exported from the port and the operating companies are BHP Billiton and Dampier Salt Ltd. BHP Billiton owns all six of the harbour tugs (Port Hedland 2003).

Iron ore exports account for approximately 97 % of all trade, with 110 Mt of iron ore exported per year and salt being exported at approximately 3 Mtpa. BHP Billiton are currently expanding port facilities to increase iron ore exports and there are plans to expand Dampier Salt operations in the Port.

A number of lower bulk exports are currently handled at the port, with manganese being the largest of the lower bulk exports. Consolidated Minerals Ltd (Consolidated Minerals 2007) export manganese through operations of their subsidiary company, Pilbara Manganese Ltd. Total manganese exports in 2006 were 888 432 tonnes. Consolidated Minerals also export chromite through the port and in 2006 a total of 252 867 tonnes of chromite were exported. Newcrest exports feldspar from the port, at approximately 50 000 tpa. Report from 2003 states that planned to expand operations, producing 130 000 tpa of copper concentrate.

A general long term average of 20 000 tpa of general cargo and livestock has been assumed.

Figure 6.2 Port Hedland

6.1.3 Port of Broome

The Port of Broome is the largest deepwater access port in the Kimberley region. It supports livestock export, offshore oil and gas exploration supply vessels, pearling, cruise liners, fishing charter boats and general cargo. The port also serves as a stopover port by the Royal Australian Navy and Australian Customs vessels. The jetty has recently been extended to 331 m long and at chart datum it is 12.5 m from the waterline to the deck of the wharf and 11.34 m to the top of the fender system. The tidal variation at the port is 9.6 m and it is the highest of any operating port in Australia.

6.1.4 Port Walcott (Cape Lambert)

Cape Lambert's Port Walcott is the other major iron ore port in the NW and is owned and operated by Rio Tinto's Pilbara Iron. It is a stand alone single user port comprising of an offshore jetty loading facility and a stockyard area adjacent to Point Samson. The port has been recently upgraded, with the ore wharf being extended from 114 m to 444 m, and iron ore is currently being exported at approximately 58 Mtpa. The port's departure channel has a depth of 16.1 m, which makes it the deepest of all the Pilbara ports (DPI 2007).

6.1.5 Yampi Sound (Cockatoo Island)

Cockatoo Island is located off the Kimberley Coast of WA. Port is owned and Portman Limited and HWE Contracting Pty Ltd (50 % joint venture partner) is responsible for mining and port operations. High-grade, low impurity haematite is mined at Cockatoo Island. Current reserves are expected to be mined out in 2007 and there is a plan to extend project life by accessing the additional ore to the east of the existing orebody. A plan for the closure of the mining operations has also been developed, which proposes to convert the seawall constructed to enable mining below sea level into a marina after the end of mining activities. Currently, 1.2 Mtpa of iron ore is exported from Cockatoo Island (Portman 2005).

6.1.6 Koolan Island

Koolan Island hematite is mined in Yampi Sound and is owned and operated by Mt Gibson Iron. This is deepwater port with loader and onsite fuel storage for operations. Production at Koolan Island recommenced in early 2007 and exports are increasing to reach the target of 4 Mtpa.

6.1.7 Onslow – Thevenard Island, Airlie Island, Onslow

All products exported from the Port of Onslow are controlled by Onslow Salt Pty Ltd. The ship loader is located on a platform positioned at the end of the jetty which extends some 1.5 km out from the shore. It is controlled normally via a remote handset from the deck of the ship or the ship loader platform, slewing and luffing to deliver salt evenly in the ship holds at 2,200 tph. Approximately 2.5 Mtpa of salt are exported out of Onslow.

6.1.8 Airlie Island

Airlie Island is located in offshore Onslow and has petroleum production and tanker loading facilities. The facilities at Airlie Island are owned and operated by Apache Energy and are strategically located near a number of small oil and gas fields.

6.1.9 Thevenard Island

Thevenard Island facilities are owned by ChevronTexaco Australia Pty Ltd (51.43 %), Santos (35.71 % and ExxonMobil (12.86 %) and operated by Chevron. Thevenard Island provides a

base for processing and storing hydrocarbons from several fields nearby. Current production is approximately 1.3 Mbbl of oil.

6.1.10 Carnarvon – Cape Cuvier, Useless Loop

Cape Cuvier

The port located at Cape Cuvier is owned and operated by Dampier Salt Ltd. Cape Cuvier is a deep water port / salt loading facility facing the open sea. Salt from Lake McLeod is is stockpiled and shipped from the port at Cape Cuvier. Approximately 2.78 Mtpa of salt are exported from Cape Cuvier (Rio Tinto 2007).

Useless Loop

The port at Useless Loop is owned by the Shark Bay Salt Joint Venture (SBSJV) and operated by Mitsui & Co. Approximately 1.3 Mtpa of salt is exported from the Useless Loop Port.

6.1.11 Wyndham

The Wyndham Port is located in the town of Wyndham, in the Kimberley region of WA. The port exports livestock to Malaysia and sugar to Indonesia and imports fuel to be used in the region and explosives for the mining industry.

6.1.12 Derby

The Derby Wharf/Jetty is located in the town of Derby, in the Kimberley region of WA. The jetty is mostly used by tourism and pleasure vessels, and for the export of lead and zinc concentrates from the Cadjebut Mine at Fitzroy Crossing.

The port's facilities have been recently upgraded and include a modern fender system, a new floating breakwater and a new barge landing facility.

6.1.13 Varanus Island

Facilities at Varanus Island are owned and operated by Apache Energy Ltd. Domestic natural gas, condensate and crude oil are exported from the port facilities.

6.1.14 Barrow Island

There is an offshore marine terminal, consisting of a subsea pipeline and offshore tanker mooring and load out facility, operated by ChevronTexaco Australia Pty Ltd. Supply vessels operating in the Barrow Island region utilise the facilities at the Port of Dampier (DITR 2006).

The major product received at ports within the North West region is fuel and oils primarily for distribution to inland areas. Fuel may be sourced from locations within or outside Australia.

6.2 Pipelines

Table 6.2 below provides an overview of the oil and gas trunklines connections between offshore facilities (NWS) including, size, length and summary notes.

Table 6.2 Current Oil and Gas trunklines Connections between offshore facilities (NWS)

Pipeline Licence	Location	Destination	Operator	Export Product	Diameter (in)	Length (km)	Summary Notes
WA-1-PL	North Rankin 'A' Platform	Withnell Bay	Woodside	Gas Condensate	40	134	The Woodside operated WA-1-PL North Rankin 'A' pipeline connects the North Rankin 'A' platform to Withnell Bay. It is a 40 " x 134 km gas and condensate pipeline in water depths of 125 m, 135 km NW of Karratha.
WA-2-PL	Goodwyn Platform	North Rankin 'A' Platform	Woodside	Gas Condensate	30	35	The Woodside operated WA-2-PL Goodwyn pipeline connects the Goodwyn platform to the North Rankin 'A' platform. It is a 30 " x 35 km gas and condensate pipeline in water depths of 130 m, 23 km SE of North Rankin 'A' and 130 NW of Karratha.
WA-3-PL	Griffin FPSO	Griffin Gas Treatment Plant onshore	BHB Billiton Petroleum	Gas	8	68	The BHP Billiton Petroleum operated WA-3-PL Griffin pipeline is located in the Griffin field, 68 km NW of Onslow. It is an 8 " x 68 km pipeline which connects the Griffin Venture FPSO to the onshore Griffin Gas Treatment Plant, approximately 30 km SW of Onslow.
WA-4-PL	Wanaea	North Rankin 'A' Platform	Woodside	Gas	12.8	2.3	This pipeline connects the gas from the Wanaea field to the North Rankin 'A' platform. It is a 12.8 " x 32.3 km pipeline located east of the North Rankin 'A' platform, in water depths of 80 m.
WA-5-PL	East Spar	Varanus Island	Apache Energy Ltd	Multiphase	14	63	The Apache operated WA-PL-5 East Spar pipeline is located 40 km NW of Barrow Island, in the East Spar gas and condensate field. It is a 14 " x 63 km multiphase pipeline connecting to the Varanus Island processing facilities.
WA-6-PL	Stag Field	Stag FSO	Apache Energy Ltd	Oil	8.6	2	The Apache operated WA-6-PL Stag pipeline is located in the Stag field, 65 km NW of Dampier. It is a 8.6 " x 2 km crude oil offloading pipeline connecting to a FSO moored to a CALM buoy.
WA-7-PL	Legendre	Karratha Spirit FSO	Woodside	Oil	10	2.5	The Woodside operated WA-7-PL Legendre pipeline is located in the 50 m deep Legendre field. It is a 10" x 2.5 km subsea oil offloading pipeline connecting to an offshore CALM buoy mooring system.
WA-8-PL	Bayu-Undan	LNG Plant at Wickham Point, Darwin	ConocoPhillips	Gas	26	500	The Bayu-Undan gas and gas condensate field is situated approximately 500 kilometers northwest of Darwin and 250 kilometers south of Suai, East Timor. The Bayu-Darwin Pipeline involved a 503 km submarine pipeline linking Wickem Point in Darwin Harbour to the Bayu Undan Platform. The Gas Export line is 26" diameter and runs from the beach in Darwin to a maximum water depth of 140 meters.

Pipeline Licence	Location	Destination	Operator	Export Product	Diameter (in)	Length (km)	Summary Notes
WA-9-PL	Echo- Yodel	Goodwyn 'A' Platform	Woodside	Gas	12	30	WA-9-PL Echo-Yodel is a 12 " x 30 km corrosion-resistant alloy pipeline that links the gas condensate Echo Yodel field to the Goodwyn A platform at up to a maximum raw gas rate of 300 MMcf/d. Field is located 23 km SW of Goodwyn A Platform.
WA-10-PL	Commonwealth Waters section of the NWS Venture Gas Field	Karratha Gas Plant	Woodside	Gas	42	130	The WA-10-PL is the largest offshore pipeline installed in Australia. It is a 42 " x 130 km LNG pipeline connecting the NWS Venture gas fields to the Karratha Gas Plant.
WA-11-PL	John Brookes Gas Field (Commonwealth Waters)	Varanus Island	Apache Energy Ltd	Multiphase	18	55	The Apache operated WA-11-PL John Brookes pipeline is located in the John Brookes gas field, 60 km NW of Varanus Island. It is an 18 " x 55 km multiphase pipeline connecting the wellhead platform to the Varanus Island facilities.
WA-13-PL	Perseus over Goodwyn	Goodwyn 'A' Platform	Woodside	Gas	16	24.1	WA-13-PL Perseus over Goodwyn Pipeline is a natural gas pipeline system owned by Woodside. It is located 22 km NE of the Goodwyn Alpha platform and 7.8 km NW of the North Rankin platform in water depths of 130 m offshore Dampier. It is part of Woodside's Perseus- Over- Goodwyn Project and is designed to carry natural gas from the offshore Perseus Field to the Goodwyn platform and then to the Karratha Gas Plant onshore. The pipeline system consists of a subsea line is 16 " x 24.1 km and two 10 " PoG pipelines measuring 1.4 km and 1.8 km, respectively and is schedule to begin operating in October 2007.
TPL/1	Harriet 'A'	Varanus Island	Apache Energy Ltd	Oil	8.6	6.5	The Apache operated TPL/1 Harriet 'A' pipeline is located in the Harriet field, 120 km NW of Dampier. It is an 8.6 " x 6.5 km oil pipeline which connects the Harriet 'A' platform to the Varanus Island processing facilities.
TPL/2	Varanus Island	Varanus Island Export Loading	Apache Energy Ltd	Oil and gas	30	3.5	The Apache operated Varanus Loading (Varanus Island Export) is a 30" x 3.5 km pipeline.
TPL/3	South Pepper (decommissioned in 1997)	Airlie Island	Apache Energy Ltd	Oil	6.6	23.7	The Apache operated TPL/3 South Pepper pipeline is located in the decommissioned (December 1997) South Pepper field. 6.6 " x 23.7 km connecting to the Airlie Island facilities, 35 km N of Onslow.
TPL/4	Airlie Island	Mooring Terminal	Apache Energy Ltd	Oil	20	1.94	20 " x 1.94 km oil pipeline located on Airlie Island and connecting to a mooring terminal.
TPL/5	Harriet 'A'	Varanus Island	Apache Energy Ltd	Gas	6.6	6.3	The Apache operated TPL/5 Harriet 'A' pipeline is located in the Harriet field, 120 km NW of Dampier. It is a 6.6 " x 6.3 km gas offloading pipeline connecting to the Varanus Island facilities.

Pipeline Licence	Location	Destination	Operator	Export Product	Diameter (in)	Length (km)	Summary Notes
TPL/6	Saladin Field	Thevenard Island	Chevron	Oil and gas Oil and gas Oil Gas Gas	8.6 6.6 24 3.5 4.5	2.8 7.5 6.4 1.5 5	Chevron operated pipeline connects from the Saladin field to the Thevenard Island facilities, 25 km NW Onslow. 8.6 " x 2.8 km oil and gas pipeline, 6.6 " x 7.5 km oil and gas pipeline, 24 " x 6.4 km oil pipeline, 3.5 " x 1.5 gas pipeline, 4.5 " x 5 km gas pipeline.
TPL/7	Chervil Field	Airlie Island	Apache Energy Ltd	Multiphase	8.3	6.4	8.3 " x 6.4 km multiphase pipeline located in Chervil Field near Airlie Island, connects Chervil to Airlie Island facilities.
TPL/8	Varanus Island	Shore	Apache Energy Ltd	Gas	11.8	70	The Apache operated TPL/8 gas pipeline is an export pipeline connecting Varanus Island to shore. 11.8 " x 70 km.
TPL/9	Barrow Island	Offshore mooring system	Chevron	Oil	20	10.4	The Chevron Operated TPL/9 oil pipeline is located on Barrow Island, 88 km N of Osnlow. It is a 20 " x 10.4 km submarine pipeline connecting to an offshore mooring system where tankers are berthed for loading.
TPL/10	Grffin FPSO	Shore	BHB Billiton Petroleum	Gas	8.6	32.5	Connects Griffin FPSO to shore. 8.6 " x 32.5 km gas. BHP operated.
TPL/11	Roller 'A' Platform	Shore	Chevron	Gas	6.6	8.5	Connecting from the Roller 'A' platform to shore. 6.6 " x 8.5 km gas.
TPL/12	East Spar	Varanus Island	Apache Energy Ltd		14	21.8	The Apache operated TPL/12 pipeline is located in the East Spar Field, 40 km NW of Barrow Island. It is a 14 " x 21.8 km offloading pipeline connecting to the Varanus Island facilities.
TPL/13	Varanus Island	Mainland	Apache Energy Ltd	Gas	16	70	The Apache operated TPL/13 Varanus Export gas pipeline connects Varanus Island to the mainland. 16 " x 70 km.
TPL/14	Wonnich	Varanus Island	Apache Energy Ltd		8	33	The Apache operated TPL/14 Wonnich pipeline is located in the Wonnich area of the Harriet Field. It is an 8 " x 33 km offloading pipeline connecting to the Varanus Island facilities.
TPL/15 TPL/16	NWS Venture Gas Field (State Waters)	Karratha Gas Plant	Woodside	Gas	42	130	TPL/15 – linked to TPL/16 and WA-10-PL. TPL/16 42 " Trunkline State Waters Section - Linked to the WA-10-PL.
TPL/17	State Water part of WA-11						TPL/17 John Brookes State Waters – part of the WA-11-PL system
PL 8	Karratha	Cape Lambert Port Facilities	Robe River Mining Co Pty Ltd		10.75	57	Pipeline going from Karratha to Cape Lambert port facilities. Operated by Robe River Mining Co. Pty. Ltd. 10.75 " x 57 km.
PL 12	Varanus Island	Varanus Island	Apache Energy Ltd	Oil	30	0.26	The Apache operated PL 12 oil pipeline is located on Varanus Island. 30 " x 0.26 km.
PL 14	Airlie Island	Airlie Island	Apache Energy Ltd	Oil and gas	20	0.64	Apache operated onshore oil/gas pipeline on Airlie Island 20 " x 0.64 km.

Pipeline Licence	Location	Destination	Operator	Export Product	Diameter (in)	Length (km)	Summary Notes
PL 15	Thevenard Island	Offshore tankers	Chevron		23.63	2.7	Chevron operated onshore pipeline on Thevenard Island, used for connection to offshore tankers. 23.63 " x 2.7 km.
PL 16	Tubridgi	Compressor Station No. 2	Sagasco South East Inc	Gas	6.6	87.5	From Tubridgi to Compressor Station No. 2. 6.6 " x 87.5 km.
PL 17	Varanus Island Export pipeline on the mainland	Compressor Station No. 1	Apache Energy Ltd	Gas	11.81	30	Connected from the Varanus Island Export pipeline on the mainland to Compressor Station No. 1. Apache operated. 11.81 " x 30 km.
PL 19	Tubridgi Gas Plant	Compressor Station No. 2	SAGASC0 South East Inc	Gas	10.75	87	Connects from the Tubridgi Gas Plant to Compressor Station No. 2. 10.75 " x 87 km.
PL 20	TPL/10 onshore	Griffin Gas Plant	BHP Billiton Petroleum	Gas	8.6	6	BHP Petroleum operated. Connects from TPL/10 onshore to the Griffin Gas Plant, 25 km SW Onslow. 8.6 " x 6 km.
PL 21	Shore	Tubridgi Gas Plant	SAGASC0 South East Inc	Gas	6.6	8	Connects from the shore to the Tubridgi Gas Plant. 6.6 " x 8 km.
PL 22 Karratha to Port Hedland Pipeline	Karratha	Port Hedland	Epic Energy (Pilbara Pipeline) Pty Ltd		17.72	213	Operated by Epic Energy (Pilbara Pipeline) Pty. Ltd. Pipeline extending from Karratha to Port Hedland. 17.72 " x 219 km gas pipeline.
PL 24 Goldfield Gas Transmission (GGT) Pipeline [1)]	NW	Kalgoorlie	Agility Services Pty Ltd	Gas	15.76	1400	15.76 " x 1400 km operated by Agility Services Pty Ltd, owned by Australian Pipeline Trust and Alinta Ltd.
PL 29	Lowendal Island	Apache	Apache Energy Ltd	Multiphase	14	0.6	The Apache operated PL29 multiphase pipeline is located on Lowendal Island. 14 " x 0.6 km.
PL 30	Varanus Island	Apache	Apache Energy Ltd	Oil	14	0.6	The Apache operated PL 30 oil pipeline is located on Varanus Island. 14 " x 0.6 km.
PL 31	HBI Plant	Karratha to Port Hedland Pipeline	Epic Energy Pty Ltd			5	Owned by Epic Energy. Pipeline connects from the HBI plant to the Karratha to Port Hedland pipeline. ?? " x 5 km.
PL 38	Burrup Gas Plant	Inlet Station on Karratha to Port Hedland Pipeline	Epic Energy Pty Ltd	Gas	24	24	Operated by Epic Energy, extends from the Burrup Gas Plant to the Inlet Station on Karratha to Port Hedland Pipeline. 24 " x 24 km
PL 40 Dampier to Bunbury Natural Gas Pipeline	Dampier	Bunbury	Alinta Asset Management	Gas	26	1789	Operated by Alinta Assest Management and connects from Dampier to Bunbury. 26 " x 1789 km.

Pipeline Licence	Location	Destination	Operator	Export Product	Diameter (in)	Length (km)	Summary Notes
PL 42	PL 17 end flange to Goldfield Gas Transmission (GGT) pipeline	Apache	Apache Energy Ltd	Gas		1	Apache operated, it is the PL 17 end flange to Goldfield Gas Transmission (GGT) pipeline. 1km long.
PL 55 PL 56	Karratha	Sons of Gwalia Tantalum mine in Wodgina	Epic Energy (Pilbara Pipeline) Pty Ltd			80	An 80 km long pipeline connecting the Pilbara Energy Pipeline to the Sons of Gwalia Tantalum mine in Wodgina.
PL 58	Onshore Section of WA-10-PL				42		Onshore (end) section of the 42 " Trunkline.
PL 60	Port Hedland	Telfer Gold Mine Power Station	Newcrest	Gas	10.75	445	
PL 62	Burrup Gas Plant lateral pipeline				.10.75 "	445	Extends from Port Hedland to the Telfer Goldmine. 10.75 " x 445 km gas pipeline which supplies gas to the Telfer Gold Mine Power Station.
PL 71	DBNGP	Maitland LNG Plant				8.2	3.2 km pipeline extending from the DBNGP to the Maitland LNG Plant
PL 72	Broome Fuel Storage Facility	Broome Power Station		Gas		12	12 km long, low pressure underground pipeline. Transmits natural gas from the Broome Fuel Storage Facility to the new gas fired Broome Power Station.

1) Although these pipelines are not on the coast these are included for completeness.

6.3 Shipping

On both a global and national scale the NWS ports, in particular Dampier and Port Hedland, handle a large tonnage of mineral and gas exports. Other export cargoes include salt, manganese, feldspar, chromite and copper. The Port of Dampier is one of Australia's largest tonnage Ports with exports of iron ore, salt, LNG, LPG, condensate and ammonia totalling 110 million tpa (tonnes per annum). The value of exports is in excess of $8.5 billion(DPA).

A new shipping route introduced in February 2007 passes west of Mutineer-Exeter, Angel and Legendre. It also passes close to Glomar Shoal which was re-surveyed to confirm the charted depth from the 1968 survey. This shoal was named after the Glomar Challenger, which AMSA believe was one of the first drilling rigs to operate on the North West Self. Even though the use of the route is not mandatory, AMSA's available traffic data indicates that almost all shipping, previously passing through the off-shore fields, are now using the new Dampier Shipping Fairway.

Figure 6.3 and Figure 6.4 show the major shipping routes in the NWS region for 2004 and 2006 respectively. Figure 6.5 and Figure 6.6 show the distribution of types of vessel in the Northwest Region subregions during 2004 and 2006.

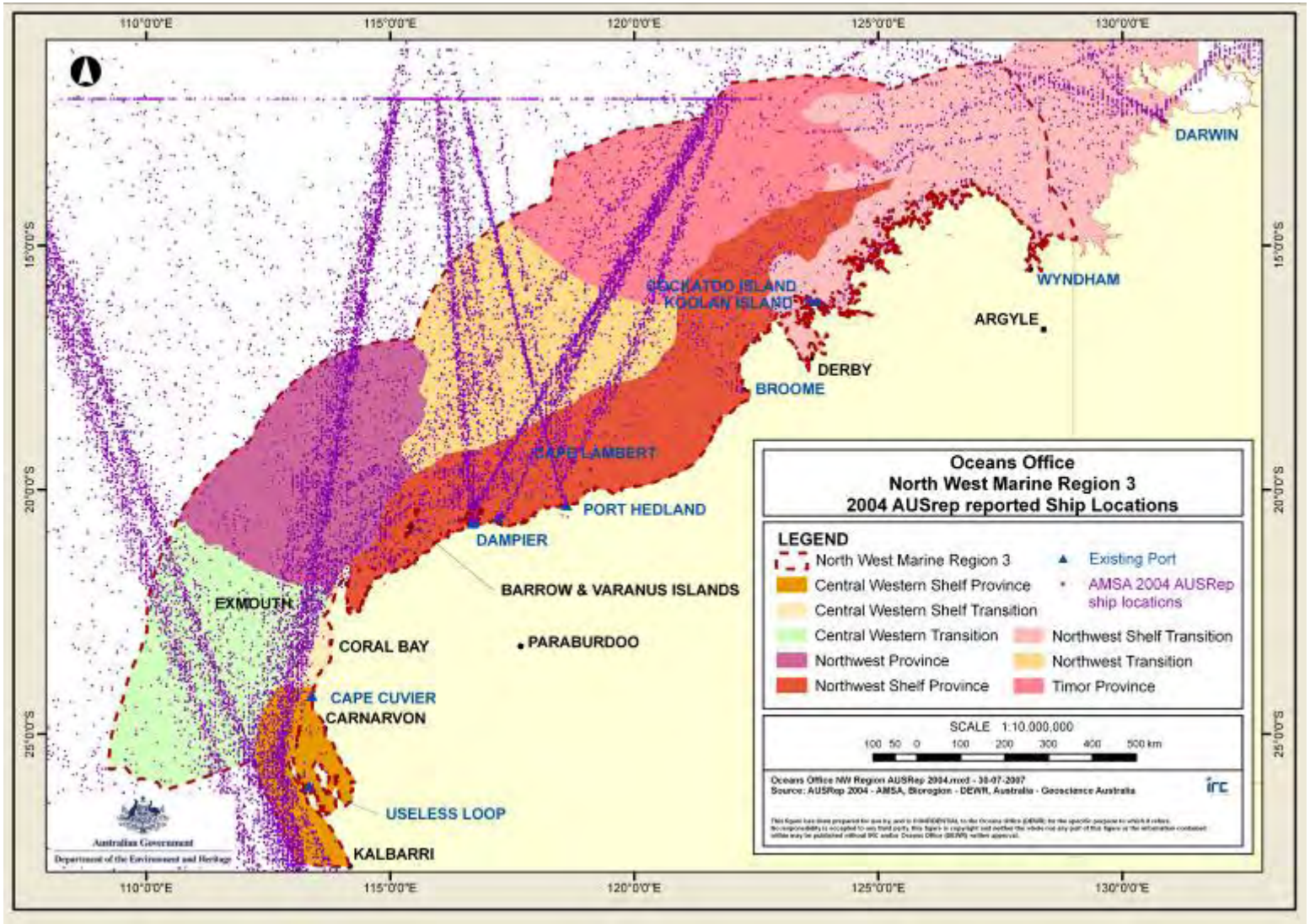


Figure 6.3 NWS Shipping 2004 (Source: AMSA)

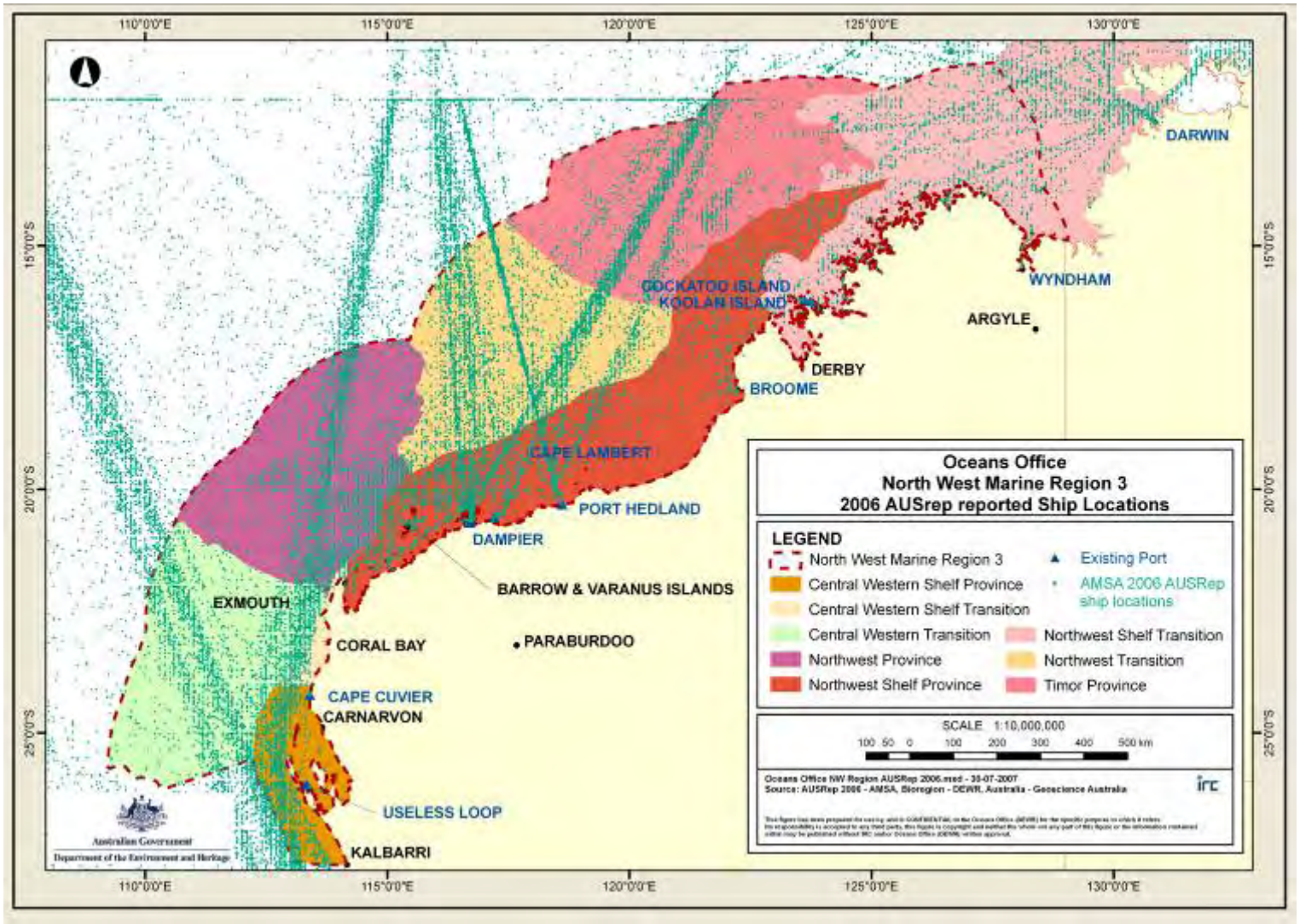


Figure 6.4 NWS Shipping (Source: AMSA)

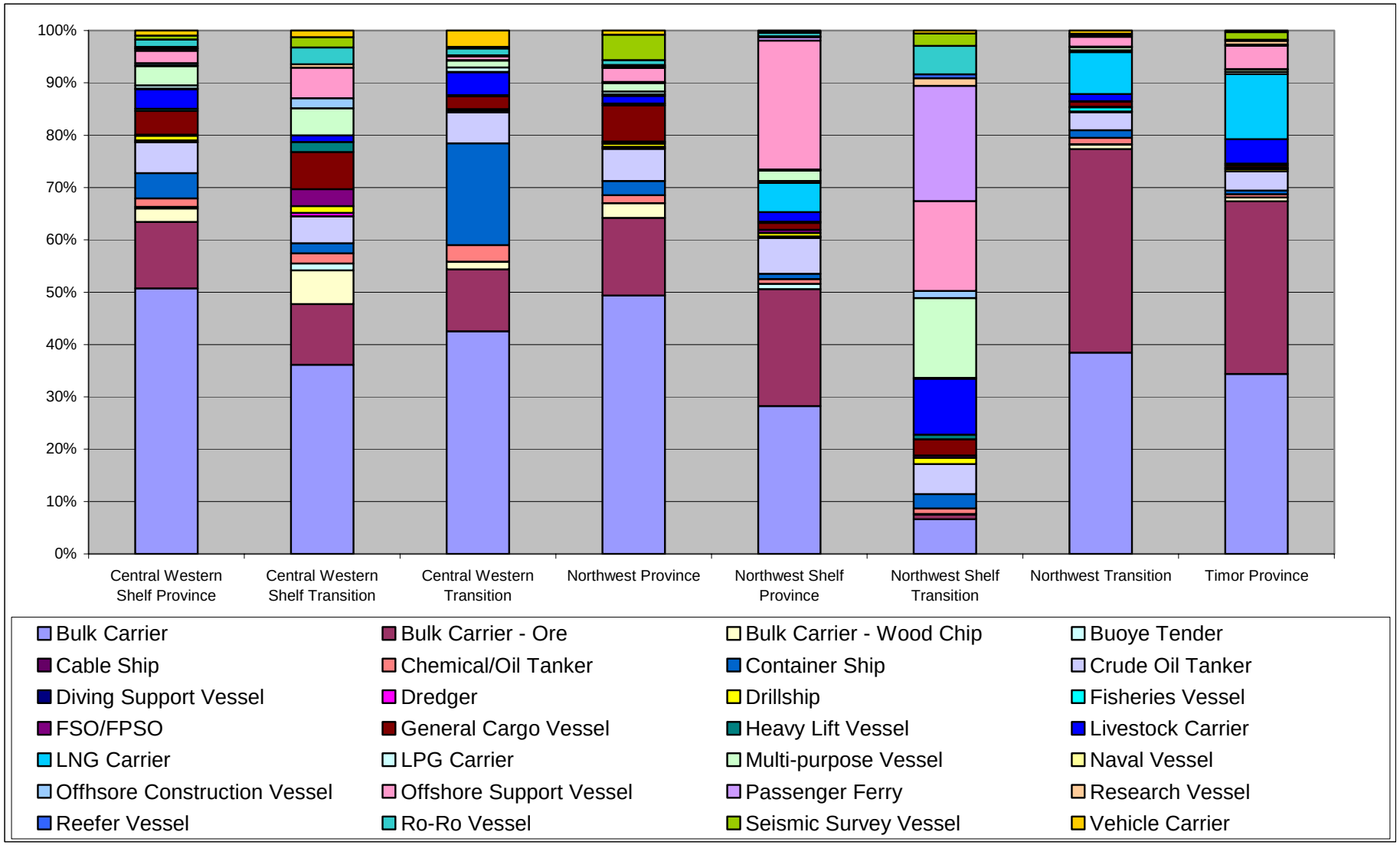


Figure 6.5 Vessel Distribution in the Northwest Region – 2004 (Source: AMSA)

Table 6.3 Vessel Distribution Data in the Northwest Region – 2004 (Source: AMSA)

IMCRA BIOREGIONS	VESSEL TYPES																												
	Bulk Carrier	Bulk Carrier - Ore	Bulk Carrier - Wood Chip	Buoye Tender	Cable Ship	Chemical/Oil Tanker	Container Ship	Crude Oil Tanker	Diving Support Vessel	Dredger	Drillship	Fisheries Vessel	FSO/FPSO	General Cargo Vessel	Heavy Lift Vessel	Livestock Carrier	LNG Carrier	LPG Carrier	Multi-purpose Vessel	Naval Vessel	Offhsore Construction Vessel	Offshore Support Vessel	Passenger Ferry	Research Vessel	Reefer Vessel	Ro-Ro Vessel	Seismic Survey Vessel	Vehicle Carrier	Totals
Central Western Shelf Province	687	172	35	4	0	22	65	80	1	4	12	0	3	61	6	50	2	8	50	2	6	32	5	1	4	19	10	13	**1354**
Central Western Shelf Transition	56	18	10	2	0	3	3	8	0	1	2	0	5	11	3	2	0	0	8	0	3	9	0	1	0	5	3	2	**155**
Central Western Transition	822	228	28	0	1	61	376	115	1	2	2	5	1	47	4	85	2	16	25	1	1	13	2	1	2	25	6	60	**1932**
Northwest Province	885	266	51	0	0	27	49	110	3	4	10	5	3	124	6	26	6	9	29	2	2	48	3	4	3	17	87	14	**1793**
Northwest Shelf Province	1,086	858	0	40	0	34	40	263	8	3	25	0	23	52	8	70	215	14	76	0	9	946	25	7	0	26	10	6	**3844**
Northwest Shelf Transition	45	6	0	1	0	7	19	39	0	0	8	0	3	21	6	73	0	1	104	0	9	117	150	10	5	37	16	4	**681**
Northwest Transition	1,097	1,111	24	2	0	35	41	99	2	1	1	22	4	27	3	39	229	9	18	1	1	54	0	5	0	10	1	18	**2854**
Timor Province	467	448	10	0	0	8	10	50	0	0	5	2	3	6	4	63	169	6	6	0	1	61	3	9	0	3	20	4	**1358**
Totals	**5145**	**3107**	**158**	**49**	**1**	**197**	**603**	**764**	**15**	**15**	**65**	**34**	**45**	**349**	**40**	**408**	**623**	**63**	**316**	**6**	**32**	**1280**	**188**	**38**	**14**	**142**	**153**	**121**	**13971**

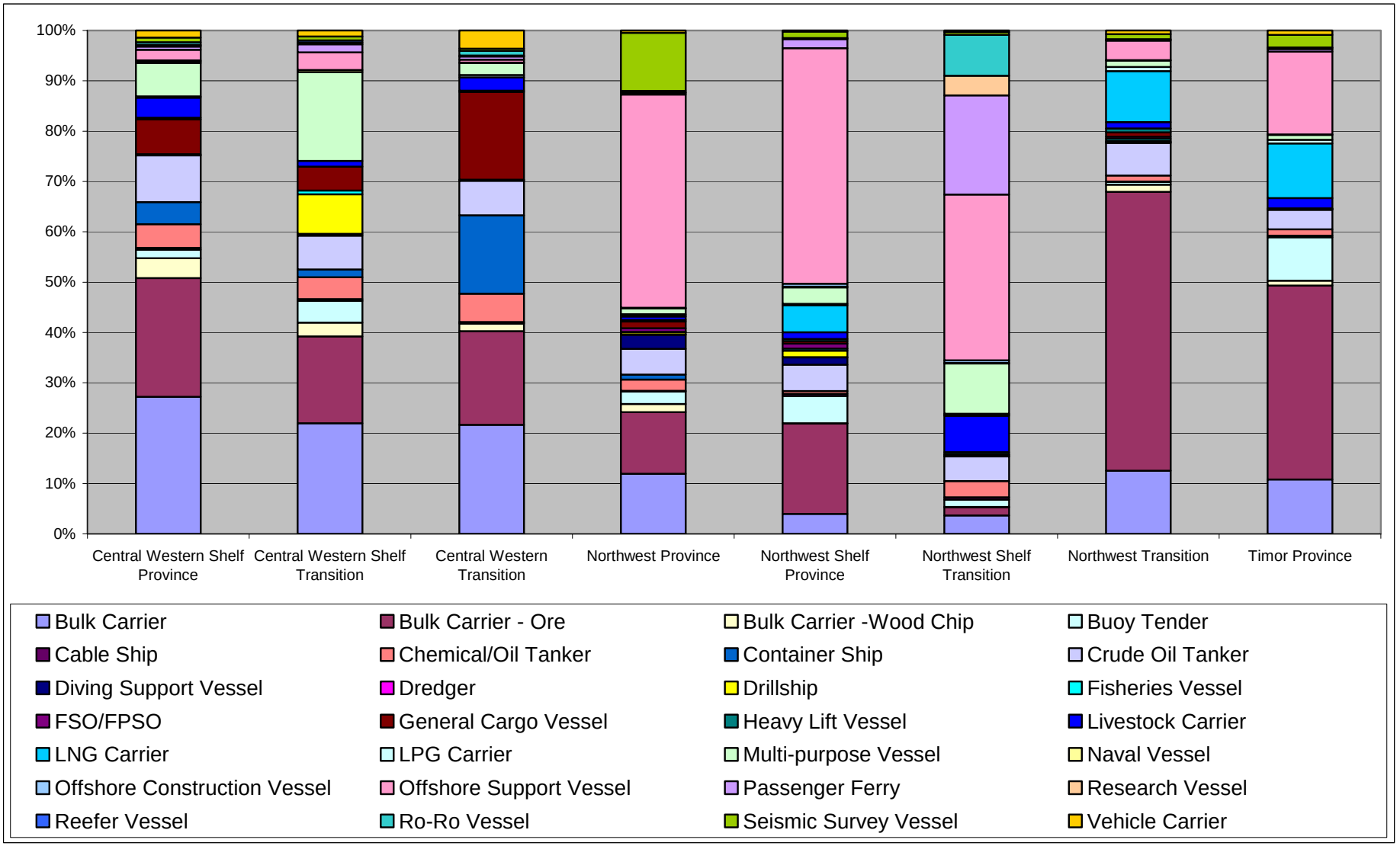


Figure 6.6 Vessel Distribution in the Northwest Region – 2006 (Source: AMSA)

Table 6.4 Vessel Distribution Data in the Northwest Region – 2006 (Source: AMSA)

IMCRA BIOREGIONS	VESSEL TYPES																											
	Bulk Carrier	Bulk Carrier - Ore	Bulk Carrier - Wood Chip	Buoye Tender	Cable Ship	Chemical/Oil Tanker	Container Ship	Crude Oil Tanker	Diving Support Vessel	Dredger	Drillship	Fisheries Vessel	FSO/FPSO	General Cargo Vessel	Heavy Lift Vessel	Livestock Carrier	LNG Carrier	LPG Carrier	Multi-purpose Vessel	Naval Vessel	Offhsore Construction Vessel	Offshore Support Vessel	Passenger Ferry	Research Vessel	Reefer Vessel	Ro-Ro Vessel	Seismic Survey Vessel	Vehicle Carrier	Totals
Central Western Shelf Province	481	416	70	30	6	83	78	164	0	1	0	3	0	122	6	70	0	5	117	5	4	37	12	4	1	10	16	25	**1766**
Central Western Shelf Transition	56	44	7	11	1	11	4	17	1	0	20	2	0	12	0	3	0	0	45	1	0	9	4	1	1	0	2	3	**255**
Central Western Transition	659	567	46	8	1	171	475	209	3	1	0	2	0	531	8	81	0	13	73	0	2	19	19	1	5	27	14	110	**3045**
Northwest Province	623	635	86	128	6	118	52	266	145	4	24	1	39	69	16	37	6	18	59	1	5	2205	18	3	1	16	601	24	**5206**
Northwest Shelf Province	324	1467	4	442	32	45	0	428	119	5	102	35	80	42	32	109	439	24	265	12	48	3819	146	13	0	4	103	20	**8159**
Northwest Shelf Transition	70	32	1	28	9	62	0	94	1	2	0	3	0	3	8	139	4	4	192	3	9	635	379	76	0	156	11	6	**1927**
Northwest Transition	543	2395	61	24	3	51	0	280	2	6	7	21	18	36	35	54	439	35	55	0	3	168	8	0	4	1	43	31	**4323**
Timor Province	227	809	20	181	7	27	0	81	2	0	0	1	0	1	2	43	228	15	20	0	2	346	10	5	2	0	53	18	**2100**
Totals	**2983**	**6365**	**295**	**852**	**65**	**568**	**609**	**1539**	**273**	**19**	**153**	**68**	**137**	**816**	**107**	**536**	**1116**	**114**	**826**	**22**	**73**	**7238**	**596**	**103**	**14**	**214**	**843**	**237**	**26781**

In addition to the three port authorities there are nine other private export facilities that operate under an agreement with the WA Department of Planning and Infrastructure, which retains ownership of each port on behalf of the government. An overview comparison of the ports located in the Northwest Marine Bioregion is presented in Table 6.5.

Table 6.5 Current Shipping Activities

Location	Operator	Commenced Operations	Exports	Annual Quantities	Max Vessel Size (DWT)	Ship Movements	Comments
Port Authorities							
Broome	Broome Port Authority	1889	Livestock, pearls	-	50,000	128	Used by offshore oil & gas exploration operations for crew change-outs/ supplies.
Dampier	Pilbara Iron (Rio Tinto)	1960's	Iron Ore	116	320,000	3,000	
	Woodside Energy	1989	LNG, LPG Condensate	14	93,000		
	Dampier Salt (Rio Tinto)	1972	Salt	3.5	< 80,000		
	Burrup Fertilisers	2006	Ammonia	0.8	50,000		
Port Hedland	BHP	1965	Iron Ore	105	300,000	700	
	Dampier Salt (Rio Tinto)	1960's	Salt	3		80	
Other Private Export Facilities							
Cape Lambert (Port Walcott)	Pilbara Iron (Rio Tinto)		Iron Ore	58	323,000	> 370	
Carnarvon	Dampier Salt (Rio Tinto) (Cape Cuvier)		Salt	1.3	-	-	
	Shark Bay Salt (Useless Loop)		Salt	1.6 or 1.3	40,000	-	
Onslow	Onslow Salt	2001	Salt	2.5	-	-	
	Chervron Australia (Thevenard Island)	1989	Crude Oil	1.3MMbbl	-	-	
	Apache Energy (Airlie Island)	1989	Crude Oil	-	-	-	Decommissioned in 1997. Currently inactive for exports.
Varanus Island	Apache Energy		Crude Oil	-	-	-	
Barrow Island	Chevron Australia	1967	Crude Oil	2.66MMbbl	-	-	
Derby	Shire of Derby/West Kimberley			-	-	-	Currently inactive for exports.
Koolan Island	Mt Gibson Iron Ore	2007	Iron Ore	-	-	-	Previously mined between 1969 and 1993.
Yampi Sound (Cockatoo Island)	Portman / Henry Walker Eltin	1948	Iron Ore	-	-	-	
Wyndham	Ord River District Cooperative	1880's	cattle and sugar	-	-	-	Primarily export of cattle and sugar

6.4 Future Marine Infrastructure

The likely expansion of the minerals industries and associated infrastructure in and adjacent to the Northwest Marine Bioregion is summarised in Table 6.6. Table 6.7 presents an overview of the currently planned future and proposed ports and presents a generalised assessment of the main environmental aspects, values and sensitivities.

Table 6.6 Summary Minerals Projects

Commodity	Operator	Status	Construction Period	Operational Period	Decommissioning Period
Existing					
Iron Ore	Aztec Resources Limited	Operational		2006 - 2016	2017 -
Iron Ore	Portman Resources	Operational		1999 - 2007 ?	2007 ? -
Future					
Iron Ore	WA Government - Statutory Authority	Planning	2006 - 2008 - 2011	2011 -	
Iron Ore	Cape Preston Mining Management	Planning	2000 -	Minimum 25 Years	
Salt	Straits Exmouth Salt	Planning	2004 -2008	2008 -	
Iron Ore, LNG, Ammonia, LPG, Salt	Dampier Port Authority	Expansion	2007 -	Ongoing	
Iron Ore, Salt	Port Hedland Port Authority, BHP Billiton	Expansion	2007 -	Ongoing	
Iron Ore	Pilbara Iron	Expansion	2007 -	Ongoing	

6.4.1 Dampier Expansion and Maintenance

There is ongoing maintenance dredging required due to normal siltation, approximately every two to three years and cyclone impacts. Expansion in capacity has been designed into recent facilities planning. For example, the bulk liquids berth requires only simple dredging of the approach channel, swing basin and berthing pocket to increase the size of vessels that can be handled from 50,000 DWT to 65,000 DWT and to add additional berths (DPA 2007a).

Monitoring studies conducted by Woodside (1983) found that post-dredging, under generally prevailing weather conditions (excluding cyclonic effects) light penetration by photosynthetically active radiation in the Materials Offloading Facility spoil ground through the water, was similar when compared with results obtained in the pre-dredging period. So, beyond the visual effects during dredging, these results indicate that water quality was not affected by the dredge spoil operation and the spoil disposal area is stable.

There are currently two spoil grounds within the port limits and these are nearing capacity. A stakeholder committee is examining site options for new spoil disposal. Future approved spoil disposal sites are planned to be either “Land Reclamation” inshore and/or “Deep Sea”.

6.4.2 Port Hedland Expansion and Maintenance

Port Hedland Port Authority undertook routine maintenance dredging in July 2004. Over 500,000 m^3 of sediment was disposed of in the Port Authority's spoil ground under strict environmental management requirements. Port Hedland Port Authority also undertook a monitoring program to examine the effects of dredging and dredge material disposal on coral habitat in the vicinity of the channel, harbour and spoil ground and results indicate that none of the corals surveyed were affected. Additional monitoring in July 2005, no coral impacts were detected but there was significant sediment movement in the spoil ground area, resulting in a reduction of the 'cap' covering the contaminated spoil.

The port is short of high ground, so limited amount of borrow fill available. Dredge volumes should be optimised and reclamation areas set based on expected yield of material. There may be potential to expand the reclamation areas by careful design of drainage paths. Proposed reclamation areas could support the levels of industry and support potential attributed to them.

Dredging will be by cutter suction dredger and trailer hopper suction dredger. All dredged material, including mangrove muds, is disposed of onshore. Fine materials could be disposed of offshore, but Sea Dumping Permit issued by Environment Australia is required. Dredged material is required as fill for either land backed wharfs or for bulk handling facilities, stockpile areas, etc. Containment of material onshore involves construction of bunded areas designed to prevent material from leaching through the bunds and to be capable of withstanding the exposed wave climate due to cyclonic effects.

According to the Port Hedland Port Authority Planning Study Phase 2 Report (Worley, 2003), the proposed reclamation areas are flexible enough to accommodate variations in uses with careful planning of site arrangements. Future reclamation areas will need to be investigated thoroughly to ensure that settlement and compaction issues are properly understood and addressed for their intended purposes.

Following on from the maintenance dredging program in July 2004, additional monitoring of the coral reference sites and the spoil ground were undertaken in July 2005 in an effort to determine any adverse impacts. No impacts in corals were detected however there had been significant sediment movement in the spoil ground area which had resulted in the 'cap' covering the contaminated spoil to be significantly reduced (Port Hedland 2006).

6.4.3 Cape Lambert/ Port Walcott Expansion and Maintenance

Robe Iron proposes to increase capacity of its port facilities from 55 Mtpa to 85 Mtpa. Two berths will be added to the existing berths at the Cape Lambert wharf and to improve the departure basins and provide a consistent depth in the main shipping channel.

Dredging will consist of capital dredging of up to 3.6 Mm^3 of mostly undisturbed material. An extended swing basin and departure channel will also be dredged to provide navigation for the additional berths. There will also be dredging to improve the departure basins and to remove inconsistent depths in the existing shipping channel, with spoil material transported

to one of the offshore spoil grounds. One of the spoil grounds, called Spoil Ground 2, is in Commonwealth waters and was previously used for spoil disposal in the Robe River 1983 dredging program. Spoil Ground 3 is also in Commonwealth waters and Spoil Ground 1 is in State waters.

Areas to be dredged comprise of :

- Approximately 250 m extension to the existing berth pockets at the wharf;
- Widening of the eastern and western departure basins; and
- Realigning of the offshore end of the existing channel through selective removal of high spots to reduce tidal restrictions on outgoing vessels and facilitate navigation.

Necessary to dredge below the required depths in some areas to consistently achieve the required minimum dredge depths over the entire dredge area. Dredging will be performed using a combination of trailer hopper suction dredge (THSD) and a cutter suction dredge (CSD). It is proposed to dispose of dredged material to the nearest spoil ground, except for any contaminated material from around the wharf, which will be disposed of at Spoil Ground 2. THSD will be used to remove soft overlying materials from the dredged area. The hard materials will be crushed by CSD for subsequent removal by THSD. Material to be removed by TSHD will mostly be of medium grain size, causing limited turbidity (EPA 2007).

New Spoil Grounds

New Spoil Ground 1 is located approximately 5.6 km from Cape Lambert, bordering the outer extent of WA Coastal Waters. It is relatively flat, approximately 1 km wide by 2 km long and in approximately 20 m of water over a surface of consolidated material with patches of sand veneer characterised by fine to coarse sand particles. Benthic habitat is limited to sparse areas of whip corals and sponges, which is similar to the benthic communities in deeper areas of the region. Only uncontaminated material will be disposed of to this spoil ground and each load of dredge material will be dumped so that the dumped material is evenly distributed over the area within the spoil ground.

Spoil Ground 2 was used as a spoil disposal ground as part of the dredging program associated with the Cape Lambert Port Upgrade in 1983-1984. Surveys indicate that the remaining capacity of the ground is 2 Mm^3. The site is relatively flat, approximately 1 km wide by 2 km long and in approximately 20 m of water with sandy substrata. Contaminated material from around the wharf will be disposed of to this spoil ground into a containment area which has been prepared by dredging a trench with an approximate 1.5 m depth and using this dredged material to build an approximately 2 m high berm surrounding the trench. After the contaminated material is disposed of to this area, a minimum of 1 m of clean material will be used to cover it.

New Spoil Ground 3 has a capacity of approximately 2 Mm^3. It is relatively featureless, approximately 1 km wide by 2 km long and in approximately 20 m of water over a surface of consolidated material with patches of sand veneer characterised by medium sands to very fine gravels. This spoil ground is located between two un-named offshore reefs, neither of

which is likely to be impacted by the dredging or disposal program. The coordinates for the area within this spoil ground that will receive spoil are given in page 48 of the EP. Each load of dredge material will be dumped so that the dumped material is evenly distributed over the area within the spoil ground. Benthic habitat is limited to sparse areas of whip corals and sponges, which is similar to the benthic communities in deeper areas of the region.

The Cape Lambert Port Upgrade Dredging Program has been referred to the Department in May 2006 and decision was that approval is not required (the Department 2007).

6.4.4 Ronsard Island

A major new iron ore port will be developed on Ronsard Island. Key port design parameters for Ronsard Island are:

- 100-350 km to iron ore tenements;
- No jetty;
- Sheltered all weather port;
- Practical channel dredge depth 14.5 m;
- Causeway length – 5 km;
- Building and reclamation;
- Channel length – 17 km; and
- No basin required

Ronsard Island is a small island 400 ha in size (4 km x 1 km), approximately 3 km north of the mainland. Site elevation is less than 5 m near coast over much of the surrounding land area. It has a naturally sheltered harbour basin with potential for multiple berths adjacent to a stockyard area on the island. The elevations on the Island need further confirmation with its highest point indicated as 25m above Australian Hight Datum. With use of dredge material the opportunity exists for reclaimed land in the lee and an efficient arrangement for the port.

Proposed layout locates facilities within a harbour basin created in the deepwater in the lee of the island. There is an adequate area for 200 ha stockyard site on the western end of the island using some reclamation material from excavation of the island and reclamation with dredge material. A proposed 3 - 5 km long access causeway with trestle segments linking the island stockyards to the mainland and rail unloading facility. Berths will be aligned with reclamation on the island and port basin and turning cycle will be created in the deep water adjacent to the island as much as possible.

Ground conditions expected to be areas of marine sands, marine clays and silts on the foreshore with some outcropping coastal lime stone features (Worley 2007). On the island, the limestone material will provide a variably hard rock platform after cutting. Site arrangement should be positioned to optimise cut to fill operations and provide the materials required to support some of the reclamation bund core material and fill requirements. Piled

foundations for the access jetty and berth will need to be socketed into limestone and possibly into granite bedrock depending on elevations. The access causeway embankments out to the island and for the rail access (and loop) onshore are most likely to be founded on marine mud deposits along the coast and some settlements should be anticipated, or alternatively ground improvement options may have to be considered. Dredging for reclamation will need to avoid possible reactive weathered clays and is likely in calcreted limestones and granular calcareous dredged materials may be suitable for fill material and infrastructure constructions such as roads etc. There is a need to develop a solution that avoids any Granite bedrock outcrops in dredging.

No breakwaters are likely to be required.

An optimum mix of use of Ronsard Island materials and selected dredge materials offers an opportunity for reclamation to locate the stockyard directly adjacent to the berth.

6.4.5 Cape Preston

The Cape Preston, operated by CP Mining Management, development includes construction of a port and materials handling facilities, production facilities, a gas pipeline, 25 km overland conveyor and accommodation facilities. A desalination plant near the port development will also be constructed to supply water for the project. Ship loading wharf will be located near Cape Preston and will accommodate Cape size ships. Shipping channel will initially accommodate Panamax/Post Panamax ships but will be able to be expanded to accommodate Cape size ships (Austeel 2000).

Dredging will be undertaken by CSD and up to 4.5 Mm^3 of material will be dredged and disposed of offshore in an area which is not environmentally sensitive and is subject to Commonwealth Government approval, under the Environmental Protection (Sea Dumping) Act 1981. Dredging will be largely confined to benthic habitat consisting of sand and silt. The port will be constructed within the Great Sandy Island Nature Reserve.

Dredging activities could affect marine fauna. An area of approximately 70 ha will be affected by the dredging of the shipping channel for port access and berthing pockets. Dredging will also affect approximately 6 ha of coral habitat for the small craft harbour and a larger area of mainly bare sand and silt.

Construction of rock causeway from Cape Preston to Preston Island would result in the direct loss of 2.5 ha of coral, algae and sponges and 3 ha of sand / algae habitat. Jetty heads and causeways for the service vessel facility off Preston Island would destroy a further 4 ha of corals. Construction of a bridge between Cape Preston and the mainland will result in the direct loss of approximately 0.15 ha of mangroves, but there'll be no indirect loss of mangroves because the existing tidal flows will be maintained through the bridge being supported on piles or box culverts. Timing of dredging activities and selection of dredge spoil sites needs to be decided in close consultation with the Department.

Causeway construction will generate some turbidity with a local plume of some suspended material (Austeel 2000). Commitment to implementing a Marine Monitoring Program, which

will allow the effects of dredging operations to be quantified and will also set criteria that will result in the suspension of dredging activities, should unacceptable turbidity levels threaten the adjacent reef system.

Post-dredging surveys will be undertaken on completion of survey and at nominated times thereafter.

The Cape Preston Iron Ore Mine, Downstream Processing and Port Construction Project has been referred to the Department and has been approved subject to conditions and procedures specified in the Ministerial Statement.

6.4.6 Maret Island

INPEX Browse Ltd is proposing to build a new LNG Facility on the Maret Islands. Preferred location for the numerous reasons, some are:

- Unallocated crown land – no conflicts with existing uses, tenure or current conservation planning;
- Small size of 750 ha keeps the environmental footprints restricted to a confined area;
- Very flat, reducing the need for development and construction impact;
- Located in near shore deepwater, therefore dredging and navigational channels for shipping are not required, bringing significant environmental benefit to the project;

INPEX has commenced detailed environmental studies of the area and consultations with stakeholders.

6.4.7 Quandong Point

Quandong Point is a possible location for a proposed New Woodside LNG Facility.

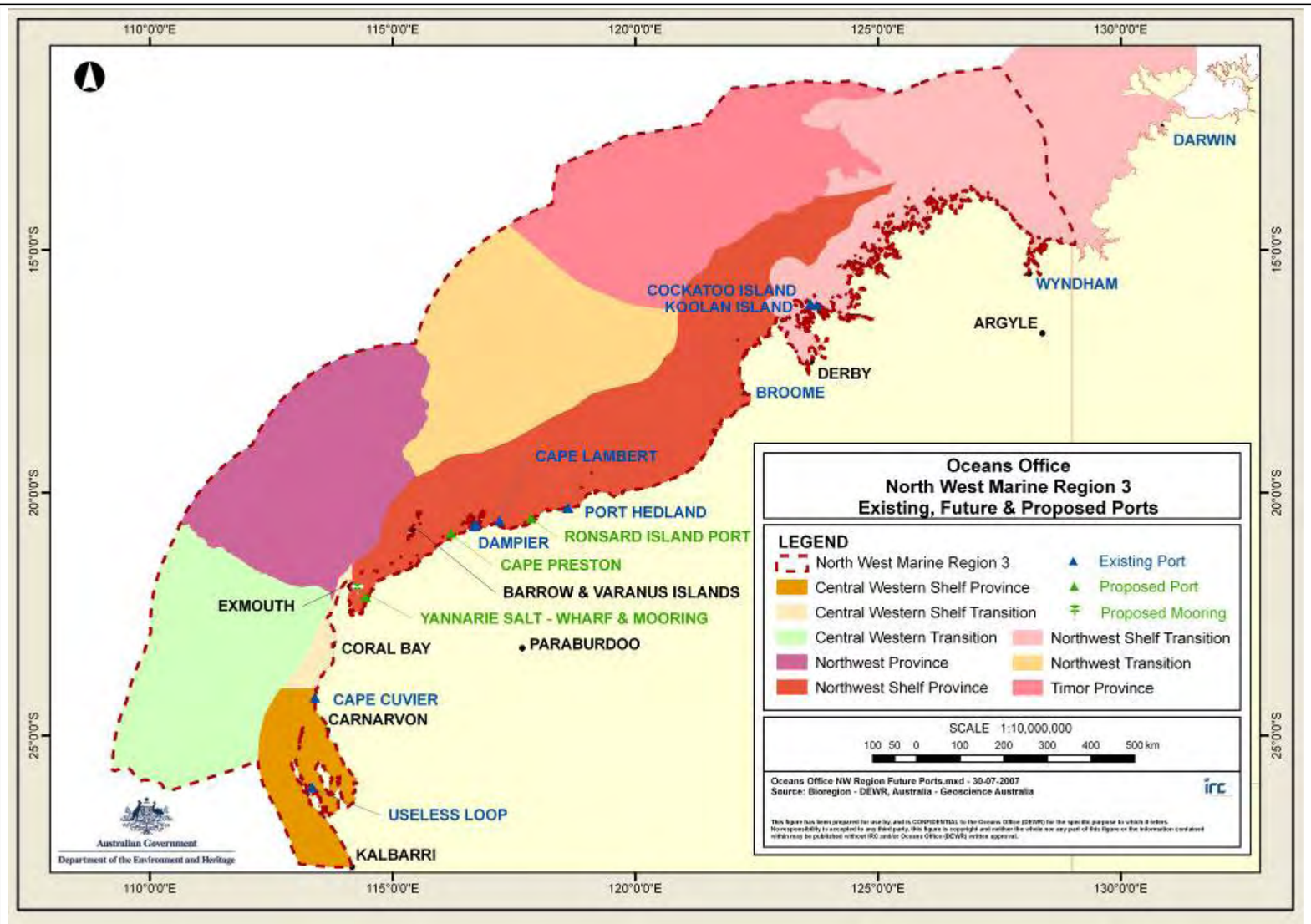
Table 6.7 Existing, Future and Proposed Ports

ASPECTS MATRIX **S**: An aspect of small magnitude **L**: An aspect of large magnitude	Physical presence	Seabed disturbance	Noise / vibration	Atmospheric emissions	Light emissions	Liquid waste disposal	Solid waste disposal	Discharges	Suspended solids	Energy usage	Introduced marine pests	Leaks or spills	Vessel Interference
APPRAISAL													
Surveys			L		S	S	S			S	L	S	L
CONSTRUCTION													
Vessel Operations			S	S	S	S	S			S	L	L	L
Dredging	S	L	S	L	S	S	S	L	L		L	L	L
Port Infrastructure		L	S		S			S	L				
COMMISSIONING & OPERATIONS													
Dredging			S			S		S				S	
Port Infrastructure	L	S	S	L	L	S	S	S		S		S	
Vessel Operations			S	S	S	S	S				L	L	L
DECOMMISSIONING & ABANDONMENT													
Plant and infrastructure removal	S	L	S				L		S				
Site rehabilitation	S	L	S				L		S				

ENVIRONMENTAL VALUE / SENSITIVITY [Low (**L**); Medium (**M**); High(**H**)]

Physical		**Biological**		**Socio-Economic**	
Sediment Quality	L	Marine Habitats	M	Marine Traffic	M
Seabed Features/Profile	M	Marine Fauna	H	Fisheries.	M
Water Quality	H	Marine Flora	L	Research	L
Air Quality	L	Seabirds	H	Heritage	M
Terrestrial Noise Levels	L	Fish	H		
Underwater Noise Levels	H	Plankton	L		

Matters of National Environmental Significance	
World Heritage Properties:	1
National Heritage Places:	3
Wetlands of International Significance (Ramsar Sites):	4
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	80
Migratory Species:	83
Other Matters Protected by the EPBC Act	
Commonwealth Lands:	2
Commonwealth Heritage Places:	6
Places on the Register of the National Estate (RNE):	157
Listed Marine Species:	139
Whales and Other Cetaceans:	34
Critical Habitats:	None
Commonwealth Reserves:	3
State and Territory Reserves:	90
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None



7 POTENTIAL FUTURE ENVIRONMENTAL IMPACT

7.1 Common Impacts

There are a number of activities common to both mining and petroleum exploration and exploitation that may result in potential impacts to the marine environment. Table 7.1 lists the typical petroleum and mining activities and associated environmental hazards and marine receptors.

Table 7.1 Summary of typical petroleum and mining activities and associated marine environmental aspects and receptors

Marine Activities	Potential Hazards	Marine Receptors
Petroleum & Mining Exploration surveys Drilling Dredging Facility installation and construction Production operations Maritime operations Decommissioning **Marine infrastructure** Ports Pipelines Shipping	Rig, vessel and platform presence Interference with fishing / shipping Atmospheric emissions Noise emissions Light emissions Drill cuttings and fluid discharges Sewage, putrescible and solid domestic wastes Waste oil, chemicals and oil contaminated drainage water Cooling water Ballast water Oil, diesel and chemical spills Vessel Collision Grounding Shallow water operations Dredging Run off from land operations	Habitats (seagrass, corals, soft bottom, mangroves, coasts and water column) Marine Fauna (seabed organisms, endangered species, protected species, migratory species) Marine Flora Fisheries Archaeology (Historic shipwreck sites) Marine Traffic Terrestrial Flora and Fauna Indigenous heritage sites

Table 7.2 Summary of potential hazards (risks) related to petroleum and minerals activities and marine environmental consequences (effects)

Potential Hazards (Risks)	Potential Consequences (Effects)
Facility presence	• Localised physical disturbance of the seabed; • Localised changes in biological productivity and diversity; • Modification of habitat associated with underwater structures; and • Behavioural impact on migratory species.
Interference with fishing and shipping	• Disruption to commercial or recreational fishing and tourism activity; • Disturbance to fish habitat, feeding and spawning areas and migration routes; and • Snagging of fishing nets on subsea equipment.
Atmospheric emissions	• Localised reduction in air quality; • Climate change; and • Ozone depletion.
Noise emissions	• Physiological effects or disruption to behaviour patterns of cetaceans, birds, turtles, fish and other marine life.
Light emissions	• Attraction and disorientation of fauna.
Drill fluids and cuttings discharges	• Increasing turbidity; • Burial and smothering of infauna and epifauna; • Toxicity and bioaccumulation to marine organisms; and • Depletion of oxygen in surface sediments.
Sewage, putrescible and solid domestic wastes	• Localised reduction in water quality - nutrient enrichment; • Modification of feeding habits of local fauna; • Nutrient enrichment of the surrounding waters; • Saprogenic effects; and • Toxicity.
Waste oil, chemicals and oil contaminated drainage water	• Localised reduction in water quality - nutrient enrichment; • Modification of feeding habits of local fauna; • Nutrient enrichment of the surrounding waters; • Saprogenic effects; and • Toxicity.
Cooling water	• Potential localised reduction in water quality.
Ballast water and introduced species	• Introduction of a population of organisms of the same species from another place; • Introduction of an exotic species that fills a vacant niche; • Introduction of an exotic species that replaces a local one occupying the same or similar niche (analogue species); and • Introduction of an exotic species that destroys (through predation or competition) one or more local species with disruption of local community structure.

Potential Hazards (Risks)	Potential Consequences (Effects)
Oil, diesel and chemical spills	• Toxicity to a variety of marine species; and • Physical effects of hydrocarbons can result in mortality and sub-lethal impacts to marine biota.
Vessel Collision	• Physical damage of marine and coastal habitats; • Release of antifouling onto seabed habitats; • Obstruction of shipping; • Interference with traditional and commercial fisheries; and • Impacts on cultural assets.
Grounding	• Physical damage of marine and coastal habitats; • Release of antifouling onto seabed habitats; • Obstruction of shipping; • Interference with traditional and commercial fisheries; and • Impacts on cultural assets.
Shallow water operations	• Turbidity; • Sedimentation; • Scouring of algal/seagrass habitats; • Interference with denitrifying processes; and • Mobilisation of contaminants/nutrients.
Dredging	• Localised loss and smothering of benthic habitats and loss/displacement of benthic species (eg corals); • Mobilisation of sediments, turbidity and sedimentation; • Hydrodynamic changes; • Loss of dredged material; • Alteration of sediments; and • Oxygen depletion.

7.1.1 Facility Presence

The physical disturbance of the seabed from drilling, dredging and/or installation vessels is mainly associated with laying and retrieval of chains. As the anchors are carried out to position by the support vessel, there may be some dragging of the anchor chain across the seabed. There may be some dragging of the anchor chain across the seabed when retrieving the chains, however winching the anchor directly upwards off the seabed minimises the impact of anchor chains dragging.

Laying and retrieval of anchor chains is likely to result in some physical damage to the seabed, though this impact is localised. (estimated to be confined to a corridor approximately 3–5 m wide for each anchor chain).

The effect of anchoring on soft sediments is expected to be slight. The anchor and anchor chain scars are expected to quickly fill in, and the biological communities associated with these sediments are expected to recover swiftly from the disturbance. Seagrass meadows may take several years to fully recover, depending on the species composition in the area.

Where the anchor chains cross over rocky or coral outcrops, it is expected that there will be localised disturbance to the biological communities associated with the outcrops. These communities are expected to have a comparatively lower potential to recover from disturbance on the assumption that they are thought to be relatively stable, slower growing communities.

Another aspect of the presence of drill rigs, platforms, dredgers and other surface and sub-sea facilities, such as moorings, well-heads and flowlines is that they provide hard substrate for the settlement of marine organisms that would not otherwise be successful in colonising the area. Further colonisation of the structures over time by other species leads to the development of a fouling community similar to that which is found on shipwrecks. The presence of the structures, and the fouling community, also provides for predator or prey refuges and visual clues for aggregation (Galloway et al. 1981). Investigation of the fouling communities on platforms on the North West Shelf has found that complex ecosystems develop within two years of being in place (Farrell 1992).

The provision of artificial habitat on the seabed is likely to influence the composition of the benthic community in the immediate vicinity due to altered predator-grazing pressures (Pollard & Mathews 1985; Hixon & Beets 1993). The environmental impacts associated with the provision of artificial habitat are locally increased biological productivity and diversity.

Removal of facilities during decommissioning will result in a loss of habitat associated with underwater structures and a return to original levels of biota. Should flowlines and moorings be left in place, habitat associated with these structures would remain intact.

The construction and installation of pipelines will not disturb the seabed as much, but may lead to medium to long term changes in benthic communities, through the provision of artificial habitat and changes to hydrodynamic regimes.

The presence of pipelines and flowlines could provide artificial habitat for marine fauna and flora. As a 500 m exclusion zone would be declared around the facilities, the presence of flowlines is unlikely to have any significant impacts.

Marine operations may involve the use of boats operating in shallow waters and the laying of anchors, resulting in physical damage to the seabed. Vessels operating in shallow water potentially create hazards including:

- turbidity;
- sedimentation;
- scouring of algal/seagrass habitats;
- interference with denitrifying processes; and
- mobilisation of contaminants/nutrients.

7.1.2 Interference with fishing and shipping

The potential impacts to fisheries arising from marine activities are:

- Disruption to commercial or recreational fishing and tourism activity;
- Disturbance to fish habitat, feeding and spawning areas and migration routes; and
- Snagging of fishing nets on subsea equipment.

7.1.3 Atmospheric Emissions

Exploration and production activities result in the release or emission of several greenhouse gases, notably carbon dioxide and methane, through the use of combustion engines and well testing (flaring). Flaring of surplus gas occurs during well testing operations and non-routine operations (which include commissioning, re-injection equipment downtime and process upsets).

Rising sea levels as a result of temperature increases (IPCC 2001) may have significant impacts on low lying islands in the Northwest Marine Bioregion. The emissions of greenhouse gases from potential mining and petroleum activities in the Northwest Marine Bioregion would contribute a very small proportion of the total emissions from Australia.

Gaseous emissions, other than greenhouse gas emissions, as a result of combustion machinery operations will occur. These include emissions of sulphur oxides, nitrogen oxides and smoke to the atmosphere. The quantities of gaseous emissions are likely to be relatively small and would, under normal circumstances, be quickly dissipated into the surrounding atmosphere.

It is possible that seismic vessels, dredgers, drill rigs, FPSOs and support vessels may have Ozone Depleting Substances (ODS) such as halon deluge systems in engine rooms and chlorofluorocarbons (CFC's) used in refrigeration systems. These systems would only be activated in the event of fire or maintenance activities, and only small volumes of ODS would be released.

Typical greenhouse gas emissions considerations are discussed below for the Chevron Gorgon, Woodside Pluto and Inpex Ichthys Developments.

Gorgon Development (Operator, Chevron)

The current development concept results in only 40 percent of the greenhouse gas emissions per tonne of LNG produced than the 1998 concept that formed the basis of the Gorgon Project's Greenhouse Challenge Agreement with the Australian Greenhouse Office. Engineering and design decisions that have resulted in significant improvements in greenhouse emissions performance compared to 1998 include:

- Replacement of the offshore gas processing platform with an all sub-sea development;
- Changes in LNG process technology;

- Improved waste heat recovery on the gas turbines resulting in a significant reduction in the use of supplementary boilers and heaters; and
- Significant reduced greenhouse gas emissions due to the injection of reservoir carbon dioxide into the subsurface.

The preferred location for CO_2 injection is on the central eastern coast of Barrow Island in the general location of the proposed gas processing plant. This site was selected to maximise the migration distance from major geological faults and to limit disturbance to areas around the proposed gas processing plant.

The number of injection wells will be confirmed following further technical studies. The wells are planned to be directionally drilled from two or three surface locations to minimise the area of land required for the well sites, surface facilities, pipelines and access roads. It is likely that a monitoring well (or wells) will be drilled from each cluster of injection wells to provide a sample point within the area of injection. A Reservoir Management Plan will be developed to integrate the monitoring activities, reservoir modelling and the management of injection operations.

The estimated greenhouse gas emissions from the proposed development are four million tonnes of carbon dioxide per annum during the steady operations phase, based on an annual production rate of 10 million tonnes of LNG and 300 TJ/d of domestic gas.

Pluto Development (Operator, Woodside Energy)

Development of the Pluto gas field will result in greenhouse gas emissions over the life of the development; comprising both direct emissions from the production of LNG and other lifecycle emissions that include emissions from the use of the LNG, for example electricity generation in other countries.

Based on LNG production of 5.9 Mtpa the estimated direct emissions for the Pluto LNG Development are in the order of 1.9 Mtpa of CO2e (carbon dioxide equivalent) increasing to approximately 4.1 Mtpa of CO2e when LNG production increases to 12 Mtpa (the greenhouse gas emissions are based on 95% plant utilisation). The increase in greenhouse gas emissions is a result of a second LNG train coming on line and also the assumption that offshore compression will be required for the Pluto gas field after 4-10 years of project operations.

Figure 7.1 presents the expected emissions profile for the Pluto LNG Development. It is anticipated that (after 4–10 years of operation) offshore gas compression facilities and the start-up of the second onshore LNG train at Site B will be required. At this point the greenhouse gas emissions are anticipated to increase to 4.1 Mtpa of CO2e based on the current design and a capacity utilisation of 95%. The timing of offshore compression will be dependent on the rate of decline of the Pluto gas reservoir pressure and therefore has the potential to be significantly delayed if the reservoir has greater gas reserves than expected or additional gas fields are tied into the platform (Woodside 2006).

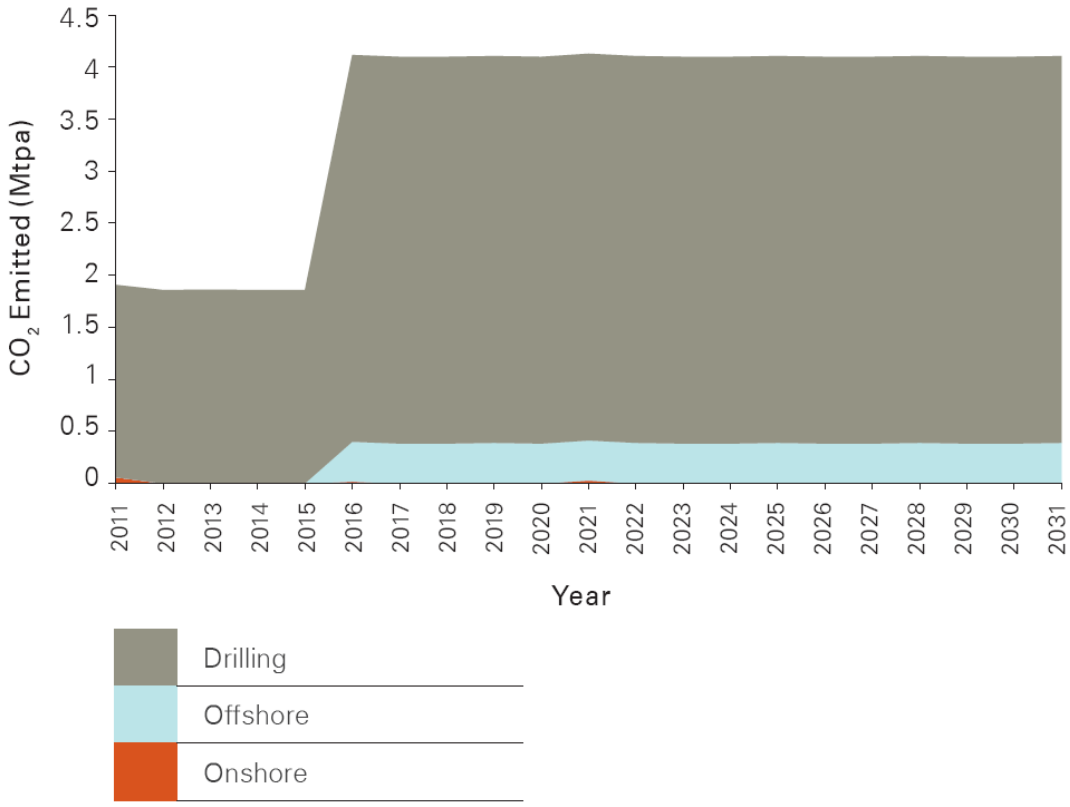


Figure 7.1 Greenhouse Gas Emissions Profile for Woodside Pluto Development

7.1.4 Ichthys Field Development (Operator, INPEX)

INPEX and its Joint Venture Partner, Total Australia, have established a Greenhouse Taskforce to determine the most appropriate long-term strategy for management and mitigation of greenhouse gases.

Details of the ultimate strategic package of mitigation options will be addressed in meaningful detail in the EIS/ERMP at which stage the development options and concept design will be at a stage of maturity to address this issues in detail. Such strategies will take into account the advice of governments.

7.1.5 Noise Emissions

The most significant source of underwater noise is seismic surveys. Other potential sources of significant underwater noise are vessels (including support vessels, installation vessels and trading tankers), dredgers, drilling rigs, FPSO vessels and fixed installations (platforms and gravity based structures).

Marine seismic surveys produce the highest levels of underwater noise. Environmental research relating to seismic surveys has largely focused on the potential effects of acoustic disturbance to fauna, particularly marine mammals (McCauley 1994). Potential effects to fauna may include:

- pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms;
- behavioural change to populations of marine organisms;
- disruptions to feeding, mating, breeding, nursery or migratory activities of marine organisms in such a way as to affect the vitality or abundance of populations;
- disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- changed behaviour or breeding patterns of commercially targeted marine species, either directly, or indirectly, in such a way that commercial or recreational fishing activities are compromised (Ecos 2001).

Reviews of available research data conclude that; although airguns pose a potential risk to individuals at close range, the transitory nature of seismic operations and the limited range over which possible effects could occur make it unlikely that airguns pose a significant threat to marine life (McCauley 1994; Darracott 1985). Immediate pathological effects are likely to be restricted to within a very short distance from the source and the majority of species are expected to practice avoidance well before they are within the range at which pathological effects may occur.

Animals which do not move away from the path of a seismic vessel because of behavioural or physical constraints, or are caught unaware within a few hundred metres of an array when it starts up, will be at risk from pathological damage. The sound intensities required to produce pathological effects in nearly all marine animals are not sufficiently researched, but probably occur at ranges from an airgun array of less than 100 m for marine mammals and 200 m for fish (McCauley 1994).

Airborne noise would be generated by all of the above and also by airborne exploration and helicopters.

The noise characteristics and level of various vessels that may be present vary considerably between vessel types. The particular activity being conducted by the vessel also greatly influences the noise characteristics, for example, if it is at idle, holding position using bow thrusters, or accelerating.

Under normal operating conditions when the vessel is idling or moving between sites, support vessel noise would be detectable only over a short distance. The noise from a vessel holding its position using bow thrusters and strong thrust from its main engines, may be detectable above background noise levels during calm weather conditions for 20 km or more.

Drilling rigs emit noise from onboard machinery and the drill pipe. McCauley (1998) measured the underwater noise emitted from a drilling rig in the Timor Sea and found the broadband noise level to be approximately 146 dB when not actively drilling and 169 dB during drilling operations. This compares to measurements of drilling rigs elsewhere recorded by Greene (1987) of 154 dB for the frequency band 10–500 Hz.

FPSOs emit noise from onboard machinery, production equipment and associated sub-sea equipment. The likely noise characteristics can be estimated by comparing the noise emitted from a similar FPSO (Cossack Pioneer) currently operating on the NWS.

The Woodside study of underwater noise from the Cossack Pioneer indicated that tonal machinery noise from the engine spaces and noise from the slowly turning propeller dominated the FPSO noise. Source noise levels from the FPSO, in production state, were estimated to range from 167 dB off the bow and 181 dB off the aft quarters, reducing to 120 dB after 1 km, and to background levels (95 dB) at near to 10 km (Woodside 2005b).

Underwater noise from cutter suction or trailer dredgers has been reported as ranging from 146 dB to 156 dB at 100 m (Richardson et al. 1995 in PB 2005).

The potential impacts of noise on marine creatures are summarised in Table 7.2 below.

Table 7.2 Summary of potential noise impacts on marine animals.

Marine Creature	Impact
Mammals	• Possible interception of acoustic perception and communication of animals in the vicinity. • Potential stress if threshold level is exceeded.
Seabirds	• Direct impact is unlikely. • Underwater noise may cause a reduction in prey availability and lead to a slight indirect impact, but difficult to quantify.
Turtles	• Limpus et al,1983 recorded that marine turtles demonstrate a startle response to sudden noises. • No information available on threshold level necessary for behavioural effects. • Possibility of some turtles avoiding the area.
Fish	• May cause some behavioural changes or masking of other acoustic cues necessary for normal biological/ecological functioning. • Avoid approaching vessels to some degree, weakening with depth. Fish below 200 m are only mildly affected and effect is temporary, with normally schooling patterns returning to normal after the noise source has passed.

7.1.6 Light Emissions

Lighting has been linked to attraction and possible disorientation of seabirds (Weise et al. 2001). Seabirds are often observed to approach and circle, and occasionally rest on, drilling rigs and production platforms in much the same way as they approach ocean-going vessels.

Lighting has also been linked to disorientation in turtles, particularly during periods of nesting and hatching (Lutcavage et al. 1996; Pendoley 1997). Studies reported by Witherington (1992) on hatchling orientation relative to spectrally controlled light sources indicated that the most disruptive wavelengths were in the range of 300–500 nanometres. In contrast, light

emitted from a natural gas flare has peak spectral intensity in the range from 750 to 900 nanometres (WAPET 1995).

7.1.7 Drilling Fluids and Cuttings Discharges

Drilling Fluids

Water Based Muds (WBM) provide the least environmental impact due to their non-toxic nature and ability to disperse and biodegrade rapidly (Terrens et al. 1998; DME 1998). A survey to evaluate the environmental effects of drilling using WBMs on the North West Shelf undertaken by Woodside (Hanley 1993) demonstrated that little environmental effect remained after three years.

Modern Non-water Based Muds (NWBM) have been designed to maintain many of the technical features and benefits available from other NWBMs used in the past, such as oil-based drilling muds, whilst incorporating a significant reduction in toxicity and a significant increase in biodegradability.

The main pathways for drilling muds to enter the marine environment during drilling activities are:

- discharge of whole drilling muds to the ocean;
- residual drilling mud coating drill cuttings that are discharged to the ocean; and
- accidental spills.

Where WBMs are used, the whole drilling muds are routinely discharged to the ocean at the end of drilling, or when the mud property requirements change. Where NWBMs are used, whole muds are not discharged to the ocean; instead they are retained for onshore reconditioning, re-use or disposal. However, a small residual amount of drilling mud will remain as a coating on the cuttings, which may be discharged overboard to the marine environment.

If NWBM is used, then the completion fluids are expected to be diesel and a base drilling mud mixed with various additives. During the well clean-up operation, these fluids are usually burnt (such as through a flare/burner). Should a WBM be used, then the completion fluids would be diesel and a fluid such as potassium chloride. The diesel would usually be burnt and the potassium chloride solution discharged overboard.

Ester-based drilling muds have shown low ecotoxicity to test species, though they have shown slightly elevated ecotoxicity in sediment tests in comparison to either olefin-based or acetal-based drilling muds. Ester-based drilling muds rapidly disappear from sediments and have exhibited high biodegradability in anaerobic conditions (Terrens et al. 1998; Neff et al. 2000).

Field studies of the environmental effects of synthetic-based drilling muds discharged on drill cuttings have shown reductions in sediment total recoverable hydrocarbon (TRH) levels of an order of magnitude over 8 to 13 months, suggesting that sediment TRH concentrations,

below 1000 mg kg^{-1} could be achieved within one to two years if recovery continues at the observed rate (IRCE 2003).

Spills caused by drilling fluid and drilling chemical transfers are rare, but because of the number of times drilling fluids (and drilling chemicals) are handled at sea and the volumes involved, this is another of the more common sources of spills. Spills during handling are caused by hose rupture, coupling failures, and tank overflow. Similar to a fuel transfer spill, the likely maximum volume of drilling fluid spilt as a result of one of these events has been estimated at 10 m^3. Quantities are minimised by shutdown of pumps and automatic closure of safety valves. Rupture of a transfer hose typically leads to a spill of no more than 0.2 m^3.

The main environmental concerns associated with the discharge of drilling muds to the marine environment are:

- turbidity;
- alteration of sediment characteristics; and
- toxicity.

On the NWS the plume from drilling mud discharge is visible in the upper parts of the water column for up to 1.5 km from the discharge point. A US study of compiled data from numerous studies regarding the growth and dilution of drilling mud discharge plumes found that the drilling mud is diluted approximately one million times after 1 km from the discharge point (US EPA 1985).

Based on studies carried out by the US Army Corps of Engineers (2000), it is calculated that at 100 m from the point of discharge the surface water turbidity will be approximately 75 NTU above background levels. At worst, the introduced turbidity would result in a 10% reduction of the received solar radiation 100 m from the discharge point (Woodside 2005b).

Dispersed drilling mud particles are transported horizontally with the ambient currents. The distance transported before settlement will be a vector of both the horizontal (currents) and vertical (sinking) transport forces. The particles are generally very fine and can alter the characteristics of sediments, leading to shifts in benthic and infaunal communities (IRCE 2003).

Drilling muds contain a variety of special purpose additives. A number of reviews have been carried out to identify common drilling mud additives, their uses, application concentrations and toxicities (eg Swan et al. 1994).

Drill Cuttings

Drill cuttings are generally either discharged to the seabed or reinjected into the tertiary loss zone (where possible). When discharged to the seabed, the cuttings will have some drilling fluid attached to them. The cuttings are treated to remove as much drilling fluid as possible. Depending on the depth and bore of the drilling, the amount of cuttings generated can range from 100–2000 m^3.

In shallow water, most of the drill cuttings would be expected to rapidly drop out of the water column and settle to the seabed, resulting in the formation of a cuttings mound, which due to strong currents in the area, would erode away and be dispersed through time. While present, the mound may be colonised by fish and other fauna.

The environmental impacts associated with the discharge of drill cuttings relate primarily to:

- increases in localised turbidity;
- smothering and alteration of sediment characteristics;
- depletion of oxygen in surface sediments; and
- toxicity of adhered drilling muds.

Smothering of benthos is likely to occur within 1000 m of the discharge point, mainly along the axis of the predominant current. Habitat disturbance will occur due to the difference in particle characteristics (such as size and abrasiveness) to the existing sediment. This may impact upon algae, seagrass, corals, benthic invertebrates and infauna.

An infauna survey at Apache Energy Limited's Stag platform undertaken two years after commissioning of the installation indicated that the distribution of drill cuttings were mostly restricted to within 50 m of the platform, with minor impact up to 1000 m (IRCE 2001).

The deposition of drill cuttings can markedly alter the sediment characteristics of an area, particularly the grain size composition. Studies carried out in the Gulf of Mexico found that sediments less than 500 m from platforms were enhanced with coarse-grained materials predominantly derived from drill cuttings (US DIMMS 2001). This change may be temporary as sediment redistributes and disperses over time or may result in long term changes in infauna community composition.

The smothering of an area of the seabed by drill cuttings will result in the covered seabed becoming anoxic over time. In circumstances where the drill cuttings have associated oil, either as coating from NWBM or from oily sands removed from the reservoir, field studies have shown that this oil persists for long periods of time before it is fully biodegraded (Schaaning et al. 1995). The observed persistence is considered to be primarily due to the reduced rates of biodegradation that occur in anoxic conditions of cuttings piles below the first few centimetres (Neff et al. 2000).

Repeated field studies have demonstrated that where changes in the composition and/or abundance of benthic biota have been observed in, or adjacent to, cuttings piles, these changes have been associated with oxygen depletion in the surface sediments (Neff et al. 2000). The observed effects usually include a decrease in the number of taxa and biological diversity, however, the total number of individuals and biomass may actually remain constant, or even increase, in some instances.

For the period of drilling during which the oil bearing formation (the final well sections) is being intersected, drilling mud will be present as a coating on the cuttings with reservoir oil adsorbed within the cuttings.

Impacts on infauna attributable to drilling operations in which NWBM coated cuttings were disposed of to the seafloor have been investigated by Apache Energy Limited over a number of years. Preliminary results indicate that where discharges were sufficient to generate sediment concentrations of Total Recoverable Hydrocarbons (TRH) above 1000 mg kg-1 there was a noticeable impact on infaunal communities. Organic enrichment was suggested as the cause for the infaunal response. Reductions in sediment TRH levels of an order of magnitude were observed over 8 to 13 months, suggesting that sediment TRH concentrations, below 1000 mg kg-1 could be achieved within one to two years if recovery continues at the rates observed (IRCE 2003).

7.1.8 Sewage, Putrescible and Solid Domestic Wastes

Treated sewage and greywater is regularly discharged to sea by vessels, dredgers, drill rigs, production platforms and FPSOs. On entering the sea the discharge stream is rapidly diluted and dispersed by the ambient currents. The greatest volumes produced by any of the activities likely to occur in the would be from petroleum drilling, and as such, this is considered here. The concerns associated with the discharge of sewage and greywater to the sea are:

- nutrient enrichment of the surrounding waters;
- saprogenic effects; and
- toxicity.

The addition of readily degradable biological material contained within the sewage to a closed ecosystem (or one with limited exchange) can lead to the depletion of oxygen from the waters and anoxic effects as the material decays.

The toxic effects of sewage discharged to sea have been relatively well studied (eg Weis et al. 1989; Gray et al. 1992) and generally only occur where high volumes are discharged.

Solid wastes include scrap materials, packaging, wood, paper and empty containers. Typically, these non hazardous waste materials are stored on board the dredger, seismic vessel, drilling rig, installation vessels, and FPSO in suitable containers (segregated from hazardous waste materials) ahead of transport back to shore for disposal/recycling in accordance with local regulations.

The discharge of food scraps and deck run-off may act to attract oceanic seabirds and some shorebirds to facilities and vessels, either directly or secondarily as a result of prey species being attracted to the facilities. The waste is usually macerated prior to discharge and the discharge volumes involved are small, with low potential for impact.

There is potential for loss of equipment off facilities and vessels during storms or other misadventure. This would generally be non hazardous, but may obstruct other users or cause physical damage to habitats and species.

7.1.9 Waste oil, chemicals and oil contaminated drainage water

The vessels, drill rigs, FPSOs and dredgers will all have bilges which will have automatic and emergency systems to pump out bilge water. This bilge water is likely to be contaminated with oils and chemicals and is usually discharged to the sea. Under normal operations, the volume of bilge water is relatively minor and unlikely to present a serious hazard. If the vessel (etc) is poorly maintained, with inadequate bunding to prevent contamination of the bilge water, the risk is increased, but is still unlikely to be a serious risk.

Hazardous wastes generated include recovered solvents, excess or spent chemicals, oil contaminated materials (eg sorbents, filters and rags), batteries and used lubricating oils. The volumes of hazardous wastes would be expected to be relatively small.

Deck drainage consists mainly of washdown water and occasional rainwater from vessels, dredgers, drilling rigs, FPSOs and production platforms. While no wastes are routinely discharged via deck washdown, the washdown or rainwater run-off will generally be directed overboard and may contain small quantities of oil, grease and detergents.

Areas which are more likely to have small oil spills are generally directed to a sump which is in turn normally directly connected to an oily-water separation system. Once separated, the oil and grease is reprocessed or stored in suitable containers ahead of transfer ashore for recycling, while the treated water is discharged to sea or re-injected.

7.1.10 Ballast Water and Introduced Species

Ballast water will be discharged from dredgers, seismic vessels, drilling rigs, FPSOs, trading tankers and possibly from support vessels. Ballast water tanks are segregated from the fuel and crude oil tanks.

Marine pest species may potentially be transported into the North West Marine Region (NWMR) as a component of ballast water (and associated sediments) or as marine fouling.

Fouling communities on vessel hulls and other submerged structures can be complex with a multitude of species present. The level of knowledge regarding the factors influencing this vector for marine pest species transport is less well known than that of ballast water. Recent work in Australia and New Zealand suggests that hull fouling may be a significant source of introduced marine pests (eg CRIMP 1999). Commercial tankers have their hulls cleaned regularly and are treated with anti-fouling paints to prevent the establishment and growth of fouling communities. This means that the presence of fouling communities is usually much less on commercial tankers than on smaller or non-commercial vessels.

The majority of marine organisms contained within ballast water taken on in port are likely to have distributions restricted to coastal habitats. Consequently most species, should they be introduced, would be expected to have a good chance of survival and reproduction, subject to suitable temperature, salinity and environmental regimes.

The degree of environmental impact from an establishment of exotic marine species will vary with the circumstances. Scenarios include:

- introduction of a population of organisms of the same species from another place;
- introduction of an exotic species that fills a vacant niche;
- introduction of an exotic species that replaces a local one occupying the same or similar niche (analogue species); and
- introduction of an exotic species that destroys (through predation or competition) one or more local species with disruption of local community structure.

The main controllable factor affecting the degree of environmental impact is the 'probability of introduction'.

The Australian Quarantine Inspection Service (AQIS) introduced mandatory ballast water management requirements for international shipping in July 2001. These requirements have legislative force under the *Commonwealth Quarantine Act 1908*. Where the potential risk is considered to be high, the compulsory requirements specify three approved options for the management of ballast water (AQIS 2000). These are:

- non-discharge of 'high risk' ballast tanks in Australian waters;
- tank-to-tank transfers; and
- full ballast water exchange at sea.

It should be noted that the large volumes of shipping traffic that already pass through the NWMR constitute a much higher risk than any increase in shipping due to potential mining or petroleum related activities.

The introduction of pest species, such as rats, onto islands where seabird and turtle rookeries exist could have large impacts on egg and young survivorship. The greatest risk is to those species which have nesting areas restricted to only a few islands, and to regionally endemic species.

7.1.11 Cooling Water

Seawater is used as a heat exchange medium for the cooling of engines on vessels, dredgers, drilling rigs, FPSOs and production platforms. During hydrocarbon production, the seawater cooling system is segregated from the processing system, therefore there is minimal risk of crude oil contamination of the cooling water discharge.

When discharged to sea the cooling water is initially subjected to turbulent mixing and some transfer of heat to the surrounding waters. The plume then disperses and rises to the sea surface where further dilution and loss of heat occurs. The plume of heated water moves in accordance with the prevailing currents. Temperatures drop swiftly with distance from the discharge point.

Elevated seawater temperatures are known to cause alteration of the physiological processes (especially enzyme-mediated processes) of exposed biota (Wolanski 1994). These alterations may cause a variety of effects ranging from behavioural response

(including attraction and avoidance behaviour), minor stress and potential mortality for prolonged exposure. The areal extent in which the production process cooling water discharge will cause significant elevation of temperature is predicted to be relatively small.

The only biota that will be exposed for long periods would be fouling species (eg barnacles) in the immediate vicinity of the outfall. The heated water will prevent species less tolerant to elevated temperatures from settling and becoming established in close proximity to the outfall. The ecological impacts associated with the cooling water discharge are very localised reduction in fouling community growth and some behavioural response from motile species (Woodside 2005b).

7.1.12 Oil, diesel and chemical spills

Spills caused by fuel handling mishaps are rare, but because of the number of times fuel is handled at sea and the volumes involved, this is one of the more common sources of spills. Causes include hose rupture, coupling failures, and tank overflow. The likely maximum volume of fuel spilt as a result of one of these events has been estimated at 10 m^3. Quantities are minimised by shutdown of pumps and automatic closure of safety valves. Rupture of a fuel transfer hose typically leads to a spill of no more than 0.2 m^3 (Woodside 2005b).

The likelihood of vessel collision either from a third party or support vessel is rare. However, should such an event occur, it is estimated that a maximum of 100 m^3 of diesel could be released.

The toxicities of crude oils are generally significantly lower than diesel. The heavier types of oil (eg crude, hydraulic fluid) are generally more persistent although not as toxic as the lighter oils such as diesel.

Lethal concentrations of toxic components leading to large scale mortalities of marine life are relatively rare, localised and short lived, and only likely to be associated with spills of light refined products or fresh crude.

At particular risk are animals and plants living in areas of poor water exchange or where special conditions, such as incorporation of fresh oil in stable sediments, cause high concentrations of the toxic components to persist for a longer period than normal.

In the event of a hydrocarbon spill in the ocean, a range of physical, chemical and biological processes act on the oil over time. Surface winds and currents are an important factor in the initial dispersal of hydrocarbons. Evaporation will account for the loss of crude oil to some extent and a large proportion of diesel fuel (estimates of more than 50% of diesel lost from the sea surface after 10 hours). Dissolution and dispersion of the oil in the water will take place over the first hours and days with wave action assisting these processes. Over longer periods of time oil particles will be diluted and dispersed in the water column and sediments, where they are subject to microbial activity and biodegradation.

The potential frequency of hydrocarbon spills on the NWS based on historical data gathered by Woodside (2005b) is shown in Table 4.3. The largest spill to have been recorded from an Australian offshore oil and gas production activity is 60 m^3 (Woodside 2005b).

Table 7.3 Potential sources and frequency of hydrocarbon release (Source: Woodside 2005b)

Volume	Maximum Potential Frequency	Example Potential Source
< 1 m^3	one in 1–2 years	Small leaks and spills
1–10 m^3	one in 2–3 years	Small offloading spill
10–50 m^3	one in 50 years	Spill of diesel day tank contents
50–100 m^3	one in 100 to 1000 years	Large offloading spill
1000 m^3	one in 10 000 years	Large cargo tank failure
>1000 m^3	as low as one in 1 000 000 years	Major cargo tank failure

Potential sources of oil spills include:

- blowouts;
- incomplete combustion during flaring; and
- leakage from machinery and bunded areas.

Leaks of hydraulic fluids from hoses or pipework in derricks or other hydraulic equipment could occur through accidents, or lack of appropriate safeguards, including: preventative maintenance, manned operations and the presence of drip pans/bunds. The volumes of any such leaks are expected to be small.

The leakage of hydraulic fluids from a hydraulic hopper dredge is possible due to the reasons outlined above. The maximum volume expected from such an event is estimated at 1000 L.

Toxicity testing of diesel by various organisations has identified it as being toxic to a variety of marine species. The range of reported toxic concentrations for standard toxicity testing protocols varies from approximately 3 to 80 mg L^{-1} (CONCAWE 1996). Diesel fuel appears to retain its toxicity during weathering due to the slow loss of light ends. In addition, the additives used to improve certain properties of diesel (eg ignition quality, flow improvers) contribute to the toxicity of the diesel oil.

In addition to toxic effects the physical effects of hydrocarbons can result in mortality and sub-lethal impacts to marine biota. Physical effects include coating and/or smothering by oil, leading, in cases of severe contamination, to death through the prevention of normal functions such as feeding, insulation, respiration and movement. As damage is caused by physical contact, the animals and plants at most risk are those that could come into contact with a contaminated sea surface. Within this category are:

- marine mammals and reptiles;
- birds that feed by diving or form flocks on the sea;
- marine life on shorelines; and

- animals and plants in aquaculture facilities and storage pens in tidal areas.

Various chemicals are carried aboard vessels, drill rigs, dredgers and support vessels. It is assumed that most of the chemicals would have generally high water solubility and would be rapidly diluted in a spill scenario.

7.1.13 Vessel Collision

Vessel collisions have the potential to have a number of impacts on the environmental assets in the NWMR. The most significant impact would occur if an oil or chemical tanker was involved in a collision and released large volumes of toxicants in a near shore environment.

This risks of collision due to increased shipping related to mining and petroleum activities

- physical damage of marine and coastal habitats;
- release of antifouling onto seabed habitats;
- obstruction of shipping;
- interference with traditional and commercial fisheries; and
- impacts on cultural assets.

7.1.14 Grounding

Strong tidal currents and the, at times, narrow shipping channels increase the likelihood of groundings occurring. Groundings can result in:

- physical damage of marine and coastal habitats;
- release of antifouling onto seabed habitats;
- obstruction of shipping;
- interference with traditional and commercial fisheries; and
- impacts on cultural assets.

7.2 Martine Infrastructure Environmental Aspects

7.2.1 Port Infrastructure

Upgrades to port infrastructure may include dredging of shipping channels and construction of new wharves, landings and warehouses. The potential impacts of these activities include the impacts associated with dredging, land clearing, terrestrial runoff resulting in turbidity and sedimentation, release of acid sulphate soils and waste associated with construction.

The activities associated with construction of processing facilities (particularly close to shorelines) may result in impacts to the marine environment. The waste streams from these facilities may also lead to environmental impacts.

Apart from short term disturbance to the seabed and the provision of artificial habitat, the installation of more navigational aids would be expected to decrease the likelihood of vessel groundings and collisions (with a concomitant decrease in the risk of spills).

7.2.2 Dredging

The process of dredging releases previously stable sediments to the surrounding water column, resulting in a combination of water column and benthic impacts. The consequence of these processes on the marine environment is well understood (USACE and US EPA. 2004; MEMG 2003). The extent and nature of these impacts varies according to dredging methodologies, size of the dredge campaign, materials to be dredged, prevailing environmental conditions and location of sensitive receptors.

Offshore mining operations will minimise long term adverse impacts on marine organisms and the physical characteristics of an area if appropriate site selection, timing, techniques and monitoring are carefully performed.

Dredging activities could result in potentially significant localised loss of benthic habitats and loss/displacement of benthic species.

If contaminated, dredging and disposal of sediment has the capacity to release toxicants into the water column and increase overall bioavailability. Where sediments contain elevated nutrient concentrations, nutrient availability may increase during dredging and may cause some level of short term eutrophication.

Fine fractions of sediment can be available for migration over significant distances. In the appropriate conditions and over extended dredging periods, the impact of these fine particulates can be a significant ecological risk.

Sedimentation can result in mortality of some benthic flora and fauna (particularly corals). If sediment loads are high and continue over time significant ecological impacts may occur. Both pelagic and benthic organisms can be impacted from increased suspended solids and subsequent deposition.

Alteration of the seabed profile due to dredging activities associated with seabed mineral extraction may result in hydrodynamic changes which may affect:

- sea levels and storm surge;
- astronomical tidal range;
- tidal currents;
- coastal processes;
- coastal residents;
- reestablishment of marine habitats;
- wave climate; and
- shipping access;

The dredged material is likely to be transferred to a barge or trailer. There exists the possibility that some of the material will spill during transfer or overflow from the barge. A cutter suction dredger would result in the overflow of fine sediments from the barge during dredging. The dredging operations would create turbid plumes and have the potential to resuspend nutrients and contaminants within the sediments.

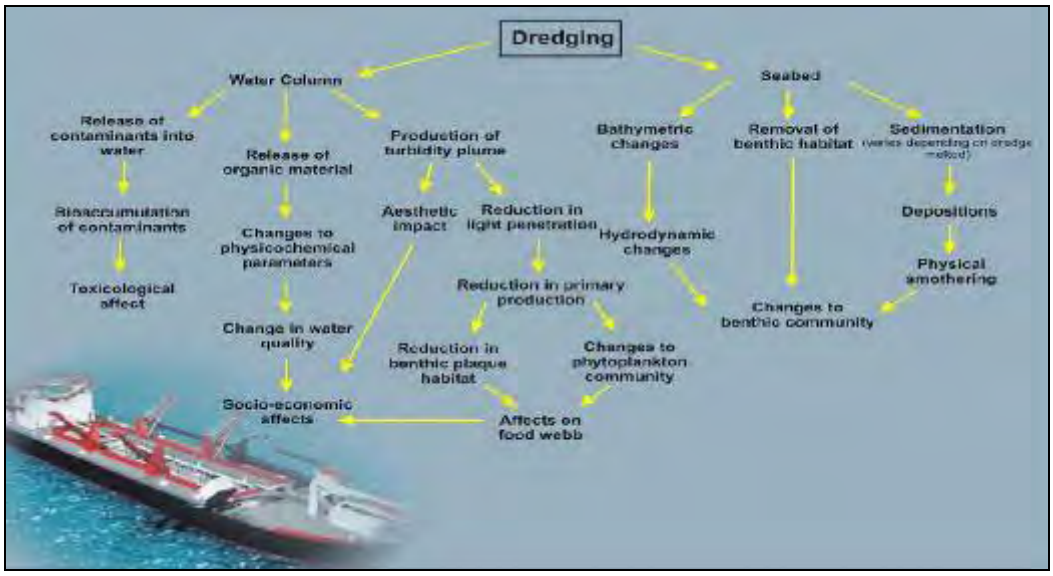


Figure 7.2 Conceptual diagram illustrating the impacts of dredging (Source: GHD 2005, after Elliot and Hemingway 2002)

Further losses of material could occur en route to the landing location, and in extreme situations, the entire contents of the trailer may be lost. This could result in significant smothering of benthic habitats.

Where large amounts of material are removed from the seabed, changes to the sediment composition may occur. Dredging, mixing and deposition of sediments has the capacity to change chemical relationships, influence the availability of toxicants and change resulting benthic community structure.

In the case of capital dredging, depth to unconsolidated materials is reduced. Consolidated material may now be exposed and be of reduced value as infauna and epibenthic fauna habitat. Natural processes of siltation will occur over time, introducing finer material to the dredged areas leading to community shifts.

Extensive and continued smothering of an area of the seabed can result in the covered seabed becoming anoxic over time. In tidally affected waters with significant currents and flushing capacity, this risk is considerably reduced.

The observed effects of oxygen depletion in the surface sediments usually include a decrease in the number of taxa and biological diversity, however, the total number of individuals and biomass may actually remain constant, or even increase, in some instances (Neff, et al., 2000).

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ATTACHMENTS

Attachment 1
EPBC Act Protected Matters Report - North West Bioregion

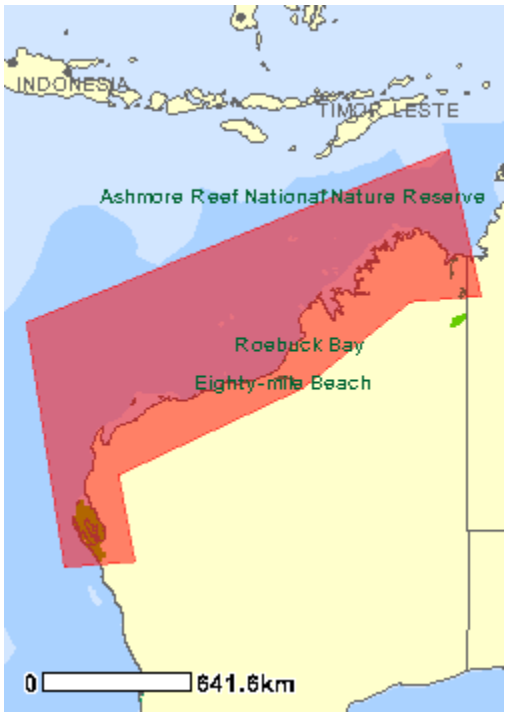
EPBC Act Protected Matters Report

22 August 2007 15:08

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html



Search Type: Area

Buffer: 0 km

Coordinates: -27.54,112.60, -27.32,115.46, -23.80,114.80, -20.28,122.28, -16.76,126.68, -16.54,129.54, -10.60,128.22, -17.6,111.06

Report Contents:

Summary
Details

- Matters of NES
- Other matters protected by the EPBC Act
- Extra Information

Caveat
Acknowledgments

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	1

National Heritage Places:	3
Wetlands of International Significance: (Ramsar Sites)	4
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	80
Migratory Species:	83

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.
The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.
Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.
A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	2
Commonwealth Heritage Places:	6
Places on the RNE:	157
Listed Marine Species:	139
Whales and Other Cetaceans:	34
Critical Habitats:	None
Commonwealth Reserves:	3

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	90
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]

Shark Bay, Western Australia WA

National Heritage Places [Dataset Information]

Dampier Archipelago (including Burrup Peninsula) WA

Dirk Hartog Landing Site 1616 - Cape Inscription Area WA

Shark Bay, Western Australia WA

Wetlands of International Significance [Dataset Information] (Ramsar Sites)

EIGHTY MILE BEACH

LAKE ARGYLE AND LAKE KUNUNURRA

ORD RIVER FLOODPLAIN

ROEBUCK BAY

Commonwealth Marine Areas [Dataset Information]

Approval may be required for a proposed activity that is likely to have a significant impact on the environment in a Commonwealth Marine Area, when the action is outside the Commonwealth Marine Area, or the environment anywhere when the action is taken within the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

EEZ and Territorial Sea

Extended Continental Shelf

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
*Acanthiza iredalei iredalei** Slender-billed Thornbill (western)	Vulnerable	Species or species habitat likely to occur within area
*Anous tenuirostris melanops** Australian Lesser Noddy	Vulnerable	Species or species habitat may occur within area
*Calyptorhynchus lathami halmaturinus** Glossy Black-Cockatoo (South Australian), Glossy Black-Cockatoo (Kangaroo Island)	Endangered	Species or species habitat may occur within area
Diomedea dabbenena * Tristan Albatross	Endangered	Foraging may occur within area
Erythrotriorchis radiatus * Red Goshawk	Vulnerable	Species or species habitat likely to occur within area

Erythrura gouldiae ***** Gouldian Finch	Endangered	Species or species habitat may occur within area
*Falcunculus frontatus whitei****** Crested Shrike-tit (northern), Northern Shrike-tit	Vulnerable	Species or species habitat likely to occur within area
*Geophaps smithii blaauwi****** Partridge Pigeon (western)	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata ***** Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus ***** Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Macronectes halli ***** Northern Giant-Petrel	Vulnerable	Species or species habitat may occur within area
*Malurus coronatus coronatus****** Purple-crowned Fairy-wren (western)	Vulnerable	Species or species habitat likely to occur within area
*Malurus leucopterus edouardi****** White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren	Vulnerable	Species or species habitat likely to occur within area
*Malurus leucopterus leucopterus****** White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren	Vulnerable	Species or species habitat likely to occur within area
Pezoporus occidentalis ***** Night Parrot	Endangered	Species or species habitat likely to occur within area
Pterodroma mollis ***** Soft-plumaged Petrel	Vulnerable	Species or species habitat may occur within area
Rostratula australis ***** Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri ***** Indian Yellow-nosed Albatross	Vulnerable	Foraging may occur within area
Thalassarche cauta ***** Shy Albatross	Vulnerable	Species or species habitat may occur within area
*Tyto novaehollandiae kimberli****** Masked Owl (northern)	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis ***** Sei Whale	Vulnerable	Species or species habitat may occur within area
Balaenoptera musculus ***** Blue Whale	Endangered	Species or species habitat may occur within area
Balaenoptera physalus ***** Fin Whale	Vulnerable	Species or species habitat may occur within area
*Bettongia lesueur lesueur****** Boodie, Burrowing Bettong (Shark Bay)	Vulnerable	Species or species habitat likely to occur within area

*Bettongia lesueur unnamed subsp.** Boodie, Burrowing Bettong (Barrow and Boodie Islands)	Vulnerable	Species or species habitat likely to occur within area
Dasycercus cristicauda * Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus geoffroii * Chuditch, Western Quoll	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus * Northern Quoll	Endangered	Species or species habitat may occur within area
Eubalaena australis * Southern Right Whale	Endangered	Species or species habitat likely to occur within area
*Isoodon auratus auratus** Golden Bandicoot (mainland)	Vulnerable	Species or species habitat likely to occur within area
*Isoodon auratus barrowensis** Golden Bandicoot (Barrow Island)	Vulnerable	Species or species habitat likely to occur within area
*Lagorchestes conspicillatus conspicillatus** Spectacled Hare-wallaby (Barrow Island)	Vulnerable	Species or species habitat likely to occur within area
*Lagorchestes hirsutus bernieri** Rufous Hare-wallaby (Bernier Island)	Vulnerable	Species or species habitat likely to occur within area
*Lagorchestes hirsutus dorreae** Rufous Hare-wallaby (Dorre Island)	Vulnerable	Species or species habitat likely to occur within area
*Lagostrophus fasciatus fasciatus** Banded Hare-wallaby, Marnine, Munning	Vulnerable	Species or species habitat likely to occur within area
Leporillus conditor * Wopilkara, Greater Stick-nest Rat	Vulnerable	Species or species habitat likely to occur within area
*Macropus robustus isabellinus** Barrow Island Euro	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis * Greater Bilby	Vulnerable	Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Vulnerable	Breeding known to occur within area
Mesembriomys macrurus * Golden-backed Tree-rat	Vulnerable	Species or species habitat may occur within area
Neophoca cinerea * Australian Sea-lion	Vulnerable	Species or species habitat may occur within area
Notoryctes caurinus * Karkarratul, Northern Marsupial Mole	Endangered	Species or species habitat likely to occur within area
*Perameles bougainville bougainville** Western Barred Bandicoot (Shark Bay)	Endangered	Species or species habitat likely to occur within area
*Petrogale lateralis West Kimberley race** Black-footed Rock-wallaby (West Kimberley	Vulnerable	Species or species habitat likely to occur within area

race)

*Petrogale lateralis lateralis** Black-flanked Rock-wallaby	Vulnerable	Species or species habitat likely to occur within area
Pseudomys fieldi * Djoongari, Alice Springs Mouse, Shark Bay Mouse	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantius (Pilbara form) * Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Sminthopsis butleri * Butler's Dunnart	Vulnerable	Species or species habitat may occur within area
Ray-finned fishes		
Milyeringa veritas * Blind Gudgeon	Vulnerable	Species or species habitat likely to occur within area
Ophisternon candidum * Blind Cave Eel	Vulnerable	Species or species habitat likely to occur within area
Remipedes		
Lasionectes exleyi * a cave-dwelling remipede crustacean	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
*Aprasia rostrata rostrata** Hermite Island Worm-lizard	Vulnerable	Species or species habitat likely to occur within area
Caretta caretta * Loggerhead Turtle	Endangered	Breeding known to occur within area
Chelonia mydas * Green Turtle	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps * Airlie Island Ctenotus	Vulnerable	Species or species habitat likely to occur within area
Ctenotus zastictus * Hamelin Ctenotus	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Vulnerable	Species or species habitat may occur within area
Egernia kintorei * Great Desert Skink, Tjakura, Warrarna, Mulyamiji	Vulnerable	Species or species habitat may occur within area
*Egernia stokesii aethiops** Baudin Island Spiny-tailed Skink	Vulnerable	Species or species habitat likely to occur within area
*Egernia stokesii badia** Western Spiny-tailed Skink	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata * Hawksbill Turtle	Vulnerable	Breeding known to occur within area

Lepidochelys olivacea ***** Pacific Ridley, Olive Ridley	Endangered	Species or species habitat may occur within area
*Liasis olivaceus barroni****** Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Natator depressus ***** Flatback Turtle	Vulnerable	Breeding known to occur within area
Sharks		
*Carcharias taurus (west coast population)****** Grey Nurse Shark (west coast population)	Vulnerable	Species or species habitat may occur within area
Carcharodon carcharias ***** Great White Shark	Vulnerable	Species or species habitat may occur within area
Pristis microdon ***** Freshwater Sawfish	Vulnerable	Species or species habitat likely to occur within area
Rhincodon typus ***** Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Beyeria lepidopetala ***** Short-petalled Beyeria, Small-petalled Beyeria	Endangered	Species or species habitat likely to occur within area
*Caladenia bryceana subsp. cracens Hopper & A.P.Brown ms.****** Northern Dwarf Spider-orchid	Vulnerable	Species or species habitat likely to occur within area
*Caladenia bryceana subsp. cracens****** Northern Dwarf Spider-orchid	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus beardiana ***** Beard's Mallee	Endangered	Species or species habitat likely to occur within area
Eucalyptus ceracea ***** Seppelt Range Gum	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus mooreana ***** Mountain White Gum, Moores Gum	Vulnerable	Species or species habitat likely to occur within area
Hibiscus cravenii *****	Vulnerable	Species or species habitat likely to occur within area
Hypocalymma longifolium *****	Endangered	Species or species habitat likely to occur within area
Lepidium catapycnon ***** Hamersley Lepidium, Hamersley Catapycnon	Vulnerable	Species or species habitat likely to occur within area
*Pandanus spiralis var. flammeus****** Edgar Range Pandanus	Endangered	Species or species habitat likely to occur within area
Pityrodia augustensis ***** Mt Augustus Foxglove	Vulnerable	Species or species habitat likely to occur within area
Stachystemon nematophorus *****	Vulnerable	Species or species habitat may occur

Three-flowered Stachystemon		within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Coracina tenuirostris melvillensis Melville Cicadabird	Migratory	Species or species habitat may occur within area
Erythrura gouldiae Gouldian Finch	Migratory	Species or species habitat may occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit	Migratory	Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Leipoa ocellata ***** Malleefowl	Migratory	Species or species habitat likely to occur within area
Merops ornatus ***** Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Petrophassa smithii blaauwi Western Partridge Pigeon	Migratory	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot	Migratory	Species or species habitat likely to occur within area
Poecilodryas superciliosa cerviniventris Derby White-browed Robin	Migratory	Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Actitis hypoleucos Common Sandpiper	Migratory	Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret	Migratory	Breeding likely to occur within area
Ardea ibis Cattle Egret	Migratory	Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Migratory	Species or species habitat likely to occur within area
Calidris alba	Migratory	Species or species habitat likely to

Sanderling		occur within area
Calidris canutus Red Knot, Knot	Migratory	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper	Migratory	Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint	Migratory	Species or species habitat likely to occur within area
Calidris tenuirostris Great Knot	Migratory	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Migratory	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Migratory	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler	Migratory	Species or species habitat likely to occur within area
Limicola falcinellus Broad-billed Sandpiper	Migratory	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit	Migratory	Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew	Migratory	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover	Migratory	Species or species habitat likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Tringa glareola Wood Sandpiper	Migratory	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat likely to occur within area

Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Migratory	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper	Migratory	Species or species habitat likely to occur within area

Migratory Marine Birds

Anous stolidus Common Noddy	Migratory	Breeding known to occur within area
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Breeding likely to occur within area
Ardea ibis Cattle Egret	Migratory	Breeding likely to occur within area
Calonectris leucomelas Streaked Shearwater	Migratory	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross	Migratory	Foraging may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird	Migratory	Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird	Migratory	Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus leucomelas Streaked Shearwater	Migratory	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	Breeding known to occur within area
Sterna albifrons Little Tern	Migratory	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern	Migratory	Breeding known to occur within area
Sterna caspia Caspian Tern	Migratory	Breeding known to occur within area
Sula dactylatra Masked Booby	Migratory	Breeding known to occur within area
Sula leucogaster Brown Booby	Migratory	Breeding known to occur within area
Sula sula	Migratory	Breeding known to occur within area

Red-footed Booby		
Thalassarche carteri Indian Yellow-nosed Albatross	Migratory	Foraging may occur within area
Thalassarche cauta Shy Albatross	Migratory	Species or species habitat may occur within area
Thalassarche chlororhynchos Yellow-nosed Albatross, Atlantic Yellow-nosed Albatross	Migratory	Species or species habitat may occur within area

Migratory Marine Species

Mammals

Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale	Migratory	Species or species habitat may occur within area
Balaenoptera borealis ***** Sei Whale	Migratory	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus ***** Blue Whale	Migratory	Species or species habitat may occur within area
Balaenoptera physalus ***** Fin Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Eubalaena australis ***** Southern Right Whale	Migratory	Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin	Migratory	Species or species habitat may occur within area
Megaptera novaeangliae ***** Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale	Migratory	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area

Reptiles

Caretta caretta * Loggerhead Turtle	Migratory	Breeding known to occur within area
Chelonia mydas * Green Turtle	Migratory	Breeding known to occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata * Hawksbill Turtle	Migratory	Breeding known to occur within area
Lepidochelys olivacea * Pacific Ridley, Olive Ridley	Migratory	Species or species habitat may occur within area
Natator depressus * Flatback Turtle	Migratory	Breeding known to occur within area

Sharks

Carcharodon carcharias Great White Shark	Migratory	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper	Listed	Species or species habitat likely to occur within area
Anous stolidus Common Noddy	Listed	Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy	Listed	Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Breeding likely to occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone	Listed	Species or species habitat likely to occur within area

Calidris acuminata Sharp-tailed Sandpiper	Listed	Species or species habitat likely to occur within area
Calidris alba Sanderling	Listed	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot	Listed - overfly marine area	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint	Listed - overfly marine area	Species or species habitat likely to occur within area
Calidris tenuirostris Great Knot	Listed - overfly marine area	Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater	Listed	Species or species habitat may occur within area
Catharacta skua Great Skua	Listed	Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Listed	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Listed	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross	Listed	Foraging may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird	Listed	Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird	Listed	Breeding known to occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler	Listed	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Larus novaehollandiae Silver Gull	Listed	Breeding known to occur within area
Larus pacificus Pacific Gull	Listed	Breeding known to occur within area
Limicola falcinellus	Listed - overfly	Species or species habitat likely to

Broad-billed Sandpiper	marine area	occur within area
Limosa lapponica Bar-tailed Godwit	Listed	Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus ***** Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew	Listed	Species or species habitat likely to occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird	Listed	Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover	Listed - overfly marine area	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel	Listed	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Listed	Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Sterna albifrons Little Tern	Listed	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern	Listed	Breeding known to occur within area
Sterna bergii Crested Tern	Listed	Breeding known to occur within area
Sterna caspia Caspian Tern	Listed	Breeding known to occur within area
Sterna dougallii Roseate Tern	Listed	Breeding known to occur within area

Sterna fuscata Sooty Tern	Listed	Breeding known to occur within area
Sula dactylatra Masked Booby	Listed	Breeding known to occur within area
Sula leucogaster Brown Booby	Listed	Breeding known to occur within area
Sula sula Red-footed Booby	Listed	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross	Listed	Foraging may occur within area
Thalassarche cauta Shy Albatross	Listed	Species or species habitat may occur within area
Thalassarche chlororhynchos Yellow-nosed Albatross, Atlantic Yellow-nosed Albatross	Listed	Species or species habitat may occur within area
Tringa glareola Wood Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper	Listed - overfly marine area	Species or species habitat likely to occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion	Listed	Species or species habitat may occur within area
Ray-finned fishes		
Acentronura larsonae Helen's Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish	Listed	Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish	Listed	Species or species habitat may occur within area
Campichthys galei Gale's Pipefish	Listed	Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish	Listed	Species or species habitat may occur within area

Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys flavofasciatus Yellow-banded Pipefish, Network Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish	Listed	Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus dactyliophorus Ringed Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus excisus Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Negros Pipefish	Listed	Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish	Listed	Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area

Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Seadragon, Ribboned Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse	Listed	Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse	Listed	Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse	Listed	Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish	Listed	Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish	Listed	Species or species habitat may occur within area
Nannocampus subosseus Bony-headed Pipefish	Listed	Species or species habitat may occur within area
Phoxocampus belcheri Rock Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pipehorse	Listed	Species or species habitat may occur within area
Solegnathus lettiensis Indonesian Pipefish, Gunther's Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus longirostris Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area

Reptiles

Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake	Listed	Species or species habitat may occur within area
Aipysurus fuscus Dusky Seasnake	Listed	Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake	Listed	Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta ***** Loggerhead Turtle	Listed	Breeding known to occur within area
Chelonia mydas ***** Green Turtle	Listed	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile	Listed	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Listed	Species or species habitat likely to occur within area
Dermochelys coriacea ***** Leathery Turtle, Leatherback Turtle, Luth	Listed	Species or species habitat may occur within area
Disteira kingii Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake	Listed	Species or species habitat may occur within area
Ephalophis greyi	Listed	Species or species habitat may occur

North-western Mangrove Seasnake		within area
Eretmochelys imbricata * Hawksbill Turtle	Listed	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake	Listed	Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake	Listed	Species or species habitat may occur within area
Hydrophis mcdowelli	Listed	Species or species habitat may occur within area
Hydrophis ornatus a seasnake	Listed	Species or species habitat may occur within area
Hydrophis pacificus Large-headed Seasnake	Listed	Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
Lepidochelys olivacea * Pacific Ridley, Olive Ridley	Listed	Species or species habitat may occur within area
Natator depressus * Flatback Turtle	Listed	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera borealis * Sei Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus *	Cetacean	Species or species habitat may occur

Blue Whale		within area
Balaenoptera physalus * Fin Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis Common Dolphin	Cetacean	Species or species habitat may occur within area
Eubalaena australis * Southern Right Whale	Cetacean	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale	Cetacean	Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale	Cetacean	Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale	Cetacean	Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale	Cetacean	Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale	Cetacean	Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale	Cetacean	Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin	Cetacean	Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Cetacean	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale	Cetacean	Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale	Cetacean	Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale	Cetacean	Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale	Cetacean	Species or species habitat may occur within area

Pseudorca crassidens False Killer Whale	Cetacean	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin	Cetacean	Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin	Cetacean	Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Cetacean	Species or species habitat likely to occur within area
Tursiops aduncus Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale	Cetacean	Species or species habitat may occur within area

Commonwealth Lands [Dataset Information]

Defence

Unknown

Commonwealth Heritage Places [Dataset Information]

Learmonth Air Weapons Range Facility WA

Mermaid Reef - Rowley Shoals WA

Ningaloo Marine Area - Commonwealth Waters WA

Scott Reef and Surrounds - Commonwealth Area EXT

Seringapatam Reef and Surrounds EXT

Yampi Defence Area WA

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

Ah Fats Cottage WA

Anglican Church of the Annunciation including Belfry WA

Bessieres Island Lighthouse WA

Broome Cemetery Japanese Section WA

Broome Courthouse WA

Broome Pioneer Cemetery WA

Browse Island (East) Wreck WA

Carnarvon One Mile Jetty WA

Chinatown Conservation Area WA

Cossack Cemetery WA

Cossack Historic Town WA

Cossack Post and Telegraph Office (former) WA

Cossack School (former) WA

Croydon Station Group WA

Customs House (former) WA

Customs House and Bond Store WA

Dampier Memorial WA

Fairy Queen Shipwreck WA

Galbraiths Store WA

Gaol, Police Station and Courthouse Precinct WA

Gascoyne River Bridge WA

Government Office and Buildings WA

Grave Site on Dolphin Island WA

Gudrun Shipwreck WA

J Kennedy Family Home WA

Jarman Island Lighthouse and Quarters WA

Jubilee Hall WA

Karratha Station Group WA

Landbacked Wharf WA

Legendre Island Lighthouse WA

Lighthouse Keepers Cottage WA

Lighthouse Keepers Quarters WA

Lillamaloora Station Ruins WA

Male Family Residence WA

Mallina Homestead and Kitchen excluding other outbuildings WA

Malus Island Whaling Site WA

Maurice Lyons House WA

McAlpine House WA

McDaniel Homestead WA

Napier Terrace Cottages WA

Naval Communication Station Harold E Holt (Area A) WA

Naval Communication Station Harold E Holt (Area B) WA

North West Mercantile Store and Office (former) WA

Old Bluestone Building WA

Old Cossack Courthouse WA

Old Gaol WA

Old Police Lockup WA

Old Roebourne School WA

Pa Normans House WA

Pearling Relics Blackhawk Bay WA

Police Quarters, Lockup and Service Buildings (former) WA

Roebourne Courthouse WA

Roebourne Police Station WA

Roebourne Post Office and Quarters WA

Roebuck Bay Hotel WA

SS Sunbeam Wreck WA

Shark Bay Road Board Office (former) WA

Sherlock Station Group WA

Streeter and Male Group of Stores WA

Sun Pictures Gardens WA

Trial Shipwreck WA

Union Bank Building (former) WA

Vlamingh Head Lighthouse WA

Wayside Inn (former) WA

West Lewis Island Pastoral Settlement WA

Wolgedda Pioneer Cottage WA

Yardie Creek Station Homestead WA

Zuytdorp Shipwreck WA

Indigenous

Abydos - Woodstock Art Sites WA

Bernier and Dorre Islands WA

Boulder Hill West Area WA

Boundaries Engravings Site WA

Burrumburra Thalu and Jigurdaar Thalu WA

Burrup Peninsula - North Area WA

Carson River Station Area WA

Checkendon Combe WA

Dampier Art Site WA

Dampier Climbing Men Area WA

Depuch Island Engraving Site WA

Derby Leprosarium WA

Derre Area WA

Donkey Ridge Area WA

Dugong Butchering Site WA

Goodluck Hills Art Site WA

Keep River Sites Complex NT

Merrimerica Hill Sand Dune Site WA

Morung Archaeological Site WA

Nelson Point Site WA

Oombalai Area WA

Parda Hill Area WA

Pardoo Creek Area WA

Paten Area WA

Plateau Hill Quarry Site WA

South West Creek Area WA

Spear Hill Engraving Complex WA

Tulleryanna Hill Art Site WA

Weaber Range Sites Complex NT

Wonakaladna WA

Natural

Barlee Range Nature Reserve WA

Barrow Island Marine Area WA

Barrow Island Nature Reserve WA

Bernier and Dorre Islands WA

Camballin Floodplain WA

Cape Range Geological Site WA

Cape Range National Park and Surrounds WA

Cape Range and Adjacent Coastal Plain WA

Chichester Range National Park (1977 boundary) WA

Clerke Reef - Rowley Shoals WA

Coastal Islands Dixon Island to Cape Keraudren WA

Coastal Islands Mary Anne to Regnard WA

Coulomb Point Nature Reserve WA

Dampier Archipelago WA

Denham Sound Freycinet Reach Hopeless Reach and Lharidon Bight WA

Dirk Hartog Island WA

Drysdale River National Park (1976 boundary) WA

Edel Land WA

Eighty Mile Beach WA

Hamelin Pool and Faure Sill WA

Hamersley Range National Park (1977 boundary) WA

Imperieuse Reef - Rowley Shoals WA

Islands Exmouth Gulf and Rowley Shelf WA

Kalbarri National Park (1978 boundary) WA

Kennedy Range Area WA

Lacepede Islands Middle and West WA

Lake MacLeod Area WA

Learmonth Air Weapons Range Facility WA

Low Rocks WA

Lowendal Islands WA

Mandora Marsh WA

Mermaid Reef - Rowley Shoals WA

Millstream National Park (1977 boundary) WA

Mitchell - Lawley Rivers Region WA

Montebello Islands Marine Area WA

Montebello Islands WA

Mooka Spring Area WA

Mungaroona Range Nature Reserve WA

Ningaloo Marine Area - Commonwealth Waters WA

Ningaloo Marine Park and Proposed Additions WA

Ningaloo Reef Tract WA

Ord River Nature Reserve (1978 boundary) WA

Palm Springs Reserve (former) WA

Parry Lagoon - Ascot - Parry's Creek Area Reserves WA

Pelican Islet WA

Peron - Nanga Area WA

Prince Regent Area WA

Roebuck Bay Area including Roebuck Plains and Lake Eda WA

Scott Reef and Surrounds - Commonwealth Area EXT

Scott Reef and Surrounds EXT

Seringapatam Reef and Surrounds EXT

Shark Bay Area WA

Small Islands in Shark Bay WA

Swan Island (King Sound) WA

Tunnel Creek National Park (1978 boundary) WA

Windjana Gorge National Park WA

Wooramel Seagrass Bank WA

Yadjiyugga Claypan and Surrounds WA

Yampi Defence Area WA

Commonwealth Reserves [Dataset Information]

Cartier Island Marine Reserve, COM

Mermaid Reef Marine National Nature Reserve, COM

Ningaloo (Commonwealth Waters) Marine Park, COM

Extra Information

State and Territory Reserves [Dataset Information]

Adele Island Nature Reserve, WA

Airlie Island Nature Reserve, WA

Barlee Range Nature Reserve, WA

Barrow Island Nature Reserve, WA

Bedout Island Nature Reserve, WA

Bernier And Dorre Islands Nature Reserve, WA

Bessieres Island Nature Reserve, WA

Boodie- Double Middle Islands Nature Reserve, WA

Browse Island Nature Reserve, WA

Bundegi Miscellaneous Conservation Reserve, WA

Burnside And Simpson Island Nature Reserve, WA

Camp Creek Conservation Park, WA

Cane River Conservation Park, WA

Cape Range National Park, WA

Charlie Island Nature Reserve, WA

Chinamans Pool Nature Reserve, WA

Coulomb Point Nature Reserve, WA

Devonian Reef Conservation Park, WA

Dolphin Island Nature Reserve, WA

Drysdale River National Park, WA

Francois Peron National Park, WA

Freycinet- Double Islands Etc Nature Reserve, WA

Friday Island Nature Reserve, WA

Gnandaroo Island Nature Reserve, WA

Great Sandy Island Nature Reserve, WA

Hamelin Pool Marine Nature Reserve, WA

Hidden Valley National Park, WA

Jurabi Miscellaneous Conservation Reserve, WA

Kalbarri National Park, WA

Karijini National Park, WA

Keep River Extension (Proposed) National Park, NT

Keep River National Park, NT

Kennedy Range National Park, WA

King Leopold Ranges Conservation Park, WA

Koks Island Nature Reserve, WA

Kununurra Miscellaneous Conservation Reserve, WA

Lacepede Islands Nature Reserve, WA

Laterite Conservation Park, WA

Lawley River National Park, WA

Lesueur Island Nature Reserve, WA

Little Rocky Island Nature Reserve, WA

Locker Island Nature Reserve, WA

Low Rocks Nature Reserve, WA

Lowendal Nature Reserve, WA

Millstream-Chichester National Park, WA

Mitchell River National Park, WA

Monkey Mia Miscellaneous Conservation Reserve, WA

Monte Bello Islands Conservation Park, WA

Muiron Islands Nature Reserve, WA

Mungaroona Range Nature Reserve, WA

Ningaloo Marine Park, WA

North Sandy Island Nature Reserve, WA

North Turtle Island Nature Reserve, WA

One Tree Point Nature Reserve, WA

Ord River Nature Reserve, WA

Parry Lagoons Nature Reserve, WA

Pelican Island Nature Reserve, WA

Point Spring Nature Reserve, WA

Prince Regent Nature Reserve, WA

Rocky Island Nature Reserve, WA

Round Island Nature Reserve, WA

Rowley Shoals Marine Park, WA

Scott Reef Nature Reserve, WA

Sedimentary Deposits Miscellaneous Conservation Reserve, WA

Serrurier Island Nature Reserve, WA

Shark Bay Marine Park, WA

Shell Beach Conservation Park, WA

Swan Island Nature Reserve, WA

Tanner Island Nature Reserve, WA

Tent Island Nature Reserve, WA

Thevenard Island Nature Reserve, WA

Toolonga Nature Reserve, WA

Tunnel Creek National Park, WA

Un-named (No. 36907) Miscellaneous Conservation Reserve, WA

Un-named (No. 36909) Miscellaneous Conservation Reserve, WA

Un-named (No. 36910) Miscellaneous Conservation Reserve, WA

Un-named (No. 36913) Nature Reserve, WA

Un-named (No. 36915) Nature Reserve, WA

Un-named (No. 37500) Miscellaneous Conservation Reserve, WA

Un-named (No. 37525) Miscellaneous Conservation Reserve, WA

Un-named (No. 38287) Miscellaneous Conservation Reserve, WA

Un-named (No. 39202) Nature Reserve, WA

Un-named (No. 41066) Miscellaneous Conservation Reserve, WA

Victor Island Nature Reserve, WA

Weld Island Nature Reserve, WA

Whalebone Island Nature Reserve, WA

Whitmore-Roberts-Doole Islands And Sandalwood Landing Nature Reserve, WA

Windjana Gorge National Park, WA

Y Island Nature Reserve, WA

Zuytdorp Nature Reserve, WA