Cliff Head Development

Public Environmental Review
and
Draft Public Environmental Report

April 2004

Roc Oil (WA) Pty Limited

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Version 2

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions emailed to the EPA Service Unit project officer would be most welcome.

Roc Oil (WA) Pty Limited ACN 083 143 383 proposes to produce oil from the recently discovered offshore Cliff Head oil field and process the crude oil onshore, south of Dongara. In accordance with the Western Australian Environmental Protection Act, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of six weeks from Tuesday 13 April closing on Tuesday 25 May 2004.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

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

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

Why not join a group?

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

Developing a submission

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

When making comments on specific elements of the PER:

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

Points to keep in mind

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

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

Remember to include:

- your name;
- address;
- date; and
- whether and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: 25 May 2004

Submissions should ideally be emailed to:

nick.woolfrey@environ.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822
OR Westralia Square
PERTH 141 St George's Terrace
WA 6842 PERTH WA 6000

Attention: [Nick Woolfrey]

Executive Summary

Proponent

Roc Oil (WA) Pty Limited (Roc), on behalf of its joint venture partners in Commonwealth Petroleum Permit Area WA-286-P, proposes to develop the Cliff Head oil field located approximately 8.5 to 12 km offshore in water depths of 10 to 20 m, 20 km south of Dongara, Western Australia (Figure ES1).

This Document

The Cliff Head oil field lies in Commonwealth waters, but much of the infrastructure of the development lies within the territory of the State of Western Australia. Development approval will require environmental consents from both jurisdictions and this document is intended to provide the environmental and social planning and impact assessment that these approvals require.

Setting

The Cliff Head Development comprises an offshore oil production platform, pipelines to shore and an onshore processing plant.

The offshore environment is a mosaic of limestone reefs and platforms, sandy mobile seafloor and beds of algae and seagrass. The project area is inshore of the main whale migration routes, but within an active rock lobster fishing area.

The coastline is a beach and foredune, backed by secondary dunes grading into flat, sandy heath country inland (Figures ES2 and ES3). The main cultural features are the 80-km linear Beekeeper's Nature Reserve running parallel and just inshore from the coast, the Brand Highway, the railway line (Figure ES4) and the now disused Westlime plant of Cockburn Cement Limited.

The predominant economic activity in the project area is the rock lobster fishery. Beekeeper's Nature Reserve is a C Class nature reserve managed by the Department of Conservation and Land Management for honey and wax production, nature conservation and passive recreation. The Brand Highway links Perth to Geraldton. It is also a major transport artery within the Mid West region of Western Australia, which comprises the shires of Greenough and Irwin and the City of Geraldton.

Planning and Design Factors

The spatial arrangement and design of project facilities follows current oil industry practice and reflects:

- The characteristics of the oil itself. The Cliff Head crude is a waxy plastic solid at ambient temperatures and pressures with a pour point of 30°C (Figure ES5). It will not flow unless it is maintained hot. If it is allowed to cool inside the production well or pipeline high-pressure injection may be required to re-mobilise the product.
- The location and nature of the reservoir. The small size of the field and its proximity to shore dictates a processing facility onshore as close as practicable. The low reservoir pressure means that the crude will not flow naturally, and must be lifted by pumping.
- Sea conditions. Rough weather in shallow seas close to shore makes for high engineering costs for exposed structures.
- Land conditions. The linear features of the beach/foredune and Beekeeper's Nature Reserve cannot be avoided, and need to be crossed with minimal disturbance and with the prospect of a feasible rehabilitation after pipeline construction.
- Engineering performance, loss prevention, safety and environmental standards.
- Applicable laws.

Development Proposal

Roc evaluated a range of configurations before settling on the layout shown in Figure ES6. These facilities comprise:

- An unmanned offshore production wellhead platform supporting six production wells and two water injection wells, with capability for two additional wells (Figure ES7). The wells will be some 1,260 m deep and take about 21 days each to drill and complete. The location of the oil field required the platform to be located west (offshore) of Horseshoe Reef (Figure ES8). Periodic inspections and maintenance will be supported by a small personnel transport vessel based in Port Denison.
- An offshore pipeline with a nominal internal diameter of 300 mm to carry produced hydrocarbons and water to shore for processing.
- A return offshore pipeline with a nominal internal diameter of 300 mm to carry produced water back to the platform for reinjection.
- An electrical umbilical line and small umbilical lines to supply corrosion and emulsion inhibitors to the production wells and hydraulic fluid (water) by which to remotely operate the platform equipment.
- Two directionally drilled pipeline shore crossings under the beach and foredune.
- Parallel production and water return pipelines across the secondary dunes and heathland of Beekeepers' Nature Reserve and under the railway to the Arrowsmith Separation Plant.
- The Arrowsmith Separation Plant on the previous industrial site of the former Westlime plant (Figure ES9) some 3 km inland from the coast. The plant will separate the produced flu-

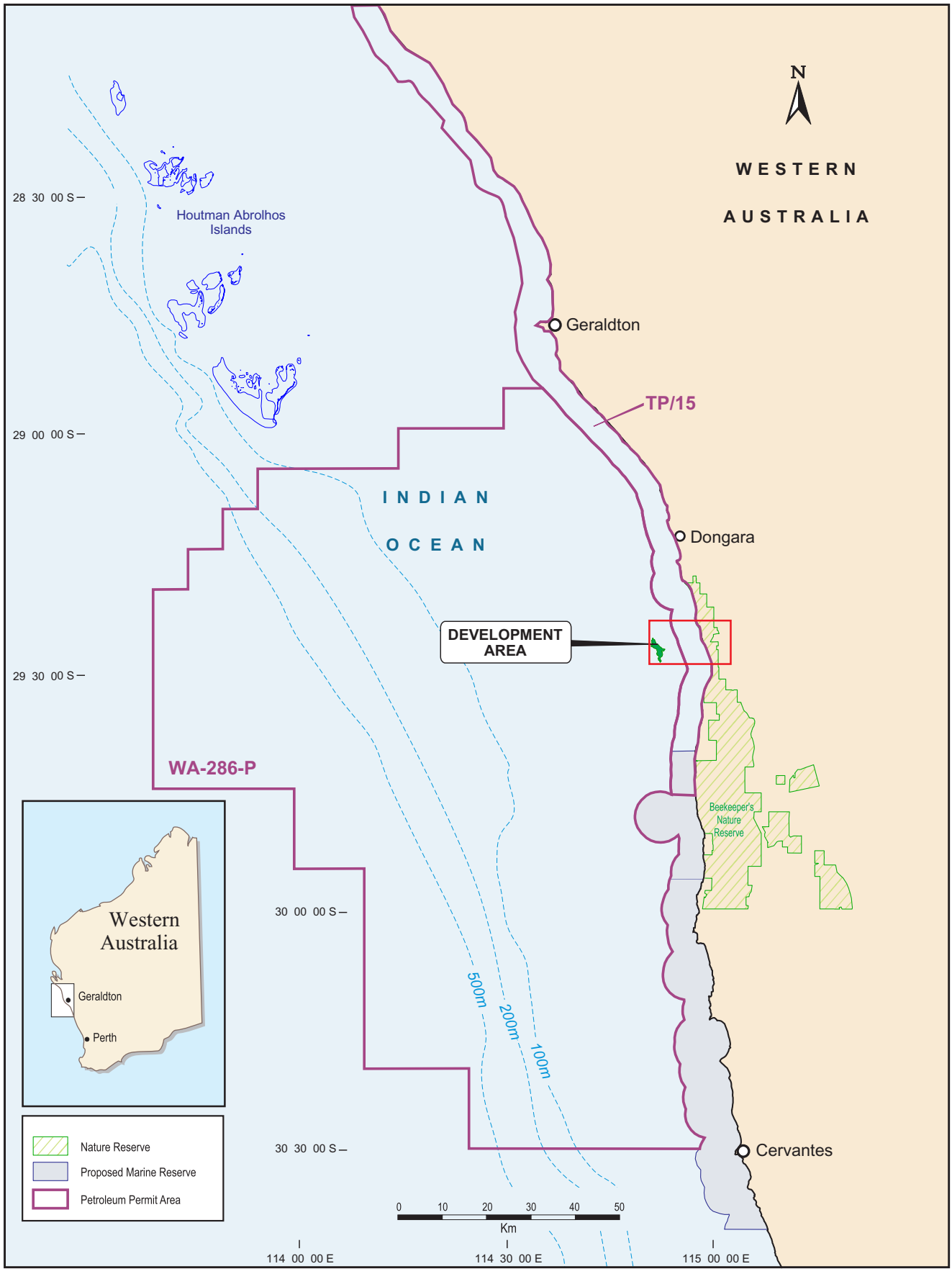


Figure ES1 Regional locality map

ids into gas, oil and water and serve as the control centre for the operation. The gas will be used as fuel gas in the processing train, the oil is the product and the water will be sent by return pipeline for reinjection into the producing formation. Make-up water will be drawn from a saline aquifer to maintain reservoir pressure. Make-up fuel gas will also be required from the existing supply line to the Westlime site. Stabilised crude oil storage of approximately 6,360 m^3 (40,000 barrels) will be provided on site, which is equivalent to two days of initial production.

Construction

The facilities will be constructed according to established oil industry practice.

- The production and injection wells will be drilled and completed by a jack-up rig.
- The production platform will be of steel construction with pile foundations. The conductors used for drilling the wells will also serve as foundation support for the facility.
- The offshore pipelines will be installed by one of two methods:
  - Welded onshore into a series of pipestrings nominally 4 km in length, and towed on temporary rollers across the foredune and beach, then bottom-towed along the seabed and joined.
  - Welded on a conventional anchored laybarge and progressively laid on the seabed.

  A concrete weight coat and either clump weighting or bolts will keep the offshore pipelines stable on the seafloor. The offshore pipelines will be completed by joins to the directionally drilled pipes where they emerge through the seafloor and to risers at the production platform.
- The preferred method for construction the pipelines' shore crossings is by conventional horizontal directional drilling (HDD) under the foredune and beach from a point between 300 m and 400 m inland to an exit point in the seafloor approximately 600 m offshore in 6 m of water. If HDD proves infeasible the shore crossing will be trenched.

Figure ES2 View east from offshore to the beach and foredune

Figure ES3 View west from the tower across the heath country of Beekeeper's Nature Reserve

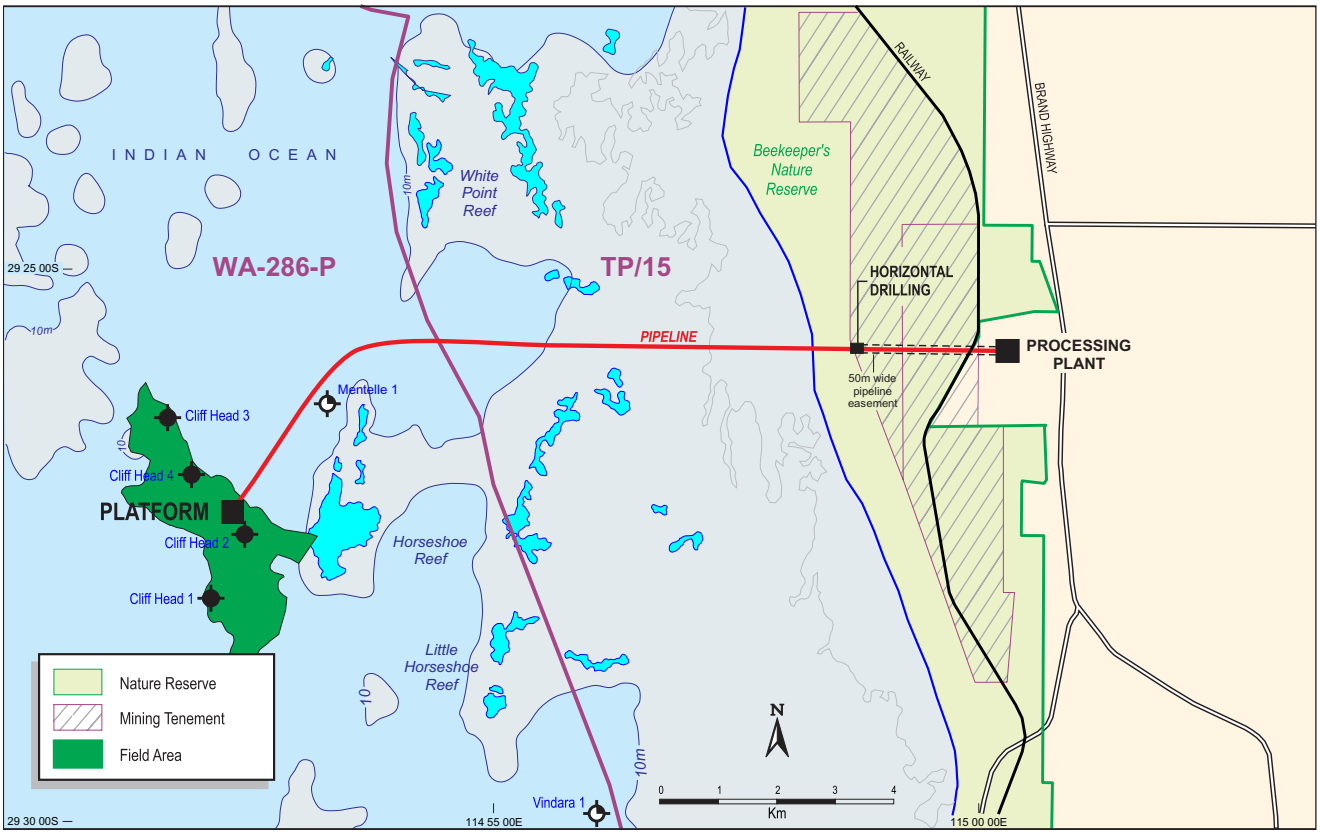


Figure ES4 Development area

- The onshore pipelines will be installed side-by-side in a trench serviced by a construction easement. The easement will be levelled by flattening the heath vegetation, but will not be graded.
- Pipeline integrity will be verified by conventional pressure testing and completed hydrotest water will be evaporated in a lined pond at the plant site.
- The Arrowsmith Separation Plant will be built by assembling prefabricated components on the site of the old Westlime plant. It will include a 5-MW electricity generator, fire-fighting, ablution and administrative services and monitoring and control facilities.

Decommissioning

Facilities will be removed and sold for use elsewhere or scrap, unless some ongoing in situ use becomes evident at the time of decommissioning and is considered appropriate by the relevant authorities.

Figure ES5 Cliff Head crude as a solid at ambient temperatures

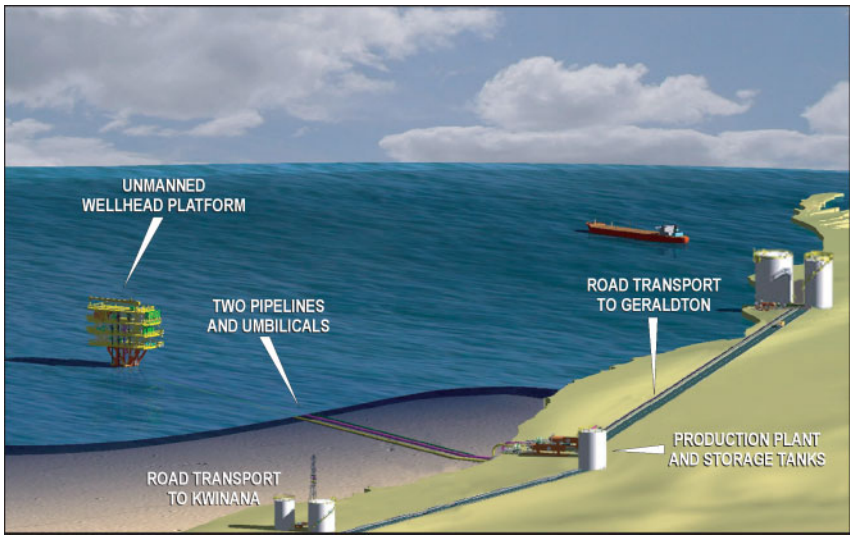


Figure ES6 Preferred option

Reserves and Crude Oil Production

A figure of 3,340,000 m^3 (21 million barrels) of recoverable oil has been adopted for planning purposes. Initial production potential could be as high as 3,975 m^3 (25,000 barrels) of oil per day, but will probably be limited by the capacity to export the crude product. Production will decline over time with depletion and as water breaks through into the production wells. Water production is forecast to increase to a maximum average rate of about 6,360 m^3 (40,000 barrels) per day after approximately two years from start up and be sustained at that level for the remainder of the field life.

The stabilised crude oil will be trucked to Kwinana for sale to the refinery, or to the Port of Geraldton for shipping.

Construction is scheduled to begin in late 2004 with first oil in second half of 2005. The field has an expected minimum life of 15 years, with a reasonable chance of extending beyond this date. A 20-year production profile is shown in Figure ES10.

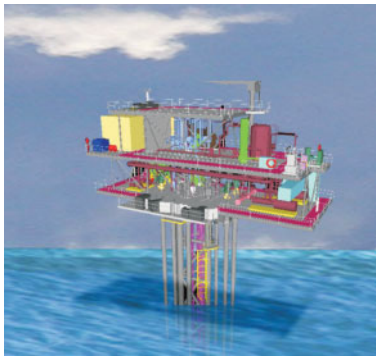


Figure ES7 Production platform

Alternatives

Prior to the adoption of the preferred development option a wide range of alternate development alternatives was considered. The main factors used to select the preferred development option were the desire to minimise impacts on the marine environment and the associated fishing industry, a desire to minimise impacts on the coast and Beekeeper's Nature Reserve, and a desire to contain the physical structure of the project to an area already disturbed for industrial purposes. Costs and engineering practicality were also critical to the process of selecting the preferred development option.

Consultation

Roc's activities in the region began in 1999 and the company has worked to establish and maintain informative and constructive relationships with both the formal stakeholders having statutory responsibilities and with the various parties, on whose interests the exploration and production activities of Roc impinge.

The more than 80 consultative interactions that have taken place during the period of Roc's activities have centred on the key issues of: environmental impacts, especially for the rock lobster fishery, cetaceans and the Beekeeper's Nature Reserve; capacity and use of existing infrastructure and services; navigation and marine safety; economic development and collateral social issues; indigenous cultural heritage; and tourism.

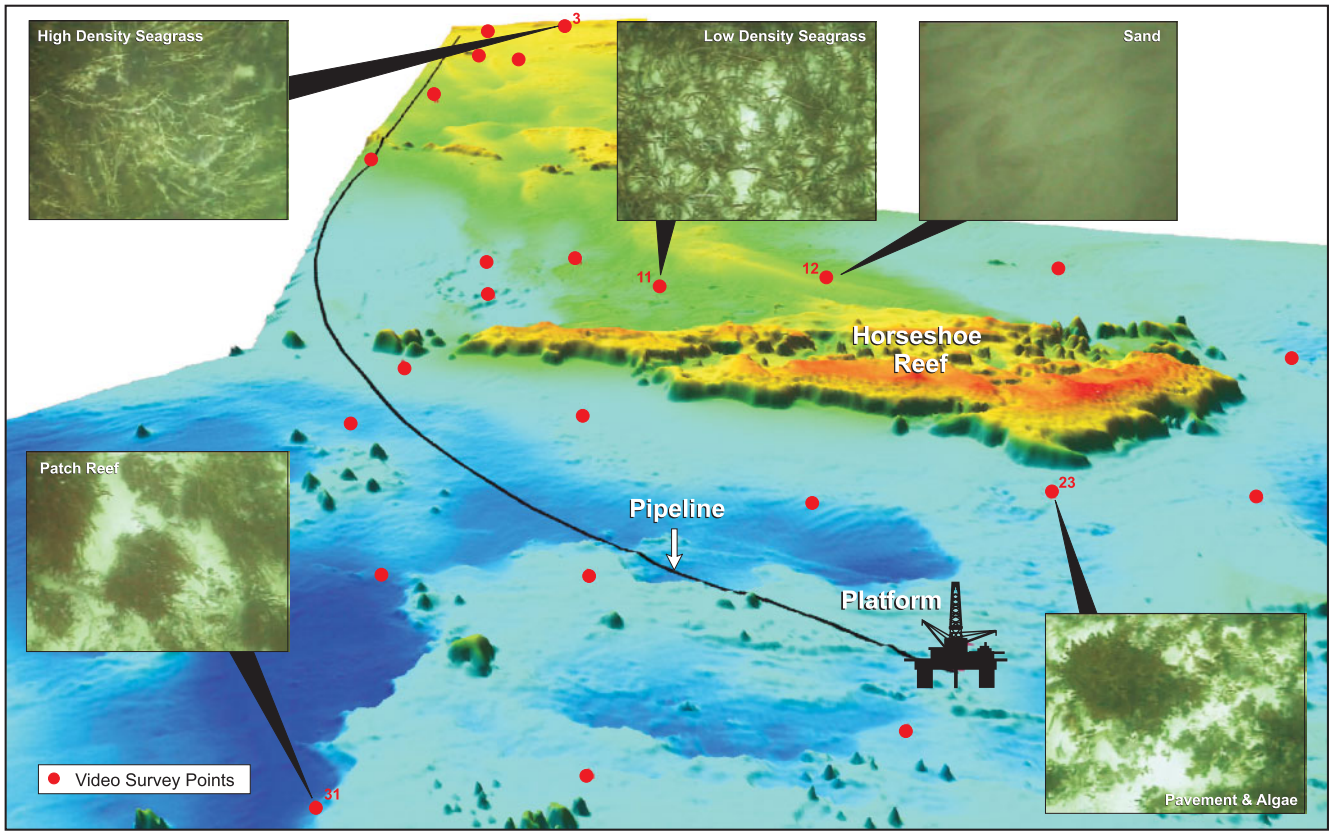


Figure ES8 Offshore digital bathymetric model and pipelines routes

The relationships established to date provide a foundation for future briefing, consultation on issues of mutual interest and the resolution of issues as they emerge.

Environmental Impacts During Construction

The principal environmental impacts of the project arise during the construction phase and are summarised below.

Marine

- The physical disturbance to the seabed in the footprint of the jack-up rig.
- The discharge of approximately 330 m^3 of cuttings per well as the production and injection wells are drilled. These materials have been tested and found to be non-toxic. The experience of exploration drilling is that they will be quickly dispersed by currents.
- The loss of drilling fluids during the drilling of the top-hole sections of wells. It is proposed to use water-based, biodegradable drill fluids of inherently low toxicity for drilling the top-hole sections of the wells. Drill fluid losses of approximately 15 m^3 per well are expected.
- Localised scouring of the seabed from the pipestring bottom-tow or anchors from the laybarge.

Figure ES9 Former Westlime plant

- Discharges of deck drainage, treated sewage, food scraps and greywater to sea in accordance with Australian and international (MARPOL) treatment and effluent quality standards.
- Tributyltin is currently being phased out and will not be used as antifouling on the production facilities. Some vessels treated before the prohibition date of 1 January 2003 may attend site during construction.

The reefs closest to the production platform are some 400 m distant and adverse effects are not expected. Non-reef benthos has been shown to recover from the localised and short-term physical and drilling impacts and this is expected to

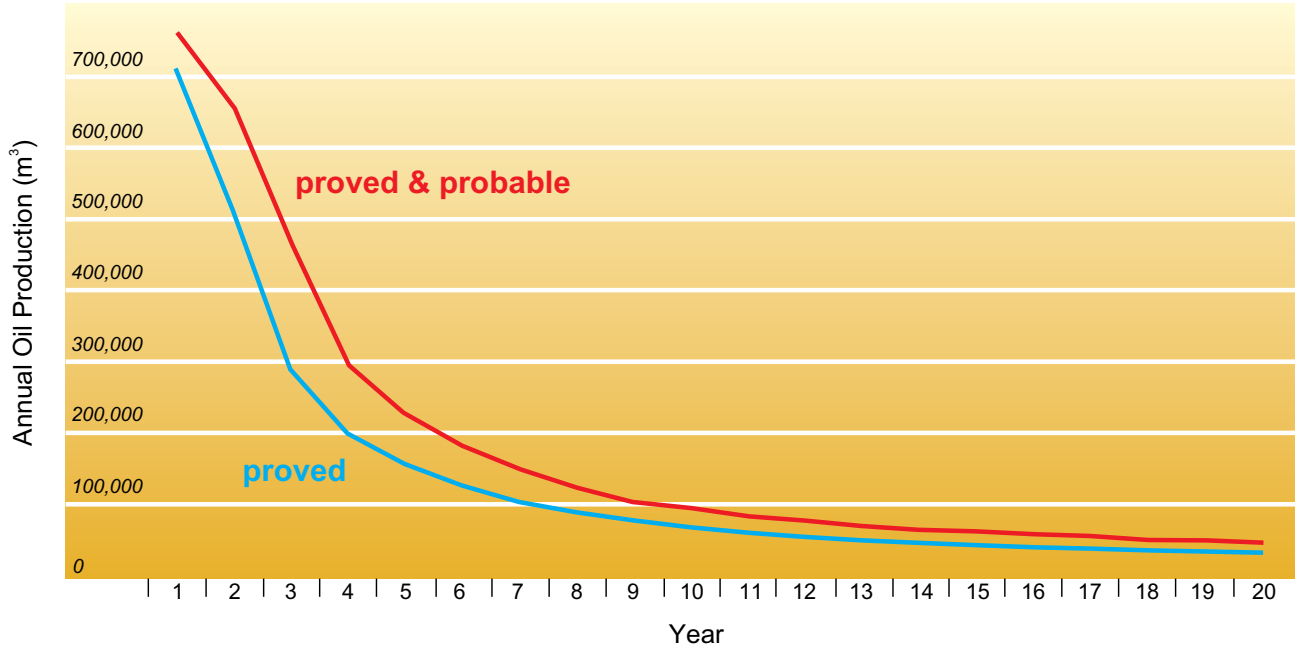


Figure ES10 Forecast Cliff Head oil production profile

occur on the seabed around the wellhead platform and pipelines. The most severe of these impacts will be the series of anchor scours from the laybarge option (if adopted) in a corridor of 8 ha through seagrass. The affected area has been estimated to comprise less than 1% of the seagrass in the development area generally.

Shore Crossing

The shore crossing will be drilled using horizontal directional drilling (HDD) techniques. This technique comprises drilling of two wide bore holes from a point approximately 300 to 400 m onshore underneath the primary sand dune and beach line to emerge on the seabed approximately 600 m offshore. Lengths of pipeline, and umbilical lines will be inserted through the bored holes. Offshore sections of the pipeline, each about 4 km in length, may be pulled from the construction area on freehold land east of the Arrowsmith Separation Plant site, across a series of rollers and out to sea. Disturbance to the shoreline will be limited to physical impacts of temporary rollers, over which the welded pipestrings will be towed.

Land

The pipeline construction corridor will only be excavated between the Railway Reserve and the HDD drill entry area. Surface materials (topsoil) will be handled separately. An HDD works area of about 50 m by 50 m will be disturbed by the presence of the HDD equipment but will retain its soil profile intact, with the heath vegetation flattened but not removed. The trench will be filled and surface material returned to the top. It is expected that recolonisation from the undisturbed vegetation on either side will be rapid. If it is decided to bore the secondary dunes, then the pipeline construction corridor will bell out to the 50 m licensed easement width to provide room for the two separate boreholes.

Onshore Processing

The Arrowsmith Separation Plant will be constructed within the site of the old Westlime plant.

Management and Long-term Outlook

The marine environment is already subject to periodic strong currents and high rates of turbidity. It is expected, based on past experience, to recover naturally from the essentially physical disturbances of drilling and pipelaying, which are by their nature localised and short-term.

On land, more active measures will be required: first, to create the correct topographic and soil conditions for vegetation recovery along the pipeline trench and HDD works area; and second, to monitor for and remedy any areas that become eroded or which are failing to maintain adequate progress to a rehabilitated condition.

Environmental Impacts During Operations

Wellhead Platform and Offshore and Onshore Pipelines

The platform and pipelines will operate essentially as passive objects in the surrounding environment. Under normal conditions, no material adverse impacts are expected (but see 'Accidental Releases' below).

The platform will be visited on a one to two weekly basis, but all routine operating requirements will be supplied by small umbilical pipelines from the onshore Arrowsmith Separation Plant.

Onshore Processing Facility

The impact of the Arrowsmith Separation Plant on air quality is restricted to minor emissions of oxides of sulphur and nitrogen from natural gas combustion and carbon dioxide (CO_2). Emissions of approximately 532,500 tonne of CO_2 equivalents are expected over the project's nominal 15-year life at an average annual emission rate of 35,500 tonne. These emissions reflect the combustion of gas to generate electricity and maintain the temperature of the process fluids. The average efficiency of 0.178 tonne of CO_2 eq/tonne of product compares favourably to an industry average of 0.34 tonne of CO_2 eq/tonne.

Social Impacts

The onshore construction period of four to six months will see a peak employment of 100 people, mostly itinerant oil industry specialists. Local social impacts and benefits from this phase will be low.

During operations, the project will employ approximately 10 people, who will be locally-based Roc employees or contractors. A transport contractor with a team of approximately 20 personnel will also be employed to undertake the export of the product to Geraldton. For the Kwinana option a proportionally larger number of personnel would be required.

While small, the project contributes to the existing pattern of economic and job growth in the Mid West Region, diversifies the economic base and enhances the attractiveness of the Perth Basin for further oil exploration.

The closest dwelling to the Arrowsmith Separation Plant is 1,400 m distant and the evidence of the project for travelers, tourists and recreational users of the area should be confined to a passing glimpse of the Arrowsmith Separation Plant and a long view to the production platform some 10 km offshore. The plant will not be visable from the Brand Highway.

Archaeological investigations have not located any artifacts and consultation with local Aboriginal groups has not revealed the existence of cultural sites within or close to the project footprint. Agreements with claimants are currently in negotiation, and conditions are expected to include cultural heritage monitoring during construction.

Accidental Releases

The risk of an oil spill is the environmental hazard common to all oil production, processing and transport operations.

However, the low reservoir pressures and waxy crude that makes the Cliff Head oil relatively hard to produce also predisposes a low oil spill risk and environmental hazard. The oil is not only of inherently low toxicity but will immediately cool if spilled into the environment and revert to a solid. For this reason, the maximum credible oil spill volume has been estimated to be as low as 6.5 m^3. However, the environmental stability that makes for its low toxicity also means that it does not break down naturally, is highly resistant to chemical dispersants, and will persist as floating wax balls until eventually making landfall. Trajectory modelling indicates that mainland landfalls are by far the most likely (as to be expected when the point of origin is within 10 km of shore). The chances of a landfall in the Houtman Abrolhos Islands has been estimated at 3% or less for the modelled spill scenarios.

The other production and process chemicals will all be handled onshore within bunded areas with sufficient capacity to contain any spill that might occur.

Environmental Management

This PER provides a basis from which to assess the environmental impacts of the development of the Cliff Head field.

However, the ultimate environmental performance, especially in the critical area of pipeline easement rehabilitation, requires an active program of management and monitoring within the framework of a safety and environmental management system (SEMS).

Roc has set out the principles and main elements of the Cliff Head SEMS and intends to develop specific management plans for the successive phases of the project, from construction, through operations and, ultimately, decommissioning.

Concluding Remarks

The Cliff Head project will have a localised and temporary environmental impact during construction and, to a lesser extent, during operations and these effects should, for all practical purposes, be progressively reversible. Meanwhile, the risk of a catastrophic oil spill is almost entirely nullified by the low reservoir pressures and waxy properties of the crude.

This executive summary has set out the main planning, design and impact issues of the project. A more complete list is attached at Table ES1.

Table ES1 Summary of environmental risk

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS guidelines for ballast water management and ANZECC Code of Practice for Antifouling.	Physical disturbance	Anchoring	Medium	Selection of pipeline route and tow path to minimise impact. Use of support vessels to deploy and recover anchors. Use of anchor pennants to lift the anchors.
			Footprint	Low	Selection of location for seabed facilities and wellhead platform.
			Pipelay Scour	Medium	Selection of pipeline route and tow path to minimise impact. Use of horizontal directional drilling and shore-based installation of the pipeline out to the 6-m water contour.
		Light	Lighting during drilling and installation	Low	Lighting during drilling and installation activities to be kept to minimum necessary for safe operations.
			Navigation lights	Low	Lighting at wellhead during operations to be minimum necessary for navigation safety.
		Noise	Drilling and Installation	Low	Apply standard industry practise for management of noise from machinery on the drilling rig and installation vessels. Monitor and record presence of whales during drilling and installation activities.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna (cont'd)		Noise (cont'd)	Operations	Low	Apply standard industry practise for management of noise from machinery.
		Liquid discharges	Utility waters	Low	Machinery and equipment will be maintained to prevent contamination of cooling waters.
			Sewage	Low	In Commonwealth waters more than three nautical miles from the coastline only sewage from a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV will be disposed to sea. Sewage will not be discharged to sea in state waters.
			Greywater	Low	Grey water and putrescible wastes will be disposed of in accordance with Clause 222 (Housekeeping) of the Schedule to the Western Australian *Petroleum (Submerged Lands) Act 1982* (PSLA), which requires that food scraps and sanitary effluents be passed through a grinder or comminuter so that the final product will pass through a screen <25 mm diameter prior to disposal to the sea.
			Deck runoff	Low	Machinery spaces on the drilling rig and installation vessels will be bunded to contain any deck spillages. Chemicals used or stored on board the drilling rig will be managed so as to prevent damage to the containers. All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal. All storage facilities and handling equipment will be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable. Procedures will be in place on the drilling rig and installation vessels for the clean-up of small deck spillages.
			Antifouling leachate	Low	Tributyltin will not be used on any subsea infrastructure of the Cliff Head Development.
		Solids (produced offshore)	Drill cuttings	Low	Drill cuttings to be separated from drill fluids prior to discharge to sea.
			Drill fluids	Low	Preference for water-based drilling fluids to be used wherever practicable to do so. Non-water–based muds to be of low toxicity and recovered from cuttings for return to shore at completion of drilling.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna (cont'd)		Accidental releases	Crude oil	Low	The wells will incorporate a blowout prevention system capable of containing pressures in the well strings of up to 10,000 psi. All machinery and engine oil spills and below-deck spills will be captured (catchment lips around potential spill areas), mopped up, containerised and sent to shore for recycling/disposal (this applies to the drilling rig). All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean. Vessel to rig transfers of drilling fluids and fuel will be conducted in accordance with defined marine drilling and supply vessel contractor procedures which will be identified to all personnel concerned with transfer operations in the job hazard analysis. Real-time oil spill modelling capability will be in place during the drilling program. Stocks of absorbent materials on board the mobile offshore drilling unit (MODU) and standby vessel(s) will be checked for their adequacy and replenished as necessary prior to the commencement of operational activities at the well. Actions to prevent marine collisions will include: -Notification of Australian Maritime Safety Authority (AMSA) via the Rescue Co-ordination Centre (RCC) in Canberra. -Issuing of standard AusCoast radio warnings to shipping by the RCC. -Standard maritime safety procedures (AusCoast warnings via the Australian Maritime Safety Authority, radio contact, display of appropriate navigational beacons and lights). Procedures and equipment for preventing loss of well control will be separately described within the MODU Safety Case. Procedures and equipment for preventing loss of hydrocarbons during operational activities will be separately described within the Operations Safety Case. A detailed oil spill contingency plan, accepted by the designated authority, will be in place prior to commencement of drilling, installation or operational activities. As a mitigating action ROC will remain a member of the Australian Marine Oil Spill Centre (AMOSC) which in turn maintains a capacity to respond to oiled wildlife in emergency situations.
			Introduction of exotic species	Medium	Adherence to AQIS regulations for controlling and preventing the introduction of marine pest species.
			Process chemicals	Low	All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Landform, drainage and site hydrology	Maintain the integrity, functions and environmental values of landforms and natural surface water drainage including watercourses and sheet flow.	Erosion	Horizontal directional drilling	Low	Minimise clearing. Investigate using HDD or bores to minimise impact on dunes during pipelay. Retain rootstock and segregate stockpiles containing vegetation or seed banks and replace. Refill to original contours.
			Pipeline Installation	Medium	Remediation and rehabilitation to existing conditions or similar. Use of wind breaks during remediation. Vegetation mats/brush matting etc. to cover soil until vegetation is established. Monitoring and remedial works as required. Weed monitoring and suppression.
		Soil contamination	Runoff from process areas	Low	Closed drain system surrounding process areas where contamination may occur. Vehicle maintenance and refuelling undertaken in an appropriate designated area wherever practicable.
			Rupture of chemical or product storage vessels	Low	Inventories of fuels and chemicals kept on site will be minimised. Pipelines, storage vessels and surrounds to be designed to minimise risk of rupture/loss. Regular inspection of pipeline integrity by way of intelligent pigging. Spill response training undertaken. Spill response equipment provided.
			Rupture of product pipes	Low	
			Spills from construction equipment	Low	
			Drilling mud release (terrestrial)	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All HDD drill cuttings to be taken offsite.
			Importation of contaminated fill	Low	Fill to be inspected and contaminant free.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Ground and surface water quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the National Water Quality Management Strategy (NWQMS) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality.	Groundwater use	Supplement produced water re-injection into reservoir	Low	Target the unused and highly saline Cattamarra Formation for recharge water. Utilise produced formation water for recharge wherever practicable. Bore constructed to ensure other locally used aquifers are not hydraulically connected to the Cattamarra aquifer.
		Alteration of surface water flow	Alteration of drainage lines	Low	Stockpiles will be used for temporary storage of fill material only. The completed trench will have a crown to allow for settlement.
		Groundwater and surface water contamination	Leaching and runoff from process areas	Low	Formation water will be recharged into the oil reservoir and not discharged on land. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
			Rupture of the pipeline	Low	Pipeline will be designed in accordance with AS 2885 and buried to depth of 1 m. Pipeline integrity will be tested prior to commencement. Regular inspection of pipeline integrity by way of intelligent pigging.
			Hydrotest water disposal	Low	Hydrotest water to be disposed of to the evaporation pond.
			Spills from construction operations	Low	Visual inspections of plant and pipeline sites undertaken regularly during construction and operations. Identified spills will be remediated immediately upon discovery. Volumes of chemicals and hydrocarbons stored on site will be minimised.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Terrestrial flora	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950.* Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999.* Protect other flora species of conservation significance.	Direct mortalities	Site clearing for the plant site	Low	Utilise a brownfield site for the plant and locate processing areas in already degraded habitat areas wherever practicable. Utilise cleared areas within the reserve for the easement wherever practicable.
			Site clearing for pipeline installation and HDD site	Low	Roll rather than remove vegetation along the pipe easement wherever practicable. No ongoing vehicle access is proposed along the pipe easement.
		Loss or modification of habitat or species distribution	Spread of weeds and/or feral animals	Medium	All vehicles to be free of dirt or seeds prior to site entry. Access from the plant to the pipe easement to be minimised and vehicles to be cleaned prior to easement access. Fill to be free of weeds and pathogens. Rehabilitation program to include weed suppression along the pipeline easement. Ongoing plant site weed management to be undertaken, particularly the control and elimination of Paterson's curse.
			Accidental fire e.g., welding or grinding activities during construction and operation	Medium	Pipe-stringing areas will be graded where required and fire-fighting equipment will be provided. Welding will be restricted to a single area where appropriate fire-management measures will be implemented. The ground flare will be buffered from vegetation.
Terrestrial fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.* Protect fauna listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999.*	Direct loss or modification of fauna habitat	Clearing for the plant site and pipeline installation	Low	Minimise vegetation removal or damage wherever practicable. Roll vegetation rather than remove wherever practicable. Commence rehabilitation of disturbed or cleared areas immediately upon the completion of works. Minimise the time pipe trenches remain open. Monitor open trenches each morning and remove any trapped fauna if safe to do so.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Terrestrial fauna (cont'd)		Reduced abundance of native fauna	Spread of weeds and dieback through road vehicle activity	Low	Utilise appropriate weed and pathogen management measures.
			Accidental fire e.g., welding or grinding activities during construction and operation	Low	Suitable fire-fighting equipment will be held on site.
		Change in behavioural patterns	Clearing and construction noise leading to temporary avoidance of the area or changed fauna corridors	Low	Rehabilitation of easements to be undertaken immediately upon completion of pipe installation.
Atmospheric emissions	Use all reasonable and practicable measures to minimize the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke. No unreasonable impacts at boundary of the plant.	Greenhouse gas emissions	Combustion of fuel gas, flaring	Low	Use of fuel gas rather than oil for power generation. Maximise extent of waste recovery throughout production processes. Use of generator flue gas instead of methane for storage tank blanketing. Minimise operational use of flare. Participate in Greenhouse Challenge Agreement through APPEA membership.
	Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity.	Oxides of nitrogen and sulphur (NOx and SOx)	Combustion of fuel gas	Low	Use of fuel gas rather than oil for power generation. Minimise operational use of flare.
	To minimise greenhouse gas emissions in absolute terms and reduce emission per unit product to as low as reasonably practicable.	Volatile organic compounds	Combustion of fuel gas	Low	

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Atmospheric emissions (cont'd)	Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.	Dust	Construction activities	Low	Areas of vehicle traffic, such as carpark and tanker loading bays, and pathways will be sealed with coarse gravel to limit the potential for dust generation.
Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997.	Disturbance to surrounding landholders	Construction activity	Low	Restrict construction activities to day periods where practicable. All construction equipment is to be fitted with mufflers in good working order. Advise local residents prior to 24-hour construction activities proceeding.
			Operational activity	Low	Monitor operational noise during early operation to ensure compliance.
Waste	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of off site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.	Liquid wastes	Hydrotest water	Low	Hydrotest water to be disposed of to the evaporation pond.
			Runoff from facilities	Low	Volumes of chemicals and hydrocarbons stored on site will be minimised. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
			HDD drill cuttings and fluids	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All HDD drill cuttings to be taken offsite.
		Solid wastes	Construction activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.
			Operation activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Culture and heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972.* Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area. Identify any areas which are close to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Commission Act 1975.*	Disturbance to significant sites	Construction activity	Low	During clearing and excavation works for the onshore pipeline, undertake archaeological monitoring involving members of the Wilinyu group.
Other uses and aesthetics	Avoid interference to other uses of area and resources. Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse.	Disturbance of natural environment for visitors to Beekeeper's Nature Reserve	Construction activity	Low	Minimise disturbance to the natural environment.
		Local community	Construction activity Operation activity	Low	Ongoing consultation and relationship building with the local community. Drug and alcohol testing will be a condition of construction contracts. Drilling crews will be employed on a fly in, fly out basis. Locals will be employed during construction where practicable. Temporary accommodation i.e., a construction village will be used to accommodate construction workforces.

Table ES1 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Other uses and aesthetics (cont'd)		Disturbance to road users on the Brand Highway	Construction activity Operation activity	Low	Observe appropriate transport legislation and guidelines. Selection of transport contractor that has a demonstrated safety record. A safety management plan will be required from the transportation contractor that will be contractually binding. The safety management plan will include the following aspects: - Shift hours. - Drug and alcohol testing. - Speed monitoring. - Performance monitoring. - Vehicle maintenance and testing.
		Disturbance to other uses of the area (fishing industry, tourism, recreation, apiary activities)	Construction activity Operation activity	Low	Design subsea infrastructure to allow fishing over the pipeline and up to the platform. Liaise closely with fishing industry regarding construction activities and operations. Develop a Memorandum of Understanding with the fishing industry to allow fishing operations to be undertaken within exclusion zone during normal operations. Temporary accommodation in Dongara will be used to accommodate the construction workforce. Ongoing consultation and relationship building with the local community and beekeepers.
Public health and safety	Ensure that risk to the public is as low as reasonably practicable and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for offsite individual fatality risk (Interim Guidance Statement No.2), and that ALARP is demonstrated, and that the DoIR's requirements in respect of public safety are met. Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety.	Public health and safety	Construction activity Operation activity	Low	Management road traffic to appropriate standards. Maintain security fencing around plant site. Maintain platform security and navigation lights.

Contents

Figures

Tables

Appendices

1. Introduction

1.1 This Document

Roc Oil (WA) Pty Limited (Roc) is a wholly owned subsidiary of the Roc Oil Company Limited (Roc Oil). Roc, on behalf of its joint venture partners in Commonwealth Petroleum Permit Area WA-286-P, proposes to develop the recently discovered Cliff Head oil field. This proposal is referred to throughout the document as the Cliff Head Development (or the Development). The Cliff Head oil field is located approximately 8.5 to 12 km offshore from the coastline, 20 km south of Dongara, Western Australia (Figure 1.1).

The Cliff Head oil field lies in Commonwealth waters, but much of the infrastructure of the development lies within the territory of the State of Western Australia. Development approval will require environmental consents from both Commonwealth and Western Australian State authorities. The legislative process for environmental consents for this Development is outlined in Figure 1.2. This document has been structured to meet both the requirements of the Commonwealth assessment process as a Public Environmental Report, and the Western Australian requirements as a Public Environmental Review.

1.2 Proponent

The proponent for the Cliff Head Development is Roc acting as operator for the WA-286-P joint venture partners. The joint venture partners comprise:

- Roc Oil (WA) Pty Limited (Operator) 37.5%.
- AWE Oil (Western Australia) NL 27.5%.
- Westranch Holdings Pty Ltd (Norwest Energy NL) 5.0%.
- Voyager (PB) Limited 5.0%.
- Wandoo Petroleum Pty Ltd 25.0%.

The registered office of Roc is as follows:

Roc Oil (WA) Pty Limited
Level 14, 1 Market Place
Sydney NSW 2000 Australia

With a market capitalisation of about US$100 million, Roc Oil is one of Australia's leading independent oil and gas companies. The Sydney-based company has a strong operating emphasis and an international focus. Its assets are grouped into four main regions: the UK, the source of the Company's revenue, West Africa, China and Australia. Within these regions, each of Roc Oil's seven permit areas is associated with a proven petroleum system—although two of those systems were only recognised as a result of recent drilling by Roc Oil and its co-venturers.

The Company's workforce of about 80 people, including part-time consultants, represent 22 different nationalities who collectively speak 15 languages fluently. Roc Oil's global portfolio covers 104,000 km^2, of which about 18,000 km^2 are net to the Company.

Roc Oil began operations in 1997 as a privately-owned company. The original shareholders, almost all of whom remain on the share register, consisted primarily of the current Board and Management, corporate entities and individuals in Australia, Asia and the United States. During 1998, Roc Oil's private shareholding structure was broadened and deepened to include individuals in the Middle East and the UK.

In 1999, Roc Oil acquired its core asset, the then undeveloped Saltfleetby Gas Field in Lincolnshire, England. The field proved to be much larger and more productive than forecast and is now recognised as Britain's largest onshore gasfield.

Most recently, Roc Oil has experienced a sequence of drilling successes which includes discovering potentially commercial oil with each of its first exploration wells in Australia, Mauritania, and China.

Besides the commissioning of this proposed Development by the end of 2005, Roc Oil's activities, during the next 18 months, will be focussed on multi-well exploration and appraisal drilling programs in, around and on trend from, its recent discoveries offshore of Western Australia, Mauritania, and China as well as in other parts of onshore UK and in deep water offshore of Equatorial Guinea.

1.2.1 Company Environmental Record

Roc Oil is committed to protecting the environment and consequently manages health, safety and environment (HSE) matters as a critical business activity. All of the Company's activities are planned and performed so that adverse effects on the environment are either avoided or kept to an acceptable level while meeting all statutory requirements. A copy of the Corporate Occupational Health, Safety and Environmental Policy is provided in Figure 1.3.

Roc Oil employs a structured approach to the management of HSE issues via a formal HSE Management System (HSE-MS). The HSE-MS ensures that impacts from Roc's operations are either avoided or kept to as low as reasonably practicable (ALARP), and it also drives continuous improvement in the Company's environmental performance. The HSE-MS assists in providing confidence to regulators, stakeholders and the community at large that Roc is responsibly discharging its environmental responsibilities.

Neither Roc Oil nor Roc is currently, nor has previously ever been, the subject of any proceedings under Commonwealth, State or Territory laws for the protection of the environment, or the conservation and sustainable use of natural resources. Roc has been actively conducting exploration activities in the offshore Perth Basin in a number of permits since 2001.

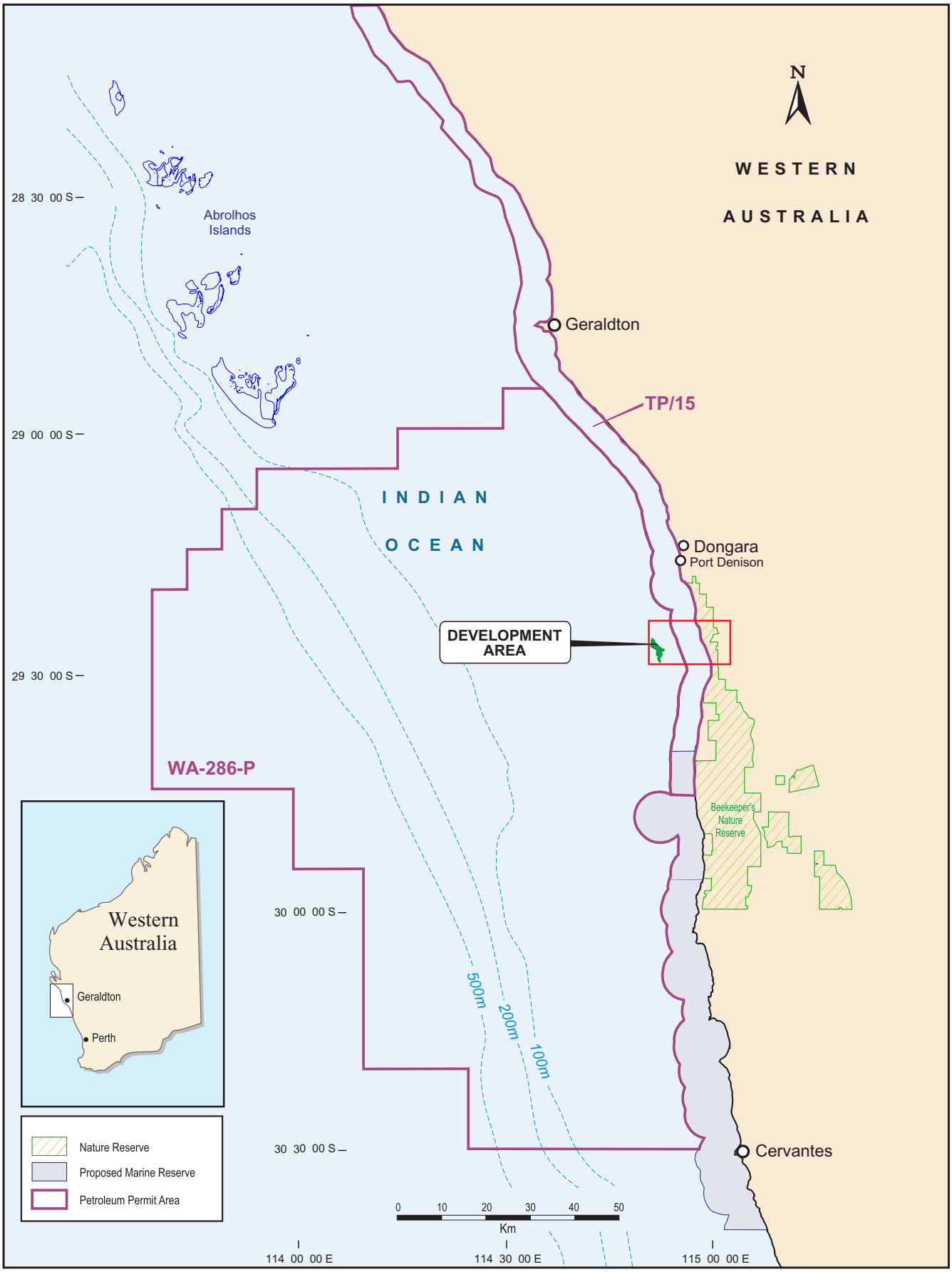


Figure 1.1 Regional locality map

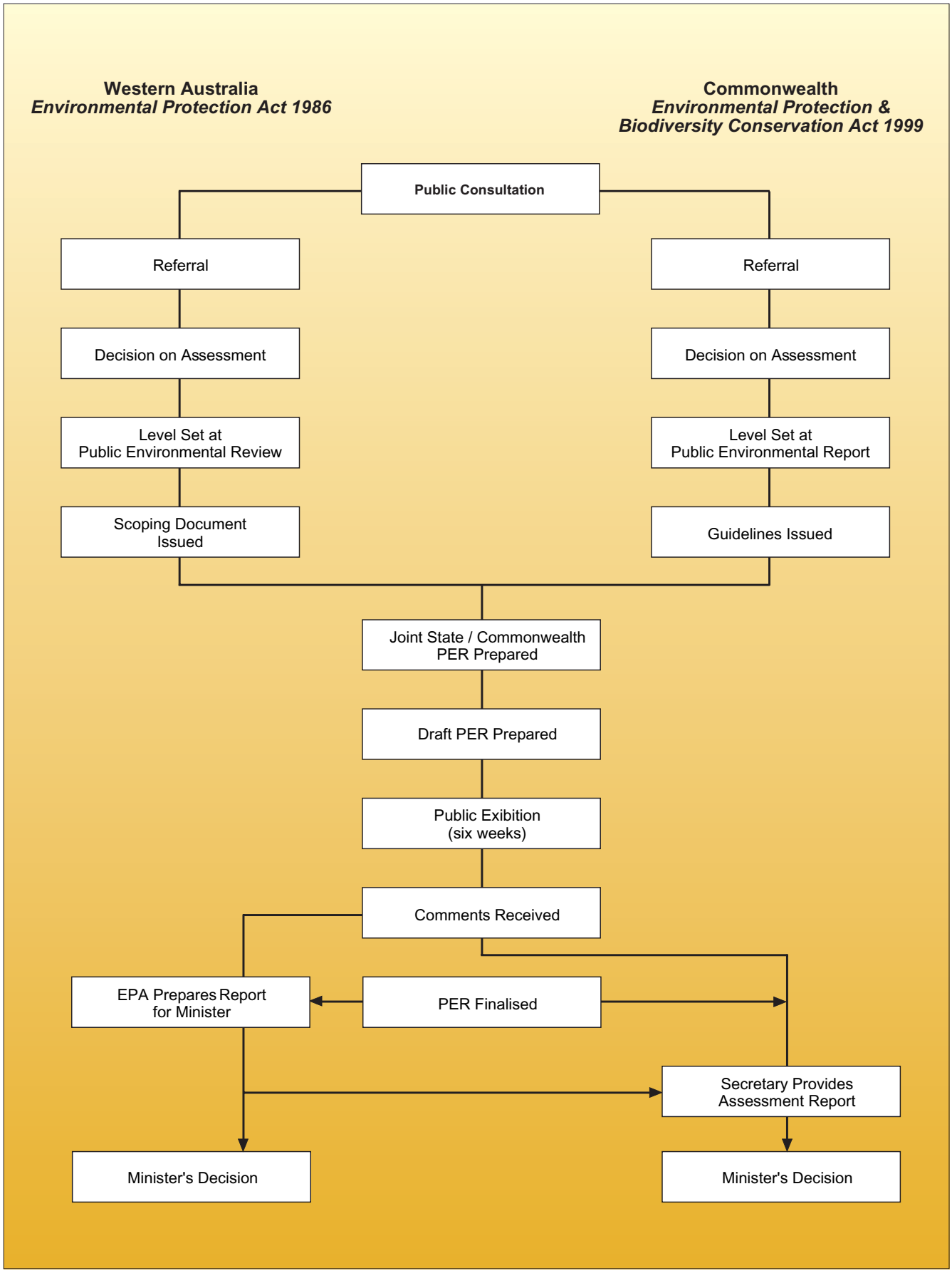
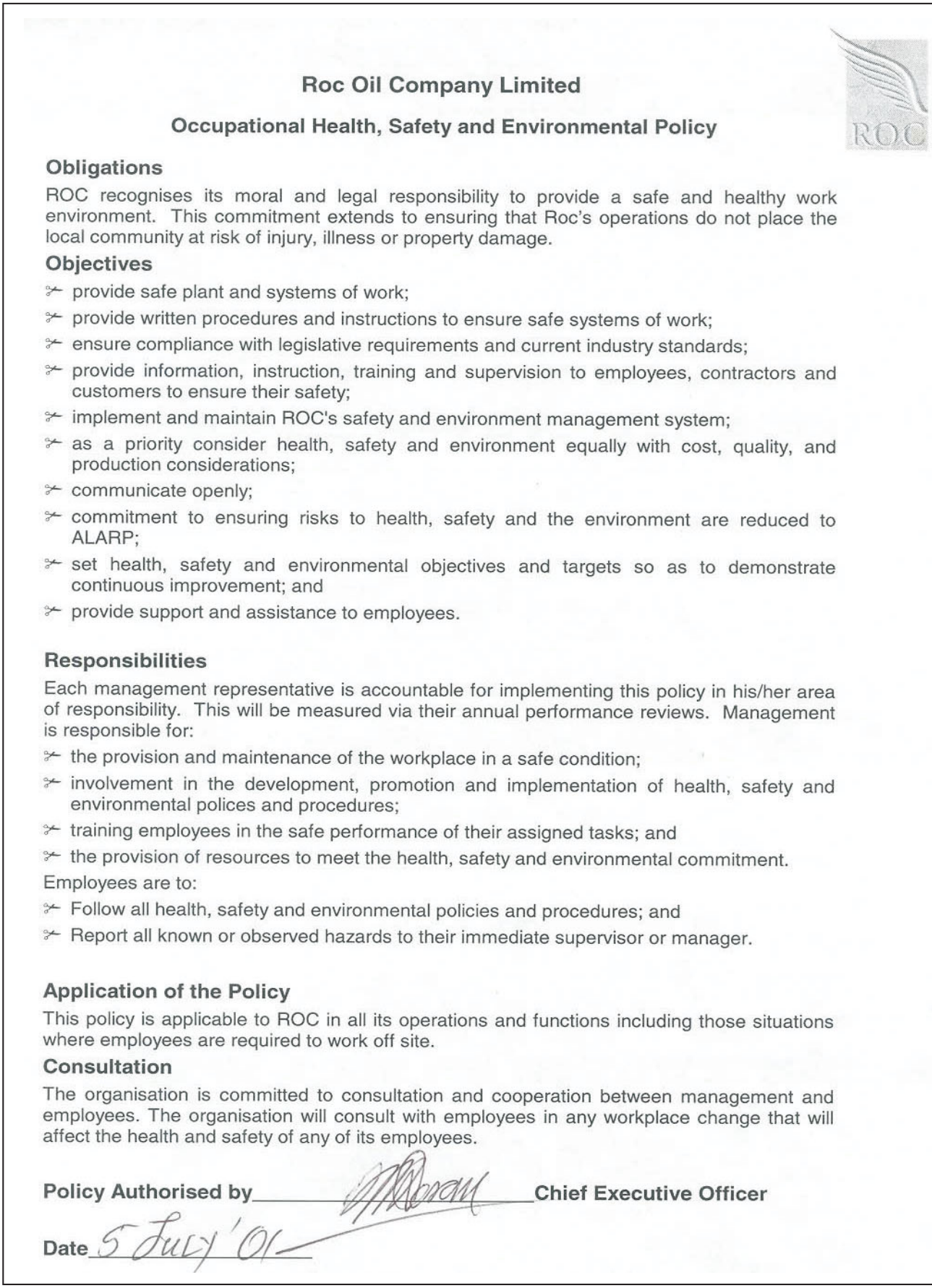


Figure 1.2 Legislative process



Roc Oil Company Limited

Occupational Health, Safety and Environmental Policy

Obligations

ROC recognises its moral and legal responsibility to provide a safe and healthy work environment. This commitment extends to ensuring that Roc's operations do not place the local community at risk of injury, illness or property damage.

Objectives

- provide safe plant and systems of work;
- provide written procedures and instructions to ensure safe systems of work;
- ensure compliance with legislative requirements and current industry standards;
- provide information, instruction, training and supervision to employees, contractors and customers to ensure their safety;
- implement and maintain ROC's safety and environment management system;
- as a priority consider health, safety and environment equally with cost, quality, and production considerations;
- communicate openly;
- commitment to ensuring risks to health, safety and the environment are reduced to ALARP;
- set health, safety and environmental objectives and targets so as to demonstrate continuous improvement; and
- provide support and assistance to employees.

Responsibilities

Each management representative is accountable for implementing this policy in his/her area of responsibility. This will be measured via their annual performance reviews. Management is responsible for:

- the provision and maintenance of the workplace in a safe condition;
- involvement in the development, promotion and implementation of health, safety and environmental polices and procedures;
- training employees in the safe performance of their assigned tasks; and
- the provision of resources to meet the health, safety and environmental commitment.

Employees are to:

- Follow all health, safety and environmental policies and procedures; and
- Report all known or observed hazards to their immediate supervisor or manager.

Application of the Policy

This policy is applicable to ROC in all its operations and functions including those situations where employees are required to work off site.

Consultation

The organisation is committed to consultation and cooperation between management and employees. The organisation will consult with employees in any workplace change that will affect the health and safety of any of its employees.

Policy Authorised by _____ **Chief Executive Officer**

Date 5 July '01

Figure 1.3 Roc OHSE policy

1.3 Development Proposal

The planned development of the Cliff Head oil field follows the success of the exploration and drilling campaign carried out over recent years by Roc and its joint venture participants in the WA-286-P permit area.

Sampling to date from the Cliff Head reservoir indicates the presence of medium density oil (specific gravity 0.86) with low gas–oil ratio. The Cliff Head field contains likely recoverable reserves of approximately 3,340,000 m^3 (21 million barrels) of crude oil.

Roc has undertaken a technical screening study to assess available development options for the Cliff Head field. This study has concluded that the most suitable development option is to have an unmanned platform at the field with liquids and gas recovered from the production wells directed by way of pipeline to an onshore separation plant where the crude oil will be degassed and dewatered to meet market specifications prior to export (Figure 1.4). The following summary description provides a brief introduction to the key components of the proposed Cliff Head oil field development.

The nature of the reservoir and its crude oil indicates that it will take approximately 15 years to produce the known resource of its calculated commercial reserves. Oil production is greatest in the initial phase of the project, tapering to a level that ultimately will become uneconomic to maintain.

Production Wells and Reinjection Wells

The proposed development plan is to drill and complete six production wells and two water reinjection wells (with capability for an additional two wells in the future). The wells will be approximately 1,200 m deep below the sea-bed, and take about 18 days each to drill and complete.

Two dedicated reinjection wells will be drilled for reinjecting produced formation water into the oil reservoir. Reinjection will serve the dual purpose of avoiding the discharge of produced waters to the marine environment and assisting to maintain pressure within the reservoir with a consequential improvement in oil recovery rates. All water produced with the oil and gas will be returned to the reservoir.

A jack-up rig, similar to that used in the exploration phases, will be used to progressively drill the production and injection wells immediately following the installation of the platform.

Platform

An unmanned wellhead platform will be installed in the field to accommodate the dry well heads and allow access to the artificial lift pumps and to house their supporting equipment. The approximate site of the platform within the field location is 29° 27' 0.01" S and 114° 52' 10.75" E and is shown on Figure 1.5. While the exact location of the platform is dependant on ongoing engineering studies, it will be located within 300 m of the marked location.

Periodic maintenance of equipment on the platform will be carried out using a support boat operating from Port Denison.

Pipelines

The offshore platform and the onshore separation plant will be connected by way of two pipelines and a number of umbilical lines. One pipeline will be for transfer of liquids, comprising water and

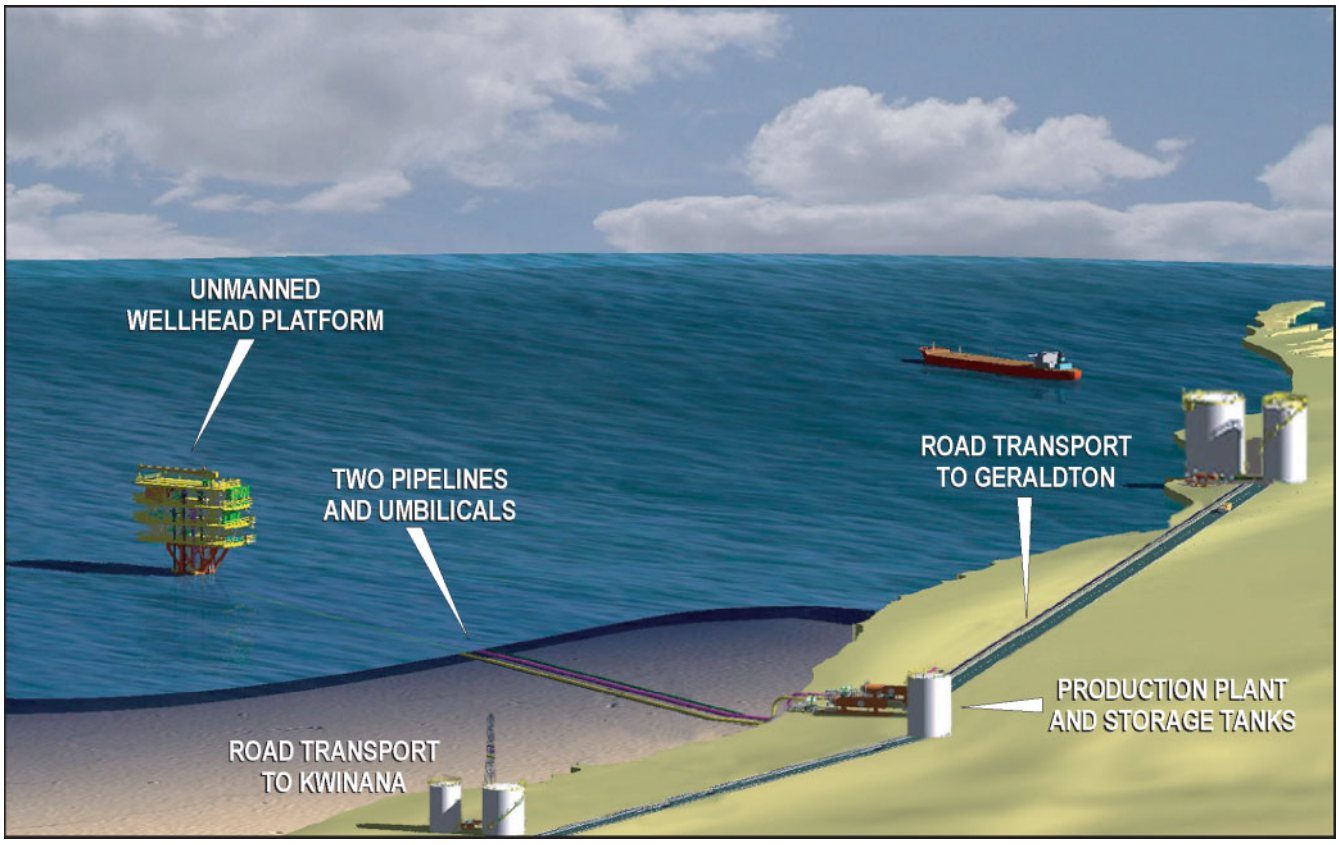


Figure 1.4 Development concept

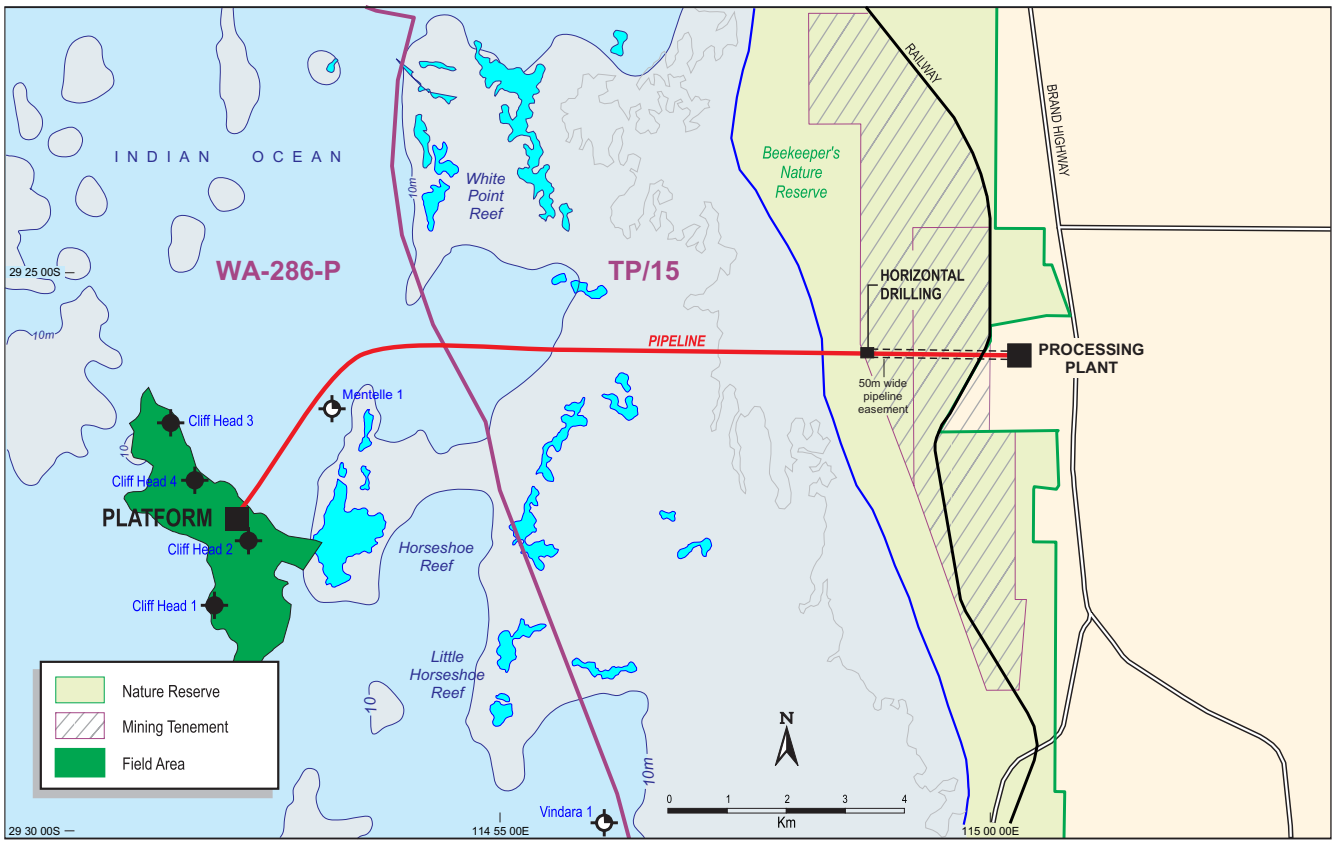


Figure 1.5 Development area

crude oil, and gas from the production wells. The other pipeline will be for the return of water for reinjection. Umbilical lines attached to the pipelines will supply chemicals, such as corrosion inhibitor and emulsion inhibitors to the production wells as well as hydraulic fluid for remote control of the platform activities.

The pipelines will traverse to the north of Horseshoe Reef and run almost due east towards the plant site. Installation through the surf zone and inland to east of the frontal dune is to be done using horizontal directional drilling technology. The onshore section east of the frontal dune will be buried so that no equipment remains evident in Beekeeper's Nature Reserve.

Onshore Treatment Facility

It is proposed to construct the onshore treatment facility at the location of a disused lime sand plant approximately three kilometres inland from the coast and 20 km south of Dongara.

Processing at the treatment facility will comprise degassing, dewatering and stabilisation of the crude oil. The facility will be designed to have a gross liquid (oil and formation water) capacity of approximately 6,360 m^3 per day (40,000 barrels per day). Plant design includes storage facilities for approximately 6,360 m^3 (40,000 barrels) of crude oil.

The volumes of gas associated with the oil are so low that they are not by themselves a practicable source of fuel for the production facilities. These minimal volumes of recovered gas will be supplemented with reticulated gas delivered to the site to provide fuel for the production facilities.

Export of Crude Oil

The method for export of crude oil product from the treatment facility to markets has not yet been finally defined and is subject to ongoing negotiations. Following an extensive options review, the most probable export option is road transport to an export facility within Geraldton Harbour and/or to the BP refinery at Kwinana. Rail transport to Geraldton was considered but is not commercially viable.

Workforce

Physical construction of the onshore elements of the project is not expected to commence until late 2004 or early 2005. At its peak the workforce engaged to construct the plant and onshore pipelines is unlikely to exceed 100. The offshore workforce associated with the drilling rig will number approximately 100 persons. As with previous drilling campaigns, this workforce tends to be dominated by operators with specialist skill, and be drawn from outside the district.

In its operational phase, it is expected that a workforce of about 10 persons will operate and maintain the plant for all but the most major maintenance tasks. Roc expects this workforce to reside locally.

1.4 Relevant Legislation and Guidelines

The proposed development of the Cliff Head oil field will occur in areas of both Commonwealth and state jurisdiction. All activities conducted during the development and operation of the Cliff Head oil field will comply with legislative requirements established under Commonwealth and state regulatory framework.

The major relevant Commonwealth and Western Australian state statutes and regulations under which the project will be developed are listed in Table 1.1 below.

1.4.1 State

All aspects of the project that are located in state waters or on state lands will be subject to the Western Australian legislative requirements.

1.4.2 Commonwealth

All aspects of the project that are located in Commonwealth waters will be subject to Commonwealth legislative requirements. The Western Australian Department of Industry and Resources administers aspects of the *Petroleum (Submerged Lands) Act 1967* (Commonwealth) as the designated authority in the area of the Cliff Head oil field.

1.5 Environmental Assessment Process

The project extends across areas under the jurisdiction of both the Commonwealth and the State of Western Australia. The Cliff Head oil field lies in a Commonwealth marine area, outside the boundaries of the State of Western Australia. The treatment plant and much of the length of the pipelines lie within state waters or on Western Australian lands. The Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) also sets out a number of areas where matters defined as of National Environmental Significance require Commonwealth assessment.

While an agreement between the Commonwealth and Western Australia exists under the EPBC Act whereby it could be expected that a single assessment process (the accredited process) would apply to the project, the fact that the field lies outside the boundaries of the State of Western Australia precludes the application of this agreement. In discussion with the administering environmental Authorities of both governments, it has been agreed that the project should be the subject of a coordinated environmental impact process (see Figure 1.2). This

Table 1.1 Relevant commonwealth and state legislation and regulations

Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999	Under this legislation all activities that will, or have the potential to, affect matters of 'National Environmental Significance' are prohibited except when undertaken in accordance with approval by the Minister for Environment, or when approved through a bilateral agreement with a state or territory, or when approved through a process accredited by the Minister.
Petroleum (Submerged Lands) Act 1967	This act relates to the exploration and exploitation of petroleum resources in the area of the continental shelf of Australia and certain Territories of the Commonwealth. Commonwealth law applies to lands beneath waters that are outside 3 nautical miles off Western Australia.
The Petroleum (Submerged Lands)(Management of Environment) Regulations 1999	These regulations are applicable to petroleum exploration and production activities in Commonwealth waters. The objective of these regulations is to ensure that petroleum activities are carried out in a manner that is consistent with the principles of ecologically sustainable development and in accordance with an approved 'Environment Plan' that has appropriate performance objectives and standards as well as measurement criteria for determining whether the objectives and standards are met.
Australian Heritage Commission Act 1975	This act identifies areas of heritage value listed on the Register of the National Estate.
Historic Shipwrecks Act 1976	This act protects shipwrecks that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the act.
Wildlife Protection (Regulation of Exports and Imports) Act 1982	This act is concerned with control over the movement of Australian wildlife (fauna and flora) in or out of the country, together with the movement of exotic (non-indigenous) flora and fauna out of the country, as well as various other matters relating to quarantining.
Hazardous Waste (Regulation of Exports and Imports) Act 1989	This act regulates the import and export of hazardous waste. Permits are required to dispose of waste overseas or to import waste into Australia.
Ozone Protection Act 1989	This act regulates the import, export and manufacture of ozone-depleting substances such as fire-fighting equipment and refrigerants.
Navigation Act 1912	This act requires that ships carrying oil and chemical tankers conform with Annex I of the MARPOL Convention for the Prevention of Pollution from Ships.
Protection of the Sea (Civil Liability) Act 1981	This act imposes civil liability for pollution damage and requires ships carrying more than 2,000 t of oil in bulk as cargo to maintain insurance to cover liability for pollution damage.
Protection of the Sea (Oil Pollution Compensation Fund) Act 1993	This act establishes a Commonwealth fund to provide compensation and indemnification for certain oil pollution damage. The fund can recover contributions on behalf of the Commonwealth.
Protection of the Sea (Powers of Intervention) Act 1981	This act regulates discharges from ships to protect the sea from pollution. The act gives powers to the Australian Maritime Safety Authority to take appropriate measures to protect the Australian coastline.

Table 1.1 Relevant Commonwealth and State Legislation and Regulations (cont'd)

Western Australia	
Environmental Protection Act 1986	This is the principal statute relevant to environmental protection in WA. It gives the Authority overall responsibility for the prevention, control and abatement of environmental pollution and for the conservation, preservation, protection, enhancement and management of the environment.
Conservation and Land Management Act 1986	This act provides for the use, protection and management of public lands, including parks and forests. It includes water, flora and fauna on these lands. The Department of Conservation and Land Management administer the act.
Petroleum (Submerged Lands) Act 1982	This act provides for the exploration and exploitation of petroleum resources on submerged lands adjacent to the coast of Western Australia.
Petroleum Pipelines Act 1969 (Section 8)	This act relates to the construction, operation and maintenance of pipelines for the conveyance of petroleum.
Fisheries Act 1905	This act is concerned with commercial exploitation and development of fisheries and marine resources. Under the act development projects must be carried out so as not to adversely impact on fisheries and marine resources.
Western Australia Marine (Sea Dumping) Act 1981	The act provides for the protection of the environment by regulating dumping and incineration of wastes and other matter at sea.
Marine and Harbours Act 1981	This act contains regulations to control the refuelling of ships and boats and is administered by the Department of Marine and Harbours.
Prevention of Pollution of Waters by Oil Act 1960	This act prohibits the discharge of oil or noxious substances into State waters, and provides for the removal of oil or any mixture containing oil from affected waters. The harbour authority or Department of Transport administers the act.
Aboriginal Heritage Act 1972	This act protects aboriginal sites from disturbance.
Agriculture and Related Resources Protection Act 1976	This act imposes controls for the containment of pests and weeds.
Explosives and Dangerous Goods Act 1961 and Regulations	This act imposes controls for storage and handling of dangerous and explosive goods.
Native Title Act 1993	This act handles aboriginal claims for land ownership.
Soil and Land Conservation Act 1945	This act provides for the control of land degradation and the clearing of lands.
Rights in Water and Irrigation Act 1914	This act licences and controls the use of groundwater.

coordination is an informal procedure, and the project has been formally required to undergo assessment under both the Western Australian and Commonwealth legislation.

The state has formally decided to assess the project at the public environmental review (PER) level.

The Commonwealth has formally required assessment at a public environmental report level.

Liaison between the State and Commonwealth has resulted in the issuing of a single scoping document that is at Appendix A.

This document has therefore been prepared as a PER (under the Western Australian state procedures) and a public environmental report (under the Commonwealth procedures).

1.6 Government and Public Consultation

Roc has maintained a policy of open and extensive consultation with all identified stakeholders throughout the exploration and appraisal activities that have lead up to this stage in the development of the Cliff Head oil field.

Techniques employed include the distribution of pamphlets describing specific exploration activities, advertisements in local newspapers advising specific activities, and meetings with government representatives and interest groups such as various fishermen's associations. A summary of consultations is given in Chapter 4.

Information sessions are planned for Perth, Geraldton and Dongara during the six week public exhibition phase of the PER process. The PER documentation will be available at key locations during this period, and the PER will be appropriately advertised in local, state and national newspapers.

Specific discussions will be organised with the associations that represent the Rock Lobster fishermen that operate in Zone B in the Cliff Head area. Specific direct discussions will also be organised with representatives of the Irwin Shire and the Department of Conservation and Land Management in respect of aspects of the project impacting on interests administered by those authorities.

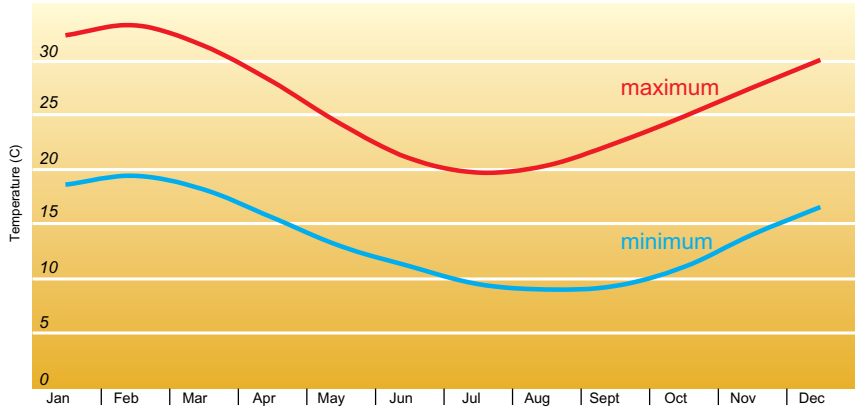
Because the project is being formally assessed under both Commonwealth and state procedures, there is a duplicated opportunity for interested parties to submit responses to the publication of the PER documentation. Roc will respond to any submissions within the established PER procedures.

2. Existing Environment

2.1 Physical Environment

2.1.1 Climate

The proposed Cliff Head Development is located within a region that has a Mediterranean type climate characterised by seasonal patterns of hot, dry summers and mild, wet winters, with a low number of rain days. The highest temperatures occur in January and February while the lowest temperatures occur in August (Figure 2.1). The mean daily rainfall and evaporation recorded at the Geraldton meteorological station are presented in Figure 2.2. There is a dominant winter rainfall with approximately 55% of annual rainfall occurring in June and August. During summer months rainfall is uncommon, resulting in a summer drought that lasts approximately four months.

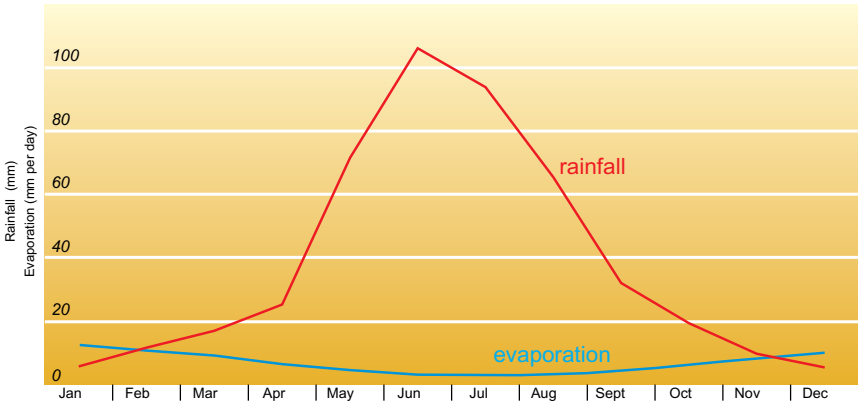


Source: BOM (2003).

Figure 2.1 Mean daily maximum and minimum temperatures recorded at Geraldton 1941 to 2001 (Bureau of Meteorology)

Wind data has been sourced from recordings made by Roc at the Cliff Head field and the output of a numerical atmospheric model (the NCEP/NCAR Model Reanalysis Project), which is operated by the NOAA-CIRES Climate Diagnostics Centre in Boulder, Colorado and made publicly available via the NOAA Web site (NOAA, 2003). Wind roses summarising the distribution of wind speeds and directions are shown for the closest wind station to the Cliff Head Development (Site 5674) (ASA Pacific, 2003) and are presented in Figure 2.3.

In general, the wind roses indicate winds over the region are relatively strong (mean 12–16 knots; maximum 30–35 knots) and are most frequently from the southern sector (southeast to southwest) during the summer months and from the eastern sector (northeast to southeast) during the winter months.



Source: BOM (2003).

Figure 2.2 Mean monthly rainfall and mean daily evaporation recorded at Geraldton 1941 to 2001 (Bureau of Meteorology)

2.1.2 Met-Ocean Conditions

Water circulation in the area is primarily influenced by wind-driven currents, although localised wave-forced currents may occur around the shallow reefs, particularly during large swell events. The currents at the surface to mid-depth have typical mean speeds of 0.08 to 0.15 ms^{-1} and near the seabed this is reduced to 0.06 to 0.1 ms^{-1}. The currents run mostly parallel to the local bathymetry/shoreline (WNI, 2000).

As a result of the strong land/sea-breezes, seas are slightly greater than swell in summer. Oceanic swells predominantly arrive from the southwest during summer. The mean swell heights range from 0.9 to 1.3 m with associated maximums of 1.7 to 3.5 m and mean periods of 12 to 16 seconds. Typical annual mean sea heights are 0.5 to 1.2 m with associated maximums of 1.5 to 2.5 m and mean periods of 4 to 7 seconds (WNI, 2000).

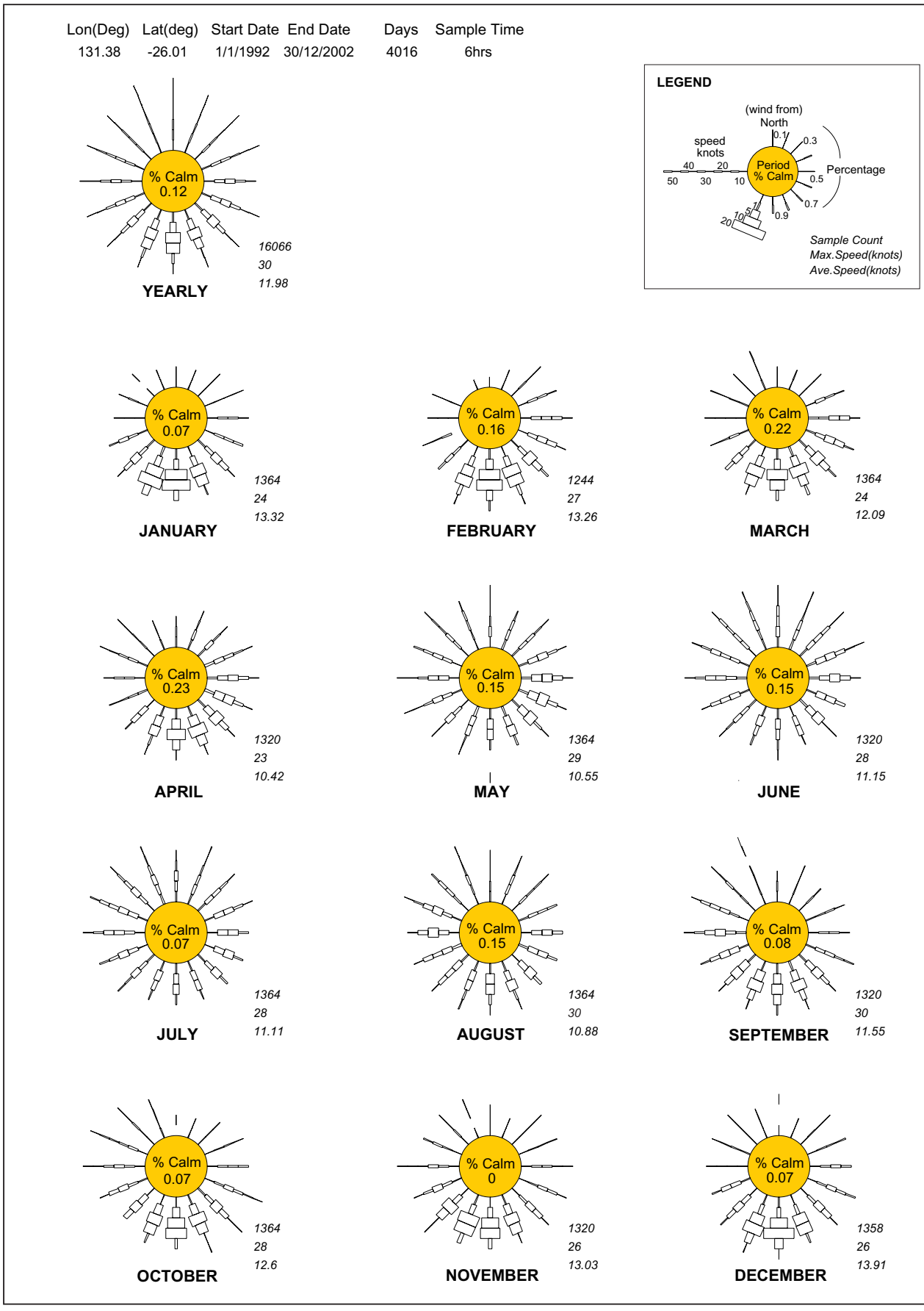


Figure 2.3 Monthly and yearly wind rose diagrams for the NCEP/NCAR Station 5674 over 10 years (1992 – 2002)

The Leeuwin Current, which is the dominant oceanic current in the region, is not expected to have a significant effect on the current regime in the inshore area of the proposed development activities. Tides are diurnal, with a small maximum range of less than one meter, and have very limited effect on water circulation in the area.

2.1.3 Bathymetry

The bathymetry across the Development area ranges from intertidal to approximately 28 m water depths. The field location is in water depths ranging from 10 to 20 m (Figure 2.4). As illustrated by Figure 2.5 the prominent features of the Development area are the sub-littoral reefs that occur as a series of broken ribbon reefs approximately 3 to 5 km and 10 to 12 km offshore.

2.1.4 Landform and Geology

The onshore components of the Cliff Head Development are situated within the Perth Basin geological province on the coastal foreplain. The area is part of the Quindalup dune system and dunes comprising Holocene age calcareous sands (DPUD, 1994) form the dominant feature of the landscape (Figure 2.6).

The dunes are generally aligned parallel to the prevailing wind direction in a north to northeasterly direction. The frontal dunes have a parabolic profile with steep, peaked relief and are up to 40 m high. The older dunes are lower and have a gently undulating relief. The younger vegetated dunes have little to no humus content and are highly susceptible to wind erosion if the vegetation on the crests is damaged or cleared. The older vegetated dunes, however, have a higher humus layer and are less vulnerable to erosion if cleared (DPUD, 1994).

Throughout the coastal plain there are a number of blowouts (highly mobile dunes); however, none are present within the Development area (see Figure 2.6).

2.1.5 Soils

The dunes are comprised of four different aged sand profiles which are identified by humus development and the degree to which the carbonate sands have been leached (DPUD, 1994; Westlime, 1995). The soils are characterised by (DPUD, 1994):

- Variable calcium carbonate content depending on the shell content levels of the beach and dune sands from which they originated.
- A typically alkaline pH level, which varies up to 9.5 in the more calcareous patches to close to neutral in swales (depressions between dunes) or where sands overlie limestone.
- Variable salinity levels caused by seawater spray, with salinity decreasing inland.
- High porosity and low water holding capacity.
- Aluminium, cobalt, copper, iron, manganese, zinc, boron and potassium deficiencies caused by high calcium levels.

2.1.6 Groundwater

The proposed onshore development overlies three groundwater resources. The upper-most groundwater is the superficial formation; below this lies the Yarragadee Formation and further below this at a depth of about 800 to 1,000 m lies the Cattamarra Formation (also known as the Cattamarra Coal Measure).

The superficial aquifer consists of Quaternary and Late Tertiary sediments extending from Geraldton in the north to Busselton in the south. In the Dongara to Geraldton area, the superficial groundwater is generally brackish and non-potable, but some is used for irrigation.

The Yarragadee Formation is the largest aquifer in the Perth Basin covering an area stretching from north of Dongara to the Serpentine area south of Perth. Regionally, the Allanooka Scheme and Wye Springs Wellfield, both operated by the Water Corporation, source water from the Yarragadee Formation. The Allanooka Scheme supplies water to the City of Geraldton, the towns of Dongara, Port Denison, Walkaway, Narngulu, Eradu and Mullewa. The Wye Springs Wellfield supplements the town water supply for Dongara and Port Denison. This wellfield is located in the Dongara–Denison Water Reserve, 12 km northeast of Dongara–Port Denison (WRC, 2002).

The depth to water table in the Yarragadee aquifer system in the Allanooka Scheme and Wye Springs Wellfield ranges between approximately 12 to 85 m below ground level and averages 50 m below ground level. Yarragadee groundwater flow in the vicinity of the wellfields is generally southwesterly (WRC, 2002).

The Cattamarra Formation is predominantly shaley with relatively thin sandstones and coal seams. It outcrops in the Hill River area to the east while depth to water table in the Development area is approximately 800 to 1,000 m below ground level (Davidson, 1995). Direction of groundwater flow is generally westerly. Salinity varies with flow and can be approximately correlated with depth (Ambellia Consultancy, 2003). The expected salinity of the Cattamarra Formation in the area is approximately 23,000 mg/L.

2.2 Biological Environment

2.2.1 Marine

Regional Description

The Development area lies within the 'Central West Coast' meso-scale region according to the IMCRA classification (IMCRA, 1997). The region is characterised by a relatively narrow continental shelf with diverse moderate energy coastal landforms (IMCRA, 1997). The area has a range of temperate species and is also at the southern limit of a suite of sub-tropical and tropical species.

The coast in the Development area is formed over the Perth sedimentary basin. Through the Pleistocene Epoch (10,000 to 2,000,000 years ago), the sea level rose across, and then receded back from, the coastal plain many times. As the sea level fell during each regression, it left behind a coastal dune field, the oldest of which have consolidated to form approximately north–south aligned ridges of aeolianite limestones. Those ridges that are now below sea level form sublittoral reefs, often undercut and cavernous on the seaward side. Small islands representing high points of flooded ridges, although not present in the Development area, are a relatively common feature of the region within a few kilometres of the shore.

The shoreline adjacent to the Development area is comprised of long sandy beaches with occasional rocky cliffs and headlands where the limestone outcrops. Notched inter-tidal rock platforms are a feature of this coast.

Marine Habitats

The benthic habitats of the area west of Horseshoe Reef have previously been characterised by diver and towed video surveys (BBG, 2000; URS, 2001). More recently the benthic habitats of the Development area, including the pipeline route, have been surveyed using a towed video camera.

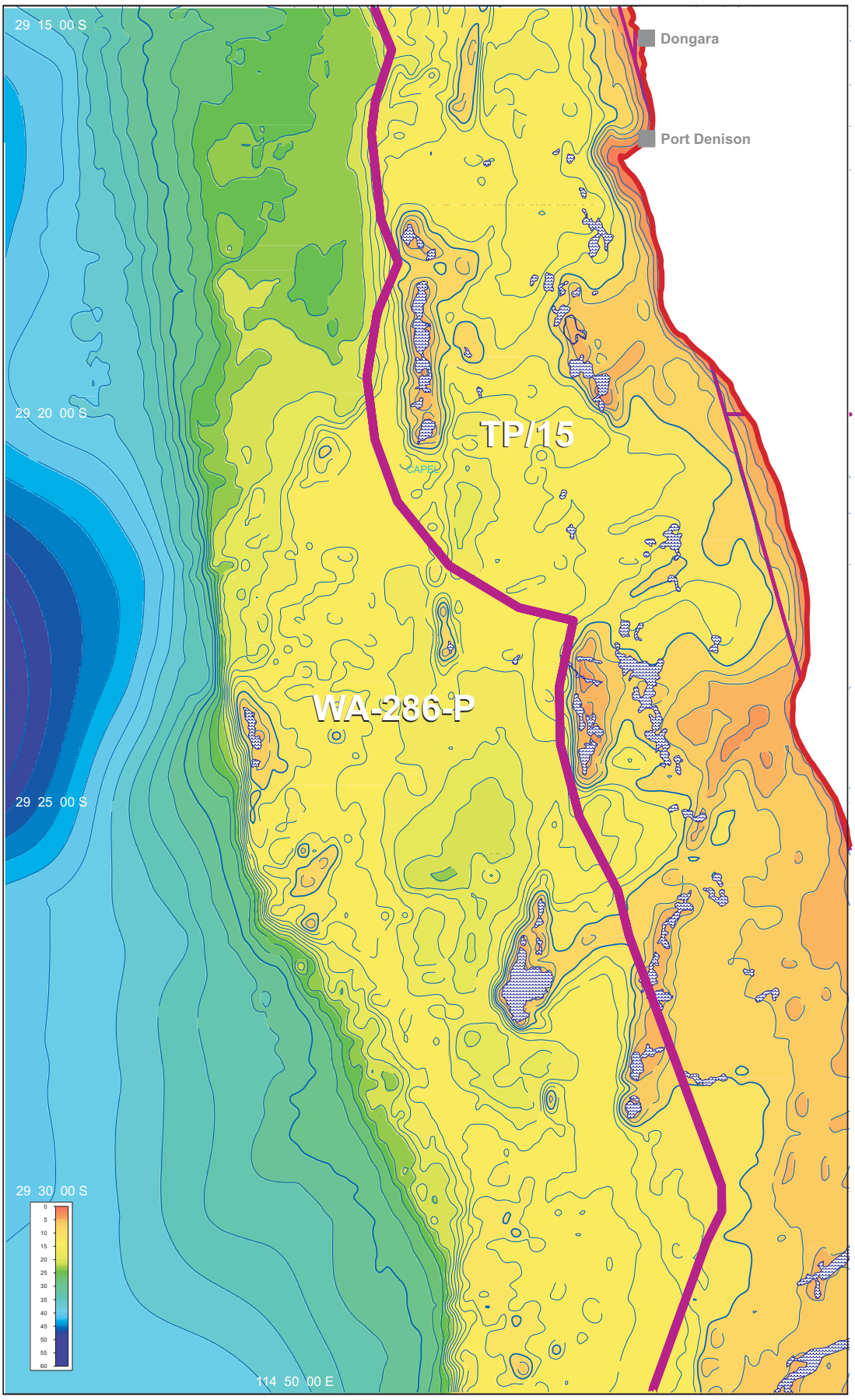


Figure 2.4 Regional bathymetry

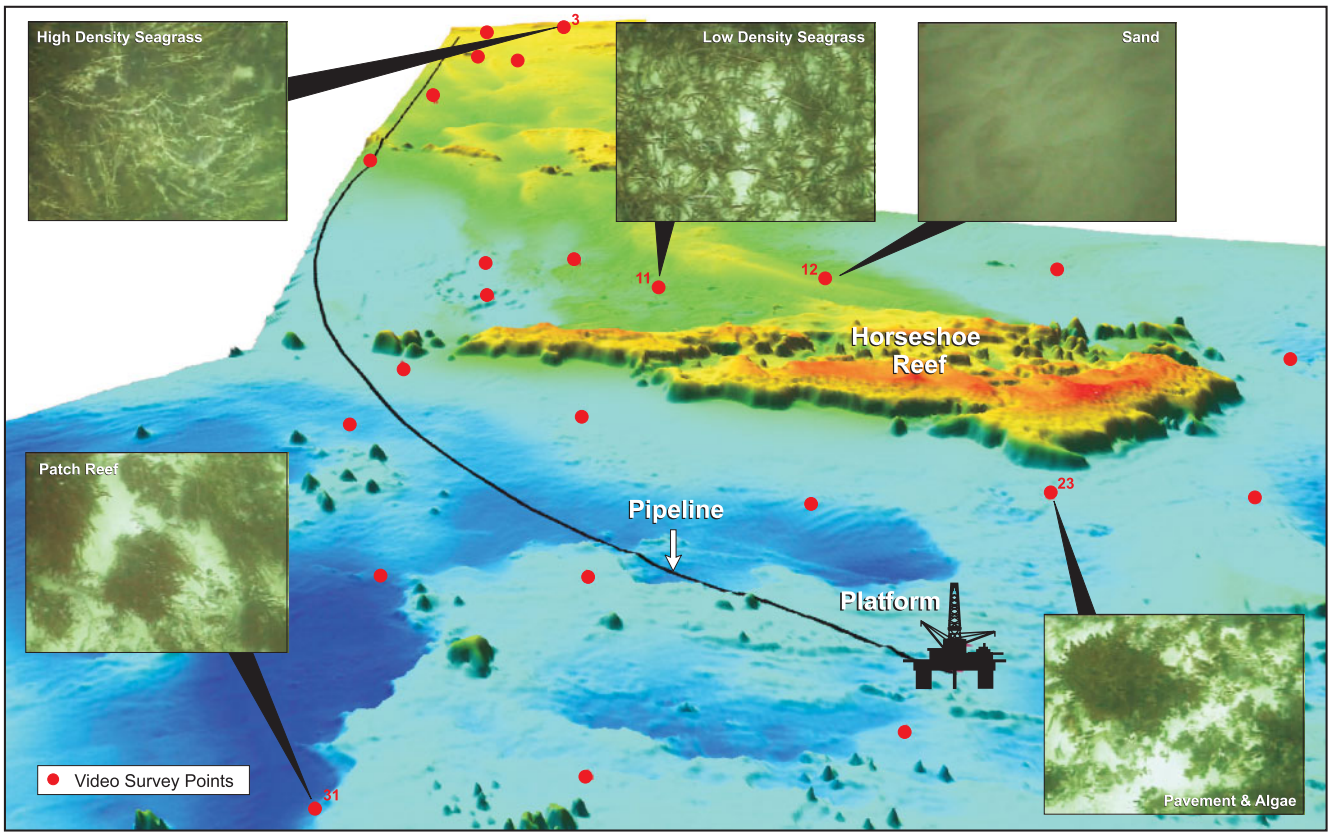


Figure 2.5 Three-dimensional bathymetry

Figure 2.7 shows the inferred distribution of benthic habitats between the shore and a depth of 30 m in the Development area, and also over the coastal area between 29° 20' and 29° 30'S. The data on inferred benthic habitat distribution is based on interpretation of aerial photographs and satellite imagery contained within the Department of Conservation and Land Management (CALM), Marine Conservation Database (Phillips, 2002), transect video footage (BBG, 2000; URS, 2001), site survey video footage (MacroEnvironmental, 2003) and discussions with fishermen familiar with the area.

The EPA guidance document (EPA, 2003) sets out a generic methodology for asPetroleum (Submerged Lands) (Management of Environment) RegulationsPetroleum (Submerged Lands) (Management of Environment) Regulationssessing the potential effects of a proposal on benthic primary producer habitat. The first step is to define the appropriate management unit. As noted in the guidance document, in the absence of any accepted scientific method, defining the management area

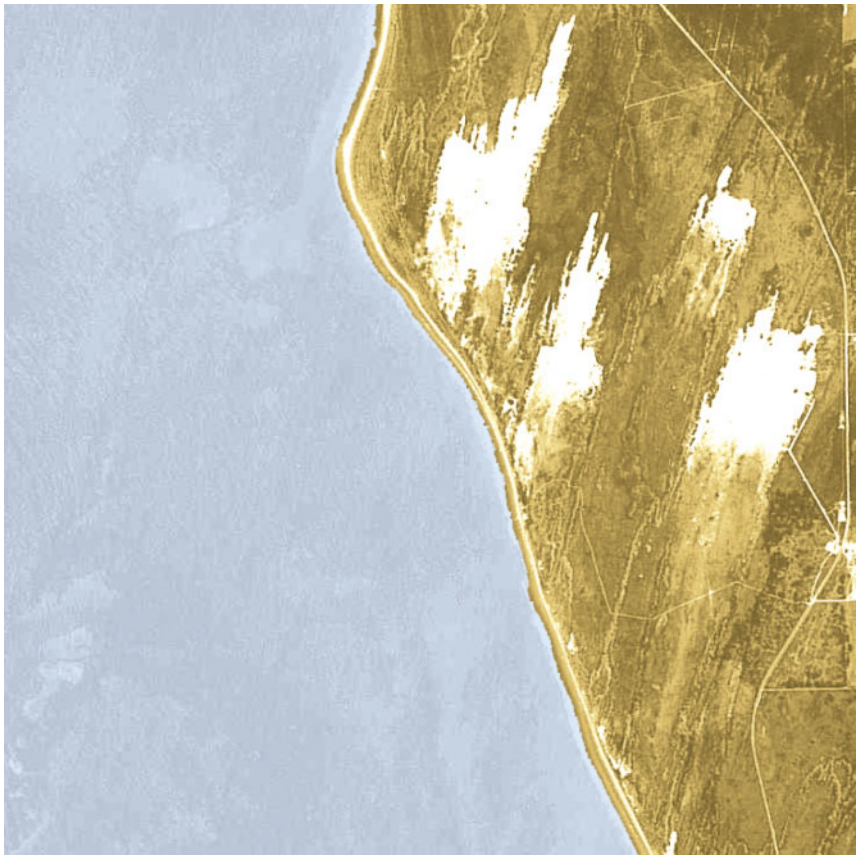


Figure 2.6 Aerial perspective showing dune blowouts

requires qualitative judgement. An examination of the development area indicates relatively clear boundaries of the coastline to the east and the 30 m depth contour to the west. There is, however, no clear northern or southern boundaries, so for the purposes of considering the impact of potential habitat loss on ecological integrity, a micro-scale management unit area of approximately 75 km^2 has been defined by taking a 5-km corridor from the coastline to the 30-m depth contour. The main habitat types within this management unit area are described below.

Intertidal Habitats

The nearest intertidal habitats occur along the coastline. The main intertidal habitats on the coastline comprise long narrow sandy beaches separated by limestone platforms and exposed beach rock. The platforms and beach rock support turf algae and molluscs with a range of small fish and crabs present in rock pools.

Sandy Seafloor

Sandy seafloor habitat occurs in subtidal areas where the sand forms a thick layer over the underlying limestone pavement. The sands are often shifting, and as a consequence the density of epibiota is low. In deeper areas, small scattered patches of seaweeds, mostly *Sargassum* and Dictyales species, and *Halophila* seagrasses, can be found.

Limestone Pavement

Limestone pavement habitat is widely distributed across the Development area, generally increasing in coverage around the 15-m isobath west of Horseshoe Reef. Red and brown macro-algae are the dominant vegetation with occasional green algae and seagrass species.

The extent of vegetation cover depends on the depth of cover of the pavement by sand. Plant growth decreases with increasing sand depth and is generally absent where the sand cover exceeds 0.3 m, as the plants attach to the underlying pavement. Occasionally, small patches of pavement occur, which are raised, usually by less than 1 m, above the general level of the seafloor. These areas of 'low relief reef' (also referred to by some as 'raised pavement') support a more diverse and luxuriant algal community and more abundant sessile fauna of sponges and ascidians. Fish and rock lobster are also attracted to these areas for food and shelter.

Patch Reef

A major physical feature in the western parts of the management area are the numerous limestone patch reefs. These are high profile structures, with steep reef faces, typically rising 1 to 4 m above the surrounding seabed with extensive horizontal ledges.

Emergent Reef

Emergent reefs support an abundant attached invertebrate cover, particularly rich in sponges and ascidians. Horizontal surfaces are characterised by a dense cover of photosynthetic organisms, particularly macroalgae, with lesser scleractinian corals. The brown macroalgae species *Ecklonia radiata* (kelp) and *Sargassum* spp. are generally the dominant macrophytes. The understorey is comprised of numerous species of smaller red, brown and green algae. Coralline algae are often present, in places becoming the dominant cover. Encrusting corals, such as *Montipora* and *Turbinaria*, are often present on shallow parts of the reefs, but are rarely dominant.

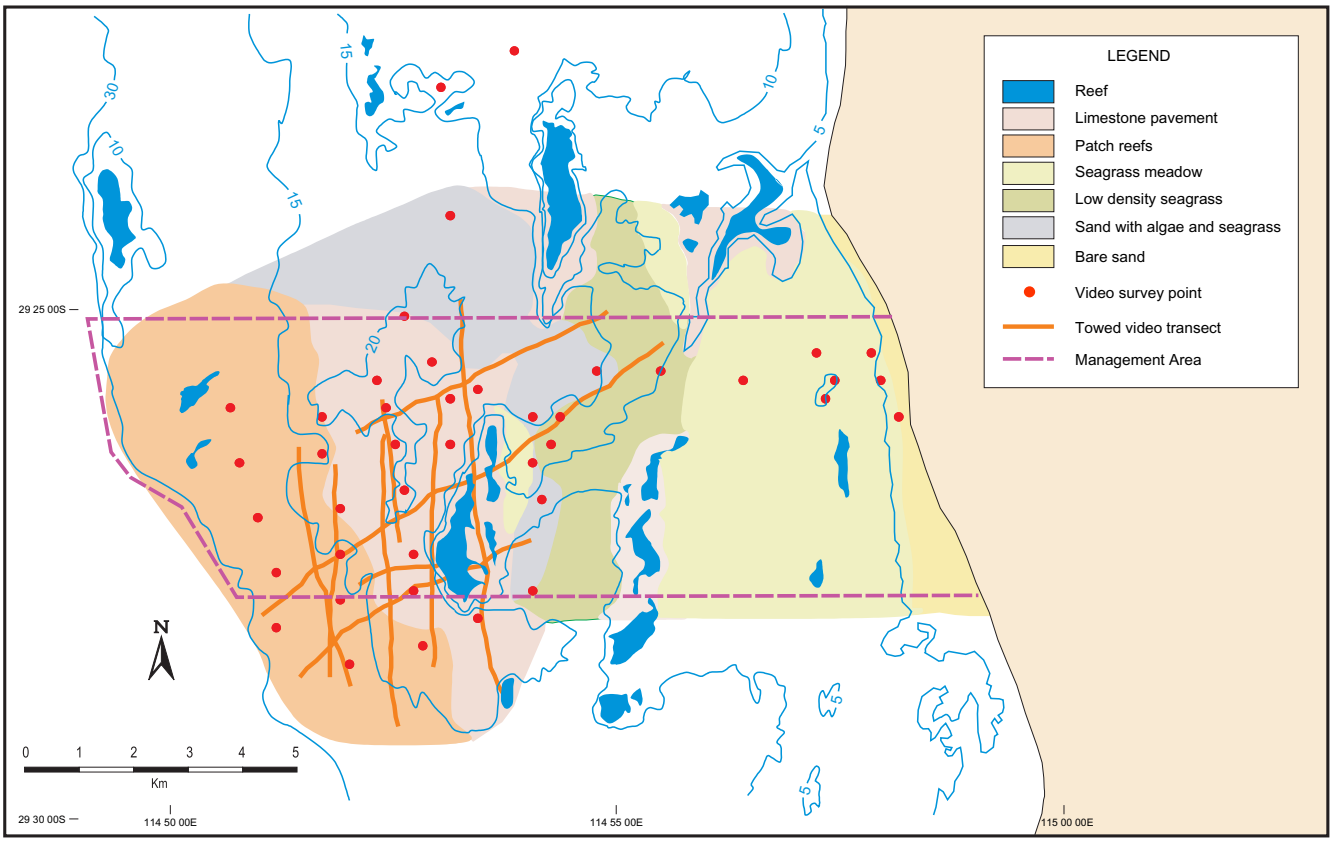


Figure 2.7 Marine habitats

Seagrass Habitat
Seagrasses occur in varying density throughout the management unit area. There are two identifiably distinct habitat types. The first type comprises areas of high density seagrass meadows that are present in the eastern parts of the management area. These meadows extend from approximately the 3- to 5-m depth contour adjacent to the shoreline to the first line of reefs at about 3 km from the shore. They contain a mixed assemblage of seagrasses species of mostly *Amphibolis, Posidonia* and *Heterozostera* species.

The second seagrass habitat type has lower density meadows of ephemeral species, such as *Syringodium* and *Halophila* on less stable sands and scattered small patches of high density *Amphibolis,* mostly found in the lee of raised limestone pavement.

Key Biota
Key biota of the area are taken to be those that are:

- Listed as threatened or endangered and may occur in the area
- Of importance to recreational and/or professional fisheries
- Of 'key' importance in ecological processes of the area.

The key marine species are presented in Table 2.1 and discussed below.

Marine Mammals
Blue whales normally remain in deeper waters off the shelf break (Rafic, 1999) and would be unlikely to occur in the Development area.

The geographical and temporal movements of humpback whales in Western Australian waters have been reviewed by Jenner et al. (2001). The humpback whales migrate between their summer feeding grounds near Antarctica to their winter breeding grounds adjacent to Australia's Kimberley coastline. On the west coast, northbound migration occurs between mid-June and mid-July, while the southbound migration occurs between October and November (Jenner et al., 2001). The migratory path of the humpback whale stock off WA covers approximately 3,600 nautical miles (nm) (Jenner et al., 2001). Within the region, it is considered that the whales follow a predictable migratory pattern within the continental shelf boundary (200 m bathymetry) and between the Houlman Abrolhos Islands and the mainland (> 30 nm offshore). Northward migration is generally offshore, whereas southward migration is typically closer to the coastline. The migration routes are presented in Figure 2.8 (Jenner et al., 2001).

The migratory patterns of the southern right whale is less well known than the humpback. It is thought that southern right whales migrate from sub-antarctic feeding grounds to their breeding grounds close to Australia's south coast during winter and spring (Bannister, 1994). Marsh et al. (1995) indicate that the regular calving areas occur between Augusta in Western Australia and Port Lincoln in South Australia, with less regular calving occurring around the southwest coast up to Perth. Occasional sightings of southern right whales have been made as far north as Geraldton during the winter and spring period.

Bryde's whale are the smallest of the baleen-type whales. They are found in oceanic and nearshore tropical and subtropical waters. Bannister et al (1996) report that Bryde's whales have previously been recorded near the Abrolhos Islands. The Bryde's whale may occasionally pass through or near to the Development area.

Sei and fin whales generally tend to stay in deeper oceanic waters and migrate to the sub-Antarctic, below latitude 35°S, to feed during the warmer months (Bannister et al., 1996).

Australian sea lions are regularly observed feeding around the larger reefs in the area. The nearest breeding grounds are on the Beagle Islands some 35 km to the south and the Abrolhos Islands approximately 100 km northwest of the area.

Turtles
Leathery turtles (also referred to as leatherback turtles) generally frequent deeper offshore waters; however, it is not uncommon for them to be sighted in the shallower coastal habitats.

Fish
The area is known habitat for the listed white shark, whose range extends primarily from Moreton Bay in Southern Queensland, around the southern coastline to the North West Cape of Western Australia (Bruce, 1995). Although no data exists for the grey nurse shark, they may also occur in the area.

The whale shark is a filter feeder, feeding on plankton, small fish and squid. They occur in both tropical and temperate waters and are normally oceanic and cosmopolitan in their distribution. They are known to aggregate in the waters adjacent to North West Cape in late March to early May, with the largest numbers being recorded in April. The season is, however, somewhat variable and whale sharks have been recorded between mid March and the beginning of June. Recent satellite tracking of whale sharks tagged off the North West Cape showed that all four individuals tagged left the area by substantially different routes (Woodside, 2002). It is unlikely that the whale shark would occur in the Development area. However, they are known to migrate long distances and have been observed further south than Dongara so their presence, although unlikely, cannot be discounted.

The diverse range of ecological niches afforded by the patch reefs across the Development area would be expected to provide suitable habitat for the listed Osteichthyes species of seahorses, seadragons and pipefish.

The variety of benthic habitats support diverse and abundant fish communities. Reef associated fishes, such as scalyfin (Parma spp) and wrasse (Labridae spp) are common, along with commercial species such as baldchin groper (*Choerodon rubescens*) and dhufish (*Glaucosoma hebraicum*) on outer reefs. Offshore, pelagic fishes such as Spanish mackerel (*Scomberomorus commerson*) and Samson fish (*Seriola hippos*) also occur.

Seabirds
Migratory seabirds, some of which are also protected by international agreements (Bonn Convention, JAMBA and CAMBA), may pass through the proposed drilling area. They are, however, uncommon in the proposed drilling area due to the lack of suitable roosting and breeding habitat but foraging groups of seabirds are sighted occasionally.

Rock Lobster
Rock lobsters are found all around the Australian coast sheltering in caves and crevices during the day and moving out at night to forage in surrounding areas. The western rock lobster (*Panulirus cygnus*) supports the most valuable single species fishery in Australia.

Table 2.1 Key marine species

Species	Common Name	Likely Presence	Commonwealth		State	
			Listed Threatened Species Status	Migratory Provisions of EPBC Act	Marine Provisions of EPBC Act	WA Wildlife Conservation Act
Marine Mammals						
Balaenoptera musculus	Blue whale	Very unlikely	Endangered	_		_
Megaptera novaeangliae	Humpback whale	Possible	Vulnerable	_		_
Eubalaena australis	Southern right whale	Possible	Endangered	_		_
Balaenoptera physalus	Fin whale	Unlikely	Vulnerable			_
Balaenoptera borealis	Sei whale	Unlikely	Vulnerable			_
Balaenoptera edeni	Bryde's whale	Possible		_		_
Neophoca cinera	Australian sea lion	Very likely transient			_	_
Dugong dugon	Dugong	Very unlikely		_	_	_
Fish						
Carcharodon carcharias	Great white shark	Possible transient	Vulnerable			_
Carchariuas taurus	Grey nurse shark (west coast population)	Possible	Vulnerable			_
Rhincodon typus	Whale shark	Unlikely	Vulnerable	_		
Osteichthyes	Seahorses, seadragons and pipefish	Possible to Very Likely		p	20 species	
Marine Reptiles						
Dermochelys coriacea	Leathery turtle	Unlikely	Vulnerable	_	_	_
Pelamis platurus	Yellow-bellied seasnake	Unlikely			_	
Seabirds						
Anous tenuirostris melanops	Australian lesser noddy	Likely	Vulnerable		_	_
Macronectes giganteus	Southern giant-petrel	Unlikely	Endangered	_	_	
Macronectes halli	Northern giant-petrel	Unlikely	Vulnerable	_	_	
Pterodroma mollis	Soft-plumaged petrel	Possible	Vulnerable		_	
Pelagodroma marina	White-faced storm-petrel	Possible			_	
Diomedea dabbenena	Tristan albatross	Possible	Endangered	_	_	
Thalassarche carteri	Indian yellow-nosed albatross	Possible	Vulnerable		_	_
Sterna caspia	Caspian tern	Possible		_	_	
Sterna dougallii	Roseate tern	Possible			_	
Catharacta skua	Great skua	Possible			_	
Larus novaehollandiae	Silver gull	Very Likely			_	
Haliaeetus leucogaster	White-bellied sea-eagle	Likely		_	_	_
Calidris ruficollis	Red-necked stint	Likely				_
Calidris alba	Sanderling	Likely				_
Arenaria interpres	Ruddy turnstone	Likely				_
Limosa lapponica	Bar-tailed godwit	Likely				_
Other Key Biota						
Angiosperms	Seagrass	Present				
Panulirus cygnus	Rock lobster	Present				

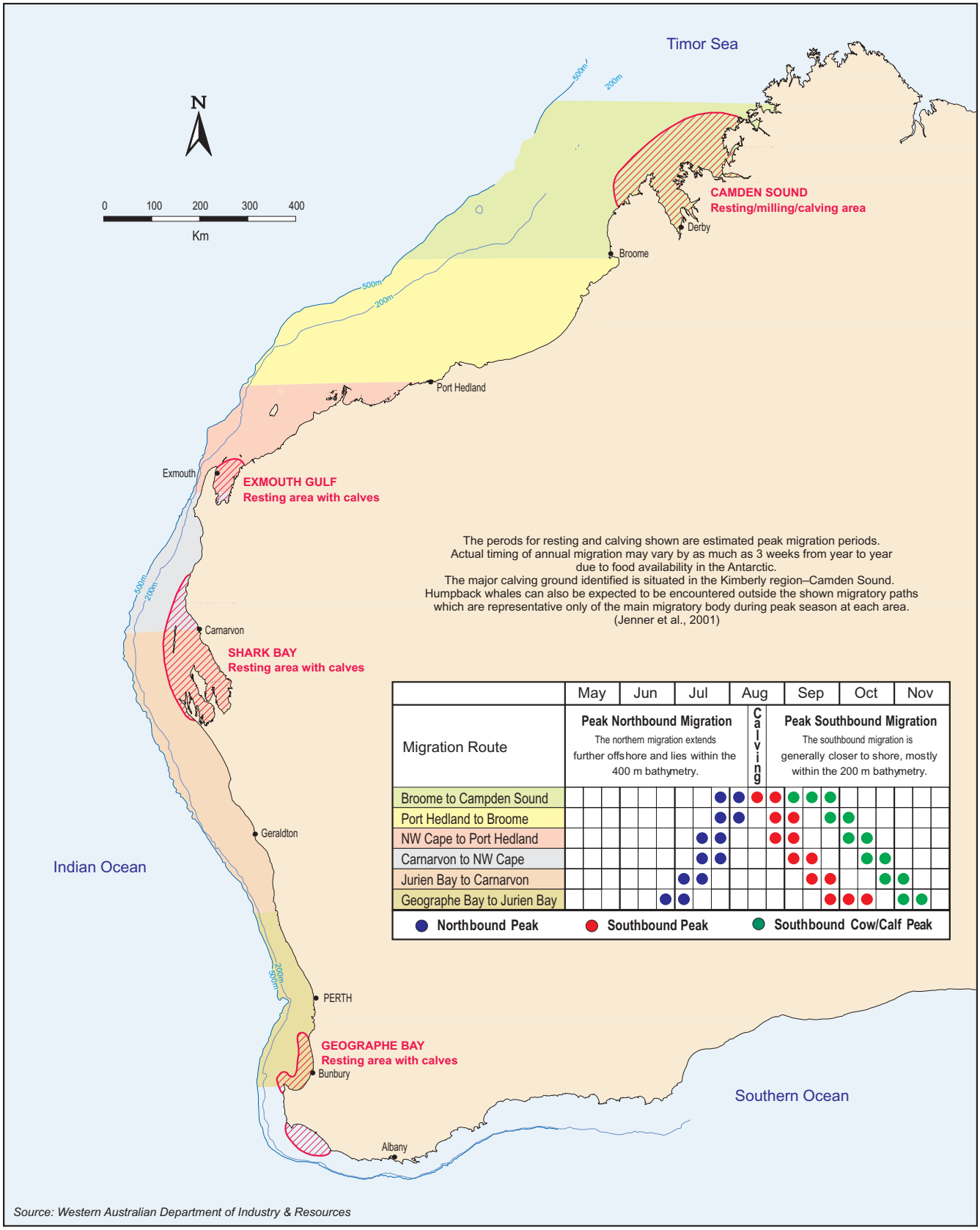


Figure 2.8 Migration pathways of humpback whales

The life cycle of the western rock lobster has been well studied. Breeding occurs in spring and early summer in waters near the edge of the continental shelf of 35 to 90 m depth. The western edge of the Development area would be an area of lobster breeding.

Fertilised eggs are carried on the underside of the female for 9 to 12 weeks before hatching. Hatched larvae, called phyllosoma, rise to the sea surface and drift long distances offshore (generally 400 to 1,000 km offshore) growing to about 35 mm over 9 to 11 months before metamorphosing into the peurulus stage. The peurulus then swims back across the continental shelf to settle in the holes and crevices of the shallow coastal reefs such as occurs in the central and eastern parts of the Development area. After settlement the peurulus undergoes a moult and assumes the form of a juvenile rock lobster (Phillips, 2002).

Juvenile rock lobsters are cryptic and the numbers seen are very small compared to the total numbers that may be present in the reef system. An intensive study carried out at Seven Mile Beach (approximately 10 km north of the Development area) estimated the density of juvenile lobster in the reef system to be approximately 40,000 per hectare (Phillips, 2002).

Seagrasses

The region has a high diversity of seagrass species with 14 species represented. The area supports extensive and diverse seagrass communities, nine species have been recorded to date with their distributions and densities varying over the range of habitats represented. Predominant species include *Amphibolis* spp, *Posidonia* spp, *Halophila* spp, *Thalassodendron pachyrhizum* and *Heterozostera tasmanica*.

Thalassodendron pachyrhizum is common in the offshore reef areas, occurring mainly in association with other small macrophytes on limestone pavement at moderate depths. *Amphibolis* spp is also associated with rocky substrates, becoming more prevalent with decreasing water depth.

Amphibolis antarctica forms dense beds on or adjacent to the nearshore reefs of the area. Seagrasses from the genus *Posidonia* are very common in the region, and range from sparse assemblages on sandy seafloor of moderate water depth (<15 m) and energy regime to dense meadows in protected areas of sand. Patch meadows of ephemeral species, such as *Syringodium* and *Halophila,* also occur on less stable sands.

2.2.2 Terrestrial Flora

A flora, vegetation and *Phytophthora cinnamomi* assessment was undertaken by Woodman Environmental Consulting Pty Ltd (Woodman, 2003) and the following text is summarised from the report.

The vegetation of the survey area was initially mapped from digital aerial photography at a scale of 1:10,000. Experienced botanists then carried out fieldwork in the Development area to ground-truth vegetation boundaries, produce a list of flora present within the area and search for declared rare and priority flora species. The area was surveyed during the 2003 spring flowering season to allow identification of all known declared rare and priority flora. The condition of the vegetation was also assessed, including the presence and distribution of significant weed species.

All areas surveyed were traversed by vehicle and on foot to confirm vegetation boundaries and search for restricted flora species. Detailed site recordings were taken within each plant community and at regular intervals in the survey area. At each recording site, the following information was collected within a 10-m radius (Figure 2.9):

- Site location (description and GPS coordinates).
- Soil type and colour.
- Slope (based on 1 to 3 scale used by Gibson et al. (1994).
- Vegetation condition (Trudgen, 1991).
- Vegetation structure (Muir, 1977).
- All vascular plant species present, and the foliage cover of the dominant species.

The DEH interactive database notes six species of flora listed under the Commonwealth EPBC Act as possibly present in the area. These are:

- *Caladenia hoffmanii.*
- *Conostylis dielsii subsp. teres*: Irwins conostylis.
- *Hypocalymma longifolium.*
- *Leucopogon marginatus*: thick-margined leucopogon.
- *Paracaleana dixonii.*
- *Wurmbea tubulosa*: long-flowered nancy.

A search of the Department of Conservation and Land Management Rare and Priority Flora Database produced a list of four priority flora species: *Anthocercis intricata* (P3), *Haloragis foliosa* (P3), *Hypocalymma tetrapterum* (P3) and *Eucalyptus zopherophloia* (P4) are known to occur in the area.

Where unknown species were encountered during the survey, specimens were collected for identification at the West Australian Herbarium. Plant species nomenclature used in this report follows Green (1985). All names were checked using the Max Database to ensure they are current. The conservation status of all species collected was checked using the current Department of Conservation and Land Management list (CALM, 2003a).

Flora

A total of 106 vascular plant taxa were recorded within the Development area (Appendix B), and of these, 18 were introduced (weed) species. This is a relatively high number for the size of the survey area and reflects the high level of disturbance within the plant site and the eastern end of the pipeline corridor. One of these, *Echium plantagineum* (Patersons curse) is listed as a Declared Plant (Category P1) by the Department of Agriculture WA. The movement of plant or seed of this species is prohibited within the state and includes prohibiting the movement of contaminated machinery. This weed species was scattered throughout the areas mapped as D and T1w on the vegetation map (see Figure 2.9).

The taxa recorded belong to 47 plant families, with Asteraceae (eight native species), Poaceae (seven native species) and Myrtaceae (six native species) the most common families present. It is estimated that this survey recorded approximately 90% of the species present within the Development area. The survey of the larger Westlime (WA) Limited lease area recorded 50 native species (Hart, Simpson & Associates, 1995). A survey of the Cockburn Cement Dongara Lime lease area, to the north of this Development area, recorded 77 native species (Kinhill, 1995).

Floristically, the Development area does not contain any significant species or groups of species not recorded else-

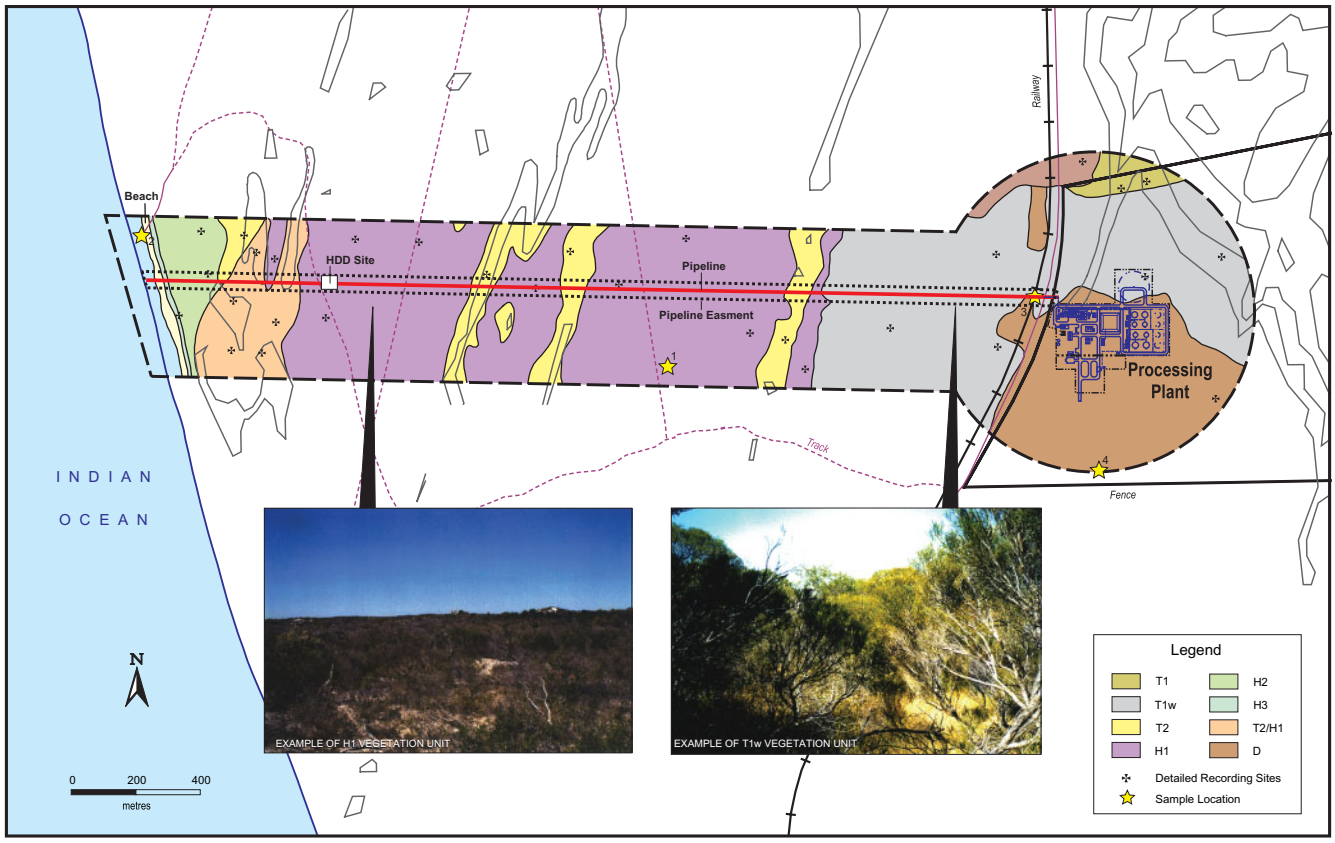


Figure 2.9 Vegetation units and Phytophthora cinnamomi *sampling locations*

where in the region (Griffin, 1993). Species diversity was lower than would be expected of Kwongan heath communities further inland, due to the lack of variation in soil type. None of the species recorded were Declared Rare Flora, as defined by the *Wildlife Conservation Act 1950*, and all are within their known habitat range.

No priority flora species as listed by CALM (2003a) or flora species listed under the EPBC Act were recorded in the Development area.

Vegetation

Vegetation condition within the Development area varied between very poor and excellent. The area surveyed for the processing plant site was in poor condition, with the majority of vegetation substantially modified by human activities. Vegetation at the eastern end of the proposed pipeline corridor was also in poor condition, with evidence of having been grazed by stock in the past. The vegetation within the remainder of the pipeline corridor (Beekeeper's Nature Reserve) was in very good to excellent condition. There was some weed invasion on the foredunes but the vegetation structure was still intact. There is evidence of a very hot fire in the central part of the proposed pipeline corridor, probably within the last five years.

The vegetation mapped within the Development area varied between tall thickets and low heaths. The plant communities present reflect the harsh nature of the environment, with species dominance and morphology within each community dependent on the soil depth and water availability at each site. The coastal heath communities dominate the more exposed sites closer to the coast on dune crests and in exposed sites on flats with little soil covering the limestone basement. The predominantly *Acacia rostellifera* thicket communities occurred in primary dune swales closer to the coast where water harvested from the dunes and shelter from the prevailing winds provides conditions suitable for plant growth. Thicket communities become more dominant further from the coast east of the secondary dunes.

A total of eight vegetation units were described and mapped within the Development area during the spring 2003 survey. These consisted of six plant communities, one mosaic unit and one disturbance unit (Table 2.2 and see Figure 2.9). None of the plant communities mapped are Threatened Ecological Communities as defined by the CALM (2003b).

Phytophthora cinnamomi

Phytophthora cinnamomi is a virulent plant pathogen that belongs to the water moulds and as such requires moist conditions to propagate, spread and infect hosts. This pathogen causes disease epidemics within native vegetation of the high rainfall areas of Western Australia, particularly in the plant families Proteaceae, Epacridaceae, and Myrtaceae. The pathogen can spread unaided by root to root contact, by native and introduced animal activity and by human vectoring in soil on machinery and footwear.

The Development area lies at the northern limit of the portion of Western Australia where plant disease caused by *Phytophthora cinnamomi* is known to occur. Active infestations of this pathogen have been recorded at Eneabba and in surrounding areas (Hart, Simpson & Associates, 1992, Ecos, 1996); however, no active infestations have ever been recorded within coastal lime sands. Soils with a high pH and, in particular, coastal sands are known to inhibit the survival and reproduction of *P. cinnamomi*. A review of the biology and ecology of the pathogen has shown that it does not inhabit and cause disease in areas of annual rainfall less than 600 mm unless the soil and vegetation is conducive to its occurrence and it is situated within a water-gaining site that artificially increases the net annual rainfall to 600 mm (Podger et al., 1996).

Table 2.2 Vegetation units

Thickets	
T1	Dense thicket of *Acacia rostellifera*, *Acacia rostellifera x xanthina* and melaleuca species over mixed shrubs on grey sand with occasional limestone outcropping. Plant community T1 was mapped in a small pocket on the northern edge of the plant site survey area. The vegetation within this community was in excellent condition, with no evidence of grazing. The acacia shrubs were generally over 2 m in height and very dense. Other common shrubs included *Melaleuca systena*, *Melaleuca cardiophylla* and *Desmocladus asper*. Interspersed within this community were patches of *Eucalyptus falcata subsp. opima* in swales. A total of 32 vascular plant taxa were recorded within this plant community. This community corresponds to Unit 2-Interdunal flats mapped by Hart, Simpson & Associates (1995) and Vegetation Type 5-Moderately dense melaleuca/acacia woodland/shrubland mapped by Kinhill Engineers (1995). Plant community T1 is similar to Group 87 identified by Griffin (1993).
T1w	Plant community T1 has been modified by grazing and other human activities and has a greatly modified understorey with a high weed cover (typical example of this unit is shown in Figure 2.9). The majority of the plant site, as well as the eastern end of the pipeline corridor, was mapped as T1w. These areas would originally have been plant community T1 but have been severely modified by grazing and clearing. The herb layer is completely dominated by weed species, with some areas also devoid of taller shrubs. Forty-one plant taxa were recorded in this unit, 11 of which were weed species.
T2	Thicket of *Melaleuca huegelii subsp. huegelii* and *Melaleuca cardiophylla* over *Acanthocarpus preissii* over mixed low shrubs and daisies on grey sand on dune crests. Plant community T2 was mapped on the crests of several narrow dunes within the proposed pipeline corridor. The cover of the vegetation was lower that in surrounding areas due to wind exposure. These crests run into a large mobile dune north of the Development area. Other common shrubs included *Melaleuca leuropoma* and *Scaevola crassifolia*. A total of 41 plant species were recorded within plant community T2. This plant community is similar to Unit 3-Dunes mapped by Hart, Simpson & Associates (1995) and Vegetation Type 6-Dense tall *Melaleuca huegelii* thickets mapped by Kinhill Engineers (1995). This plant community is similar to Group 118 described by Griffin (1993).
Heaths	
H1	Heath dominated by *Melaleuca leuropoma* and *Melaleuca huegelii subsp. huegelii* over a herb layer dominated by sedge and daisy species on grey sand with limestone outcropping (typical example of this unit is shown in Figure 2.9). This plant community was mapped over the majority of the pipeline corridor on the plains between the dune systems. It was generally very uniform in cover and height although small patches of emergent *Allocasuarina lehmanniana subsp. lehmanniana* were present. Common understorey species included *Baumea juncea*, *Lepidosperma pubisquameum* and *Rhodanthe citrina*. It was the most diverse plant community mapped within the Development area, with 64 species recorded. This community is similar to Unit 6 mapped by Hart, Simpson & Associates (1995) and Vegetation Type 2 mapped by Kinhill Engineers (1995). This plant community is similar to Group 64 described by Griffin (1993).
H2	Dense heath dominated by *Lepidosperma gladiatum*, *Scaevola crassifolia* and *Zygophyllum fruticulosum*, with occasional taller shrubs, over herbs on white sand. Plant community H2 was mapped on the plain behind the foredune. It differed structurally from the heaths on the plains further from the beach. The plants here were shorter, probably due to greater exposure to wind. Occasional taller shrubs were present, including *Acacia rostellifera xanthina*, *Santalum acuminatum* and *Allocasuarina lehmanniana subsp. lehmanniana*. This plant community was in excellent condition with a total of 37 species recorded. This community was not mapped during the previous studies in the area as neither of these studies approached the coast. This plant community is part of Super Group D described by Griffin (1993).
H3	Low heath dominated by *Scaevola crassifolia*, *Tetragonia decumbens* and *Myoporum insulare* on white sand. This plant community was mapped in a very narrow strip on the ocean side of the foredune. Vegetation cover was low and sparse, with some weeds present. Only nine plant species were recorded. A similar vegetation type was mapped by Kinhill Engineers (1995) on the margins of mobile dunes. Plant community H3 corresponds to Group 11 as described by Griffin (1993).
Others	
T2/H1	Mosaic of plant communities T2 and H1 on dune crests and swales. An area located between plant communities H2 and H1 was mapped as a mosaic unit. It was situated in an area of high topographical relief where the vegetation on the dunes and swales could not be separated. This area contained both plant community T2 and plant community H1 in small merging patches.
D	Areas where the vegetation has been almost completely removed by human activity. A large portion of the plant site has been completely cleared for grazing and previous limesand processing. This area was mapped as D on Figure 2.9. It contained some patches of tall acacia species but the shrub and herb layer were either completely removed or very sparse. Only six native plant species were recorded within this area.

The environment at Cliff Head and within the Development area is therefore considered to be generally hostile to *P. cinnamomi* because of its low rainfall (<600 mm) and the presence of lime sands.

The Development area was surveyed by two experienced interpreters for the presence of symptoms of plant disease caused by *P. cinnamomi* during October 2003. The survey focused on areas that were most at risk of containing the pathogen through a history of human access such as tracks and previous operational areas. These areas were inspected on foot for symptoms of plant disease and samples of soil and plant material collected for analysis. Four samples were collected within the Development area (see Figure 2.9) and analysed for the presence of *P. cinnamomi* by the Vegetation Health Service laboratory at the Department of Conservation and Land Management.

The Development area has been classified as 'uninterpretable' due to the extremely low density of species within the vegetation that are known to be susceptible to the pathogen. Despite the presence of long utilised fisherman's tracks to the beach and a mining operation, no clear evidence supporting the presence of *P. cinnamomi* within the Development area was observed during the survey. Soil moistures were adequate to support a recovery of the pathogen from samples in the event that it may have been present and the only observed stressed plants were sampled during the survey. All four samples collected during the survey returned analysis results negative for the presence of *P. cinnamomi* (Table 2.3).

The survey results and existing site conditions (low rainfall and lime sands) suggest that the Development area is free from *P. cinnamomi* and not vulnerable to infestation by the pathogen. The introduction of small to moderate volumes of infested material to the site would in all likelihood not result in a successful establishment of the pathogen, and disease progression within the vegetation would also be very unlikely to occur.

2.2.3 Terrestrial Fauna

A terrestrial fauna assessment was undertaken by Bamford Consulting Ecologists and Woodman Environmental Consulting Pty Ltd (Bamford and Woodman, 2003) and the following text is summarised from the report.

A visit to the study area was conducted on the 29th October 2003 by Dr Michael Craig to gather data on the habitats available within the area. Approximately 3.5 hours were spent at the study area and, during this visit, information on fauna species present, vegetation and general habitat characteristics were collected.

Observations made on fauna in the field were supplemented by a search of the Western Australian Museum FaunaBase and the Threatened Fauna Database managed by the Department of Conservation and Land Management. Records were obtained from the area bounded by 29° 00' S to 30° 00' S, and 114° 30' E to 115° 30' E.

Taxonomy and nomenclature for fauna species used in this report generally follow Aplin and Smith (2001) for amphibians and reptiles, How et al. (2001) for mammals and Johnstone (2001) for birds. Alternative names, including common names recommended for national and international use by Christidis and Boles (1994) for birds, are also given.

Assessment of Conservation Significance

Fauna species included under conservation acts and/or agreements (e.g., the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the *Western Australian Wildlife Conservation Act 1990*) are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by the Department of Conservation and Land Management (CALM), or that are included in publications such as Garnett and Crowley (2000) and Cogger et al. (1993) but not in state or federal acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. On the basis of the above comments, three levels of conservation significance are recognised in this report:

Level 1 — Species listed under state or federal acts.

Level 2 — Species not listed under state or federal acts, but listed in publications on threatened fauna or as Priority species by CALM.

Level 3 — Species not listed under acts or in publications, but considered of at least local significance because of their pattern of distribution.

Habitats

Habitats within the study area varied from beaches to *Acacia rostellifera* thickets. The site visit revealed that there were six main habitat types within the study area:

- Open beach – White sand beach with no vegetation but covered by washed up Seagrass leaves close to the ocean (Figure 2.10).
- Primary dune vegetation – This was typical vegetation found on the primary dunes along the west coast of southwestern Australia. It contained

Table 2.3 Sample analysis results

Sample No.	Sample Details	Sample Material	Species Sampled	Analysis Result
1	Plant death on edge of track. Stress evident in vegetation.	Soil and plant	*Allocasuarina lehmanniana subsp. lehmanniana*	Negative
2	Beach camp site in water-gaining area with sedges.	Soil	Not applicable	Negative
3	Wet site adjacent to mine haul road.	Soil	Not applicable	Negative
4	Road drain adjacent to dead vegetation in plant area.	Soil	Not applicable	Negative

widespread species such as *Cakile maritima*, *Scaevola crassifolia*, *Carpobrotus virescens*, *Rhagodia baccata* and *Tetragonia decumbens*.

- Coastal heath with acacia overstorey – This was the predominant habitat type in the western half of the study area. It was rich in plant species and contained many species of Epacridaceae, Myrtaceae and Proteaceae. There was also a high cover of *Acacia* spp. in the heath. There were small, scattered patches of *Acacia rostellifera* throughout this habitat type. On the dune tops there were more *Acacia* spp. and less species from other families.
- *Acacia rostellifera* thickets – This was the predominant habitat type in the eastern part of the study area. The thickets were typically dense and contained few species in the understorey although clematis and grass species were present in most thickets.
- Melaleuca thickets – These occurred in scattered patches in the eastern part of the study area. Similar in structure to the *Acacia rostellifera* thickets, they presumably replace them in wetter areas. There were some mixed thickets of *Acacia rostellifera* and melaleuca species.
- Degraded areas – These occurred primarily in the eastern part of the study area among the *Acacia rostellifera* thickets, and typically consisted of a dense carpet of wild oats, *Avena barbata,* although *Pelargonium capitatum* was common as well.

Figure 2.10 View of beach in Development area

Fauna

Eighteen fauna species were recorded during the site visit, including one mammal and 17 birds. However, it is expected that a large number of other species also utilise the habitats present in the study area. Lists of mammal, bird, frog and reptile species that may occur in the area are given in Appendix B. Species that are listed under the EPBC Act or the WA Wildlife Conservation Act and may occur in the area are noted in Table 2.4.

Frogs

No species of frogs were observed during the site inspection but eight species may occur within the area on the basis of habitats present (Table 1 of Appendix B). Two of these species, the granite froglet and Guenther's toadlet, will only be present regularly if there are seasonal wetlands nearby. Of the remaining species, the turtle frog breeds terrestrially and while the other species breed in seasonal wetlands, the terrestrial adults can live up to several kilometres from wetlands (Bush et al., 1995; Bamford, 1992).

Reptiles

Although no reptiles were recorded during the site inspection, as many as 58 species could be present. This estimate is based upon the number of reptile species recorded in the vicinity of the Development area and the habitats present (Table 2 of Appendix B).

One reptile species of Conservation Significance level 1 and one of Conservation Significance level 2 may be present. These are:

- South-west carpet python *Morelia spilota variegata* (Other Specially Protected Fauna of the WA Wildlife Conservation Act).
- South-west population of the Woma or Ramsay's python *Aspidites ramsayi* (Priority 1 according to CALM).

The south-west carpet python is almost certainly present, as it is widespread in southwest Western Australia and has also been observed just north of Dongara (Bamford, pers. obs., 2003). It would be expected to occur in a range of habitats within the study area at a low density.

The status of the Woma in the southwest is uncertain but the few recent records have been from the Badgingarra/ Watheroo/Carnamah region. It is a species associated with sandy soils. On the basis of habitat and the location of recent sightings, it is therefore likely that the species is present within the Development area.

At least four reptile species are of Conservation Significance level 3 (see Table 2, Appendix B). These species are close to the limit of their distribution in the area but are widespread otherwise.

The proposed development will result in a small loss of habitat for reptiles but effects will generally be minor because of the small area involved and the large area of surrounding habitat that will not be disturbed.

Avifauna

Of the 114 bird species that may occur in the study area, 17 were recorded during the site inspection (Table 3, Appendix B). The total of 114 species excludes those that may occur on the site as vagrants, and excludes waterbirds that might fly over the Development area. Species of conservation significance recorded or

Table 2.4 Listed terrestrial fauna of the area

Species	Common Name	Likely Presence	Commonwealth			State
			Listed Threatened Species Status	Migratory Provisions of EPBC Act	Marine Provisions of EPBC Act	WA Wildlife Conservation Act
Terrestrial Birds						
Leipoa ocellata	Malleefowl	Unlikely	Vulnerable	_	_	_
Calyptorhynchus latirostris	Carnaby's black-cockatoo	Possible	Endangered	_	_	_
Charadrius ruficapillus	Red-capped plover	Possible	_	_	_	_
Thinornis rubricollis	Hooded plover	Possible	_	_	_	_
Falco peregrinus	Peregrine falcon	Very likely	_	_	_	_
Apus pacificus	Fork-tailed swift	Possible	_	_	_	_
Morops ornatus	Rainbow bee-eater	Possible	_	_	_	_
Reptiles						
Morelia spilota imbricata	Carpet python	Possible	_	_	_	_
Aspidites ramsayi	Woma	Possible	_	_	_	_

expected in the Development are as follows:

Conservation Significance level 1

- Carnaby's black cockatoo (also known as the short-billed black-cockatoo *Calyptorhynchus latirostris).* Listed as Endangered under the EPBC Act and Schedule 1 (Endangered) of the WA Wildlife Conservation Act. This species is listed on the CALM threatened fauna database as occurring in the Dongara area. This species feeds on the seeds of banksias, dryandras and hakeas, so there is suitable foraging habitat on the site. Although not observed during the site inspection, it is likely to be a regular non-breeding visitor to the area.
- Peregrine falcon *(Falco peregrinus).* Listed under Schedule 4 of the WA Wildlife Conservation Act. Individuals of this species are wide-ranging but the Development area is probably within the range of a pair. This species is listed on the CALM threatened fauna database as occurring in the Dongara area.
- Migratory species: The EPBC Act lists the following species as migratory and these species are also listed under the China–Australia Migratory Bird Agreement (CAMBA) and the Japan–Australia Migratory Bird Agreement (JAMBA):
  - White-bellied sea-eagle *(Haliaeetus leucogaster).*
  - Red-necked stint *(Calidris ruficollis).*
  - Sanderling *(Calidris alba).*
  - Ruddy turnstone *(Arenaria interpres).*
  - Bar-tailed godwit *(Limosa lapponica).*
  - Fork-tailed swift *(Apus pacificus)*.
  - Rainbow bee-eater *(Merops ornatus)*.

  None of these species was observed during the site visit although they probably all visit the study area. The White-bellied sea-eagle is probably resident along the coast and the red-necked stint, sanderling, ruddy turnstone and bar-tailed godwit probably visit the beach occasionally. Fork-tailed swift are likely to occur over the study area occasionally and rainbow bee-eaters undoubtedly visit the area regularly and probably nest in some of the sandy banks along the tracks.

Conservation Significance level 2

- Hooded plover *(Thinornis rubricollis tregallasi).* Listed as Priority 4 according to CALM and classified as Near Threatened by Garnett and Crowley, 2000. The western subspecies is confined to inland saltlakes and coastal sandy beaches. The species is likely to use the beach in the study area occasionally although no individuals were seen there during the site visit.
- Australian bustard *(Ardeotis australis).* Listed as Priority 4 according to CALM and classified as Near Threatened by Garnett and Crowley, 2000. Bustards typically inhabit low shrublands and grasslands and are particularly attracted to recently burnt areas. Habitat within the study area appeared suitable and the area is probably visited occasionally by the species although it is now scarce on the mid-west coast of Western Australia.
- Striated fieldwren *(Calamanthus campestris montanellus).* Listed as Priority 4 according to CALM and classified as Near Threatened by Garnett and Crowley, 2000. The southwest race has declined due to clearing for agriculture, so surviving populations are significant. This subspecies typically inhabits saltbush, samphire and heaths, and the heath within the study area appears to be suitable habitat so the subspecies is probably present. This species is listed on the CALM threatened fauna database as occurring in the Dongara area.
- White-browed babbler *(Pomatostomus superciliosus ashbyi*). Listed as Priority 4 according to CALM and classified as Near Threatened by Garnett and Crowley, 2000. The southwest race has declined due to clearing for agriculture, so surviving populations are significant. The Development

area is at the western limit of the range and the subspecies typically inhabits eucalypt forests and woodlands so habitat within the study area is only marginally suitable. This conspicuous, sedentary species was not recorded during the site inspection but, given the brevity of the inspection, could potentially occur in the study area. This species is listed on the CALM threatened fauna database as occurring in the Dongara area.

- Crested bellbird *(Oreioca gutturalis gutturalis)*. Listed as Priority 4 according to CALM and classified as Near Threatened by Garnett and Crowley, 2000. The southern race of the crested bellbird has declined due to clearing for agriculture, so surviving populations are significant. The subspecies typically inhabits woodland, mallee and acacia shrublands so there is suitable habitat within the study area. The species is conspicuous when calling and, although not recorded during the site visit, could potentially occur within the study area.

Conservation Significance level 3

- Pacific gull *(Larus pacificus*. The pacific gull is a scarce species that has recently been estimated as having a Western Australian population of only 800 individuals (Meathrel, pers. com., 2003). It probably occurs occasionally along the coast.
- Square-tailed kite *(Lophoictinia isura)*. The square-tailed kite may occur in the study area on passage. Johnstone and Storr (1998) consider this to be a breeding visitor from July to April as far north as Moora, with birds further north than this being on migration. Heathland is a favoured habitat of the species so there is suitable habitat in the study area.
- White-breasted robin *(Eopsaltria Georgiana)*. The white-breasted robin has an isolated population along the midwest coast that has begun differentiating from the southern population (Schodde & Mason, 1999). The northern population usually inhabits near-coastal thickets so probably occurs in the study area.

Mammals

Although the western grey kangaroo was the only mammal species recorded during the site inspection, a total of 22 native and four introduced species may occur in the area (Table 4 of Appendix B). This does not include regionally extinct species. The mammal fauna within the Development area is probably depauperate due to the regional extinction of a number of species. Species of conservation significance that are expected in the Development area are as follows:

Conservation Significance level 2

- Brush wallaby *(Macropus irma*). (Listed as Priority 4 by CALM. May be present throughout Development area, using heathlands for shelter. This species is not listed on the CALM threatened fauna database for the Dongara area.
- Water rat *(Hydromys chysogaster)*. Listed as Priority 4 by CALM. This species may occur occasionally along the coastline, although its presence in the study area is unlikely. This species is not listed on the CALM threatened fauna database for the Dongara area.

Conservation Significance level 3

- The bush rat *(Rattus fuscipes)* would be approaching the northern edge of its range in the study area. The species is typically common in coastal and near-coastal heaths and may be present in the study area.

Invertebrates

The only information available on invertebrate fauna in the region is from CALM's threatened fauna database. The area does not contain any karstic formations so stygofauna would be absent from the study area. The CALM database lists the following for the Dongara area:

- Priority 1 – Scorpion fly (*Austromerope poultoni*). This species is associated with forest leaf litter so is unlikely to be present within the Development area.
- Priority 2 – Stick insect (*Phasmodes jeeba)*. This poorly collected invertebrate is only known from the Eneabba area. It is unlikely to be found within the Development area as its known habitat is not present.
- Priority 3 – Cricket (*Hemisaga vepreculae)* and native bee (*Hyaleus globuliferous*). These species may both be found within the Development area as their preferred habitat and food sources are present within the area surveyed.

2.3 Social Environment

2.3.1 Aboriginal

Archaeology

An Aboriginal archaeological assessment was undertaken for the proposed plant site and the pipeline easement by Gavin Jackson P/L (Stephens et al., 2003) and is summarised below.

The assessment comprised a search of the Register System at the Heritage and Culture Division of the Department of Indigenous Affairs (DIA) and a field survey.

Register Search

The register search revealed that although no Aboriginal heritage surveys had previously been conducted within a 10-km radius of the area, a number of surveys have been conducted within a 20-km radius. The search also found there are no previously recorded Aboriginal sites located within, 5 km of the Development area. There was, however, one previously recorded Aboriginal site within 10 km (Site ID 5574) and a further six within 20 km of the Development area (Table 2.5).

As shown in the Table 2.5 the most common sites found in this area are artefact scatters. Burials and shell middens are also present. Burial sites are the second most common site type recorded in the Irwin Shire with six of the 20 previously recorded sites (30%) corresponding to burial sites recorded from coastal dune contexts.

Field Survey

The field survey consisted of a series of closely spaced parallel pedestrian transects. The western, seaward section of the pipeline easement was examined by pedestrian transects across its full 500-m width. The remainder of the pipeline easement was examined by pedestrian transects over a total width of 200 m, comprising 100 m on either side of the designated centre line. The pedestrian transects were spaced at 50-m intervals and were undertaken longitudinally along the pipeline easement, to and from accessible bisecting roads and tracks. No Aboriginal archaeological sites or isolated stone artefacts were found on the pipeline easement area surveyed.

A comprehensive visual inspection was undertaken on the proposed plant site area (200 m by 200 m) which is heavily

disturbed by historic Westlime mining and processing activities. Railway embankments, roads, lime stockpile areas, compound grounds and surrounding reserve were also inspected where accessible. The inspection of the existing Westlime plant site and stockpiles was, however, limited by health and safety considerations owing to the presence of caustic material. The area of the Westlime compound adjacent to the Brand Highway was not accessible and was therefore not surveyed. No Aboriginal archaeological sites or isolated stone artefacts were located on the proposed plant site area surveyed.

Although no archaeological sites or artefacts were found during the survey there is potential for subsurface archaeological material including human skeletal material to be present within the Development area.

Ethnography

An ethnographic assessment (McDonald, 2003) was undertaken for the proposed plant site and the pipeline easement by Ethnosciences and is summarised below.

The assessment comprised archival research including a search of the DIA register for previously recorded ethnographic sites, consultation with the Yamatji Land and Sea Council, interviews and a site inspection with the Wilinyu Aboriginal consultants and subsequent consultation with the Wilinyu Aboriginal consultants about the archaeological findings as reported in Stephen et al. (2003).

The Yamatji Land and Sea Council advised that the Wilinyu group were the appropriate group to consult with because they had associations with and interests in the country encompassing the Cliff Head Development area.

Archival research revealed there are no previously recorded ethnographic sites in the Development area. The Wilinyu Aboriginal consultants also indicated there were no known ethnographic sites located within the Development area. However, the Wilinyu Aboriginal consultants did express concern that skeletal material or burials might be discovered during the pipeline excavation and drilling, especially in the coastal dunes. They therefore recommended that archaeological monitoring, involving members of the Wilinyu group be undertaken during ground disturbance activities.

Table 2.5 Registered Aboriginal sites within 20 km of the survey area

Site ID	Grid Reference	Access Code	Site Type	Site Name
5574	305,139 E 6,735,151 N	Open	Burial	Cliff Head
4670	300,638 E 6,762, 651 N	Open	Artefacts	Irwin River
5217	320,739 E 6,729,651 N	Open	Artefacts	NatGas 137
5218	305,939 E 6,761,151 N	Open	Artefacts	NatGas 138
5280	298,639 E 6,760,651 N	Open	Artefacts and midden	Leander Point Denison
5682	325,639 E 6,761,651 N	Open	-	Stoney Hill
5918	299,138 E 6,762,251 N	Open	Burial	Irwin River

2.3.2 European History

Dongara was first settled in 1850 when 60,000 acres of grazing land was leased by the Cattle Company. Surveyed for use as a townsite in 1852, Dongara became one of Western Australia's first settlements and by 1854 the population exceeded 350. In the 1860s, a jetty was constructed in what is known today as Port Denison. The police station and court house were established in 1871 and the Anglican and Methodist churches were consecrated in 1884. In 1894 the Midland to Perth railway was opened and the Royal Steam Flour Mill built soon after.

There are a number of significant shipwrecks off the Batavia Coast. Incomplete charts were a major contributing factor to the danger of navigating through the reefs and surf around Dongara. Strong seasonal winds also contributed to the hazardous nature of entering Port Denison. Although there are a number of shipwrecks north of the proposed Development, there are no known significant shipwrecks nearby.

2.3.3 Socio-economic Profile

A social and economic assessment was undertaken for the Cliff Head Development by Q & A Communications (Q&A, 2003) and is summarised below.

The Cliff Head Development is located in the Shire of Irwin, in the Mid West region of Western Australia. The twin towns of Dongara and Port Denison are the nearest townships to the Development.

Population and Demographics

The Mid West region has a population of approximately 50,000 people. The two largest shires in the region are the City of Geraldton and the Shire of Greenough which account for about 60% of the region's population. The population of the Shire of Irwin is small in comparison, comprising 2,800 people. However, it has the largest average annual population growth of any Mid West town at a rate of 3.0% (from 1996 to 2002).

The Shire of Irwin has a relatively homogenous community comprising a high level of people from English-speaking backgrounds compared with other parts of Australia and a predominantly Australian born population (83.1%) (Figure 2.11). Other features of the shire's population are a relatively balanced gender mix (49% female, 51% male), a relatively low proportion of indigenous people (2%), a slight under-representation of youth and young adults when compared to the whole state and a family-oriented profile with high proportion of young families (56% have children under the age of 11).

Education and Employment

The total employment in the Shire of Irwin in the June 2003 quarter was 987 people. The agriculture and fishing industries employ the most people, with retail trade, construction and manufacturing industries being the next highest employers (Figure 2.12).

Males were more likely to be employed than females (68% compared to 32%); however, they also have a higher rate of unemployment (16.5% compared to 9.5%). This is predominantly a result of almost half of the Shire's female population not being in the workforce, probably because they are either retirees or remaining in the home raising young families.

Compared to the employment and education statistics of Western Australia the Shire of Irwin had:

- Higher levels of youth unemployment (21% compared to 16%).
- Lower numbers of secondary-aged students attending school (79% compared to 87%).
- Higher percentage of indigenous children attending school (66% compared to 62%).
- Lower percentages of individuals with postgraduate or graduate degrees, diplomas or graduate certificates (0.7% compared to 2.7%).

Within the shire, females are more likely to hold a bachelor degree or higher qualification than males (59% compared to 40%). However, more males hold trade certificates or diplomas. Of the qualifications held, engineering and related technologies were the most popular, followed by management and commerce, health and education qualifications (Figure 2.13).

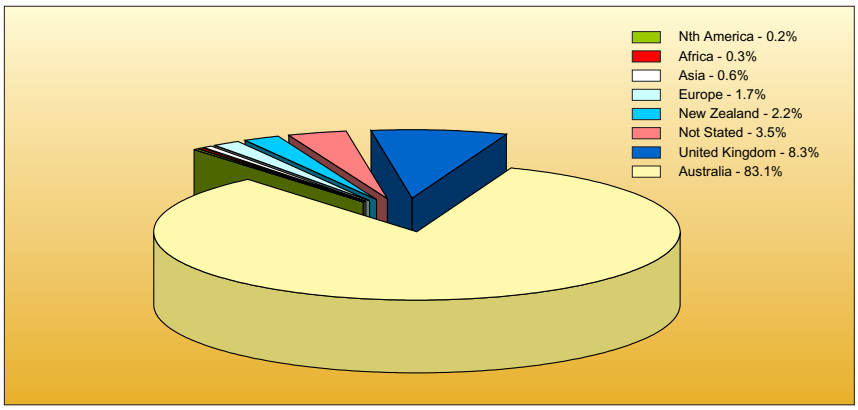


Figure 2.11 Birth place of Shire of Irwin population

Economic

The key economic indicators point to a growing and healthy economy for the Mid West region. The gross regional product for 2000–2001 was $2.95 billion. Overall workforce participation and indigenous workforce participation (excluding CDEP) were higher than the State average by 10% and 7% respectively.

Capital works, both new and continuing, for 2001–2002 were $1.14 billion, reflecting the expansion of the Geraldton Port and Airport. However, median individual incomes are slightly lower than the state median.

The Shire of Irwin is also going through a phase of development and expansion, with building applications including commercial and residential applications peaking at about 80 new applications per annum. Again, the average weekly family income is slightly lower at $600–$699 per week compared to $700–$799 across Western Australia.

Industry

The mining and petroleum industry is the main contributor in terms of value to the Mid West region, followed by agriculture, retail, manufacturing, fishing and aquaculture and tourism industries (Table 2.6). Within the Shire of Irwin, however, the mining industry only employees 5.6% of the available workforce and the agriculture and fishing industry dominates, accounting for 24% of the employment (see Figure 2.12).

Infrastructure and Services

Dongara township has water and waste water systems that are shared with Denison. Electricity is provided by Western Power and is distributed to Dongara via 33-kV line from Geraldton or Eneabba (Western Power, 2003). The Dongara township is also serviced by the Parmelia natural gas pipeline.

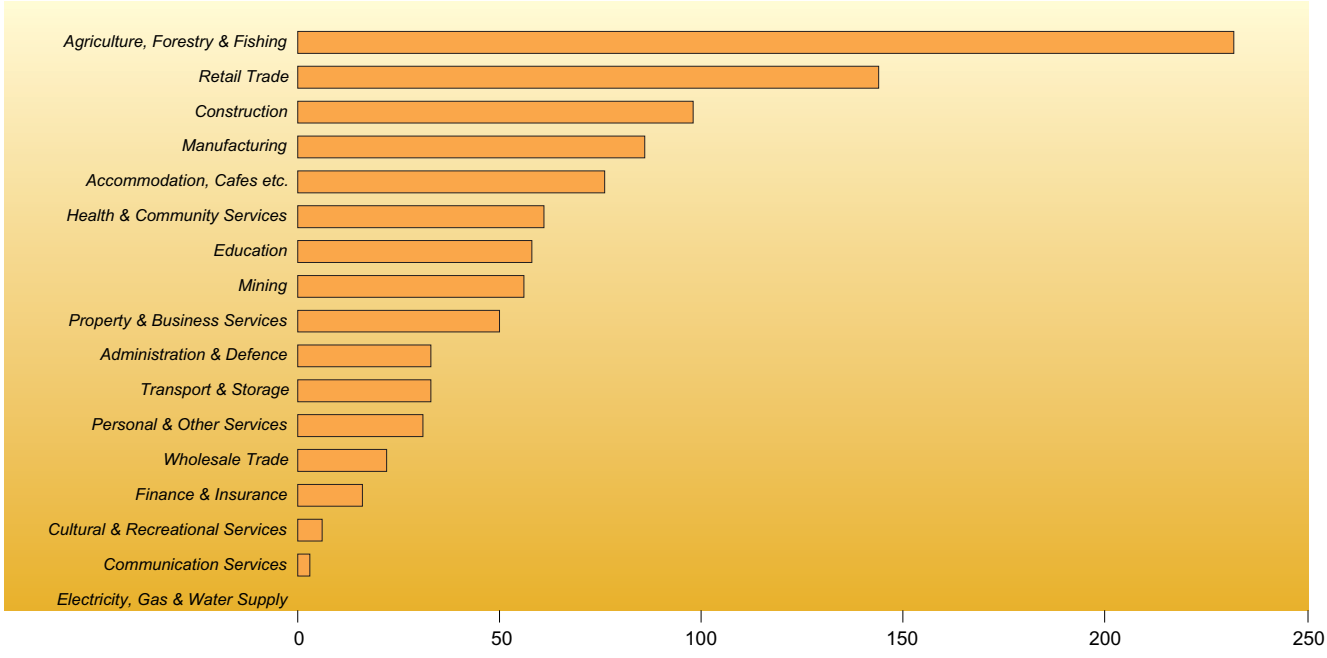


Figure 2.12 Employment by industry within the Shire of Irwin

The Mid West is well-serviced by road with a network of major sealed roads that provide for extensive use of double and triple road trains (MWDC, 2003). Close to the coast the major arterial road is the Brand Highway which connects Perth, Dongara and Geraldton. This highway currently services about 3,470 vehicles per week (Main Roads, 2003). A railway line runs adjacent to the Brand Highway between Geraldton and Eneabba; the Dongara–Eneabba portion of this line currently is used only to transport mineral sands.

The Geraldton Port is the major port in the Mid West region and has a diverse range of imports (including petroleum products, phosphate and fertiliser) and exports (including wheat and other grains, mineral sands, talc, stockfeed, livestock and copper and zinc concentrates) (MWDC, 2003). Geraldton also has the major regional airport, which operates regular passenger services. Services at the airport include apron parking for four large commercial aircraft, a helicopter pad, three private air charter operators and security and maintenance services (MWDC, 2003).

The majority of the education facilities in the region are in Geraldton but the Shire of Irwin supports one district high school and a number of primary schools. The Mid West region as a whole has one secondary college, seven district high schools and 22 primary schools that are government run (MWDC, 2003). There are also three private secondary colleges, two private secondary schools and six non-government primary schools (MWDC, 2003). Central West College of TAFE is the major provider of post-secondary education in the region. The Geraldton Universities Centre (established in 2002 by a consortium between Curtin University of Technology, Edith Cowan University and the University of Western Australia) offers a number of bachelor degrees (MWDC, 2003).

The Dongara health service operates a 24-hour-emergency service and employs three general practitioners (Hospital Administrator, pers. com., 2003). Geraldton has two hospitals: the Geraldton Regional Hospital (60 staffed beds) and the St John of God Hospital (40 staffed beds). There are also 25 general practitioners based in the city. A wide range of medical and health services are offered in Geraldton (through the public system and private practices) including dental, physiotherapy, occupational therapy and podiatry.

Table 2.6 Value of industries to Mid West region

Industry	Value ($)	Year
Mining and petroleum	1,880	2001/02
Agriculture	613	1999/00
Retail	403	2001/02
Manufacturing	222	1999/00
Fishing and aquaculture	175	2001/02
(rock lobster)	(148)	
Tourism	120	2001/02

Source: DLGRD, 2003.

Safety and Security

Dongara has a relatively low crime rate and there has been no dramatic increase in any areas of reportable offences over the past few years (DPS, 2003). Reported crime fluctuates with the seasons and is noted to relate to population increases in during holiday periods (DPS, 2003). Several community groups are established in the town to address safety/crime issues including Neighbourhood Watch, School Watch, Safety House and Roadwise.

Accommodation

Within the Shire of Irwin there are 1,143 dwellings, the majority of which are sepa-

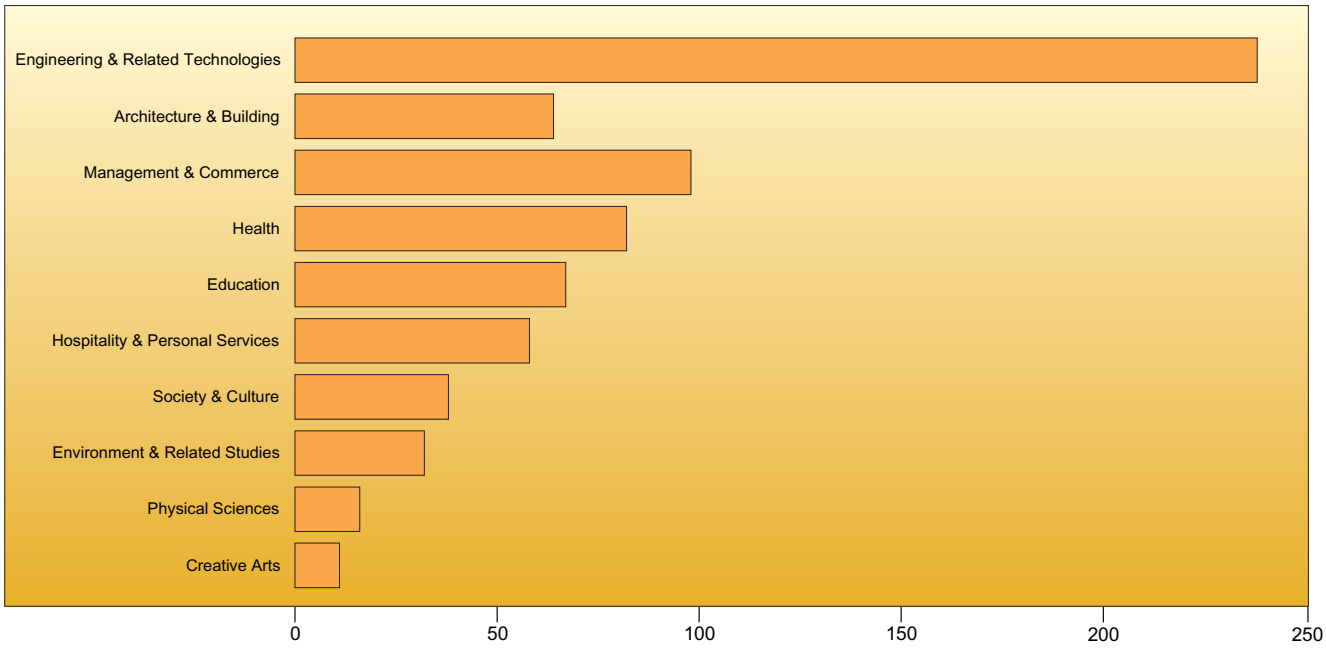


Figure 2.13 Qualifications within Shire of Irwin population

rate or stand-alone houses. In Dongara/Denison, there are 23 accommodation providers, the majority of which are caravan parks, small B&Bs or motel-type accommodation (Q&A, 2003). The total bed number in the community is in the vicinity of 200; however, the three large establishments in the area only have between 20–30 rooms or units (Q&A, 2003). The available capacity during peak season averages around 10% and during the summer low season months around 40% (Q&A, 2003).

Across the Mid West region there is considerably more accommodation available with Geraldton having approximately 2,000 visitor beds and Kalbarri 4,000 (Douglas, pers. com., 2003).

2.3.4 Land Use and Tenure

The offshore marine areas lie within petroleum permit area WA-286-P and TP/15 and the Zone B rock lobster fishing grounds (Figure 2.14). The Cliff Head oil field and proposed platform lie in the WA-286-P permit area in Commonwealth waters. The pipeline connects to the platform and crosses the TP/15 permit area which is in state waters.

The onshore components of the Development comprise the pipeline easement and the plant site (see Figure 2.14). The pipeline easement passes through Beekeeper's Nature Reserve (Reserve No. 24496). The reserve is a 'C' class reserve and is managed by the Department of Conservation and Land Management. The total area of the reserve is around 68,000 hectares. The reserve is used for honey and beeswax production, passive recreation and nature conservation. There are also two mining tenements (MLA70/642 and ML70/711) overlying the portion of Beekeeper's Nature Reserve that is traversed by the pipeline.

The plant site is located on freehold land, which is currently occupied by a disused lime sand plant. Roc has purchased the freehold title to this land. There is one native title claim (Federal court no. WAG6273/98) over the area which is awaiting determination.

The nearest residential property to the Development is located approximately 1,400 m northeast of the plant site.

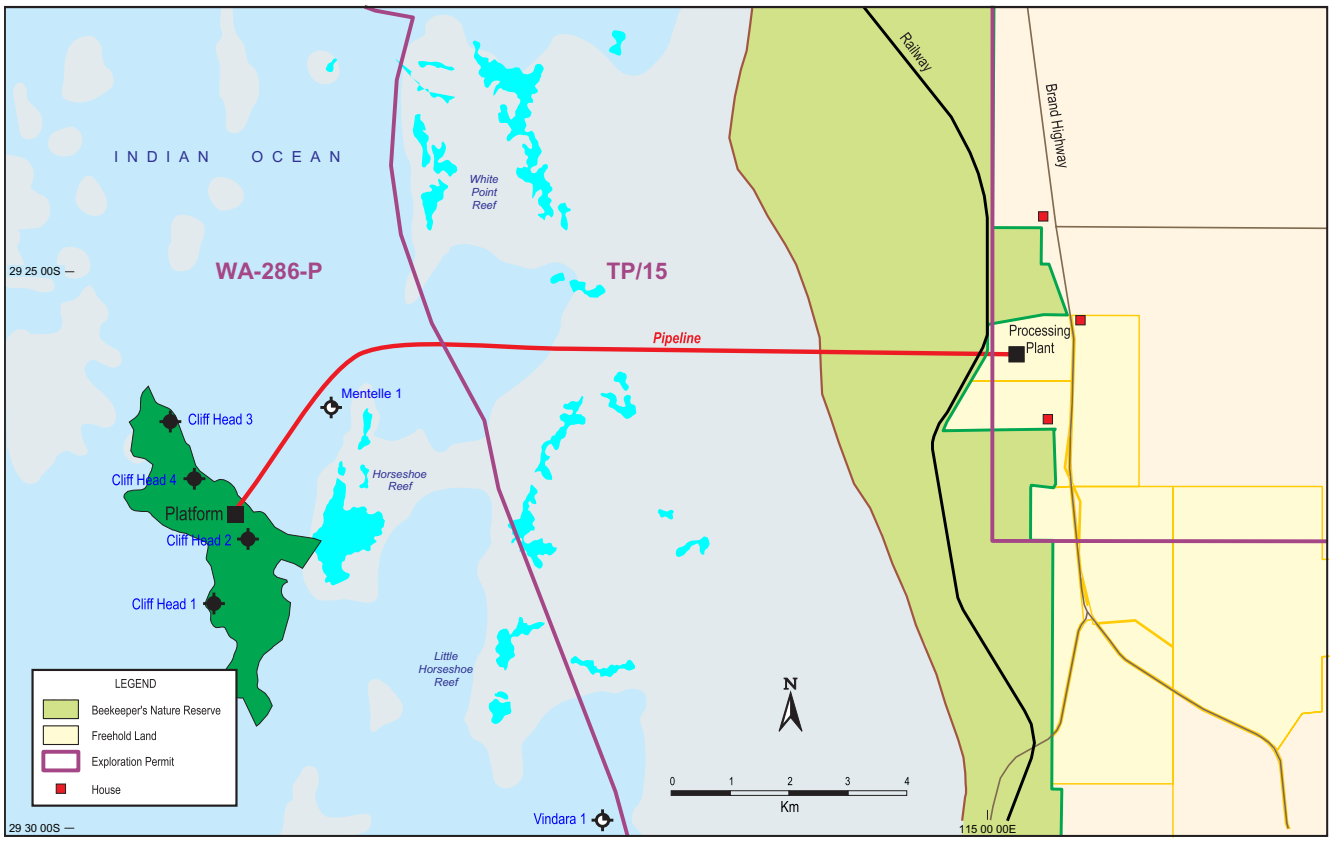


Figure 2.14 Land use and tenure

3. Project Description

3.1 Development Outline

The key characteristics of the proposed development are described in Table 3.1.

3.2 Background

Historically, exploration in the Perth Basin has focussed on the onshore part of the Northern Perth Basin where a number of oil and gas fields have been discovered. Most significant of these are the Dongara (discovered 1966), Woodada (discovered 1980) and Beharra Springs (discovered 1988) fields, as well as the recent Hovea, Eremia and Jingemia discoveries. Offshore drilling in the Northern Perth Basin has been limited to only 17 wells, drilled between 1968 and 2003.

Previous operators active in the offshore area were WAPET who acquired reconnaissance seismic in 1976, Diamond Shamrock who drilled Leander Reef-1 in 1983 and acquired 320 km 2D seismic in 1984 and Premier Oil Australasia who acquired 586 km of 2D seismic data in 1999. In 1999 Premier Oil Australasia, was awarded exploration permit WA-286-P for a six-year term. Roc farmed into WA-286-P at the seismic acquisition phase and became operator in April 2000.

Roc acquired the 47-km, Jean 2D marine seismic survey in 2002, followed by the Cliff Head 3D MSS in 2003. The

Table 3.1 Key characteristics of the proposed Cliff Head Development

Element	Description
Production and reinjection wells	Up to ten wells comprising six production wells and two water reinjection wells, with capacity for an additional two production or injection wells. The wells will be approximately 1,260 m deep below the seabed, and extend up to about 3.5 km horizontally.
Production platform	One offshore wellhead platform will be located approximately 10 km from shore in about 17 m of water. The wellhead platform will cover an area of approximately 10 m by 30 m and stand 12 m clear of the sea surface. The platform will normally operate unmanned and will be accessed by vessel from Port Denison, with potential to access by helicopter from Geraldton
Pipelines	Two pipelines (nominal diameter of 300 mm) will connect the platform to the onshore separation plant. The offshore components of the pipelines will be approximately 11 km long and the onshore sections 3 km long. The pipelines will be thermally insulated and the offshore sections will be weight-clad and stabilised with rock bolts to the seabed. A power cable and umbilical will be installed with the pipelines.
Arrowsmith Separation Plant	The onshore plant will be located on freehold land and occupy an area of approximately 20 ha.
Water wells	Two onshore water wells within the freehold area into the Cattamarra Formation to yield up to a total of 6,360 m^3 (40,000 barrels) of water per day.
Associated infrastructure	Truck loading facilities, fire suppression systems, office and staff facilities buildings, maintenance and storage buildings, pollution containment and management works.
Vegetation clearing	Vegetation clearing at the plant site (including temporary work areas) will be restricted to approximately 20 ha of previously disturbed vegetation. Temporary vegetation disturbance in the easement across Beekeeper's Nature Reserve for the HDD site and pipeline route, will be no more than 7 ha.
Maximum pipeline flow rates	8,000 m^3 (50,000 barrels) per day total fluids (oil plus water) in the production line and 8,000 m^3 (50,000 barrels) per day water in the injection line.
Plant production rate	For planning purposes a rate of 2,385 m^3 (15,000 barrels) of oil per day has been adopted. However the production rate could be as high as 3,975 m^3 (25,000 barrels) of oil per day if the reservoir performs well and export capacity is available.
Plant storage capacity	Maximum product storage volume at the onshore plant 6,360 m^3 (40,000 barrels).
Power requirements	The required 5 MW of power for the project will be generated from natural gas.
Export rate	The maximum rate of export from the plant is 3,975 m^3 (25,000 barrels) per day of product crude oil.
Operating times	The platform and processing facility will operate 24 hours a day, seven days per week for the duration of the project (nominally 15 years).

drilling of Cliff Head-1, in late 2001, was the first discovery in the offshore part of the Perth Basin. The well encountered a 5-m column of oil in the Early Permian Irwin River Coal Measures. A second well, Cliff Head-2 was drilled to a shallower part of the same structure, finding a 36-m oil column with a similar oil–water contact.

3.3 Reservoir

3.3.1 Geology and Structure

The Cliff Head structure lies in the offshore region of the Northern Perth Basin (Figure 3.1 and Figure 3.2). The block is bounded to the west by the Geraldton Fault. The Cliff Head oil is trapped in three formations, the High Cliff Sandstone, Irwin River Coal Measures and the Dongara Sandstone. The lowest reservoir unit, the High Cliff Sandstone, is a massive clean sandstone with significant quartz cementation reducing the porosity. Only the very top of the formation rises above the oil-water-contact at the crest of the field.

3.3.2 Hydrocarbon Characteristics

The physio-chemical characteristics of oil will determine the recovery and processing technology that must be used for commercial development and therefore influences the potential environmental effects associated with operation of the Development. The Cliff Head crude is unusual in that it is a waxy crude with a pour point of approximately 30°C and therefore solidifies under typical ambient conditions (Figure 3.3). As indicated by the gas chromatograph trace, presented in Figure 3.4, the Cliff Head crude has a very low percentage composition (less than one percent) of the more volatile (<C5) light-end hydrocarbon components. The key physio-chemical characteristics of the Cliff Head crude are listed in Table 3.2.

The main design implications of these characteristics are that the oil needs to be heated to allow it to be pumped along the pipeline from the production well to the processing plant onshore. The pipeline also needs to be insulated and the offshore pipeline length minimised (as much as practicable) to prevent the oil from cooling.

3.3.3 Reserves

Based on reservoir data obtained from the exploration and appraisal wells, studies were conducted by Roc using mathematical simulation of fluid flow in the reservoir rocks to assess:

- How much oil can be recovered (reserves).
- The production characteristics of the reservoir.
- The number and type of development wells required.
- Capacity of production facilities and pipelines.

Because of uncertainties in the reservoir parameters, reserves are quoted in ranges. The range of recoverable reserves calculated for the Cliff Head reservoir at this stage is 2,385,000 m^3 to 4,770,000 m^3 (15 to 30 million barrels) of

Table 3.2
Cliff Head crude characteristics

Property	Value
API gravity	32.1
Pour point	30°C
Wax content	20.4%
Viscosity	16.0 cP at 45°C

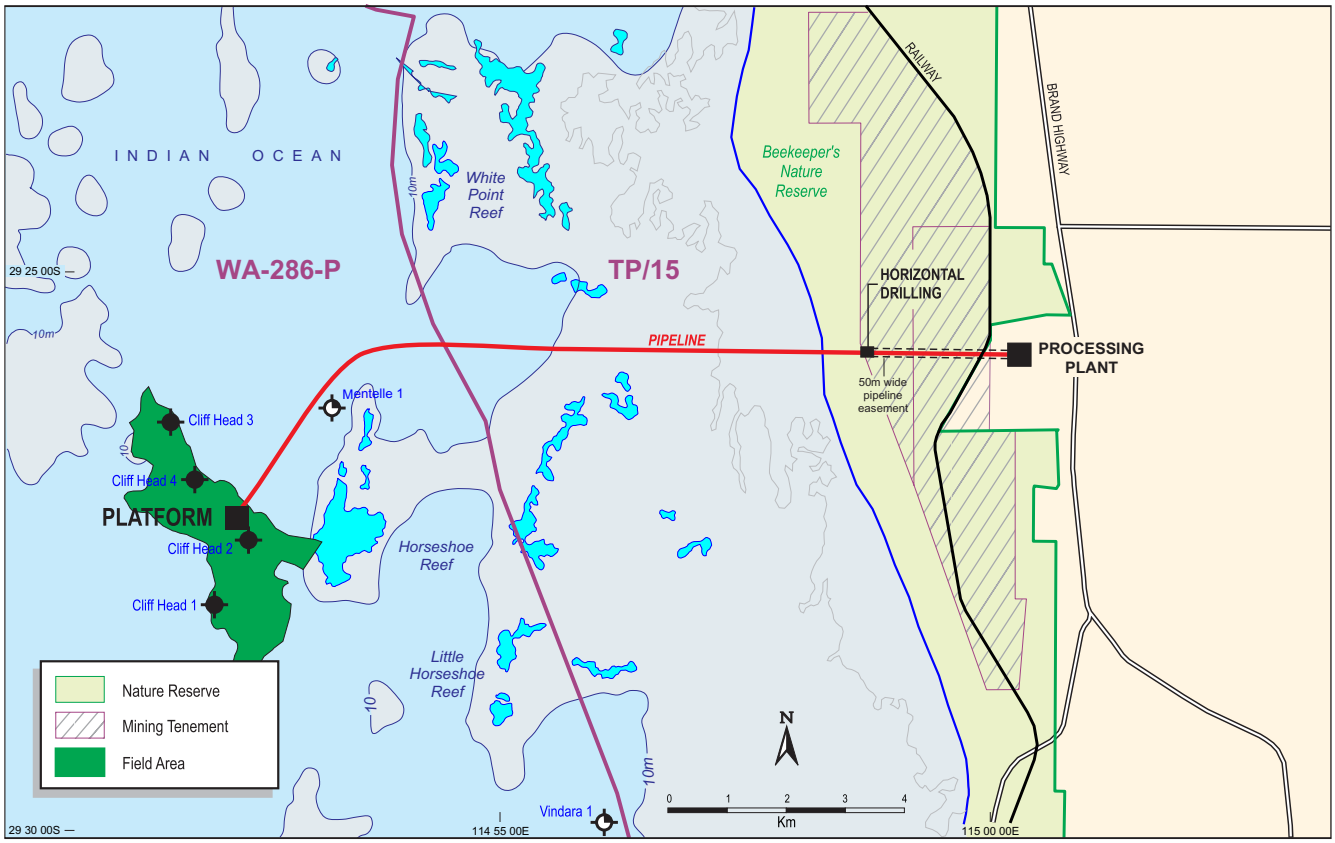


Figure 3.1 Development area

stabilised oil[1]. The reserve used as a planning basis is 3,340,000 m^3 (21 million barrels). This is designated 'Proved and Probable Reserves' and approximately represents the statistical mean of the range of possible reserves.

The initial production rate potential of the reservoir will depend on the characteristics of the rocks encountered in the development drilling program. Initial potential after all production wells have been drilled could be as high as 3,975 m^3 (25,000 barrels) of oil per day.

Oil reservoirs are subject to a natural decline in production potential as oil is withdrawn. The potential production rate of Cliff Head is forecast to decline from start of production, particularly as water, which is more mobile than oil in the reservoir, breaks through into the production wells. Once this happens, the production of oil to surface declines and the proportion of water increases. In the latter stages of the production profile of the reservoir, the production is predominantly water and the oil rate declines to levels that are eventually unprofitable. The water production is forecast to increase to a maximum average rate of about 6,360 m^3 (40,000 barrels) per day after approximately two years from start up and be sustained at that level for the remainder of the field life.

The oil production profile used as the development planning basis for Cliff Head is shown on Figure 3.5. In the early period, the field capacity may exceed the capacity to deliver crude to market. For planning purposes a peak average annual production rate of 2,385 m^3 (15,000 barrels) of oil per day has been adopted, although this could be as high as 3,975 m^3 (25,000 barrels) of oil per day if the reservoir performs well and export capacity is available. The rate of decline of oil production capacity will also depend on reservoir performance. Reservoir monitoring will be adopted throughout the production life to regularly assess the future production performance.

Studies carried out by Roc indicate that water injection will be necessary to maintain sufficient pressure in the reservoir to keep the oil flowing towards the production wells and through the wells to the surface. The water utilised for water injection into the reservoir will be hot saline water of broadly similar composition

[1] Interpretation of recent 3D seismic data will further refine reservoir estimates.

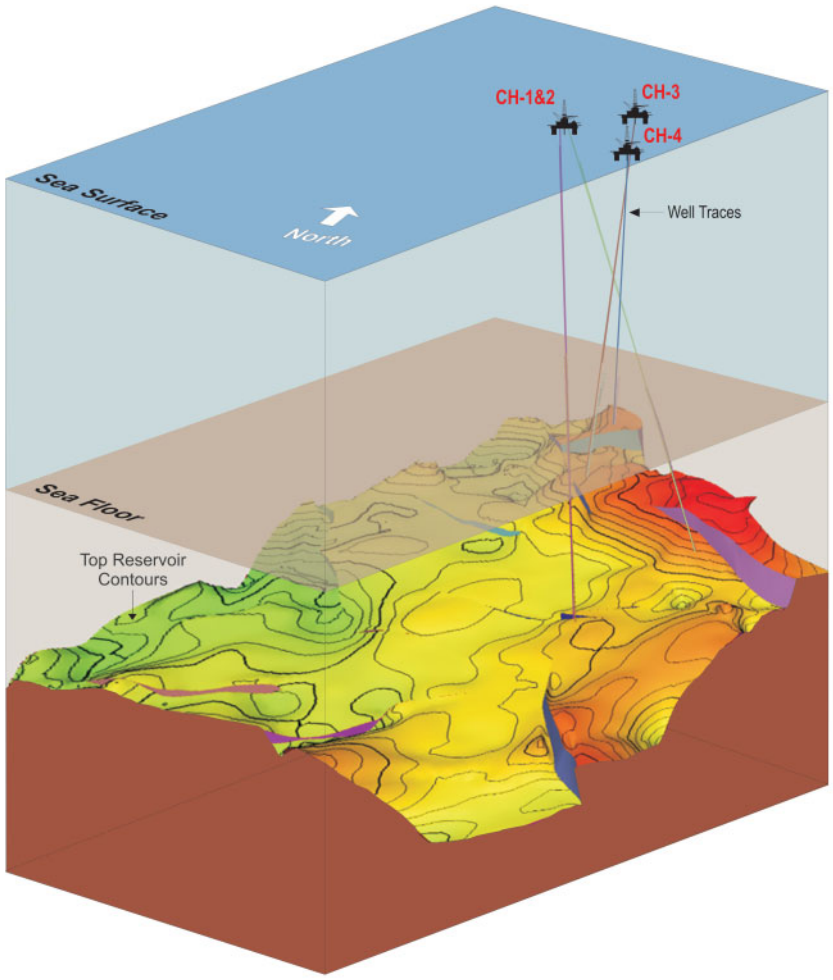


Figure 3.2 Cliff Head reservoir

Figure 3.3 Cliff Head crude as a solid at ambient temperatures

as the formation water. The water injection requirement assumed for planning purposes is 6,360 m^3 (40,000 barrels) per day. Initially this capacity would be sourced from the onshore Catamarra Formation via one or two wells drilled at the plant location, but the increasing rate of produced formation water would steadily replace the onshore saline water.

3.4 Alternatives Considered

A range of potential development scenarios was considered for the Cliff Head Development. These alternatives included:

- Not proceeding with development of the hydrocarbon reserves.
- Field development scenarios.
- Onshore plant location.
- Pipeline route.
- Onshore plant design.
- Export of crude oil product.

3.4.1 No Project Alternative

The Cliff Head Development is a proposal to develop the hydrocarbon reservoir discovered within Commonwealth petroleum permit area WA-286-P. Failure to develop the reservoir will result in forgone opportunity for economic development. Additionally if the development does not proceed then the potential benefits of direct and indirect local and regional employment would be lost.

3.4.2 Field Development Scenarios

A range of field development scenarios has been considered by Roc (Figure 3.6). Each of the scenarios was reviewed at a high level and then subjected to progressively more detailed screening process.

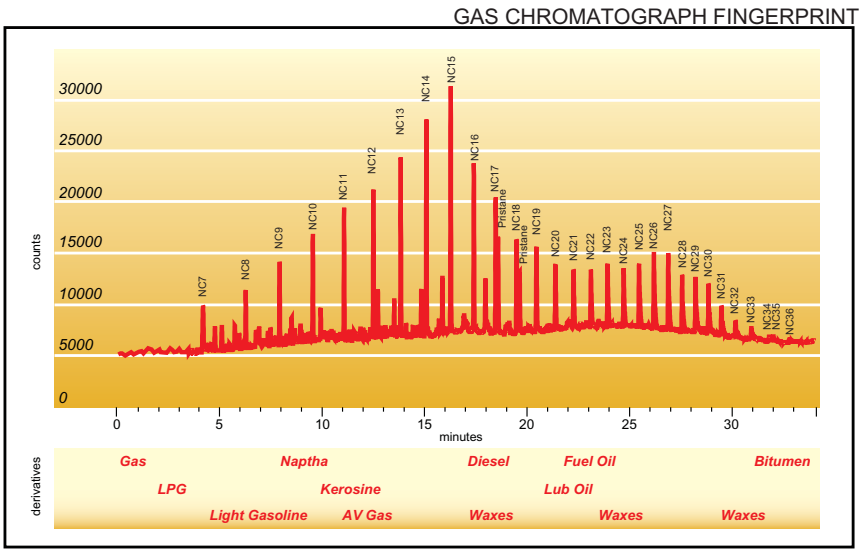


Figure 3.4 Gas chromatograph fingerprint of Cliff Head oil

In the final analysis only one development scenario was considered worthy of carrying forward, this being the jack-up installed wellhead platform with pipeline to shore and onshore processing (Figure 3.7). Table 3.3 presents a summary of the development options considered and their main features.

3.4.3 Pipeline and Onshore Plant Location

The primary factor affecting locations of the onshore plant and the offshore and onshore pipeline components is that the onshore plant needs to be positioned as close to the Cliff Head field as practical, subject to environmental constraints.

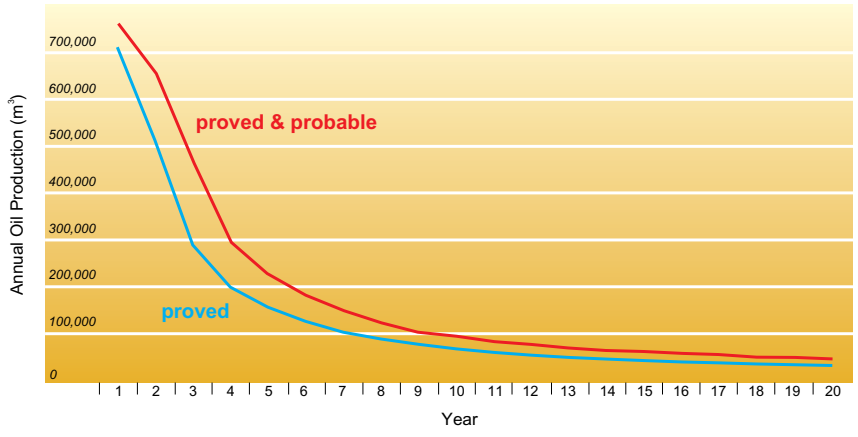


Figure 3.5 Forecast Cliff Head oil production profile

Beyond this, selection of the plant site and pipeline route are inter-related elements of the Development and a functional nexus between each geographic element is essential.

The geographical location of the Cliff Head field presents some unique environmental constraints for an offshore field with an onshore production facility. Offshore, seagrass meadows are present as an almost continuous band adjacent to the coast while inshore, Beekeeper's Nature Reserve extends parallel to the coast for about 70 km. Consequently, the prime environmental concerns were to minimise disturbance to seagrass habitat offshore and to minimise disturbance to Beekeeper's Nature Reserve onshore.

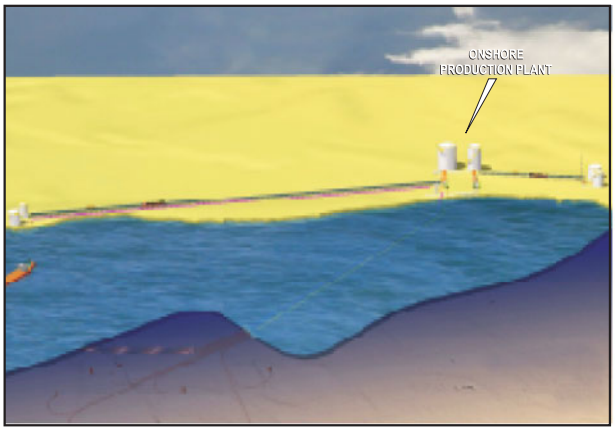
Five plant sites were considered in detail during the initial evaluation phase. Table 3.3 presents a summary of the alternative sites considered. The location of the sites is shown on Figure 3.8. The Westlime plant site was considered to offer the best environmental solution. This location has the advantage of existing infrastructure: gas to site, sealed road to highway, security fence, buildings and internal road and concrete paved areas. The site is screened from the highway by an adjacent dune system. It is also in line with a direct pipeline route from offshore and results in the shortest distance, 2.8 km, of pipeline across the reserve. The chosen offshore pipeline alignment has the shortest distance of

disturbance to seagrass habitat and also results in the pipeline landfall occurring at a relatively low point in the coastal dune system.

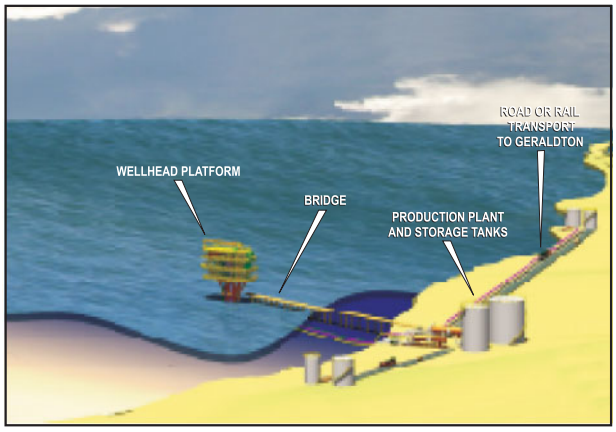
3.4.4 Export of Crude Oil Product

Carrying forward the development option for production and processing with an onshore plant, Roc then screened options for transport of stabilised crude oil to market. Constraints imposed on export related primarily to field size, weather conditions and economic viability. The export options considered were:

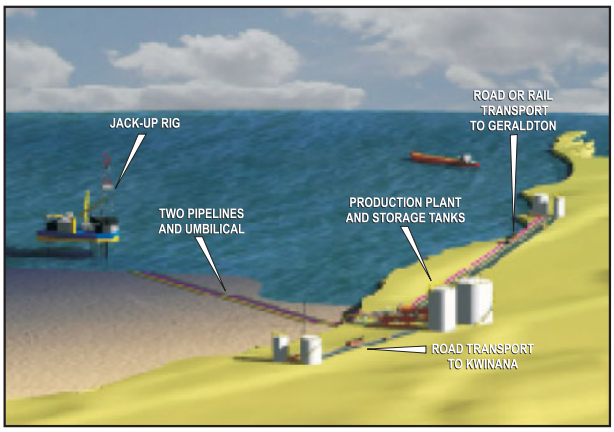
- Export via single buoy mooring (SBM): Stabilised crude would be exported offshore to a SBM located in deeper water. The water injection line would be used for this purpose manifolded for dual functionality with a 6.5-km extension beyond the field to the SBM.



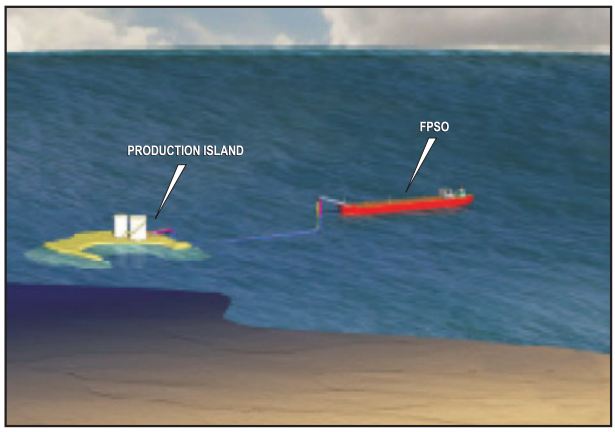
Subsea completions to onshore plant



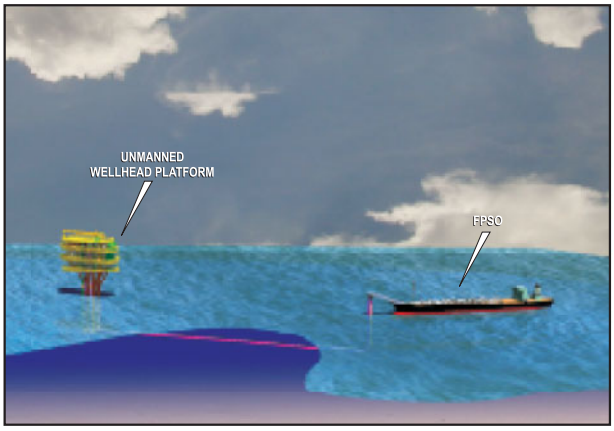
Wellhead platform (east) to onshore plant bridge linked



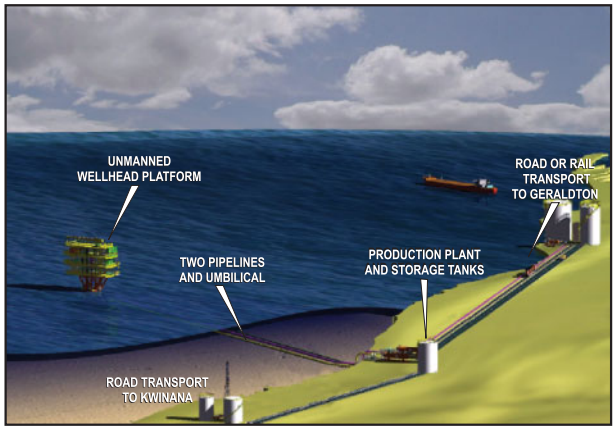
Jack-up production facility to onshore plant



Production island to FPSO



Wellhead platform to FPSO



Wellhead platform to onshore plant

Figure 3.6 Field development scenarios considered

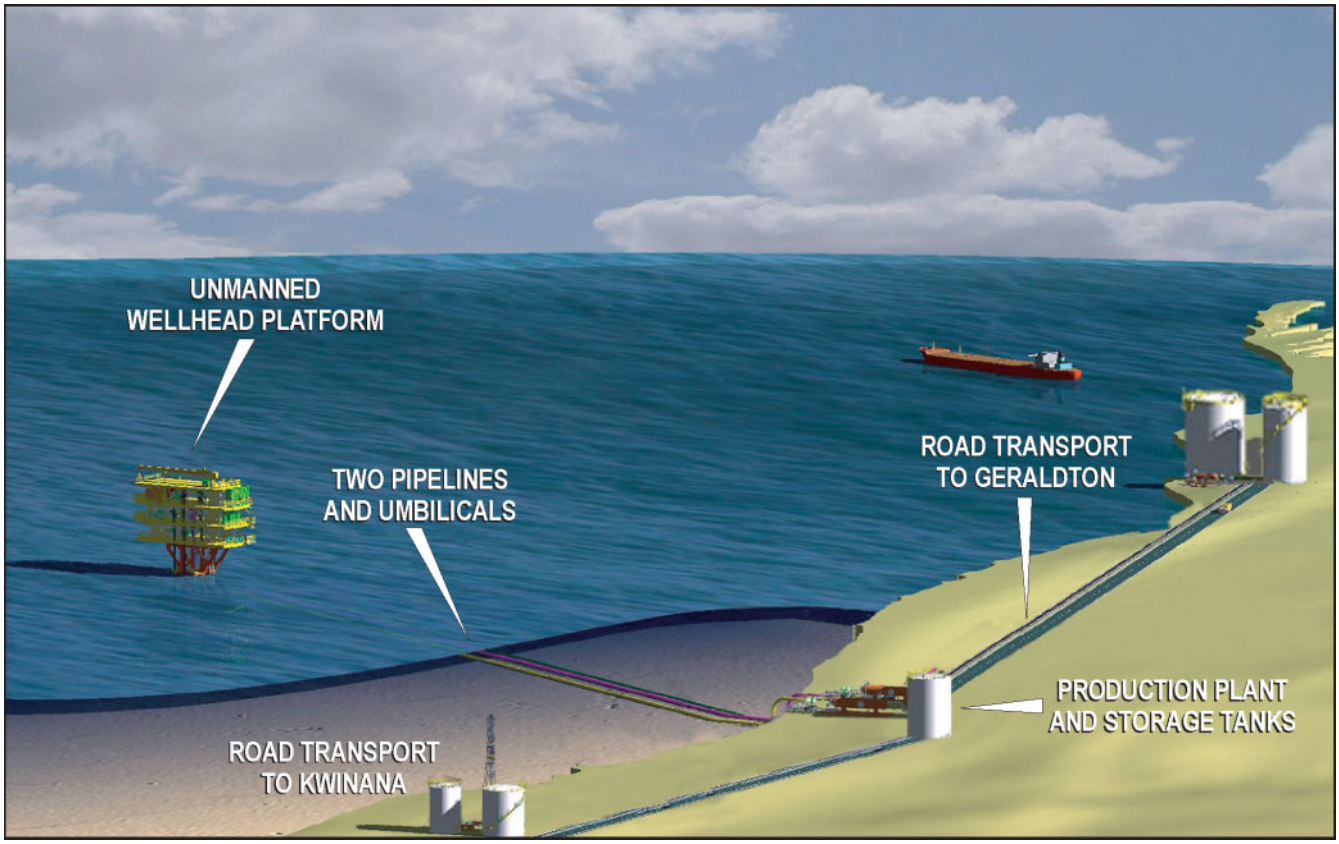


Figure 3.7 Preferred option

- Export ship loading facility located at Bookara: Mt Gibson mining had a proposal to build an ore export facility at Bookara. Sharing this facility was considered; however, Iluka subsequently dropped this option and is exporting ore via Geraldton.
- Export ship-loading facility at Geraldton to southeast Asia markets, with the stabilised crude oil being transported to Geraldton Port via one of the following options:
  - A 100-km pipeline from the North Perth Basin area. This pipeline would have to be constructed for the Development. This option was precluded by capital costs and flow assurance difficulties.
  - Rail transport from the onshore processing plant. This option requires the construction of new rail car-unloading facilities at Geraldton Port. There are also constraints due to rail siding sharing at Geraldton with talc, wheat and iron ore producers. Immediately prior to the issue of this document the option had been dropped for commercial reasons.
  - Truck transport from the onshore processing plant. This option provides the most flexibility out of the three alternatives and is the most economically viable.
- Rail transport of stabilised crude to Kwinana. This is technically feasible but entails prohibitive capital operating costs.
- Truck transport of stabilised crude to Kwinana. Higher transport costs are offset by elimination of Geraldton storage infrastructure and port charges.

The proposed Cliff Head Development has export of crude oil by road transport to Geraldton and/or road transport to Kwinana.

3.5 Production and Reinjection Wells

3.5.1 Drilling and Completion

The base development plan is for six production wells and two water reinjection wells, with capability for an additional two wells on the offshore facility. The wells will be approximately 1,260 m deep below the seabed, and take about 21 days each to drill and complete. Drilling will be undertaken from a conventional cantilever type jack-up rig, similar to that used during exploration (Figure 3.9), positioned over the wellhead platform (29° 27’ 0.73”S, 114° 52’ 10.75”E). The drilling fluids will be water-based. There is a small possibility however that non-water–based synthetic fluids will be required for completion of the bottom-hole sections. Completion involves the installation of all downhole casing, tubing and fittings necessary to control and monitor well production from the reservoir. If non-water–based synthetic fluids are used then wastes will be contained in a closed system and recovered for recycling or disposal onshore.

Typically, during drilling operations the following materials will be produced:

- Drill cuttings. Drill cuttings are expected to be non-toxic comprising inert carbonates, marls, claystones and sandstones. Formation materials retrieved from the well may also include heavy metals. However, as noted by Swan et al. (1994), many of these metals are usually present as insoluble sulphides or metal granules or adsorbed onto sediments, which are not readily bioavailable. Cuttings will be separated from recyclable drill fluid prior to discharge to the ocean. The volume of cuttings discharge will vary depending on the measured distance of the well. On average the volume of cutting discharge is estimated to be approximately 330 m^3 per well, assuming no downhole losses when drilling.
- Drilling fluids are recycled during drilling, but minor losses occur when cuttings are discharged. On well completion the active surface volume of water-based drilling fluids are discharged to sea, in line with standard industry practice. The volume of water-based drilling fluids discharged will vary depending on the number of times discharge is necessary (it may not be required after the completion of each well). However, on average the discharged volume will be approximately 160 m^3 per well, assuming no downhole losses when drilling.
- Drill rig deck drainage. Runoff is collected in a sump connected to an oily water separator. After separation of water from the oil the water is discharged overboard and the free oil is transferred to drums for disposal/recycling onshore. The oil in water concentration will not exceed 50 mg/L at any one time or an average of

Table 3.3 Development scenario options considered

Scenario	Description	Technical Considerations	Outcome
Subsea	The field would be developed using 8–10 subsea wells tied back to a central manifold with pipeline to shore and onshore processing or floating production, storage and offloading (FPSO).	Water depth (15 m) average over field area, with height of subsea trees considered. Would represent an obstacle to fishing vessels. Flow assurance issues with subsea pipelines to central manifold and thence shore or FPSO considered insurmountable.	Option not technically feasible and dropped from further study.
Production Platform with bridge deck constructed from shore (7 km)	A production platform would be installed by jack-up to the east of Horseshoe Reef and a piled bridge deck constructed to the platform. The deck would carry all produced and injected fluids and allow access for workover rigs.	Weather conditions would make construction and lifetime corrosion and stress considerations vital. The position of the platform relative to the field would make all the wells extended reach wells.	Cost estimate made the option commercially non-feasible and further study not warranted.
Leased jack-up with flowlines to shore	A second-hand jack-up would be leased and refurbished as a production facility. Flowlines would be installed to shore with processing plant located onshore.	Technically feasible. No platform removal costs or concerns. The jack-up would drill all the wells and then be converted to a production platform. Time lag between completing wells and first oil of probably six months.	Lower capital expenditure but high operating costs. This would significantly reduce the economic production limit of the field and reduce ultimate recovery.
Production Island to FPSO	Construct production island on Horseshoe Reef with processing facilities and storage offshore. Production to FPSO moored offshore in deeper water.	Technically challenging, but feasible. Would require construction of approximately 15–20 acres to accommodate facilities and be designed to withstand sea conditions.	Not estimated. Considered to be too environmentally hazardous and risky. No further study. Issues with produced water.
Wellhead platform to FPSO	Production from WHP with all processing on offshore-moored FPSO.	Feasible, but discharge of produced water considered an environmental issue in rock lobster fishing area. High risk loading product tankers on lee shore.	Combined costs would significantly reduce the economic production limit and reduce ultimate recovery.
Wellhead platform with production to shore processing facility	Install wellhead platform with jack-up that drills and completes the development wells. Concurrently construct shore-based processing facility and install production pipeline to shore. Shore-based storage with transport to market as appropriate.	Technically feasible. Benefit of low operating expenditures once the jack-up has departed. Minimal mobilisation of construction vessels. Concern about flow assurance issues in pipeline to be reviewed.	Option carried forward as base case for 25–30 million barrel development.

30 mg/L over any 24-hour period in accordance with IMO and Australian petroleum legislation regulations.

- Sewage, grey water and putrescible domestic wastes. During drilling and well test operations the personnel aboard the drilling rig will contribute up to an estimated 7 m^3 of discharge per day incorporating sewage, grey water and putrescible waste. Sewage will be discharged via a certified sewage treatment system. Grey water will be discharged direct to sea. Food scraps will be macerated to <25 mm diameter prior to disposal to the sea.
- Solid wastes. All solid wastes such as packaging and domestic wastes, will be separated and stored in designated areas for proper disposal onshore. No solid wastes will be disposed of overboard.

Support Logistics

The drilling rig will be attended and serviced by two offshore workboats operating out of the Port of Geraldton. One workboat will be in attendance to the rig at all times. A helicopter most likely operating out of Geraldton will also be used to transport drilling and construction crews to and from the development area.

3.5.2 Safeguards

Well Control

The loss of well control, in particular a blowout, is a serious event that has environmental and health and safety implications. Extensive training, procedures and equipment including multiple blowout preventers (in accordance with the P(SL)A) will be in place to maintain well control and prevent blowouts. These procedures and equipment will be separately described within the drill rig Safety Case. The Safety Case will be submitted to the designated authority. Drilling will not commence unless the Safety Case has been accepted by the designated authority.

Table 3.4 Production plant and pipeline options considered

Site	Description and Issues	Outcome
1 – Westlime Site	This option has the advantage of existing infrastructure – gas to site, sealed road to highway, security fence, buildings and internal road and concrete paved areas. It is also in line with a direct pipeline route from offshore and results in the shortest distance of 2.8 km of pipeline across the reserve. The site is screened from the highway by an adjacent dune system.	Roc believes that this site offers the best environmental solution in terms of minimum impact to fishing, use of an existing industrial site and minimal impact to Beekeeper's Nature Reserve, with a buried pipeline easement of 2.8 km across the reserve. The chosen alignment also results in the pipeline landfall occurring at a relatively low point in the coastal dune system.
2 – Grice Property	This option was studied in some detail. This is a greenfields site which would require a 4.5-km length of pipeline wending through some high dunes in Beekeeper's Nature Reserve. This site would require low additional cost including land cost compared to Option 1.	Because of the additional length of pipeline in Beekeeper's Nature Reserve and additional cost, this was rejected in favour of Option 1
3 – Jingemia Oilfield Site	This site is the exploration well site of Origin Energy. The offshore pipeline was 10.5 km, assuming a direct route to shore. The onshore line was 7 km through Beekeeper's Nature Reserve, assuming a direct route. The cost of provision of gas to this site would be substantial although possibly offset by savings in transport over project life. This site would require moderate additional cost compared against Option 1.	While there may have been some synergies in operating alongside Origin, these were outweighed by the environmental impacts associated with the additional length of pipeline through the reserve and the additional capital cost.
4 – North of Beekeeper's Nature Reserve	This option to a DOLA - administered reserve adjacent to the Dongara airport, would require an offshore pipeline of 16.5 km, assuming that a direct route is possible. Supply of gas would be a substantial cost. The shore dunes in this area are high. Cost of transport to Geraldton would be reduced over the life of the project. This site would require large additional cost compared against Option 1.	The greater flow assurance risk and impact on lobster fishing, combined with a large cost burden, assuming that land was available on the reserve, together with difficulty in lack of a pipeline stringing site and environmental impacts associated with negotiation of pipe strings over high steep coastal dunes, led to rejection of this option.
5 – South of Beekeeper's Nature Reserve	The first freehold land to the south, where Beekeeper's Nature Reserve is not adjacent to the coast would require an offshore pipeline of about 17 km, assuming that a direct route is possible. A crude stabilisation plant at this location would have a high visual impact. This location would require the extension of the gas supply pipeline (for plant and offshore power) by 16.5 km and would potentially require a construction easement for that length, if it could be located in the existing road easement. This option has the highest additional cost relative to Option 1.	Notwithstanding higher capital and operating costs, this option would result in greater risk from a flow assurance standpoint, have a greater impact on exclusion areas within the lobster fishing zones and potentially have a greater impact on Beekeeper's Nature Reserve, because of a construction easement for the gas supply pipeline.

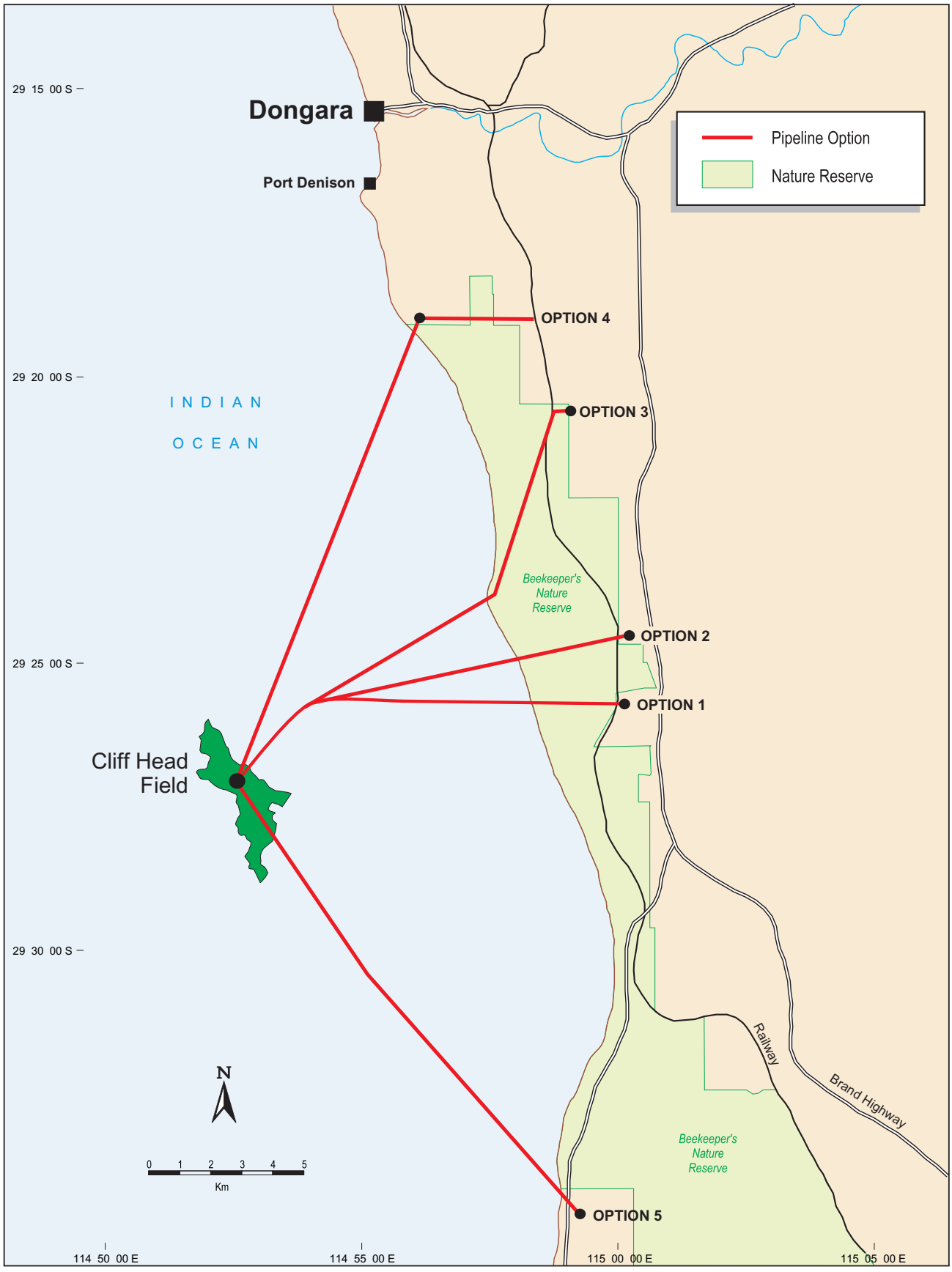


Figure 3.8 Pipeline options

Section 5.2.6 details a range of specific measures proposed to avoid or minimise the potential effect of oil spills. The Oil Spill Contingency Plan for construction and production will be similar in structure and content to the Oil Spill Contingency Plan that was put in place for drilling of the Cliff Head exploration wells, a copy of which is provided in Appendix C.

Exclusion Zone

A 500-m-radius exclusion zone will be established around the drilling rig and a notice to mariners warning of the presence of the rig will be broadcast. Fishing during drilling operations will be managed as per previous drilling campaigns undertaken in 2002 and 2003.

3.6 Platform

The Cliff Head facility will be located approximately 10 km from shore in about 17 m of water. The platform will be located at (or within a few hundred metres of) 29° 27' 0.73"S, 114° 52' 10.75"E as indicated by Figure 3.1. It will house the six production wells and two water injection wells that will be used to develop the reservoir (Figure 3.10). There will also be provision for two additional wells. The platform will operate unmanned, with infrequent routine maintenance and operations conducted using a vessel from either Port Denison or Geraldton.

The wellhead platform will cover an area of approximately 10 m by 30 m and stand 12 m clear of the sea surface. The platform will be of steel construction with pile foundations. The conductors used for drilling the wells will also serve as foundation support for the facility. Figure 3.11 illustrates the conceptual design of the wellhead platform to be installed at the Cliff Head field.

The primary equipment on board will be the wellheads, with their associated valves and flowlines and pumps for artificially lifting the produced fluids onto the platform, then into the pipeline and on to the onshore plant. Electrical power will be supplied to the wellhead platform from the onshore plant by way of cable. The platform will have a crane, electrical switchgear and control systems. Chemicals such as corrosion inhibitor and demulsifier will be delivered via a subsea umbilical.

The produced fluids will be crude oil, produced formation water and a small volume of natural gas. These will be transported to shore in a 300-mm-diameter steel pipeline. The formation water will be treated and reheated onshore then returned offshore via another 300-mm pipeline and reinjected into the reservoir.

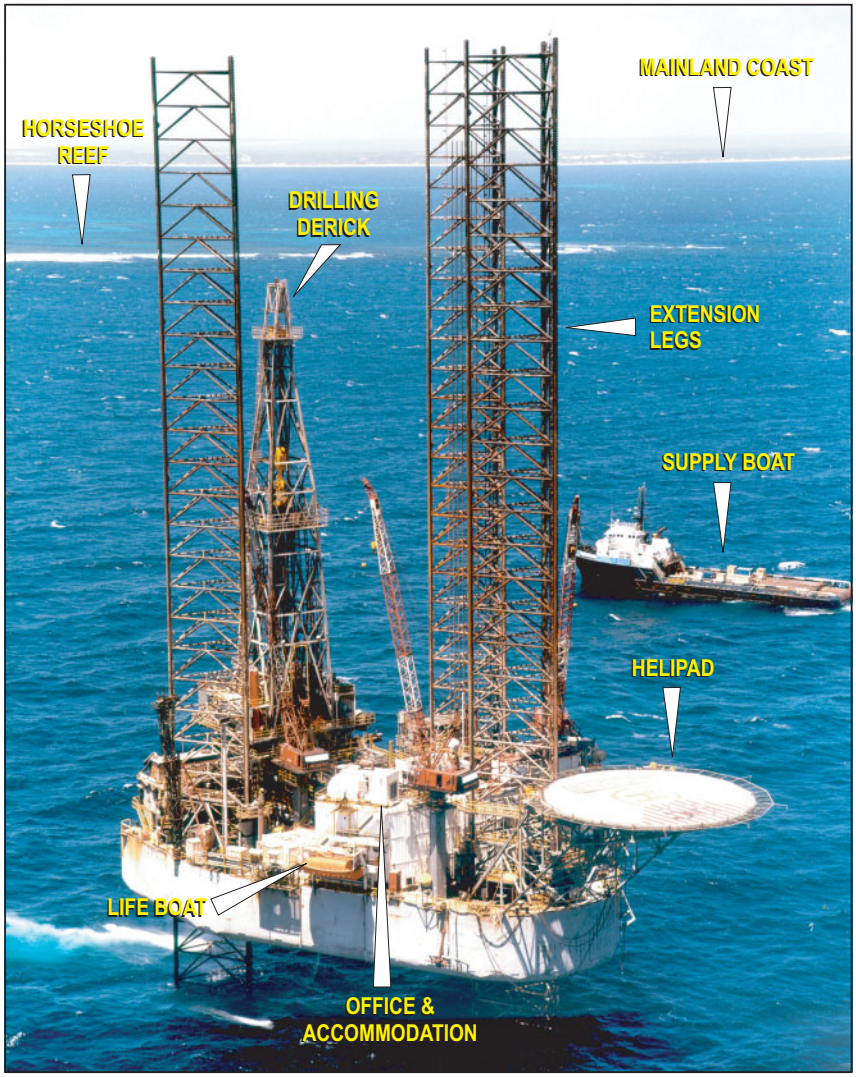


Figure 3.9 Jack-up drilling rig at Cliff Head field during exploration

The deck design will capture any minor hydrocarbon drips and spills associated with maintenance activities. These fluids will be returned to the production system.

The facility will be remotely controlled from the onshore plant by way of communication cable (or possibly satellite) with back-up radio communications. Fire and gas detection systems will be in place and the facility will be capable of shutting down the platform operations automatically in addition to being able to shut down the platform remotely from the onshore plant.

For safety reasons access to the cellar deck from the boat access platform will be secured. A security system, potentially comprising closed circuit television and motion sensors will be used to detect and monitor any unauthorised access to the wellhead platform.

3.7 Pipelines

The Cliff Head Development includes construction and operation of two pipelines with a nominal internal diameter of 300 mm. One pipeline will carry the wellstream fluids and gas from the wellhead platform to the onshore plant. The other will be used to transport produced formation water and, for the first few years, additional injection water drawn

from the Catamarra Formation, from the onshore plant back to the reservoir.

3.7.1 Offshore Pipeline

The high wax content and high pour point of the Cliff Head crude oil require insulation of the pipelines in the offshore sections to prevent cooling and gelling of the crude oil. The water reinjection pipeline will also be insulated to deliver water back to the reservoir at 55°C. The pipelines will not give rise to any measurable thermal effects in the surrounding seawater. Figure 3.12 shows a cross-section of the offshore pipeline. The pipeline and associated stabilising infrastructure will be designed to allow lobster fishing without exclusion; however, anchoring over the pipeline will be excluded.

The potential for crude oil to gel and form an immovable plug requires minimising the length of offshore pipeline, or the application of pour point depressant chemicals. The shortest practicable route, having regard for areas of special sensitivity and the seabed environment, also minimises the impact of pipeline installation on the seabed. The offshore pipelines will be located within 100 m of the proposed route shown in Figure 3.1.

Two methods are currently under consideration for construction of the offshore pipeline. The first method, bottom tow, involves assembling the pipeline in sections at an onshore location east of Beekeeper's Nature Reserve. Each section, nominally four kilometres in length, is pulled across the reserve and out to sea along the pipeline route where the sections are then joined together. It will be necessary for the area where the pipeline is strung to be cleared to allow access for transporting pipeline segments and materials, to even out areas of steep grades and also to reduce the potential for fire during the welding activities.

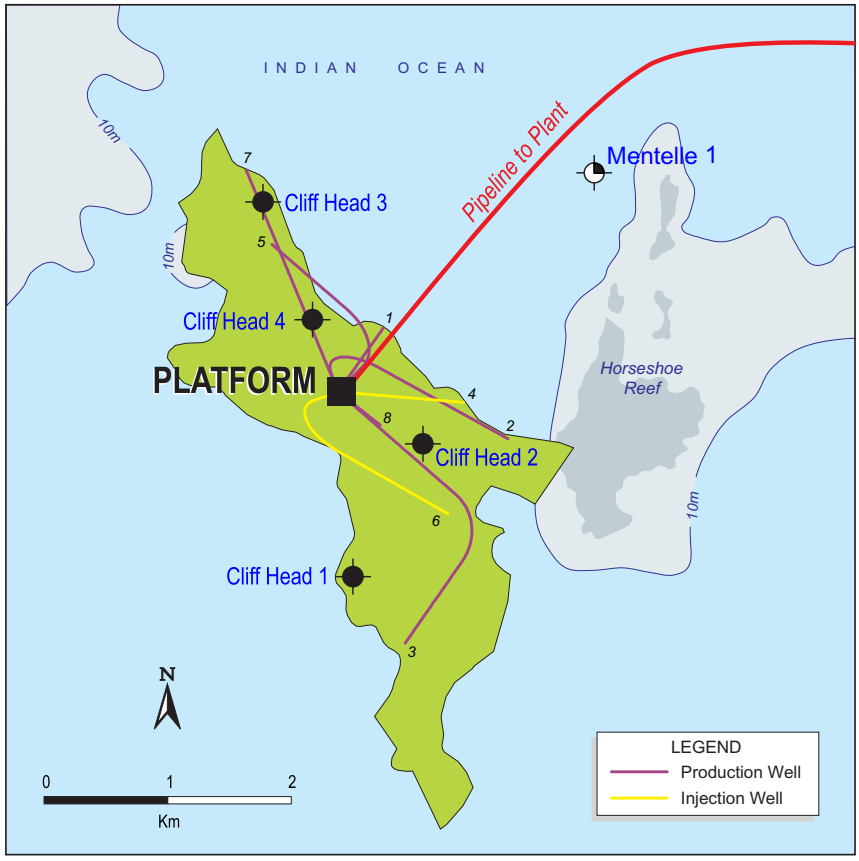


Figure 3.10 Offshore production well layout

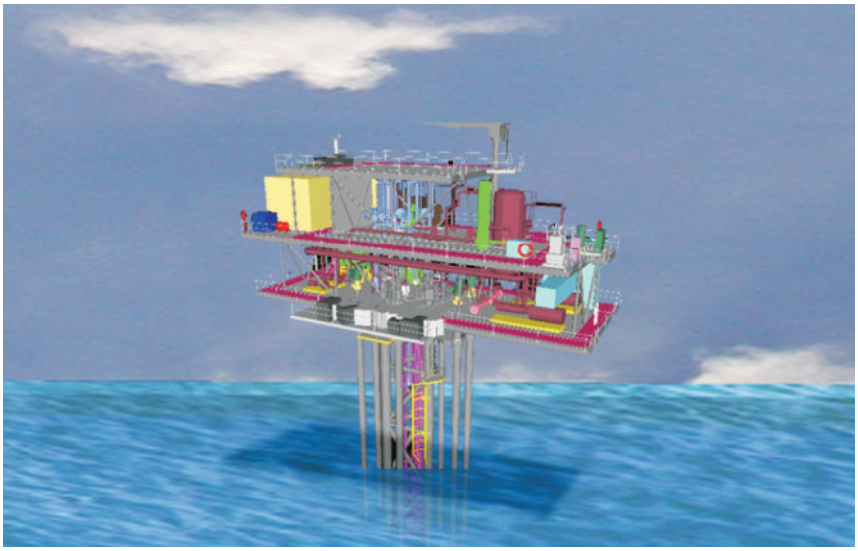


Figure 3.11 Conceptual design of wellhead platform

The potential for minimising disturbance within Beekeeper's Nature Reserve by boring short tunnels under the two main sand dune systems is being investigated and will be utilised if found to be practicable. At the shore crossing the pipeline will be pulled across an area slightly north of the horizontal directional drilling (HDD) entry point where the primary dune is lowest, so as to protect the integrity of the dune as much as possible. The bottom tow and tie-in of pipeline is expected to take approximately 15 days to complete.

The alternative method for offshore pipeline construction, lay barge, utilises a specialised, shallow-water pipeline lay barge. The subsea pipeline installation process will involve welding 12-m (nominal) lengths of line pipe together on a pipelay vessel and moving the vessel ahead to lay the pipe on the seabed. Pipelaying may commence at either the platform end or from the shore crossing. During pipelaying, the pipelay vessel will move ahead by pulling on anchor winches connected by wire rope to a minimum of eight drag anchors which

are continuously moved forward in sequence by two anchor handling vessels. Anchoring is necessary because the water is too shallow for vessels to operate using dynamic positioning. A typical arrangement for the anchor spread is indicated in Figure 3.13. Line pipe will be transported from an onshore storage yard to the pipelay vessel as required by the pipelaying operations.

The pipelay vessel will have approximately 80 personnel on board during pipelaying operations. These personnel are likely to be transported by helicopter to and from the vessel from Geraldton if required. The pipelay and tie-ins at both ends is estimated to take about 10 days, excluding bad-weather downtime.

Regardless of the method selected for construction of the offshore pipeline, waste management procedures for vessels involved are similar to those applying to any seagoing vessel. All waste, apart from domestic sewage, will be held temporarily aboard the tug or barge before being shipped ashore for disposal at appropriate waste management facilities.

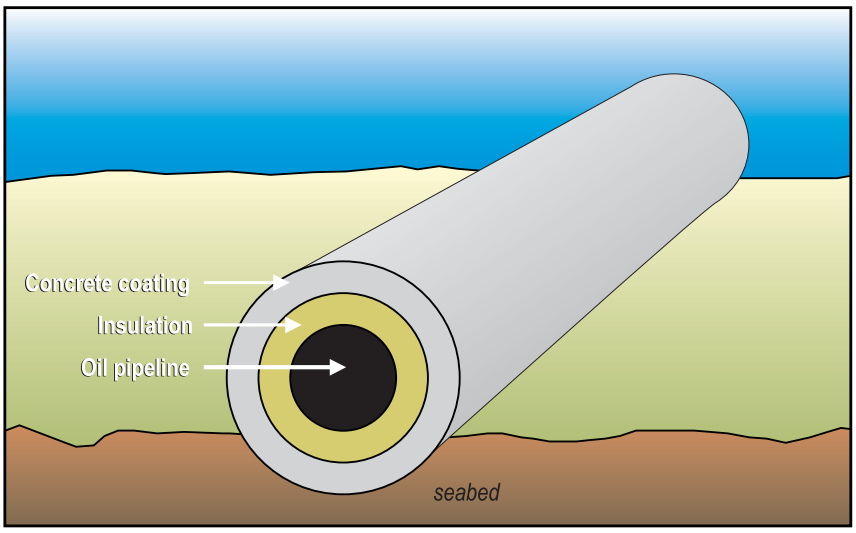


Figure 3.12 Offshore pipeline cross-section

An assessment of stability of the pipeline has been conducted. The results of which indicate that even with heavy walled steel pipe and concrete coating additional stabilisation will be required to ensure that the pipeline does not move during storm events. It is proposed to use either a clump-weighting or seabed-bolting system for stabilisation. Trenching or rock dumping will not be used.

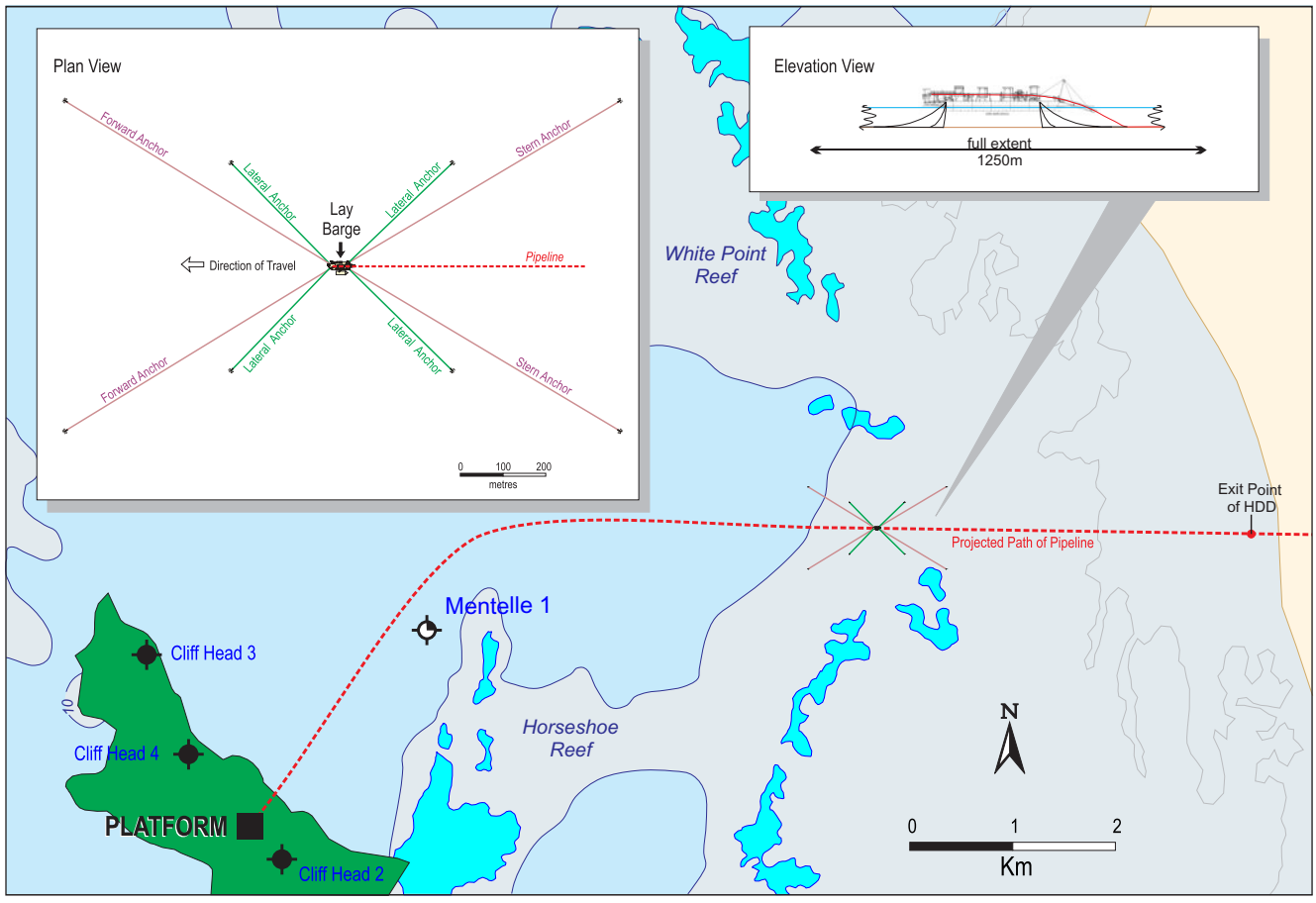


Figure 3.13 Typical arrangement for laybarge and anchor spread

3.7.2 Shore Crossing

HDD is the preferred method for the construction of the shore crossing. If HDD proves infeasible, the shore crossing will be trenched. The locations of the HDD entry point and the seabed exit point have been selected to minimise the extent of environmental disturbance (Figure 3.14). The HDD site is proposed to be located approximately 300 to 400 m inland in a flat area near an existing track behind the primary dune as indicated by Figure 3.15 (Section 2.2 describes the environmental features of the HDD location). The seabed exit point is approximately 600 m offshore in an area of about 6 m water depth.

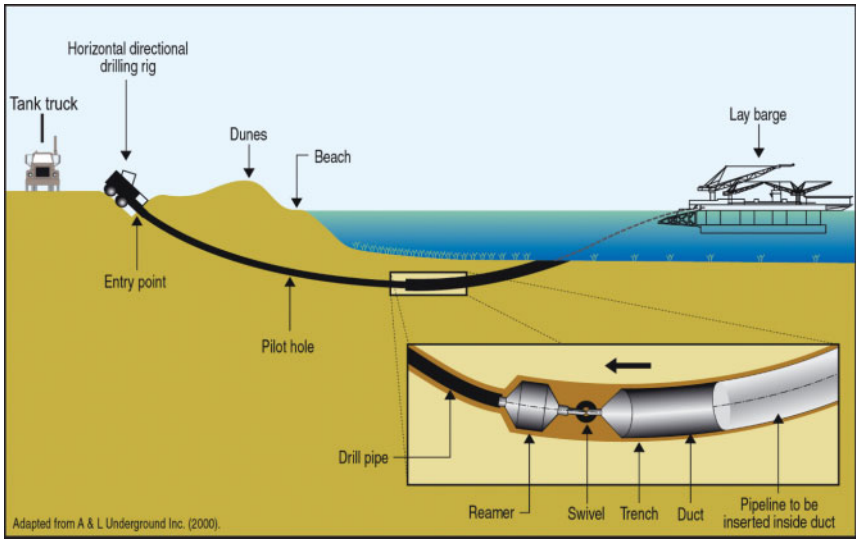


Figure 3.14 Horizontal directional drilling cross-section schematic

The onshore HDD site will be around 50 m by 50 m in size, and will include (Figure 3.16):

- An HDD drilling rig.
- A mud system (including mixer/storage/pumps/cuttings removal).
- A drill pipe rack.
- Workshop.

Careful consideration will be given to the placement of HDD equipment within the location so as to minimise disturbance to the local landform and heathland community wherever practicable. Two holes will be drilled using HDD, one for each pipeline (the umbilical line will be bundled with one of the pipelines) about 25 m apart.

During construction the HDD rig will drill a pilot hole (nominally 150 mm) from the shore location to the seabed exit point. An offshore barge will pick up the drill string and fit a larger diameter reaming bit. The onshore rig pulls the bit back through thereby enlarging the hole di-

Figure 3.15 Onshore pipeline route

ameter. The hole is progressively widened through a series of push–pull operations until the hole is of sufficient diameter to accommodate the pipeline.

Bentonite drilling mud (a naturally occurring clay) will be used to keep the drilled hole open and for lubrication during drilling. The mud will be stored in tanks alongside the HDD drill rig. It will be pumped into the drill string, separated from the soil cuttings and reused.

Upon completion the site will be fully remediated and rehabilitated.

3.7.3 Onshore Pipeline

The location of the onshore pipeline is shown on Figure 3.15. Over the majority of the onshore pipeline length, the pipes will be placed side-by-side in a trench about 1 m deep and 1.5 m wide within a construction corridor approximately 20 m across, located within the 50-m-wide licensed easement. However, at the HDD site and the dune boring points (should boring be used to tunnel under the secondary dunes), the pipes would separate by about 15 to 20 m to ensure integrity of the drilled holes. It is recognised that the corridor width may have to be reduced at certain places due to obstacles or environmental constraints.

Weed hygiene will be put in place during pipeline construction (see Section 5.5). The proposed onshore pipeline construction methods involve (Figure 3.17):

- Clearing the construction corridor by slashing or rolling the vegetation. Vegetation clearing will be limited to the width required to dig the trench and store the trench spoil and cleared vegetation. Additional work areas within the easement will be rolled flat and the vegetation left in situ to protect rootstock and topsoil.
- Assembling and welding the pipelines along the corridor.
- Using an excavator to carry out trenching. The topsoil will be stockpiled separately from other soil for re-instatement at completion of trenching operations.
- Pipelines will be installed in the trench using conventional sidebooms.
- Joining the onshore and offshore pipelines and testing integrity of the welds.
- Backfilling the pipe trench, and restoring topsoil as far as is practicable.
- Remediation and rehabilitation of disturbed portions of the easement back to the surrounding vegetation types to protect the reserve from weed invasion and erosion.

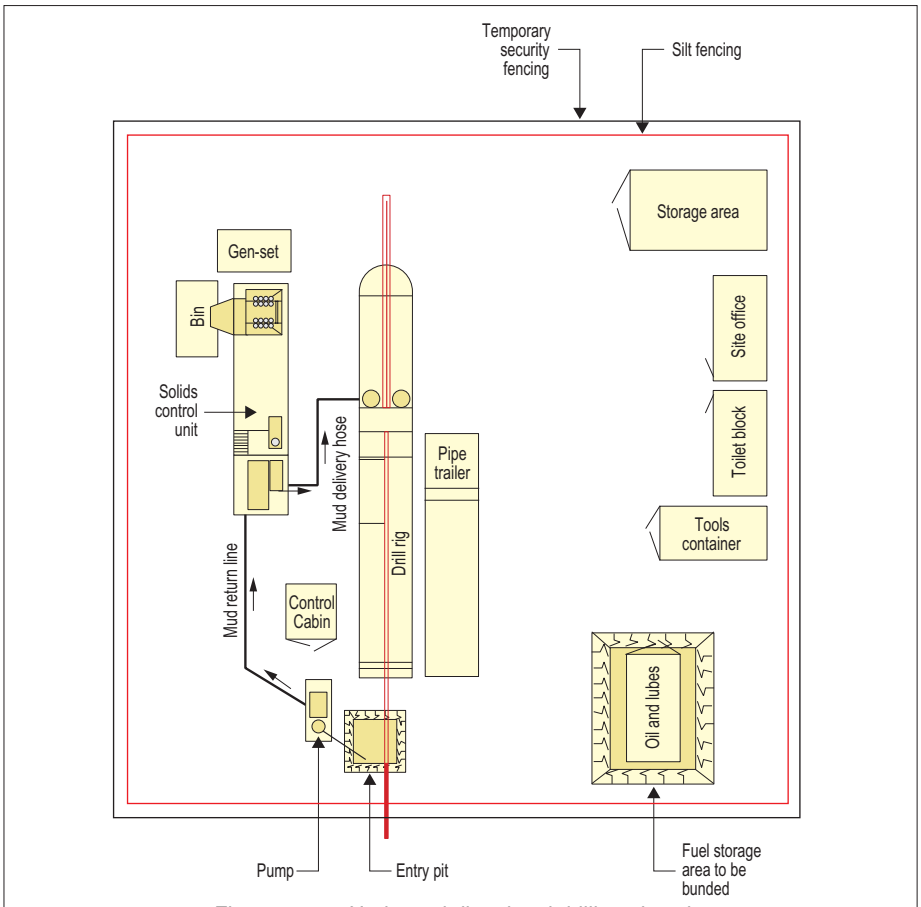


Figure 3.16 Horizontal directional drilling plan view

All construction activity will be confined to the pipeline construction corridor. During the period when the trench is being constructed or is open, the trench will be inspected at least daily for fauna that may have entered and become trapped in the trench. Any fauna found will be removed and released. Other specific measures for protection of fauna are described in Section 5.6.

3.7.4 Pipeline Hydrotesting

The integrity of the pipelines prior to commissioning requires confirmation by pressure testing. Pressure testing entails filling the pipelines with water, pressurising the water and monitoring for any change in pressure over time in a process normally referred to as 'hydrotesting'. At completion of the hydrotest, the hydrotest water will be discharged to the lined evaporation pond at the onshore plant location.

3.8 Arrowsmith Separation Plant

3.8.1 Onshore Plant

The Arrowsmith Separation Plant will be located on the site of the former Westlime production facility (Figure 3.18). It is located approximately 20 km south of Dongara, between the Brand Highway and the coast (see Figure 3.1). The proposed plant layout and process flow sheet are shown in Figures 3.19 and 3.20 respectively.

The main purpose of the plant is to separate and treat the oil, formation water and natural gas. It will also serve as an operations control base for the offshore facility.

Figure 3.20 provides a schematic illustration of the production process. The incoming fluid mix will be heated to approximately 85°C to facilitate the separation process. The separated oil will pass through segregation tanks with 24-hour residence time, enabling any residual water to be separated. The oil will then be stored in insulated, heated tanks, awaiting export.

The water will be further treated, following separation, to reduce the oil content to less than 100 ppm. The water will be retained for approximately 24 hours in a settling tank and then pumped back offshore to the platform and into the reservoir.

In the initial months of the project, additional water will be required for reservoir maintenance. Simultaneously, this volume will be returned to the reservoir by reinjection water sourced either from the Cattamarra Formation or a deeper formation. The rate of water extraction will be greatest during the first year and then decrease as the percentage of water from the well increases. The aquifer water extraction rates are expected to fall rapidly from 4,800 m^3 per day at the start of oil production, to 890 m^3 per day after three years and to only 240 m^3 per day after ten years.

Over the life of the project, about 21 million barrels of oil will be produced from the reservoir. Simultaneously, this volume will be returned to the reservoir by reinjection water sourced from the onshore Cattamarra Formation. Oil production from the reservoir will also involve the circulation of approximately 300 million barrels of water through the reservoir. All water reinjected into the reservoir will be appropriately dosed with biocide to prevent the souring of the reservoir and the generation of hydrogen sulphide. Chemicals to inhibit scale and precipitate formation will also be necessary to prevent fine particles blocking the injection wells. As the water in the reservoir circulates, it will be necessary to adjust the chemical injection rate to achieve optimal control of these factors.

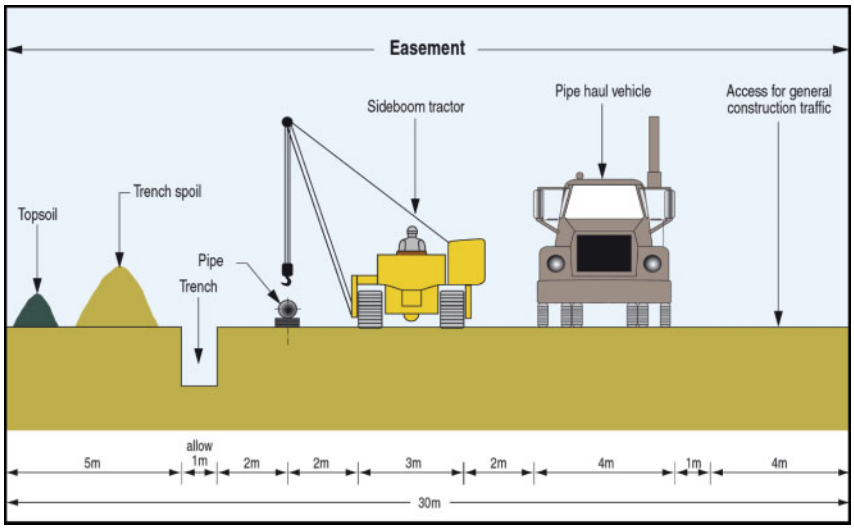


Figure 3.17 Typical trenching cross-section schematic

Power will be generated onsite to meet the 5-MW peak load. To power the generators, produced gas from the reservoir will be supplemented from an external gas supply, already established onsite. Power to the offshore facility will be delivered from the onsite generators via a submarine electric cable.

The plant will also contain a fire fighting system, product loading facility, workshop, warehouse, motor control centre, control room and amenities building. Ablutions will be connected to the septic system previously constructed by Westlime.

Figure 3.18 Former Westlime plant

3.8.2 Export

The plant will produce stabilised crude oil into heated storage tanks. These tanks will hold up to 6,360 m^3 (40,000 barrels), approximately two days production at maximum field production. The storage tanks will be located within a bund with an impermeable liner to prevent any leakage of oil. There will be systems in place to monitor leakage beneath the tanks and within the bunded area.

The ultimate market for the crude oil is currently undetermined. The bulk of production may be sold into the international crude oil market and be delivered into refineries or power stations throughout Asia and even further afield. This will involve transport by international tankers with parcel size of approximately 79,500 m^3 (500,000 barrels) loading from the Port of Geraldton or Kwinana. The other possible destination for produced crude is the BP refinery in Kwinana, on the southern outskirts of Perth.

Transport of crude product from the onshore treatment plant, will be carriage by truck to Geraldton, or to Kwinana.

Carriage by rail has proved impracticable. There are currently no crude oil production operations in Australia utilising rail transport. Establishing a rail transport capacity would entail the importation of specialised rail cars with thermal insulation. At Geraldton an ambitious project has been initiated to re-align the

transport corridor to the port away from the city centre. The timing of the establishment of the railway in this corridor and for siding and unloading facilities at the port would be 12 months later than the schedule of the Cliff Head project. These financial, logistical and practical factors mitigate against the use of rail transport.

Road transport will be provided by way of a contracted trucking company. The size of the necessary trucking fleet depends on three predominant factors, the phase of the project being considered, the size of individual truck loads, and the destination for truck discharge. As discussed in Section 3.3.3, the project planning basis is peak annual average production at 2,385 m^3 (15,000 barrels) of oil per day, but this could be as high as 3,975 m^3 (25,000 barrels) of oil per day, depending on the actual performance of the wells drilled. Peak production is not expected to be maintained for longer than one year before natural reservoir decline reduces the yield of crude oil for export.

In the case where oil is trucked to Geraldton, the transportation could be by pocket or triple road trains. At the planned initial production rate of 2,385 m^3 (15,000 barrels) per day, approximately 20 to 30 truck trips will be required depending on actual tanker size. Should the higher production rate prove achievable, this number would increase proportionally. It is expected that each trucking unit would be capable of 5 to 6 round trips each day. Trucking would be a 24 hour, 7 day per week operation.

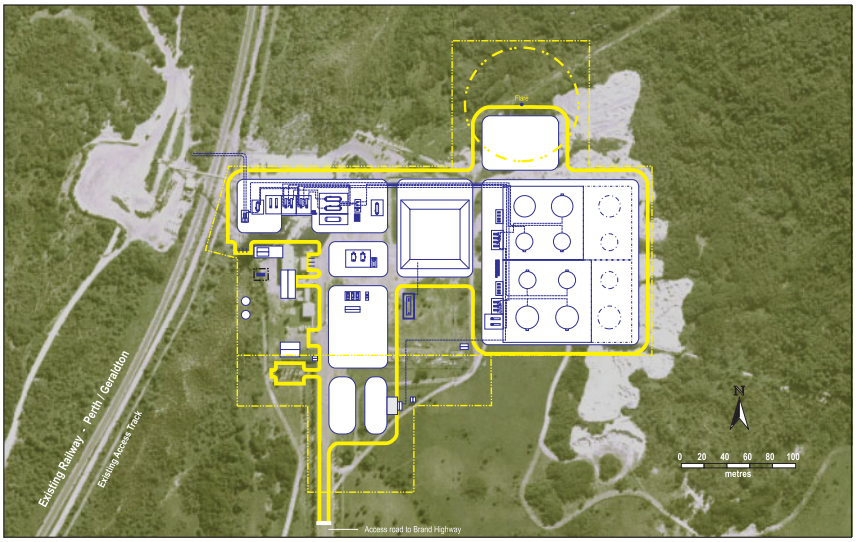


Figure 3.19 Proposed onshore production facility

Pocket and triple road trains currently operate on the Brand Highway between the Arrowsmith plant site and the Port of Geraldton.

In the case of trucking to Kwinana, vehicle size is constrained to the pocket road train or B/double units. The longer turnaround time of about 13 hours for the loading, driving, unloading and return cycle demands a truck fleet of 18 units to achieve the approximately 30 truck trips per day to transport the expected production rate of 2,385 m^3 (15,000 barrels). As with the Geraldton case, if higher production is achieved, the transport effort would increase proportionally.

Marketing of the crude oil will remain a dynamic matter throughout the life of the project. It is possible that, even if export facilities are constructed in Geraldton, at times during the project a fraction of the production may still be trucked directly to the Kwinana refinery.

This document does not address details of oil export facilities within the Port of Geraldton.

3.9 Operations

3.9.1 Field Production

The wellhead platform will be normally unmanned except for periodic visits for maintenance and inspection. The anticipated frequency of visits during normal operations is about twice per month. Chemicals will be transported to the platform via umbilicals to small storage containers (circa maximum of 20 L). These chemical storage containers will be located within bunded and contained areas.

Transport to and from the wellhead platform for routine maintenance will be by work vessel mobilised from Port Denison. Transportation of specialised heavy equipment will be undertaken by suitable vessels from either Geraldton or Fremantle.

Workover drilling, should it be required, would be carried out from a jack-up drilling rig. The equipment and methods used would be essentially similar to that described for drilling activities in Section 3.5

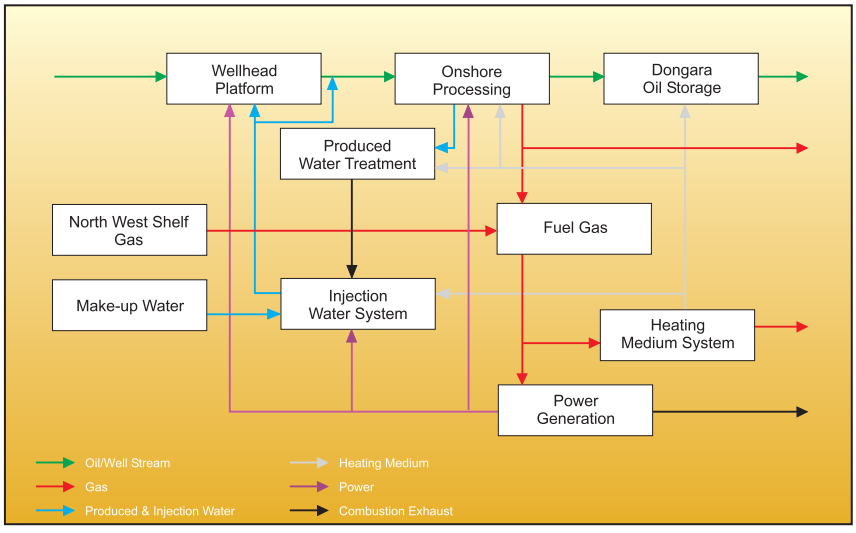


Figure 3.20 Process flow sheet

The waxy nature of the Cliff Head crude oil requires regular cleaning of the pipelines, referred to as 'pigging'. During pigging operations, a pig is launched at the onshore plant from where it will travel through the water reinjection pipeline out to the wellhead platform and be routed back to shore through the production pipeline. As it travels through the production pipeline, it will scrape oily deposits from the pipeline walls and any loose material back to the onshore plant. These deposits will be recovered and blended into the export product.

It is not expected that significant quantities of reservoir sands would be carried through to the onshore plant. However, if sands are recovered either from pigging operations or cleaning of the separators they will be disposed of to a suitable, landfill in accordance with regulatory standards and requirements.

3.9.2 Processing

Operational Traffic from Plant Operational Activities

Traffic generated by the ongoing operation of the onshore plant will include transportation of equipment and materials for ongoing operation, transportation of staff and export of crude oil product. Materials, including chemicals used during operation will be transported to, and stored on site. It is anticipated that the onshore plant will employ up to 10 personnel on a 24 hour/7 days a week basis. It is assumed that operational staff will travel mostly from the local area, including Dongara.

The main road-based outputs from the plant site will be export of crude oil product, which will be trucked out using road tankers of approximately 85 tonnes capacity. There will typically be 27 tankers leaving the site each day during peak production. It is estimated an initial trucking contractor workforce of approximately 20 personnel will be required to undertake this work. This will decline over the operational life of the Development. Table 3.5 contains estimates of the number of vehicles likely to be generated by each operational activity.

Chemical Use

A number of chemicals will be utilised by the Development for management of reservoir, pipeline integrity and product flow. The chemicals that may be used and typical quantities are listed in Table 3.6. All of the chemicals are either recovered at the plant or terminate in the oil reservoir. No chemicals will be discharged to sea or land.

Liquid Emissions

Routine liquid emissions associated with operations of the onshore plant are listed within Table 3.7.

Air Emissions

The operating gas plant will release emissions to the atmosphere from a number of sources. Table 3.8 describes emissions that are identified under Western Australian air quality legislation and provides an explanation of the control measures applied to the proposed onshore plant design.

Greenhouse Gas Management

The main sources of greenhouse gas (GHG) emissions from the onshore plant are the power generators and the heating equipment. Emission levels from these sources will be more or less consistent over the life of the project with annual carbon dioxide emissions of 24,000 t CO_2 equivalents for the power generators and 11,000 t CO_2 equivalents for process heating. The emission estimate for the power generators is based on an assumed electrical load of 5 MW for the life of the field and a level of fuel consumption based on a G3612 caterpillar gas-engine generator operating at 75% load. The emission estimate from the medium-fired heaters is based on a process duty of 5.13 MW for the life of the field; this requirement excludes the 3 MW of heat that is assumed to be recovered from the waste heat recovery units.

The next most significant source of GHG is the flare. The flare will be a vertical construction about 12 m high. It will be fitted with a conventional tip with a natural gas pilot light that is continuously alight. Under normal conditions, a low flow of blanket gas will be burnt. This low volume will not be visible from the Brand Highway.

Plant conditions resulting in high flows to the flare can arise from two sources: pressure relief from the separators, and unplanned flows (perhaps from stuck valves) directly from the natural gas import line. Both sources are regarded as events occurring at infrequent intervals and for only short durations of some minutes until plant stability is restored. It is possible, however, that during such flare events, the light may be visible from the Brand Highway, particularly if the events occur at night.

An annual emission of 500 t of carbon dioxide has been estimated for the flare, based on 30% of produced gas being flared. This estimate includes an allowance for continuous flare pilots and purge. It is not anticipated that 30% of the produced gas will be continuously flared and the estimate is intended to cover upset situations.

The total GHG emissions for the onshore plant is therefore 35,500 t/a CO_2 equivalent, comprised of 24,000 from power generation, 11,000 t from process heating and 500 t from flaring.

Sulphur and Nitrogen Oxides

The basis of design for the Arrowsmith Separation Plant will include the requirement to meet the standards of less than 0.9 g/m^3 of nitrogen oxide and less than 2 g/m^3 of sulphur oxides (expressed as SO_3). These standards are consistent with the Western Australian EPA guidelines for emissions from gas turbines and the guidelines for emissions from stationary sources (EPA, 2000).

Volatile Organic Compounds

In oil production operations volatile organic compounds (VOCs) may be emitted from crude oil treatment and storage or power generation facilities. The Cliff Head crude oil has very low composition of gases and volatile components. Any gases associated with the crude oil stream will be removed and used to sup-

Table 3.5 Operational traffic generation

Activity	Number of Vehicles	Frequency	Period
Transporting materials/chemicals to site	2	Monthly	Project life
Transporting staff to site	6	Daily	Project life
Transporting export product	20 to 30 (peak)	Daily	Project life

plement natural gas used for power generation.

Flue gas from the generators will be used as blanket gas for the crude oil storage. As the crude oil storage is filled the blanket gas will be expelled to atmosphere. The small volumes of VOCs that may be released from the crude oil to the blanket gas will be quickly dispersed in the surrounding atmosphere.

3.10 Schedule

Subject to attainment of all necessary regulatory approvals and final investment decision by the joint venture participants, it is envisaged that construction of the Cliff Head Development would commence in late 2004. Production and export of crude oil would commence in the third quarter of 2005. Figure 3.21 illustrates the general schedule for drilling, installation and construction activities for the Cliff Head Development.

3.11 Decommissioning

3.11.1 Platform Decommissioning

Detailed plans for platform decommissioning have not yet been developed. It is proposed that these plans will be developed in consultation with the relevant regulator of the day thereby allowing flexibility to incorporate technology advances over the life of the project. Platform decommissioning is anticipated to involve removal of all material above the seabed, transportation to shore for dismantling and recycling or re-use as scrap.

3.11.2 Subsea Well and Pipeline Decommissioning

Well decommissioning is anticipated to involve removal of wellheads and tubing. The wells will be sealed and the conductor and casing strings cut off below the seabed. All conductor and casing strings above that point will be removed.

Subsea equipment decommissioning is anticipated to involve removal of equipment, such as the manifold, with transportation to shore for recycling. It is expected that decommissioning of the pipeline would entail it being thoroughly cleaned and disconnected. The offshore pipeline will then be flooded and left open-ended on the seabed. Roc recognises that in some circumstances there can be a desire to leave some structures in the seabed if marine life has colonised the area. This will therefore be reviewed with the regulator of the day to determine a fit for purpose decommissioning strategy.

Decommissioning of the onshore pipeline will follow practices for pipelines set in Western Australia and other states. At present, this involves filling the pipeline with water containing a long-term corrosion inhibitor, sealing the pipeline and maintaining inspection and cathodic protection.

3.11.3 Plant

It is expected that upon decommissioning the plant components will be removed and the plant site rehabilitated to at least the current condition of the site.

Table 3.6 Summary of Cliff Head Development chemical dosing

Chemical Type	Nominal Dose Rate	Approximate Annual Consumption
Forward demulsifier	50 ppm	140 m^3
Reverse demulsifier	30 ppm	84 m^3
Anti-foam	5 ppm	14 m^3
Oxygen scavenger	2 to 10 ppm	5.5 to 28 m^3
Biocides	Nominally 500 ppm for 4 hours once a fortnight	33 m^3
Scale inhibitor	15 ppm	42 m^3
Corrosion inhibitor	25 ppm	70 m^3
Hypochlorite	2 ppm	5.5 m^3

Table 3.7 Summary of liquid emissions

Type	Volume	Fate
Greywater and sewage	600 L/day	Septic system
Runoff from process areas	Variable	Evaporation pond
Washdown water	Intermittent ~ 15 m^3/year	Evaporation pond

Table 3.8 Summary of atmospheric emissions

Type	Volume	Fate
Greenhouse gases	35,000 t/a	Atmosphere
Oxides of Nitrogen	< 0.09 g/m^3	Atmosphere
Sulphur oxides	< 0.2 g/m^3 as SO_3	Atmosphere
Volatile organic compounds	negligible	Atmosphere

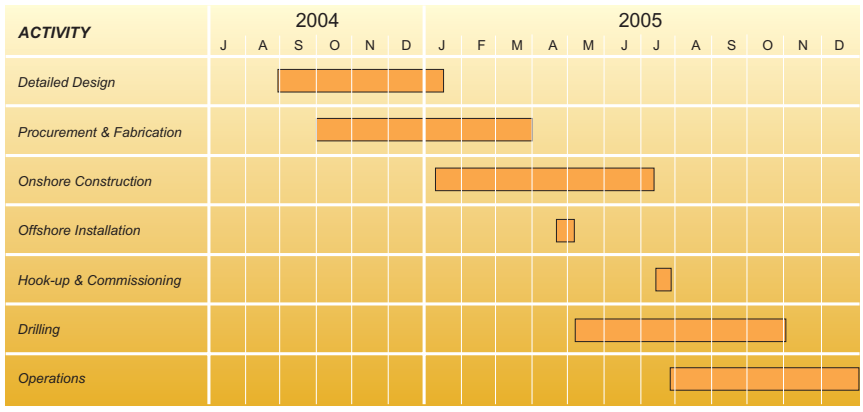


Figure 3.21 Construction schedule

4. Community and Stakeholder Consultation

4.1 Consultation

Since commencing operations in the region in 1999, Roc have consulted with various stakeholders in an endeavour to keep them informed of Roc's intentions and progress. Most stakeholders will therefore be familiar with Roc and its activities in the region prior to specific consultation about the Cliff Head Development.

Consultation to date has taken a range of forms including face-to-face meetings, town and shire meetings, meetings with regulatory authorities, letters to key stakeholders, notices of drilling activities at local boat ramps, a notice in the local press, and media coverage in Business News and Geraldton Times. These activities will continue during the development, construction and operational phases of the project.

To date over 80 consultation interactions have occurred with various stakeholders, including (Q&A, 2003):

- Local communities of Dongara, and Port Denison.
- Local shire councils (in particular the Irwin Shire Council, but also the Greenough Shire and Geraldton City).
- Western Australian Government including representatives of Department of Industry and Resources, Department of Conservation and Land Management, Department of Environment, Fisheries Western Australia, and Department of Planning and Infrastructure.
- Federal Government including the Department of Environment and Heritage, Geoscience Australia and Department of Industry Tourism and Resources.
- Rock lobster and fishing industry, including the Western Rock Lobster Council, Dongara Professional Fishermen's Association, Geraldton Professional Fishermen's Association, United Mid West Professional Fishermen's Association, Longline Association, Kalbarri Professional Fishermen's Association and Western Australian Fishing Industry Council.
- The Western Australian Conservation Council.
- Geraldton Port Authority.
- WA-286-P joint venture partners and shareholders, Roc Board and employees and Roc-engaged contractors.

A more detailed list of consultation activities is provided on pages 28 to 29 of Appendix A

4.2 Stakeholder Issues

The following issues have been summarised from the Social and Economic Assessment (Q&A, 2003) and Roc's consultation records.

Fishing Industry

The Dongara, Kalbarri and Geraldton Professional Fishermen's Associations, and the United Mid West Professional Fishermen's Association represent the industry locally. The Western Rock Lobster Council and Western Australian Fishing Industry Council represent the industry at a state level. In the vicinity of the project, commercial fishing is restricted to rock lobster fishing (Figure 4.1).

Figure 4.1 Rock lobster fishermen

The key issues for this group include the potential for petroleum operations to damage fishing equipment, the maintenance of fishing access to areas where the marine pipeline and platform are proposed, and the threat of pollution to the marine environment during construction and drilling, and during the operation of the project.

Local Government Authorities
Local government authorities affected by the project include the Shire of Irwin, the City of Geraldton, and the Shire of Greenough. The impacts of this development will predominately occur within the Shire of Irwin and the City of Geraldton. The Irwin Shire has expressed support for the selection of the Westlime plant site as the onshore facility site for the project.

The key issues for this group include the generation of economic opportunities within their areas, the demands for accommodation and housing, the requirement for infrastructure and community development that the project may involve, any potential impact on other local industries, and any impact reducing community cohesion. Irwin Shire has expressed strong support for appropriately managed development projects within its boundaries, and has actively encouraged Roc to develop the Cliff Head field.

Department of Conservation and Land Management (CALM)
CALM are responsible for the management of Beekeeper's Nature Reserve. Key issues for CALM include: direct impacts on Beekeeper's Nature Reserve, such as weed control and fire; indirect impacts, such as changes in access to the reserve because of the project easement; and potential impacts from the project on areas of conservation interest such as the seagrass meadows adjoining the reserve.

Conservation Council
The key issues for this group is how the development will be managed to minimise potential impacts on the natural environment, and how justified the project is in the context of sustainable development.

Beekeepers
Input from beekeepers has been sought and no comments have been received to date. Key issues for this group are likely to be fire management, access to apiary sites, the potential impacts of pollution on honey-harvesting activities, and any potential impacts on the surrounding flora.

Mid West Development Commission and Chamber of Commerce
There are a number of business, industry and professional group associations within the region including a Chamber of Commerce in Dongara, agricultural associations and societies and progress associations. The Mid West Development Commission is active in promoting development of the region.

Key issues for this group are likely to include economic opportunities, site development, workforce location, housing and accommodation, impact on other industries. Direct contact has not yet been established with this group.

Health, Police and Emergency Services
Port Denison's Sea Rescue Group, Dongara Fire and Rescue Service, Dongara Police and Dongara Health Service are key organisations in the existing local emergency response strategy. Key issues for this group are likely to include understanding the project's safety procedures and emergency response plans, consideration of access to project infrastructure such as vessels during a community crisis, involvement of employees in local volunteering and integrating their capacity to assist in a project incident or crisis event.

Tourism Industry
Neither the offshore platform location, nor the onshore plant site is likely to be accessed by tourists, but key issues for the local tourism industry will include the need to minimise visual impacts of the project, impacts on accommodation, service provision, access to recreational beaches and amenity.

Local Dongara/ Port Denison Community
Key issues for local residents are likely to include economic opportunities, accommodation and housing, impact on lifestyle or social cohesion due to short-term influx of contracting personnel, alcohol and drug policies for contracting personal, access to recreational areas and amenity.

5. Assessment of Environmental Risk and Proposed Management Strategies

This section examines the potential environmental impacts and proposed management strategies associated with each environmental factor identified in the guidelines provided by the EPA and DEH (Appendix A). The management strategies identified in this chapter will form the basis of the environmental management plans that will be developed if the Cliff Head Development proposal is accepted. In many cases, management strategies for one environmental impact will contribute to the management of other impacts. For simplicity, each strategy is discussed in most detail where it contributes most to managing a particular impact.

The analysis and discussion that follows in this section is necessarily itemised to individual impacts and potential impacts. However, some perspective can be drawn from the following:

- The main impacts derive from construction: drilling wells, installing the platform and laying the offshore and onshore pipelines. These impacts are physical in nature, and are temporary, localised and, for all practical purposes, recoverable.

  The Arrowsmith Separation Plant will involve the re-development of a brownfields industrial site.

- During operations, the offshore facilities and offshore and onshore pipelines will operate passively with negligible discharges to air or water.

- Operational discharges from the Arrowsmith Separation Plant will comprise mainly combustion products from burning natural gas.

- The waxy nature of the Cliff Head crude and its low reservoir pressure, means that the quantity able to be spilled is very small and its toxicity very low.

Roc envisages the main environmental management challenges as the rehabilitation of the land-sections of pipeline that must run through 3 km of erosion-prone, exposed and sandy country between the coast and the Arrowsmith Separation Plant.

5.1 Risk Assessment of Environmental Impacts

Environmental risk assessment is a process that evaluates the likelihood and consequence of adverse environmental effects that may occur as a result of exposure to one or more stressors (US EPA, 1998). The process has been used to systematically evaluate and organise data, information, assumptions, and uncertainties in order to help understand and predict the relationships between stressors and environmental effects in a way that is useful for environmental decision-making.

The risk assessment has included an evaluation of the significance of the potential short-term and long-term environmental impacts of physical, chemical and biological stressors. It has included consideration of the potential environmental risks associated with the routine and non-routine (accidental) activities and operations of the proposed Development.

Table 5.1 Environmental risk assessment category definitions

Frequency	**Qualitative Description of Frequency**
Unlikely	Impact has not occurred in the past and there is a low probability that it will occur in exceptional circumstances.
Possible	Impact may have occurred in the past and there is a moderate probability that it will occur at some time.
Likely	Impact has occurred in the past and there is a high probability that it will occur at some time.
Highly Likely	Impact has been a common problem in the past and there is a high probability that it will occur in most circumstances.
Routine	Impact will occur, is currently a problem in the area or is expected to occur in almost all circumstances.
Consequence	**Qualitative Description of Environmental Effects**
Slight	Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
Minor	Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or ecological system.
Major	Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without loss of pre-incident conditions.
Severe	Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-incident conditions.
Disastrous	Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

The overall method applied is consistent with that described within AS/NZS 4360; however, the terminology used for ranking of likelihood and consequence differs slightly in accordance with emerging industry practice.

The likelihood of occurrence for the potential environmental impacts from the proposed Development have been estimated based on industry incident reporting, risk assessment workshop findings and professional judgement. Environmental consequences arising from potential environmental aspects of the survey have been categorised from slight to disastrous, using the qualitative methodology described by Stoklosa (1998) and defined in Table 5.1.

Table 5.2 Generic environmental event potential matrix

	Likelihood				
Consequence	Unlikely	Possible	Likely	Highly likely	Routine
Slight	Low	Low	Low	Low	Low
Minor	Low	Low	Medium	Medium	Medium
Major	Medium	Medium	Medium	Medium	Medium
Severe	Medium	Medium	Medium	High	High
Disastrous	High	High	High	High	High

Table 5.2 shows the overall environmental risk assessment matrix (also referred to as an event potential matrix) that compares the likelihood and consequences of key environmental aspects arising from the proposed Development and assigns a level of environmental risk.

5.2 Marine Ecology

Factor	EPA Objective
Marine ecology including sea floor, marine flora and fauna	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS guidelines for ballast water management and ANZECC Code of Practice for Antifouling.

Aspect summary: marine ecology

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Physical disturbance	Anchoring	Medium	Selection of pipeline route and tow path to minimise impact. Use of support vessels to deploy and recover anchors. Use of anchor pennants to lift the anchors.
	Footprint	Low	Selection of location for seabed facilities and wellhead platform.
	Pipelay Scour	Medium	Selection of pipeline route and tow path to minimise impact. Use of horizontal directional drilling and shore-based installation of the pipeline out to the 6 m water contour.
Light	Lighting during drilling and installation	Low	Lighting during drilling and installation activities to be kept to minimum necessary for safe operations. Floodlighting of the drilling-rig decks to allow 24-hour operations will be adjusted to avoid directly illuminating the adjoining ocean area.
	Navigation lights	Low	Operational maintenance will be a daylight only activity. The platform will be unmanned at night. The only platform lighting will be navigational safety lights, similar to those on moderate-sized vessels.
Noise	Drilling and Installation	Low	Apply standard industry practise for management of noise from machinery on the drilling rig and installation vessels. Monitor and record presence of whales during drilling and installation activities.
	Operations	Low	Apply standard industry practise for management of noise from machinery.
Liquid discharges	Utility waters	Low	Machinery and equipment will be maintained to prevent contamination of cooling waters.
	Sewage	Low	In Commonwealth waters more than three nautical miles from the coastline, only sewage from a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV will be disposed to sea. Sewage will not be discharged to sea in state waters.
	Greywater	Low	Greywater and putrescible wastes will be disposed of in accordance with Clause 222 (Housekeeping) of the Schedule to the Western Australian *Petroleum (Submerged Lands) Act 1982* (PSLA), which requires that food scraps and sanitary effluents be passed through a grinder or comminuter so that the final product will pass through a screen <25 mm diameter prior to disposal to the sea.

Aspect summary: marine ecology (cont'd)

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Liquid discharges (cont'd)	Deck runoff	Low	Machinery spaces on the drilling rig and installation vessels will be bunded to contain any deck spillages. Chemicals used or stored on board the drilling rig will be managed so as to prevent damage to the containers. All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal. All storage facilities and handling equipment will be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable. Procedures will be in place on the drilling rig and installation vessels for the clean-up of small deck spillages.
	Antifouling leachate	Low	Tribulytin will not be used on any subsea infrastructure of the Cliff Head Development.
Solids	Drill cuttings	Low	Drill cuttings to be separated from drill fluids prior to discharge to sea.
	Drill fluids	Low	Preference for water-based drilling fluids to be used wherever practicable to do so. Non-water–based muds to be of low toxicity and recovered from cuttings for return to shore at completion of drilling.
Accidental releases	Crude oil	Low	The wells will incorporate a blowout prevention system capable of containing pressures in the well strings of up to 5,000 psi. Platform and pipeline equipment will be designed to withstand full reservoir pressures without loss of containment. All machinery and engine oil spills and below-deck spills will be captured (catchment lips around potential spill areas), mopped up, containerised and sent to shore for recycling/disposal (this applies to the drilling rig). All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean. Vessel to rig transfers of drilling fluids and fuel will be conducted in accordance with defined marine drilling and supply vessel Contractor procedures which will be identified to all personnel concerned with transfer operations in the job hazard analysis. Real-time oil spill modelling capability will be in place during the drilling programme. Stocks of absorbent materials on board the mobile offshore drilling unit (MODU) and standby vessel(s) will be checked for their adequacy and replenished as necessary prior to the commencement of operational activities at the well. Actions to prevent marine collisions will include: - Notification of Australian Maritime Safety Authority (AMSA) via the Rescue Co-ordination Centre (RCC) in Canberra. - Issuing of standard AusCoast radio warnings to shipping by the RCC. - Standard maritime safety procedures (AusCoast warnings via the AMSA, radio contact, display of appropriate navigational beacons and lights). Procedures and equipment for preventing loss of well control will be separately described within the MODU Safety Case. Procedures and equipment for preventing loss of hydrocarbons during operational activities will be separately described within the Operations Safety Case. A detailed oil spill contingency plan, accepted by the designated authority, will be in place prior to commencement of drilling, installation or operational activities. As a mitigating action Roc will remain a member of Australian Marine Oil Spill Centre (AMOSC) which in turn maintains a capacity to respond to oiled wildlife in emergency situations.
	Introduction of exotic species	Medium	Adherence to AQIS regulations for controlling preventing the introduction of marine pest species.
	Process chemicals	Low	All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean.

5.2.1 Physical Disturbance

The degree of physical disturbance to the seabed will be greatly affected by the final selection of method for pipelay. Two methods are under consideration, these being pipelay from a barge and bottom tow of pipeline strings (see Section 3.7).

Anchoring

If the pipeline is to be installed from a pipelay barge, the barge will be held in place using anchors. Pipelay barges typically utilise eight anchors spread out from the barge. A typical anchor deployment pattern is shown by Figure 3.13.

The pipelay barge would pass over approximately 2.8 km of high (>80%) density seagrass meadow, 1.5 km of low (<20%) density seagrass with interspersed bare sand, 2.5 km of mostly bare sand with occasional pavement and 4.0 km of limestone pavement (refer to Section 2.2 for fuller description of habitat types).

Physical disturbance of the seabed will be mainly associated with lateral movement of the anchor lines as the barge moves along the pipeline route and, to a lesser extent, as the anchors are picked up and moved. Where the anchor chains cross over limestone pavement or isolated patch reefs, it is expected that there will be localised disturbance to the biological communities associated with the outcrops. This disturbance is unlikely to have a significant impact on the populations of biota associated with the outcropping due to their widespread distribution throughout the Development area. In areas of sandy seafloor, 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. In areas of seagrass, lateral movement of the anchor cable will result in seagrass being flattened and torn as the cable passes across. Areas where the seabed is mounded will receive greatest impact as the weight of the anchor cable passing across will tend to smooth out smaller mounds; conversely, areas of depressions will be passed over with minimal impact.

The rate of recovery of the seagrass will be dictated by the severity of impact and the growth characteristics of the species affected. The seagrass meadows are comprised predominantly of *Amphibolis, Thallasodendron* and *Heterozostera* species. *Amphibolis* is relatively deep rooted in sandy sediments and, although there would be some loss of apical meristem branches, this would be offset somewhat by the survival of the rhizomes and relatively rapid rate of rhizome elongation. It is predicted that recovery of *Amphibolis* will occur within a short to medium time-frame (i.e., one to three years for full recovery) where the severity of impact from the anchor cable has been light to medium. In areas of heavy impact where the sediment has been graded by the anchor cable, there is potential for removal of the rhizomes. In such cases recovery depends on growth inwards from the disturbance edge and new propagules becoming established. Prediction of the timeframe for recovery in areas of heavy impact from the anchor cables is uncertain.

Thallasodendron and *Heterozostera* both have intercalary meristematic regions. In areas where the severity of impact is light to medium, recovery is predicted to occur relatively rapidly from rhizomes. As is the case for *Amphibolis,* the rate of recovery in areas of heavy impact from the anchor cables is uncertain.

An area of approximately 11.2 ha of high-density seagrass meadow would be affected to varying degrees. Within the management unit area (as defined in Section 2.2.1) there is approximately 1,600 ha of high density seagrass meadow. Because of the low level of disturbance that has occurred in the area it is assumed, for the purpose of this assessment, that the current areal extent of seagrass is equivalent to the pre-European areal extent of seagrasses. The area affected is equivalent to approximately 0.7% of the seagrass meadow habitat within the management unit area.

The Western Australian EPA Draft Guidance No 2, Benthic Primary Producer Habitat Protection for Western Australia's Marine Environment sets out cumulative loss thresholds for six categories of marine ecosystem protection. The marine area between Leeman and Dongara is given as an example of a Category D: Non-designated Area. The appropriate cumulative loss threshold for this category is given as 5% of benthic primary-producer habitat. The predicted area of impact to seagrass meadow is substantially less than this cumulative loss threshold.

Support vessels will also anchor in the vicinity of the drilling rig from time to time when not on active service. The impacts associated with anchoring these vessels is predicted to be slight and the environmental risk low.

Footprint

Seabed disturbance will occur when long-term seabed fixtures such as the platform and pipelines are installed as well as when the drilling rig is jacked up. Each leg of the jack-up drill rig typically occupies an area less than 70 m^2 so that the total footprint area from the drilling rig is very small compared with the overall extent of the habitat in this area.

The potential environmental impact of the footprint of the facilities and the drilling rig will be minimised by locating the facilities and drilling rig in areas less sensitive to physical disturbance within the operational constraints of the project. The environmental consequence of this impact is considered to be slight; therefore, the environmental risk is categorised as low.

Pipelay Scour

If the pipeline is installed using the bottom tow method, it will result in scouring of seabed along the route as the pipelines are dragged into place. The potential consequences of scouring are the trenches that result where the pipes are drawn over the sea floor, and the disturbance caused from propeller wash as high towage requirements are delivered in shallow waters. A series of essentially parallel trenches would be generated that would cause disturbance approximately 0.5 m wide. Some disturbance of sea floor sediments would be expected in the shallower sections of the tow-vessel path. The area of high density seagrass meadow that would be impacted by bottom tow of the pipeline strings would involve a number of narrow tow lines within a corridor of about 8 ha. The total area within which the affected areas would lie is equivalent to approximately 0.5% of the seagrass meadow habitat within the management unit area.

Management of Potential Impacts

- Selection of location for seabed facilities and wellhead platform has included preference for lowest impact to benthic communities.
- Selection of pipeline route and tow path to minimise impact on high density seagrass meadows.
- Use of support vessels to deploy and recover anchors.
- Use of anchor pennants to lift the anchors.

- Use (where practicable) of horizontal directional drilling and shore-based installation of the pipeline out to the 6 m water contour.

5.2.2 Light

Drilling and Installation

Drilling and installation are carried out 24 hours a day and operations will be flood-lit for functional and safety reasons for the six months required for offshore construction and commissioning.

While is difficult to make precise predictions of the impact of artificial light, the following outlines the effects on two faunal groups for which empirical evidence is available.

- Lutcavage et al. (1996) and Pendoley (1997) have linked lighting to disorientation in turtles, particularly during periods of nesting and hatching. At Cliff Head, the Development area is a small part of the extensive range of a number of turtle species. However, the locality-specific and most susceptible phase in the turtles life-cycle, nesting, does not take place in the Development area.
- Studies from the Gulf of Mexico and North West Atlantic by Weise et al. (2001) suggest that artificial light can disorient seabirds, which may be attracted to the lighting and other visual cues present on the MODU. The duration of this potential behavioural effect will be the six months of drilling and installation, after which the less intense navigation lighting regime of the operational phase will take over.

In both cases, the most intrusive artificial lighting will be temporary and localised to a small part of an extensive area of similar coastal and marine habitat. The impacts of lighting will be behavioural and by inference, similarly short-term and localised.

Operations

The wellhead platform is unmanned and so there is no functional or safety need for flood lighting during normal operations. Maintenance will take place during daylight and there is no provision for flaring gas.

Navigation lighting is designed to indicate the presence of a hazard without affecting night vision (rather than to illuminate). It might give rise to some localised attraction of squid and some fish to the platform, or may repel some other marine species. It would be of lesser intensity that the artificial lighting used specifically for fish-attraction by commercial and recreational fishers, and without the latter's fatal consequences for the attracted species.

Lights from the onshore plant will not be directly visible from the sea surface.

Management of Potential Impacts

- Lighting during drilling and installation activities to be kept to minimum necessary for safe operations.
- Lighting at wellhead during operations to be kept to minimum necessary for navigation safety.

5.2.3 Noise

Drilling and Installation

Noise sources from the activity will consist of the physical drilling process, generators and pumps, support vessels and helicopters.

The effect of noise on whales and other marine animals depends on their sensitivity to the sound intensity and sound frequencies. For comparison, a breaching whale's sound intensity is approximately 200 dB re 1 μPa2/Hz at 1 m, and background noise levels in the sea are approximately 100 dB re 1 μPa2/Hz (McCauley, 1998).

An underwater noise survey commissioned by Shell Development Australia and carried out by Curtin University's Centre for Marine Science and Technology during the drilling of the Evans Shoal-2 well in July 1998 (McCauley, 1998) concluded that:

- The peak noise generated from normal drilling activities was 115–117 dB re 1 μPa at 405 and 125 m respectively from the wellhead and, under ideal conditions, may be audible up to 11 km away.
- The peak noise generated from rig support vessel maintaining position off the rig was 137 dB re 1 μPa at 405 m astern the rig, and 120 dB re 1 μPa at 3–4 km from the rig and, under ideal conditions, may be detectable up to 20 km away.
- This noise level decreased rapidly with distance from the wellhead.
- The lack of any threatening stimuli accompanying the noise from the drill rig would allow for rapid habituation, greatly reducing the impact of the noise.

The level of noise generated from drilling is well below the source levels of the highest components of humpback whale song (192 dB re 1 μPa2/Hz), and is not much greater than the ambient background noise level (McCauley, 1998). Thus, the noise from the drilling rig must be well within the range which humpback whales would be expected to cope with physiologically, since it would be difficult to argue that humpback whale song can cause physiological problems to the animals (McCauley, 1994). Some avoidance behaviour may be exhibited, but given that the area is in shallow water and distant from the main migratory routes, this is likely to be of slight impact.

Short-term noise and vibration due to drilling activities are considered to have a negligible impact on migratory whales. The likely frequency of visitation to the Development area by whales and turtles is perceived to be low. Whales have relatively short periods of migration through the wider locale adjacent to the Development area; however, none are known to utilise the area for either feeding or breeding. It is possible that some marine fauna may exhibit behavioural modifications as a consequence of noise generated during drilling and installation activities. However, the level of environmental impact associated with noise from the proposed Development is expected to be temporary and slight and the environmental risk is considered to be low.

Operations

The broadband noise produced by an operational wellhead has been measured by McCauley (2002) and found to be very low (113 dB re 1μPa), which is only marginally above rough-sea-condition ambient noise.

There are no substantial flow restrictions in either the wellstream or produced water reinjection pipeline, thus the primary mechanism for generating sound within the pipeline, turbulent flow around an obstruction, will be minimised. This implies that the source levels of sound within the pipeline will be low. The pipeline will also have an external thermal insulation and concrete coatings that will act to dampen the transfer of sound from within the pipe to the water column. Given that the mechanisms for noise generation within the pipeline are minimal and that the pipeline is to be insulated and concrete coated, then it is unlikely that there will be any significant sound produced along the pipeline length.

Most marine benthic invertebrates, including rock lobster, have poorly developed mechano-sensory systems (McCauley, 1994) and would therefore

be little affected by noise generated by drilling or flow of liquids through the pipeline. Thus it is unlikely that any benthic invertebrates would suffer any direct negative impacts from noise generated by the proposed Development.

The levels of noise that are expected to occur are unlikely to cause any significant physiological effects to marine fauna whether considered individually or cumulatively with existing noise sources.

Management of Potential Impacts

- Apply standard industry practise for management of noise from machinery on the drilling rig and installation vessels.
- Monitor and record presence of whales during drilling and installation activities.

5.2.4 Liquids

Sewage and Greywater

Treated sewage and greywater wastes will be disposed to sea in Commonwealth waters more than three nautical miles from the coastline. Sewage will not be discharged to sea in state waters.

Treated sewage and greywater (comprising laundry, shower and hand-basin waters) will be discharged to sea at location from the drilling rig, support vessels and (if used) laybarge. Drilling rigs and laybarges are normally equipped with a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV that uses aeration, clarification and chlorination processes. Greywater from showers and the laundry are discharged directly overboard. During drilling and well test operations (if conducted), the personnel aboard the drilling rig will contribute up to an estimated 7 m^3 of sewage and greywater discharge per day.

The environmental impacts due to the discharge of sewage and greywater as a result of the well programme are anticipated to be slight due to the low volumes involved, rapid dispersal in oceanic currents and high biodegradability/low persistence of the wastes. The ecological effects of the discharge of small volumes of sewage and greywater are considered to be slight and the environmental risk is considered to be low.

Utility Waters

During drilling and construction operations, utility water, comprising cooling water and wastewater from desalination systems, will be discharged to sea. The discharged waters will initially be subject to turbulent mixing and dilution. Heat loss and dilution to background levels would occur quickly. The ecological effects of the discharge of utility waters are considered to be slight and the environmental risk is considered to be low.

Deck Drainage

Deck drainage from the drilling rig and laybarge consists mainly of washdown water and occasional rainwater. While no wastes will be routinely discharged via deck washdown, the washdown or rainwater runoff will generally be directed overboard, but may contain small quantities of oil, grease and detergents. Areas on the vessels that are more likely to have small oil spills will be directed to a sump, which is, in turn, normally directly connected to an oily-water separation system such as the slops tanks.

Deck drainage from the wellhead platform will be injected into the product pipeline and transferred to the onshore Arrowsmith Separation Plant.

The ecological effects of the discharge of small volumes of deck drainage during drilling and construction containing low concentrations of oil-in-water are considered to be slight and the environmental risk is considered to be low.

Anti-fouling Leachate

Tributyltin (TBT) is by design toxic to marine life and has for some time been the active ingredient in anti-fouling paint. TBT leached from vessels hulls and offshore structures breaks down relatively quickly in the oxygenated water column, but can persist in anoxic sediments for some years.

In November 1999, the International Maritime Organisation (IMO) directed the Marine Environment Protection Committee to develop an instrument, legally binding throughout the world, to address the harmful effects of anti-fouling systems used on ships. The objective was to institute a global ban on the application of TBT paints on ships by 1 January 2003 and a complete prohibition on the presence of TBT paints on ships by 1 January 2008. The five-year gap allows for ships legally coated with TBT before 1 January 2003 to operate until their next dry-docking for maintenance. These conditions will apply to all vessels and the wellhead platform.

Vessels and marine structures are now in the transition period in Australia and around the world. The new facilities at Cliff Head will therefore not use TBT, but TBT may be present on some of the vessels used for installation.

Antifouling for the platform will be a cold-applied liquid application (paint) with aluminium as the active constituent. Application will be completed prior to the installation of the platform at the location.

Management of Potential Impacts

- In Commonwealth waters more than three nautical miles from the coastline, only sewage from a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV will be disposed to sea.
- Sewage will not be discharged to sea in state waters.
- Greywater and putrescible wastes will be disposed of in accordance with Clause 222 (Housekeeping) of the Schedule to the Western Australian *Petroleum (Submerged Lands) Act 1982* (PSLA), which requires that food scraps and sanitary effluents be passed through a grinder or comminuter so that the final product will pass through a screen <25-mm diameter prior to disposal to the sea.
- Machinery spaces on the drilling rig and installation vessels will be bunded to contain any deck spillages.
- Chemicals used or stored on board the drilling rig, laybarge, wellhead platform and support vessels will be managed so as to prevent damage to the containers.
- All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal.
- All storage facilities and handling equipment will be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable.
- Procedures will be in place on the drilling rig and installation vessels for the clean-up of small deck spillages.
- TBT will not be used on any subsea infrastructure of the Cliff Head Development.

5.2.5 Solids

Drill Cuttings and Fluids

The potential environmental impacts of drill cuttings and drilling fluid discharges

are both physical and biochemical. The level of impact will be determined by a combination of factors such as:

- Sensitivity of the environment and organisms in the affected area. The benthic community in the vicinity of the proposed wellhead platform are adapted to cope with short periods of very high turbidity that occur naturally. However extended periods of high turbidity or very heavy sedimentation loads would be detrimental.
- Type and chemical composition of cuttings particles and drilling fluids. The cuttings from the well are expected to be inert carbonates, marls, claystones and sandstones. Toxicity tests carried out on drill cuttings recovered from the Cliff Head-1 well (West, 2002) indicate they are of non-toxic nature. It is proposed that water- based drill fluids with low inherent toxicity will be used for drilling the top-hole sections. The lower-hole sections may be drilled with non-water–based synthetic fluids. If this does occur then these fluids would be recovered (except for a small fraction that adheres to the cuttings) and returned to shore for recycling or disposal. Water-based drilling fluids have low toxicity and low bioaccumulation potential and are routinely accepted for discharge in open waters by the WA Department of Industry and Resources (DoIR) and other designated authorities.
- Volume of discharge. The volume of discharge cuttings will be approximately 330 m^3 of cuttings and 160 m^3 of fluids per well.
- Depth of discharge. The cuttings and muds will be discharged in water depths of approximately 17 m. At this depth the cuttings, and associated drilling fluids, will settle rapidly to the seafloor forming a relatively thick layer of new sediment over a very localised area. However, strong currents, such as those which occur during storm events, will disperse these sediments over a wider area.
- Rate of degradation of chemical components of the fluid system. Water based fluids proposed for use are highly biodegradable and will not persist in the marine environment.

Three-dimensional computer modelling of the fate of discharged drill cuttings and drilling fluid was undertaken for the Cliff Head-1 well (GEMS, 2000). The modelling utilised the sediment and solutes behaviour model MUDMAP coupled with a three-dimensional, hydrodynamic model. The results indicated that:

- Drill cuttings discharged during drilling of the well would settle in an elliptical pile measuring approximately 125 m by 60 m. The pile was predicted to extend in a roughly north–south direction around the well with a maximum thickness of 1 m near the centre. Importantly, a post-drill survey conducted shortly after the drilling of Cliff Head-1 failed to find any evidence of persistent drill cutting piles. It is considered that this was due to the cuttings being remobilised after deposition and dispersed by the strong ambient surge currents present in the area.
- A relatively thin discharge plume of drilling fluids would extend to the north-northeast of the rig, parallel to the alignment of the shallow reefs of the area. In the area immediately surrounding the discharge pipe, maximum concentrations would reach 120 g/m^2. Based on the ecotoxicity testing results for typical water-based drilling fluids (Hinwood et al., 1994), these levels are unlikely to be toxic to marine biota.

The nearest reefs containing biota that may be susceptible to smothering from fine materials are at Horseshoe Reef, more than 400 m away. Local reefs frequently experience naturally high levels of suspended sediments due to wave action resuspending seabed sediments. The concentration of drilling fluids that may reach reef areas has been calculated to be significantly lower than the expected natural sedimentation loads. Discharge to sea of drilling fluid from the Development is unlikely to have an effect on the reef biota.

Experimental exposures much higher than will be the case at Cliff Head show rapid recovery of the non-reef benthos following the discharge of water-based drilling fluids. Evidence for this is provided by a field experiment conducted by Bakke et al., (1985). In this study, trays of seabed sediment devoid of flora and fauna were covered with a 10-mm layer of water-based fluid slurry, returned to the sea and periodically sampled to assess recolonisation. Sampling of trays found colonisation by algae (principally diatoms), meiofauna and macrofauna components commenced immediately. Peak meiofauna densities were reached within two weeks and macrofauna diversity was found to be comparable to mature sediment communities within one year.

It is predicted that discharge of drill cuttings (and adhered fluids) will result in a temporary reduction of the abundance and biomass of non-reef flora and fauna in the immediate environmental setting. However it is unlikely to cause any change to biodiversity or ecological systems. The environmental consequence of the discharge of drill cuttings is considered to be minor; therefore the environmental risk is categorised as medium.

The discharge of drilling fluids will lead to a temporary increase in turbidity of the surrounding waters and slight increase in sedimentation rates. The area is subject to short periods of very high turbidity from natural causes. It is predicted that the biota present will be able to tolerate the discharge of drilling fluids with only slight impact; therefore the environmental risk of drilling fluid discharge is categorised as low.

Management of Potential Impacts

- Water-based drilling fluids will be used wherever practicable and technically feasible to do so.
- Non-water–based drilling fluids, if used, will be recovered and transferred to shore for recycling or disposal in accordance with local regulatory requirements.
- Well design will minimise the use of drilling fluids as far as practicable, through measures such as maximising recovery from drill cuttings, batch drilling and reuse of fluids.
- Drill cuttings recovered to the drilling rig will be discharged to sea after separation from drilling fluids.
- Water-based drilling fluids will be discharged to sea.

5.2.6 Accidental Releases

Crude Oil

Characteristics and Impact Factors

Most of the world's crudes have a severe physical and toxicological impact on the plants and animals with which they come into contact. The overall severity of impact then becomes a function of the volume spilled, which in turn usually reflects either the size of the ruptured container or pipeline (for produced oil) or the parameters of a production or exploration well in the case of a blowout.

The worst-case combinations of these factors have a low (and gradually declining) probability of occurrence—major spills are becoming less common as industry standards improve. But they do occur from time to time and the effects can be severe.

The reservoir at Cliff Head and the oil that it contains are, in all important respects, exceptions to the worst-case spill impact scenario outlined above:

- First, the hydrocarbons comprise very little gas and reservoir pressures are low (undesirably so from a production standpoint and in need of artificial pressure maintenance by water injection).
- Second, the waxy crude has a high pour point of 30°C and solidifies at ambient sea temperatures.
- Third, the oil, being low in the lighter (and more reactive) liquid fractions, is of inherently low toxicity.

In other words:

- Active measures are required to produce the wells and maintain the oil as a fluid.
- If any vessel were to rupture, the volume of oil escaping would be low, because no offshore vessels contain large volumes of oil, and the active production measures (the pumps) would be turned off.
- The oil that did escape in small volumes would solidify at once.
- The contact toxicity of the resulting wax balls would be low unless they were ingested.

These characteristics are not the most desirable from a production, processing and product value standpoint, but they do at least predispose:

- A relatively low risk of spill.
- A relatively small volume of oil in a spill, if one were to occur.
- A low environmental impact of such a spill.
- The possibility of a relatively complete clean-up, in that most of the wax balls would wash up on the beaches close to the field.

While wells are being drilled into the reservoir sections, blowout preventers capable of containing pressures of up to 5,000 psi will be in place. On completion, all wells will be fitted with sub-sea safety valves that fail shut in the highly unlikely event of the loss of the platform or the well heads. When first brought into production, wells are expected to be capable of natural flow, but at well-head pressures of less than a few hundred psi. Once the water cut rises to above about 20%, wells are not expected to flow without artificial lift. The production pumps are designed and operated to deliver a well-head pressure in the range of 300 to 400 psi. The surface flow and piping facilities will be sized to withstand pressures of over 3,000 psi. The pressure capacity of the facilities will thus be far in excess of any pressures that could be derived from the reservoir, either naturally, or as the result of the water injection.

Spill Scenarios

There will be small inventories of crude oil at the Cliff Head field location and the pipeline to the onshore plant during the various stages of the Development. Hazard identification studies by Roc have identified a number of sources of potential hydrocarbon spillage. Mitigation measures will be put in place to prevent the accidental release of hydrocarbons from these sources, as described in Chapter 7. Although the Development will be managed to minimise the potential for accidental release of all substances, a residual potential exists for accidental release of hydrocarbons.

The most likely significant spill event involves a potential small release of approximately 80 L of crude oil from the lubricator. The largest credible spill release was estimated to be 6.5 m^3 (about 40 barrels) from a pipeline rupture. This volume is very low in comparison to the largest credible spill size from other oil field developments. The difference is due to the uncommon physical characteristics of both the reservoir and the crude oil itself. The reservoir is not under high pressure, and requires pumps to lift the oil out and transfer it along the pipeline. Consequently if the pumps are shut down, as would happen in the event of a leak being detected by way of the drop in flow rate at the plant, the oil will stop flowing. The pour point of the crude is approximately 30°C and at normal ambient seawater temperatures the crude will form a waxy solid (see Figure 3.3). Therefore with no pressure to drive the oil out of the pipeline, the oil is expected to solidify within the pipeline and only a small volume would actually escape to the marine environment.

Fate and Effects

Any particular crude oil is comprised of hundreds of chemical substances. The relative balance of the constituent substances influences its chemical and physical properties, which in turn affects the potential for environmental impact on marine biota (Connell, 1995).

The effect of weathering on the chemical and physical properties of the Cliff Head crude oil was determined in a study carried out by Leeder Consulting (Leeder, 2003). On release to seawater, under controlled laboratory conditions, the Cliff Head crude formed a solid mat that remained on the surface of the water. The oil remained solid over the full four-day study period; it did not form a mousse or disperse into the water column. The oil did show some change in characteris-

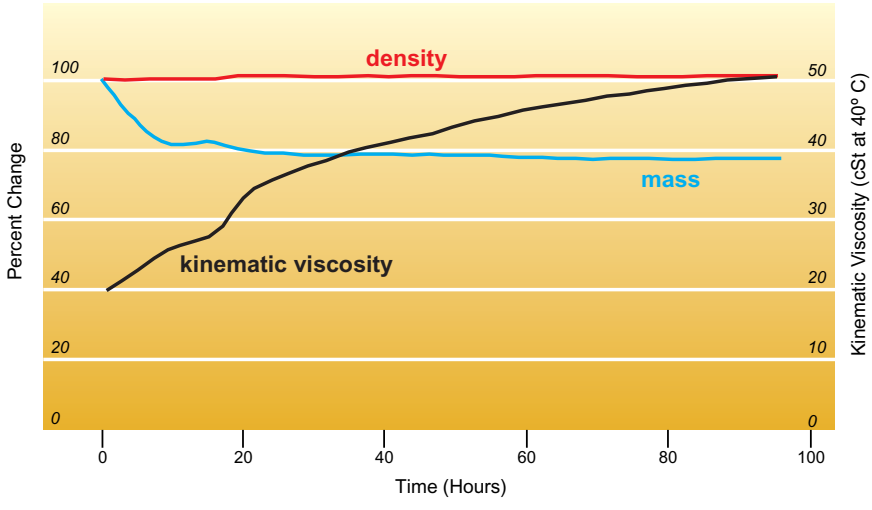


Figure 5.1 Change in physical properties of Cliff Head oil with time

tics, as indicated in Figure 5.1, due to an evaporative loss of the more volatile components of the crude oil.

The amenability of the Cliff Head crude oil to chemical dispersion was tested for three AMSA-approved dispersants (Corexit 9500, Corexit 9527 and Dasic Slickgone). As shown in Figure 5.2 the application of dispersants did not result in any of the crude oil being dispersed into the water column (Leeder, 2003).

Numerical oil spill modelling was carried out to predict the trajectory for two spill release scenarios, an 80-L release from the wellhead platform (nominal location 29° 27' 0.01" S, 114° 52' 10.75" E) and a 6.5-m^3 release from a point approximately mid-way along the pipeline (nominal location 29° 25' 30.0' S, 114° 55' 44.4" E). Both scenarios were repeated for summer, winter and transition weather conditions.

When oil is spilt to the sea surface it spreads and disperses over time. Typically the cut-off point for spill trajectory data modelling and presentation relates to the toxicity of the oil, that is, the minimum concentration modelled is based on the minimum concentration at which toxic response is likely to occur. In the case of Cliff Head crude, because the oil is of very low toxicity and does not disperse into water column, it was considered more appropriate to base the cut-off point for modelling on the more conservative aspect of spill response. A value of 0.05 g/m^2 of crude oil (roughly equivalent to one 'tar-ball' every 20 m^2) was used as the threshold concentration for modelling based on this being considered the minimum amount that a spill responder would be able detect on the sea surface. Results of the modelling are presented in Figures 5.3 to 5.8.

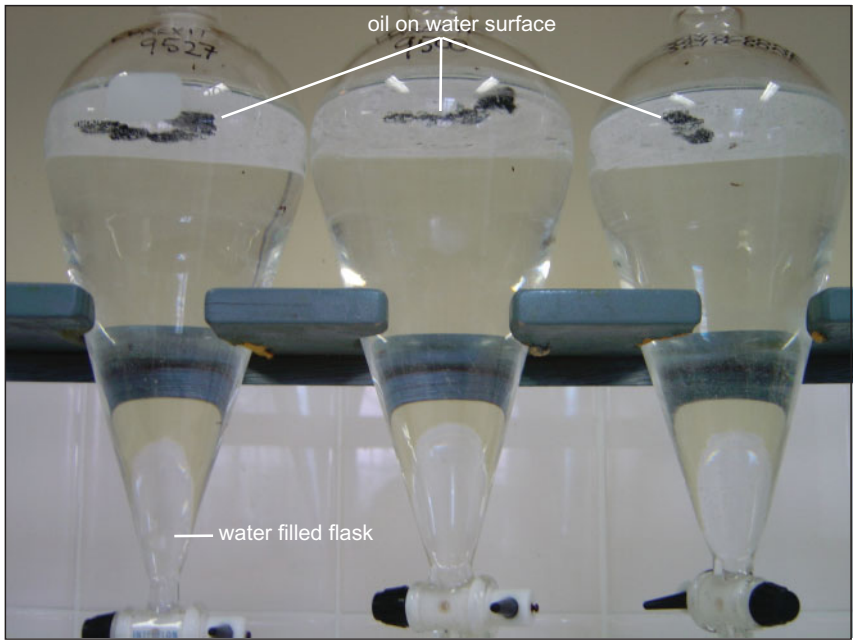


Figure 5.2 Effect of dispersents on Cliff Head oil

It is important to note that the spill envelopes are derived from modelling of 100 separate spill events, each one starting at a random time within the season being considered. Because each modelled spill event starts independently, each event is subject to slightly different metocean conditions and therefore travels in slightly different directions. Each figure presented combines these 100 different spill events and depicts the combined probable area within which the spill may be found. The oil spill envelopes do not represent the extent of any one spill event.

When interpreting the figures (see Figures 5.3 to 5.8) a 20%-probability contour means that there is a 20% chance of finding oil at a concentration greater than 0.05 g/m^2 within that contour boundary. Similarly, a 1%-probability contour means that there is a 1% chance of finding oil at a concentration greater than 0.05 g/m^2 within that contour boundary.

Table 5.3 Summary of modelling results for two release scenarios and three weather seasons

Volume	Season	Shoreline	Probability of Exposure	Minimum Time Before Exposure	Worst Case Volume on any Shoreline	Percentage of Initial Spill (%)
80 L	Winter	Abrolhos Islands	<1%	not relevant	not relevant	not relevant
		Mainland coast	53%	9 hr	30 L	38%
	Summer	Abrolhos Islands	1%	152 hr	57 L	73%
		Mainland coast	26%	13 hr	60 L	74%
	Transitional	Abrolhos Islands	1%	164 hr	64 L	80%
		Mainland coast	32%	10 hr	57 L	73%
6.5 m^3	Winter	Abrolhos Islands	1%	162 hr	2.1 m^3	33%
		Mainland coast	85%	3 hr	4.6 m^3	72%
	Summer	Abrolhos Islands	5%	115 hr	3.0 m^3	48%
		Mainland coast	71%	5 hr	4.6 m^3	73%
	Transitional	Abrolhos Islands	3%	161 hr	2.1 m^3	33%
		Mainland coast	78%	2 hr	3.7 m^3	58%

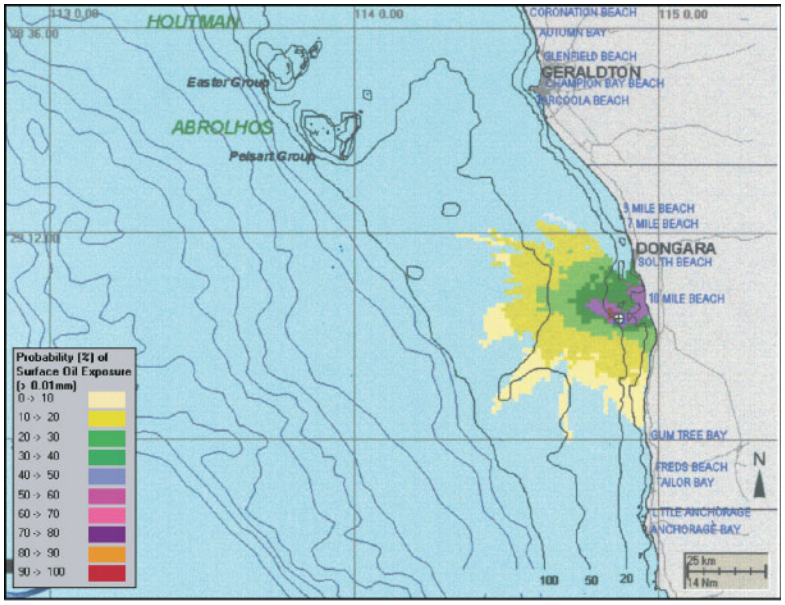


Figure 5.3 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 80 L during winter conditions (May to July inclusive)

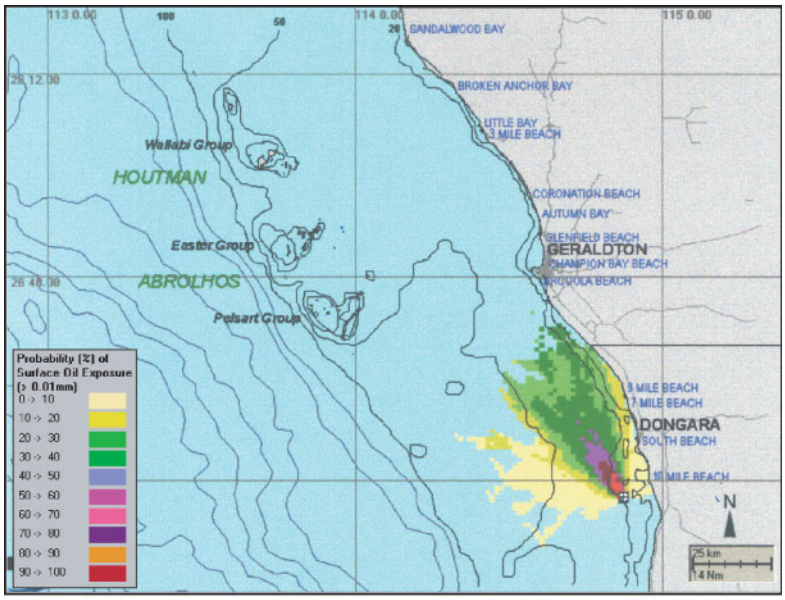


Figure 5.4 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 80 L during summer conditions (January to March inclusive)

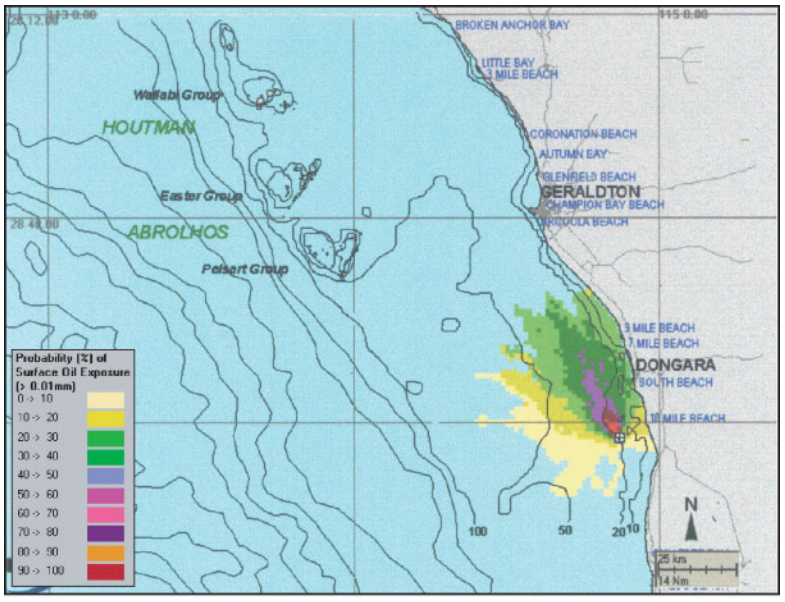


Figure 5.5 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 80 L during transitional conditions (April and August to October inclusive)

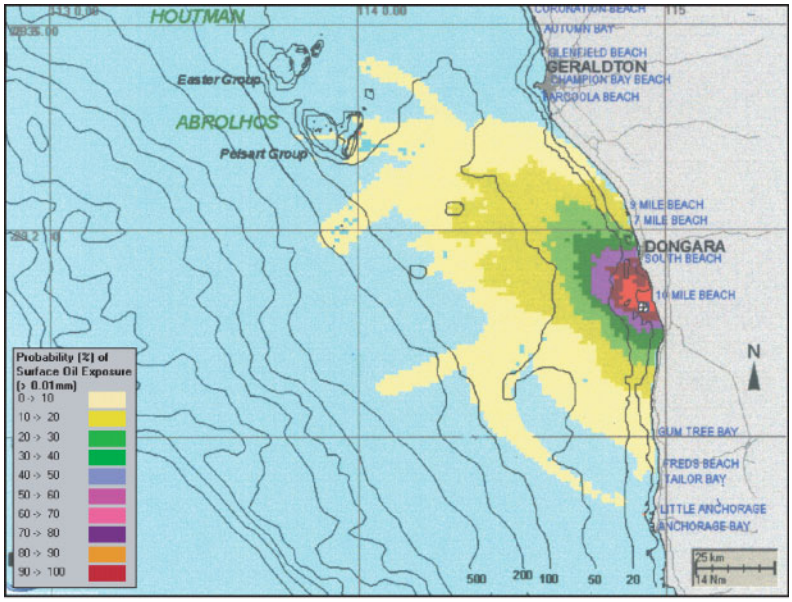


Figure 5.6 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 6.5 m³ during winter conditions (May to July inclusive)

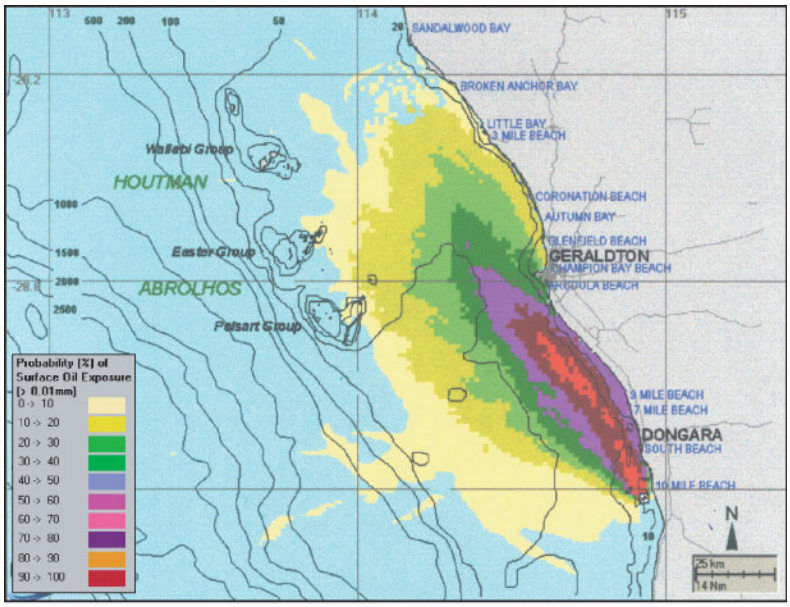


Figure 5.7 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 6.5 m³ during summer conditions (January to March inclusive)

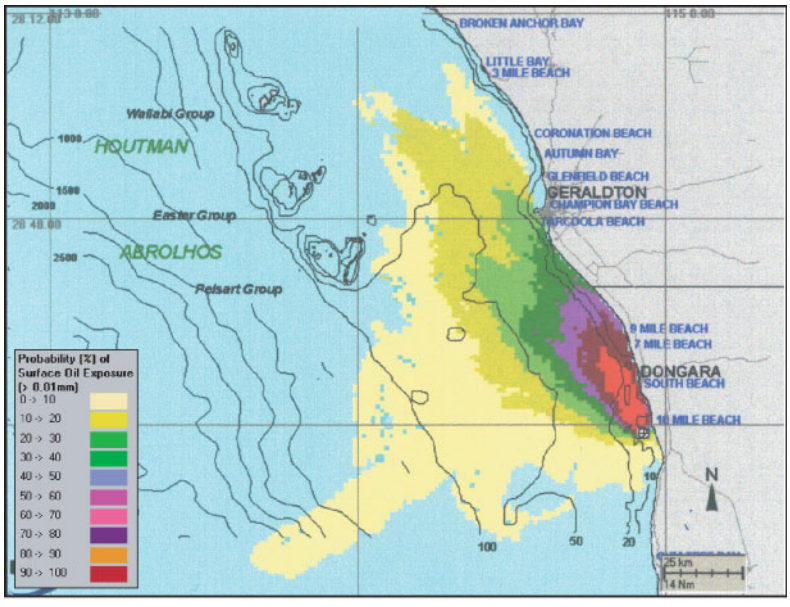


Figure 5.8 Probability of surface exposure to Cliff Head crude oil at average concentration greater than 0.05 g/m², six days after a release of 6.5 m³ during transitional conditions (April and August to October inclusive)

As noted previously, the Cliff Head oil is unusual because it has a pour point of about 30°C, so if spilt to sea it forms a waxy solid that is buoyant and resistant to evaporative and dispersion losses. Consequently it floats in the surface water and, in all of the modelled cases, some portion of the spill will eventually be carried towards a shoreline where it would become stranded. Table 5.3 gives the probability of exposure of the mainland and Houtrman Abrolhos Islands shorelines along with likely volumes of stranding for each modelled scenario.

The probability of stranding on the Houtman Abrolhos Islands shorelines was found to be low. The highest probability occurs during summer with a 5% probability of stranding for 6.5-m^3-release scenarios, when the prevailing winds are more strongly from the south-southeast. In comparison, the probability of contact with the HoutmanAbrolhos Islands shorelines for both spill scenarios decreased to 1% or less in winter, when the winds are more evenly distributed. The probability of contact with the islands shorelines was 1% and 3% during the transition periods for 80 L and 6.5 m^3 release scenarios respectively.

As expected for a development that is only 10 km offshore, there is a high probability of spilt oil being carried towards, and stranding on, the shorelines. The highest probability of contacting the mainland shorelines occurs during winter when there is an 85% probability of stranding for a 6.5-m^3 release from midway along the pipeline and 53% probability of stranding for 80-L release from the wellhead location.

For an 80-L release from the wellhead, the lowest probability of contact with the mainland shoreline occurs during the summer period when the probability of contact is 26%. For the larger spill scenario (6.5 m^3), from a location approximately mid-way along the pipeline, the lowest probability of contact is 71%and also occurs during summer.

The environmental effects of oil spills to the marine environment have been the subject of numerous studies and reviews. The constant theme that emerges from these studies and reviews is the high level of variability with regard to environmental impact from oil in the marine environment. The degree of impact is dependant on the interaction of many factors, primarily:

- The volume of oil spilt.
- Toxicity of the oil.
- The concentration and nature of dispersed hydrocarbons.
- Length and timing of exposure.
- Sensitivity of species exposed (both generally and at the time of exposure).

The maximum volume of Cliff Head oil that may credibly be released in an accidental event from the Cliff Head Development has been estimated at 6.5 m^3. This is a relatively small volume that for oil spill planning purposes would be categorised as a Tier 1 spill under both the National Oil Spill Contingency Plan (NatPlan) and the State Oil Spill Contingency Plan (StatePlan).

The toxicity of Cliff Head crude oil has been evaluated using the standard Microtox toxicity test. The toxicity of the water-accommodated fraction was determined for loadings of 1 g/L and 10 g/L. The results indicated a low toxicity of the oil with EC50 values of 70 for the 1-g/L loading and 24 for the 10-g/L loading (Leeder, 2003). Components that elicit a toxic response in oils are typically water-soluble fractions that disperse out of the oil and are able to pass across cell membranes. In laboratory tests simulating oceanic conditions (Leeder, 2003) the Cliff Head crude oil did not exhibit any tendency to disperse into the water column. Therefore the potential for toxic effects to marine flora and fauna for Cliff Head crude oil is relatively low in comparison to many other hydrocarbons.

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 and marine life on shorelines.

Oil Spill Response

In the unlikely event of an oil spill from either the platform or the pipeline, the initial response actions will be to:

- Ensure the safety of any people that may be affected.
- Halt the flow of fluids giving rise to the loss and secure the breached vessel.
- Monitor the movement of the spilt oil on the sea surface.

The trajectory modelling indicates a strong probability of any spilt oil reporting to the shore between Cliff Head and Geraldton. Attempts to recover oil from the surface of the sea are unlikely to be successful because the wind and sea conditions along this coast preclude use of oil recovery equipment that invariably requires relatively calm conditions. Oil recovery response will be aimed at collecting the waxy oil balls from effected beaches using either hand labour or light-loading machinery. In this exercise, care will need to be exercised to collect only the oily waste and not the large mass of weed debris that frequently marks the high-tide strand line along these beaches. Collected oily waste will then to be disposed of in an appropriate managed waste facility. A detailed oil spill contingency plan will be in place for the duration of the project. Appended to this document is the contingency action plan (Appendix C) which details all procedural steps required in a response to an oil spill.

Marine Mammals

Marine mammals surface to breathe air. They are therefore theoretically vulnerable to exposure to oil spill impacts caused by intersecting an area of oil slick on the sea surface (AMSA, 1998). Whales and dolphins are smooth-skinned, hairless mammals, so oil tends not to stick to their skin and since they do not rely on fur for insulation they will not be sensitive to the physical effects of oiling. Seals and sea lions do have fur and would therefore be more vulnerable to physical oiling effects.

Small doses of oil, when aspirated, have been shown to cause acute fatal pneumonia in mammals. Ingested oil, particularly the lighter fractions, can be toxic to marine mammals. However, because the Cliff Head crude oil has very low percentage of lighter fractions (less than 1% are <C5 hydrocarbons) the potential for aspiration is negligible.

Some whales and dolphin species live and migrate in small groups while others are predominantly solitary. These feed-

ing and behavioural differences mean that oil spills will have varying impacts, may be very seasonal and may affect a few individuals or a relatively large number of animals. Humpback whales and southern right whales do not normally feed during their migration past the Development area and so would not be likely to ingest significant quantities of crude oil in the unlikely event of a spill occurring.

Turtles

There is little documented evidence of the effect of oil on turtles. Should turtles make contact with a spill, the impact is likely to include oiling of the body as well as irritations caused by contact with eyes, nasal and other body cavities and possibly ingestion or inhalation of toxic vapours (Jones, 1986). Post mortem investigations on dead loggerhead turtles from the Mediterranean implicated oil as a cause of death in a number of cases (Gramentz, 1988). In these cases, tar-balls were found in the mouth and gastrointestinal tract of the turtles, suggesting ingestion of tar-balls as a possible cause of death.

Algae and Seagrasses

The effect of hydrocarbons on algae is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to the algae. The morphological features of the algae, such as the presence of a mucilage layer or the presence of fine 'hairs', will influence the amount of hydrocarbon that will adhere to the algae. A review by Connell and Miller (1981) of field studies conducted after spill events indicated a high degree of variability in level of impact but, in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. They attributed the rapid recovery of algae to the fact that, for most algae, new growth is produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are continually lost.

A heavy oiling of medium crude oil in Panama resulted in the loss of algae on coastal reefs. Within two months, algal cover had 'recovered' to a level in excess of the seasonal average, although species composition had changed (Cubit et al., 1987). The time necessary for recovery of species diversity and community structure is not known.

Laboratory tests have illustrated the sensitivity of seagrasses to both surface oil and dissolved or physically dispersed hydrocarbons (for examples refer to Hatcher and Larkum, 1982; Baca and Getter, 1984). As the Cliff Head crude oil does not appreciably dissolve or disperse into the water column, only impacts associated with direct oiling have the potential to occur. Deeper communities will be protected from oiling under all but the most extreme weather conditions. Shallow or intertidal seagrasses are more likely to be affected by oil droplets. However, seagrasses within the area are generally restricted to areas of greater than about 3 m water depth and therefore are not likely to be affected in the event of a spill of Cliff Head crude oil.

Rocky Shore and Limestone Platform Biotic Assemblages

Algae and immobile benthic animals that colonise intertidal rocky shores are vulnerable to oil spills. Filter feeders such as molluscs are especially liable to ingest oil with lethal and various sub-lethal effects. The latter include alteration in respiration rates, decreases in filter feeding activity, reduced growth rates, biochemical effects, increased predation, reproductive failure and mechanical destruction by waves due to inability to maintain hold on substrate (Ballou et al., 1989; Connell and Miller, 1981).

Seabirds

Birds which congregate in large numbers on the sea or shorelines to breed, feed or moult are particularly vulnerable to oil pollution. Although oil ingested by birds during preening may be lethal, the most common cause of death is from drowning, loss of body heat and starvation following damage to the plumage by oil. Birds rely on the air trapped within their feathers to provide insulation and buoyancy. Feathers and down matted with oil lose their waterproofing and insulating properties often leading to death by drowning or hypothermia. Because the Cliff Head crude oil would coagulate into solid balls on the sea surface, the risk to seabirds from contact and coating is lessened.

A seabird's immediate response to oiling is to preen itself. It has been shown that seabirds are able to preen themselves to remove small amounts of adhered oil (Birkhead et al., 1973). But, as it preens its oily feathers, the bird also inhales or swallows toxic compounds that may damage its liver, lungs, kidneys, intestines, and other internal organs with lethal or sub-lethal effects (Piatt et al., 1990).

Many seabirds found in the Development area feed by picking or snatching prey at or near the water surface (e.g., frigate birds and noddies) or while paddling on the water (e.g., wedge-tail shearwaters and petrels) and, in doing so, can contact oil on the sea surface. Accounts of seabird mortalities from oil spill events indicate that seabirds with these types of feeding habits are the most likely to be severely affected (Leighton, 1995). However the potential for impact to these species is reduced because of the nature of the Cliff Head crude. Other seabirds, such as the pied oystercatcher and common seagull, may contact oil adhered to algae or the shoreline during feeding or resting. Mortalities among shoreline feeding/resting species are generally a less common outcome of oil spill impact.

The potential environmental impact from accidental release of Cliff Head crude oil is considered to be minor, principally because of the low volumes and low toxicity of the oil. The strict management requirements imposed under the requirements of the PSLA, combined with oil spill contingency plans mean that the likelihood of a release actually occurring can be categorised as 'possible' with a consequential 'low' ranking of environmental risk.

Introduction of Exotic Species

Marine pest species are species that have been introduced to an area outside of their natural range and have survived to become a threat to the receiving environment. The probability of the successful establishment of an exotic species depends primarily on two factors: frequency of immigrant arrivals (introduction); and post-arrival mortality (survival). The potential sources of introduction are ballast waters and hull fouling.

Drilling and installation will be conducted from vessels. The vessels involved are highly specialised and operate within the world market. It will be a condition of contract award that ballast water is exchanged in deep oceanic waters prior to the vessels entering the Development area. 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 signifi-

cant source of introduced marine pests (CRIMP, 1999).

The likelihood of survival and reproduction of exotic organisms in a new environment is influenced by a number of variable factors and cannot easily be predicted (Waiters, 1996). Furthermore, the degree of environmental impact from an establishment of exotic marine species will vary with the circumstances. The following scenarios may be envisaged:

- 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).
- Introduction of an exotic species that destroys (through predation or competition) one or more local species causing disruption to the local community structure.

The potential environmental impact from the unintentional introduction of marine pest species to the surrounding marine waters of the Development area is considered to be moderate to severe. The management of ballast water through ballast water exchange in open ocean areas and fulfilling AQIS requirements (including compulsory ballast reporting) would reduce the potential likelihood of introduction to possible with a consequential moderate environmental risk.

Process Chemical

Chemical spills may result from the accidental leakage of process chemicals used for injection into the wells and pipeline. The volume that could be released would be less than 20 L. It is predicted that accidental release of process chemicals would result in a localised and temporary reduction in water quality with perhaps a short-term reduction in abundance/biomass of flora and fauna in the affected environmental setting. However it is unlikely to cause any change to biodiversity or ecological systems. The environmental consequence of the accidental release of process chemicals is considered to be minor; therefore the environmental risk is categorised as low.

Solid Wastes

Although solid wastes will not be discharged to the marine environment, the potential exists for materials to be dropped overboard, particularly during transfer operations. The environmental effect of these small-scale disturbances is considered to be slight and the environmental risk low.

Management of Potential Impacts

- The wells will incorporate a blowout prevention system capable of containing pressures in the well strings of up to 10,000 psi.
- All machinery and engine oil spills and below-deck spills will be captured (catchment lips around potential spill areas), mopped up, containerised and sent to shore for recycling/disposal (this also applies to the drilling rig).
- All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean.
- Vessel to rig transfers of drilling fluids and fuel will be conducted in accordance with defined marine drilling and supply vessel contractor procedures which will be identified to all personnel concerned with transfer operations in the job hazard analysis.
- Real-time oil spill modelling capability will be in place during the drilling program.
- Stocks of absorbent materials on board the MODU and standby vessel(s) will be checked for their adequacy and replenished as necessary prior to the commencement of operational activities at the well.
- Actions to prevent marine collisions will include:
  - Notification of AMSA via the RCC in Canberra.
  - Issuing of standard AusCoast radio warnings to shipping by the RCC.
  - Standard maritime safety procedures (AusCoast warnings via the AMSA radio contact, display of appropriate navigational beacons and lights).
- Procedures and equipment for preventing loss of well control will be separately described within the MODU Safety Case.
- Procedures and equipment for preventing loss of hydrocarbons during operational activities will be separately described within the Operations Safety Case.
- A detailed oil spill contingency plan, accepted by the designated authority, will be in place prior to commencement of drilling, installation or operational activities. The oil spill contingency plan for construction and production will be similar in structure and content to the oil spill contingency plan that was put in place for drilling of the Cliff Head exploration wells, a copy of which is provided as Appendix C.
- As a mitigating action, Roc will remain a member of AMOSC which, in turn, maintains a capacity to respond to oiled wildlife in emergency situations.

5.3 Landform

Factor	EPA Objective
Landform, drainage and site hydrology	Maintain the integrity, functions and environmental values of landforms and natural surface water drainage including watercourses and sheet flow.

Aspect summary: landform

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Erosion	Horizontal directional drilling	Low	Minimise clearing. Investigate using HDD or bores to minimise impact on dunes during pipelay and pipe stringing activities. Retain rootstock and segregate stockpiles containing vegetation or seed banks and replace. Refill to original contours. Remediation and rehabilitation to existing conditions or similar. Use of wind breaks during remediation. Vegetation mats / brush matting etc to cover soil until vegetation is established. Monitoring and remediative works as required. Weed monitoring and suppression.
	Pipeline Installation	Medium	
Soil contamination	Runoff from process areas	Low	Closed-drain system surrounding process areas where contamination may occur. Vehicle maintenance and refuelling undertaken in an appropriate designated area wherever practicable.
	Rupture of chemical or product storage vessels	Low	Inventories of fuels and chemicals kept on site will be minimised. Pipelines, storage vessels and surrounds to be designed to minimise risk of rupture/loss. Regular inspection of pipeline integrity by way of intelligent pigging. Spill response training undertaken. Spill response equipment provided.
	Rupture of product pipes	Low	
	Spills from construction equipment	Low	
	Drilling mud release	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All drill cuttings to be taken offsite.
	Importation of contaminated fill	Low	Fill to be inspected and contaminant free.

5.3.1 Erosion

The onshore Development area is susceptible to wind-initiated erosion. Evidence for this can be seen by the large dune blowouts shown in the aerial photograph (Figure 2.6) of the area. Protection of land from wind erosion will be a high priority for environmental management during the proposed Development. The primary method for preventing wind erosion is the maintenance wherever practicable of the existing vegetation cover since this protects the mobile sands from being lifted and eroded by winds. This is of particular importance in areas where wind scour would be expected to be greatest, predominantly the peaks of the dune systems, areas where gradients are steepest, areas where wind is channelled or areas of sparse vegetation.

Horizontal Directional Drilling (HDD)

The HDD rig and equipment will be set up in a flat area landward of the dune second from the coastline as illustrated by Figure 3.16. Access to the HDD site will largely be by way of the existing track. This existing track is fairly stable and will be suitable to transport HDD equipment and personnel to and from the site without destabilising surrounding landforms. Currently this track carries a small volume of light-vehicle (4WD) traffic for fishing and beach access requirement. No widening or improvement to the access track is proposed; however, there is a requirement for a vehicle turnoff point for HDD site access. This will be designed to minimise, where practicable, vegetation removal along the road verge. It will be closed and rehabilitated upon completion of the HDD and pipelay activities.

A small area around the drill entry point (approximately 10 m by 10 m) will be cleared to provide a cleared staging area for the HDD. Other areas within the HDD site will be rolled flat to preserve the rootstock and enhance remediation at completion. Because the HDD is located in an area that is largely protected from the prevailing winds and because the area of disturbance is small, it is expected that remediation and rehabilitation will proceed quickly on cessation of pipe installation activities. Therefore the potential for erosion is considered to be low.

Rehabilitation of cleared areas will include the removal of all surface equipment or materials from the site and commencement of a replanting and revegetation program. Rapid establishing native plants will be favoured as re-

habilitation stock, to lock disturbed soils in place quickly and prevent an outward spread of disturbance due to possible wind scour effects. Where practicable, local genotypes will be collected and used in the regeneration program.

Where existing vegetation has been rolled or flattened, it is expected that, once activities on the site cease, vegetation will recover. Recovery may be aided in places (ripping to relieve compaction, watering, selective planting etc.) where higher levels of disturbance occur (storage and turning areas etc.).

Pipeline Installation

Pipeline installation can be considered to comprise two distinct erosion elements, i.e., construction and installation of the onshore pipeline and towing of the offshore pipeline segments from the stringing area across land to the ocean, should the 'bottom tow' method of offshore pipeline installation is chosen.

HDD represents the best practicable method for crossing the primary dune and shoreline systems from an environmental perspective and Roc is committed to this approach. The alternative, trenching, represents a less desirable outcome in terms of its potential to destabilise the primary dune and shoreline systems.

An corridor of approximately 20 m width will be established from the onshore plant site to the HDD location for construction and installation of the onshore pipeline. The greatest potential for erosion to occur is as the pipeline crosses the dune tops. There are two main dune crests between the onshore plant and the HDD location. Because of the increased exposure to wind at the dune crests and the inherently unstable nature of the dunes, a cleared easement has the potential to initiate erosion and, in the worst case, re-mobilise the dune if not carried out carefully and fully rehabilitated. Consequently the environmental risk associated with this method of pipeline construction is considered to be medium. The risk can be reduced by careful and immediate remediation and rehabilitation of easements and disturbed areas to prevent erosion gaining a foothold.

In order to minimise the potential effect of erosion on the dunes, the practicality of boring under the secondary dunes is also being investigated. Should it be feasible, then the pipeline working easement of 20 m will widen to approximately 50 m as it approaches the dunes so that there is adequate separation between the two pipelines (one for import from the wellhead platform and one for return of produced water for reinjection) to prevent the boreholes collapsing during construction and installation. After passing through the dunes the pipelines will reconverge to a single trench.

If the 'bottom tow' method of offshore pipeline installation is chosen, the offshore pipeline segments will be welded into several 4-km-long (nominal length) strings (a process referred to as 'stringing'). The pipelines will be strung together at an area on private property east of the plant site. It will be necessary for the area where the pipeline is strung to be cleared to allow access for transporting pipeline segments and materials, to even out areas of steep grades and also to reduce the potential for fire during the welding activities.

When pipe stringing is required, a dedicated area within the freehold block purchased to accommodate the Arrowsmith Separation Plant will be used. Some vegetation clearing will be required, but only in an area that has been previously cleared for pasture improvement and is currently the subject of weedy secondary growth. Welding will be restricted to a single area where all flammable material will be removed for fire control. This welding location will be most likely an open-sided temporary shed where some weather protection is afforded the welding operators. This shed will be removed at the completion of construction.

Clearing of vegetation at the stringing location will be by way of flattening and slashing of existing vegetation rather than grading, wherever practicable and safe to do so, thereby preserving the rootstock and seed-bank. Grading of soil will be kept to the minimum necessary and, where it is necessary, the topsoil and rootstock will be stockpiled for remediation after stringing operations are complete. The potential for erosion at the stringing location is considered to be low.

The pipeline strings will be towed across the pipeline easement and shoreline and then out to sea. A series of rollers will be installed along the easement across which the pipelines will be pulled. The rollers will be placed from light trucks using a mobile crane. Because the pipelines can only tolerate a relatively small angle of bend, the height of the rollers will be carefully set. For the most part, the rollers will be within the onshore pipeline construction easement and no additional risk of erosion will be incurred. After passing the HDD location, an additional clear path within the easement of about 10 m width is required. The pipeline will be pulled across an area slightly north of the HDD entry point where the primary dune is lowest, so as to protect the integrity of the dune as much as possible. Immediate and thorough site rehabilitation will minimise risk from erosion.

Upon completion of pipelay activities, all equipment will be removed from site at which point stabilisation and replanting activities shall commence. Fast-establishing local dune and heathland species shall be used in areas identified as being most at risk from erosion processes such as dune crowns, heavily disturbed areas or areas highly accessible to prevailing winds. Upon completion of pipelay activities, the onshore pipe will be buried and the trench refilled with a small 'crown' which will settle over time to the original surface contouring. In areas of high wind scour potential, wind breaks (generally low geofabric fences or similar) will be deployed to trap and lock scoured sands. This will also ensure better strike rates for plantings. Vegetation mats can also be used in high wind scour areas or steep sections of dunes to minimise wind scour until plantings have time to establish.

Ongoing maintenance and care of rehabilitation areas will be undertaken on an 'as required' basis to ensure early rehabilitation and stabilisation efforts are effective. Dead plants will be replaced where appropriate and areas of slow regeneration may be given special attention. Weed management is discussed in more detail in Section 5.5. Maintaining a weed-free environment along the pipe easement will eliminate any potential competition native species may otherwise encounter during re-establishment.

The environmental risk to the dune systems from erosion associated with trenching dune systems and with the bottom tow method of offshore pipeline construction and installation is categorised as 'medium' providing that the management measures outlined are implemented promptly and effectively. All other activities proposed are categorised as holding a 'low' risk of erosion impact.

Management Measures

- Minimise clearing.
- Investigate using HDD or bores to minimise impact on dunes during pipelay and pipe stringing activities.
- Retain rootstock and segregate stockpiles containing vegetation or seed banks and replace.
- Refill to original contours.
- Remediation and rehabilitation to existing conditions or similar.
- Use of wind breaks during remediation.
- Vegetation mats/brush matting etc. to cover soil until vegetation is established.
- Monitoring and remediative works as required.
- Weed monitoring and suppression.

5.3.2 Soil Contamination

Runoff from Process Areas

All operation process areas with identified potential for leakage or spills will be sealed and bunded to contain any spillage. Spilled liquids and runoff from such areas will be directed to a closed drain system. The closed drain system will flow into a lined evaporation pond capable of containing the volumes of stormwater expected to come from the process areas.

Chemical and hydrocarbon storages, processing areas, bunds, drainage systems and other areas where contamination of soils might occur will be designed to minimise the likelihood of a spill occurring and limit the potential severity of a spill in the event that it does occur. Examples of design initiatives to be included in plant design include: sealing process, loading and storage areas; bunding storage areas; and diverting all stormwater runoff from areas that may contain contamination to a closed drain and treatment system.

Rupture of Chemical or Product Storage Vessels

The storage tanks for crude oil, produced water and chemicals will be surrounded by an impermeable bund, designed in accordance with industry standards and capable of containing a major vessel rupture. In addition, volumes of chemicals stored on site will be minimised, in accordance with good operating practice. Given the exclusion of operational and storage areas from permeable areas and minimisation of chemicals on site, the potential environmental risk associated with soil contamination from the plant area during operations is categorised as being low.

Rupture of the Pipelines

The onshore section of pipeline will be designed in accordance with the Australian Standard for pipe design (AS 2885) and buried. The remote location of the pipeline, combined with a burial depth of approximately 1 m and visible signage along the pipeline easement, is expected to preclude most forms of human-induced pipe damage including accidental trench or agricultural activity interceptions, road or rail accidents etc. Therefore it is considered that the possibility of pipeline rupture is extremely low.

In the extremely unlikely event of pipe rupture, oil would be expected to contaminate soil in the immediate area. Remediation strategies would be formulated on a case by case basis and would include measures such as removal of contaminated soils to a contaminated soil facility and replacement with clean fill.

Spills from Construction Equipment

During construction of the plant and pipeline, the potential exists for small spillages of fuel and oil from machinery or chemicals being transported. The potential for significant contamination is low due to the small volumes involved and limited area that may be affected.

Any spills identified will be cleaned up using spill kits or via shovelling up contaminated soils and disposing of this material to an approved facility, although it is recognised that the soil in the area is highly porous and spilt liquid would be readily transported down through the soil. Spill clean-up and notification measures would be addressed in further detail in construction environmental management plans, which will also detail spill response training requirements for staff. During construction, routine vehicle maintenance and mobile vehicle refuelling will only be undertaken in an area delineated for the purpose wherever practicable.

HDD Drilling Mud Release

The HDD rig will have drilling fluid stored in mud tanks for use and recirculation during drilling. Some drilling mud will be lost to the surrounding environment during the HDD process via infiltration from the drill hole through the relatively porous sands. The objective of the drilling team is, however, to minimise mud loss. Use of a naturally occurring and non-toxic clay (bentonite) as the basis for the drilling mud will minimise the impact on surrounding environmental values. Drill cuttings will be disposed of offsite in an approved manner and any remaining drilling mud will be taken offsite for reuse.

Importation of Contaminated Fill

There is a low risk that additional fill sourced from the local area may contain contamination. Where additional fill is required for either the plant area or pipeline, fill will be certified as being free of contaminants and weeds.

Management Measures

- Fill to be contaminant free.
- Non-toxic drilling muds to be used.
- Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD.
- All drill cuttings to be taken offsite.
- Vehicle maintenance and refuelling undertaken in an appropriate designated area wherever practicable.
- Pipelines, storage vessels and surrounds to be designed to minimise risk of rupture/loss.
- Regular inspection of pipeline integrity by way of intelligent pigging.
- Spill response training undertaken.
- Spill response equipment provided.
- Closed drain system surrounding process areas where contamination may occur.
- Inventories of fuels and chemicals kept on site will be minimised.

5.4 Groundwater and Surface Water

Factor	EPA Objective
Ground and surface water quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected, consistent with the National Water Quality Management Strategy (NWQMS) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Aspect summary: groundwater and surface water

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Groundwater use	Supplement produced water re-injection into reservoir	Low	Target the unused and highly saline Cattamarra Formation for recharge water. Utilise produced formation water for recharge wherever practicable. Bore constructed to ensure other aquifers are not hydraulically connected to the Cattamarra aquifer.
Alteration of surface water flow	Alteration of drainage lines	Low	Stockpiles will be used for temporary storage of fill material only. The completed trench will have a crown to allow for settlement.
Groundwater and surface water contamination	Leaching and runoff from process areas	Low	Formation water will be recharged into the oil reservoir and not discharged on land. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed-drain system.
	Rupture of the pipeline	Low	Pipeline will be designed in accordance with AS 2885 and buried to depth of 1 m. Pipeline integrity will be tested prior to commencement. Regular inspection of pipeline integrity by way of intelligent pigging
	Hydrotest water disposal	Low	Hydrotest water to be disposed of to the evaporation pond.
	Spills from construction operations	Low	Visual inspections of plant and pipeline sites undertaken regularly during construction and operations. Identified spills will be remediated immediately upon discovery. Volumes of chemicals and hydrocarbons stored on site will be minimised.

5.4.1 Groundwater Use

Supplement Produced Water Reinjection into Reservoir

During operations, groundwater will be drawn from the Cattamarra Formation to be injected into the Cliff Head field to enhance the rate of oil recovery. As the volumes of produced water from the field increases, produced water will be used instead of groundwater to enhance the rate of oil recovery, thereby returning the produced water back to the reservoir and reducing use of groundwater.

The aquifer water extraction rates are expected to fall rapidly from 4,800 m^3/day at the start of oil production, to 890 m^3/day after 3 years and only 240 m^3/day after 10 years.

Groundwater resources are of significant importance in meeting Australia's water needs. Groundwater is used for potable water supplies, for stock watering and for agricultural irrigation needs in particular. Different aquifers can meet some or all of these beneficial objectives, and the realisation of these beneficial uses is in part dictated by the quality of the groundwater, the depth to the aquifer and the relative abundance and quality of alternatives (surface water).

The Cattamarra Formation is a deep aquifer, lying some 800 to 1,000 m below the surface. It is highly saline (in the order of 23,000 mg/L salt), and hence unsuitable for direct use as a potable water source or for other high-end beneficial uses without significant treatment. Although the area experiences low rainfall and there is little surface water, this aquifer is currently not utilised. As there is no need in the foreseeable future to extract this resource for a higher-end use, the proposed use of this aquifer as a source of water to enhance oil recovery represents an appropriate use of this resource.

A bore will be constructed through two shallower aquifers to reach the Cattamarra aquifer. Industry-standard techniques for bore construction will be utilised to ensure these other aquifers are not hydraulically connected to the saline Cattamarra aquifer.

Management Measures

- Target the unused and highly saline Cattamarra Formation for recharge water.
- Utilise produced formation water for recharge wherever practicable.
- Bore constructed to ensure other aquifers are not hydraulically connected to the Cattamarra aquifer.

5.4.2 Alteration of Surface Water Flow

The plant is situated in a relatively flat area of land. Although no significant drainage lines pass through the plant

site, it is possible that sheet runoff may occur during severe storm events. Such events are usually of short duration and it is unlikely that any alteration to natural surface water flow will occur. Any alteration to overland flow is likely to be mainly influenced by the presence of stockpiles. However, it is not envisaged that stockpiles will remain beyond construction into operation.

The pipeline route traverses dune and flat inter-dunal areas. Because the sands are highly porous, rainfall infiltrates down through the soil with only a small amount of moisture being retained. The dune and inter-dunal areas are underlain by weakly cemented limestone that in some areas retain moisture (one such area is apparent just north of the pipeline corridor at the point where the track crosses onto the beach). There is a low potential that construction of the pipeline trench may intersect a cemented layer that is retaining moisture, leading to change in water holding capacity in the short term and vegetation characteristics in the longer term.

The buried pipe trench will be overlain by a small crown of topsoil obtained at the commencement of trenching. The aim of this crown is to allow the backfilled pipe trench to settle and, upon completion of this settlement period, it is expected that the trench will be at the same level as the surrounding landscape. This will aid in reducing the likelihood that the pipe trench may cause a preferential drainage line.

Management Measures

- Stockpiles will be used for temporary storage of fill material only.
- The completed trench will have a crown to allow for settlement.

5.4.3 Groundwater and Surface Water Contamination

There are four key areas where the project has the potential to impact on groundwater or surface waters: leaching or runoff of contaminated water from the plant site, rupture of the product or produced water pipelines, disposal of hydrotest water and spills from construction plant and equipment.

Leachate Runoff from Process Areas

As discussed in Section 5.3.2, Soil Contamination, all process areas with identified potential for leakage or spills will be sealed, bunded and connected to a closed drain system and runoff directed to a lined evaporation pond. This system will be designed to contain a 1 in 20 year storm event, and is anticipated to only contain traces of contaminants during routine operations. In the event that a non-routine spill is identified, other contingency measures (spill kits etc.) will be employed to prevent bulk discharge of these contaminants to the evaporation pond.

Pipeline Rupture

The potential for pipeline rupture is extremely low. The management measures in place to prevent this occurrence and to remediate in the event it does happen are discussed in more detail in Section 5.3.2, Soil Contamination. The resultant risk to groundwater or surface water is categorised as low.

Hydrotest Water Disposal

Hydrotest water used to test the integrity of the completed pipeline is likely to contain a dilute cocktail of chemicals, potentially including biocides, corrosion inhibitors, oxygen scavengers, and fluorescent dyes. All hydrotest water will be directed to the evaporation pond and not released to the surrounding environment. These chemicals are likely to break down quickly into benign compounds whilst within the evaporation pond.

Spills from Construction Equipment

Spills from construction equipment, from construction chemical stores and from vehicle refuelling and maintenance represent the highest frequency contamination event expected. However, volumes of spills are expected to be small and quite obvious. The soils within the plant and pipeline corridors are very porous (mainly sands) and hence larger volumes of chemical or fuel spills would be likely to infiltrate down into soils quickly, hampering the effectiveness of absorbent spill kits. Remediation of these events will be undertaken by removing the contaminated soil. Minimising the risk of spill exposure represents the best means for preventing contamination and hence vehicle maintenance and refuelling will, wherever practicable, be conducted in a designated area suitable for that purpose.

Management Measures

- Formation water will be recharged into the oil reservoir and not discharged on land.
- Hydrotest water to be disposed of to the evaporation pond.
- All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
- Visual inspections of plant and pipeline sites undertaken regularly during construction and operations.
- Identified spills will be remediated immediately upon discovery.
- Volumes of chemicals and hydrocarbons stored on site will be minimised.

5.5 Terrestrial Flora

Factor	EPA Objective
Terrestrial flora	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect declared rare and priority flora, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*. Protect other flora species of conservation significance.

Aspect summary: terrestrial flora

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Direct mortalities	Site clearing for the plant site	Low	Utilise a brown-field site for the plant and locate processing areas in already degraded habitat areas wherever practicable. Utilise cleared areas within the reserve for the easement wherever practicable.
	Site clearing for pipeline stringing, installation and HDD site	Low	Roll, rather than remove, vegetation along the pipe easement wherever practicable. No ongoing vehicle access is proposed along the pipe easement.
Loss or modification of habitat or species distribution	Spread of weeds and/or feral animals	Medium	All vehicles to be free of dirt or seeds prior to site entry. Access from the plant to the pipe easement to be minimised and vehicles to be cleaned prior to easement access. Fill to be free of weeds and pathogens. Rehabilitation program to include weed suppression along the pipeline easement. Ongoing plant site weed management to be undertaken, particularly the control and elimination of Paterson's curse.
	Accidental fire e.g., welding or grinding activities during construction and operation	Medium	Pipe stringing areas will be graded where required and fire fighting equipment will be provided. Welding will be restricted to a single area where appropriate fire management measures will be implemented. The ground flare will be buffered from vegetation.

Disturbance of all native flora, regardless of its conservation status will be minimised. The area within the pipeline easement that is likely to be disturbed will cover a maximum area of 8.0 ha, the majority of which is dominated by *Melaleuca lueropoma* and *M. hueglelli* over a herb layer of mostly sedge and daisy species.

The plant site and associated property have a history of agricultural use and as such is highly degraded with weeds dominating the landscape. Weeds are also a common feature in the native communities west of the plant and rail corridor until the first dune belt west of the plant.

The Department of Land Management Rare and Priority Flora Database identified four priority species to potentially occur in the area; however, no declared rare or priority listed species were found during surveys of the corridor or plant site. None of the plant communities mapped in the Development area are listed as Threatened Ecological Communities by CALM.

5.5.1 Direct Loss

Site Clearing Activity

Two main areas of clearing will be undertaken to host the proposed Development: at the plant site on a permanent basis and the HDD and pipeline route on a temporary basis.

Site Clearing – Plant Site

The proposed plant site selected is a previous industrial site, utilising the Westlime plant site and lime storage areas. It is currently highly degraded from a floristic perspective, containing little remnant vegetation and a high density of weeds. Risk of impact resulting from clearing at this site is negligible and a weed suppression program may result in a positive outcome for native flora in the area.

Site Clearing – Pipeline and HDD Sites

The pipeline easement and HDD site represent largely intact remnant native vegetation with low weed invasion. Permanent vegetation loss at these areas is not proposed and an active revegetation program should result in no net loss of vegetation or diversity. No vehicle access, other than via the existing beach track, is proposed for operational pipeline access. There is some potential to utilise areas within the reserve that are already clear or devoid of significant vegetation for the pipe easement and this opportunity will be explored during final easement alignment. Any operations pipeline inspections or rehabilitation work will be conducted on foot. As discussed in Section 5.3.1, Erosion, wherever safe and practicable to do so, vegetation will be rolled rather than removed, thus reducing temporary vegetation loss.

Vegetation community mapping undertaken indicates that vegetation along the proposed easement is broadly represented in the surrounding reserve and clearing will not unduly reduce any particular vegetation class. It is expected that rehabilitation will return the pipeline easement to a state similar to present.

Management Measures

- Utilise a previous industrial site for the plant and locate processing areas in already degraded habitat areas wherever practicable.
- Roll rather than remove vegetation along the pipe easement wherever practicable.
- Utilise cleared areas within the reserve for the easement wherever practicable.
- No ongoing vehicle access is proposed along the pipeline easement.

5.5.2 Alteration of Community Composition

Spread of Weeds and Dieback

The primary concern with pest plants (weeds) is that major invasions change the natural balance and diversity of ecological communities. A total of 18 weed species were noted during the flora survey within the Development area, one of which is listed as a Declared Plant (*Echium plantagineum* or Paterson's curse). State regulations prohibit the movement of plants or seeds of this species and this includes prohibiting the movement of contaminated machinery. The majority of the weed species identified lie within the proposed plant site in the Westlime property boundaries and currently very few weed specimens are located within the pipeline corridor and surrounding reserve.

Maintaining a weed-free environment along the pipeline easement is a high priority and weed invasiveness represents a medium risk. Weed invasion into this area would have several negative outcomes including degrading the quality of remnant vegetation, decreasing native species diversity in the longer term and hampering native vegetation rehabilitation efforts. Stringent construction vehicle hygiene measures and an active rehabilitation program (including weed suppression and removal) will result in this risk being acceptably managed.

The Development area was assessed for the occurrence of *Phytophthora cinnamomi*. However, due to the extremely low density of susceptible indicator species, dieback assessments were unable to categorically rule out the presence of the pathogen in the project area. Four samples were taken from stressed plants and all returning negative results for the presence of the pathogen. Given the low rainfall (<600 mm per year), relatively high pH (~9) and local geology (coastal sands), the area is likely to be unfavourable to the phytophthora pathogen and local conditions are likely to inhibit this species survival. The introduction of small to moderate volumes of phytophthora-infested material would in all likelihood not result in a successful establishment of the pathogen in the area (Woodman, 2003).

Mitigation measures to control the spread of weeds and prevent a phytophthora invasion include a stringent vehicle hygiene program, imported fill screening and weed management program. All construction vehicles brought on site, or crossing from the Westlime land to the pipeline easement will be cleaned of dirt, mud or seeds via either a wash-down bay or dry scrubbing. Vehicle movement to the pipe easement from the Westlime site will be minimised where practicable. Construction equipment coming from a known phytophthora area will be thoroughly decontaminated before being allowed on site.

During rehabilitation, ongoing weed suppression at both the plant site and along the pipe easement will be undertaken. Where necessary, hand weeding or selective hand spraying will be undertaken along the pipe easement to ensure weeds do not get established in the reserve. On the plant site, measures will be put in place to actively combat Paterson's curse, including strict quarantine measures regarding vehicle movement around site, spraying and hand weeding. General site maintenance and care will include spraying campaigns and, potentially, reinstatement of native vegetation in areas currently infested with weeds.

Management Measures

- All vehicles to be free of dirt or seeds prior to site entry.
- Access from the plant to the pipe easement to be minimised and vehicles to be cleaned prior to easement access.
- Fill to be free of weeds and pathogens.
- Rehabilitation program to include weed suppression along the pipeline easement.
- Ongoing plant site weed management to be undertaken, particularly the control and elimination of Paterson's curse.

Fire

Fire represents a natural component of the Australian landscape; however, it can be very detrimental to man-made assets and, in the short term, flora and fauna. Uncontrolled fire also represents a significant safety and operational risk to plant staff and the plant itself. During construction, pipe-stringing activities have the highest potential for triggering fire as welding and oxy-acetylene equipment will be required to string the pipeline. Easement grading and clearing (although kept to a minimum), in combination with fire-fighting equipment on site, will reduce the risk of uncontrolled fire escaping into surrounding bush to an acceptable level of risk.

The plant will have an operation ground flare, continuously alight in case of gas flaring emergencies or for routine maintenance. The flare will be housed in an enclosure and removed from other flammable material or surrounding vegetation. Risk of a fire being triggered by the flare is predicted to be very low.

All other risks of fire or explosion at the plant have been reduced to ALARP levels consistent with protecting life and assets and are categorised as being highly infrequent events.

Management Measures

- Pipe stringing areas will be graded where required and fire fighting equipment will be provided.
- Welding will be restricted to a single area where appropriate fire management measures will be implemented.
- The flare will be buffered from vegetation.
- Permit to work approval for 'hot works' involving an ignition source.
- Fire protection systems will be in place for operational activities.

5.6 Terrestrial Fauna

Factor	EPA Objective
Terrestrial fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect specially protected (threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*.

Aspect summary: terrestrial fauna

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Direct loss or modification of fauna habitat	Clearing for the plant site and pipeline installation	Low	Minimise vegetation removal or damage wherever practicable. Roll vegetation rather than remove wherever practicable. Commence rehabilitation of disturbed or cleared areas immediately upon the completion of works. Minimise the time pipe trenches remain open. Monitor open trenches each morning and remove any trapped fauna if safe to do so. Trapped fauna will be identified and recorded.
Reduced abundance of native fauna	Spread of weeds and dieback through road vehicle activity	Low	Utilise weed and pathogen management measures identified in Section 5.5, Flora.
	Accidental fire e.g., welding or grinding activities during construction and operation	Low	Suitable fire fighting equipment will be held on site.
Change in behavioural patterns	Clearing and construction noise leading to temporary avoidance of the area or changed fauna corridors	Low	Rehabilitation of easements to be undertaken immediately upon completion of pipe installation.

5.6.1 Direct Loss or Modification of Habitat

Clearing for the Plant Site and Pipeline Installation

As noted in Section 5.5, Flora, some vegetation along the pipeline route will be removed for a short period and adjacent vegetation will be rolled flat. This will reduce or destroy habitat for some native species for a short to medium period, whilst construction continues and afterwards whilst vegetation is rehabilitating. The fauna assessment concluded that the impact to native fauna caused by vegetation loss along the pipeline route would be low due to the short duration of activities and the small amount of vegetation to be cleared.

There is some potential for animals to get trapped in the pipe trenches whilst they are open, becoming easy prey for birds or other larger predatory species or suffering from exposure. Any sections of the trenches remaining open during construction will be monitored each morning and, if trapped fauna is discovered, a suitably capable person shall remove trapped fauna and release it into the surrounding area. The period between trench excavation and backfilling is expected to be less than one week.

It is anticipated that some territorial fauna or fauna with a low range may be temporarily displaced or injured during rolling or grading activities. Given the small area to be impacted by the pipelay and plant construction activities, the impact of this on native fauna is expected to be low.

Management Measures

- Minimise vegetation removal or damage wherever practicable.
- Roll vegetation rather than remove wherever practicable.
- Commence rehabilitation of disturbed or cleared areas immediately upon the completion of works.
- Minimise the time pipe trenches remain open.
- Monitor open trenches each morning and remove any trapped fauna if safe to do so. Trapped fauna will be identified and recorded.

5.6.2 Reduced Abundance of Native Fauna

Spread of Weeds and Dieback through Road Vehicle Activity

Weed introduction into the reserve has been identified as a medium risk to flora, but can have a secondary effect to fauna, reducing preferred habitat, ground cover or food sources for some species. It is anticipated that suitable weed management will reduce the risk of weed invasion to a low risk. Vegetation communities in the immediate vicinity of the pipeline route are well represented in the surrounding area. Weed management is detailed in Section 5.5.

Fauna roadkill

During construction, the movement of vehicles within the Beekeeper's Nature Reserve poses a minor threat to resident fauna. Vehicles will only enter the reserve after accessing the construction site from the highway down the existing sealed roadway to the abandoned lime works. Tracks within the reserve will be unformed and of a temporary nature so that traffic speeds will be very low. Roc will impose a speed limit of 20 kph on construction traffic. Preliminary surveys (Bamford, 2003) indicate low fauna numbers in the immediate vicinity of the project. The predominant movement of construction vehicles in daylight hours will also tend to reduce interactions with the resident fauna.

Accidental Fire

Fire represents a direct threat to native fauna and also reduces quantities of available habitat for the short to medium term. Fire management is discussed in more detail in Section 5.5. Suitable fire fighting equipment capable of extinguishing small fires that may be triggered by welding operations will be kept on site during construction. During operation, a fire fighting system suitable for protection of the plant will be maintained. Risk to fauna from fire generated by the construction and operation of the plant is categorised as low.

Management Measures

- Utilise weed management measures identified in Section 5.5.
- Site induction to ensure operators of machinery minimise the risk of roadkill in Beekeeper's Nature Reserve.
- A speed limit of 20 kph to be imposed on vehicles operating in the Beekeeper's Nature Reserve.
- Suitable fire fighting equipment will be held on site.

5.6.3 Change in Fauna Behavioural Patterns

Clearing and Construction Noise Leading to Temporary Avoidance or Changed Fauna Corridors

Construction of the pipeline, HDD and plant site represents a short term and uncharacteristically noisy operation. This may cause some behavioural avoidance in native fauna species, including birds, which may temporarily avoid the area. Given the continuous nature of surrounding vegetation, it is unlikely that this will impact any but the most territorial species and represents a low risk to native fauna.

The trench is expected to cause a minor disruption to local fauna movement corridors during pipelay operations and, to a lesser extent, during rehabilitation. The cleared easement is unlikely to affect larger species but may represent a barrier to smaller fauna. The short term nature of this barrier and abundance of surrounding vegetation will minimise the impact on small native fauna species.

Management Measures

- Rehabilitation of easements to be undertaken immediately upon completion of pipe installation.
- Open trench sections will be inspected daily and any trapped fauna recorded and removed.

5.7 Atmospheric Emissions

Factor	EPA Objective
Atmospheric emissions	Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke. No unreasonable impacts at boundary of the plant. Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity. To minimise greenhouse gas emissions in absolute terms and reduce emission per unit product to as low as reasonably practicable. Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and state policies including EPA Interim Guidance No 12.

Aspect summary: atmospheric emissions

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Greenhouse gas emissions	Combustion of fuel gas, flaring	Low	Use of fuel gas rather than oil for power generation. Maximise extent of waste recovery throughout production processes. Use of generator flue gas instead of methane for storage tank blanketing. Minimise operational use of flare. Participate in Greenhouse Challenge Agreement through APPEA membership.
Oxides of nitrogen and sulphur (NOx and SOx)	Combustion of fuel gas	Low	Use of fuel gas rather than oil for power generation. Use of generator flue gas instead of methane for storage tank blanketing. Minimise operational use of flare.
Volatile organic compounds	Combustion of fuel gas	Low	
Dust	Construction activities	Low	During construction, unsealed areas subjected to vehicle traffic will be kept damp using a water truck to control dust.

5.7.1 Greenhouse Gas Emissions

Greenhouse gases are a natural part of the earth's atmosphere. The earth's atmosphere allows most sunlight to enter and warm the earth. As the surface of the earth cools it emits infra-red radiation (heat), some of which is absorbed by gases in the atmosphere and radiated back to earth, phenomenon known as the greenhouse effect. The main gases responsible for this effect are water vapour, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The other main gases; perfluorocarbons, hydro-fluorocarbons and sulphurhexafluoride will not be released from the proposed Development.

The global warming potential of the different gases varies according to their particular phyico-chemical structure and the time span over which the effect is being considered. In order to compare the effect of different gases, the global warming potential (GWP) is expressed relative to CO_2 over a time horizon of 100 years. The GWP of CO_2 is taken to be 1, of CH_4 21 and of N_2O 310.

Over a 15-year life span, it is estimated that the proposed development will result in the emission of approximately 532,000 t of CO_2 equivalents at an average annual emission rate of 35,000 t. This equates to an average efficiency of 0.178 t of CO_2 eq/t of product and compares favourably to an industry average of 0.34 t of CO_2 eq/t of product.

The relatively low rate of emissions is due primarily to the use of natural gas as fuel gas for power generation and the extensive use of heat recovery throughout the production process.

The estimated annual emissions from the Cliff Head Development would cause a slight increase in Western Australia's annual greenhouse gas emissions (approximately 0.07% increase from 1995 emissions) and a very slight addition to Australia's annual greenhouse gas emissions (approximately 0.006% of year 2000 emissions) (Table 5.4).

Management Measures

- Increase greenhouse gas efficiency by use of fuel gas rather than oil for power generation.
- Maximise extent of waste recovery throughout production processes.
- Use of generator flue gas instead of methane for storage tank blanketing.
- Minimise operational use of flare.
- Participate in Greenhouse Challenge Agreement through membership of the Australian Petroleum Production and Exploration Association (APPEA).

5.7.2 Oxides of Nitrogen and Sulphur

Gas for power production, sourced from the Dampier to Bunbury Gas Pipeline, will have very low concentrations of hydrogen sulphide. Consequently the emissions of sulphur oxides are likely to be very low and the ground level concentrations of sulphur oxides have not been modeled.

Table 5.4 Predicted increase in greenhouse gas emissions due to Cliff Head relative to Australia's and Western Australia's baseline

	Million Tonnes of CO_2 eq/year	Percentage Increase
Australia's 1990 Baseline*	503.3	0.0069
Australia's 2000 Emissions*	535.3	0.0065
Western Australia's 1990+ Baseline	42.5	0.08
Western Australia's 1995+ Emissions	49.3	0.07

*Australian Greenhouse Office 2002.

+WA EPA 2002.

Management Measures

- Use of fuel gas rather than oil for power generation.
- Minimise requirement for power generation by maximising extent of waste recovery throughout production processes.

5.7.3 Volatile Organic Compounds

The Cliff Head crude oil has very low composition of gases and volatile components. Any gases associated with the crude oil stream will be removed and used to supplement natural gas used for power generation.

The volume of VOCs has been calculated based on the predicted rate of gas consumption for power generation and standard efficiency factors provided by the Australian Greenhouse Gas Office (1998) and E&P Forum (1994). The predicted daily emission of VOCs from the storage tanks is in the order of approximately 0.5 kg of methane and 3 kg of non-methane VOC per day. This vapour is recovered and directed to the low pressure flare which has an assumed combustion efficiency of 95%, leading to total final VOC emission from crude oil storage of about 0.15 kg. The combustion of natural gas for power will generate a further daily quantity of approximately 7.2 kg of methane and 2.7 kg of non methane VOC. This includes emissions from both the turbines and the heaters.

Management Measures

- Use of fuel gas rather than oil for power generation.
- Minimise requirement for power generation by maximising extent of waste recovery throughout production processes.

5.7.4 Dust

Dust principally results from the disturbance of dry soils, especially fine-grained or heavily trafficked soils. Dust emissions will be intermittent in nature and mainly associated with construction activities. It is unlikely that dust emissions would cause any significant health or nuisance issues given its intermittent nature and the distance from the nearest residences.

Management Measures

- To control dust during construction, a water truck will be used to dampen unsealed areas subjected to traffic movements.
- Areas used for traffic movements during the production phase of the operation will be sealed.

5.8 Noise

Factor	EPA Objective
Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997.

Aspect summary: noise

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Disturbance to surrounding landholders	Construction activity	Low	Restrict construction activities to day periods where practicable. All construction equipment is to be fitted with mufflers in good working order. Advise local residents prior to 24-hour construction activities proceeding.
	Operational activity	Low	Monitor operational noise during early operation to ensure compliance.

5.8.1 Disturbance to Surrounding Landholders

The types of noise expected during construction and operation of the Development represent an aesthetic impact to local residents and potentially a disruption to local fauna in the area. For environmental assessment purposes, noise is measured and weighted according to the sensitivities of the human ear—this weighting leading to a measurement in decibels (dB(A)). To gain an understanding of how the addition of a noise source will affect local residents and fauna requires an understanding of existing acoustic environment. Noise sampling has not been conducted to date, so a conservative adoption of very low noise levels has been assumed. Background noise levels at the plant site are likely to be influenced by wind-generated noise through vegetation and noise from passing trains. The background noise levels at the shore crossing are expected to be influenced predominantly by wind and wave noise.

Operational and construction noise are assessed differently, owing to the short-term and generally noisier nature of construction noise and the long-term and generally constant nature of operational noise. Legislatively, construction noise levels are allowed to be higher than operational limits, recognising the short-term nature of these activities. Noise guidelines also recognise the need for some construction and operational noise to occur on a 24-hour basis. However, this is weighed against the need for a 'sleep window' during which noise levels must be minimised. A minimum noise limit of 35 dB(A) would apply to the operating plant during night periods, conservatively adopting a very quiet

background noise level as the basis for the assessment.

Construction Activity

During construction of the pipeline and plant, typical construction noise ranges from 60 to 75 dB(A) at approximately 50 m from the activity (BassGas, 2001). The construction of the HDD and pipelay operations will occur over a period of approximately three months, during which period noise levels of approximately 40 to 50 dB(A) are expected at the nearest receptor, some 1,400 m away.

Where practicable, pipeline and plant construction activities will be restricted to the defined day period but in some instances may need to run on a 24-hour basis. Where this is required, potentially affected local residents will be notified in advance. All equipment used on site during construction will be fitted with a muffler in good working order. The impact of construction noise on local residents is expected to be low. The impact of noise on local fauna is discussed in Section 5.6, Fauna.

Operational Activity

Preliminary plant design information indicates that the plant will produce noise levels in the order of 85 dB(A) at 1 m from the noise source. The nearest sensitive receptor is a residence, some 1,400 m away. Applying the following empirical noise dissipation formula:

Decibels of Change = 20 x log (distance 1 / distance 2)

indicates a resultant reduction in noise at the nearest sensitive receptor of approximately 62 dB(A). This indicates that a conservative estimate of noise from the plant will meet legislative requirements for 24-hour operation and it is anticipated that no detailed noise modelling will be required to demonstrate compliance.

Noise spot-checks will be undertaken at sensitive receptors upon operation of the plant to confirm compliance and, if found to breach legislative limits, corrective action, such as acoustic muffling of the plant will be undertaken.

Management Measures

- Restrict construction activities to day periods where practicable.
- Advise local residents prior to 24-hour construction activities proceeding.
- All construction equipment is to be fitted with mufflers in good working order.
- Monitor operational noise during early operation to ensure compliance.

5.9 Waste

Factor	EPA Objective
Waste	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of offsite at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.

Aspect summary: waste

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Liquid wastes	Hydrotest water	Low	Hydrotest water to be disposed of to the evaporation pond.
	Runoff from facilities	Low	Volumes of chemicals and hydrocarbons stored on site will be minimised. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
	HDD drill cuttings and fluids	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All drill cuttings to be taken offsite.
Solid wastes	Construction activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.
	Operation activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.

Roc recognise the importance of careful management of wastes. Technology for oil production facilities is reasonably mature and established waste management measures exist for all of the predicted waste streams. Detailed waste management plans will be prepared as part of the environmental management plans for construction and operational activities. Roc will apply the waste management hierarchy as a guiding principal where alternatives to waste generation and disposal are considered in the following order:

- Avoid.
- Reduce.
- Reuse/recycle.
- Treatment.
- Disposal.

5.10 Socio-Economic

Factor	EPA Objective
Culture and heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972.* Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area. Identify any areas which are close to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Commission Act 1975.*
Aesthetic	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse.
Other uses	Avoid interference to other uses of area and resources.
Public health and safety	Ensure that risk to the public is as low as reasonably practicable and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for offsite individual fatality risk (Interim Guidance Statement No.2), and that ALARP is demonstrated, and that the DoIR's requirements in respect of public safety are met. Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety.

Aspect summary: socio-economic

Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Disturbance to significant sites	Construction activity	Low	During clearing and excavation works for the onshore pipeline, undertake archaeological monitoring, involving members of the Wilinyu group.
Disturbance of natural environment for visitors to Beekeeper's Nature Reserve	Construction activity	Low	Minimise disturbance to the natural environment.
Local community	Construction activity Operation activity	Low	Ongoing consultation and relationship building with the local community. Drug and alcohol testing will be a condition of construction contracts. Drilling crews will be employed on a fly in, fly out basis. Locals will be employed during construction where practicable. Temporary accommodation i.e., a construction village will be used to accommodate construction workforces.
Disturbance to road users on the Brand Highway	Construction activity Operation activity	Low	Observe appropriate transport legislation and guidelines. Selection of transport contractor that has a demonstrated safety record. A safety management plan will be required from the transportation contractor which will be contractually binding. The safety management plan will include the following aspects: -Shift hours -Drug and alcohol testing -Speed monitoring -Performance monitoring -Vehicle maintenance and testing.
Disturbance to other uses of the area (fishing industry, tourism, recreation, apiary activities)	Construction activity Operation activity	Low	Design subsea infrastructure to allow fishing over the pipeline and up to the platform. Liaise closely with fishing industry regarding construction activities and operations. Develop a Memorandum of Understanding with the fishing industry to allow fishing operations to be undertaken within exclusion zone during normal operations. Temporary accommodation i.e., a construction village will be used to accommodate construction workforces. Ongoing consultation and relationship building with the local community and beekeepers.
Public health and safety	Construction activity Operation activity	Low	Traffic management as described in Section 5.10.4. Maintain security fencing around plant site. Maintain platform security and navigation lights.

5.10.1 Aboriginal Culture and Heritage

Archival research, discussions with local Aboriginal groups (Yamatji Land and Sea Council and the Wilinyu Aboriginal consultants) and field surveys have found that there are no known Aboriginal sites or artefacts in the area. There is, however, potential for subsurface Aboriginal archaeological material (including skeletal remains) to be present, and this material may be encountered during the clearing and excavation works for the onshore pipeline.

Management Measures

- During clearing and excavation works for the onshore pipeline, undertake archaeological monitoring, involving members of the Wilinyu group.

5.10.2 Aesthetic

The plant site and the offshore platform will be the only visible infrastructure components of the Development. The plant site will be constructed on the existing Westlime site which is not visible from the Brand Highway or beach. The visual impact of the plant site is expected to be similar to that of the existing Westlime plant site, but with the addition of security lighting at night. The plant site will also have a flare, which is unlikely to be visible to the general public during normal operations. Other aesthetic aspects of the plant site are noise and odour, the impacts of which are expected to be minimal.

The offshore platform is a relatively small structure and is known as a mini-platform. The platform will be approximately 12 m high above sea surface and will have navigation lights. The platform is located approximately 10 km from the shoreline and will be visible from the shore. The view from the shore to the platform will be similar to that of the jack-up rig used during exploration drilling at Cliff Head (the view from the jack-up rig towards shore is shown in Figure 3.9). However, the mini-platform will be smaller than the rig. The presence of the platform will add an industrial element to the current landscape and therefore present a significant change to the character of the area.

The impact to the aesthetic environment from the development is considered low, but as aesthetic values are subjective, it is expected that the communities feelings toward the development are likely to affect their perceptions of aesthetic impact.

Management Measures

- Ongoing consultation and relationship building with the local community.

5.10.3 Impact on Local Communities

Population

During the on-shore construction period of 4–6 months, approximately 100 individuals will be employed. Assuming the construction workforce is sourced from outside the Shire of Irwin, this would result in a temporary increase in the shire population of around 4% and a slight increase in the male to female ratio (assuming a gender ratio similar to other construction teams) (Q&A, 2003).

Short-term increases in population can have negative impacts on the local communities, including pressure on community services, shifts in demographics towards a male-dominated construction workforce and the associated recreational impacts such as increased alcohol and drug use and perceived anti-social behaviour (Q&A, 2003). There is, however, likely to be positive impacts associated with the temporary population increase, including increased demand for service provision and supplies, strengthening of community capacity and diversity and increased spending in the local area (Q&A, 2003). It is also likely that there will be employment opportunities for local people as part of the construction workforce. The employment of locals would reduce the potentially negative impact of this short-term workforce.

Only positive impacts are expected to be associated with the introduction of the operations workforce and their families to the area.

Economic

The Cliff Head Development will have a positive economic impact on the communities associated with the project through employment and associated flow on benefits and, to a lesser extent, the purchasing of goods and services.

Accommodation

Short term impacts on accommodation are likely to be felt during construction and decommissioning activities (Q&A, 2003). During peak season, the available accommodation from existing service providers is likely to be around 20 beds (Q&A, 2003). This will be insufficient for a potential construction workforce of 100 people, unless a considerable proportion of the workforce is sourced locally (Q&A, 2003).

Management Measures

- Drug and alcohol testing will be a condition of construction contracts.
- Drilling crews will be employed on a fly in, fly out basis.
- Locals will be employed during construction where practicable.
- Temporary accommodation i.e., a construction village will be used to accommodate construction workforces.

5.10.4 Traffic

Construction

During construction, equipment, materials and staff will be transported to site. While travelling to and from the Development area, these vehicles and, in particular, the over-sized construction vehicles such as the low-loaders containing the pipelines, have the potential to inconvenience users of public roads.

Operations

During operations vehicles will be used to transport equipment, materials, staff and crude oil product. Export of crude oil product will comprise the bulk of the traffic load (see Table 3.4) and a transport contractor will be employed for this role. The Brand Highway is already used as a trucking route for many industries in the region and it is not expected that the additional vehicle load from the Development will create any problems with existing traffic flows.

Management Measures

- Observe appropriate transport legislation and guidelines.
- Selection of a transport contractor who has a demonstrated safety record.
- A safety management plan will be required from the transportation contractor which will be contractually binding. The safety management plan will include the following aspects:
  - Shift hours.
  - Drug and alcohol testing.
  - Speed monitoring.
  - Performance monitoring.
  - Vehicle maintenance and testing.

5.10.5 Other Uses

Fishing Industry

During offshore construction there will be some disturbance to the marine environment (see Section 5.2). This may have a short-term impact on the distribution of

marine fauna in the immediate vicinity of the Development; however, no long-term negative impacts to fish or lobster populations are expected. Once laid, it is expected that the pipeline will be utilised as lobster habitat.

An exclusion zone will be established encompassing the pipeline and platform area. Access by fishing vessels to this zone will be restricted during the construction phase and also when the platform is being serviced during the operations phase. During normal operations, however, fishing will be permitted up to the platform and over the pipeline.

Recreation and Tourism

Recreational activities such as fishing, boating, sight-seeing and SCUBA diving may be impacted during the construction period by a decrease in visual amenity and restricted access to the easement and offshore construction areas. This short-term impact is expected to be minor as the areas adjacent to the Development area will still be available for these activities. No long-term impact to the recreational activities are expected.

During the construction period the tourism industry may experience short-term pressure on accommodation. No long-term impacts to the tourism industry are expected.

Apiary Activities

Impact to the existing apiary activities in the Beekeeper's Nature Reserve are expected to be minimal.

Management Measures

- Design infrastructure to allow fishing over the pipeline and up to the platform.
- Liaise closely with fishing industry regarding construction activities and operations.
- Develop a Memorandum of Understanding with the fishing industry to allow fishing operations to be undertaken within the exclusion zone during normal operations.
- Temporary accommodation i.e., a construction village will be used to accommodate construction workforces.
- Ongoing consultation and relationship building with the local community and beekeepers.

5.10.6 Public Health and Safety

All aspects of construction and operations will be undertaken in accordance with the appropriate legislation, guidelines and Roc's corporate safety and environmental management system (SEMS). During construction, public access to the Development area will be prevented by fencing onshore and the exclusion zone offshore.

During operations, the main source of public exposure to the Development will be through the public roads, in particular the Brand Highway, which will be used to transport the product. The crude oil product is of a relatively low volatility and would not constitute a significant risk of explosion in the event of a spillage.

The safety record of the transport contractors will be a significant factor affecting the contractor selection process. Furthermore, safety will be a key performance criteria in ongoing assessment of the transport contractor during operations.

The offshore platform presents a navigation hazard for vessels; however, the potential for collision is considered unlikely. The platform will be clearly visible, marked on marine charts and it will be lit with appropriate navigation lights. It is anticipated that the platform will become a local navigation landmark which may possibly assist vessels in navigating around the reefs. The other main issue associated with the platform is platform security. Closed circuit television and barriers to entry will be installed on the platform to minimise the potential for trespassing.

There is no public access to the plant site and the nearest residence is located approximately 1.4 km away. Access to the pipeline is also restricted because it will be underground and underwater.

Management Measures

- Traffic management as described in Section 5.10.4.
- Maintain security fencing around plant site.
- Maintain platform security and navigation lights.

6. Summary of Environmental Impacts

6.1 Summary of Impacts to Listed Species

The potential effects of the proposed Cliff Head Development on each of the key biota are summarised within Table 6.1. The summary groups potential effects into 12 categories of disturbance, these 12 groups being based on the categories used in the Australian regional marine planning process (National Oceans Office, 2002), modified to reflect petroleum activities. The first ten relate to routine activities, while the last two relate to potential accidental effects. The impact groups are:

1. Physical disturbance: direct change as a result of placement of physical structure or materials.
2. Temperature change: change in seawater temperature outside the normal range of variability.
3. Noise: increasing the level or amount of noise in the environment beyond its normal range of variability (normal variability is taken to include background anthropological noise).
4. Artificial light: introducing a source of light that would not normally exist in the environment.
5. Turbidity/light: changing the extent to which light penetrates the water column (relates only to the marine environment).
6. Contaminants: introducing substances that are not normally found in the environment, such as heavy metals and litter.
7. Chemical change: changing the concentration or properties of compounds naturally occurring in the environment.
8. Nutrients: changing the concentration of organic and inorganic nutrients in the surrounding environment.
9. Drill cuttings: discharging of drill cuttings and drilling fluids to sea (relates only to the marine environment).
10. Greenhouse gas emissions: release of greenhouse gas emissions to atmosphere.
11. Exotic pests: introducing species outside of their natural or historical ranges.
12. Hydrocarbon spills: accidental release to the marine environment of hydrocarbons such as crude oil or diesel fuel.

It is important to note that the potential effects relate to the predicted levels of disturbance assuming that routine oilfield practises are applied. For example potential impacts associated with nutrients have assumed that sewage will be treated and macerated prior to discharge.

6.2 Summary of Environmental Factors

Table 6.2 presents a summary of the detailed assessment of environmental risk provided in Chapter 5. It is important to note that the potential effects relate to the predicted levels of disturbance assuming that routine oilfield practises are applied. For example potential impacts associated with nutrients have assumed that sewage will be treated and macerated prior to discharge.

Table 6.1 Summary of effects to listed species

Species	Common Name	Likely Presence	Physical	Temperature	Noise	Artificial Light	Turbidity / Light	Contaminants	Chemical Change	Nutrients	Drill Cuttings	Atmospheric Emissions	Exotic Species	Hydrocarbon
Marine Mammals														
Balaenoptera musculus	Blue whale (true)	Very Unlikely	1	1	2	1	1	1	1	1	1	1	1	2
Balaenoptera brevicauda	Blue whale (pygmy)	Unlikely	1	1	2	1	1	1	1	1	1	1	1	2
Megaptera novaeangliae	Humpback whale	Possible	1	1	2	1	1	1	1	1	1	1	1	1
Eubalaena australis	Southern right whale	Possible	1	1	2	1	1	1	1	1	1	1	1	1
Balaenoptera edeni	Bryde's whale	Possible	1	1	2	1	1	1	1	1	1	1	1	2
Balaenoptera physalus	Fin whale	Unlikely	1	1	2	1	1	1	1	1	1	1	1	2
Balaenoptera borealis	Sei whale	Unlikely	1	1	2	1	1	1	1	1	1	1	1	2
Neophoca cinera	Australian sea lion	Very likely transient	1	1	1	2	1	1	1	1	1	1	1	2
Dugong dugon	Dugong	Very unlikely	1	1	1	2	2	1	1	1	1	1	1	1
Marine Reptiles														
Dermochelys coriacea	Leathery turtle	Unlikely	1	1	1	1	1	1	1	1	1	1	2	3
Pelamis platurus	Yellow-bellied seasnake	Unlikely	1	1	1	1	1	1	1	1	1	1	2	1
Fish														
Carcharodon carcharias	Great white shark	Possible transient	1	1	1	1	1	1	1	1	1	1	1	1
Carchariuas taurus	Grey nurse shark	Possible	1	1	1	1	1	1	1	1	1	1	1	1
Rhincodon typus	Whale shark	Unlikely	1	1	1	1	1	1	1	1	1	1	1	1
Acentronura australe	Southern little pipehorse	Likely	2	1	1	1	1	1	1	1	1	1	2	1
Campichtys galei	Gale's pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Choeroichthys suillus	Pig snouted pipefish	Very Likely	2	1	1	1	1	1	1	1	1	1	2	1
Halicampus brocki	Brock's pipefish	Unlikely	2	1	1	1	1	1	1	1	1	1	2	1
Lissocampus fatiloquus	Prophet's pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Maroubra perserrata	Sawtooth pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Mitotichthys meraculus	Western crested pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Nannocampus subosseus	Bony-headed pipefish	Likely	2	1	1	1	1	1	1	1	1	1	2	1
Pugnaso curtirostris	Pug-nosed pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Solegnathus lettiensis	Gunther's pipefish	Very unlikely	2	1	1	1	1	1	1	1	1	1	2	1
Stigmatopora argus	Spotted pipefish	Likely	2	1	1	1	1	1	1	1	1	1	2	1
Stigmatopora nigra	Black pipefish	Likely	2	1	1	1	1	1	1	1	1	1	2	1
Syngnathoides biaculeatus	Alligator pipefish	Very unlikely	2	1	1	1	1	1	1	1	1	1	2	1
Urocampus carinirostris	Hairy pipefish	Unlikely	2	1	1	1	1	1	1	1	1	1	2	1
Vanacampus margaritifer	Mother of pearl pipefish	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Hippocampus angustus	West spiny seahorse	Very likely	2	1	1	1	1	1	1	1	1	1	2	1
Hippocampus breviceps	Short-head seahorse	Possible	2	1	1	1	1	1	1	1	1	1	2	1
Hippocampus subelongatus	West Australian seahorse	Very likely	2	1	1	1	1	1	1	1	1	1	2	1
Phycodurus eques	Leafy seadragon	Likely	2	1	1	1	1	1	1	1	1	1	2	1
Phyllopteryx taeniolatus	Weedy seadragon	Likely	2	1	1	1	1	1	1	1	1	1	2	1

Table 6.1 Summary of effects to listed species (cont'd)

Species	Common Name	Likely Presence	Physical	Temperature	Noise	Artificial Light	Turbidity / Light	Contaminants	Chemical Change	Nutrients	Drill Cuttings	Atmospheric Emissions	Exotic Species	Hydrocarbon
Seabirds														
Anous tenuirostris melanops	Australian lesser noddy	Likely	1	1	1	1	1	1	1	1	1	1	2	2
Macronectes giganteus	Southern giant-petrel	Unlikely	1	1	1	1	1	1	1	1	1	1	2	2
Macronectes halli	Northern giant-petrel	Unlikely	1	1	1	1	1	1	1	1	1	1	2	2
Pterodroma mollis	Soft-plumaged petrel	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Pelagodroma marina	White-faced storm-petrel	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Diomedea dabbenena	Tristan albatross	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Thalassarche carteri	Indian yellow-nosed albatross	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Thalassarche chlororhynchos	Yellow-nosed albatross,	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Thalassarche cauta	Shy albatross	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Puffinus pacificus	Wedge-tailed shearwater	Possible	1	1	1	1	1	1	1	1	1	1	2	3
Sterna anaethetus	Bridled tern	Likely	1	1	1	1	1	1	1	1	1	1	2	3
Sterna caspia	Caspian tern	Likely	1	1	1	1	1	1	1	1	1	1	2	3
Sterna dougallii	Roseate tern	Likely	1	1	1	1	1	1	1	1	1	1	2	3
Catharacta skua	Great skua	Possible	1	1	1	1	1	1	1	1	1	1	2	2
Larus novaehollandiae	Silver gull	Very Likely	1	1	1	1	1	1	1	1	1	1	2	2
Haliaeetus leucogaster	White-bellied sea-eagle	Very Likely	1	1	1	1	1	1	1	1		1	2	2
Calidris ruficollis	Red-necked stint	Likely	1	1	1	1	1	1	1	1		1	2	2
Calidris alba	Sanderling	Likely	1	1	1	1	1	1	1	1		1	2	2
Arenaria interpres	Ruddy turnstone	Likely	1	1	1	1	1	1	1	1		1	2	2
Limosa lapponica	Bar-tailed godwit	Likely	1	1	1	1	1	1	1	1		1	2	2
Land Birds														
Leipoa ocellata	Malleefowl	Unlikely	1	1	1	2		1	1	1		1	2	1
Calyptorhynchus latirostris	Carnaby's Black cockatoo	Likely	1	1	1	1		1	1	1		1	2	1
Charadrius ruficapillus	Red-capped plover	Possible	1	1	1	1		1	1	1		1	2	1
Thinornis rubricollis	Hooded plover	Possible	1	1	1	1		1	1	1		1	2	1
Falco peregrinus	Peregrine falcon	Very likely	1	1	1	1		1	1	1		1	2	1
Apus pacificus	Fork-tailed swift	Possible	1	1	1	1		1	1	1		1	2	1
Morops ornatus	Rainbow bee-eater	Possible	1	1	1	1		1	1	1		1	2	1
Reptiles														
Morelia spilota imbricata	Carpet python	Possible	1	1	1	1		1	1	1		1	2	1
Aspidites ramsayi	Woma	Possible	1	1	1	1		1	1	1		1	2	1
Plants														
Caladenia hoffmanii.	-	Very unlikely	1	1	1	1		1	1	1		1	3	1
Conostylis dielsii subsp. teres	Irwins conostylis	Very unlikely	1	1	1	1		1	1	1		1	3	1
Hypocalymma longifolium	-	Very unlikely	1	1	1	1		1	1	1		1	3	1
Leucopogon marginatus	Thick-margined leucopogon	Very unlikely	1	1	1	1		1	1	1		1	3	1
Paracaleana dixonii	-	Very unlikely	1	1	1	1		1	1	1		1	3	1
Wurmbea tubulosa	Long-flowered nancy	Very unlikely	1	1	1	1		1	1	1		1	3	1

1= no/negligible impact; 2= localised short term impact; 3=localised medium-term impact; 4= widespread medium to long-term impact.

Table 6.2 Summary of environmental risk

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS guidelines for ballast water management and ANZECC Code of Practice for Antifouling.	Physical disturbance	Anchoring	Medium	Selection of pipeline route and tow path to minimise impact. Use of support vessels to deploy and recover anchors. Use of anchor pennants to lift the anchors.
			Footprint	Low	Selection of location for seabed facilities and wellhead platform.
			Pipelay Scour	Medium	Selection of pipeline route and tow path to minimise impact. Use of horizontal directional drilling and shore-based installation of the pipeline out to the 6-m water contour.
		Light	Lighting during drilling and installation	Low	Lighting during drilling and installation activities to be kept to minimum necessary for safe operations.
			Navigation lights	Low	Lighting at wellhead during operations to be minimum necessary for navigation safety.
		Noise	Drilling and Installation	Low	Apply standard industry practise for management of noise from machinery on the drilling rig and installation vessels. Monitor and record presence of whales during drilling and installation activities.
			Operations	Low	Apply standard industry practise for management of noise from machinery.
		Liquid discharges	Utility waters	Low	Machinery and equipment will be maintained to prevent contamination of cooling waters.
			Sewage	Low	In Commonwealth waters more than three nautical miles from the coastline only sewage from a certified approved sewage treatment plant in place under Regulation 8 (1) (b) of MARPOL 73/78 Annex IV will be disposed to sea. Sewage will not be discharged to sea in state waters.
			Greywater	Low	Grey water and putrescible wastes will be disposed of in accordance with Clause 222 (Housekeeping) of the Schedule to the Western Australian *Petroleum (Submerged Lands) Act 1982* (PSLA), which requires that food scraps and sanitary effluents be passed through a grinder or comminuter so that the final product will pass through a screen <25 mm diameter prior to disposal to the sea.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna (cont'd)			Deck runoff	Low	Machinery spaces on the drilling rig and installation vessels will be bunded to contain any deck spillages. Chemicals used or stored on board the drilling rig will be managed so as to prevent damage to the containers. All chemical and hazardous wastes, such as cleaning products, acids, solvents, toxic waste and medical waste, will be segregated into clearly marked containers prior to onshore disposal. All storage facilities and handling equipment will be segregated in good order and designed in such a way as to prevent and contain any spillages as far as practicable. Procedures will be in place on the drilling rig and installation vessels for the clean-up of small deck spillages.
			Antifouling leachate	Low	Tributyltin will not be used on any subsea infrastructure of the Cliff Head Development.
		Solids (produced offshore)	Drill cuttings	Low	Drill cuttings to be separated from drill fluids prior to discharge to sea.
			Drill fluids	Low	Preference for water-based drilling fluids to be used wherever practicable to do so. Non-water–based muds to be of low toxicity and recovered from cuttings for return to shore at completion of drilling.
		Accidental releases	Crude oil	Low	The wells will incorporate a blowout prevention system capable of containing pressures in the well strings of up to 10,000 psi. All machinery and engine oil spills and below-deck spills will be captured (catchment lips around potential spill areas), mopped up, containerised and sent to shore for recycling/disposal (this applies to the drilling rig). All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean. Vessel to rig transfers of drilling fluids and fuel will be conducted in accordance with defined marine drilling and supply vessel contractor procedures which will be identified to all personnel concerned with transfer operations in the job hazard analysis. Real-time oil spill modelling capability will be in place during the drilling program. Stocks of absorbent materials on board the mobile offshore drilling unit (MODU) and standby vessel(s) will be checked for their adequacy and replenished as necessary prior to the commencement of operational activities at the well.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Marine ecology including sea floor, marine flora and fauna (cont'd		Accidental releases (cont'd)	Crude oil (cont'd)		Actions to prevent marine collisions will include: -Notification of Australian Maritime Safety Authority (AMSA) via the Rescue Co-ordination Centre (RCC) in Canberra. -Issuing of standard AusCoast radio warnings to shipping by the RCC. -Standard maritime safety procedures (AusCoast warnings via the Australian Maritime Safety Authority, radio contact, display of appropriate navigational beacons and lights). Procedures and equipment for preventing loss of well control will be separately described within the MODU Safety Case. Procedures and equipment for preventing loss of hydrocarbons during operational activities will be separately described within the Operations Safety Case. A detailed oil spill contingency plan, accepted by the designated authority, will be in place prior to commencement of drilling, installation or operational activities. As a mitigating action ROC will remain a member of the Australian Marine Oil Spill Centre (AMOSC) which in turn maintains a capacity to respond to oiled wildlife in emergency situations.
			Introduction of exotic species	Medium	Adherence to AQIS regulations for controlling and preventing the introduction of marine pest species.
			Process chemicals	Low	All drainage from the decks of the platform will be injected into the pipeline to the plant onshore. No drainage will leave the platform to the ocean.
Landform, drainage and site hydrology	Maintain the integrity, functions and environmental values of landforms and natural surface water drainage including watercourses and sheet flow.	Erosion	Horizontal directional drilling	Low	Minimise clearing. Investigate using HDD or bores to minimise impact on dunes during pipelay. Retain rootstock and segregate stockpiles containing vegetation or seed banks and replace. Refill to original contours.
			Pipeline Installation	Medium	Remediation and rehabilitation to existing conditions or similar. Use of wind breaks during remediation. Vegetation mats/brush matting etc. to cover soil until vegetation is established. Monitoring and remedial works as required. Weed monitoring and suppression.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Landform, drainage and site hydrology (cont'd)		Soil contamination	Runoff from process areas	Low	Closed drain system surrounding process areas where contamination may occur. Vehicle maintenance and refuelling undertaken in an appropriate designated area wherever practicable.
			Rupture of chemical or product storage vessels	Low	Inventories of fuels and chemicals kept on site will be minimised. Pipelines, storage vessels and surrounds to be designed to minimise risk of rupture/loss. Regular inspection of pipeline integrity by way of intelligent pigging. Spill response training undertaken. Spill response equipment provided.
			Rupture of product pipes	Low	
			Spills from construction equipment	Low	
			Drilling mud release (terrestrial)	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All HDD drill cuttings to be taken offsite.
			Importation of contaminated fill	Low	Fill to be inspected and contaminant free.
Ground and surface water quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the National Water Quality Management Strategy (NWQMS) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality.	Groundwater use	Supplement produced water re-injection into reservoir	Low	Target the unused and highly saline Cattamarra Formation for recharge water. Utilise produced formation water for recharge wherever practicable. Bore constructed to ensure other locally used aquifers are not hydraulically connected to the Cattamarra aquifer.
		Alteration of surface water flow	Alteration of drainage lines	Low	Stockpiles will be used for temporary storage of fill material only. The completed trench will have a crown to allow for settlement.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Ground and surface water quality (cont'd)		Groundwater and surface water contamination	Leaching and runoff from process areas	Low	Formation water will be recharged into the oil reservoir and not discharged on land. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
			Rupture of the pipeline	Low	Pipeline will be designed in accordance with AS 2885 and buried to depth of 1 m. Pipeline integrity will be tested prior to commencement. Regular inspection of pipeline integrity by way of intelligent pigging.
			Hydrotest water disposal	Low	Hydrotest water to be disposed of to the evaporation pond.
			Spills from construction operations	Low	Visual inspections of plant and pipeline sites undertaken regularly during construction and operations. Identified spills will be remediated immediately upon discovery. Volumes of chemicals and hydrocarbons stored on site will be minimised.
Terrestrial flora	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950.* Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999.* Protect other flora species of conservation significance.	Direct mortalities	Site clearing for the plant site	Low	Utilise a brownfield site for the plant and locate processing areas in already degraded habitat areas wherever practicable. Utilise cleared areas within the reserve for the easement wherever practicable.
			Site clearing for pipeline installation and HDD site	Low	Roll rather than remove vegetation along the pipe easement wherever practicable. No ongoing vehicle access is proposed along the pipe easement.
		Loss or modification of habitat or species distribution	Spread of weeds and/or feral animals	Medium	All vehicles to be free of dirt or seeds prior to site entry. Access from the plant to the pipe easement to be minimised and vehicles to be cleaned prior to easement access. Fill to be free of weeds and pathogens. Rehabilitation program to include weed suppression along the pipeline easement. Ongoing plant site weed management to be undertaken, particularly the control and elimination of Paterson's curse.
			Accidental fire e.g., welding or grinding activities during construction and operation	Medium	Pipe-stringing areas will be graded where required and fire-fighting equipment will be provided. Welding will be restricted to a single area where appropriate fire-management measures will be implemented. The ground flare will be buffered from vegetation.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Terrestrial fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*.	Direct loss or modification of fauna habitat	Clearing for the plant site and pipeline installation	Low	Minimise vegetation removal or damage wherever practicable. Roll vegetation rather than remove wherever practicable. Commence rehabilitation of disturbed or cleared areas immediately upon the completion of works. Minimise the time pipe trenches remain open. Monitor open trenches each morning and remove any trapped fauna if safe to do so.
		Reduced abundance of native fauna	Spread of weeds and dieback through road vehicle activity	Low	Utilise appropriate weed and pathogen management measures.
			Accidental fire e.g., welding or grinding activities during construction and operation	Low	Suitable fire-fighting equipment will be held on site.
		Change in behavioural patterns	Clearing and construction noise leading to temporary avoidance of the area or changed fauna corridors	Low	Rehabilitation of easements to be undertaken immediately upon completion of pipe installation.
Atmospheric emissions	Use all reasonable and practicable measures to minimize the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke. No unreasonable impacts at boundary of the plant.	Greenhouse gas emissions	Combustion of fuel gas, flaring	Low	Use of fuel gas rather than oil for power generation. Maximise extent of waste recovery throughout production processes. Use of generator flue gas instead of methane for storage tank blanketing. Minimise operational use of flare. Participate in Greenhouse Challenge Agreement through APPEA membership.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Atmospheric emissions (cont'd)	Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity.	Oxides of nitrogen and sulphur (NOx and SOx)	Combustion of fuel gas	Low	Use of fuel gas rather than oil for power generation. Minimise operational use of flare.
	To minimise greenhouse gas emissions in absolute terms and reduce emission per unit product to as low as reasonably practicable.	Volatile organic compounds	Combustion of fuel gas	Low	
	Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.	Dust	Construction activities	Low	Areas of vehicle traffic, such as carpark and tanker loading bays, and pathways will be sealed with coarse gravel to limit the potential for dust generation.
Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997.	Disturbance to surrounding landholders	Construction activity	Low	Restrict construction activities to day periods where practicable. All construction equipment is to be fitted with mufflers in good working order. Advise local residents prior to 24-hour construction activities proceeding.
			Operational activity	Low	Monitor operational noise during early operation to ensure compliance.
Waste	Where possible, waste should be minimised, reused or recycled.	Liquid wastes	Hydrotest water	Low	Hydrotest water to be disposed of to the evaporation pond.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Waste (cont'd)	Liquid and solid wastes should be treated on site or disposed of off site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.	Liquid wastes (cont'd)	Runoff from facilities	Low	Volumes of chemicals and hydrocarbons stored on site will be minimised. All risk areas and areas where contaminants may be expected will be connected to the evaporation pond via a closed drain system.
			HDD drill cuttings and fluids	Low	Non-toxic drilling muds to be used. Drilling mud to be stored in a lined pit or prefabricated tank, and taken offsite for future use upon completion of the HDD. All HDD drill cuttings to be taken offsite.
		Solid wastes	Construction activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.
			Operation activity	Low	All solid wastes to be segregated at source and stored in appropriate containers ahead of transport offsite for recycling or disposal.
Culture and heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*. Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area. Identify any areas which are close to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Commission Act 1975.*	Disturbance to significant sites	Construction activity	Low	During clearing and excavation works for the onshore pipeline, undertake archaeological monitoring involving members of the Wilinyu group.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Other uses and aesthetics	Avoid interference to other uses of area and resources. Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse.	Disturbance of natural environment for visitors to Beekeeper's Nature Reserve	Construction activity	Low	Minimise disturbance to the natural environment.
		Local community	Construction activity Operation activity	Low	Ongoing consultation and relationship building with the local community. Drug and alcohol testing will be a condition of construction contracts. Drilling crews will be employed on a fly in, fly out basis. Locals will be employed during construction where practicable. Temporary accommodation i.e., a construction village will be used to accommodate construction workforces.
		Disturbance to road users on the Brand Highway	Construction activity Operation activity	Low	Observe appropriate transport legislation and guidelines. Selection of transport contractor that has a demonstrated safety record. A safety management plan will be required from the transportation contractor that will be contractually binding. The safety management plan will include the following aspects: - Shift hours. - Drug and alcohol testing. - Speed monitoring. - Performance monitoring. - Vehicle maintenance and testing.

Table 6.2 Summary of environmental risk (cont'd)

Environmental Factor	EPA Objective	Potential Environmental Impact	Activity Contributing to Risk	Impact Risk	Management Strategy
Other uses and aesthetics (cont'd)		Disturbance to other uses of the area (fishing industry, tourism, recreation, apiary activities)	Construction activity Operation activity	Low	Design subsea infrastructure to allow fishing over the pipeline and up to the platform. Liaise closely with fishing industry regarding construction activities and operations. Develop a Memorandum of Understanding with the fishing industry to allow fishing operations to be undertaken within exclusion zone during normal operations. Temporary accommodation in Dongara will be used to accommodate the construction workforce. Ongoing consultation and relationship building with the local community and beekeepers.
Public health and safety	Ensure that risk to the public is as low as reasonably practicable and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for offsite individual fatality risk (Interim Guidance Statement No.2), and that ALARP is demonstrated, and that the DoIR's requirements in respect of public safety are met. Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety.	Public health and safety	Construction activity Operation activity	Low	Management road traffic to appropriate standards. Maintain security fencing around plant site. Maintain platform security and navigation lights.

7. Environmental Management

7.1 Environmental Management Framework

7.1.1 Environmental Management System

The Cliff Head Development will be managed in accordance with Roc's Occupational Health, Safety and Environmental Policy (see Section 1.2.1) which applies to all company activities, locations, personnel and contractors. The HSE policy is implemented through the company's Safety and Environmental Management System (SEMS) which takes into account the principles of AS/NZS ISO 14001 and OSHAS 18001. The key elements to the SEMS are:

- Management, leadership, commitment and accountability.
- Occupational health, safety and environmental policy and strategic objectives.
- Organisation and resources, third party services, information and documentation.
- Hazard identification and risk management.
- Planning and conduct of work.
- System implementation and monitoring, incident reporting and investigation.
- Audit and review.

7.1.2 Responsibilities

Figure 7.1 shows the chain of responsibility for environmental management from a corporate level through to the project level for the Cliff Head Development. The key SEMS responsibilities for personnel are shown in Table 7.1.

7.1.3 Reporting and Auditing

Incident Reporting

Roc will utilise its existing incident reporting and investigation procedures that exist within the SEMS. All environmental incidents will be reported to the site or construction manager (depending on whether it occurs during the operational or construction phase) in the first instance and recorded in Roc's environmental incidents database.

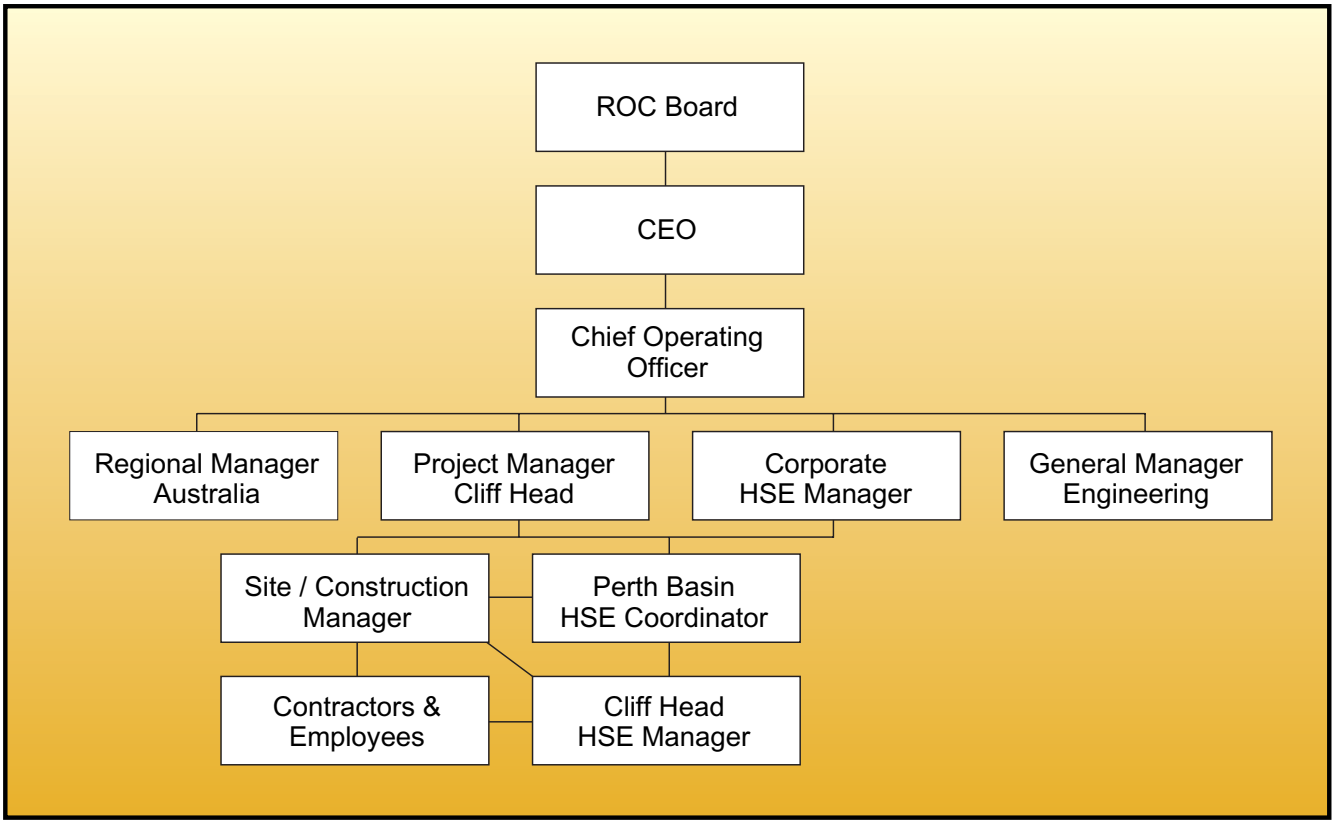


Figure 7.1 Organisation chart

Performance Reporting

Environmental performance will be reported as an integral part of operations/ construction reporting. Performance will be reported against the objectives set out in the SEMS.

Auditing

Primary Contractors

It is the normal practice in Roc to incorporate an operational audit of a primary contractor as an integral step of the tendering/contracting process. Such audits have a broad scope, but include operational aspects of environmental management. Where a contractor has recently been audited by an acceptable entity and is at liberty to divulge to Roc the complete report of this audit, then Roc may choose to accept this audit as fulfilling its requirements.

ROC will either audit or obtain acceptable audit reports from all primary contractors involved in the Cliff Head Development including drilling rig, workboat, HDD, pipeline construction/installation and transport contractors.

Construction Phase

Roc will conduct at least one operational environmental audit during the onshore and offshore construction phases. The appropriate authority will be invited to participate in the audits.

Table 7.1 Key safety and environmental management responsibilities

Role	Key SEMS responsibilities
Roc Board	• Remain informed of SEMS performance and provide guidance to management on SEMS performance and improvement.
CEO	• Review, revise and approve Roc's Occupational Health, Safety and Environmental Policy and SEMS • Ensure implementation of the policy and SEMS.
Chief Operating Officer	• Ensure operations are maintained and operated to approved health, safety and environmental standards. • Provide adequate resources for environmental management.
Corporate Health, Safety and Environmental Manager	• Review and recommend SEMS improvements. • Performance monitoring, audit and review of health, safety and environmental compliance. • Provide awareness education. • Support preventative and corrective action implementation.
Project Manager – Cliff Head	• Ensure operations are maintained and operated to approved health, safety and environmental standards. • Maintain communication with company personnel, and project stakeholders including government agencies and local community. • Ensure follow-up actions from environmental audits are undertaken.
General Manager – Engineering	• Ensure operations are maintained and operated to approved health, safety and environmental standards.
Regional Manager – Australia	• Ensure operations are maintained and operated to approved health, safety and environmental standards.
Perth Basin HSE Coordinator	• Liaise with project manager and site manager to ensure compliance with legislation, SEMS, commitments and conditions. • Organise environmental audits during construction and operations. • Oversee project HSE risk assessment and management. • Supervise the Cliff Head HSE Manager on site.· • Ensure contractor/subcontractor awareness and compliance with Roc SEMS, EMPs and EPs.
Cliff Head HSE Manager	• Develop project safety and environmental documentation for government approval and implementation. • Performance monitoring and review of project health, safety and environmental compliance and performance;
Site/ Construction Manager	• Implementation of SEMS, EMPs and EPs. • Reporting of environmental incidents to Project Manager. • Undertake follow-up actions from environmental audits. • Ensure employees and contractors follow environmental guidelines.
Employees and Contractors	• Take reasonable care to protect themselves and others in the workplace including reporting of hazards and incidents. • Apply the EMP/EP. • Cooperate with employers. • Use safe work practices and personal protective equipment. • Follow good housekeeping procedures and work practices.

Operational Phase
During operations Roc will conduct at least two environmental audits per year, with one of these being undertaken by an independent auditor.

7.2 Environmental Management Plans

The implementation of environmental management plans for construction, operation and decommissioning of facilities within state lands and waters is a legally binding requirement of the project approval under the Western Australian EP Act. A works approval and license may also be required under Part V of the EP Act.

7.2.1 Construction

Onshore
An environmental management plan (EMP) will be produced to manage the onshore component of construction. This plan will cover all land-based activities including plant construction, installation of the onshore section of pipeline, horizontal directional drilling and stringing of the offshore pipeline. The environmental management plan will be approved by the Department of Environmental Protection and will include procedures for managing the following issues:

- Air quality.
- Culture and heritage.
- Fire.
- Noise.
- Soil and water.
- Flora and fauna.
- Visual amenity.
- Waste.
- Weeds and pathogens.

Offshore
An Environmental Plan (EP) will be produced to manage all offshore construction activities including platform installation, drilling and completion of wells and laying of the offshore pipeline. Under the requirements of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999, offshore petroleum activities in Commonwealth waters cannot commence until the designated authority, which in this case is the Director, Western Australian Department of Industry and Resources, Petroleum Division, has accepted the EP.

The contents of an EP must include a statement of the operator's corporate environmental policy, a description of the activity and environment, an assessment of the potential environmental effects and risks and the environmental performance objectives, standards and measurement criteria. An implementation strategy (IS) for ensuring that the environmental performance objectives and standards are met must also be included in the EP. The IS is, in many ways, analogous to an environmental management system. In the vein of an environmental management system, the regulations require that an IS must include:

- Specific systems, practises and procedures for reducing environmental risk.
- A description of the roles and responsibilities of personnel.
- Provision for appropriate skills and training measures.
- Provision for the monitoring, audit and review of environmental performance and the IS.
- Provision for the maintenance of records of emissions and discharges.
- Provision for an emergency response manual and provision for consultation with relevant authorities and interested persons.

7.2.2 Operations

A single operations EMP will be produced to manage routine operations and emergency response procedures during the operational phase for both offshore (Commonwealth and state waters) and onshore activities. The operations EMP will be structured to take account of requirements under the Petroleum (Submerged Lands) (Management of Environment) Regulations and Roc's SEMS, which takes into account the principles of AS/NZS ISO 14001 and OSHAS 18001.

The operations EMP will be subject to approval by the Department of Environmental Protection (state activities) and acceptance by the designated authority (Commonwealth waters activities). It will include procedures for managing the following issues:

- Accidental discharges.
- Air quality.
- Fire.
- Noise.
- Rehabilitation.
- Socio-economic.
- Traffic.
- Visual amenity.
- Waste.
- Water.
- Weeds and pathogens.

7.2.3 Decommissioning

An environmental management plan will also be produced to manage the decommissioning phase of the project, which will be subject to approval by the Department of Environment Protection.

7.3 Commitments

Roc's commitments for the Cliff Head development are shown in Table 7.2.

Table 7.2 Cliff Head Development commitments

No.	Topic	Objectives	Commitment	Timing	Advice from (if required)	Measurement Criteria
1.	Environmental management	Ensure appropriate procedures are in place to manage environmental issues.	Environmental management plans/ environmental plans will be prepared for the construction and operation phases of the development.	Prior to commencement of construction.	DEP/DoIR/CALM, Dept. of Fisheries, Shire of Irwin, Rock Lobster Fishery Association	Letter endorsing EMP/EP from relevant authority.
2.	Environmental management	Ensure contractors are experienced in environmental management and suitable for the work.	All primary contractors will undergo an operational audit or audit review which includes examination of environmental management procedures prior to appointment.	Prior to appointment of contractors.		Record of operational audit.
3.	Environmental management	Ensure compliance with guidelines and commitments.	Environmental audits will be undertaken during construction and operations.	At least once during construction and at least two times per year during operations.	DEP, DoIR, CALM	Records of environmental audits.
4.	Environmental management	Ensure personnel are familiar with the environmental management systems and environmental issues.	All personnel going to site will undergo an environmental induction.	At all times.	DEP, DoIR, CALM	Records of inductions and other environmental training kept.
Design and route selection						
5.	Socio-economic	Minimise impact to lobster fishing industry.	The offshore pipeline will be designed to be compatible with lobster fishing activities.	During final design.	Dept. of Fisheries, Rock Lobster Fishery Association	Record of liaison with rock lobster fishing industry regarding final design of pipeline coating.
6.	Landform	Maintain integrity of frontal dune and beach system.	Horizontal directional drilling (HDD) will be used to cross under the frontal dune and shoreline if feasible.	During final design.	DEP, DoIR, CALM	No impact to dune from HDD activity.
7.	Marine flora and fauna	Minimise impact to marine habitat and marine flora and fauna.	The HDD exit point will be located to minimise impact to seagrass beds.	During detailed design of HDD route.	DEP, CALM, Dept. of Fisheries	Map showing planned HDD exit point and seagrass distribution provided to relevant authority.
8.	Marine flora and fauna	Minimise impact to marine habitat and marine flora and fauna.	A pipeline route that minimises disturbance to sensitive marine habitats will be selected.	Prior to commencement of construction.	DEP, CALM, Dept. of Fisheries	Map showing pipeline route and marine habitats.

Table 7.2 Cliff Head Development commitments (cont'd)

No.	Topic	Objectives	Commitment	Timing	Advice from (if required)	Measurement Criteria
Onshore Construction						
9.	Fire	Ensure that appropriate fire management procedures are in place.	Develop a fire management plan as part of the Construction EMP.	Prior to commencement of onshore construction.	CALM, Shire of Irwin, DoIR, Bushfire Authorities	Letter endorsing EMP from relevant authority.
10.	Fire	Gain local knowledge and integrate plan with existing fire management procedures.	Consult with local fire authorities and CALM during development of the fire management plan.	During development of fire management plan.	CALM, Shire of Irwin, DoIR, Bushfire Authorities	Records of consultation kept.
11.	Rehabilitation	Minimise erosion and minimise establishment of weed species.	Areas disturbed along pipeline easement will be rehabilitated.	Following construction.	DEP/ CALM, Shire of Irwin, Dept. of Agriculture	Monitoring results show rehabilitation successful.
12.	Public access	Ensure public's health and safety, protect easement from disturbance.	Public access to the easement will be prevented.	During construction and operations.	CALM, Shire of Irwin, Native title Claimant Group	Records of public interaction.
13.	Vegetation, flora and fauna	Minimise impact to vegetation, flora and fauna.	Minimise area of vegetation clearing during pipeline construction and installation.	During onshore construction.	CALM, Shire of Irwin, DEP, DoIR	Demobilisation report with photos showing extent of vegetation cleared.
14.	Weeds and pathogens	Prevent introduction and spread of weeds and pathogens.	A weed and pathogen hygiene plan will be established as part of the construction EMP.	Prior to commencement of onshore construction.	DEP/ CALM, Shire of Irwin, Dept. of Agriculture	Letter endorsing EMP from relevant authority.
Offshore Construction						
15.	Accidental discharges	Ensure appropriate spill response procedures are in place.	An oil spill contingency plan (OSCP) will be prepared.	Prior to commencement of offshore construction.	DoIR, AMSA, DEP, Dept. of Fisheries	Letter endorsing emergency response plan (including OSCP) from relevant authority.
16.	Marine flora and fauna	Minimise impact to sensitive marine habitats.	Procedures adopted to minimise damage by anchors during pipeline installation.	Prior to commencement of offshore construction.	DoIR, AMSA, DEP, Dept. of Fisheries, CALM	Audit of procedure implementation.
17.	Marine pest species	Prevent introduction of marine pest species.	Vessels and rigs will comply with Australian Quarantine Inspection Guidelines.	At all times during offshore construction.	AQIS, DEP, DEH	All international vessels to submit AQIS ballast water reporting forms to Roc and AQIS.

Table 7.2 Cliff Head Development commitments (cont'd)

No.	Topic	Objectives	Commitment	Timing	Advice from (if required)	Measurement Criteria
Operations						
18.	Accidental discharges	Ensure appropriate spill response procedures are in place.	An OSCP will be prepared covering onshore and offshore activities during operations.	Prior to commissioning.	DoIR / AMSA / DEP / Dept. of Fisheries	Letter endorsing emergency response plan (including OSCP) from relevant authority.
19.	Air quality	Reduce greenhouse gas emissions and minimise production of incomplete combustion products.	Transport vehicles will be regularly serviced to ensure vehicles/engines run efficiently.	At all times.	AGO / DEP	Service records kept.
20.	Transport	Minimise potential for transport accidents.	Procedures will be put in place to minimise the potential for transport accidents.	At all times.	Dept of Transport / Shire of Irwin / Shire of Geraldton	Audit of procedure implementation.
21.	Socio-economic	Minimise impact on rock lobster fishing industry.	An agreement will be made with fishing industry allowing fishing up to the platform during periods when the platform is not being serviced.	Prior to commissioning.	Rock Lobster Fishery Association / Dept. of Fisheries	Memorandum of Understanding.

8. Glossary and Conversions

8.1 Glossary

airshed: the geographic area requiring unified management for achieving air pollution control.

ambient air: the surrounding air.

aromatics: chemical classification relating to the structure of hydrocarbon. Aromatic hydrocarbons have carbon atoms arranged in rings with some of the electrons shared over the whole ring, for examples, benzene and naphthalene.

Australian waters: the territorial sea of Australia and any sea that is on the landward side of the territorial sea of Australia, other than any part of the sea that is within the limits of a state or of the Northern Territory.

benthic: living in or utilising the bank or bed surface of water bodies.

bioaccumulated: the accumulation in an individual or in a trophic level of substances other than food that has been ingested from the environment.

biota: the sum of all living organisms of an ecosystem, or of a defined area or period.

bund: an earth, rock or concrete wall constructed to prevent the inflow or outflow of liquids.

cathodic protection: application of an electrical current to the pipeline exterior to prevent the electrochemical process of corrosion occurring.

depauperate: impoverished, low numbers.

easement: a right held by the proponent to make use of the land of another for the installation and operation of a pipeline. Also referred to as a right of way.

emissions: substances being released to the environment.

epifauna: animals living on the sea floor.

exotic species: a species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities.

fetch: the uninterrupted distance travelled by a wave on the sea.

fugitive emissions: substances that escape to air from a source not associated with a specific process but scattered throughout the plant, e.g., leaks from equipment, dust blown from stockpiles.

geotechnical: relating to the engineering study of subsurface soils, involving specialised drilling or sampling for soil analysis and testing.

greenhouse effect: term used to describe the heating effect due to the trapping of long-wave radiation by greenhouse gases produced from natural and human sources.

groundwater: underground water contained within a saturated zone or rock.

habitat: the place or type of site in which an organism naturally occurs.

hydrocarbons: substances composed only of hydrogen and carbon

hydrogeology: the science of groundwater and surface water.

hydrostatic testing (or hydrotesting): a means to check the pipeline for strength and leaks prior to operation by filling the pipeline with water and increasing the pressure and monitoring under controlled conditions.

infauna: animals that live in or burrow into sediments.

intelligent pig: electronic devices inserted into the pipeline at regular time intervals to clean and check the integrity of the line.

intertidal: the area of land lying between the high-and the low-water marks.

Joint Authority: the Joint Authority consists of relevant state and Commonwealth agency representatives involved in granting of petroleum offshore pipeline and production licences.

native vegetation: any local indigenous plant community containing throughout its growth the complement of native species and habitats normally associated with that vegetation type or having the potential to develop these characteristics.

natural gas: a gaseous mixture of low molecular weight hydrocarbons (mostly containing methane and ethane with small amounts of propane, butane and higher hydrocarbons).

pig: a tool which is inserted into the pipeline and which is carried by the gas flow to clean the pipe wall or inspect the pipeline.

pollutant: a chemical that may reduce the quality of the environment.

potable water: drinkable water.

priority flora: are threatened species that are included on the Priority Species List under the *Wildlife Conservation Act 1950*. Information on these species is poorly known and requires further monitoring to be considered as rare flora.

rare flora: are protected species under the *Wildlife Conservation Act 1950* that are considered to be in danger of extinction, rare or otherwise in need of special protection.

riser: the section of a subsea pipeline from the seafloor up to a production platform.

turbidity: interference with the passage of light through water caused by suspended matter.

8.2 Conversions

Oil

1 barrel	=42 US gallons	=159 litres
1 m^3	=6.29 barrels	=1,000 litres

Gas

1 scf	=0.0283 m^3
1 Mcf	=28.3 m^3
1 MMcf	=28.3 kcm
1 TCF	=28.3 million kcm
1 GJ	=109 J
1 TJ	=1012 J

Miscellaneous

1 psig	=6.8948 kPa
1 hp	=0.746 KW
1 ha	=10,000 m^2

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10. Study Team

Roc has assembled a skilled study team drawing on company resources and external consultants to complete this document for the proposed Cliff Head Development. The members of the study team include the following key personnel:

Roc Oil (WA) Pty Limited

- Kevin English, Project Manager.
- Don Kratzing, HSE Coordinator.
- Graham Ryrie, Draftsperson.

MacroEnvironmental, Environment and Resource Consultants

- Peter Farrell, marine ecology, risk assessment and PER preparation.

Enesar Consulting

- Alastair Sharp-Paul, environmental management and specialist advice.
- Tara Halliday, environmental management and PER preparation.
- Jill O'Neil, desktop publishing.

Woodman Environmental Consulting

- Greg Woodman, terrestrial flora surveys.

Bamford Consulting Ecologists

- Mike Bamford, terrestrial fauna studies.

Q & A Communications

- Danicia Dutry, social impact assessment.

Wanati

- John Clark, Aboriginal and ethonograhic studies.

Asia-Pacific Applied Science Associates

- Scott Langtry, oil spill modelling.

Ecotox Services Australasia

- Rick Krassoi.

Ethnosciences

- Edward McDonald, Ethnographic studies.

Gavin Jackson P/L

- Gavin Jackson, Aboriginal archeological studies.

Appendix A

Cliff Head Oil Field Development
Environmental Scoping Document

CLIFF HEAD OIL FIELD DEVELOPMENT

ENVIRONMENTAL SCOPING DOCUMENT

ROC OIL (WA) PTY LIMITED

FEBRUARY 2004

Revision	Date	Description	By	Checked
1	Dec 2003	As submitted to EPA/DEH	P Farrell	D Kratzing
2	Feb 2004	Updated with EPA/DEH comments	P Farrell	D Kratzing

INDEX

1. PURPOSE OF THIS DOCUMENT

Roc Oil (WA) Pty Limited (Roc), as operator of the Commonwealth Petroleum Permit Area WA-286-P, proposes to develop the Cliff Head oil field.

The project has been referred to both the Commonwealth and Western Australian State environmental agencies for consideration. Roc is seeking a coordinated Commonwealth and State environmental impact assessment process for the proposed Cliff Head oil field development.

This document is structured to meet the requirements of a Preliminary Information document to meet the requirements of Section 86 of the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), and is being submitted to the Minister, via Environment Australia, to allow the Minister to determine the level of assessment for the proposed action under Part 8 of the EPBC Act.

Additionally this document has been structured to meet the requirements of a Scoping Document under Section 6.1 of the Western Australian Environmental Impact Assessment (Part IV Division I) Administrative Procedures 2002.

1.1. Commonwealth Assessment

A Referral Form for the proposed Cliff Head oil field development has been completed and submitted to the Commonwealth Department of Environment and Heritage (DEH) with this Preliminary Information document for assessment by the Commonwealth Environment Minister. The first step of the assessment process is for the proponent to provide preliminary information for the Minister to determine the level of assessment.

This document has been prepared to meet the requirements of a *Preliminary Information* document under the EPBC Act, and is being submitted to the Commonwealth Environment Minister, via Environment Australia, to allow the level of assessment for the proposed development to be determined under the EPBC Act. Roc considers that the proposed Cliff Head oil Field development is a controlled action, requiring assessment under the EPBC Act and that the appropriate level of assessment is a Public Environmental Report.

1.2. Western Australian State Assessment

An EPA Referral Form for the proposed Cliff Head oil field development has been completed and submitted to the Western Australian Environmental Protection Authority (EPA) with this document under Section 38(1) of the Environmental Protection Act (EP Act) for a decision on whether or not the proposed development requires assessment under the EP Act.

This document has been prepared to meet the requirements of a *Scoping Document* under Section 6.1 of the Western Australian Environmental Impact Assessment (Part IV Division I) Administrative Procedures 2002 to allow the level of assessment for the proposed development under the EP Act to be determined. Roc considers that the proposed Cliff Head oil Field development is an action, requiring assessment under the EP Act and that the appropriate level of assessment is a Public Environmental Review.

2. INFORMATION SOURCES

Sources of information used in this Preliminary Information/Scoping Document are listed in the reference section of this document. All information was taken from original sources, which include State and Commonwealth Government Department publications, consultant reports, scientific literature, or internal Roc reports. All of the documents incorporate varying levels of technical and peer review.

3. IDENTIFICATION OF PROPONENT

The proponent for the Cliff Head oil field development is Roc Oil (WA) Pty Limited acting as operator for the WA-286-P joint venture partners. The joint venture partners comprise

Roc Oil (WA) Pty Limited	30%
ARC Energy NL	7.5%
AWE Oil (Western Australia) Pty Ltd	27.5%
Westranch Holdings Pty Ltd	5%
Voyager Energy Limited	5%
Wandoo Petroleum Pty Ltd	25%

3.1. Company Environmental Record

Roc is committed to protecting the environment and consequently manages health, safety and environment (HSE) matters as a critical business activity. All of the company's activities are planned and performed so that adverse effects on the environment are either avoided or kept to an acceptable level while meeting all statutory requirements. A copy of the Corporate Health, Safety Environmental Policy is provided overleaf

Roc employs a structured approach to the management of HSE issues via a formal HSE Management System (HSE-MS). The HSE-MS ensures that impacts from Roc's operations are either avoided or kept to as low as reasonably practicable (ALARP), and it also drives continuous improvement in the company's environmental performance. The HSE-MS assists in providing confidence to regulators, stakeholders and the community at large that Roc is responsibly discharging its environmental responsibilities.

Roc is not currently, and has not previously been, the subject of any proceedings under Commonwealth, State or Territory laws for the protection of the environment, or the conservation and sustainable use of natural resources.

Roc Oil Company Limited

Occupational Health, Safety and Environmental Policy

Obligations

ROC recognises its moral and legal responsibility to provide a safe and healthy work environment. This commitment extends to ensuring that Roc's operations do not place the local community at risk of injury, illness or property damage.

Objectives

- provide safe plant and systems of work;
- provide written procedures and instructions to ensure safe systems of work;
- ensure compliance with legislative requirements and current industry standards;
- provide information, instruction, training and supervision to employees, contractors and customers to ensure their safety;
- implement and maintain ROC's safety and environment management system;
- as a priority consider health, safety and environment equally with cost, quality, and production considerations;
- communicate openly;
- commitment to ensuring risks to health, safety and the environment are reduced to ALARP;
- set health, safety and environmental objectives and targets so as to demonstrate continuous improvement; and
- provide support and assistance to employees.

Responsibilities

Each management representative is accountable for implementing this policy in his/her area of responsibility. This will be measured via their annual performance reviews. Management is responsible for:

- the provision and maintenance of the workplace in a safe condition;
- involvement in the development, promotion and implementation of health, safety and environmental polices and procedures;
- training employees in the safe performance of their assigned tasks; and
- the provision of resources to meet the health, safety and environmental commitment.

Employees are to:

- Follow all health, safety and environmental policies and procedures; and
- Report all known or observed hazards to their immediate supervisor or manager.

Application of the Policy

This policy is applicable to ROC in all its operations and functions including those situations where employees are required to work off site.

Consultation

The organisation is committed to consultation and cooperation between management and employees. The organisation will consult with employees in any workplace change that will affect the health and safety of any of its employees.

Policy Authorised by _____ **Chief Executive Officer**

Date 5 July '01

4. SUMMARY DESCRIPTION OF PROPOSAL

Roc Oil (WA) Pty Ltd (ROC), on behalf of its joint venture partners in Commonwealth Petroleum Permit Area WA-286-P proposes to develop the recently discovered Cliff Head oil field. The Cliff Head oil field development will comprise:

- an unmanned platform at the Cliff Head oil field location approximately ten kilometres offshore,
- a pipeline from the offshore platform to an onshore production facility, and
- an oil production facility for the treatment, stabilisation and export of crude oil.

The Cliff Head oil field lies within Commonwealth waters offshore from Western Australia in Petroleum Permit Area WA-286-P. The permit area is at its closest boundary 5.4 kilometres from the coastline. The oil field itself is some 1,500 metres below the seabed and extends across an area that is approximately 8.5 to 12 kilometres offshore from the coastline and 16 to 20 kilometres south of Dongara, Western Australia as illustrated by Figure 1. Bounding coordinates of the field location and approximate site of the proposed wellhead platform are presented below.

The oil production facility is proposed to be built at the site of an existing disused lime sand plant facility approximately three kilometres inland from the coastline and 20 kilometres south of the township of Dongara. The coordinates for the production facility are given in presented below.

Bounding Coordinates of the Cliff Head Field, Wellhead Platform and Centre Coordinates of Onshore Production Facility

	Easting	Northing
Field Location	E 290,150	N 6,742,700
	E 294,100	N 6,742,700
	E 290,150	N 6,736,650
	E 294,100	N 6,736,650
Wellhead Platform	E 293,385	N 6,740,245
Production Facility	E 306,250	N 6,742, 850

Sampling to date from the Cliff Head reservoir indicates the presence of medium density oil (specific gravity 0.86) with low gas-oil ratio. The Cliff Head field contains likely recoverable reserves of approximately 3,370,000 cubic metres (21 million barrels) of crude oil.

ROC has undertaken a technical screening study to assess available development options for the Cliff Head field. This study has concluded that the most suitable development option is to have an unmanned platform at the field with liquids and gas recovered from the production wells directed byway of pipeline to an onshore production facility where the crude oil will be degassed and dewatered to meet market specifications prior to export. The following text provides a brief description of the key components of the proposed development and Figure 2 provides a schematic representation of the proposed Cliff Head oil field development.

Figure 1. Locality Diagram

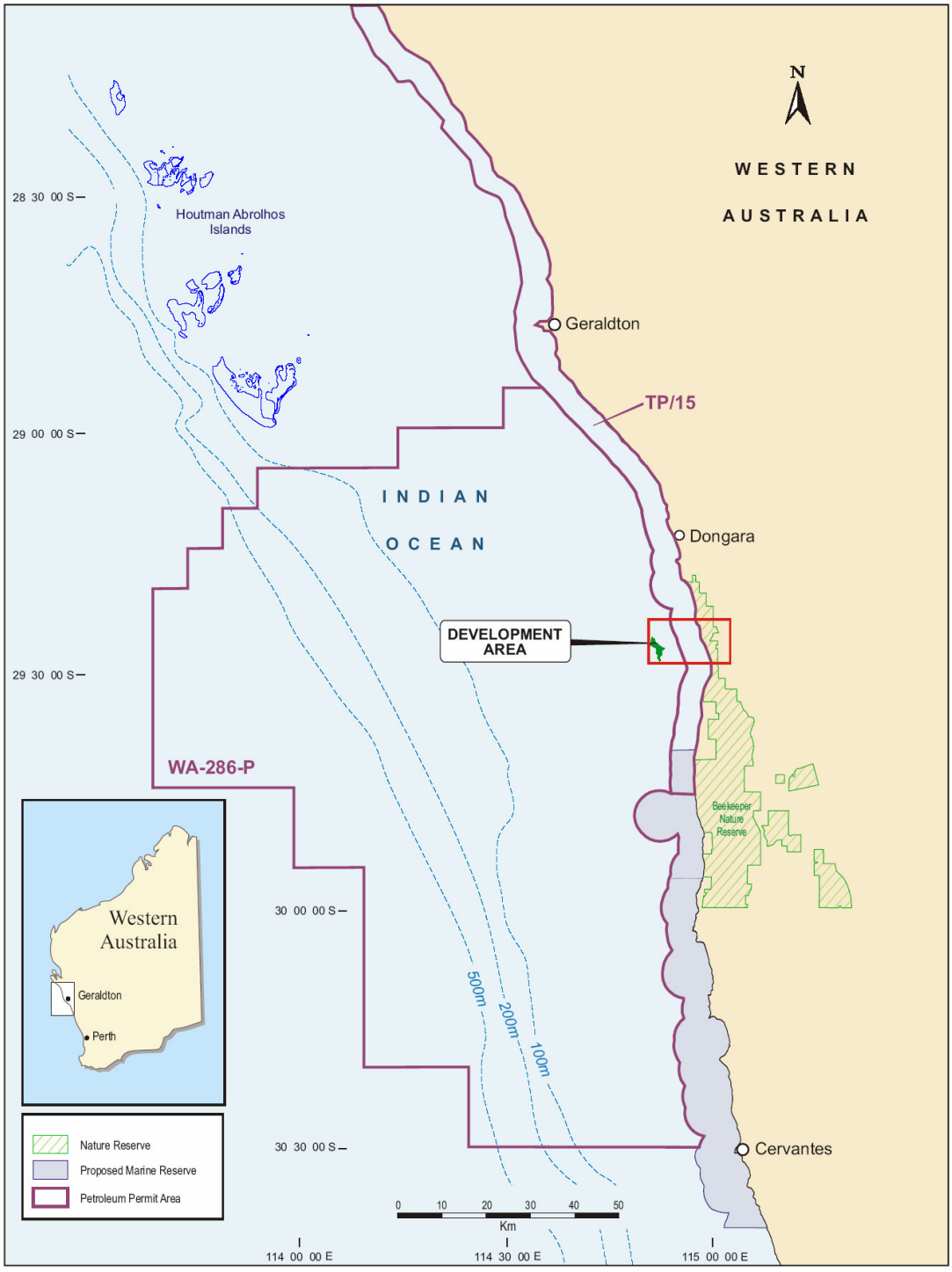
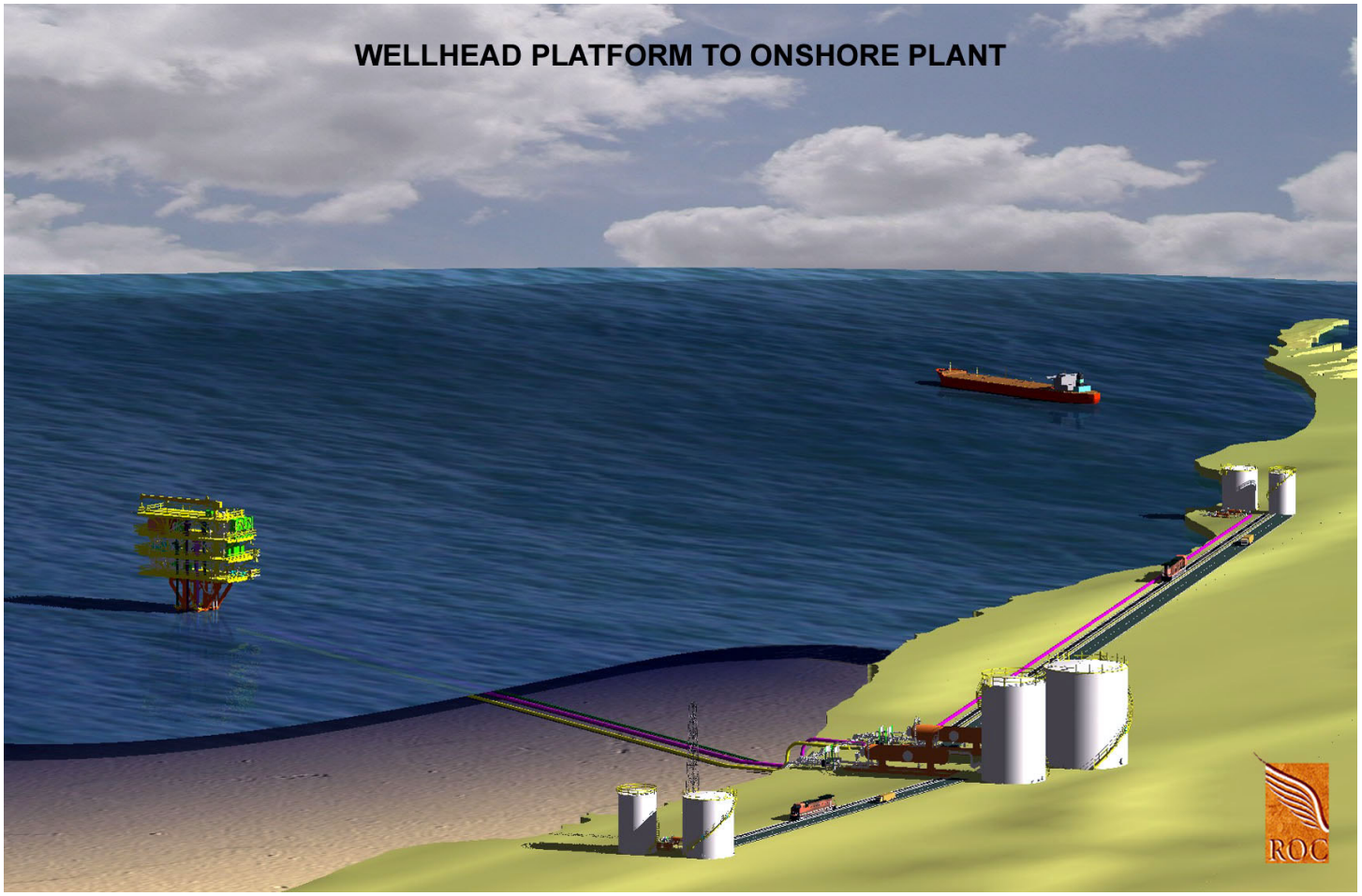


Figure 2. Schematic Illustration of Cliff Head Oil Field Development: Roc Oil (WA) Pty Limited



4.1. Production Wells and Re-Injection Wells

The proposed development plan is to drill and complete up to eight production wells. The wells will be approximately 1500 meters deep below the sea-bed, and take about 10 to 15 days each to drill and complete.

Two or three dedicated re-injection wells will be drilled for re-injecting produced formation water into the oil reservoir. Re-injection will serve the dual purpose of avoiding the discharge of produced waters to the marine environment and assisting to maintain pressure within the reservoir with a consequential improvement in oil recovery rates.

The timing and phasing of drilling will be dependent upon factors such as rig availability and project scheduling requirements.

4.2. Platform

A normally unmanned wellhead platform will be installed in the field location to accommodate the dry well heads and allow access to the artificial lift pumps and to house their supporting equipment . The approximate site of the platform within the field location is presented in Table 1. The final decision on wellhead platform site will be based on a detailed consideration of environmental, technical and financial factors .

4.3. Subsea Pipelines

The offshore platform and the onshore production facility will be connected byway of two pipelines and an umbilical line. One pipeline will be for transfer of liquids, comprising water and crude oil, and gas from the production wells. The other pipeline will be for the return of water for re-injection. The umbilical line will supply chemicals, such as corrosion inhibitor and emulsion inhibitors to the production wells as well as hydraulic fluid for remote control of the platform activities.

4.4. Production Facility

It is proposed that the production facility will be constructed at the site of a disused lime sand plant approximately three kilometres inland from the coast and 20 kilometres south of Dongara.

Processing at the production facility will comprise degassing, dewatering and stabilisation of the crude oil. The production facility will be designed to have a gross liquid (oil and formation water) capacity of approximately 5,500 cubic metres per day (35,000 barrels per day). Plant design includes storage facilities for approximately 6,400 cubic metres (40,000 barrels) of crude oil.

The volumes of gas associated with the oil are so low that they are not by themselves a practicable source of fuel for the production facilities. These minimal volumes of recovered gas will be supplemented with reticulated gas delivered to the site to provide fuel for the production facilities.

4.5. Export of Crude Oil

The method for export of crude oil product to markets has not yet been finally defined and is subject to ongoing negotiations. Following an extensive options review, the possible export options still options being considered are road and rail transport to either Geraldton or Kwinana.

4.6. Decommissioning

During the design phase of the Cliff Head, the requirements for decommissioning of the facilities will be considered. This will include the removal of the platform from location. A strategy for well plugging and abandonment, and decommissioning of the pipelines, umbilicals and the onshore production facilities will be determined during the development engineering phase.

While the physical removal of pipelines may not be the eventual preferred option, engineering design will ensure that it remains a practical option for all pipelines on the sea floor. The exact scope of activities required for offshore and onshore field decommissioning will be developed nearer the end of field life and does not form part of this referral.

5. ALTERNATIVES CONSIDERED AND SELECTION OF PREFERRED OPTION

ROC has undertaken a technical screening study to assess available development options for the Cliff Head field. The major options considered, and analysis outcomes, are summarised by Table 1

Table 1: Summary of Cliff Head Development Alternatives

Option	Description	Issues	Outcome
Subsea Completion, produced to shore	8 to 10 subsea wells tied to a central manifold. Production pipeline to Onshore Plant	Subsea trees considered a hazard to fishing vessels. Flow assurance of subsea flowlines considered technically impractical	Technically discounted (no CAPEX estimate done)
Wellhead Platform (east of reef) with 7km bridge	Jack-up installed Wellhead Platform (east of Horseshoe Reef). 8-10 wells. Piled 7km bridge to shore. Production pipeline to Onshore Plant	Drilling would require extended reach wells. Wells assessed as extremely technically challenging	Commercially non-feasible
Converted Jack-up rig	Converted Jack-up rig (leased). 8-10 wells, production facilities & injection facilities offshore. Production pipeline to Onshore Plant (storage and export)	Manned offshore.	Low CAPEX but very high OPEX – commercially non-feasible
"Production Island" on Horseshoe Reef to FSO	Construct a "Production Island" on Horseshoe Reef. 8-10 wells, production & injection facilities on "Island". Pipeline to FSO for storage	Manned "Island". Technically challenging building island for seastate. Environmentally hazardous	Environmentally discounted (no CAPEX estimate done)
Wellhead Platform to FPSO	Jack-up installed Wellhead Platform (west of Horseshoe Reef). 8-10 wells. Production pipeline to FPSO. Production, Injection, Storage and Export Facilities on FPSO	Flow Assurance of Production Pipeline (technically feasible). Manned offshore (FPSO). Offshore oil inventory	Commercially non-feasible
Wellhead Platform to Onshore Plant	Jack-up installed Wellhead Platform (west of Horseshoe Reef). 8-10 wells. Production pipeline to Onshore Plant. Production, Injection, Storage and Export Facilities onshore	Flow Assurance of Production Pipeline (technically feasible). Unmanned offshore facility	Favoured option

The nature of the Cliff Head crude oil is such that for it remain in liquid form during transport between the well head and the production plant it must remain at temperatures above about 35^{o}C. This results in the imposition of a significant constraint on the length of pipeline that is technically and economically viable, which in turns constrains the geographic area within which the production plant can be located.

There is an inevitable nexus between pipeline route and plant site location. The shortest practicable pipeline route improves technical reliability and, normally, decreases expenditure. These two concerns need to be balanced against potential impacts associated with each of the alternative plant site and pipeline routes. Within the geographic area pre-determined by technical and economic feasibility a total of five potential plant sites were evaluated during the early phases of project planning. All of the potential sites are on freehold land. Table 2 presents a summary of the alternative sites considered.

Table 2: Summary of Cliff Head Plant Site Alternatives

Site	Description and Issues	Outcome
1 - Westlime Site	Located 2km south of the Grice property, this option has the advantage of existing infrastructure – gas to site, sealed road to highway, security fence , buildings and internal road and concrete paved areas. It is also in line with a direct pipeline route from offshore and results in the shortest distance of 2.8 km of pipeline across the reserve. The site is screened from the highway by an adjacent dune system.	ROC believes that this site offers the best environmental solution in terms of minimum impact to fishing, use of an existing industrial site and minimal impact to Beekeepers Reserve, with a buried pipeline easement of 2.8 km across the reserve. The chosen alignment also results in the pipeline landfall occurring at a relatively low point in the coastal dune system.
2 - Grice Property	This option was studied in some detail. This is a greenfields site which would require a 4.5 km length of pipeline wending through some high dunes in Beekeepers Reserve. This site would require low additional cost including land cost compared relative Option 1.	Because of the additional length of pipeline in Beekeepers Reserve and additional cost this was rejected in favour of Option 1
3 – Jingemia Oilfield Site	This site is the exploration well site of Origin Energy. The offshore pipeline was 10.5 km, assuming a direct route to shore. The onshore line was 7 km through Beekeepers Reserve, assuming a direct route. The cost of provision of gas to this site would be substantial although possibly offset by savings in transport over project life. This site would require moderate additional cost compared against Option 1.	While there may have been some synergies in operating alongside Origin, these were outweighed by the additional length of pipeline through the reserve and the additional capital cost.
4 - North of Beekeepers	This option to a DOLA - administered reserve adjacent to the	The greater flow assurance risk and impact on lobster fishing,

Reserve	Dongara airport, would require an offshore pipeline of 16.5 km. assuming that a direct route is possible. Supply of gas would be a substantial cost. The shore dunes in this area are high. Cost of transport to Geraldton would be reduced over the life of the project. This site would require large additional cost compared against Option 1.	combined with a large cost burden, assuming that land was available on the reserve, together with difficulty in lack of a pipeline stringing site and negotiation of pipe strings over high steep coastal dunes, led to rejection of this option.
5 – South of Beekeepers Reserve	The first freehold land to the south, where Beekeepers Reserve is not adjacent to the coast would require an offshore pipeline of about 17 km. assuming that a direct route is possible. A crude stabilisation plant at this location would have a high visual impact. This location would require the extension of the gas supply pipeline (for plant and offshore power) by 16.5km and would potentially require a construction easement for that length, if it could be located in the existing road easement. This optin has the highest additional cost relative to Option 1.	Notwithstanding higher capital and operating costs, this option would result in greater risk from a flow assurance standpoint, have a greater impact on exclusion areas within the lobster fishing zones and potentially have a greater impact on Beekeepers Reserve, because of a construction easement for the gas supply pipeline.

6. DESCRIPTION OF ENVIRONMENT

6.1. Climate and Oceanography

The wind climate of the project area is highly seasonal. The two primary winds regimes are the sea breeze dominated summer pattern and the synoptically dominated winter pattern (GEMS, 2001). In spring and autumn the winds are in transition between the two main regimes. With the sea-breeze effect less pronounced, the winds are less 'concentrated' and reflect the migratory aspects of weather systems.

Oceanic swells predominantly arrive from the southwest during spring and summer. The mean swell heights range from 0.9 to 1.3 m with associated maximums of 1.7 to 3.5 m and mean periods of 12 to 16 seconds. Typical annual mean sea heights are 0.5 to 1.2 m with associated maximums of 1.5 to 2.5 m and mean periods of 4 to 7 seconds (WNI, 2000). Water circulation is primarily influenced by wind driven currents. Tides are diurnal, with a small maximum range of less than one metre, and have very limited effect on water circulation in the area.

6.2. Landforms and Geomorphology

The onshore components of the proposed development are situated within the Perth Basin Geological Province on the coastal foreplain comprising unconsolidated beach and calcareous deposits. The area is characterised by parabolic sand dunes running approximately parallel to the coast on a sandy plain. The soils comprise:

- variables levels of calcium carbonate, related to the shell content of the beach and dune sands from which they originated,
- a pH that is typically alkaline, up to 9.5 in more calcareous patches and close to neutral in swales between dunes,
- variable salinity from seawater spray, decreasing inland, and
- very porous nature with consequential low water holding capacity.

6.3. Terrestrial Flora

The proposed development area lies within the Irwin District of the South-Western Botanical Province which is associated with a coastal limestone belt one to five kilometres wide south of Port Denison (Beard 1976). The vegetation consists primarily of low heath with small shrubs and patches of Acacia species and mallee thickets. The principal species are *Acacia lasiocarpa* and *Melaleuca acerose*, with areas of *Scavola* species dominating.

Preliminary results of flora surveys indicate the presence of 106 species forming two thicket communities, three heaths and two communities that had been modified by grazing and other agricultural activities within the project area.

The plant communities present reflect the harsh nature of the environment, with species dominance and morphology within the communities altering to suit the soil depth and water availability at each site. The coastal heath communities dominate the harsher sites closer to the coast on dune crests and in exposed sites on flats with little soil covering the limestone basement. The predominantly *Acacia rostellifera* thicket communities occurred in primary dune swales closer to the coast where water harvested from the dunes and shelter from the prevailing winds provides conditions suitable for plant growth. Thicket communities become more dominant further from the coast east of the secondary dune environments.

6.4. Terrestrial Fauna

Preliminary results of fauna surveys indicate the presence of 18 native animals, comprising a single mammal and 17 bird species present in the development area. However the list of fauna that could possibly occur within the area includes 22 mammals, 114 birds, 58 reptile species and eight frogs.

Species of conservation significance that may possibly occur in the project area include 8 reptiles, 17 bird species and 3 mammal species. The Department of Conservation and Land Management's (CALM) list of threatened fauna species from the Dongara area includes 3 birds and 5 insects. No stygofauna are expected from the area due to the lack of Karst formations in the local area.

The short-billed black cockatoo (*Calyptorhynchus latirostris)*, listed as endangered under the EPBC Act is likely to be a regular non-breeding visitor to the area. Several species of listed migratory birds are also likely to occur in the area.

6.5. Water Flows, Rivers, Creeks and Impoundments

There are no wetlands or significant drainage basins present in the area of the proposed development.

6.6. Marine Environment

The development area lies within the 'Central West Coast' meso-scale region according to the IMCRA classification (IMCRA, 1997). The region is characterised by a relatively narrow continental shelf with diverse moderate energy coastal landforms (IMCRA, 1997). The area has a range of temperate species and is also at the southern limit of a suite of sub-tropical and tropical species.

The bathymetry across the proposed development area ranges from zero to 30 metres water depths. The water depth at the proposed wellhead platform site is approximately 20 metres. The prominent features of the development area are the sub-littoral reefs that occur as a series of broken ribbon reefs approximately three to five and 10 to 12 km offshore. These are high profile structures, with steep reef faces and extensive horizontal ledges, which support an abundant attached invertebrate cover, particularly rich in sponges and ascidians.

The area supports diverse seagrass communities, with their distributions and densities varying over the range of habitats represented. Predominant species include *Thalassodendron pachyrhizum, Amphibolis* spp*, Posidonia* spp*, Halophila* spp*,* and *Heterozostera tasmanica*, but up to nine separate species may form mixed communities on sand substrates in sheltered nearshore environments and in the lee of offshore reefs.

Species of conservation significance that may potentially occur in, or near to, the affected marine area include several listed under the endangered or vulnerable and/or migratory provisions of the EPBC Act. These include:

- Blue whale *Balaenoptera musculus* (endangered, migratory)
- Southern right whale *Eubalaena australis* (endangered, migratory)
- Humpback whale *Megaptera novaeangliae* (vulnerable, migratory)
- Great white shark *Carcharodon carcharias* (vulnerable, migratory)
- Grey nurse shark *Carchariuas taurus* (vulnerable)
- Whale shark *Rhincodon typus* (vulnerable, migratory)

7. SUMMARY OF POTENTIAL IMPACTS, SIGNIFICANCE AND MANAGEMENT RESPONSES

There will be no impacts of the proposed activities on World Heritage properties, Ramsar wetlands, threatened ecological communities or Commonwealth land.

The environmental effects of oil and gas production activities are well known and have been subject to numerous reviews (e.g. US EPA, 1985; Swan *et al*., 1994; URS Australia, 2001). A preliminary assessment of the potential environmental impacts of the proposed Cliff Head development is presented below.

7.1. Marine Ecology

Potential impacts to the marine environment relate primarily to routine disturbances during drilling and construction and to a lesser extent accidental disturbances during operational life of the field.

The discharge of treated sewage and greywater from the drilling rig and construction vessels may result in a temporary reduction in quality of the surrounding waters during the construction and drilling period of approximately 6 months. All drilling rigs and construction vessels will be required to have sewage treatment facilities onboard.

Drilling muds will be selected with a preference for water-based muds and lowest toxicity while still meeting technical requirements. Where non-water-based muds are used these will be recovered and recycled. Observations of the seabed after drilling of the Cliff Head exploration wells has indicated that cuttings are rapidly dispersed by the strong surge currents present in the area. Consequently no special measures are proposed for the disposal of drill cuttings.

Pipelay operations will cause some direct, localised physical impact on seagrass and other benthic communities. Areas of sandy seabed and limestone pavement, which extend over

the majority of the development area, would be expected to recover quickly from physical disturbances. Seagrasses however would require substantially greater recovery periods. The pipeline route will be selected to minimise disturbance to areas of seagrass meadows and anchoring pattern of the lay-barge will be designed to avoid areas of seagrass meadows as far as practicable.

The activity of bringing a drilling rig, construction vessels and associated support vessels into the area results in the risk of exotic pest species introduction. Roc will require that all contractors stringently adhere to AQIS guidelines and regulations for control of exotic marine pest species, including the exchange of ballast in deep oceanic waters.

Although oil spills from oil and gas exploration and production are very rare events within Australia a low risk of spill does exist during any shipping and offshore activities where hydrocarbon inventories are present. Hydrocarbon spills may be associated with crude oil, bunker fuels or diesel. The potential environmental impacts of hydrocarbons spills have been subject to a large number of studies and reviews. The severity of impact is highly variable depending on, among other factors, type of hydrocarbon, quantity of spill, timing of spill and metocean conditions at time of the spill. The emphasis on management is to avoid the potential for hydrocarbon release through careful evaluation of operations. Additional to this Roc will prepare a detailed oil spill contingency for responding to spill events. Under requirements of the Commonwealth and State *Petroleum (Submerged Lands) Acts* the oil spill contingency plan must be accepted by the Designated Authority before operations can commence.

7.2. Atmospheric Emissions

Gaseous products of combustion, including SOx, NOx, greenhouse gases will be released to atmosphere during construction, installation and commissioning of facilities.

The generation of dust during construction will be managed using a number of techniques, such as soil wetting, to prevent any negative impact on environmental, health or amenity values.

7.3. Landform, Drainage and Hydrology

The predominant landforms of the area are the parabolic dunes. The construction of shore crossing and onshore pipeline has the potential to cause negative environmental impact on the dunes. The dunal environments range from fairly stable where vegetation cover is well established to highly mobile. Mobile dunes are a feature of this landscape and disturbance to the dune vegetation could result in severe wind erosion on the site.

The level of impact will be minimised in the first instance by selecting the shore crossing point and pipeline route to avoid sensitive areas. The application of horizontal directional drilling technology for construction of the shore crossing will further avoid impacts to the primary dune system.

It is not expected that any significant impacts will occur to drainage or hydrology as a result of the proposed development.

7.4. Wastes

All wastes will be segregated into hazardous, non-hazardous and recyclable waste streams at source and disposed of through accredited waste disposal contractors in accordance with Roc's Health Safety and Environmental Management System requirements and the requirements of appropriate State hazardous waste legislation and local shire disposal guidelines.

7.5. Terrestrial Flora

The onshore pipeline route traverses approximately 2.5 to 3.0 kilometres of Beekeepers' Reserve. During construction of the pipeline it will be necessary to establish working easement of approximately 20 metres width. The major potential environmental impacts relate to the manner in which the easement is created and the potential for introduction of weeds species.

Management of pipeline construction operations will strive to ensure minimum disturbance to the existing vegetation through the application of measures such as rolling or slashing of vegetation rather than clearing along the easement.

The proposed site for the production facility, outside of Beekeepers' Reserve, has previously been pastoral land and, most recently, a lime-sand plant. It is generally of very poor nature with almost all areas either bare or colonised by weed species and pasture grasses.

The site is situated within the Quindalup dune system on alkaline (lime) sands that are known to suppress *Phytophthora cinnamomi*'s ability to survive and spread. Also, the predominantly non - proteaceous vegetation provides few susceptible species suitable for the pathogen to colonise. Therefore the project area is not particularly vulnerable to colonization by this pathogen and there is a low risk of the pathogen becoming established and causing disease within the vegetation.

The highly degraded nature of the eastern end of the project area provides a ready source of weed seed that could be introduced into the western portion of the project area. The proposed pipeline route could provide a significant risk to the integrity of the native vegetation in this portion of the nature reserve and rehabilitation and weed management will be integral to the project. Equipment and activities will be managed to minimise the potential for introduction of weeds and the area will be rehabilitated at completion of the construction.

7.6. Terrestrial Fauna

Due to the nature of the project and the limited area of disturbance, impacts to fauna are expected to be negligible and restricted to temporary disturbances associated with construction of the pipeline.

7.7. Cultural Heritage

There are no recorded sites of ethnographic (ie mythological, religious or cultural) significance that would be affected by the proposed development. Heritage surveys with a representative of the native title claimant group have been partially completed. Roc is committed to ensuring that consultation with the native title claimant group continues with the objective of reaching a mutually agreeable resolution.

7.8. Visual Amenity

The offshore wellhead platform will have minimal lighting necessary for safety of navigation. It will be visible from the coastline, however it is not anticipated that this would represent a significant negative impact to amenity values of the area.

The onshore plant will be shielded from view by the natural landforms and consequently is not expected to have any negative impact on visual amenity of the area.

8. PROPOSED STUDIES AND INVESTIGATIONS

A number of studies and investigations have been either initiated or are planned to be conducted to address and better understand the potential environmental impacts associated with the proposed Cliff Head oil field development. The main studies are described in brief below.

8.1. Marine Flora and Fauna

The marine flora and fauna will be investigated through a combination of desk-top literature reviews, broad-scale mapping and targeted site surveys. Specifically, the existing abundance, species diversity, and distribution of marine ecological communities in the area will be described. The presence of species of conservation significance (including species listed on the Schedules of the EPBC Act) will be determined.

The potential for direct and indirect impacts on marine ecological communities of routine and potential accidental events, including cumulative impacts will be assessed.

Strategies for the management of potential exotic organism introduction associated with ballast water will be developed consistent with the AQIS guidelines for ballast water management.

8.2. Oil Spill Modelling

The potential sources of accidental releases, including size and frequency will be determined through review of available industry reporting data and an analysis of likely inventories and release rates. This information will be used to form discussion on fate and potential impacts.

A numerical model will be used to predict the trajectory of realistic and credible oil spill scenarios under representative weather conditions. Strategies for the management and control of accidental releases will be developed.

8.3. Terrestrial Flora Survey

The Environmental Protection Authority document "Guidance for the Assessment of Environmental Factors – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia – N0. 51. Draft. February 2003" provides guidelines for survey timing and sampling intensity in baseline biological surveys. The development area falls into a category where Level Two survey intensity will be required.

The vegetation of the development area will initially be mapped from aerial photography with ground truthing and sampling of the vegetation to confirm plant community boundaries and develop as complete a species list as possible for the site.

Department of Conservation and Land Management databases will be interrogated for known populations of Declared Rare (DRF) and Priority listed flora and Threatened Ecological Communities (TEC). Plant communities identified on site will be compared with descriptions of TECs to determine their presence.

Vegetation condition will be assessed including presence and distribution of invasive weed species. This data will be analysed to produce a report discussing the conservation significance of the flora and vegetation on the site and identify the potential impacts of

The proposed pipeline and plant site are predominantly within Crown land managed by CALM. CALM Policy Statement No. 3 of 2000 requires *Phytophthora cinnamomi* (Dieback) Interpretation to be conducted to CALM standards by an accredited Disease Interpreter. The site will be interpreted for the presence of *P. cinnamomi* by a CALM accredited

Interpreter, and the distribution of the disease within the Site mapped. A report will be prepared that will discuss the management issues presented by the mapped distribution of the disease with respect to both the project and the flora and vegetation on the Site.

8.4. Terrestrial Fauna Survey

The draft Guidance for the Assessment of Environmental Factors (No. 56 Terrestrial Fauna Surveys) produced by the EPA suggests that a development in the Dongara to Eneabba area with moderate impacts, such as a pipeline and plant, requires a level 1 survey, which consists of background research and a reconnaissance survey. This project will include a Site inspection to confirm habitats and observe some fauna, with a literature review to develop species lists. A report to discuss conservation and management issues consistent with EPA guidelines will be prepared.

8.5. Ethnographic and Aboriginal Survey

Archaeological, ethnographic surveys and consultations will be undertaken with Aboriginal communities and the recgnised native title claimant group to assess potential impacts on areas of indigenous cultural significance.

8.6. Social Impact Study

A social impact assessment will be completed. This study will describe other uses of the area and resources, such as fisheries, shipping and mining. It will also provide details of any potential impacts and propose measures by which they may be addressed.

8.7. Air Emissions

All emissions to atmosphere from the proposal with a potential to have non-trivial impact on the environment (including impact on human health, nuisance, amenity, vegetation or fauna) will be quantified.

The predicted quantities of greenhouse gas emissions, including emissions over the life of the project, will be estimated and compared with other plants/technology producing similar products (considering the full life cycle and global context).

8.8. Environmental Management

The outline of environmental management plans for each stage of the project setting out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the development will be presented within the EMP, including:

- Guiding policies
- Roles and responsibilities
- Processes for measuring and reporting performance
- A consolidated list of mitigation measures proposed to avoid or minimise potential adverse environmental impacts.

9. ENVIRONMENTAL FACTORS

Roc has conducted a systematic review of the proposed development and consulted with a range of stakeholders, including local government, government agencies and members of the public, to identify the relevant environmental issues/factors and associated EPA objectives for the proposed Cliff Head oil field development. Table 2 presents the relevant environmental issues/factors, EPA objectives and scope of studies and investigations to be carried out.

Table 3 Environmental Factors, Objectives and Scope of Studies

Factor	Topic	EPA Objective	Actions Needed
Terrestrial flora	Vegetation communities Declared Rare and Priority Flora; Flora of Conservation Significance	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*. Protect other flora species of conservation significance.	Undertake a field study to determine the existing abundance, species diversity, geographic distribution and regional significance of vegetation communities in the project area (Apply the DEP/CALM Terrestrial Biota Survey Guidelines'). Determine the presence of Declared Rare Flora, Priority Flora or other species of conservation significance (including species listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999).* Identify potential direct and indirect impacts on vegetation communities. Assess potential impacts (direct and indirect) on significant flora and identify taken and proposed measures to minimise impacts and manage unavoidable impacts (Note include consideration of erosion and blowout on dune vegetation). Show the measures taken in plant siting, layout/footprint to minimise impacts, and any other proposed measures to further reduce impacts and manage unavoidable impacts. Assess potential impacts (direct and indirect) on significant flora and identify taken and proposed measures to minimise impacts and manage unavoidable impacts.
Terrestrial Fauna	Specially Protected (Threatened) Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*	Undertake a suitable field survey to determine the existing abundance, species diversity, geographic distribution and significance of terrestrial fauna throughout the areas to be affected by the proposal including Specially Protected (Threatened) Fauna (Note, will need to discuss the survey design with CALM. and also refer to DEP Position Statement #3; '*General requirements for biological surveys for EIA in WA*') and EPBC Act listed fauna Provide an assessment of the potential impacts (direct and indirect) from the proposal, and propose measures to minimise and manage unavoidable impacts.

Factor	Topic	EPA Objective	Actions Needed
Landform, drainage and site hydrology	Landform, drainage, site hydrology and surface water	Maintain the integrity, functions and environmental values of landforms and natural surface water drainage including watercourses and sheet flow.	Provide details of requirements and sourcing of raw materials and fill (if any) in levelling of the site for construction. Provide details of potential impacts from proposal on landform and measures proposed to minimise and manage impacts. Identify watercourses, and types of surface water flow including sheetflow throughout the areas to be affected by the proposal (including roads). Provide details of potential impacts from proposal on natural surface water drainage, creekline and dependent vegetation, sediment transport and erosion and how they will be addressed during construction and operation (See Draft Guidance No.26 'Management of Surface Run-Off from Industrial and Commercial Sites). Assess the potential impacts on surface water disturbance and how they will be addressed.
Water supply			Provide details of water quantity required and sources of supply. Identify potential impacts and measures to manage impacts.
Ground and surface water quality	Wastewater discharge from site	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *National Water Quality Management Strategy* (NWQMS) – *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*	Assess the potential impacts on surface and groundwater quality and how they will be addressed Provide a detailed description of wastewater discharge from the site, including options considered, assessment of options and proposed measures to avoid or minimise impacts consistent with the NWQMS Guidelines. Details of chemical storage and management on site should be included. (Refer to EPA Draft Guidance for the Assessment of Environmental Factors No. 26, *Management of Surface Run-off from Industrial and Commercial Sites*.).

Factor	Topic	EPA Objective	Actions Needed
Marine ecology including sea floor, marine flora and fauna	Wastewater discharge to the marine environment Solid wastes discharged to the marine environment Increased shipping Accidental discharges to the marine environment	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS guidelines for ballast water management and ANZECC Code of Practice for Antifouling. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999*	Describe the existing abundance, species diversity, and distribution of marine ecological communities in the area of the proposed development. Determine the presence of species of conservation significance (including species listed on the Schedules of the *Environment Protection Biodiversity Conservation Act 1999).* Identify potential direct and indirect impacts on marine ecological communities and species of conservation significance of routine and potential accidental events. Demonstrate that the cumulative impacts of any discharge to the marine environment are acceptable. Assess and describe any likely contaminants resulting from increased shipping movements including the potential for accumulation of TBT and heavy metals. Develop strategies for the management of potential exotic organism introduction associated with ballast water and in-water hull cleaning and demonstrate how these are consistent with the AQIS guidelines for ballast water management and ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance. Identify potential sources of accidental releases, including size and frequency and provide discussion on fate and potential impacts. Develop and describe strategies for the management of accidental releases, including regulatory controls (eg OSCP requirements)

Factor	Topic	EPA Objective	Actions Needed
Atmospheric emissions	General Odour Dust Greenhouse gases	Ensure that gaseous emissions, from this proposal in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria, (including the NEPM for Ambient Air Quality, with advice sought from the DEP on specific pollutants as necessary), or cause an environmental or human health/ amenity problem. Use all reasonable and practicable measures to minimize the discharge of significant atmospheric wastes such as volatile organic compounds NOx, SOx, greenhouse gases, toxic gases, particulates and smoke. No unreasonable impacts at boundary of the plant Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity; To minimize greenhouse gas emissions in absolute terms and reduce emission per unit product to as low as reasonably practicable. Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.	Identify and quantify all emissions (not limited to those below) to atmosphere from the proposal with a potential to have non-trivial impact on the environment (including impact on human health, nuisance, amenity, vegetation or fauna). Note The DEP have guidelines regarding air quality modelling. Provide details of any potential impacts (including cumulative impacts) and how they will be minimised and managed. Provide details of odorous emissions and how these will be controlled. Provide information on sources and extent of dust emission sources during construction and operation and how these will be managed. Provide details of greenhouse gas emissions including emissions over the life of the project, using annual CO2 equivalent quantities. Provide a comparison with other plants/technology producing similar products (considering the full life cycle and global context). Provide details of efforts to minimise greenhouse gas emissions to best practice levels in terms of energy efficiency in greenhouse gas/unit product.

Factor	Topic	EPA Objective	Actions Needed
Waste	Liquid and solid waste disposal	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of off site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.	Provide details of all liquid and solid wastes that will be produced by the proposal and how they will be disposed of, and rationale for chosen options, any potential impacts and how they will be addressed and managed. Identify measures taken to reuse and reduce waste.
Other emissions	Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997.	Provide details of noise emissions. Determine whether detailed modeling is required. Provide details of any potential impacts and how they will be managed, including community consultation. (EPA Guidance No 8 "*Environmental Noise*" should be consulted for guidance on noise modelling).
	Light	Manage potential impacts from plant/platform light overspill.	Provide details of any potential impacts of light spill and how they will be addressed.
Socio-economic	Other uses	Avoid interference to other uses of area and resources.	Describe other uses of the area and resources, such as fisheries, shipping and mining. Provide details of any potential impacts and how they will be addressed.

Factor	Topic	EPA Objective	Actions Needed
Public health and safety	Risk and hazard Road transport and traffic impacts	Ensure that risk to the public is as low as reasonably practicable and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for offsite individual fatality risk (Interim Guidance Statement No.2), and that ALARP is demonstrated, and that the DoIR's requirements in respect of public safety are met. Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety.	Assess and describe the on-site and off-site risks associated with the various aspects of the proposal. (Refer to EPA Draft Guidance for the Assessment of Environmental Factors No. 2, *Risk Assessment and Management: offsite individual Risk from Hazardous industrial plant*). Undertake a preliminary risk assessment to provide details of any potential risks and hazards associated with the proposal including platform, plant and associated pipelines. Demonstrate compliance with the Worksafe Australia Standard for the Control of Major Hazard Facilities. Describe pipeline management and how public and environmental risk will be reduced or managed. Provide details of how road traffic will be managed and construction materials transported during construction and operations.

Factor	Topic	EPA Objective	Actions Needed
Culture and heritage	Aboriginal culture and heritage Register of the National Estate Historic shipwrecks	Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972. Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area. Identify any areas which are close to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the Australian Heritage Commission Act 1975. Ensure historic shipwrecks are not disturbed, consistent with the requirements of the *Historic Shipwrecks Act 1976* (Cth)	Undertake archaeological and ethnographic surveys and consultations with Aboriginal communities and the Department of Indigenous Affairs, and assess potential impacts on areas of indigenous cultural significance. Provide details of how any impacts will be addressed and managed both during construction and operation. Provide details of potential impacts on any such areas and how the impacts will be addressed Provide an assessment of the likelihood of presence of historic shipwrecks and, where necessary, any actions to be taken to avoid disturbance to historic shipwrecks.
Aesthetic	Visual amenity and recreation	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse.	Provide details of any potential impacts on visual amenity resulting from the construction and operation of the plant and required infrastructure, possibly through the use of two dimensional silhouette images, overlaid on ground level photographs or drawings. Provide details of how any impacts will be addressed

10. APPLICABLE LEGISLATION

The proposed development of the Cliff Head oil field will occur in areas of both Commonwealth and State Jurisdiction. All activities conducted during the development and operation of the Cliff Head oil field will comply with legislative requirements established under Commonwealth and State regulatory framework.

The major relevant Commonwealth and Western Australian State statutes and regulations are listed in Table 4 below

Table 4 Relevant Commonwealth and State Legislation and Regulations

Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999	Under this legislation all activities that will, or have the potential to, affect matters of "National Environmental Significance" are prohibited except; when undertaken in accordance with approval by the Minister for Environment, or when approved through a Bilateral Agreement with a State or Territory, or when approved through a process accredited by the Minister.
Petroleum (Submerged Lands) Act 1967	This Act relates to the exploration and exploitation of petroleum resources in the area of the continental shelf of Australia and certain Territories of the Commonwealth. Commonwealth law applies to lands beneath waters that are outside 3 nautical miles, except within zone A of the Zone of Cooperation (ZOCA) off Western Australia and the Northern Territory.
The Petroleum (Submerged Lands)(Management of Environment) Regulations 1999	These regulations are applicable to petroleum exploration and production activities in Commonwealth waters. The objective of these regulations is to ensure that petroleum activities are carried out in a manner that is consistent with the principles of ecologically sustainable development and in accordance with an approved 'Environment Plan' that has appropriate performance objectives and standards as well as measurement criteria for determining whether the objectives and standards are met.
Australian Heritage Commission Act 1975	This Act identifies areas of heritage value - listed on the Register of the National Estate.
Historic Shipwrecks Act 1976	This Act protects shipwrecks, which have lain in Territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act.
Wildlife Protection (Regulation of Exports and Imports) Act 1982	This Act is concerned with control over the movement of Australian wildlife (fauna and flora) in or out of the country, together with the movement of exotic (non-indigenous) flora and fauna out of the country, as well as various other matters relating to quarantining.
Hazardous Waste (Regulation of Exports and Imports) Act 1989	This Act regulates the import and export of hazardous waste. Permits are required to dispose of waste overseas or to import waste into Australia.
Ozone Protection Act 1989	This Act regulates the import, export and manufacture of ozone depleting substances such as fire fighting equipment and refrigerants.
Navigation Act 1912	This Act requires that ships carrying oil and chemical tankers conform with Annex I of the MARPOL convention for the Prevention of Pollution from Ships.
Protection of the Sea (Civil Liability) Act 1981	This Act imposes civil liability for pollution damage and requires ships carrying more than 2,000 tons of oil in bulk as cargo to maintain insurance to cover liability for pollution damage.
Protection of the Sea (Oil Pollution Compensation Fund)	This Act establishes a Commonwealth Fund to provide compensation and indemnification for certain oil pollution damage.

Act 1993	The Fund can recover contributions on behalf of the Commonwealth.
Protection of the Sea (Powers of Intervention) Act 1981	This Act regulates discharges from ships to protect the sea from pollution. The Act gives powers to the Australian Maritime Safety Authority to take appropriate measures to protect the Australian coastline.
Western Australia	
Environmental Protection Act 1986	This is the principal statute relevant to environmental protection in WA. It gives the Authority overall responsibility for the prevention, control and abatement of environmental pollution and for the conservation, preservation, protection, enhancement and management of the environment.
Conservation and Land Management Act 1986	This Act provides for the use, protection and management of public lands, including parks and forests. It includes water, flora and fauna on these lands. The Department of Conservation and Land Management administer the Act.
Petroleum (Submerged Lands) Act 1982	This Act provides for the exploration and exploitation of petroleum resources on submerged lands adjacent to the coast of Western Australia.
Petroleum Pipelines Act 1969 (Section 8)	This Act relates to the construction, operation and maintenance of pipelines for the conveyance of petroleum.
Fisheries Act 1905	This Act is concerned with commercial exploitation and development of fisheries and marine resources. Under the Act development projects must be carried out so as not to adversely impact on fisheries and marine resources
Western Australia Marine (Sea Dumping) Act 1981	The Act provides for the protection of the environment by regulating dumping and incineration of wastes and other matter at sea.
Marine and Harbours Act 1981	This Act contains regulations to control the refuelling of ships and boats; administered by the Department Of Marine And Harbours.
Prevention Of Pollution Of Waters By Oil Act 1960	This Act prohibits the discharge of oil or noxious substances into state waters, and provides for the removal of oil or any mixture containing oil from affected waters. The harbour authority or Department Of Transport administers the Act.
Aboriginal Heritage Act 1972	This Act protects aboriginal sites from disturbance
Agriculture and Related Resources Protection Act 1976	This Act imposes controls for the containment of pests and weeds
Explosives and Dangerous Goods Act 1961 and Regulations	This Act imposes controls for storage and handling of dangerous and explosive goods.
Native Title Act 1993	Handles aboriginal claims for land ownership
Soil and Land Conservation Act 1945	This Act provides for the control of land degradation and the clearing of lands.

11. COMMUNITY AND STAKEHOLDER CONSULTATION

In the two years since commencement of operations in the region Roc has established a presence in the local community characterised by the high level of consultation with stakeholder groups and sponsorship of community activities. Table 5 below provides a list communications with various stakeholders and demonstrates the extensive nature of consultation undertaken by Roc to date.

Further consultation will be carried out during preparation of the environmental assessment document with stakeholder and community groups that may be affected by the proposed Cliff Head oil field development. A summary of consultation undertaken will be presented in the PER along with, where possible, a summary of views expressed regarding the proposed development.

Table 5 List of Consultations Undertaken to Date

Location	Date	Stakeholder Group	Topic
Dongara	26.2.02	Irwin Shire, Dongara Professional Fisherman's Association (DPFA)	Cliff Head 1 discovery
Dongara	1.7.02	Irwin Shire	Seismic
Dongara	27.8.02	Irwin Shire	Seismic operations
Dongara	26.9.02	DPFA	Drilling for 03
Dongara	18.12.02	Irwin Shire, DPFA	Release of pamphlet
Dongara	7.1.03	DPFA	Drilling operations details
Dongara	6.3.03	DPFA	Seismic proposal North Island
Dongara	20.10.03	DPFA	Amendments to Seismic operations
Geraldton	26.2.02	Geraldton Port Authority (GPA)	Cliff Head 1 discovery
Geraldton	1.7.02	GPA	Seismic
Geraldton	1.7.02	Active Community Environmentalists Inc	Seismic & Cliff Head
Geraldton	28.8.02	McBoats	Seismic operations near scallops
Geraldton	24.9.02	Geraldton Professional Fishermen's association (GPFA) & United Midwest Professional fishermen's Association (UMWPFA)	Drilling for 03
Geraldton	28.10.02	GPA	Seismic vessel induction
Geraldton	18.12.02	Geraldton Port Authority, Geraldton City Council, Fisheries, DEP	Release of pamphlet outlining drilling programme
Geraldton	6.1.03	DoIR	Drilling rig audit
Geraldton	7.1.03	Fisheries	Drilling operations management details
Geraldton	4.3.03	UMWFA & GPFA	Seismic proposal North Island
Geraldton	3.7.03	Irwin Shire, Greenough Shire, Geraldton City, Geraldton Port Authority, Fisheries, DEP	Cliff Head development
Geraldton	20.10.03	UMWFA & GPFA	Amendments to Seismic operations
Geraldton	20.10.03	Longline Association	Seismic operation
Geraldton	21.10.03	Fisheries	Seismic operations
Geraldton	22.10.03	DEP	Cliff Head Development options & seismic
Jurien	22.10.03	CALM	Cliff Head development options & Beekeeper's Reserve
Kalbarri	25.9.02	Kalbarri Professional	Drilling for 03

		Fishermen's Association (KPFA)	
Kalbarri	5.3.03	KPFA	Seismic proposal North Island
Perth	27.2.02	Western Australian Conservation Council (WACC)	Cliff Head 1 discovery
Perth	27.2.02	Western Rock Lobster Council (WRLC)	Cliff Head 1 discovery
Perth	27.2.02	Western Australian Fishing Industry Council (WAFIC)	Cliff Head 1 discovery
Perth	28.2.02	DoIR & Fisheries & DEP	Cliff Head 1 discovery
Perth	2.7.02	Fisheries	Seismic
Perth	2.7.02	WACC	Seismic
Perth	2.7.02	DoIR	Seismic
Perth	2.7.02	WRLC / WAFIC	Seismic
Perth	1.8.02	Centre for Marine Science and Technology, Curtin University	Lobsters
Perth	2.8.02	WRLC	Cliff Head discovery & seismic
Perth	23.9.02	DoIR	Drilling for 03
Perth	27.9.02	WRLC, WAFIC	Drilling for 03
Perth	29.10.02	Cetacean Permit Objector	Seismic impact discussion
Perth	8.1.03	WRLC	Drilling operations details
Perth	7.3.03	WRLC	Seismic Proposal North Island
Perth	2.7.03	DoIR, DEP, CALM	Cliff Head development
Perth	22.9.03	CALM	Cliff Head Development
Perth	17.10.03	DoIR, CALM	Development Options study presentation
Perth	17.10.03	DoIR, CALM	Development Options study presentation
Perth	23.10.03	DoIR	Seismic proposal North Island
Perth	23.10.03	WRLC	Seismic operations & Cliff Head development options
Perth	23.10.03	Fisheries DoIR	Amendments to seismic operations
Perth	20.11.03	DoIR, Fisheries, CALM, DEP, WAFIC	Cliff Head development environmental risk workshop
Canberra	20.2.02	Dept ITR, EA, Geoscience Australia	Discuss Cliff Head 1 discovery
Canberra	19.6.02	EA	Cetacean permit for seismic
Canberra	16.9.02	DITR & EA	Seismic operations, Cetacean permit
Canberra	23.7.03	DoITR, EA	Cliff Head development

12. PROJECT AND ASSESSMENT SCHEDULE

Subject to attainment of all necessary regulatory approvals and final investment decision by the joint venture participants, it is envisaged that construction of the Cliff Head oil field development would commence in late 2004. Production and export of crude oil would commence in 3rd quarter of 2005.

It is predicted that the field life will be in the order of 15 years. Peak productivity of up to about 3,400 tonnes of oil per day will occur over the first two years. After this period, productivity of the field will gradually decline over the remaining years.

13. STUDY TEAM

Roc has assembled a skilled study team drawing on Company resources and external consultants to complete the environmental impact assessment of the proposed Cliff Head oil field development.

The members of the study team include the following key personnel:

Roc Oil (WA) Pty Limited:

- Kevin English: Project Manager
- Don Kratzing: HSE Coordinator

MacroEnvironmental, Environment and Resource Consultants

- Peter Farrell: Marine ecology, risk assessment and PER preparation

Enesar Consulting

- Alistair Sharp-Paul, Tara Halliday, environmental management and PER preparation

Woodman Environmental Consulting

- Greg Woodman: Terrestrial flora surveys

Bamford Consulting Ecologists

- Mike Bamford: Terrestrial fauna studies

Q & A Communications

- Danicia Dutry: Social impact assessment

Wanati

- John Clark: Aboriginal and ethnographic studies

Asia-Pacific Applied Science Associates

- Scott Langtry: Oil spill modelling

Ecotox Services Australasia

- Rick Krassoi

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Appendix B

Flora and Fauna Lists

Flora Species

Vascular Plant Species Recorded in the Project Area, 2003

Family	Species	Plant Community							
		T1	T1w	T2	H1	H2	H3	T2/H1	D
Poaceae	*Austrodanthonia occidentalis*				+				
	Austrostipa ? compressa	+	+	+	+	+		+	
	Austrostipa elegantissima	+	+						+
	Austrostipa flavescens					+		+	
	**Avena barbata*	+	+						+
	**Bromus diandrus*		+	+					+
	**Lolium rigidum*		+						
	Poa poiformis				+	+		+	
	Spinifex longifolius						+		
	Sporobolus virginicus				+				
	? Vulpia bromoides*				+				
Cyperaceae	*Baumea juncea*				+				
	Gahnia trifida				+				
	Lepidosperma gladiatum					+		+	
	Lepidosperma pubisquameum	+			+			+	
	Schoenus sp.				+	+			
Restionaceae	*Desmocladus asper*	+	+	+	+			+	
Dasypogonaceae	*Acanthocarpus preissii*	+		+	+	+		+	
Anthericaceae	*Thysanotus patersonii*			+	+	+		+	
Asphodelaceae	**Asphodelus fistulosus*		+						+
Haemodoraceae	*Conostylis ? stylidioides*	+		+	+	+		+	
Orchidaceae	*Caladenia ? vulgata*				+				
Casuarinaceae	*Allocasuarina lehmanniana* subsp. *lehmanniana*		+	+	+	+			
Urticaceae	*Parietaria debilis*			+				+	
Santalaceae	*Anthobolus fovealatus*	+	+						
	Exocarpos sparteus		+	+	+				
	Leptomeria preissiana				+	+	+	+	
	Santalum acuminatum			+	+	+		+	
Loranthaceae	*Nuytsia floribunda*				+				
Polygonaceae	*Muehlenbeckia adpressa*		+		+				
Chenopodiaceae	*Atriplex cinerea*						+		
	Rhagodia baccata	+	+	+	+	+		+	+
	Salsola tragus		+						
	Threlkeldia diffusa			+					+
Gyrostemonaceae	*Gyrostemon ramulosus*	+	+		+				
Aizoaceae	*Carpobrotus virescens*					+	+	+	
	**Tetragonia decumbens*						+		

Vascular Plant Species Recorded in the Project Area, 2003 (cont'd)

Family	Species	Plant Community							
		T1	T1w	T2	H1	H2	H3	T2/H1	D
Portulacaceae	*Calandrinia brevipedata*			+	+	+		+	
Ranunculaceae	*Clematis linearifolia*	+	+	+	+	+		+	+
Lauraceae	*Cassytha aurea*	+	+	+	+	+		+	
	Cassytha ? pomiformis				+				
Brassicaceae	**Cakile maritima*						+		
Crassulaceae	*Crassula colorata* var. *acuminata*			+	+				
Mimosaceae	*Acacia cyclops*					+			
	Acacia pulchella	+	+	+	+	+		+	
	Acacia rostellifera	+	+		+				+
	Acacia rostellifera x *xanthina*	+	+	+	+	+		+	+
	Acacia saligna				+				
Papilionaceae	*Gompholobium tomentosum*				+				
	Hardenbergia comptoniana	+		+		+		+	
	**Melilotus indicus*		+						
	Nemcia ? pauciflora				+	+			
	Templetonia retusa	+							
Geraniaceae	**Pelargonium capitatum*							+	
Zygophyllaceae	*Zygophyllum billardierei*			+	+			+	
	Zygophyllum ? fruticulosum			+	+	+		+	
Rutaceae	*Diplolaena ferruginea*	+							
Polygalaceae	*Comesperma confertum*				+				
	Comesperma ? volubile		+		+				
Euphorbiaceae	*Adriana quadripartita*		+						
	Beyeria viscosa		+						
	**Euphorbia terracina*		+	+					
	Phyllanthus calycinus	+	+						
	Phyllanthus scaber	+							
	Poranthera microphylla				+				
Stackhousiaceae	*Stackhousia monogyna*		+		+	+			
Rhamnaceae	*Spyridium globulosum*		+		+	+		+	
Malvaceae	*Alyogyne huegelii*	+							
Sterculiaceae	*Guichenotia ledifolia*	+							
Dilleniaceae	*Hibbertia subvaginata*	+	+	+					
Myrtaceae	*Eucalyptus ? falcata* subsp. *Opima*	+							
	Melaleuca cardiophylla	+	+	+	+			+	
	Melaleuca huegelii subsp. *Huegelii*	+	+	+	+	+		+	

Vascular Plant Species Recorded in the Project Area, 2003 (cont'd)

Family	Species	Plant Community							
		T1	T1w	T2	H1	H2	H3	T2/H1	D
Myrtaceae (cont'd)	*Melaleuca lanceolata*				+				
	Melaleuca ?leuropoma		+	+	+	+		+	
	Melaleuca systena	+	+		+			+	
Apiaceae	*Trachymene pilosa*	+		+	+	+		+	
Epacridaceae	*Acrotriche cordata*					+			
	Leucopogon insularis		+	+	+	+			
	Leucopogon parviflorus			+	+	+		+	
Primulaceae	**Anagallis arvensis*	+	+						
Cuscutaceae	**Cuscuta epithymum*							+	
Boraginaceae	**Echium plantagineum*		+						
Lamiaceae	*Hemiandra pungens*			+	+	+		+	
Solanaceae	*Anthocercis littorea*			+	+				
Scrophulariaceae	**Dischisma arenarium*				+			+	
Myoporaceae	*Myoporum insulare*					+	+	+	
	?*Myoporum insulare*				+			+	
	Myoporum tetrandrum			+					
Rubiaceae	*Opercularia vaginata*		+		+				
Lobeliaceae	*Isotoma hypercrateriformis*			+	+	+			
Goodeniaceae	*Goodenia berardiana*			+				+	
	Scaevola crassifolia			+	+	+	+	+	
	Scaevola thesioides subsp. *thesioides*	+	+	+	+			+	
Asteraceae	?*Angianthus tomentosus*				+				
	Erymophyllum ramosum subsp. *involucratum*				+				
Asteraceae	**Hypochaeris glabra*		+						
	Olearia axillaris	+	+		+	+	+	+	
	Podolepis canescens			+	+			+	
	Podotheca gnaphalioides			+	+			+	
	Rhodanthe citrina			+	+	+		+	
	Senecio lautus ?subsp. *maritimus*			+	+	+		+	
	**Sonchus oleraceus*		+						
	**Taraxacum officinale*		+						+
	**Ursinia anthemoides*								+
	Waitzia podolepis	+		+	+			+	

Fauna Species

Table 1. Frog species that may occur in the study area based on the literature review (see methods)

Species		23/10/03	Status
Myobatrachidae (ground frogs)			
Granite Froglet	*Crinia pseudinsignifera*		
Moaning Frog	*Heleioporus eyrei*		
Spotted Burrowing Frog	*Heleioporus albopunctatus*		
	Heleioporus psammophilus		
Pobblebonk	*Limnodynastes dorsalis*		
Turtle Frog	*Myobatrachus gouldii*		
Humming Frog	*Neobatrachus pelobatoides*		
Guenther's Toadlet	*Pseudophryne guentheri*		

Species recorded during the site visit are marked as 'X'. CS1 = Conservation Significance level 1 (see Methods). CS2 = Conservation Significance level 2 (see Methods). CS3 = Conservation Significance level 2 (see Methods).

Table 2. Reptile species that may occur in the study area based on the literature review (see methods)

Species		23/10/03	Status
Gekkonidae (geckoes)			
Clawless Gecko	*Crenadactylus ocellatus*		
	Diplodactylus alboguttatus		
	Diplodactylus ornatus		
	Diplodactylus polyopthalmus		
Spiny-tailed Gecko	*Strophurus (Diplodactylus) spinigerus*		
Tree Dtella	*Gehyra variegata*		
Marbled Gecko	*Phyllodactylus marmoratus*		CS3
Barking Gecko	*Underwoodisaurus milii*		
Pygopodidae (legless lizards)			
Sandplain Worm Lizard	*Aprasia repens*		
	Aclys concinna		CS3
Fraser's Legless Lizard	*Delma fraseri*		
	Delma grayii		
Burton's Legless Lizard	*Lialis burtonis*		
	Pletholax gracilis		CS3
Common Scaleyfoot	*Pygopus lepidopodus*		
Agamidae (dragon lizards)			
Mountain Devil	*Moloch horridus*		
Western Bearded Dragon	*Pogona minor*		
Spotted Dragon	*Ctenophorus maculatus*		
Sandhill Dragon	*Rankinia (Tympanocryptis) adelaidensis*		
Varanidae (monitors or goannas)			
Gould's Sand Goanna	*Varanus gouldii*		
Black-tailed Tree Goanna	*Varanus tristis*		

Table 2. Reptile species that may occur in the study area based on the literature review (see methods) (cont'd)

Species (cont'd)		**23/10/03**	**Status**
Scincidae (skink lizards)			
Fence Skink	*Cryptoblepharus plagiocephalus*		
	Cyclodomorphus celatus		
	Ctenotus australis		
	Ctenotus catenifer		
	Ctenotus fallens		
	Ctenotus gemmula		
	Ctenotus impar		
	Ctenotus pantherinus		
	Ctenotus schomburgkii		
King's Skink	*Egernia kingii*		
	Egernia multiscutata		CS3
Salmon-bellied Skink	*Egernia napoleonis*		
	Lerista christinae		
	Lerista distinguenda		
	Lerista elegans		
	Lerista lineopunctulata		
	Lerista praepedita		
Dwarf Skink	*Menetia greyii*		
Spotted Morethia	*Morethia lineoocellata*		
Dusky Morethia	*Morethia obscura*		
Western Bluetongue	*Tiliqua occipitalis*		
Bobtail	*Tiliqua rugosa*		
Typhlopidae (blind snakes)			
	Ramphotyphlops australis		
	Ramphotyphlops waitii		
Boidae (pythons)			
Carpet Python	*Morelia spilota imbricata*		CS1
Stimson's Python	*Antaresia stimsoni*		
Woma	*Aspidites ramsayi*		CS1
Elapidae (front-fanged snakes)			
Yellow-faced Whip-Snake	*Demansia psammophis*		
Bardick	*Echiopsis (Notechis) curtus*		
Mulga Snake	*Pseudechis australis*		
Gwardar	*Pseudonaja nuchalis*		
Gould's Snake	*Parasuta gouldii*		
Jan's Bandy-Bandy	*Simoselaps bertholdi*		
	Simoselaps littoralis		
Black-naped Snake	*Neelaps bimaculata*		
Half-ringed Snake	*Brachyurophis semifasciata*		
Narrow Banded Snake	*Brachyurophis fasciolata*		

Species recorded during the site visit are marked as 'X'. CS1 = Conservation Significance level 1 (see Methods). CS2 = Conservation Significance level 2 (see Methods). CS3 = Conservation Significance level 2 (see Methods).

Table 3. Bird species that may occur in the study area based on the literature review (see methods)

Species		23/10/03	Status
Water birds			
Accipitridae (hawks and eagles)			
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		CS1
Scolopacidae (sandpipers)			
Red-necked Stint	*Calidris ruficollis*		CS1
Sanderling	*Calidris alba*		CS1
Ruddy Turnstone	*Arenaria interpres*		CS1
Bar-tailed Godwit	*Limosa lapponica*		CS1
Charadriidae (lapwings and plovers)			
Red-capped Plover	*Charadrius ruficapillus*		
Hooded Plover	*Thinornis rubricollis*		CS2
Laridae (gulls and terns)			
Silver Gull	*Larus novaehollandiae*		
Pacific Gull	*Larus pacificus*		CS3
Land birds			
Dromaiidae (emus)			
Emu	*Dromaius novaehollandiae*		
Phasianidae (pheasants and quails)			
Stubble Quail	*Coturnix pectoralis*		
Accipitridae (kites, hawks and eagles)			
Black-shouldered Kite	*Elanus notatus*		
Square-tailed Kite	*Lophoictinia isura*		CS3
Whistling Kite	*Haliastur sphenurus*		
Spotted Harrier	*Circus assimilis*		
Brown Goshawk	*Accipiter fasciatus*		
Collared Sparrowhawk	*Accipiter cirrhocephalus*		
Wedge-tailed Eagle	*Aquila audax*		
Little Eagle	*Hieraaetus morphnoides*		
Falconidae (falcons)			
Peregrine Falcon	*Falco peregrinus*		CS1
Australian Hobby	*Falco longipennis*		
Brown Falcon	*Falco berigora*		
Nankeen Kestrel	*Falco cenchroides*	X	
Turnicidae (button-quails)			
Painted Button-quail	*Turnix varia*		
Little Button-quail	*Turnix velox*		
Otidae (bustards)			
Australian Bustard	*Ardeotis australis*		CS2
Charadriidae (lapwings and plovers)			
Banded Lapwing	*Vanellus tricolor*		
Columbidae (pigeons and doves)			
Rock Dove (Domestic Pigeon)	*Columba livia*		Int
Laughing Turtle-Dove	*Streptopelia senegalensis*	X	Int

Table 3. Bird species that may occur in the study area based on the literature review (see methods) (con'td)

Species (cont'd)		23/10/03	Status
Land birds			
Columbidae (pigeons and doves) (cont'd)			
Common Bronzewing	*Phaps chalcoptera*		
Brush Bronzewing	*Phaps elegans*		
Crested Pigeon	*Ocyphaps lophotes*		
Cacatuidae (cockatoos)			
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*		CS1
Galah	*Cacatua roseicapilla*		
Western (Butler's) Corella	*Cacatua pastinator butleri*		
Psittacidae (lorikeets and parrots)			
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		
Regent Parrot	*Polytelis anthopeplus*		
Australian Ringneck	*Barnardius zonarius*		
Rock Parrot	*Neophema petrophila*		
Elegant Parrot	*Neophema elegans*		
Cuculidae (cuckoos)			
Pallid Cuckoo	*Cuculus pallidus*		
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		
Strigidae (hawk-owls)			
Southern Boobook	*Ninox novaeseelandiae*		
Tytonidae (barn owls)			
Barn Owl	*Tyto alba*		
Podargidae (frogmouths)			
Tawny Frogmouth	*Podargus strigoides*		
Aegothelidae (owlet-nightjars)			
Australian Owlet-nightjar	*Aegotheles cristatus*		
Caprimulgidae (nightjars)			
Spotted Nightjar	*Eurostopodus argus*		
Apodidae (swifts)			
Fork-tailed Swift	*Apus pacificus*		CS1
Halcyonidae (forest kingfishers)			
Laughing Kookaburra	*Dacelo novaeguineae*		Int
Sacred Kingfisher	*Todiramphus sanctus*		
Meropidae (bee-eaters)			
Rainbow Bee-eater	*Merops ornatus*		CS1
Maluridae (fairy-wrens)			
Splendid Fairy-wren	*Malurus splendens*		
Variegated Fairy-wren	*Malurus lamberti*	X	
Blue-breasted Fairy-wren	*Malurus pulcherrimus*	X	
White-winged Fairy-wren	*Malurus leucopterus*	X	
Southern Emu-wren	*Stipiturus malachurus*		

Table 3. Bird species that may occur in the study area based on the literature review (see methods) (con'td)

Species (cont'd)		23/10/03	Status
Land birds			
Pardalotidae (pardalotes)			
Striated Pardalote	*Pardalotus striatus*		
White-browed Scrubwren	*Sericornis frontalis*	X	
Rufous Fieldwren	*Sericornis campestris montanellus*		CS2
Weebill	*Smicrornis brevirostris*		
Western Gerygone	*Gerygone fusca*		
Inland Thornbill	*Acanthiza apicalis*	X	
Western Thornbill	*Acanthiza inornata*		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		
Meliphagidae (honeyeaters)			
Red Wattlebird	*Anthochaera carunculata*		
Western Wattlebird	*Anthochaera lunulata*		
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		
Yellow-throated Miner	*Manorina flavigula*		
Singing Honeyeater	*Lichenostomus virescens*	X	
Brown-headed Honeyeater	*Melithreptus brevirostris*		
Brown Honeyeater	*Lichmera indistincta*	X	
White-cheeked Honeyeater	*Phylidonyris nigra*	X	
Tawny-crowned Honeyeater	*Phylidonyris melanops*		
Western Spinebill	*Acanthorhynchus superciliosus*		
Black Honeyeater	*Certhionyx niger*		
Pied Honeyeater	*Certhionyx variegatus*		
Crimson Chat	*Epthianura tricolor*		
White-fronted Chat	*Epthianura albifrons*		
Petroicidae (Australian robins)			
Jacky Winter	*Microeca leucophaea*		
Scarlet Robin	*Petroica multicolor*		
Red-capped Robin	*Petroica goodenovii*		
Hooded Robin	*Melanodryas cucullata*		
White-breasted Robin	*Eopsaltria georgiana*		CS3
Pomatostomidae (Australian babblers)			
White-browed Babbler	*Pomatostomus superciliosus*		CS2
Neosittidae (sittellas)			
Varied Sittella	*Daphoenositta chrysoptera*		
Pachycephalidae (whistlers)			
Crested Bellbird	*Oreoica gutturalis gutturalis*		CS2
Golden Whistler	*Pachycephala pectoralis*	X	
Rufous Whistler	*Pachycephala rufiventris*		
Grey Shrike-thrush	*Colluricincla harmonica*		
Dicruridae (flycatchers)			
Restless Flycatcher	*Myiagra inquieta*		

Table 3. Bird species that may occur in the study area based on the literature review (see methods) (con'td)

Species (cont'd)		23/10/03	Status
Land birds			
Dicruridae (flycatchers) (cont'd)			
Magpie-lark	*Grallina cyanoleuca*	X	
Grey Fantail	*Rhipidura fuliginosa*		
Willie Wagtail	*Rhipidura leucophrys*	X	
Campephagidae (cuckoo-shrikes)			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		
White-winged Triller	*Lalage sueurii*		
Artamidae (woodswallows)			
Masked Woodswallow	*Artamus personatus*		
Black-faced Woodswallow	*Artamus cinereus*		
Dusky Woodswallow	*Artamus cyanopterus*		
Grey Currawong	*Strepera versicolor*	X	
Grey Butcherbird	*Cracticus torquatus*	X	
Pied Butcherbir	*Cracticus nigrogularis*		
Australian Magpie	*Gymnorhina tibicen*		
Corvidae (ravens and crows)			
Australian Raven	*Corvus coronoides*	X	
Little Crow	*Corvus bennetti*		
Motacillidae (pipits and true wagtails)			
Richard's Pipit	*Anthus novaeseelandiae*		
Passeridae (finches and allies)			
Zebra Finch	*Taeniopygia guttata*		
Dicaeidae (flower-peckers)			
Mistletoebird	*Dicaeum hirundinaceum*		
Hirundinidae (swallows)			
White-backed Swallow	*Cheramoeca leucosternus*		
Welcome Swallow	*Hirundo neoxena*		
Tree Martin	*Hirundo nigricans*		
Fairy Martin	*Hirundo ariel*		
Sylviidae (Old World warblers)			
Rufous Songlark	*Cincloramphus mathewsi*		
Brown Songlark	*Cincloramphus cruralis*		
Zosteropidae (white-eyes)			
Silvereye	*Zosterops lateralis*	X	

Species recorded during the site visit are marked as 'X'. CS1 = Conservation Significance level 1 (see Methods). CS2 = Conservation Significance level 2 (see Methods). CS3 = Conservation Significance level 2 (see Methods). Int. = Species introduced in Western Australia

Table 4. Mammal species that may occur in the study area based on the literature review (see methods)

Species		**23/10/03**	**Status**
Tachyglossidae (echidnas)			
Echidna	*Tachyglossus aculeatus*		
Dasyuridae			
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		
dunnart	*Sminthopsis dolichura*		
White-footed Dunnart	*Sminthopsis granulipes*		
dunnart	*Sminthopsis griseoventer*		
Tarsipedidae (honey possum)			
Honey Possum	*Tarsipes rostratus*		
Macropodidae (kangaroos and wallabies)			
Western Grey Kangaroo	*Macropus fuliginosus*	X	
Brush or Black-gloved Wallaby	*Macropus irma*		CS2
Mollosidae (mastiff bats)			
White-striped Bat	*Tadarida (Nyctinomus) australis*		
	Mormopterus planiceps		
Vespertilionidae (vesper bats)			
Gould's Wattled Bat	*Chalinolobus gouldii*		
Chocolate Wattled Bat	*Chalinolobus morio*		
King River Eptesicus	*Vespadelus (Eptesicus) regulus*		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*		
Gould's Long-eared Bat	*Nyctophilus gouldii*		
Greater Long-eared Bat	*Nyctophilus timoriensis*		
Muridae (rats and mice)			
Rakali or Water Rat	*Hydromys chrysogaster*		CS2
House Mouse	*Mus musculus*		
Noodji or Ashy-grey Mouse	*Pseudomys albocinereus*		
	Pseudomys occidentalis		
Moodit or Bush-Rat	*Rattus fuscipes*		CS3
Black Rat	*Rattus rattus*		
Leporidae (rabbits and hares)			
Rabbit	*Oryctolagus cuniculus*		Int
Canidae (foxes and dogs)			
European Red Fox	*Vulpes vulpes*		Int
Felidae (cats)			
Feral Cat	*Felis catus*		Int
Bovidae (bovids)			
Feral goat	*Capra hircus*		Int

Species recorded during the site visit are marked as 'X'. CS1 = Conservation Significance level 1 (see Methods). CS2 = Conservation Significance level 2 (see Methods). CS3 = Conservation Significance level 2 (see Methods). Int. = Species introduced in Western Australia

Appendix C

Perth Basin Oil Spill Contingency Plan

ROC Oil (WA) Pty Ltd

PERTH BASIN

OIL SPILL CONTINGENCY PLAN

ACTION PLAN

COPY NUMBER

TABLE OF CONTENTS

1.0 USING THIS ACTION PLAN

This Action Plan contains key procedures from the Roc Oil Perth Basin Oil Spill Contingency Plan (OSCP).

It is designed to provide rapid access to essential information for personnel who are nominated for response roles or who may be required to report or respond to spills.

The Roc Oil Perth Basin OSCP should be referred to for details or for ongoing management procedures.

Each Action Plan holder should ensure that this document is up to date and contains all procedures required for their nominated spill response role or function.

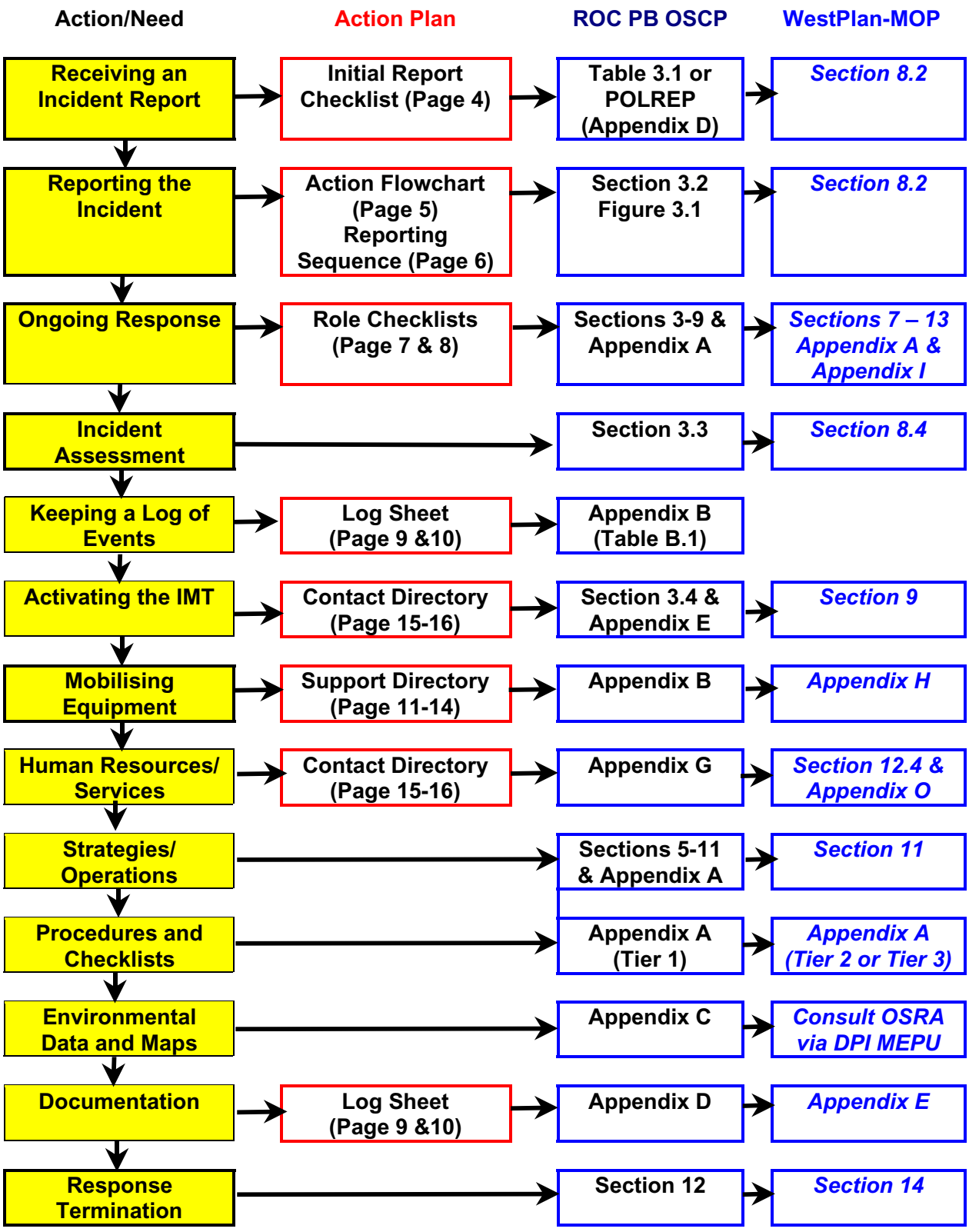
The Contents Page (page 2) should be maintained by each Action Plan holder and may be checked periodically for currency by the nominated Incident Controller.

Action Plan pages are contained in plastic sleeves so that:

- They can be used in the field, and remain clean.
- Multiple copies of forms can be held, and
- Revised pages can be readily added.

Plan holders must ensure that all pages are present and up to date.

2.0 LOCATION OF INFORMATION



3.0 INITIAL REPORT INFORMATION CHECKLIST

Question			Prompt/Answer	
1	Full Name of Reporter.			
2a	Contact details:	Telephone No..	Bus:	
2b			A/H:	
2c		Fax		
2d		E-mail		
3	Position of observer when sighting made		Aircraft _____ Vessel _____Ground ____ Other (*Details*):_____	
4	Position of the slick			
5	Source of spill (*If known*).			
6	Type of substance spilled (*If known*).			
7	Amount of substance spilled (*If known*).			
8a	Description of slick	General		
8b		Colour	Black ___ Brown ___ Rainbow ___ Silver ____ Other (*Specify*)_____	
8c		Area	Length _____ (m), Width _____(m)	
8d		Other	Broken up? Yes _____ No __ _ Windrows (Streaks)?Yes _____ No _____	
9	Direction of slick movement (*If known*)			
10	Weather/sea conditions.			
11	Other information			
12	Name of person receiving report			
13	Agency/Division/Role			
14	Report to be forwarded to:		Name	
			Position	
			Address	

4.0 ACTION FLOWCHART

For for ongoing response actions consult Checklists in Appendix A

SPILL

Consult Reporting Requirements in OSCP Section 4

MODU

OBSERVER ON MODU
- Inform PIC (OIM /Drilling Supervisor)
- Take steps to safely stop release of oil.

OIM/DRILLING SUPERVISOR
- Ensure safety of MODU and crew.
- Inform Drilling Supervisor/OIM.
- Take immediate actions to control spill .
- Obtain details of spill (fill out POLREP; i.e. Form Rep 01).
- Ensure appropriate Navigation Warning is issued-if needed.
- Report spill (send POLREP). to the Drilling Operations Manager (ROC ERG Leader)
- Assist in assessment of response Tier.
- Keep ROC ERG Leader informed of weather, sea state, position/condition of slick (via SITREPS, Form Rep 02).
- Maintain a log of events.

Nominated Officer*
- Obtain incident details and report to OIM.
- Monitor slick and report to OIM
- Obtain sample of oil if requested

* *This will depend on the nature of the incident and may be a member of the MODU, Drilling or Supply Vessel crew.*

Vessel

OBSERVER ON VESSEL
- Inform Vessel Master.
- Take necessary steps to safely stop the release of oil.

VESSEL MASTER
- Ensure safety of vessel and crew.
- Verify report and obtain details (see POLREP; OSCP Form001).
- Report to:
  - OIM* and:
  - AMSA if in Comm. Waters.
  - WA DPI MEPU if in WA waters.
  - Harbourmaster* and Materials & Logistics Coordinator if in Port.
- Monitor slick and inform PIC (*above).

* *PIC*

Sydney

CEO (CERT LEADER)
- Obtain incident details from ROC ERG Leader.
- Ensure that Statutory Agencies have been informed.
- Inform WA DMPR Director, Petroleum via POLREP if volume >80 litres
- For Tier 2/3 response contact Lead Combat Agency Incident Controller and determine ROC role.
- Maintain a Personal Log.

DRILLING OPERATIONS MANAGER (ROC ERG LEADER)
- Obtain details of spill and actions taken
- Assess spill response status in consultation with Drilling Supervisor .
- Notify via POLREP and phone:
  - WA DMPR Environment Manager.
  - WA DPI MEPU.
  - AMSA, EPG.
  - Harbourmaster (Geraldton)
- Inform CEO (CERT Leader) via POLREP.
- If Tire 2/3 request assistance from WA DPI MEPU or AMSA.
- If Tier 2/3, inform CERT Leader of Lead Combat Agency and Incident Controller.
- Mobilise ROC ERG as required.
- Maintain a Log of Events.
- If needed, arrange aerial surveillance through Materials and Logistics Coordinator (Shore Base).

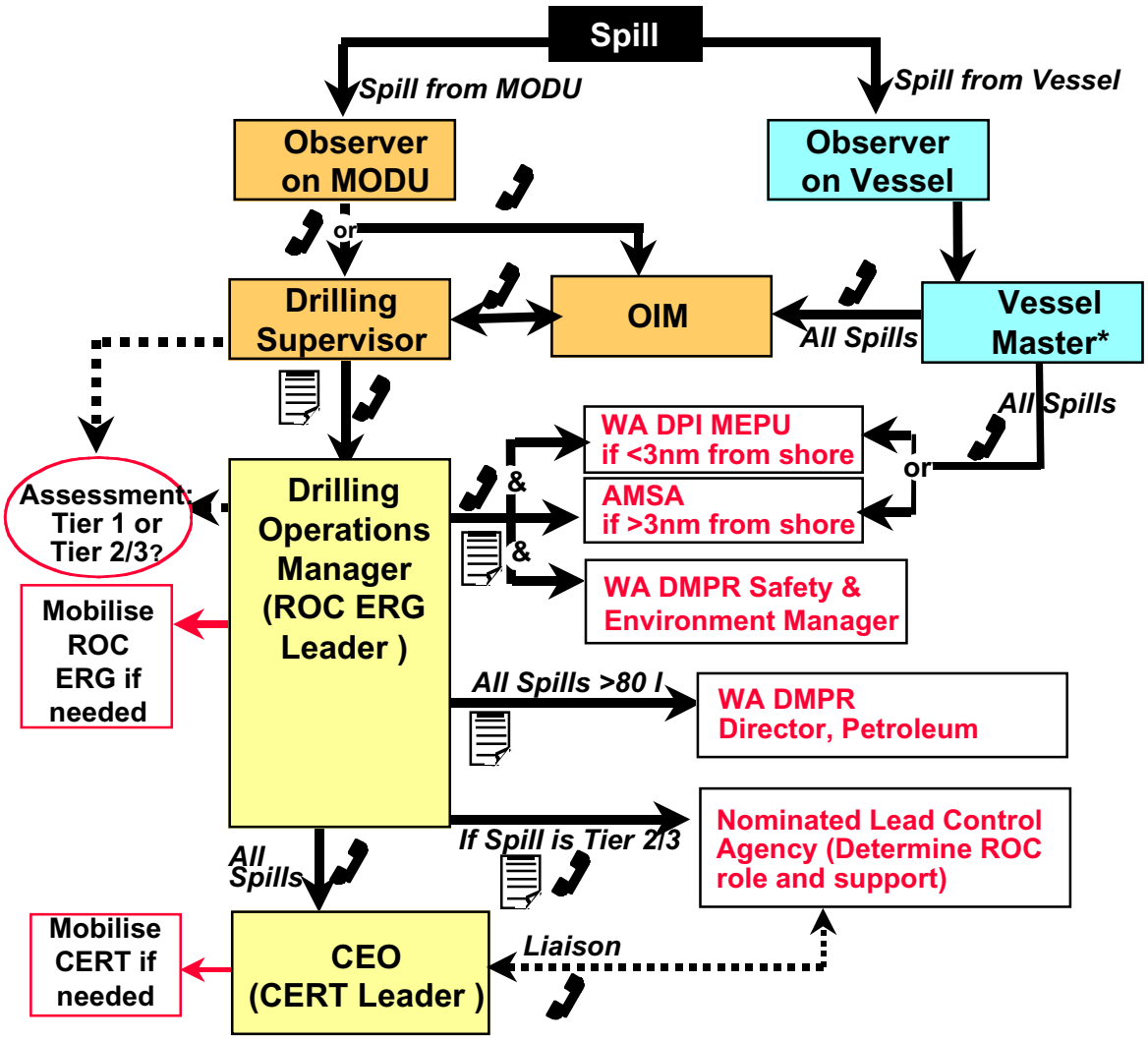
Shore Base

MATERIALS & LOGISTICS COORDINATOR
- Obtain details of spill and actions taken
- .Ensure that Statutory Agencies have been notified (see OSCP Section 2)
- Assess spill response status in consultation with the Port Harbourmaster
- Inform Drilling Operations Coordinator (ROC ERG Leader) via POLREP.
- At request of ROC ERG Leader, arrange aerial surveillance.

Perth Basin OSCP Immediate Actions Action Flowchart 1

01/10/2002
Revision 0

5.0 REPORTING SEQUENCE FLOWCHART



Key

POLREP (FormRep01)

Verbal, Phone or radio

* *Vessel Master to report to Shore Base rather than OIM if close to Shore Base. Shore Base will then contact Drilling Superintendent.*

REPLACE THIS PAGE
WITH
RELEVANT ROLE DESCRIPTION AND CHECKLIST
FROM
ROC PB OSCP APPENDIX A

REPLACE THIS PAGE
WITH
RELEVANT ROLE DESCRIPTION AND CHECKLIST
FROM
ROC PB OSCP APPENDIX A

PERSONAL LOG OR SECTION/ UNIT LOG

Spill Incident		Ref. No.	
Name/ Section		Unit	

Date	Time	Details	Cost

PERSONAL LOG OR SECTION/ UNIT LOG

Spill Incident		Ref. No.	
Name/ Section		Unit	

Date	Time	Details	Cost

8.0 SUPPORT DIRECTORY

Aircraft: Surveillance

If local aircraft are unavailable, or sources cannot be located, a request can be made to the Senior Search and Rescue Officer - Aviation (SARO) AusSAR Canberra. The request should specify the task to be performed by an aircraft. Where commercial aircraft are unsuitable, or not available, Defence Force aircraft may be available.

Aircraft: Spraying Operations

Activation of the Fixed Wing Aerial Dispersant Capability (FWADC) is through AMSA, EPG's Duty Officer, who can be contacted via AusSAR (see Appendix G).

Defence Force Assistance

Requests for Defence Force assistance are to be directed to the AMSA, EPG. After assessing and approving any requests, AMSA, EPG shall seek the support of the resources of the Defence Forces through Emergency Management Australia (EMA), Canberra. EMA will arrange for Defence Force assistance once all avenues of utilising commercial resources have been exhausted, or where time frames are such that it is impractical to use normal commercial resources.

Dispersant: OH&S

Material Safety Data Sheets (MSDS) for the available dispersants are provided in Appendix F of WestPlan-MOP.

Documentation

Appendix D contains standard forms.

Environmental Information

Primary source of information is the WA ESC or AMSA ESC.
It is recommended to access local sources through the Port of Geraldton Harbourmaster. The WA DPI MEPU Duty Officer should also be contacted, who will access information from the Oil Spill Response Atlas (OSRA).

Equipment: AMOSC

AMOSC equipment will be released on the request of a Santos Authorised Officer (see Appendix G).

Equipment: National Plan and WA

National stockpiles are listed in the MOSES database This can be accessed via the Duty officer at AMOSC, WA DPI MEPU or AMSA, EPG.

National Plan equipment can be released by contacting AMSA or the relevant State releasing officer. In WA this is the Executive Response Group (ERG) Coordinator.

Equipment: Oil Company

Under AMOSPlan industry can access mutual aid from other industry company resources. To activate the plan a request for assistance is made from the Mutual Aid Contact (MAC) of the affected company to the MAC of a company that is able to provide assistance.

Refer to Technical Appendix F.

Equipment: Local

The equipment available at the Port of Geraldton is listed in Table B.1.

Table B.1 Local Equipment List
(see also Appendix G for local contractors and service providers)

Item	Qty	ID No.	Owner
Recovered oil tanks			
FLEXIDAM 10000LT		PBD11969	AMSA Contact AMSA EPG Duty Officer. or Harbourmaster Port of Geraldton
TANK RECOVERED OIL FLEXIDAM 10000LT		PBD11970	
COLLAPSIBLE TRANSPAC 2.6T		PBD4391	
COLLAPSIBLE TRANSPAC 2.6		PBD4401	
TANK COLLAPSIBLE TRANSPAC 2.6T		PBD4402	
Skimmers			
WEIR FOILEX MINI		PDA11981	As above
DISC VIKOMA KOMARA 12K MK2		PDC4395	
Boom			
SELF BUOYANT STRUCTURFLEX GP	195 m	PDF11948	As above
SELF INFLATING VERSATECH ZOOM 12/18	300 m	PDH4298	
BEACH STRUCTURFLEX LAND SEA	100 m	PDI106022	
Other			
ANCHOR KIT SMALL 15KG SET OF 5		PDO11643	As above
TRAILER BOX TANDEM AXLE		VCA4409	

Health & Safety Contact the ROC HSE Coordinator (See Appendix G).

International Assistance International assistance can be obtained through AMSA, EPG.

Oil Character Appendix E contains a description of the oils and lists their characteristics.

Oil Character: Modelling See “Oil Weathering Modelling”.

Oil Spill Response Atlas (OSRA) Information on environmental resources can be obtained from the Oil Spill Response Atlas (OSRA) held by:

- WA DPI MEPU.
- National: Via AMSA, EPG.

Oil Spill Trajectory Modelling Oil spill trajectory modelling is available from AMSA, EPG Canberra and can be run at the request of:

- Port Harbourmaster.
- WA ERG Coordinator.

The Oil Spill Trajectory Model (OSTM) can be accessed by contacting:

- AMSA, EPG Duty Officer.
- AMSA’s Web Site, www.amsa.gov.au.
- After hours, AusSAR who will contact the AMSA, EPG Duty Officer.

Oil Spill Trajectory Modelling Continued

The AMSA "Oil Spill Trajectory Modelling (OSTM) Request" Form should be used and sent by either e-mail or fax. The form is available on the AMSA web site and in Appendix E of WestPlan-MOP.

Arrangements may be made with AMSA, EPG for model output to be sent, via facsimile or e-mail, to the ERR, or other location, at regular intervals.

Caution: Like all models, the output is a prediction only and is not a substitute for field observations.

Oil Spill Trajectory Calculation

The trajectory of a spill can be roughly calculated by adding the surface current velocity to 3% of the wind velocity. This is done using a "vector diagram" (see OSCP Section 6).

Oil Weathering Modelling

Oil fate predictions can be obtained from AMSA, EPG. This is available through OSTM and also through the "Automated Data Inquiry for Oil Spills (ADIOS)" model developed by the US National Oceanographic and Atmospheric Administration (NOAA). ADIOS can also be run by:

- AMOSC.
- WA DPI MEPU.
- ROC HSE Coordinator.

Personnel: STATE

WA assistance can be obtained through:

- AMSA.
- ERG Coordinator at WA DPI MEPU.

Contact details are in Appendix G.

Personnel: NATIONAL

National Response Team (NRT) members can be seconded through AMSA, EPG (see Appendix G).

Response Role Checklists and procedures

Appendix A provides Checklists for the Tier 1 response roles.

Major responses are likely to be under the control of AMSA or WA Lead Combat agencies and the role descriptions and Checklists in Appendix A of WestPlan-MOP should be consulted.

Weather

Weather information can be obtained from the WNI Duty Forecaster (see Appendix G, Directory 0.8).

Weather conditions and predictions are available from the Duty Officer of the Bureau of Meteorology (24 hour contact).

Local information should also be sought on ambient conditions from the nearest Port or Port Authority (Geraldton).

Table B.1 Local Support Notes

Name	Address	Service	Contact

9.0 KEY CONTACT DIRECTORY

(See ROC PB OSCP Appendix G for full Contact Directory)

ROC ERG and CERT Nominees

Position	Name/Position	Directory
CERT Leader		0.1
ROC ERG Leader	Drilling Operations Manager	0.1
Information Coordinator		0.1
Services Coordinator	Don Kratzing, HSE Adviser	0.1
Materials and Logistics Coordinator		0.2
Marine Coordinator	OIM	0.3
	Drilling Supervisor	0.3

ROC Oil AMOSC Authorising Officers

Position	Name/Position	Directory

Government Reporting and Notification Numbers

Statutory Authority	Position/ Name	Telephone No. Facsimile No.		Details in Directory
WA DMPR	Manager, Environment	**T**	08 9222 3142 Pgr 9480 9096	1.3, 1.4
		F	08 9222 3799	1.3, 1.4
	Director, Petroleum	**T**	08 9222 3254/ 08 9386 1996	1.2, 1.4
		F	08 9222 3799	1.2, 1.4
WA DPI MEPU	Duty Officer	**T**	1800-1700/ 08 9239 2400	1.1
		F	08 9239 2426	1.1
	ERG Coordinator	**T**	08 9216 8902/ 08 9482 4839	1.1
		F	08 9216 8982	1.1
AMSA, EPG	Duty Officer	**T**	02 6230 6811/ 1800 641 792	2.1
		F	02 6279 5076	2.1
	Manager	**T**	02 6279 5929/ 02 6269 0800	2.1
		F	02 6279 5076	2.1
Port of Geraldton	Harbourmaster	**T**	08 9964 0522/ 0409 640 543	1.5
		F	08 9964 0546	1.5

EMERGENCY NUMBERS

Service	Number	Agency	Directory
Ambulance/ Hospital	08 9956 2222	Geraldton Regional Hospital	
Medical Emergency	Perth: 1800 625 800/ 08 9417 6300	Royal Flying Doctor Services	0.7
	Derby: 1800 625 800 HF 5300 kHz		0.7
Police	08 9964 1400/ 1077/ 1511	000	0.7
SES	08 9921 6444	**Midwest Region**	0.7

ADDITIONAL CONTACTS AND NOTES

ROC Oil Continued	NAME	BUSINESS	24 HOURS	MOBILE	FAX	EMAIL