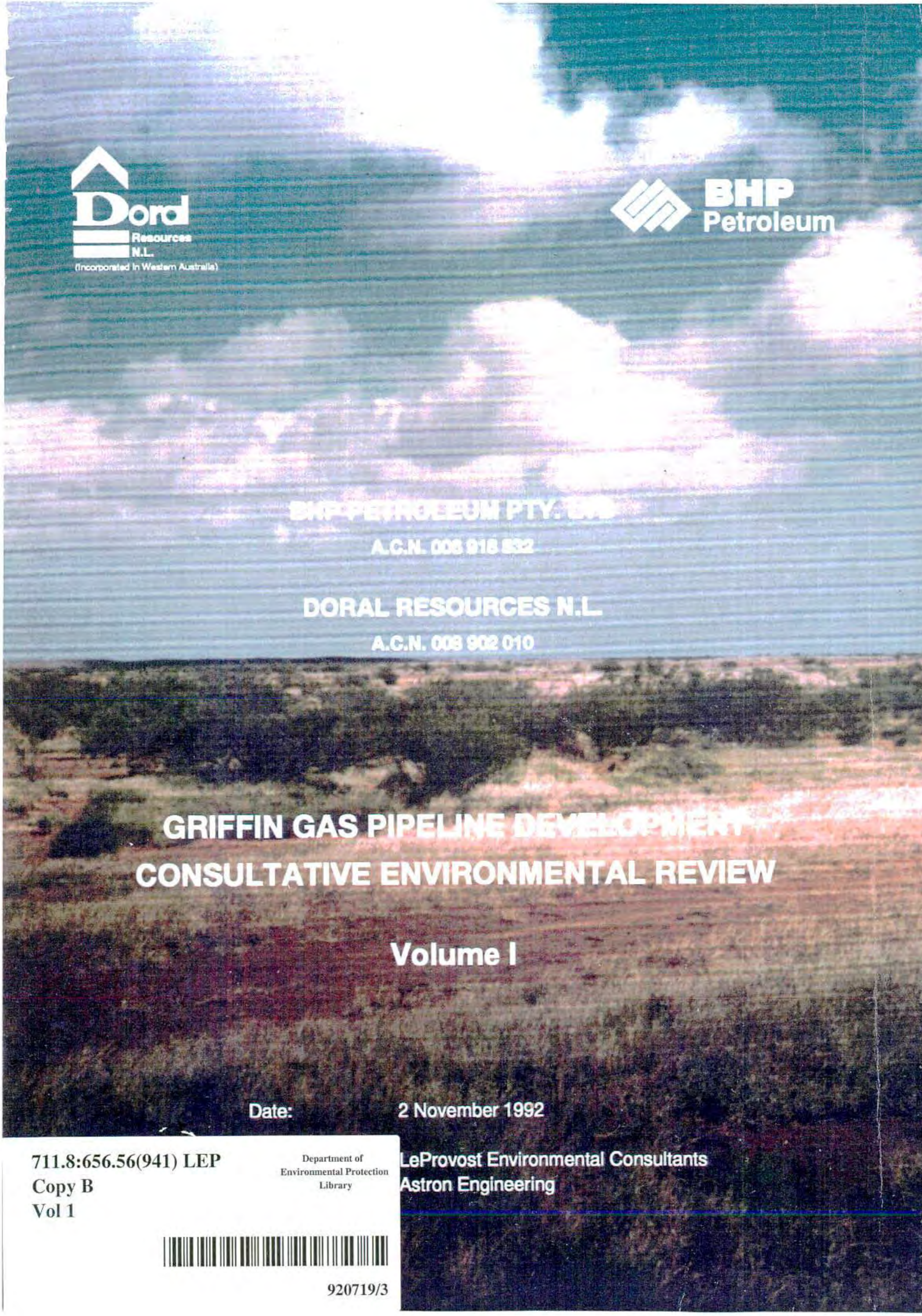

Dorál Resources N.L. (Incorporated in Western Australia)

BHP Petroleum

BHP PETROLEUM PTY. LTD

A.C.N. 006 918 832

DORAL RESOURCES N.L

A.C.N. 009 902 010

# GRIFFIN GAS PIPELINE DEVELOPMENT
# CONSULTATIVE ENVIRONMENTAL REVIEW

## Volume I

Date: 2 November 1992

LeProvost Environmental Consultants
Astron Engineering

## INVITATION

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

The Consultative Environmental Review (CER) proposes the construction of a gas pipeline from the Griffin Oilfield to the mainland where it will join the State Energy Commissions' Dampier to Perth gas pipeline. In accordance with the Environmental Protection Act, a CER has been prepared which describes the proposal and its likely effects on the environment. The CER is available for a public review period of 4 weeks from 2nd November 1992, hence closing on 30 November 1992.

Following receipt of comments from government agencies and the public, the EPA will prepare an assessment report with recommendations to the government, taking into account issues raised in the submissions.

**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 may be fully or partially utilised in compiling a summary of the issues raised or, where complex or technical issues are raised, a confidential copy of the submission (or part thereof) may be sent to the proponent. The summary of issues is normally included in the EPA's assessment report. Submitters would not be identified to the proponent without the submitters permission.

**Why not join a group?**

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

**Developing a submission**

You may agree or disagree with, or comment on, the general issues discussed in the CER 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 environmentally more acceptable.

When making comments on specific proposals in the CER:

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

**Points to keep in mind**

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

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

Remember to include:

- your name, address and date.

The closing date for submission is 30 November 1992.

Submissions should be addressed to:

Chairman
Environmental Protection Authority
Westralia Square
38 Mounts Bay Road
PERTH W.A. 6000
Attention: Jim Treloar

0413.jc

**GRIFFIN GAS PIPELINE DEVELOPMENT**
**CONSULTATIVE ENVIRONMENTAL REVIEW**

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# 1. INTRODUCTION

## 1.1 This Document

This document is a Consultative Environmental Review (CER) for the proposed Griffin Gas Pipeline Development, including onshore gas processing facilities, in nearshore Commonwealth and State territorial waters off North West Australia. Reference is made to the floating, production, storage and offloading facilities (FPSO) that will be used to develop the Griffin oilfields. The purpose of this document is to provide information to facilitate environmental approval, a necessary prerequisite for the proposed development to proceed. It has been prepared for submittal to the Western Australian Environmental Protection Authority (EPA) in accordance with their guidelines for preparing the CER (reproduced in Appendix 1). These guidelines were developed by the EPA in consultation with the Commonwealth Environment Protection Agency (CEPA).

Section 1 provides details of the proponent, presents a brief description of the project (including its background and current status), and outlines legislative requirements applicable to the project. Details of the various public consultations which have taken place are given in Section 2.

Justification for the proposed gas pipeline is presented in Section 3, whilst Section 4 reviews the alternative pipeline routes which were evaluated before selection of the preferred route. Section 5 describes the project, including process facilities, in detail to provide a clear description of the construction and operation activities associated with the development. Section 6 describes pertinent aspects of the biophysical and social environment within 100 km of the project. The effects of the project on the environment are subsequently assessed in Section 7 and environmental management procedures aimed at minimising adverse environmental effects are detailed in Section 8. Commitments given by the proponents are summarised in Section 9.

## 1.2 The Proponent

The Griffin Gas Pipeline Development will comprise four stages of work identified as the Offshore Pipeline, the Onshore Pipeline - Shoreline to Gas Treatment Plant, the Onshore Pipeline - Export Section and the Gas Treatment Plant. The Griffin Project Venturers are the proponent of the Offshore Pipeline, the Onshore Pipeline - Shoreline to Gas Treatment Plant and the Gas Treatment Plant. The Tubridgi Project Venturers are the proponent of the Onshore Pipeline - Export Section, which is downstream of the Gas Treatment Plant.

BHP Petroleum Pty Ltd is the nominated operator of the Griffin Oilfield Development project on behalf of the Griffin Project Venturers, a joint venture comprising:

| | |
|---|---|
| BHP Petroleum (Australia) | 45% |
| Mobil Exploration & Producing Australia Pty Ltd | 35% |
| Inpex Alpha Ltd (INPEX) | 20% |

Doral Resources NL is the nominated operator of the Tubridgi Gas Project on behalf of the Tubridgi Project Venturers, a joint venture comprising:

| | |
|---|---|
| Doral Resources NL | 50.10% |
| Pan Pacific Petroleum NL | 41.50% |
| Haoma Petroleum Pty Ltd | 2.80% |
| Strata Petroleum Pty Ltd | 2.70% |
| Carnarvon Oil and Gas | 1.50% |
| Kiwi International | 0.70% |
| R.A. Radford | 0.35% |
| R.G. Campbell | 0.35% |

BHP Petroleum Pty Ltd (BHPP) is operator of the offshore section of the pipeline up to and including the onshore gas processing facility. Doral Resources NL (Doral) is operator of the onshore section of the pipeline, downstream of the gas processing facility.

## 1.3 Background to Proposal

The Griffin oilfields are located in the Southern Carnarvon Basin, 68 km offshore from Onslow, Western Australia within exploration permit WA-210-P. The oilfields are on the outer continental shelf slope where water depth is approximately 130 m, and at geographic co-ordinates 21°13'S 114°37'E (Figure 1.1).

The Griffin oilfields will be developed utilising a Floating Production, Storage and Offloading (FPSO) facility, moored to a catenary mooring-riser system. Oil and gas will be produced from subsea completed wells via flowlines to the FPSO, where the oil will be stabilised and stored. Stabilised oil will be offloaded by means of a floating hose to an export tanker moored in tandem to the FPSO (Figure 1.2). An overview of the Griffin oilfields and FPSO development including environmental aspects, is provided in Appendix 2.

Gas will be produced along with the oil. The gas will be compressed and transferred to the mainland via a submarine pipeline. Onshore, it is proposed to link this pipeline into the existing easements of the Tubridgi gas development, which is located approximately 30 km south-west of Onslow (Figure 1.1).

The life of the oilfields is presently estimated to be approximately 15 years at the rates of production proposed for the field. Peak oil production rate is expected to be about 12,720 $m^3/d$ (80,000 stb/d) for the first two years. Thereafter production is expected to gradually decline.

## 1.4 Legislative Requirements

The Griffin oilfields and the proposed offshore production facilities occur within Commonwealth Waters. The boundary to State Territorial Waters occurs some

The shallow onshore waters of the inner continental shelf are designated a Special Protection Locality (DCE Bulletin 104) by the EPA due to the sensitivity of marine resources in this region (Figure 1.3).

Approval for the onshore transmission of gas will therefore be required from both Commonwealth and State Authorities. Production and pipeline licences will be required from the Designated Authority under Commonwealth legislation and the Minister for Mines under Western Australian legislation. The licences will require the holder to comply with the regulations of the *Petroleum (Submerged Lands) Act, 1967* as amended (Commonwealth) and the *Petroleum (Submerged Lands) Act, 1982*, as amended (Western Australia). A licence for the onshore pipeline from the coast processing plant and from the processing plant to the SECWA pipeline will be required under the *Petroleum Pipeline Act, 1969*, as amended, (Western Australia).

Environmental approvals may be required for the portion of the development in Commonwealth waters from the Commonwealth in accordance with the *Environment Protection (Impact of Proposals) Act, 1974*, as amended. Approval is required from the EPA for the submarine and onshore gas pipeline in accordance with the *Environmental Protection Act, 1986*.

Other laws relating to environmental matters whose provisions may apply to the proposed development include:

*Aboriginal Heritage Act 1972*
*Agriculture and Related Resources Protection Act 1976*
*Bush Fires Act 1954*
*Conservation and Land Management Act 1984*
*Environment Protection (Sea Dumping) Act, 1981*
*Explosives and Dangerous Goods Act 1961*
*Fisheries Act 1905*
*Land Act 1933*
*Licensed Surveyors Act 1909*
*Marine Archaeology Act 1973*
*Marine Navigation Aids Act 1973*
*Marine and Harbours Act 1981*
*Petroleum Act 1967*
*Pollution of Waters by Oil and Noxious Substances Act 1987*
*Prevention of Pollution of Waters by Oil Act 1960*
*Shipping and Pilotage Act 1967*
*Soil and Land Conservation Act 1945*
*WA Marine Act 1982*
*WA Marine (Sea Dumping) Act 1981*
*Wildlife Conservation Act 1950-1980*

## 1.5 Current Status of Project

The current status of the Griffin oilfields development is that the proponent has produced a development plan and an environmental assessment document, and has submitted both to the Western Australian Department of Minerals and Energy (WADME) as Designated Authority for review and approval.

The proponent has also submitted an application for a production licence over four graticular blocks (Blocks 944, 945, 1016 and 1017 of Map Sheet Hamersley Range SF-50).

Submittal of a copy of the environmental assessment document to WADME resulted in referral of the project to the EPA, who subsequently advised that the portion of the gas pipeline traversing State waters and the mainland would be assessed at the level of a CER. However, the guidelines and this CER have been written to encompass the pipeline from the FPSO to the junction with the State Energy Commission of Western Australia's (SECWA's) gas pipeline. Background information on the FPSO is included as Appendix 2.

## 1.6 The Proposed Project

The proposed pipeline route is shown in Figure 1.1. The route is from the Griffin oilfields to the Tubridgi gasfield, it then uses the existing pipeline easement to the connection into SECWA's Dampier to Perth Gas Pipeline. A 200 nominal bore (NB) pipeline is proposed. This will be layed on the seafloor for most of the offshore section in deeper (Commonwealth) waters, and will be stabilised in shallower (State) waters via a range of techniques including weight coating, pinning and burial. Onshore it will be buried in accordance with the provisions of Australian Standard 2885.

The offshore section of the pipeline route was selected on the basis of environmental and geotechnical surveys which are described in Section 4.

It is planned to construct a gas processing facility in the vicinity of the existing Tubridgi facilities.

The onshore pipe from the gas processing facility may be of increased size from that intended for the offshore section. Both 250mm and 300mm NB line sizes are options.

# 2. COMMUNITY CONSULTATIONS

## 2.1 Background

Community consultation was undertaken to help identify potential impacts and issues of concern within the community so that these could be addressed by project planning and the CER. The consultation was used to create a better understanding of the project and its objectives.

Initial consultations were held in Exmouth and Onslow during April 1992. Consultation continued during the preparation of the CER. Meetings have been held with representatives of the relevant Shires, fishermen, West Australian Fishing Industry Council (WAFIC), local pastoralists, the Aboriginal community, EPA, WADME, the Department of Conservation and Land Management (CALM) and relevant Commonwealth authorities.

The proponents anticipate maintaining on-going liaison with the fishermen and the pastoralists during implementation of the proposal. The proponents wish to be 'good neighbours' and minimise inconvenience to others as a result of their activities.

During the four week public review period, further discussions may be held with specific interest groups, if they so wish, to obtain direct feedback and provide explanations of the management strategies.

## 2.2 Principal Issues Identified During Consultations

The issues raised during consultation are summarised below. In each case, a brief response from the proponent is provided, with a referral to other sections of the report for a more detailed response.

*Will there be a need for an exclusion zone around the pipeline?*

Current plans are to bury the nearshore section of the pipeline where it crosses the Onslow Area 1 prawn fishery. Technical or environmental factors may however prevent burial along part of the pipeline, in which case an exclusion zone will be required to prevent fouling of trawling gear on the pipeline.

Should satisfactory burial not be possible, BHPP will seek to negotiate a mutually satisfactory arrangement for an exclusion zone with the affected fishermen and their representatives.

(Refer to Section 5.2 for explanation of pipeline stabilisation options).

*Interruption to prawn trawling activities during construction*

The prawn fishing season is between April and mid-November. The fishermen expressed concern about interruption to fishing activities should construction take place during this period.

(Offshore construction is planned to take place between August and October. For the majority of construction, activities will be outside the Area 1 trawling ground and not affect fishing activities. At any time, the area affected by construction activities will be small compared to the area of the fishery, reducing the likelihood of any interruption to fishing activities. It is anticipated that liaison with the fishermen will be able to address such issues.)

*Impact on coral and sensitive marine habitats*

There are a number of coral reefs and sensitive marine habitats in the vicinity of the proposed pipeline route. Concerns were expressed about the potential impact of pipeline construction on these habitats.

(The routes of the offshore pipeline have been selected specifically to avoid traversing areas in close proximity to sensitive marine habitats, refer to Sections 4.2 and 4.3. A separation of at least 1,200 m has been achieved between the proposed route and significant reefs, the EPA's preferred minimum separation requirement is 500 m.)

*Impact on humpback whales*

The outer section of the offshore pipeline is located in an area through which humpback whales migrate. Some whales may pass through the area during construction.

(Refer to Section 7.2.1.1. At this point the migratory route is wide and unconfined with no barrier effect apparent and therefore no adverse effects on whale movements are anticipated. Use of underwater explosives during pipeline construction is not planned.)

*Coral spawning*

Mass coral spawning takes place during March and April each year. Concerns were raised about the potential effects of increased turbidity arising from construction activities on coral spawning.

(Construction has been scheduled for August to October to avoid the coral spawning period.)

*Effect on whalesharks*

Whalesharks frequent the Ningaloo Marine Park, some 75 km from the project area, around the time of coral spawning.

(Construction activities will avoid the coral spawning period and hence interaction with whalesharks is extremely unlikely.)

*Impact on conservation values of offshore islands*

The Rowley Shelf islands are listed on the National Estate Register. A number of the islands are A-class or C-class reserves, while a proposal for reservation status covers the remainder. Concerns have been raised about potential effects on these islands.

(The proposal does not involve any use of these islands for construction or operational purposes. Refer to Section 6.5.7 for a discussion of the conservation values of the islands.)

*There is a plethora of pipelines in the area*

The fishermen suggested that petroleum companies co-operate and share infrastructure to minimise further construction of pipelines in the area.

At present there are no other proposals to build a gas pipeline to shore in the area that can be shared. (The proponents will evaluate any future proposals from other companies to use the Griffin gas pipeline on their merits.)

*Archaeological and ethnographic issues*

Concerns were raised about the potential impacts on burial sites in the nearshore dunes.

(The pipeline route across the dunes was located to avoid disturbance to a known burial site. Archaeological and ethnographic advice has been sought to assist in the siting of the onshore facilities and pipeline. Refer to Section 6.5.2 and 8.3.5.)

*Effect of pipeline construction on nearshore sand dunes*

The long-term stability of the nearshore sand dunes and the potential effect of pipeline construction was of concern.

(The pipeline will be buried as it crosses the sand dunes. The area of disturbance by construction activities will be minimised and rehabilitation and revegetation to original state will occur, refer to Section 5.3.5 and Section 8.)

*Effect of construction across the dunes on the local aquifer*

A freshwater aquifer at the beach crossing area is used by the landholder for stockwatering purposes and domestic consumption purposes.

(Construction activities will endeavour to avoid this water source, but should excavation below the water table be necessary the trench will be isolated from it to avoid contamination, refer to Sections 5.3.4, 7.2.2.1 and 8.3.2.6.)

*Requirements for access road upgrading*

Roads in the vicinity of the proposed project may require upgrading to enable access by heavy vehicles to the gas processing facility. The question of who would fund the required upgrades was asked.

(The proponents will be responsible for repair of damage caused by the proponents to the access roads).

*Removal of trees for the gas plant site*

The area presently proposed for the gas processing facilities has a number of trees along one edge, the landholder has expressed concerns about the removal of these trees.

(The site has been identified on the basis of archaeological, flood risk and environmental considerations. The removal of trees will be minimised, and appropriate revegetation of disturbed areas will be initiated. Refer to Section 8.3.4.)

*Noise*

The landholder at Urala has expressed concern about the potential for increases in noise arising from the gas processing facility at the homestead, approximately 5 km away.

(The gas processing facilities will be designed to ensure noise levels are within regulatory requirements at the plant boundary and within the operator accommodation located adjacent to the facilities. It is not anticipated that this will affect existing ambient noise levels at the homestead. Refer to Section 5.5.6).

*Effects of construction and operational activities on stock*

The landholder at Urala has raised concerns about the effect of increased activity on stock.

(The proposed project is restricted to areas already affected by the existing Tubridgi Gas Project, refer to Figure 4.6. It is not anticipated that the project will add significantly to the existing level of disturbance. Truck movements to collect the LPG for sale will be restricted to the main access track between the plant and the boundary, a distance of approximately 4 km.)

# 3. PROJECT JUSTIFICATION

## 3.1 Source of Gas

The Griffin oilfields comprise three hydrocarbon-bearing structures known as Griffin, Chinook and Scindian. The hydrocarbon resource is contained within two distinct reservoirs one overlying the other. The uppermost reservoir is termed the Mardie Greensand, the lowermost is the Barrow Group formation.

The resource comprises both oil and gas. The oil is a very light crude with a specific gravity of only 0.77 (53° API). The volumes of recoverable hydrocarbons as currently projected are as follows:

| | Proven (P90) | Proven Plus Probable (Expectation) |
|---|---|---|
| Oil | $10.16 \times 10^6$ m$^3$ (63.9 MMstb) | $20.85 \times 10^6$ m$^3$ (131.2 MMstb) |
| Gas | $1.19 \times 10^9$ m$^3$ (42.1 Bscf) | $2.59 \times 10^9$ m (91.6 Bscf) |

The reservoir fluid consists primarily of crude oil, natural gas, and saline water (50,000 ppm). Treatment is required to separate each of these components.

Separation of the reservoir fluids will be accomplished offshore, on the FPSO, in a three stage process which is designed to stabilise the crude product to a safe vapour pressure for storage. In the first stage separator, the water and most of the gas is taken from the oil. In the second and third stage separators, the oil is degassed further. The stabilised oil product is taken from the third stage separator, cooled in a titanium plate heat exchanger, and then pumped into the FPSO storage tanks.

Gas from the first stage separator is treated in a compression/refrigeration process to recover natural gas liquids which are subsequently blended with the crude oil to increase product recovery. The purpose of this process is to recover all liquids out of the gas so that the gas can be stabilised for transport to the onshore gas processing facilities, injected into a well to increase oil production by 'gas lift', or reinjected into the reservoir for later use.

## 3.2 Gas Utilisation Options

The recommended development plan for the Griffin oilfields development has been derived from extensive studies to determine the optimum reservoir development scheme and the most appropriate production facilities and infrastructure. Due regard has been paid throughout the planning process to regulatory requirements and good oil field practices, and significant effort has been expended exploring all possible options for disposal of produced gas, with emphasis on finding an environmentally responsible solution which does not seriously compromise project profitability.

The gas handling options which have been investigated are:

1. flaring the gas;
2. gas export with no reinjection;
3. gas reinjection with no export; and
4. gas reinjection with export.

The main constraints which affect the viability of each option are:

- **Geological considerations:** The lowermost reservoir (Barrow Group formation) is highly permeable and has strong aquifer support. As such it has excellent productivity combined with high recovery characteristics. In contrast, the uppermost reservoir (Mardie Greensand) has very low permeability and may have limited aquifer support and, as such, has a low oil recovery characteristic. Gas reinjection into the Mardie Greensand reservoir may be a means of improving oil recovery potential, but it is not possible to assess the viability of this scheme until the production performance of the Mardie reservoir has been tested. Furthermore, there is insufficient volumetric space in the Mardie reservoir to accommodate all the Griffin gas, thus eliminating option 3.

- **Environmental considerations**: Protection of the environment against real or perceived adverse effects of gas flaring on "greenhouse" gases has become a pressing concern for environmental authorities in Australia. BHPP is aware of this concern and proposes to minimise gas flaring, although it must be recognised that some flaring will be a necessity during both project commissioning and operation, effectively eliminating option 1.

- **Social considerations**: Conservation of scarce petroleum resources demands that every reasonable effort should be taken to avoid flaring off a potential fuel source. The W.A. Department of State Development (Morehall et al., 1991) is actively promoting a policy of encouraging development of gas gathering schemes, effectively eliminating option 1.

- **Financial considerations**: Substantial capital costs are required for both the gas reinjection and gas export options. The corresponding benefits, in terms of enhanced oil recovery and gas sales revenues, are relatively very minor.

**Preferred Option**

The currently preferred option (partial gas reinjection into the Mardie reservoir plus export of surplus gas to shore via pipeline) was selected because it avoided excessive gas flaring, may have benefits in terms of increased oil recovery and also produces a raw gas stream which is transportable via gas pipeline to the shore where it can be processed into a saleable product.

### 3.3 Proposed Gas Sales

The Griffin Project Venturers will sell Griffin gas at the outlet of their processing plant to the Tubridgi Joint Venturers who will be responsible for on-selling this gas in the Western Australia marketplace.

### 3.4 Benefits to Community

The Western Australian community will benefit from the proposed project in the following ways:

- o jobs will be provided for the Australian construction industry during the construction phase of the pipeline and onshore gas processing facilities;
- o Western Australia's commercially available supplies of gas will be increased; and
- o the pipeline provides a potential future option for utilisation of other gas resources located in the region.

### 3.5 The No-Development Option

Should the gas pipeline project not proceed, not only will the above benefits be lost but the resource will have to be flared at the FPSO to enable development of the Griffin Oilfields project. Should flaring be disallowed, it could threaten the feasibility of the Griffin Oilfields Development with resultant loss of major benefit to the community. Gas flaring at the FPSO will be required to handle the volume of gas which cannot be reinjected.

# 4. EVALUATION OF ALTERNATIVE PIPELINE ROUTES

## 4.1 Determining Potential Routes

The following factors were considered during the evaluation of an appropriate route for the Griffin gas pipeline:

- market access - the pipeline must reach SECWA's Dampier-Perth gas pipeline so that the Griffin gas can be transported to the major gas markets;
- the marine environment - the pipeline route should avoid sensitive marine resources of ecological or conservational value;
- the length of the route - pipeline length is directly related to the amount and number of potential environmental effects from construction, as well as to costs;
- the presence of fishing grounds near the mainland coast;
- the terrestrial environment - maximising the use of areas already disturbed by existing infrastructure, such as the Tubridgi gas pipeline easements; and
- the potential to collect and transport additional gas from existing or future offshore sources.

Initial evaluation of possible gas pipeline routes identified four potential routes for the offshore section of the pipeline, each crossing the mainland coast in the region of the Tubridgi gas plant (Fig. 1.1). These were selected for further study including environmental and geotechnical seafloor surveys.

## 4.2 Surveys Conducted

### 4.2.1 Background

Four field surveys were commissioned. A marine environmental survey of four potential routes for the offshore section of the pipeline was undertaken by LEC in May 1992. A marine geotechnical survey of two of these routes was subsequently undertaken by Racal in June and July 1992.

Vegetation and geotechnical surveys of the shoreline crossing area were undertaken during July and August 1992 by Astron Engineering and Dames & Moore respectively.

### 4.2.2 Marine Environmental Survey

BHPP commissioned LEC to conduct an environmental survey in May 1992 of the seafloor along and near the four potential pipeline routes to determine surface substrate and habitat characteristics for route selection and environmental impact assessment purposes.

The objective was to obtain sufficient information to permit identification of ecologically sensitive areas and recommendation of preferred routes. The methods and results of this survey are presented in Appendix 3.

The scope of work undertaken during the environmental survey involved:

- o recording the bathometric profile of each potential pipeline route, with interpretation of seafloor characteristics assisted by inspecting video images produced by a colour depth sounder;
- o inspecting the seafloor and habitat type by diving at appropriate locations along each route. Inspection points were selected on the basis of bathometric and depth sounder information and local experience, and divers also inspected the seafloor where bathometric/depth sounder features indicated a significant change in substrate and/or habitat type;
- o inspecting shallow subtidal habitats in the vicinity of the potential routes; and
- o reviewing previous reports containing descriptions of the shallow marine habitats in the vicinity of the potential pipeline routes.

Detailed descriptions of the seafloor substrate and habitat types along each of the four potential routes are given in Appendix 3, and the findings of the marine environmental survey are summarised in Figures 4.1 to 4.3.

Figures 4.1 and 4.2 show the dominant seafloor habitat types along each pipeline route in plan view and horizontal profile respectively. Figure 4.3 provides a broad-brush picture of the regional distribution of the various marine habitats in the region of the pipeline routes. While the boundaries shown on this schematic diagram are not precise, they provide an idea of the distribution of the principal marine habitats (as inferred from data collected from the field survey and other sources; Appendix 3).

Each of the four potential pipeline routes which run between the mainland shoreline and 30 m isobath were found to traverse similar habitat types, albeit distributed in varying proportions. The habitats whose generalised distribution is shown in Figure 4.3 can be summarised as follows:

- o sand dunes and a sand beach at the shoreline crossing;
- o localised inshore occurrences of intertidal and shallow subtidal silt-veneered limestone platform, colonised by varying proportions of turfing algae, sponges and silt-tolerant hard coral species;
- o very soft muddy sediments (dominated by red silts and clays from the Ashburton River) in the shallow and highly turbid inshore areas near the mouths of the Ashburton River delta;

- o sheets of brown gravelly, sandy and silty sediments occupying nearshore waters between 5 m and 10 m deep, and which extend to roughly 10 km offshore. Much of this habitat appears to have been trawled;

- o sheets of white carbonate sands supporting *Halophila* seagrass beds (common in the outer region of the inner Rowley Shelf where waters are clearer and typically less than 12 m deep); and

- o bare or sand-veneered limestone pavement colonised by sponges, algae, gorgonian corals (sea whips and sea fans) and isolated hard corals, and most prevalent at the edge of the inner Rowley Shelf where water depths rapidly increase from ~ 12 m to 30 m.

Of the above benthic habitats, the most important from an ecological perspective are the large areas of bare or thinly-veneered limestone pavement in the offshore portion of the inner Rowley Shelf, since these support the greatest abundance and variety of macroflora, and are therefore considered the most productive. (This will also be the area least impacted by pipeline construction as rock bolts or concrete weighting will be used for stabilisation. This avoids the need to cut into limestone.)

The other habitat of ecological interest are the apparently extensive, though generally sparse, meadows of minor seagrass species (*Halophila* spp.). These colonise sheets of carbonate sands and were found to be best developed in offshore areas where water depths exceed 10 m (Fig. 4.3). The patchy *Halophila* meadows may comprise an important food source for dugongs, but their significance as feeding areas for turtles is less certain.

All four potential pipeline routes also traverse a wide area of predominantly bare silty sands and gravels, the most extensive habitat in the nearshore portion of the inner Rowley Shelf. The gravelly and silty sands are relatively depauperate of surface-dwelling (epibenthic) plants and animals. Much of this area is used by the local trawling industry for tiger and western king prawns which burrow into the soft sediments. Trawling may contribute to the loss of epibenthic species on the prawning grounds.

In terms of direct habitat loss, none of the habitats traversed by the four potential pipeline routes are sufficiently rare or unusual to constrain pipeline route selection. All the habitats are well distributed throughout the region with the possible exception of the isolated inshore limestone platform areas, some of which are colonised by coral (Appendix 3). However, since the pipeline can be deviated around these isolated and silt-veneered platform reefs, they also do not constrain selection of the preferred offshore route.

From an environmental management perspective (i.e. minimisation of ecological impact) the four potential offshore routes can be ranked in order of preference as follows:

1. Routes 1 and 3 - both involved the shortest distance and hence reduce the amount and duration of disturbance caused by pipelaying activities. Both routes traverse similar amounts of bare and sand- veneered limestone

pavement, but much less than that traversed by Route 4 (Fig. 4.1). In addition, Routes 1 and 3 do not pass close to major coral reef areas, although both routes reach the mainland coastline where there are isolated outcrops of limestone platform supporting up to 40% cover of silt-tolerant corals;

2. Route 2 - this route traversed the highest proportion of sandy substrates, but it is longer than Routes 1 and 3 and passes near moderate sized coral reefs at Table Island, Locker Reef, Locker Island and the Baylis Patches (Fig. 4.1); and

3. Route 4 - is by far the longest route and traverses the greatest amount of limestone pavement (Fig. 4.1). It also passes near substantial coral reef development at Tortoise Island, Ashburton Island and at Roller Shoal.

From a social perspective, all routes except Route 2 (west of Locker Island) traverse prawn trawling grounds considered important by the Onslow commercial fishermen, hence requiring burial to avoid loss of fishing grounds and/or potential accidental damage to both pipeline and trawling gear. Route 2, however traverses the Exmouth prawn trawling areas. Compared with Routes 1 and 3, Route 4 has the most potential to disrupt fishing activities as it traverses a much larger area of the nearshore prawn trawling grounds (Fig. 4.1).

It was therefore concluded that there were no single major natural constraints along potential Routes 1 to 3 which would preclude them from being utilised. There would also be no major social constraints provided that the pipeline was buried where it traverses prawn trawling grounds. However, Routes 1 and 3 were considered preferable from an environmental management perspective, while Route 2 was seen as probably the most preferable to local prawn fishermen (Appendix 3).

### 4.2.3 Marine Geotechnical Survey

A geotechnical survey of the seabed was undertaken in July 1992 along Routes 1 and 3, the two routes which had been identified as preferable from an environmental management viewpoint. The aim of the geotechnical survey was to identify the route that would be most preferable from a pipelaying and pipeline stabilisation perspective.

Seismic investigation of the seabed along Route 1 found the offshore section to be unsuitable, as a major limestone ridge structure was found near Bessieres Island. Route 3, however, was found to be free of major ridge structures, thereby providing a more uniform descent off the inner portion of the Rowley Shelf.

The preferred route identified by the seabed geotechnical survey does not follow the path inspected by the environmental survey of Route 3 for all of its length. A divergence occurs south of Bowers Ledge and north of Locker Island, where the preferred pipeline route parallels Route 3 at a distance of approximately 2 km to the west (Fig. 4.4). The reason for this was to avoid ridge formations, that may have required blasting, north of tongue shoals.

During the geotechnical survey, grab sampling and vibrocoring was undertaken to check the geological make-up of the seabed along the preferred route. The results were classified as typical of the area, namely regions of calcarenite rock of several geological eras, and covered with variable layers of sands, silts and gravels (Fig. 4.5). Outcrops of bare or thinly-veneered limestone were most prevalent in the area to the east of Bessieres Island (c.f. Figs 4.4 and 4.5).

#### 4.2.4 Terrestrial Surveys

The terrestrial survey work was governed by the decision to utilise land in the vicinity of the existing Tubridgi Gas Plant site for the proposed Griffin Onshore Processing Plant and the Tubridgi Gas Pipeline easement for the new onshore pipeline which Griffin Gas will utilise. This approach was taken to ensure that impacts on landform and vegetation would be minimised through the use of recently disturbed pipeline corridors. In the event that the gas plant site is not considered acceptable, other sites in the vicinity, adjacent to existing corridors, may be considered.

Assessment of terrestrial pipe routes therefore began by considering the viability of routes between the plant site and one of the three coastal crossing points that resulted from the four offshore pipeline route proposals. The central point of the three was the only one considered in detail because it corresponded to the preferred offshore pipeline route. It had obvious advantages from a land disturbance viewpoint, being the most direct route (4.6 km) to the existing Tubridgi and proposed Griffin plant site. The western landfall, in comparison, would require 9 km of disturbance to tussock grassland of high pastoral value. In addition, it is south of the plant site and would utilise significantly more line pipe. The eastern landfall is 8 km from the plant site and the pipeline would pass through an area containing numerous Aboriginal sites. This route also has the disadvantage of crossing a wide parallel dune area, a creek and saline flats which are wet for much of the time. The central landfall minimises the width of dune crossing and has the significant advantage of allowing the new pipe to utilise existing Tubridgi flowline routes. This reduces terrestrial disturbance to approximately 1.3 km. Planning therefore concentrated on the proposal landfall of offshore pipe route 3 which is 1.5 km south-west of Rocky Point, on Urala Station.

Terrestrial surveys were undertaken by archaeological, ethnographical, land impact and flora consultants, with further engineering and geotechnical input from appropriate sources. An alignment midway between Kapock Well and Rocky Point was considered desirable to avoid previously recorded archaeological sites. A further constraint was the presence of a fresh-water aquifer in the area, which is utilised by the pastoralist. Any contamination of this source by seawater along the pipeline trench would affect the pastoralist's operations. It was therefore desirable to keep the pipe some distance from Kapock Well.

The preferred route crosses approximately 1 km of sand dunes before reaching the saline flats. The pipe extends a further 100 m across the flats before following the Tubridgi 5 flowline back to the plant. The Tubridgi flowlines were installed in July 1991 so the majority of the onshore pipe route will traverse recently disturbed ground.

At the beach crossing, the dunes lie parallel to the shore with a wide coastal berm and two large swales behind the secondary foredune. They are partially vegetated, with dense shrubland on the berm and a moderate grass cover further inland. Large areas are nevertheless bare sand which appears to move locally. The pipeline has been positioned to traverse the narrowest neck of dunes and the area with the most extensive grass cover. Dense shrubland on the berm has been avoided.

The saline mud flats are covered with varying densities of salt-tolerant *Halosarcia* species. The 100 m between the dunes and Tubridgi 5 well which will need to be cleared is of moderate density. The flowline easement from Tubridgi 5 to the plant (a distance of 5.4 km) has been cleared to a width of 20 m.

Surveys to assess the proposed coastal crossing were made on foot and by helicopter between Rocky Point and Kapock Well. Extensive midden sites were located throughout the survey area. After agreement with local aboriginal informants permission was obtained from the Aboriginal Sites Committee of the West Australian Museum to disturb those sites along the pipe alignment provided the sites were appropriately recorded and/or salvaged. Detailed in situ recording and radiocarbon dating of surface shell was subsequently undertaken across the middens. A rare and poorly-known plant species, *Stemodia sp "Onslow"*, was discovered during the flora survey. Its extent was mapped and it was concluded that the pipeline will have a very minor impact on the species. Further details of the vegetation and reasons behind the choice of pipeline alignment at the beach crossing are contained in Appendix 5.

The existing plant and pipeline route have been themselves the subject of detailed environmental surveys which resulted in the production, submission and final approval of a Consultative Environmental Review (Worley Engineering, 1990). Biological data has continued to accrue from this project and is included in Appendix 4 of this document.

To summarise, the terrestrial pipeline route has been chosen to minimise disturbance to landform vegetation, archaeological sites and pastoral activities. Only 1.3 km out of a total 93 km of onshore pipeline will be on undisturbed land, the remainder of the route having received prior environmental approval for a development which occurred during 1991. No endangered plant species occur on the route and the route avoids areas identified as being of archaeological or ethnographic interest. The entire pipeline route will be rehabilitated and the main environmental effect will be a temporary loss of vegetation. Doral has developed a good relationship with pastoralists along the route and will liaise with them regarding the proposal.

### 4.3 Selection of the Offshore Pipeline Route

The route across the inner Rowley Shelf identified by the seabed geotechnical survey has been selected by BHPP as the preferred route for the following reasons:

- it is reasonably short and avoids major limestone ridge structures, and therefore both the amount of environmental disturbance and pipelaying costs will be reduced;

- it does not pass close to islands, major coral reefs and other productive and ecologically-important shallow marine habitats;

- it avoids the long tracts of thinly-veneered limestone pavement occurring to the north-east, which support algae, gorgonians and corals;

- it traverses the nearshore prawn trawling grounds at right angles, and in area where the sediment sheets appear sufficiently thick to permit safe pipeline burial to allow for continued prawn trawling;

- the pipeline can be deviated to avoid passing directly over the isolated outcrops of inshore limestone platform;

- it reaches the mainland shoreline very close to the existing Tubridgi gas field, thereby minimising the amount of coastal vegetation that would otherwise need to be disturbed to form suitable onshore easement and access points; and

- the pipeline route comes ashore at a point where it can cross the beach and foredune in an area away from significant Aboriginal sites.

# 5. PROJECT DESCRIPTION

## 5.1 General

The offshore section of the preferred pipeline route extends for a distance of 64 km from the FPSO at the Griffin oilfields to the landfall location, south of Rocky Point on a beach near the Urala pastoral station (Figs 1.1, 4.4, 4.6). The purpose of the offshore pipeline is to transport gas from the Griffin oilfields to the landfall, where it will join with an onshore pipeline that transports the gas some 5 km to a processing plant to be constructed in the vicinity of the existing Tubridgi gas field, and then on for a further 87.3 km to the point of sale and SECWA's Dampier-Perth gas line.

The offshore and onshore sections of the proposed pipeline, the Tubridgi gas line and gas processing plant are described in Sections 5.2, 5.3, 5.4 and 5.5 respectively.

## 5.2 Offshore Pipeline

### 5.2.1 Pipeline Design

The pipeline has been designed by J.P. Kenny Pty. Ltd. to both Australian and international codes incorporating the most recent available data and recommended practices. In all design considerations, Australian Standards and Codes of Practice have priority.

The offshore pipeline (200 NB) will have a 219 mm outside diameter and a wall thickness of 11.1 mm. The pipeline will be manufactured to API 5LX specifications with a yield strength of 410 MPa and a tensile strength of 515 Mpa. This will permit constant use of the pipeline at 21 MPa gas pressure for the full 20 year life.

The principal design criteria are as follows:

| | |
|---|---|
| Design Pressure | 20.7 MPa |
| Design Temperature | 70°C |
| Design Life | 20 years |
| Production Rate | 42.2 million SCFD (maximum) |
| Stability: | |
| Lateral ) | |
| Vertical ) | 100 year storm |
| Environmental Loads: | |
| Wave ) | |
| Current ) | 100 year storm |

Other elements considered in the design include:

- thermal expansion;
- wave induced orbital velocities;
- pipeline spanning;
- vortex induced vibrations;
- installation loads;
- upheaval buckling;
- fatigue;
- corrosion prevention; and
- pigging.

### 5.2.2 Additional Safety Factor

The pipeline has been designed to the above referenced Codes and Standards. However, owing to the requirement of BHPP to minimise potential problems that can be both time consuming and expensive to correct in remote offshore locations, an additional safety factor has been added to the pipeline strength by means of increasing wall thickness. This safety factor is additional to all requirements of the Codes and Standards, and is also additional to the latest practices of almost all pipeline operators.

### 5.2.3 Pipeline Route

The preferred offshore route has been carefully selected following the completion of four field surveys. These surveys and details of the preferred pipeline route have been described in Section 4. The preferred route, which will minimise problems associated with pipelaying and stabilisation, has been chosen on the basis of safety, protection of the environment and minimisation of social impacts, as well as on the basis of maintaining reasonable costs.

### 5.2.4 Pipeline Construction

Installation of the subsea gas pipeline is presently planned to be undertaken between August and October 1993. This schedule avoids the cyclone season and the March/April mass coral spawning period.

The pipeline will be installed by a vessel, yet to be contracted, which will be one of two basic types. The most frequently used vessel is a 'pipelay barge', and is usually held in place with a spread of six or eight anchors which are layed out ahead and behind the barge. The barge position is controlled by winches, and a standby vessel (barge tender) is used to redeploy the anchors when the barge has moved along the pipeline route to its full extent. Sections of pipe are welded together on the pipelay barge, and the pipeline is supported by a floating adjustable pipe ramp between the barge and seafloor. This pipe ramp is called a 'stinger', and the section of the pipeline which extends from the end of the barge to the seafloor is called the 'catenary'.

The other vessel type, used less frequently because of the limited number available, is a 'reel ship'. Reel ships do not require anchors as they utilise thrusters (lateral propellers) to maintain position. For this technique, the pipe sections are welded onshore and spooled onto a large reel mounted near the stern of the reel ship, and the pipeline is subsequently layed out from the stern using a similar stinger/catenary system. The pipeline is straightened prior to installation immediately before the pipe passes over the stern of the reel ship.

Whichever vessel type is used, the planned sequence of work will be first to position the vessel some 2-4 km off the mainland coast. The vessel will then feed pipe to the beach. To pull the pipeline ashore whilst maintaining sufficient tension to minimise risk of damage, a winch will be anchored at the back of the beach, and most probably on the toe of the foredune. When the end of the pipeline is pulled up to the winch it is also anchored, and then the vessel starts to move further offshore along the predetermined route. The temporary site for the beach-pull operation will occupy approximately 150 m x 150 m, with access either by landing craft or by track through Urala Station.

The position of the pipelay vessel will be precisely controlled by using radio beacons presently located at survey stations on various islands (such as those used for the geotechnical survey on Thevenard and Serrurier Islands). Each station transmits data which enable the vessel to maintain position at an accuracy of 5-10 m.

The pipelay vessel will continue along the route until arriving at the FPSO location at the Griffin oilfields. At this point the end of pipeline, which is sealed by a valve assembly and supported on a heavy pipeline end block ('pleb'), will be placed on the seafloor.

The pleb supports the valve assembly and will also act as the transition point between the steel pipeline and the flexible pipe which will connect to the FPSO. The stability of the pleb is maintained by its own weight, and it will be protected from sliding and scour. The valve assembly will also act as an isolator to prevent gas in the pipeline from back-flowing into the FPSO. An emergency valve will be placed 60 m from the terminus of the offshore pipeline, not far from the onshore processing plant. Another valve will be located at the gas plant itself. The offshore valve at the pleb will be remotely controlled from the FPSO control room.

### 5.2.5 Pipeline Stabilisation

The pipeline will be stabilised to ensure that it does not become overstressed during 'worst-case' storm conditions, in this case a major, one-in-100 year storm or cyclone. The possibility of seismic movement (from an earth tremor) is catered for by the pipeline's Australian design codes.

Stabilisation of subsea pipelines is achieved either by leaving the pipeline on the seafloor and providing weighting and strengthening, by burying the pipeline so that it is not subjected to environmental loadings and stress, or by rock bolting the pipeline to the seafloor.

The first method has the advantage that once installed on the seafloor, the pipeline is immediately secure. However, in shallow water areas it may be impossible to provide sufficient weighting and/or strengthening to prevent movement and stress. Moreover, the exposed pipeline will restrict prawn trawling by posing a serious hazard to the trawl boards and net. It will act as an artificial reef and therefore attract marine life.

Burial enables the pipeline to be designed more efficiently and permits continued professional fishing activities without hindrances following the construction stage. On the other hand, adequate pipeline burial that will enable continued trawling can never be guaranteed in advance owing to the difficulties in accurately determining the thickness and consistency of the seafloor sediments at every point along the pipeline route.

Should burial be prevented in some areas due to geotechnical and engineering reasons, the pipeline may be stabilised by the rock bolting method. This utilises a saddle over the pipeline that is subsequently secured to the seabed by drilling a hole 1 - 3 m into the seabed, inserting a 'bolt' and grouting the bolt into the seabed.

Plans to stabilise the pipeline where it traverses the shallow sections of the inner Rowley Shelf have taken into account that both weighting and burial methods may be required.

For ease of reference, the offshore pipeline has been categorised into four zones in accordance with the seafloor sediment characteristics that were found by the geotechnical survey. These zones are shown in Figure 5.1 and are described in the following table:

**TABLE 5.1: Seafloor Sediment Characterisation**

| Zone | Start Pt | Finish Pt | Soil Type |
|---|---|---|---|
| 1 | KP0 (shoreline) | KP5 (Locker) | Sand/Mud |
| 2 | KP5 (Locker) | KP39 (Bessieres) | Calcarenite/Sand Veneers |
| 3 | KP39 (Bessieres) | KP46 | Limestone/Sand Veneers |
| 4 | KP46 | FPSO | Sand/Mud |

**Zone 1**

Zone 1 is the section from the mainland to the 5 kilometre point (KP 5). KP 5 is situated east of Locker Island and is close to the eastern extremity of an area containing bare limestone pavement and outcrops of limestone platform that appears to exist west of Locker Island. Further east, a similar area containing limestone outcrops was also found heading eastward towards Manicom Bank (Fig. 4.3). At KP5, the gap between these areas is 400 m wide and KP5 marks the centre of this gap.

The soil between the mainland shoreline and KP5 is essentially sand and mud. There was no evidence of rock or hard soils, except for some small, isolated outcrops of limestone close inshore. The pipeline will be stabilised by one or more of the following methods:

**(a) Pre-trenching**

Prior to installing the pipeline from KP5 to the shoreline, a trench will be excavated and the pipeline laid into the trench. The trench is likely to be approximately 2 metres deep and 3-5 metres wide. The trench may be excavated by water jetting or air lifting, or by a marinised excavator.

**(b) Post-trenching**

After installing the pipeline, the trench is excavated by utilising equipment which is placed on top of the pipeline and moves the soil away on either side. Such equipment includes a jet sled, a plough, a cutter/trencher or a combination of these.

**Zone 2**

Zone 2 is the 34 km long section running from KP5 to KP39. KP39 is located 9 km to the north-east of Bessieres Island (Figs 4.4 and 5.1).

The geotechnical survey found that a major limestone ridge structure probably commences at either Flat or Serrurier Islands and runs north-west to Bessieres Island. The structure continues from Bessieres Island in the general direction of the Rosily Islands. While the survey vessel did not investigate the length of this structure, it was clear that gradients were steepest to the west of Bessieres Island. East of Bessieres, an area was found where the ridge was much reduced, before becoming more severe further to the north-east. The preferred route shown in Figure 4.4 traverses the area where the ridge structure is lowest.

Soil sampling at over 20 locations between KP5 and KP39 indicated a variable sand veneer (0.1-2.0 m thick) overlying calcarenite rock of strength varying from 1.0 MPa to 25.0 MPa (measured). It is considered that the rock may have areas approaching 35 MPa strength, which can be described as being as hard as poorly-layed or weak concrete.

Pipeline stabilisation in Zone 2 will utilise one general method with provision for a contingency technique. It is presently planned that pipeline trenching and burial will be the primary method, with rock bolting by divers as the main fall back technique (to supply adequate pipeline anchoring points in bare areas).

Trenching will probably be undertaken by a cutter/trencher or plough after the pipeline has been layed. In areas where adequate trenching is not possible owing to the hardness of the substrate and thinness of soils, then the back up system would be a combination of trencher, plough and rock bolting. The 'worst case' would require divers installing rock bolts at regular intervals (typically spaced between 22 m and 100 m) along the 34 km section of pipeline, but this is considered highly unlikely. The best case is if the plough or cutter/trencher equipment can excavate an adequate trench for the entire length.

**Zone 3**

Zone 3 is 7 km long and forms the first major deep water area from the KP39 to the KP46 locations (Fig. 5.1). Zone 3 is not part of any prawn trawling area and has water depths between 70 and 100 metres. It is characterised by areas of exposed limestone. Initial data from the soil tests indicate that the limestone forms a rock of substantial strength. Readings greater than 50 MPa have been recorded, and it is expected that readings of 70 - 80 MPa could be encountered. There are no known post-trenching spreads available that could reliably excavate a trench through rock of these strengths.

On the other hand, concrete weight coating is possible both in this Zone and Zone 4, since the greater water depths will result in markedly reduced stresses on the pipeline, thereby reducing the need for pinning or burial. The disadvantage of weight coating is that it minimises the type of pipelaying vessel that can perform the work. This is because the coated pipe requires a large capacity pipelay vessel with heavy machinery and equipment. If there were no coatings then smaller pipelay barges and reel ships remain viable, thereby maximising the choice of vessels. It is therefore intended to stabilise the pipeline either by weight-coating, or by trenching or rock bolting, or by a combination of all these techniques.

**Zone 4**

Zone 4 is the 19 km long section from KP46 to the pleb which will be installed near the FPSO (Fig. 5.1). This offshore zone is similar to the near shore zone in that the seafloor is predominantly covered by thick sheets of sand and mud. Stabilisation is likely to be either by weight coating or trenching.

Trenching is expected to be relatively straightforward since the soft sediments should allow ploughing, water jetting, airlifting or cutter/trenching.

### 5.2.6 Pipeline Testing

Offshore pipelines are normally hydrostatically pressure tested after they have been installed and stabilised, but sections may be tested prior to stabilisation due to the logistics of the principal vessels involved in pipelaying operations. For example, pipeline integrity could be tested prior to the departure of a pipelay vessel from the project area, particularly if its departure is planned immediately after pipelaying. In this case, the hydrostatic pressure test will be performed prior to completion of pipeline stabilisation.

The testing procedure is to fill the pipeline with treated seawater by pushing one or more 'pipe-pigs' through the pipeline under pressure. The pipeline is then pressure tested to specified pressures which are maintained for a minimum period of 24 hours. Upon completion of testing, the water is discharged from the pipeline and the pipeline is dried by further pipe-pigging using compressed gases or by creating a vacuum.

The testing procedure will most likely be performed from the gas plant end with pipe-pigs running towards the FPSO. Seawater will be suction pumped from the sea and treated with anti-corrosion additives at the pressure pump outlet.

The additives planned to be used are similar to Catoleum Pty Ltd products 'Visco D4007' and 'Uni-treat 3900' at concentrations of 100 ppm and 500 ppm respectively. The former is a biocide and the latter is a scale inhibitor and oxygen scavenger, and both are required to prevent internal corrosion by the seawater. After testing is completed, the treated seawater (approximately 1,850 $m^3$) will be discharged to the ocean at the FPSO site.

### 5.2.7 Maintenance Programme

Maintenance operations will be undertaken on the pipeline. External maintenance will consist of inspections by side-scan sonar from a surface vessel every five years, and also after the first significant cyclone has passed directly over the pipeline. The sonar inspections will indicate if any sections of the pipeline have shifted. If pipeline movement is detected, visual inspections using a Remotely Operated Vehicle (ROV), equipped with television cameras and deployed from a surface vessel, may be undertaken.

### 5.2.8 Future Tie-Ins

Provision has been made for two future tie-ins, and these will be located at the valve station near the FPSO and at a point close to KP39 (north-east of Bessieres Island where water depth is approximately 70 metres; Fig. 5.1). Both tie-in points will consist of a T-piece. Thus if new gas resources are discovered in this region of the North West Shelf by BHPP or other operators in the future, one or other of the tie-in points can enable new sources of gas to be flowed to the mainland without the need to install another pipeline across coastal waters.

## 5.3 Shore to Gas Plant Pipeline

### 5.3.1 Connection with the Offshore Pipeline

The first section of the onshore pipeline will run approximately 1 km from the beach-pull area described earlier (Section 5.2.4), directly across the sand dunes to a point (T5) near the existing Tubridgi No. 5 well, and along the existing flowline (Fig. 4.6) that connects the No. 5 well to the Tubridgi gas plant, a distance of 5 km.

This section will be identical to the offshore pipeline, namely 200 NB. This allows the pipe to be permanently buried across the beach and dunal area, since the high offshore safety factors means that external inspections in the future will not be necessary, thereby avoiding future disturbance to the coastal dunes.

The pig station, that will enable pipe-pigs to be launched towards the FPSO for hydrotesting after construction and received from the FPSO during operations, will be installed 60 m from the plant site.

### 5.3.2 Onshore Pipeline Design

The onshore pipeline will be designed by Pipe Line Technologists, a subsidiary of Wholohan, Grill and Partners. The design standards will be in accordance with the requirements of Australian and International Codes and Standards.

The design criteria as outlined in Section 5.2.1 for the offshore pipeline will also apply to the onshore pipeline.

### 5.3.3 Onshore Pipeline Route

The preferred route across the sand dunes from the beach to T5 has been discussed with representatives of the local Aboriginal community who have advised that the route is acceptable. The route passes between two identified archaeological sites, approximately 200 m and 280 m distant from the centre line of the route. The preferred route from T5 to the new gas processing plant (which will be constructed in the vicinity of the Tubridgi plant) will utilise the existing easement of the Tubridgi No. 5 gas pipeline.

### 5.3.4 Onshore Pipeline Installation

The pipeline will be installed by conventional land based equipment.

The beach and dunal area will be pretrenched, the pipe sections will be welded then laid into the trench and hydrostatically tested following backfill. The trench will follow the existing topography so as to minimise dune disturbance. The trench will not be allowed to intersect known freshwater aquifers, as it is recognised that these are considered highly important to the routine operational requirements of the Urala station (Section 2). The minimum pipe cover is anticipated to be 2,000 mm across the beach, 1,200 mm across stable dune areas, 2,000 mm across unstable areas and 2,500 mm under the peaks.

The pipe trench from T5 to the Griffin Gas plant will be at least 750 mm deep deep, and will be backfilled as soon as the pipeline is installed. Overburden in the salt flat areas will be allowed to self-stabilise.

### 5.3.5 Rehabilitation of Dunes

The maximum area of disturbance across the dunes is planned not to exceed a 60 metre wide strip following the pipeline centre. Perimeter fences will be erected each side of the pipeline centreline to prevent construction equipment and personnel straying into areas of sensitive dune vegetation.

Areas disturbed by construction, including the beach pull area, will be rehabilitated wherever possible to their original condition or better. Dune rehabilitation techniques have been established by the pipeline design consultant through their environmental subcontractor, Dames and Moore (Appendix 6). A summary of rehabilitation procedures is contained in Section 8.

### 5.3.6 Hydrotesting

The onshore pipeline will be hydrostatically pressure tested following burial. The test water will be treated with the same anti-corrosion additives as used for the offshore pipeline (Section 5.2.6). The pipe may be filled with treated seawater pumped from the beach, or with treated water obtained from the Ashburton River, or with water obtained from a bore sunk at the gas plant site. The location of the selected water source will dictate the location of pig launching and receiving stations.

The onshore pipeline will then have the final closing weld to the gas plant completed and tested by non-destructive testing methods such as ultrasonics or radiography.

### 5.3.7 Maintenance

The pipeline will need no maintenance, but if circumstances indicate it to be necessary, then it is possible to inspect internally using intelligent pigs between the FPSO and the gas plant. Exhumation of the onshore pipeline for inspection purposes will not be required.

## 5.4 Tubridgi Export Pipeline

### 5.4.1 Connection with Griffin Gas Treatment

The new Tubridgi export line will be fed from an inlet manifold that will be connected to the Griffin gas treatment plant. The manifold will have provision to connect to other potential future gas suppliers as well as the existing Tubridgi gas plant. This new pipeline is required because there is insufficient capacity in the existing Tubridgi pipeline to accommodate the Griffin gas.

The pipeline is expected to be either 250 mm or 300 mm nominal diameter and will run along the existing 87.3 km pipeline easement to a meter station located downstream of Compressor Station No. 2 on the SECWA Dampier to Bunbury gas pipeline.

### 5.4.2 Export Pipeline Design

The export pipeline will be designed and constructed in accordance with AS 2885 Pipelines - Gas and Liquid Petroleum. The pipe will be fully welded and designed in accordance with the following parameters:

| | |
|---|---|
| Design Pressure | 13.5 MPa |
| Rating for Fittings | ANSI Class 900 |
| Material | Steel API 5L Gr X-70 |
| Depth of Cover | 750 mm minimum |
| Corrosion Protection | external coating impressed current |
| Internal Cleaning | abrasive and swab pigs |
| NDT Testing | gamma ray radiography |

### 5.4.3 Export Pipeline Route

The 87.3 km pipeline will follow the existing pipeline ROW as indicated on Figure 5.2.

### 5.4.4 Export Pipeline Installation

The pipeline will be installed using conventional pipe construction methods which are not anticipated to vary significantly from those used during the installation of the original Tubridgi line in 1991.

Pipe will be delivered by road from either Dampier or Perth and will be strung directly along the ROW where it will be welded, tested and lowered into the adjacent trench. Trenching will be by use of a bucket wheel trenching machine or track mounted excavator.

The work is expected to be carried out between July and October to attempt to avoid the mustering season and minimise the chances of wet weather disruption.

### 5.4.5 Rehabilitation of Disturbed Areas

It is not anticipated that more than 5 metres will need to be added to the existing cleared width along the right of way.

Rehabilitation of the disturbed areas is discussed in Section 8 and will follow similar procedures to those used for the existing line. Particular attention will be paid to the condition of the existing ROW to optimise rehabilitation procedures particularly with respect to any damage due to wind or water erosion.

### 5.4.6 Hydrotesting

The line will be tested in at least two sections using fresh water obtained from the Ashburton River. It is likely that inhibitors will not be required but if used they will be of a bio-degradable type. The line will be dried immediately after testing using dry air with hydrotest water being disposed of by evaporating in a suitable low lying area.

### 5.4.7 Maintenance

Maintenance of the pipeline will involve regular inspection of the right of way (approximately 2 monthly), monthly pig runs, annual cathodic protection surveys, and a detailed annual inspection and testing of all safety and operational systems in line with the approved procedures detailed in a Mandatory Inspection Procedures Manual.

## 5.5 Gas Treatment Plant

### 5.5.1 Location and Requirement

As part of the proposed gas pipeline development, BHPP intends to construct and operate a gas processing plant occupying a site approximately 2.4ha in area in the vicinity of the existing plant at the Tubridgi gas field which is operated by Doral (Figs 5.2, 5.3). The additional plant is required because of differences in the composition of Griffin gas to Tubridgi gas which means that the existing plant is no suitable for processing Griffin gas. The Griffin gas plant which will remove inert and natural gas liquids (i.e. LPG) from the gas is required to ensure that the Griffin gas will meet SECWA's gas quality specifications enabling its sale into the Western Australian market.

Table 5.2 shows the properties of the raw gas and the sales gas specifications which must be met.

**TABLE 5.2: Raw Gas and Sales Gas Specifications**

| | Raw Feed Gas | Sales Gas Specification |
|---|---|---|
| Hydrocarbon dewpoint (2.5 to 8.72 MPa) | <0°C | <0°C maximum |
| Carbon dioxide content | 2.5 mol % | ≤4.0 mol % |
| Total inerts content | 9.2 mol % | ≤5.0 mol % |
| Oxygen content | <0.2 mol % | ≤0.2 mol % |
| Total sulphur | >20 mg/sm$^3$ | ≤10 mg/sm$^3$ |
| Hydrogen sulphide | 20 mg/sm$^3$ | ≤2 mg/sm$^3$ |
| Water (vapour phase) | 48 mg/sm$^3$ | ≤48 mg/sm$^3$ |
| LPG (propane and butane) | >1.45 t/TJ Gas | ≥1.45 t/TJ gas delivered |
| Higher Heating Value | 40.82 | 37.3 - 41.0 MJ/sm$^3$ |
| Wobbe Index | 48.12 MJ/sm$^3$ | 47.2 - 51.0 MJ/sm$^3$ |
| Mercury | 200 ng/sm$^3$ | free by commercial standards - approx. <20 nanograms/sm$^3$ |

The plant is designed to process 1,000 tonne/day of produced gas. This is the maximum gas rate envisaged from Griffin. It will however normally operate at about 60% of this rate and is designed to operate at as low as 30% of design capacity.

### 5.5.2 Gas Treatment Process

The plant design chosen utilises a non-conventional cryogenic process which does not include the amine-based extraction facility typical of conventional designs. This design minimises the environmental impact of the gas plant as it produces less waste than conventional plants.

This process description should be read in conjunction with the diagrams shown in Figures 5.3 and 5.4. The gas treatment plant consists of four stages:

1. mercury removal unit;
2. dehydrating and sulphur removal unit;
3. natural gas liquids (NGL) recovery unit; and
4. nitrogen removal unit (NRU).

Gas from the offshore pipeline is first fed into the Mercury Removal Unit where trace quantities of mercury are removed using a non-regenerative sulphur impregnated activated carbon bed. The mercury free gas is dehydrated and desulphurised by molecular sieve absorberts which are regenerated using fuel gas from the low temperature separation unit. The dry sulphur free sweet gas is then split and a side stream processed in the NRU. This is a low temperature separation unit for nitrogen removal. The gas is then recompressed and recombined with the main sales gas stream.

A portion or all of the NRU feed may be sidestreamed through the NGL Recovery Unit to enable the sales gas specification for higher heating value and/or Wobbe index to be met. The recovered NGL's will be either sold as fuel or used within the plant to augment the gas plant fuel requirements or flared. NGL lean gas is recompressed from the NGL recovery unit and fed to the NRU.

The NRU incorporates a cryogenic process which uses a combination of cooling, expansion and flash separation operations to achieve the required nitrogen rejection for specification sales gas product. A nitrogen rich fuel gas byproduct is also produced by this unit. This is used within the gas plant to provide drier regeneration gas and the gas plant energy requirements.

### 5.5.3 Gas Plant Emissions and Wastes

Gas plant emissions can be separated into four categories:

- combustion gases from power plants and heaters;
- combustion gases from flaring during plant start-ups;
- fugitive emissions from leaks; and
- emissions from sampling and purging during routine operations.

Combustion gases will be released into the atmosphere from the burning of sour gas and fuel gas at the plant. These gases are burnt to provide energy for electricity generation and the compressors. These energy requirements are expected to produce the following combustion gases:

| | |
|---|---|
| Nitrogen ($N_2$) | 52,900 kg/hr |
| Carbon dioxide ($CO_2$) | 2,900 kg/hr |
| Water vapour ($H_2O$) | 2,300 kg/hr |
| Oxygen ($O_2$) | 14,500 kg/hr |
| Nitrogen oxides ($NO_x$) | 10 kg/hr |
| Sulphur dioxide ($SO_2$) | 5 kg/hr |

Flaring will occur during plant start-ups. During these times all or at least part of the sales gas has to be flared. It is estimated that these events will add 15 kt/yr of $CO_2$ to the atmosphere. Other flarings may be required should the plant's monitoring systems detect abnormal behaviour. Efficient design, maintenance and operational procedures will ensure that such unscheduled flaring will be minimised.

Based on experience of other similar gas plants, fugitive emissions from leaks are expected to total 600 kg/yr for gaseous hydrocarbons such as methane. Emissions from sampling and purging during routine plant operations are expected to total 3,000 kg/yr of gaseous hydrocarbons.

Small quantities of solid industrial wastes are produced by this plant. Liquid wastes will be plant stormwater runoff and domestic sewage which will be treated in a septic tank system.

Solid wastes generated by gas processing will comprise:

- approximately 5,500 kg of spent activated carbon, which is expected to contain 0.03% mercury (but up to 0.24% mercury following worst-case conditions), will be transported either to a suitable licensed landfill site or a mercury recovery processor after 15 years of gas plant operation. The activated carbon used for mercury removal will also be impregnated with up to 10% sulphur, and the captured mercury will be in the form of mercuric sulphide; and

- fourteen tonnes of spent molecular sieves containing hydrocarbons are expected to be transported to a suitable licensed landfill site every three years. The molecular sieves comprise beads of calcium-sodium alumina-silicates. Fresh beads have a very high surface area (approximately 500 $m^2$ per gram), and become spent when they have lost 50% of this area either by hydrocarbon contamination or after breaking up into a powder and restricting the passage of gas.

### 5.5.4 Chemicals Held on Site

In addition to the process emission and waste inventories, it is expected approximately 1,000 L of lubricating oil will be held on site. Immediately prior to Molecular Sieve Drier changeout (about every three years) up to 14 t of fresh Molecular Sieves will be temporarily held on site.

### 5.5.5 Alternative Processes for Gas Treatment

During detailed design alternative pretreatment processes will be evaluated. This may lead to using an alternative sulphur removal system to the molecular sieves.

### 5.5.6 Noise and Vibration

The gas plant contains rotating machinery, control valves and a flare system, all of which can cause vibration and noise. Both will be minimised by good design and appropriate insulation to ensure that noise is kept below 85 db(A) at 1 m from all ground level equipment. Flare noise will be limited to accepted industry standards, and during normal operations noise from both plant equipment and the flare will be kept below 75 db(A) at 100 m from the boundary of the plant.

### 5.5.7 Plant Construction

The gas plant will be constructed off site in modular form, with each module being tested then transported to site by road for final assembly. Where possible the modules will be skid mounted. The gas plant will consist of discrete structures with generally clean lines and a low vertical profile. A visual impression is given in Plate 1.

Preparation of the site for on site assembly will include:

- upgrade of the existing road where necessary between the processing plant and the highway (approximately 33 km) to provide adequate access for construction vehicles (if necessary);
- clearing, grading and security fencing;
- construction of roadways within the plant boundary; and
- earthworks for the foundations and concrete pads of vessels, equipment, site utilities and skids.

During the construction phase it is expected that there will be approximately 20 construction personnel who will be housed in accommodation either at Urala Station or in Onslow for three months (Urala Station has a fully equipped camp approximately 6 km from the gas plant construction site). A desalination plant will be installed at the gas plant site to provide potable water for the construction force and plant operational personnel, and the planned septic tank will be large enough to cater for all greywater effluents generated on site. Other kitchen and domestic wastes generated by the workforce will be sent by road to an approved landfill site, as will construction wastes such as steel offcuts, timber, packaging, fasteners, etc.

### 5.5.8 Access and Rights of Way

The gas plant will be serviced by road and a helipad for occasional air service (present intentions are for an average of one return flight from Karratha per two weeks). Existing roadways, most recently developed for the Tubridgi gas development, will be utilised wherever possible. It is expected that one crossover of the gas pipeline will be required for the access road to reach the plant.

### 5.5.9 Operating Personnel

The site will be manned 24 hours per day by operators who will be housed at the new gas plant site and skilled in all plant operations. They will receive specific training concerning the environmental management of the gas plant with respect to operational contingencies. These include:

- shutdown and start-up procedures;
- equipment failures and emergencies;
- flaring;
- site inspections and weather conditions;
- communications and transport; and
- liaison with pastoral stations.

### 5.5.9 Export of LPG

Alternatives being considered, but not limited to, are:

- upgrade of road to provide access by road tankers;
- pipeline installation to provide suitable location for loading of road tankers adjacent existing suitable road access;
- combination of both above.

## 6.2 Climate

The onshore pipeline route lies near the Ashburton River, a major geographic feature in the area. The Ashburton River lies in the arid sub-tropical zone with low, rainfall, high evaporation and day temperatures which vary from warm in the winter to very hot in the summer. Weather is dominated by dry anticyclonic high pressure cells throughout the year and occasional tropical cyclones in the summer (Payne et al., 1988).

Rainfall is low and erratic, averaging approximately 270 mm near the coast and 210 mm further inland. At Kooline Station, for which records exist since 1896, the mean rainfall is 243 mm, but this varies between 34 mm received in 1936 and 596 mm received in 1942.

Temperatures vary slightly through the region, mainly because of distances from the coast and elevation. Fairly typical for the pipeline location would be Nyang which has a mean monthly maximum of 42.2° C in February and 24° C in July. Corresponding mean monthly minimums are 25.3° C and 11.5° C.

Mean monthly evaporation figures are very high, often exceeding 400 mm in summer and varying between 150 mm and 200 mm in winter. Humidity is generally low, increasing in the winter months. Nyang's maximum mean monthly relative humidity is 41% in May and 12% in November.

The summer season is characterised by prolonged periods of hot, dry conditions created by anticyclonic activity to the south. Thunderstorms may develop as a result of convectional activity, producing localised falls of rain. Tropical cyclones, which develop over the Timor Sea, usually cross the coast further to the north, but occasionally do reach the pipeline area, producing large amounts of rainfall as a result.

During winter, the anticyclonic belt is usually centred about the latitude of the Ashburton River and conditions are fine and warm in the day and cool at night. Sometimes, the cool, dry winter conditions are broken by an incursion into the area of rain-bearing depressions from the south. Winter rains can also occur by the interaction of southern depressions with middle level disturbances moving through from the tropics.

Winds blow consistently throughout the year (Fig. 6.1). During winter (June-August), moderate to strong south-easterlies and easterlies prevail, while in summer (November-March) moderate southerly, south-westerly and westerly winds dominate. Spring (September-October) and autumn (April-May) are transitional periods during which both summer and winter winds can occur (Fig. 6.1). Periods of light winds, i.e. less than 4 m/s (< 14 km/h), prevail for approximately 30% of the time, and these may occur any time during the year, but are typically most frequent during autumn.

Winds recorded at Thevenard Island during the period January 1987 to December 1990 (Table 6.1) show that the predominant (63.3%) wind direction for nearshore waters in the Onslow-Tubridgi region is from the south-west quadrant and occurs in spring, summer and autumn. The remaining 36.7% is roughly equally distributed (≈ 7%) from the remaining cardinal points of the compass. The strongest winds typically occur during easterly or south-westerly gales (excepting cyclones).

**TABLE 6.1: Average percentage occurrence of wind speed and direction at Thevenard Island between January 1987 and December 1990.**

| DIRECTION | WIND SPEED | | | | | | | | TOTALS (%) |
|---|---|---|---|---|---|---|---|---|---|
| | (knots) 0.2-3.9 | 4.1-7.8 | 8.0-11.7 | 11.8-15.5 | 15.7-19.4 | 19.6-23.3 | 23.5-27.2 | >27.4 | |
| | (m/s) 0.1-2.0 | 2.1-4.0 | 4.1-6.0 | 6.1-8.0 | 8.1-10.0 | 10.1-12.0 | 12.1-14.0 | >14.1 | |
| **North** | 1.5 | 3.3 | 1.7 | 0.8 | 0.2 | | | | **7.5** |
| **North-east** | 0.9 | 1.8 | 1.6 | 1.3 | 0.8 | 0.3 | 0.1 | 0.1 | **6.8** |
| **East** | 0.7 | 1.8 | 2.0 | 1.3 | 0.7 | 0.3 | | | **6.8** |
| **South-east** | 0.7 | 2.6 | 2.1 | 1.4 | 0.7 | 0.1 | | | **7.7** |
| **South** | 1.0 | 3.5 | 4.9 | 5.0 | 2.9 | 0.6 | | | **18.0** |
| **South-west** | 0.9 | 5.4 | 8.3 | 8.1 | 3.4 | 0.5 | | | **26.8** |
| **West** | 0.9 | 5.1 | 6.3 | 5.1 | 1.0 | 0.1 | | | **18.5** |
| **North-west** | 0.8 | 3.1 | 2.4 | 0.5 | | | | | **6.9** |
| **Total (%)** | **7.6** | **26.5** | **29.2** | **23.5** | **9.7** | **1.9** | **0.4** | **0.2** | |

Occurrence of calms 1.1%.

Source: Steedman Science & Engineering (1992).

The gales are often the result of strong pressure gradients associated with intense high pressure cells. Depending on the time of the year, these gales may comprise strong easterlies or west to south-westerlies, with speeds up to 20 m/s (72 km/h). These storms can persist for 3-4 days.

Squalls accompanying thunderstorms during the summer season may produce localised wind speeds of 15-35 m/s (54-125 km/h), with instantaneous gusts to 45-50 m/s (160 km/h). These squalls may come from any direction but their duration is short (rarely exceeding two hours and often lasting for less than 30 minutes).

The region experiences on average two cyclones per year during a season which typically extends from January to April. Winds associated with these events usually exceed 22 m/s (80 km/h) and gusts exceeding 56 m/s (>200 km/h) can occur near the eye of severe cyclones. The highest wind gust ever recorded in Australia was at Onslow, where an anemometer disintegrated at 71 m/s (256 km/h) on the 'quiet' side of Cyclone Trixie (Steedman Science & Engineering, 1992). Cyclone paths are typically from the north-east, and either remain offshore (paralleling the mainland coast in a west-south-west direction) or turn southwards to cross the mainland coast between Dampier and the North West Cape.

## 6.3 Marine Environment

### 6.3.1 Physical Environment

#### 6.3.1.1 Oceanography

**(a) Offshore characteristics**

The oceanographic characteristics of the Griffin oilfields area were investigated by Steedman Science & Engineering (1992).

Waves contain a sea wave and swell component. Sea waves are generated by local winds, and are usually of short period (1-10 seconds) and reflect the directionality of these winds. Persistent sea waves (<2 m height) arrive from the south-western quadrant in summer and the eastern quadrant in winter. The calmest seas tend to occur between September and November, while larger seas (>2 m height) occur from June to August.

Long period south-westerly swells (1-2 m height) are predominant in the Griffin oilfields area. Larger swells (3 m height) occur in winter, whilst summer cyclones generate extreme swells that can exceed 8 m in height.

Tidal range in offshore waters is about 2 m at spring tides and 1 m at neap tides. Semi-diurnal tidal currents, involving four current reversals each day, are a dominant feature of the offshore current regime during the spring tidal period. During neaps, drift currents may inhibit such reversals. Barotropic tidal streams have a maximum speed at spring tides of 0.1 $ms^{-1}$ and flow in east-west directions. Baroclinic currents vary slightly in magnitude but may reach over 0.2 $ms^{-1}$ near the bottom and over 0.1 $ms^{-1}$ near the surface, with a predominant onshore-offshore direction.

Wind-driven currents (excluding those produced by tropical cyclones) may reach 0.8 $ms^{-1}$ near the surface and 0.3 $ms^{-1}$ near the bottom. The surface oceanic drift current, the Leeuwin Current, is strongest in the Griffin area during March and April, with speeds of 0.25 $ms^{-1}$ to the south-west along the shelf break (Holloway & Nye, 1985; Steedman Science & Engineering, 1992).

Surface seawater temperatures during summer and winter range between 26-31°C and between 19-24°C respectively. The water column is strongly stratified in late summer and almost isothermal in winter. Water clarity is high.

**(b) Nearshore characteristics**

The oceanography of the nearshore (inner Rowley Shelf) region in the Onslow area has been described by Steedman Limited (1986) and Steedman Science and Engineering (1991).

During winter, locally-generated wind waves are formed by prevailing easterlies, south-easterlies and southerlies. Maximum wave heights generated by easterly gales can exceed 2 m where depth and wind fetch are not restricted. Summer wind waves with heights of 0.5-1.5 m are generated from prevailing westerlies and south-westerlies. Swells from the Southern and Indian Oceans are refracted into the region from the north and north-west, but are considerably attenuated by the time they approach the coastline.

Surface water movement in the shallow inshore area of the Rowley Shelf is dominated by tidal currents and modified by wind stresses. The strength and direction of water movement in shallow nearshore waters is also locally modified by bathometry. Currents up to 2 m/s (4 knots) occur in shallow waters (<5 m deep), while deeper and more open waters (>10 m deep) experience currents in the vicinity of 0.5 m/s (1 knot). Moderate to strong local winds tend to have greater influence on surface current direction during neap tides, while spring tidal currents tend to over-ride wind-driven currents in shallow waters.

Tidal currents in the region generally flow parallel to the mainland coast with north-easterly floods and south-westerly ebbs. In general, neap tidal periods are coincident with low current velocities and clear water, while spring tides produce stronger currents which result in sediment reworking in shallow areas and consequently more turbid waters.

Nearshore turbidity is further increased during occasional flows from the Ashburton River. Coriolis and density-gradient forces cause an overall north-westerly movement of river outflow at speeds less than 0.2 m/s.

#### 6.3.1.2 Bathometry, geology and geomorphology

The Griffin oilfields are located on the inner edge of the outer continental shelf which slopes away from the Rowley Shelf toward the Exmouth Plateau. Geotechnical studies of the Griffin location (Dames & Moore, 1991) indicate that the seabed in this area is relatively smooth, featureless and gently slopes to the south-west. The seabed consists of a relatively thick sequence of carbonate sediments described by Jones (1973) as sandy silts and silty sands. The main component of the sediments is skeletal debris from the bodies of invertebrate animals including foraminiferans, molluscs, bryozoans and corals.

The Rowley Shelf is a vast and mainly shallow submarine platform of Pleistocene limestone, much of which is covered by sandy veneers in offshore waters and by sandy, gravelly and silty sheets and shoals closer to the mainland. The inner Rowley shelf gently slopes from the mainland shoreline to a depth of 20 m approximately 25-30 km offshore. Locally the inner shelf is interrupted by numerous limestone outcrops, coral reefs, sand cays and islands of various size.

The islands are typically surrounded by an intertidal to shallow subtidal limestone platform. The islands are of two types: sand cays (such as Thevenard Island), and continental limestone outcrops (e.g. Barrow and Muiron Islands) which are fringed by rocky shores and pocket beaches.

The coast in the Onslow region is in a long-term erosional regime, interrupted occasionally by short-term periods of net accumulation (State Planning Commission (SPC, 1987)). Prevailing summer winds are believed to produce a net eastward littoral transport of sediments. Cyclones and storms can cause periodic coastal erosion and temporary westward or offshore movement of sediment.

The mainland coast adjacent to the oilfield contains geomorphic units which are typical of the Pilbara Coastal System (Semeniuk, 1986). These units are:

- relatively narrow sand beaches backed by shore-parallel sand dunes;
- intertidal flats, creeks and embayments; and
- river deltas, typically in a wave-dominated lobate form. Freshwater discharge is ephemeral, since the rivers flow only when episodic rainfall has occurred within their catchments.

The catchment area of the Ashburton River is over 75,000 $km^2$ and, when in flood, this river contributes large quantities of terrigenous sediments to the coast and nearshore waters.

### 6.3.2 Biological Environment

#### 6.3.2.1 Regional overview

The marine biota of the region belong to the broad Tropical Indo-Pacific Biogeographic Province (Wilson et al., 1979; Jones, 1986). Compared with temperate or subtropical areas, the waters of this large biogeographic province are generally characterised by warmer average temperatures, higher clarity, higher salinity and deeper light penetration (Ferguson Wood & Johannes, 1975). Much of this comparison is also true for the coastal area near Onslow, where inshore turbidities are often high and surface water temperatures often below 22°C in winter.

#### 6.3.2.2 Outer shelf

The biota of the continental shelf (i.e. near the Griffin oilfields) is not well described. Some general information about the biota and nutrient dynamics is available as a result of survey work undertaken during the late 1970's and 1980's by the CSIRO's Division of Fisheries and Oceanography. Much of this work has been reviewed by Holloway et al. (1985).

The continental shelf forms a relatively productive trawl fishing area which has produced substantial quantities of demersal fishes (Sainsbury, 1979). This fish community is supported mainly by a benthic fauna of crustaceans, cephalopods and small fish which live within a structural habitat formed by a sparse community of sponges, soft corals, sea pens and gorgonians (Holloway et al., 1985). The main nutrient source for the outer shelf fishery is a summer upwelling of nitrate-rich deep water (Holloway et al., 1985).

### 6.3.2.3 Inner shelf

The principal habitats on the inner Rowley Shelf are:

- o intertidal flats;
- o sand beaches;
- o intertidal limestone platforms;
- o subtidal limestone pavement and platform;
- o coral reefs; and
- o subtidal gravel, sand and silt sheets and shoals.

The following sections provide summary descriptions of these habitats in the vicinity of the proposed pipeline route, and a generalised schematic diagram showing the regional distribution of the above habitats is shown in Figure 4.3. More detailed descriptions of the various marine habitats (including the biota they support) are given in Appendix 3.

**(a) Intertidal flats**

Between Tubridgi Point and Onslow, salt flats occur extensively in the upper intertidal zone behind the mainland beaches and barrier dunes. The salt flats support halophytic shrubs and leathery blue-green algal mats. Between mean sea level and the mean high water springs mark, the intertidal flats also support mangroves.

The mainland mangrove assemblages are important habitats for several reasons. For example, they provide regionally important sources of shelter and food for a range of marine organisms including prawns which are commercially-fished in Exmouth Gulf and near Onslow, and the mangroves also form important shoreline stabilisers and buffers to storm surge.

Mangroves between Tubridgi Point and Onslow are confined to the Ashburton River delta and to the edges of six small tidal creek systems (from Urala Creek in the west to Beadon Creek in the east). The most extensive and diverse mangrove stands are at the Ashburton delta, where six mangrove species were recorded during a recent survey (LEC, 1991b). The closest mangroves to the pipeline route line the banks of a small, un-named tidal creek behind Rocky Point (approximately 1 km north-east of the shoreline crossing; Fig. 4.3).

**(b) Sand beaches**

Beaches of coarse to medium carbonate sands are common on most offshore islands and along much of the mainland shore between Tubridgi Point and Onslow. These shorelines are dynamic and subject to strong erosional and depositional processes.

# 6. DESCRIPTION OF ENVIRONMENT

## 6.1 Available Information

A substantial amount of marine environmental information has been obtained from the inner Rowley Shelf region in recent years as a result of increasing oil industry activity in the area. This information was recently synthesised and reviewed by LeProvost & Gordon (1991), and general descriptive information has been accessed from this publication. Information on the marine environment more specific to the present project has come from previous reports produced by LEC for West Australian Petroleum Pty Ltd (WAPET) which are now in the public domain. These reports include:

- o Saladin Oilfield Development, Environmental Review and Management Programme - February 1987;
- o Roller Oilfield Development, Consultative Environmental Review - April 1991; and
- o Permit Area TP/3 Part 1: Five Year Drilling Programme, Consultative Environmental Review - May 1991.

Information has also been obtained from other reports produced by LEC for WAPET. Approval from WAPET to access this information is gratefully acknowledged.

Oceanographic information for the offshore area has been obtained from oil spill trajectory studies commissioned by BHPP (Steedman Science & Engineering, 1992). Pertinent information on the seafloor survey commissioned by BHPP for the proposed gas pipeline development has been summarised from Appendix 3.

Much of the information on the onshore environment has been obtained from the CER of the Tubridgi Gas Field at Onslow, the environmental sections of which were prepared by Astron Engineering on behalf of Doral. Data has also been collected from field studies of the shore crossing component of the pipeline route (between the high tide mark and the Tubridgi Gas Field) commissioned by Doral and BHPP. These are as follows:

- o a description of existing flora and fauna along the proposed onshore Griffin gas pipeline route (Appendix 4);
- o a summary of terrestrial surveys and description of pipeline routing between the plant site and the coast (Appendix 5);
- o an archaeological recording and salvage programme at Tubridgi near Onslow, Western Australia; and
- o dune rehabilitation (Appendix 6), geotechnical and flooding reports.

The macrobiota inhabiting these beaches are sparse, but the beaches are used by birds for loafing, foraging and, for some species, nesting. Many of the island beaches are also used by turtles for nesting. In spring and early summer, turtles congregate near favoured breeding areas including Thevenard Island, Serrurier Island and the Muiron Islands. Nesting commences in early summer and continues through to mid summer. Hatchlings generally appear during late summer and autumn. The beaches are little used by turtles during winter.

**(c) Intertidal limestone platforms**

Intertidal limestone platforms occupying most of the low intertidal zone (from mean sea level to the low tide mark) surround most sand beaches of offshore islands, but form a relatively minor component of the mainland coastline (Fig. 4.3). The closest intertidal platform to the pipeline route is at Rocky Point (approximately 1 km to the north-east; cf. Figs 4.3-4.4).

A range of biota is distributed over the platform according to its height and exposure with respect to sea level, and to other factors affecting dampness such as shading and the presence of rock pools. The distribution of organisms across the intertidal platforms is described in Appendix 3.

**(d) Subtidal limestone pavement and platform**

Limestone pavement areas are typically flat and, depending on location, are either bare or veneered by silts or thin sheets of sands of variable thickness and extent. Subtidal limestone platform areas have a higher relief (typically 1-2 m) and contain ledges, overhangs and other broken areas which provide a generally more diverse habitat. Taller outcrops of limestone form small, isolated 'pinnacle reefs' that can rise some 5 m from the surrounding seafloor (e.g. Santo Rock; Fig. 4.3).

Wide and occasionally extensive areas of very shallow subtidal limestone pavement form offshore extensions to the low intertidal platforms around many islands. The outer edges of these areas are usually marked by the point where the water consistently attains depths 1 m or more below chart datum, and where coral cover suddenly increases to between 30% and 80%, forming a fringing coral reef (Section 6.3.2.3(e)). Beyond the line of coral reef (which includes isolated patch reefs and 'bommies'), the subtidal pavement in offshore areas is either colonised by various macroalgal, gorgonians and occasional corals or by seagrasses and calcareous green algae, depending on the presence of sand veneers.

Where sand veneers are absent or thin and patchy, the limestone pavement is colonised by a variety of calcareous and foliose macroalgae and by sessile animals including sponges, soft and hard corals, ascidians and bryozoans.

The most extensive macroalgae meadows occur on shallow subtidal pavement areas (~5 m deep) such as those surrounding the larger islands and shoal areas located 15 km or more offshore (e.g. off Thevenard and Serrurier Islands). Where the sand veneers are thicker and sufficiently persistent, seagrass meadows also occur. The various shallow subtidal algal and seagrass meadows in these well-illuminated offshore areas (where water clarity is relatively high) are productive and provide important feeding grounds for turtles and dugongs. In deeper areas (> 10 m), macroalgal and seagrass coverage is lower.

In nearshore areas, outcrops of limestone in the form of raised platform or 'pinnacle reef' up to 5 m high occur to produce 'Patch' and 'Shoal' areas such as the Baylis Patches, Locker Reef, East Locker Patch, Santo Rock and Roller Shoal. These isolated subtidal structures are veneered by sandy silts and colonised by varying amounts of turfing algae, sponges and both soft and hard corals.

Close to the mainland shore where waters are frequently very turbid, shallow subtidal limestone platform areas such as those near Tubridgi Point and Urala Station have thick silty veneers and are colonised by varying proportions of sponges, turfing algae, bryozoans and both soft and hard corals. Hard corals occur only on the topmost parts of these platforms, where they presumably rely on wave action at low tides to prevent smothering by silts. The inshore platform areas are typically small and discrete, and either merge or abruptly terminate beside thick veneers of silty sands.

Figure 4.3 shows that across the inner Rowley Shelf, the sand veneered and bare limestone habitats at depths between 30 m and 8 m will be traversed by approximately 8.5 km of the proposed gas pipeline. In shallower areas, isolated outcrops of limestone platform close to the mainland beach lie close to the preferred pipeline route.

**(e) Coral reef**

Coral reefs comprise diverse and productive shallow water ecosystems that provide food and shelter for a wide range of marine organisms, including numerous representatives of the sponges, cnidarians, crustaceans, molluscs, echinoderms and fishes. Most coral spawning is synchronised and occurs over short and predictable periods in late summer (Simpson 1985; 1991). Apart from their ecological importance in providing a complex structural habitat and food source utilised by a wide range of biota, coral reefs are also important for tourism, and also act as nursery areas for several commercial and recreational fish species.

The high diversity which characterises coral reefs results from the wide range of periodic and episodic disturbances which affect the coral community at different scales in time and space. Apart from changes brought about by recruitment fluctuations, competition for space and mortality, coral monitoring in the region since 1985 has found that natural disturbances to coral colonies include periodic catastrophic events such as wave and suspended sediment damage during cyclones, episodic incidents of large numbers of coral-eating predators (e.g. the gastropod snail *Drupella*), bleaching events (most common in later summer when water temperatures are high), major discharges of silt-laden freshwater from the Ashburton River, and localised oxygen depletion events when slicks of coral spawn lie over a coral reef during periods of calm.

Figure 4.3 shows the distribution of coral reefs in the region of the development. These areas are where hard coral is a predominant component of the seafloor substrate and coverage exceeds 25%.

Most of the coral reefs in the region occur near the islands most of which are at least partially, if not almost completely, encircled by fringing coral reef (Fig. 4.3). These reefs typically span an area where water depth declines from 1 m to 5 m or more below chart datum, and where coverage by hard coral frequently exceeds 30%. The largest area of almost continuous coral reef lies along the south side of Thevenard Island (Fig. 4.3).

In nearshore waters less than 7 km from the coast, recent surveys commissioned by WAPET (LEC, 1991; 1992) found that the most developed and extensive occurrences of hard coral are at Ward Reef near Onslow and on the shallowest parts of Roller Shoal (north of the Ashburton River; Fig. 4.3). The seafloor survey commissioned by BHPP found similar, though less extensive, hard coral development at Locker Reef and the Baylis Patches (Fig. 4.3 and Appendix 3).

No major coral reefs occur along the mainland coastline between Tubridgi Point and Onslow, a feature probably related to the turbidity of the inshore waters and the amount of silty sediments originating from the Ashburton River delta. However, isolated outcrops of shallow subtidal limestone platforms where hard coral coverage exceeds 25% are present close to the mainland shore west of Locker Point and near Urala Station (Fig. 4.3 and Appendix 3). The latter comprise the only case where 'coral reef' lies closer than 1.2 km to the preferred pipeline route.

**(f) Subtidal gravel, sand and silt sheets and shoals**

In the nearshore region surrounding the Ashburton River delta, the seafloor is presently characterised by an extensive sheet of soft, red/brown silts and clays (Fig. 4.3). These sediments originate from the Ashburton River, which had been flowing almost continuously since February 1992 owing to unusually high amounts of rainfall in the Pilbara from late summer to winter 1992. Long red plumes of fine sediments extending from the Ashburton River delta have been occurring virtually on a daily basis (Appendix 3).

Beyond the apron of red silts and clays surrounding the Ashburton River, much of the seafloor near the mainland coast comprises thick (> 1 m) sheets of dark to light brown silty sands and gravelly shoals which overlay calcarenite limestone. These form the dominant seafloor habitat in the nearshore area south of Round Island, Tortoise Island and Ashburton Island (Fig. 4.3). Distinct shoaling areas where the more gravelly sediments prevail include Manicom Bank, Tongue Shoals and South West Patch (Fig. 4.3).

The nearshore subtidal sediment sheets are regularly trawled for prawns and are colonised by a relatively sparse epibenthic fauna. Beds of macroalgal and seagrass meadows are absent owing to high water turbidities, and frequent sediment reworking by spring tidal currents, storms and trawling.

Further offshore, and where depths approach 10 m, both the thick sediment sheets and the veneers which cover limestone pavement are dominated by white medium and coarse grained carbonate sands. These habitats also occur in much of the shallow area between Serrurier and Bessieres Islands, and in the shallower areas north-west and west of Ashburton Island (Fig. 4.3). In May 1992, both the sand sheets and veneered pavement were colonised by patchy meadows of seagrass (mainly *Halophila ovalis* and *Halophila spinulosa*), with substrate coverage ranging from <1% to 50% (Appendix 3). The *Halophila* meadows may function as important food sources for dugongs, but their significance as potential feeding areas for turtles is less certain.

Figure 4.3 indicates that the preferred pipeline route will traverse approximately 15 km of the silty nearshore sediment sheets and approximately 8 km of the thick sheets of carbonate sands which occur further offshore.

## 6.4 Terrestrial Environment

### 6.4.1 Physical Environment

#### 6.4.1.1 Land form and topography

The pipeline route is contained within the Coastal Plain geomorphic province (Payne et al., 1988) which extends inland from the coast for about 90 km. It is characterised by broad alluvial plains associated with the Ashburton River, extensive sandy plains, claypans, and circular grassy depressions with inland dunes. Saline mud flats and tidal creeks characterise the coastal area, which also has substantial units of sand plains and linear dunes. Further inland, numerous shallow waterways flow toward the Ashburton River which appears to have changed its course a number of times. No tributaries of any consequence flow into the Ashburton in this region. Relief along the proposed pipeline is subdued with few hills rising above an elevation of 100 m. Ground levels at the southern end of the pipeline average approximately 50 m. The plain has a gradual downward incline toward the coast, with elevations in the range of 5 to 10 m several kilometres inland.

#### 6.4.1.2 Geology

The pipeline route is generally located in areas containing sediments of the Quaternary Period, (Worley Engineering, 1990). The general geology of the area is well known, most having been mapped at 1:250,000 scale with explanatory notes. (Van de Graff et al., 1980, 1982). Quaternary alluvium, colluvium and aeolian sand covers most of the area, though several outcrops of lower cretaceous sedimentary rocks and Proterozoic granite and metamorphic rocks occur in isolated areas. Investigations for the Tubridgi Gas Project (Soil and Rock Engineering Pty. Ltd., 1990), revealed the following geological units:

(i) Sand dunes and residual sand plains (comprising quartz sand);
(ii) Clay pans with sand dunes (comprising clay, silt, sand and gravel);
(iii) Alluvial materials (comprising clay, silt, sand and gravel partly calcreted);
(iv) Colluvium materials (comprising poorly sorted clay, silt, sand and gravel).

Near the site of the river crossing some rock, comprising sandstone/siltstone and granule conglomerate materials of the Nanutarra Formation has been observed in the river bed.

### 6.4.2 Biological Environment

#### 6.4.2.1 Regional perspective - flora and fauna

The vegetation that occurs along the proposed pipeline route belongs to the Carnarvon Botanical District, one of the naturally occurring subdivisions of the vast phytogeographical region referred to as the Eremaean Botanical Province (Beard, 1975). The area is semi-arid and the vegetation is eremaean in character reflecting the harshness of its environment. Vegetation cover along the pipeline route is moderate; density and species diversification varies with differing topography. It is well adapted to local conditions, but vulnerable to disturbance.

Native fauna in the area is poorly documented. A relatively small range of ecosystems occur within the zoogeographical region known as the Eyrean Zoogeographic Zone (Serventy & Whitell, 1976). It is through this zoogeographic zone that the pipeline route will run. Fauna in the region tend to be hardy and well adapted to the arid conditions. The larger species are generally nomadic, following food and water sources as necessary, therefore population numbers vary. Other species, especially frogs, reptiles and snails have the ability to aestivate. Pastoral areas along the proposed route provide windmills and bores to support more water-reliant species, as does the close proximity of the Ashburton River. Despite baiting and various other eradication programs, feral cats, donkeys and foxes all compete with native fauna populations in the area.

#### 6.4.2.2 Physiographic vegetation units specific to the pipeline route

Topography dictates dominant species, and although species diversification is not great for the entire pipeline route, ten significant physiographic vegetation units have been identified for this report. These are:

1. coastal dunes;
2. saline flats;
3. sand plains;
4. circular depressions;
5. low lying plains and depressions;
6. alluvial plains;
7. stony drainage area;
8. river;
9. grasslands parallel to the river; and
10. inland dunes.

These units are described in full in Appendix 4. A general description of the entire route follows.

Coastal dunes in the vicinity of the proposed pipeline crossing are dominated by *Acacia coriacea*, over hummock grassland of frequent *Spinifex longifolius* and *Triodia pungens*. Shifting sands on the fore and secondary dunes have resulted in occasional occurrence of these species, however, they are found in abundance in the interdunal swales, along with *Acacia translucens*, and the rare and endemic *Stemodia sp. "Onslow"* (W.H. Barker).

The salt tolerant *Halosarcia* species dominate saline flats.

The Triodia species, chiefly *T. pungens*, *T. lanigera*. *T. wiseana* and *T. angusta* dominate grass cover for the entire area. There is an abundance of the introduced fodder species, Buffel Grass, *Cenchrus ciliaris*, especially in close vicinity to the river. *Eriachne benthamii* and *Eragrostis setifolia* dominate glazed claypans and the salt tolerant Sea couch, *Sporobolus virginicus*, the saline flats.

Middle storey species include *Senna artemisioides* subsp. *oligophylla, Scaevola spinescens*, and *Rhagodia eremaea* with occasional *Enchylaena tomentosa. Acacia translucens* and *Pityrodia paniculata* are common on inland sand dunes.

The Acacia species dominate the middle upper storey with *Acacia synchronicia* being most widespread in the area, along with abundant *A. tetragonaphylla* and *A. farnesiana*. Towards the river, *A. trachycarpa* and *A. coriacea* are more common. Groves of *A. xiphophylla* occur, especially on bare areas with stony mantle along, the entire route.

The upper storey consists of scattered Coolibahs, *Eucalyptus coolibah*, found 25 km inland from the coast along the pipeline route. Often dwarfed in claypan areas, they become tall and dense along the river and water courses. The banks of the river also support tall River Red Gum, *Eucalyptus camaldulensis*, and Cajeput, *Melaleuca leucodendron*.

An Acacia species uncommon in this area, *Acacia pachyacra*, occurs rarely in the claypans. This species is more common in southern areas and it is theorised that it has arrived here with shifting sands.

Although the vegetation appears harsh and well adapted, it is in fact very fragile and vulnerable to disturbance. After disturbance ephemeral and annual colonising species rapidly establish. However, years are needed before perennial plants, which are the more deep rooted soil stabilisers, establish and mature. Lack of vegetation with substantial root material causes erosion and soil loss, therefore it is imperative that it remains as undisturbed as possible.

A vegetation species list is given in Appendix 4 of this report.

### 6.4.2.3 Fauna along proposed pipeline route

The natural ecosystems along the proposed pipeline route have been somewhat degraded by introduced grazing animals, both domestic and feral.
Animals native to the pipeline vicinity include the Red Kangaroo, Emu, Common Wallaroo and various species of Antechinus. The Pebble Mound Mouse (*Pseudomys chapmanii*), has been recorded in stony areas in the vicinity of the southern area of the pipeline route. The Spinifex Hopping Mouse has been observed by landholders and it is likely that other rodents are common.

Forty-seven bird species have been identified in the area of the pipeline route over the past two years (see Appendix 4 of this report). The proximity of permanent water in the Ashburton River ensures the number of species will be much higher.

At least 60 species of reptiles have been recorded in the area. Faunal lists are included in Appendix 4 to this report.

### 6.4.2.4 Rare and endangered flora and fauna

At the area of the pipeline beach crossing, a new plant species has been recently discovered (Astron Engineering, 1992a). Found in the interdunal swales bordering areas where fresh water surfaces after heavy rainfall, the provisionally named *Stemodia sp. "Onslow"* (W.H. Barker 2145), was identified during field research for this document. The species is currently being described, but until further research is done on the extent of its occurrence, it is to be considered as a rare species (pers. comm. W R Barker, Senior Botanist, State Herbarium of Adelaide). The extent of its occurrence in the area of the pipeline route has been mapped (see Fig. 6.6).

When the vegetation survey was carried out two years ago for Doral, an Acacia species, then described as *Acacia victoriae*, was found to be frequent along the route. Since then, further research has been carried out on this species and it has now been subdivided into five new species (Maslin, 1992). One, *Acacia glaucocaesia*, is presently classified under the Western Australian Wildlife Act as being "rare". It has previously been collected in the area, and it is possible that the plant previously described as *A. victoriae* may include the rare *A. glaucocaesia*. Attempts to carry out a further survey to confirm for the purpose of this CER, whether this is so have been unsuccessful due to extensive water crossing the pipeline route making it impassable.

Fauna in the area of the pipeline route is poorly documented and research data is scarce. There are currently no species of vertebrate fauna known to be exclusive to the pipeline route, but recently there have been recordings of the rare or endangered *Pseudomys chapmanii*, the Pebble Mound Mouse, in the vicinity of the southern portion of the route.

#### 6.4.2.5 Noxious weeds

Mesquite, *Prosopis* sp., occurs on coastal dunes and berms in very close proximity to the proposed pipeline route. Some trees have obviously been treated, others have not.

## 6.5 Social Environment

### 6.5.1 Land Use and Tenure

The pipeline route covers four pastoral leases: Urala, Minderoo, Yanrey and Nanutarra.

Urala Station homestead is located 55 km by road from Onslow. The station covers some 56,000 ha and fronts the coast. The mouth of the Ashburton River is located in the north-west of the station near the old Onslow township. Urala has common boundaries with Minderoo and Koordarrie stations.

The landscape consists of broad, gently undulating sand plain, low lying sand plain, sand dunes, clay pans, bare saline mud flats and tidal creeks with dense fringing mangrove communities.

The major portion of the pipeline crosses through Minderoo Station. Minderoo homestead is located 45 km south by road from Onslow. The station has common boundaries with Peedamulla, Mt. Minnie, Nanutarra, Yanrey, Koordarrie and Urala Stations. The entire area of the station is some 225,000 ha. The station flanks both sides of the Ashburton River which runs for about 80 km in a north-north-west direction through the centre of the property. Landforms consist of broad alluvial plains associated with the Ashburton River and sandy coastal plains and dunes. The station is used for grazing livestock.

Only a small portion of the pipeline route passes through Yanrey Station. The pipeline terminates at Compressor Station 2 on Nanutarra Station. Nanutarra homestead is situated close to the North West Coastal Highway where it crosses the Ashburton River, about 379 km north of Carnarvon. The entire area of the station is some 369,000 ha.

### 6.5.2 Aboriginal History and Significance

Aboriginal occupation of the Onslow area probably dates from more than 40,000 years before present (White & O'Connel, 1982). In a survey of the aboriginal 'tribes' of Australia, Tindale (1974) identified the people residing throughout the area of the present survey as belonging to a group known as Talandji. The Talandji people no longer reside in their traditional territory, but live in the larger settlement areas of Roebourne, Carnarvon and Onslow.

Knowledge of the importance of certain places on the stations has, nevertheless, been passed down and traditional knowledge remains strong. Aboriginal people still continue to visit the country, engaging in hunting and other activities. The Ashburton River has special significance to the Talandji. There is a close association between aboriginal people and water courses throughout the Pilbara and this is especially so for the Talandji, whose land is centred on the Ashburton.

### 6.5.3 History of the Ashburton Coastal Region

#### 6.5.3.1 Minderoo and the opening up of the Ashburton

In 1861 Francis Thomas Gregory and his party set out to explore the North-West of Western Australia. On June 22, 1861 he discovered and named the Ashburton River, "after the noble President of the Royal Geographical Society". He described the point at which he crossed the river as "a fine open level valley", yielding "abundant grass" through which the river was "running gently".

Upon receiving Gregory's favourable reports about grazing land in the north-west, Walter Padbury, a WA grazier and one who had helped finance Gregory's expedition, applied to the government for concession to occupy these lands. He obtained the first pastoral lease to be granted in 1864 and was the first to set forth, moving quickly to occupy the best land. He finally chose the De Grey River area. In his wake, others followed.

The Ashburton was re-surveyed in 1878 by John and Alexander Forrest. They leased a large property lying either side of the Ashburton River. It was named Minderoo and is still known as such to this day. The Forrest family agreed that the younger son, David, should be responsible for its management. He arrived at Minderoo in 1878 to become founder of a pastoral dynasty that continues to this day. The present homestead is the original one, and the Forrest family continue to occupy the land.

#### 6.5.3.2 Onslow

Many attribute the idea of a port at the mouth of the Ashburton to David Forrest. Whether this was the case or not, it was becoming very evident that the Ashburton District - the greatest sheep raising and wool producing portion of WA at that time - desperately needed a port facility. In 1885 Onslow was first surveyed by Beasley and the existing riverside wharf was improved. This still proved insufficient to meet the growing demands of the Ashburton which was producing wool, pearl shell, sandalwood and tortoise shell, as well as the products of a growing mining industry. Many attempts were made to improve the wharf, only to be continually frustrated by regular cyclones and other problems.

Further difficulties were to ensue. Overgrazing of land in the Ashburton catchment had caused great depositions of silt in the river which, over the years, resulted in a bar forming across the river mouth. This made it unsuitable for most vessels. A new sea jetty was therefore constructed in July 1896 but by December 1897 it had been destroyed by a cyclone. It was rebuilt, only to prove unsatisfactory. Between 1910 and 1920 the area suffered 4 years of drought, extreme cyclones and the effects of the Great War. It became obvious that a new jetty needed to be positioned at a deep water location.

In April 1922, a contract for a new jetty went out to tender. It was built 14 miles up the coast in an easterly direction from Old Onslow, at Beadon Point. This decision inevitably meant that the little town of Onslow had to move - a process which took approximately 7 years. In May 1925 the jetty was formally opened. The old township was finally reverted to the Crown in 1976, 51 years after the new jetty at Beadon Point had been opened.

#### 6.5.3.3 Urala

In 1912 at the height of the drought when prices were low, a Mr James Clark, ships engineer, lighterman, and well known merchant in Onslow, took over a lease known as Glenroy, west of the river mouth. In the same year, a weir near a concrete crossing leading to the station, was built. It was designed to keep back salt seawater which would otherwise, when the river was low, turn the water upstream brackish. In 1920 Kilda Clark bought Glenroy from his father James, paid for, it is rumoured, out of his Returned Servicemans Grant. The well known merchants and carpenters, the Hooley Brothers built a new homestead at Glenroy for Kilda Clark in 1928. The station appears to have changed hands several times.

In 1965 the West Pilbara Shire agreed to lease the 1,700 acres of Old Onslow to Fred Lacey, who had taken over Glenroy station the previous year. The name appears to have changed from Glenroy to Urala at this time. Between Mr Lacey's occupation and that of the present lessees, a Peter Collins also occupied Urala Station.

### 6.5.4 Population Centres and Regional Economy

The nearest population centre to the gas pipeline is the town of Onslow located some 55 km by road to the east. The next nearest centre is Exmouth, which is 90 km directly across the Exmouth Gulf to the west. Onslow was established in 1884 to service the pastoral, pearling and mining industries of the Ashburton District. These industries declined during the first half of this century, but in 1963 WAPET discovered oil on Barrow Island and established a jetty and supply base at Onslow to service this oilfield.

Subsequent offshore and onshore oil exploration during the 1980s resulted in the discovery and development of a number of oil and gas fields in the region. As a result the town of Onslow, via its tidal port at Beadon Creek and nearby airfield has become a supply base for servicing some of these developments, including the major Saladin oilfield at Thevenard Island.

The present population of Onslow is approximately 700 people, a number that increases to about 1,500 in winter as a result of the tourist influx. Tourism has assumed increasing importance to the town's economy in recent years largely as result of the sealing of the North West Coastal Highway and the Onslow access road. Most tourists are attracted primarily by the recreational fishing opportunities both offshore and along the coast.

The main tourist season has traditionally been limited to the April-November period by the summer cyclone season, although the game fishing season extends from late October to early February. Tourist facilities located on offshore islands include eight units on Thevenard Island, one rental A-frame cottage on Direction Island, and a leasehold arrangement with the Department of Conservation and Land Management (CALM) allowing a maximum of eight people to camp on Serrurier (Long) Island at any one time.

Onslow provides a base for a small commercial fishing fleet of prawn trawlers and wet line and trap fishing boats. Fishing charters to the offshore islands and waters also operate from the port. Conditional environmental approval has recently been granted by the EPA for a proposal to construct a solar salt project at Onslow (EPA, 1991). If the plan proceeds, this project would lead to a significant increase in the town's permanent population. On the basis of the available information (Gulf Holdings Pty Ltd, 1990) the solar salt project is not anticipated to impact on this proposal.

Exmouth is the largest town in the region, having a resident population of approximately 2,500 (SPC, 1988). The town was established in 1963 as a support base for the United States Navy Communications Station on North West Cape. Future population levels are likely to decline with the withdrawal of the United States navy personnel. Exmouth is now a major tourist centre and base for the large Exmouth Gulf prawn fishery. Further detail regarding the economy of the region is provided in subsequent sections.

### 6.5.5 Petroleum Industry

The past decade has seen a substantial increase in oil industry activity in the region. Several oil companies have conducted extensive seismic surveys and exploration drilling programmes. Further exploratory drilling activities are forecast since the potential for future discoveries of economically recoverable reserves is considered high.

Offshore developments are:

- o the island-based Barrow Island oilfield operated by WAPET
- o the Saladin, Cowle and Yammaderry oilfields which are linked by subsea pipelines to treatment and storage facilities on Thevenard Island,
- o the North-Herald, South Pepper and Chervil fields operated by Western Mining Corporation, and

- the Harriet field operated by Hadson Energy Limited. Hadson has recently commenced gas production from offshore gas fields which are linked to the Dampier-Perth gas pipeline by a subsea gas pipeline running from the Lowendal Islands.

WAPET has also recently announced plans to develop the Roller oilfield using its facilities at Thevenard Island.

Onshore, the Tubridgi gas field development operated by Doral has now been operating for nearly two years. The Tubridgi area was first explored in 1966 by West Australian Petroleum (WAPET), when it drilled the Wildcat Onslow-1 (Thompson, 1992). Fluorescence and gas shows were observed and this, with more recent seismic data, convinced a consortium led by Pan Pacific Petroleum to drill the Tubridgi 1 Well in June 1981. This hole encountered gas and six more appraisal wells were drilled that year. Development was, however, delayed by the fields remote location and even after construction of the Dampier to Perth gas pipeline, a gas surplus denied new markets. A perceived market opportunity occurred in 1989, however, and an agreement was made to supply SECWA, was signed in early 1990. Development of the field then began in earnest, with the joint venture being headed by Doral. Two more appraisal wells were drilled and environmental approvals were obtained later in 1990. Construction of a processing plant and pipeline began in 1991 and gas sales commenced in September of that year. Field life is expected to be ten years.

### 6.5.6 Commercial Fisheries

A number of commercial fisheries operate throughout the region (Jones, 1986). These are:

- the North West slope trawl fishery (12 boats) - operating in deep waters (300-550 m) on the outer continental shelf for scampi and deep water prawns. Boats are based at Learmonth and Dampier;

- the Exmouth Gulf prawn fishery - operating some 17-20 boats in the Gulf between 1 March and 15 November each year. This fishery is also based at Learmonth;

- the smaller Onslow-based prawn fishery - presently operating four boats which utilise mainly nearshore waters off Onslow on an exclusive basis between 2 April and 5 November each year;

- the Pilbara Coast line and trap fishery - comprising up to 40 fishing boats which are mainly active in deeper offshore waters along the edge of the Rowley Shelf. Mostly reef fish plus pelagic schooling fish such as spanish mackerel and queenfish are taken;

- the Pilbara Coast shoreline net fishery - presently comprising only three units which have access to most of the Pilbara coastline; and

- pearl culture leases - four of these are present in the region. Two operations are based at the southern end of Exmouth Gulf, whilst the other two are based immediately east of Onslow.

All the above fisheries are managed by the Western Australian Department of Fisheries through a system of licences, catch and equipment regulations and use of delineated fishing areas (Fig. 5.2).

The fishery potentially most affected by the proposed gas pipeline is the Onslow prawn fishery, which became a limited area fishery with three delineated areas in 1989. The nearshore Area 1 parallels the mainland coastline westward from its western boundary to near Locker Island (Fig. 6.3). Six boats were originally licensed for this area. However, since then, a licence buy-back scheme has been instigated and presently there are only four active boats.

Although the four boats are licensed to operate in two other delineated areas to the north and east of Onslow (Areas 2 and 3, which they share with trawlers operating from Learmonth and Dampier), an important part of their annual catch comprises brown tiger prawns and western king prawns obtained near the mainland coast in Area 1. While Area 1 is exclusive to the Onslow fishery, Area 2 is trawled by up to 19 licensed vessels and the large Area 3 (most of which lies to the east of Barrow Island) is fished by up to 14 licensed boats.

During a typical season the bulk of the prawn catch is taken during the first four months. Fewer prawns are caught during winter as the cooler water temperatures cause the prawns to become less active and consequently harder to catch. A second peak in catch rate occurs during October when water temperatures begin to increase. The Onslow fishery has traditionally targeted mainly brown tiger prawns from Area 1, and which accounted for nearly 60% of the Area 1 catch in 1989. The western king prawn makes up the bulk of the remainder of the catch. The total landed catch for Area 1 in 1990 was 59 tonnes, up 73% from the 1989 catch of 34 tonnes (Fisheries Department, 1991).

### 6.5.7 Conservation Values and Human Uses

The gas pipeline will span both Commonwealth and State waters. The boundary to the Western Australian State Territorial Waters lies approximately 30 km south-east of the Griffin oilfields area. Waters in the immediate vicinity of the oilfields are not heavily used, with occasional coastal shipping movements to or from northern Australian ports passing within 25 km of the proposed FPSO.

Closer to the mainland coast, the inner Rowley Shelf area cannot strictly be considered as 'pristine' owing to petroleum exploration and production activities, commercial prawn trawling and fishing activities, tourism and recreational fishing and diving activities centred at Exmouth, Onslow and Thevenard Islands, and regular chartered and private boating trips to other offshore islands such as Serrurier and Direction Islands. Petroleum industry infrastructure has also reduced the visual aesthetics and 'wilderness value' of some parts of the region.

Nevertheless, there is no evidence to suggest that key benthic and pelagic ecosystems have been lost or markedly degraded, and these continue to provide or support important marine resources of state, national and/or international significance. The importance of the inner shelf region has been recognised by the National Estate and Heritage Commission, which nominated the area covered by the Exmouth Gulf and the Rowley Shelf islands as significant at the State/Territory level. The National Estate Register (21 July 1983) number is 05/08/190/004/01.

Important wildlife resources in the area include seabird nesting areas, turtle nesting beaches, dugong feeding and breeding areas, fish and prawn nurseries, mangrove and tidal flats, coral reefs and other shallow water areas where primary production and/or diversity is high (Fig. 6.2). Humpback whales pass along the edge of the Rowley Shelf during their migration south to Antarctica in spring, and north to the tropics in early winter. Their migration path takes them north past the Montebello Islands from where they disperse, with some moving back towards the mainland coast in the general vicinity of Dampier, and others taking a more easterly course towards the coastline at Broome. West of the project area, whale sharks are known to congregate along the Ningaloo Reef tract during autumn, and particularly during the coral spawning season.

The National Estate Register also recognises that human use requirements, apart from oil exploration and production, include:

- o commercial and recreational fishing,
- o tourism,
- o shell collecting,
- o other water-based recreational activities, and
- o protection of historic shipwrecks (Fig. 6.4).

In 1975 the EPA, through its Conservation Through Reserves Committee (EPA, 1975), recommended that the area of Exmouth Gulf to Cape Keraudren be reserved as a nursery area in order to prevent unsupervised or unapproved destruction of mangroves in the region (EPA, 1975; Sections 8.7 and 9.8). It further recommended that the offshore islands be proclaimed as A-class reserves for the purpose of conservation of flora and fauna, or B-class reserves for the purpose of recreation and conservation of flora (Fig. 6.2). Most of the larger islands (Muiron, Serrurier and Thevenard Islands) are presently C-class reserves, while the smaller islands remain Vacant Crown Land. Presently, Barrow Island and Locker Island are A-class reserves vested with the National Parks and Nature Conservation Authority for conservation of flora and fauna (Fig. 6.2).

In 1984, the EPA (then the Department of Conservation and Environment) delineated geographic areas of the Western Australian coast based on their biological sensitivity to oil spills (Jones et al., 1984). In this scheme, the shallow waters of the inner Rowley Shelf adjacent to the Griffin oilfields have been designated a Special Protection Locality (SPL) due to the significant marine life they support (Fig. 1.3). The Griffin oilfields themselves are located within a Special Conditions Zone established as an outer 'buffer' to the SPL. Within this zone, the use of dispersants to combat oil spills is acceptable and recommended, whereas their use inside the boundary of the SPL requires approval from the EPA (Jones et al., 1984).

The EPA also administers the discharge of wastes in State waters via a pollution control licensing system. This is linked to published water quality criteria for recognised 'Beneficial Uses' of Western Australia's marine and estuarine waters (DCE, 1981). The Beneficial Uses and attendant schedules which apply to the waters in the region of the gas pipeline include:

- Beneficial Use 1 - Direct Contact Recreation (swimming, diving);
- Beneficial Use 2 - Harvesting of Aquatic Life (excluding molluscs) for Food (recreational and commercial fishing);
- Beneficial Use 6 - Aquaculture (pearl culture);
- Beneficial Use 8 - Maintenance and Preservation of Aquatic Ecosystems (Classes 1, 2 and 3; conservation of key marine resources and scientific and educational studies); and
- Beneficial Use 16 - Navigation and Shipping (Onslow Port and vessel movements to and from the offshore terminals at Barrow, Varanus, Thevenard and Airlie Islands; plus coastal shipping further offshore).

# 7. ENVIRONMENTAL EFFECTS

## 7.1 Overview

Environmental effects of the project can be separated into those which will occur as a result of construction and operation of the pipeline and gas plant ('actual effects'), and those which could occur ('potential effects').

### 7.1.1 Summary of Actual Effects

Actual effects arising from construction and operation of the pipeline are:

(A) Marine Environment

- o direct loss and disturbance to benthic organisms along the ~20 m wide pipelay corridor (amounting to a total area of 1.3 $km^2$ over the 65 km distance from the mainland shoreline to the FPSO);
- o temporary sediment plumes and increases in water turbidity emanating from the centre pipelay activities during the offshore installation period;
- o provision of artificial substrate and shelter where the pipeline remains unburied;
- o disposal of hydrotest waters containing residual biocide at 100 ppm (some 1850 $m^3$ at the FPSO site);
- o temporary alienation of commercial prawn trawling grounds within 1 km of the pipeline route during the construction phase; and
- o greywater (domestic) waste discharges from the pipelay vessel, tenders and other support craft.

(B) Terrestrial Environment

- o disturbance to landform and temporary loss of flora along the 60 m wide and 1.2 km long pipelay corridor from the beach to the existing Tubridgi No. 5 gas well;
- o loss of faunal habitat and associated flora at the 2.4 ha plant site;
- o disturbance to land form and temporary loss of flora which has become established along the existing easements between Tubridgi No. 5 gas well, the gas plant and the SECWA pipeline;
- o temporary discharges and emissions during the construction phase, which will include dust, vehicle and machinery fumes, light, vibration, heat, wastes, treated sewage and hydrotest water;

- emissions and discharges from gas plant operation, which will include dust, vehicle and machinery fumes, light, occasional light from flare, vibration, combustion gases, heat, various liquid and solid wastes; and

- possible dust, noise and vehicle emissions associated with the tankers collecting the LPG depending on method of LPG export used.

(C) Social Environment

- disturbance to some archaeological sites (middens) which have been identified pre-salvaged and recorded;

- temporary access limitations to pastoral activities and loss of fodder;

- population increase in area during construction period, resulting in a permanent workforce of 2 at the gas plant site;

### 7.1.2 Summary of Potential Effects

Potential effects are those which may arise during the construction and operations of the pipeline as a result of:

(A) Marine Environment

- accidental spills of fuel oil, lubricating oils or hydraulic fluid from the pipelay fleet or marinised excavator during pipeline installation;

- cyclone or storm-induced damage before pipeline stabilisation; and

- pipeline rupture.

(B) Terrestrial Environment

- accidental spill of fuel oil, lubricants or hydraulic fluid from machinery and vehicles used for construction or maintenance activities;

- fire, caused by ignition of vegetation during construction activities or following accidental ignition of gas leaks;

- erosion after extreme rainfall and flooding events;

- invasion of noxious weeds;

- damage following accidental pipeline rupture.

(C) Social Environment

- accidental damage to aboriginal sites;

- o workforce conflicts with local population;
- o accidental damage to station property.

## 7.2 Actual Effects

### 7.2.1 Marine Environment

The following section contains information obtained during the recent installation of the subsea gas pipeline for the Harriet Oilfield gas-gathering scheme. This project was managed by Hadson Energy Limited, whose permission to refer to the findings of their monitoring program is gratefully acknowledged.

#### 7.2.1.1 Construction/installation phase

The main effect of gas pipeline installation will be the temporary disturbance and loss of benthic biota within the 20 m wide pipelay corridor due to mechanical clearing and smoothing, trenching and/or other pipeline stabilisation activities. The total area occupied by the pipelay corridor amounts to 1.3 $km^2$, of which some 50% ($\sim$0.65 $km^2$) will comprise benthic habitats on the inner Rowley Shelf (i.e. from the 30 m contour to the mainland shore).

The preferred pipeline route does not traverse or pass close to productive and/or regionally-important shallow water habitats such as the fringing coral reefs and areas of shallow subtidal limestone pavement supporting algae or seagrasses. The benthic habitats which the proposed pipeline will traverse are widely distributed throughout the region, with the exception of the inshore limestone platform reef near Urala Station, of which only a few have been found between Tubridgi Point and Onslow. Further east, however, the number and extent of similar occurrences close to the mainland shore are higher (LEC, 1992), and include inshore patch reefs located near Barrigoombar Well (east of Coolgra Point).

Most of the route across the inner Rowley Shelf traverses a wide area of silty sediments where the benthic biota predominantly consists of a burrowing fauna that have the capacity to rapidly re-colonise disturbed sediments. Similarly, the small *Halophila* and *Halodule* species which make up the irregular seagrass patches on the sandy sediments further offshore, are termed 'pioneering' seagrass species because of their ability to rapidly colonise new or disturbed areas of sediment (unlike seagrasses such as *Posidonia* and *Amphibolis*). Thus wherever the pipeline is buried, the soft bottom is expected to become naturally recolonised. This is also considered the case for the deeper offshore areas lying beyond the 30 m contour.

Where the pipeline remains exposed, observations of existing subsea pipelines in the region indicate that the pipeline and pipeline corridor will be recolonised by encrusting biota, as will any concrete weights or rock armour protection of the pipeline itself. The pipeline will also form a structural habitat ('artificial reef') that will provide additional shelter, territory and feeding areas for fish.

The pipeline is likely to be colonised by a range of organisms including algae, sponges, hydrozoans, gorgonians, wing shells and other bivalve molluscs, in turn helping to attract of variety of fish. For example, the North West Shelf gas pipeline between Dampier and North Rankin has become a favoured fishing spot for local recreational fishermen.

Where the pipeline cannot be buried to achieve stabilisation, the 20 m wide pipelay corridor is planned to be cleared and smoothed mechanically without the use of explosives.

Apart from the direct effects that will occur within the pipelay corridor, the main indirect effect of pipelaying activities will be temporary and localised increases in water turbidity for variable distances downstream from trenching and pipelay activities, with the plume direction, length and width changing frequently according to tidal and wind conditions.

Recent trenching operations undertaken for the Harriet gas-gathering scheme produced visible plumes which were typically narrow and on occasion up to 1.5 km long during spring tides, or were wide and less than 0.5 km in length in neap tidal periods (Hadson Energy Limited, unpublished data). Corals and coral reef areas lying between 2 km and 200 m from pipelay activities at the Lowendal Islands were also monitored. Recent diver inspections and video tapes of the fixed monitoring transects that were installed prior to commencement of pipelaying activities have found no evidence of coral mortalities due to sediment plumes, although in some places there had been physical destruction and removal of whole corals due to Cyclone Ian (a severe tropical cyclone which passed the area in March 1992; Hadson Energy Limited, unpublished data).

The experience gained by the installation of the Harriet sales gas pipeline strongly indicates that the plumes generated by pipelaying activities will not produce major sedimentation effects or cause temporary smothering of biota other than those lying within 100 m of the pipelay corridor. The duration of plumes at any one location will be measured in days rather than weeks, and marine benthos located beyond 500 m of pipelay activities are likely to experience temporary sediment plumes which are similar or less than the suspended loads that occur naturally and regularly in the region.

In this context, biota in the region between Tubridgi Point and Onslow are frequently exposed to high turbidities and sediment re-working events produced by spring tidal currents, from periods of strong winds and cyclones, and from occasional major silt-laden discharges from the Ashburton River (Section 6; Appendix 3). Superimposed on these natural patterns are localised turbidity events produced by prawn trawling.

In the case of the isolated limestone platforms which lie close to the preferred route near the mainland shoreline, it is likely that the corals which colonise their uppermost surfaces have coped with the naturally high sedimentation regime owing to their very shallow position. Thus any sediments which may temporarily settle on the corals are regularly washed off by wave action during periods of low tide (Appendix 3).

The present sedimentation and turbidity regime in the nearshore area, coupled with the characteristics of the various types of benthic biota close to the pipeline route, suggest that localised and temporary increases in water turbidity and localised sedimentation produced by pipelaying activities will exert either minor short-term or negligible effects from which the marine ecosystem will rapidly recover. No long-term adverse impacts are anticipated.

The outer section of the offshore gas pipeline is located in an area through which humpback whales migrate and some whales may pass close to the FPSO. However, the migratory route is wide and unconfined at this point with no barrier effect apparent, and therefore no adverse effects on whale movements are expected during either the construction or operational phases. BHPP regularly records whale sightings from its facilities. The closest known occurrences of whale shark congregations occur at Ningaloo Reef, some 75 km to the west and are not expected to be affected by the project.

#### 7.2.1.2 Disposal of hydrotest waters

Immediately after pipelay activities have finished, the offshore pipeline will be hydrotested. Approximately 1850 $m^3$ of hydrotest waters will be discharged in deep water at the FPSO end of the pipeline. The capacity for rapid dilution and dispersion of the residual biocide and corrosion inhibitor is high, and any potential effects on benthic biota caused by the discharge stream or its contents will be minimised to the area immediately surrounding the pleb (Fig. 5.1).

#### 7.2.1.3 Alienation of prawn trawling ground

The preferred pipeline route passes through the western portion of the coastal trawling grounds used exclusively by the small Onslow prawn fishery (Fig. 6.3). A restriction applies to prawn fishing within 2 nautical miles (nm) off the coast from Beadon Creek between Onslow and a point 3 nm west of the Ashburton River. Thus the nearshore waters west of this point to the western boundary of Area 1 is the only nearshore waters that are open to prawn trawling.

Local fishermen consider this area to be a productive source of king and tiger prawns, and as such would prefer the pipeline to be buried or routed along the western boundary of Area 1 (D. Fenwick, pers. comm.). Further discussion has been held with representatives of this industry including WAFIC, during which the environmental, engineering and economic constraints associated with Route 2 were discussed (as well as opportunities for pipeline burial on the preferred route enabling continuation of trawling).

#### 7.2.1.4 Waste discharges from pipelay vessels

Under MARPOL 73/78 regulations administered by the Western Australian Department of Marine and Harbours and Department of Minerals and Energy (formerly the Department of Mines), any oily wastes generated onboard pipelay vessels must be stored for disposal ashore, or passed through approved oil/water separation equipment before discharge overboard.

Empty containers, plastics, metal wastes, paper and other solid materials will be stored on board for routine disposal ashore. Kitchen scraps, domestic greywater and sewage will be discharged into the ocean. These biodegradable wastes will produce negligible effects owing to their rapid dilution and dispersion in the exposed open waters of the Rowley Shelf (and the fact that the pipelay fleet will not be stationary).

### 7.2.2 Terrestrial Environment

Pipeline impacts will include disturbance of landform and flora but have negligible effect on fauna. Areas recently disturbed for the Tubridgi Gas Pipeline will be utilised as far as possible to minimise environmental impacts. Disturbance which does occur will be limited to the narrow corridor of the pipeline easement and an area around the new plant site. Landform disturbance will be short term, as recontouring to the original land profile will be carried out on completion of construction. The impact on vegetation is locally significant but the new pipe route has been chosen to minimise disturbance and avoid any rare species. Colonising annual and ephemeral species will rapidly establish on the disturbed areas as has occurred on the existing Tubridgi easement.

#### 7.2.2.1 Land disturbance

**(a) Clearing**

A right-of-way of approximately 15-20 m width will be cleared of vegetation for the pipeline. This clearing will generally occur on the previously disturbed areas of the existing Tubridgi easement, but in sections there may be a requirement to widen the cleared area on to undisturbed land. At the beach crossing area, a wider corridor will need to be cleared to allow for battering of sand inclines in the pipe trench. A cleared width of approximately 60 m is expected at the coastal dunes. Clearing will be also required at the plant site, at borrow pits (if these are required), at laydown areas and any new access tracks. The requirement for new access tracks is, however, minimal.

Clearing may be unsightly, and has the potential to cause erosion. It is, however, a short-term effect as vegetation removal will be minimised, and at the end of the construction phase regeneration will be promoted. The total amount of permanently cleared landscape which will result from the Griffin Gas Pipeline Development is expected to be less than 5 ha.

**(b) Erosion**

The most common form of erosion will be that caused by traffic on bare soils. Less common, but still significant will be soil movement caused by wind or by heavy rains. Erosion may be a particular problem along cleared slopes at waterway embankments and on the friable, clay soils of the vicinity, which tend to bulldust. Unrecognised drainage lines may also cause problems when large rainfall occurs and trapped water must cut a new channel.

Rutting of tracks is likely if they are used when wet and in such cases there is the associated temptation for operators to stray from the established road alignment to obtain firmer ground. Measures to minimise these effects are outlined in Section 8. Nevertheless, some erosion of surface soils is inevitable, particularly during trenching and earthworks. The management program includes regular inspection of the construction work to ensure that these impacts will be minimised.

**(c) Compaction**

Compaction of the soil may occur along cleared areas used for access ways. Many portions of the pipeline are positioned on sandy soils, however, and compaction in these areas will not be a problem.

**(d) Surface and groundwater sources**

A fresh water aquifer is known to exist at the beach crossing area of the pipe route. All attempts will be made to avoid this water source, but if excavation below the water table is necessary, the trench will be isolated from it.

Water may be obtained from surface water sources if these are available and the water can be safely and sensitively removed. Approval of the pastoralist and environmental consultants will be sought. Some damage to river or pool banks may occur. This damage will be rectified, by hand if necessary, and regrowth encouraged.

**(e) Excavation and backfill**

The entire pipeline is to be buried, and a trench to a depth of 1.2 m and width 600 mm will be dug along the right of way. Borrow pits may also be required, (although none were necessary for the recent Tubridgi pipeline installation), and the river crossing will require excavation. The new plant is likely to require both excavation and importation of appropriate fill material. Pipeline trench backfill will normally be excavated sub-soil. Padding material for the pipeline will be either selected trench spoil or sand obtained from the easement itself or from approved borrow pits.

Excavation and backfill work may promote erosion through the redirection of surface runoff by the trench crown or by backfill settlement along the pipe route. Erosion may also occur below the surface, in the porous trench backfill material. If the pipeline has adequate slope, an effective drain line occurs within the backfill and if water volumes are adequate and the fill is sufficiently permeable, tunnelling may occur. This is of particular concern at the excavated river crossing which will have a steep pipeline gradient on either side, but the shallow gradients elsewhere along the route make any other problems of this nature highly unlikely.

#### 7.2.2.2 Discharges

**(a) Gaseous**

Gaseous emissions which will occur may be divided into construction and operation categories. The former are generally vehicle fumes, power generation and miscellaneous equipment exhaust discharges, and purging gases. Operation emissions have been described in Section 5.5.3 above and include nitrogen, carbon dioxide, water vapour, oxygen, nitrous oxides and sulphur dioxide. Vehicle emissions whether during operation or construction phases, are small in volume and readily disperse. They are not a significant pollutant. Construction equipment will be utilised for a short time, is generally diesel driven and is consequently relatively non-polluting.

Gas flaring may occur due to an emergency shut-down but this will be a rare occurrence. Being lighter than air, product gas will dissipate rapidly into the atmosphere.

**(b) Liquid**

Liquid discharges include hydrotest water, sewage, brine and drainage sediment. These will be either transported to an acceptable disposal area, or treated on-site and safely disposed of in the area.

**(c) Dust**

Significant discharge of dust will occur throughout the construction period and particularly during all earthwork phases of the project. This is likely to be most extensive during trenching operations. Trenching will be confined to a two month period however, so the discharge will be a temporary one-off event. Vehicles and other equipment also create significant amounts of dust on the dry, clay soils of the area. Trucks bringing in pipeline supplies will cause the greatest volumes, but significant dust will be a short-term effect during the construction phase.

Dust from operations will arise from the tankers (up to three per day) collecting LPG, and any occasional pipeline maintenance and inspections of the route. Pipeline route inspections by operators will occur at approximately two monthly intervals.

**(d) Noise and vibration**

Noise and vibration will occur during construction work due to the use of heavy machinery and access vehicles. Blasting is unlikely to be required as none was required during installation of the Tubridgi Gas Pipeline. The transient nature of the work and the remoteness of the site make this a minor impact.

Noise at the plant site will occur as described in Section 5.5.6.

**(e) Light, heat and wastes**

Light and heat will occur due to the presence of plant and vehicles. As there are no photo-sensitive animal species in the area, this is not expected to cause any problems.

Various grades of wastes shall be produced, but all will be removed from the site as discussed in Section 5.5.3. Certain concrete castings left over from construction may be left for the use of the pastoralists if they so desire.

### 7.2.2.3 Biological effects

**(a) Vegetation**

Impact on the vegetation of the area will be confined to the plant site and the pipeline easement. Areas to be cleared of vegetation include the pipe route, laydown areas, camp sites, borrow pits and the plant itself. Vegetation cover in the region is generally sparse to moderate; the only dense growth being in areas of permanent or semi-permanent water and interdunal swales along the coastal strip. While permanent and semi-permanent water courses will be avoided, dunes must be crossed and vegetation there will be more significantly affected. Dune stabilisation, will therefore be addressed carefully in the Rehabilitation and Management Plan.

Experience on the Tubridgi Gas Project indicates that disturbed areas will be initially colonised by opportunistic ephemerals and annuals. It is expected that perennial species will establish themselves over a period of years, but it is unknown as to whether the original climax community will completely replicate itself. Although an area of some 200 ha will be cleared, only a small portion of this (approximately 15%) will have topsoil removed. The intent of the management plan is to remove vegetation to ground level only to allow regeneration wherever possible from root stock. As was done during construction of the original Tubridgi pipeline, larger tree and shrub species will be avoided wherever possible.

Major plant species along the pipeline route which will be affected include various species of *Acacia*, notably *Acacia coriacea* and *A. translucens* along the coastal strip, and elsewhere *A. ? synchronicia*, *A. xiphophylla*, *A. tetragonaphylla* and *A. trachycarpa*. Some *Eucalyptus coolabah* and *Grevillea* sp will be removed, but dense stands will be avoided.

Larger areas of the dominant grass species along the route, *Triodia* spp. and *Cenchrus ciliaris* will be disturbed. The latter species, being an exotic, will re-establish itself rapidly. The vulnerable and slow growing *Triodia* species, will take some years to recolonise in disturbed areas as will valuable native fodder grasses *Eriachne* and *Eragrostis* species.

Some re-contouring of the ground will be necessary as the pipe route crosses claypans and their encompassing sand hills. Removal of vegetation in such areas will be required but efforts will be made to limit this as much as possible as such areas are vulnerable to erosion when vegetation is removed. Where possible, the pipeline will be installed around sand dune contours to minimise erosion. Species affected in these areas include the samphires, *Halosarcia* spp in the saltpans, grass species *Eragrostis* spp and *Eriachne* spp. in the claypans, with *Cenchrus ciliaris*, *Triodia pungens* and the shrubs *Acacia translucens* and *A. coriacea* on the sandhills.

Where the pipe route crosses the interdunal swale which is the habitat of the currently considered rare *Stemodia* sp. *"Onslow"* (W.R. Barker), impact is more significant. The area of destroyed vegetation here will be confined as strictly as possible.

**(b) Fauna**

The major impact on fauna will be that due to habitat destruction, a result of the loss of vegetation along the pipe route and other sites. Although a significant area of habitat, (approximately 200 ha) was destroyed for the original Tubridgi Gas Project, the Griffin Project occurs largely on the previously disturbed areas. These will have been partly revegetated but the mobility of most animals means that mortality and impacts will be far less than that indicated by vegetation loss. Small animals, particularly lizards, and insects such as scorpions and centipedes will be most adversely affected but except for these, no other animals are expected to be significantly disrupted.

The presence of a workforce in the area is potentially disruptive to native fauna but strict regulations and long working hours will leave little scope for hunting or access to pristine bush areas. Firearms will be banned from construction camps.

### 7.2.3 Social Environment

#### 7.2.3.1 Impact on pastoral activities

There will be some effect on the activities of pastoralists on the pipeline route. These will be confined to the two stations (Urala and Minderoo), over which most of the pipeline runs. Impacts will include minor restriction of access during construction, a loss of land use at the pipeline easement and a temporary loss of fodder.

**(a) Access limitation**

During construction it is possible that up to 5 km of pipeline trench will remain open for as long as 2 weeks. This will require the adoption of specific measures including the use of strategically located cross-overs and breaks in the line of strung pipe to ensure access to the pastoralist is not unduly restricted and to prevent stock from being isolated from water supplies. These measures will be taken in consultation with the pastoralists.

**(b) Loss of natural feed**

The arid nature of the land and the size of the stations means that temporary loss of fodder due to vegetation clearing is a minor restriction. The greatest loss will occur at Minderoo, which is crossed by 74 km of pipeline. This will involve a loss of 120 ha or 0.05% of the pastoral land available. Much of this land has already been disturbed, for the Tubridgi Pipeline. Further loss of feed is therefore marginal only and of negligible impact on the station.

As is evidenced along the Tubridgi pipeline easement, vegetation loss will be only temporary. The existing, previously disturbed right-of-way is still evident, but only because of the obvious lack of middle and upper storey vegetation along its length. Annual and ephemeral herb species, predominantly *Dysphania rhadinostachya, Salsola kali, Atriplex semilunaris*, various *Ptilotus* and *Asteraceae* species, have rapidly taken advantage of the disturbed soil. Most of these colonising species are not palatable for stock, but an abundance of the colonising grass, *Cenchrus ciliaris* replaces fodder material. Native perennial fodder grasses, namely the *Eriachne* and *Eragrostis* species have not yet re-established themselves in disturbed areas. Ephemeral fodder grasses, such as *Dactyloctenium radulans, Aristida contorta* and *Enneapogon caerulescens* compensate for this to some extent during their season.

### 7.2.3.2 Archaeological impacts

The only impact to archaeological sites is the disturbance to shell scatters at the beach crossing. Approval to remove these has been obtained. Significant archaeological sites have been avoided and as the pipeline route is almost entirely along an existing easement, no further impacts are anticipated.

### 7.2.3.3 Social impacts

Social impacts of a project of this type in a remote area may include undesirable noise and friction with local residents. Experience with the very similar Tubridgi Gas Project in 1991 has indicated that social impacts of the proposed Griffin Gas Project will, however, be minimal. The reasons for this are as follows:

(a) the workforce is not large - approximately 20 persons will be employed on the pipeline installation and 30 on the gas plant facilities construction. Even in the Onslow area, this is a small population increase;

(b) the work is located at a remote location away from the town of Onslow. Pipeline workers will be even more remotely located and will be continually relocated along the route; and

(c) the long working hours leave little time for social contact with locals.

Although an undisciplined workforce could cause irritation to pastoralists for the reasons above, no difficulties are anticipated. Where possible local sources of services, labour, machinery, food, consumables and accommodation will be used with consequent employment opportunities and financial input to the local community.

## 7.3 Potential Effects

### 7.3.1 Marine Environment

#### 7.3.1.1 Oil spills

Minor spills are possible as a result of refuelling spillages, or seepage of hydraulic fluid from worn or damaged seals on underwater equipment. A spill of up to 1000 L of hydraulic fluid is possible if a long hydraulic hose connecting underwater equipment to a vessel-mounted power source (i.e. the umbilical) bursts. A 'worst-case' oil spill scenario would require the holing of the fuel storage tanks on the pipelay vessel, with the result that diesel (No. 2 fuel oil) stored in its tanks could start escaping into the ocean before salvage operations commence. In the case of a large pipelay barge, the total quantity of fuel kept on board could exceed 10 tonnes.

Accidental spillages during refuelling operations are small (typically less than 50 L), most of which would be contained on-board by deck drainage systems. Their potential indirect effects in the open marine environment where the pipelay fleet will be operating are considered negligible. The same also applies to any accidental spill of hydraulic fluid. Loss of hydraulic fluid will be detected by a fall in reservoir levels and gauge pressures, causing the equipment to shut down automatically. Hydraulic fluids are highly-refined, low-toxicity mineral oils with extremely small residual quantities of polycyclic aromatic compounds (<0.1%). Total aromatic content is typically less than 6%. A spill of hydraulic fluid produces a slick that has a much lower spreading rate than diesel. The slick would be amenable to clean-up using absorbent mats which could be deployed from the tug or any other vessel accompanying the pipelay barge.

In the extremely unlikely event which could produce a more serious spill (e.g. sinking of the pipelay vessel when operating in shallow waters between Bessieres Island and the mainland), BHPP would invoke the Emergency Response Plan for the operation, which includes an Oil Spill Contingency Plan.

#### 7.3.1.2 Storm-induced damage during construction

Should commencement of offshore pipelaying (planned for August 1993) become unavoidably delayed (e.g. no suitable pipelay vessel available in the south-east Asian region), the potential exists for a storm or cyclone to occur before the pipeline has been stabilised and tested. This occurred during the recent installation of the Harriet sales gas pipeline in March 1992. Sufficient warning was provided to evacuate the pipelay fleet, and no vessels were sunk.

The cyclone (severe tropical Cyclone Ian) caused movement of one section of the unstabilised pipeline in a shallow water area near the coastline. The pipeline formed a curve whose apex was several hundred metres from the original pipelay point. The cyclone also caused the trench, which in this case had been excavated prior to pipelaying, to fill up with sediments. These events caused the construction period to be extended for three months.

#### 7.3.1.3 Gas pipeline rupture

The pipeline specifications governing its strength, integrity and stabilisation are such that an errant locally-based fishing vessel would not have the engine power to drag or accidentally rupture an unburied section of the pipeline with trawling gear or an anchor (anchoring within 500 m of the pipeline will not be permitted, as per standard marine navigation regulations.

On the other hand, the possibility that the submarine gas pipeline could accidentally leak or rupture as a result of some other cause cannot be totally discounted (see Section 7.3.2.2). Pipeline rupture would form a fire and safety hazard rather than a potential environmental disaster, since the gas would directly vent through the water column to the atmosphere. The amount of liquid hydrocarbons (e.g. any condensates which formed in the pipeline) is expected to be negligible, and these very low-density liquids would rise to the surface where they rapidly evaporate.

Emergency shutdown valves, set off by the monitored rapid fall in pipeline pressure, would shut off the flow of gas from the FPSO and isolate the onshore gas plant. The section of damaged pipeline could then be replaced once a small pipelay fleet is assembled. Thus even if a rupture did occur, it is highly unlikely that this could lead to any secondary event that had the potential to produce more serious environmental consequences (e.g. fire on the FPSO).

### 7.3.2 Terrestrial Environment

#### 7.3.2.1 External damage to pipeline

Natural gas pipelines are inherently safe installations, but the possibility exists that damage can occur due to earthmoving equipment or similar heavy machinery. While this is extremely unlikely in such a remote area, this danger will be minimised by installing marker signs at regular intervals, passing information on the route to Government and mapping authorities and making regular checks of the route itself.

#### 7.3.2.2 Rupture within process

As the plant and pipeline will be designed to appropriate standards to ensure a safe facility, it is highly unlikely that any fracture or other failure within the process will occur. Nevertheless, there is the remote possibility that a flange or fitting could leak in the plant or a rupture could occur in a pipeline or vessel. This would result in a gas leak, or possibly a fire.

Petroleum industry procedures have been developed to accommodate this possibility, and automatic shutdown of the process would occur. The worst foreseeable effect from some process failure would be an explosion or fire at the plant site. This would be localised to the site owing to the safety valves and flame-out devices located on the pipeline near its entry and exit points to the plant site.

#### 7.3.2.3 Accidental oil spill during construction

Minor oil spills may occur during construction. The source for such incidents would be the many pieces of machinery and equipment used for installing the pipe and plant. Causes could include leaking sumps, spills during refuelling, collision or maintenance accidents. Any such spill would be of likely to be less than 20 L. Any significant pollution of the soil would be treated by removing the affected material for burial at an approved landfill disposal site.

#### 7.3.2.4 Accidental fire during construction

Although construction will occur during the cooler winter season, there remains a risk that construction or operations activity will result in a fire.

Precautions will be taken to minimise this risk which will involve shielding of welding when winds are high, and prohibiting naked flames when fire risk is high. Environmental education will include a briefing on prevention of fires. Fire-fighting equipment will be included in vehicles.

#### 7.3.2.5 Erosion due to flooding

Flooding after high rainfall may cause erosion in areas where vegetation has been removed despite practices established to avoid erosion. When the countryside dries out after flooding, all facilities will be inspected, any erosion made good and additional drainage provided if necessary.

#### 7.3.2.6 Invasion of noxious weeds

The declared noxious *Prosopis* sp., Mesquite, occurs on the coastal dunes and berms in the immediate vicinity of the proposed pipeline route. One large tree, growing within 10 m of the route, appears to have been treated as foliage is dying off. However, the tree was observed to still have some flowers and seedpods during a field survey conducted on 14 August 1992. Several other trees varying in size, were found in the immediate vicinity which appeared not to have been treated.

The possibility therefore exists that noxious weeds could be transported along the right-of-way, on construction machinery.

### 7.3.3 Social Environment

#### 7.3.3.1 Damage to Aboriginal sites

The gas processing and pipeline across the dunes have been located after archaeological and ethnographic surveys and discussions with the community to minimise disturbance to important sites. For example, the proposed pipeline route across the dunes was moved to avoid a burial site, considered important by the local community.

The possibility of damage to Aboriginal sites adjacent to the work will be minimised through education and maintenance of a degree of secrecy as to their location.

#### 7.3.3.2 Workforce conflict with local population

The possibility of workforce conflict with the local population will be minimal due to the small workforce, the remote nature of the site and the long working hours.

#### 7.3.3.3 Damage to station property

There is a potential for damage to station facilities such as fences, wells or outbuildings, although no such incidents occurred during the Tubridgi Gas Project. Any damage to station property will be rectified and compensation paid.

# 8. ENVIRONMENTAL MANAGEMENT

## 8.1 Introduction

BHPP and Doral are committed to conducting business in a manner that ensures the safety of its operations, promotes the health and safety of personnel and protects the environment. To this end, both BHPP and Doral have established Corporate Health, Safety and Environment Management Programmes. As part of this programme BHPP is committed to:

- o the adoption of industry standards and guidelines for design and control of production facilities, and control of sea transport;
- o compliance with government regulations and all legal requirements;
- o production of a safety procedures manual for the Griffin development;
- o production of an emergency response manual for the Griffin development;
- o production and testing of an Oil Spill Contingency Plan approved by the Western Australian State Committee for Combating Oil Pollution;
- o regular review and auditing of the effectiveness of the environmental management practices; and
- o decommissioning the field upon completion of production.

## 8.2 Marine Management

### 8.2.1 Emergency Response Plan

As part of BHPP's routine approach to operational safety requirements, an Emergency Response Plan (incorporating the Cyclone Contingency Plan as appropriate) will be implemented for the pipelay fleet. The objective of the plan is to ensure the safety of all personnel and the pipelay fleet. The cyclone component relies on weather forecasting and the designation of alert classifications which are based on the proximity of the cyclone.

Weather forecasts, and continual updates of any cyclone, will be obtained from both the Bureau of Meteorology and a private service [Ocean Routes (Australia) Ltd]. In addition, wind and sea state conditions will be continuously monitored in the field. Specific criteria for significant wave height, continuous wind speed and distance/time to an approaching cyclone will be set for initiating the various stages of the contingency plan.

An Emergency Response Plan (incorporating the Cyclone Contingency Plan) will be developed for the ongoing operations of BHP Petroleum facilities, including the pipeline and onshore gas processing facilities.

### 8.2.2 Oil Spill Contingency Plan (OSCP)

The objective of the OSCP is to protect personnel and property while minimising the release of hydrocarbons and contamination of sensitive marine habitats. The principles of the plan are as follows:

- spills in deepwater areas offshore which do not represent a hazard to personnel, facilities or the environment, will be monitored until they disperse naturally. A slick considered to potentially represent a hazard to shallow water habitats will be dispersed using low-toxicity dispersants before it has the chance to move into areas containing shallow water (< 10 m deep), where application of dispersants is usually not acceptable;

- spills in shallow water areas will be monitored, contained or dispersed in consultation with relevant authorities including State Combat Committee in order to minimise potential impacts on the environment.

- BHPP will take every practical action to prevent spill residues coming ashore at environmentally sensitive areas such as mangroves or moving across fringing coral reefs; and

- any residues of a spill that become beached will be removed from shorelines, unless such removal causes more damage to the shoreline than allowing them to degrade naturally.

An example of the decision-making process used by petroleum industry OSCP's is shown in Figure 8.1.

Portable and airborne dispersant spray units and stocks of the low toxicity dispersant ARDROX 6120 will be stored on support vessels and on the FPSO. Absorbent mats will also be available. In the event of a serious spill that is beyond BHPP's capacity to control alone, a request will be made for the oil industry's Marine Oil Spill Action Plan (MOSAP) to be activated by the Regional Industry Controller (RIC) in Karratha. This plan would co-ordinate regional industry oil spill control facilities. There are many operating oilfields within 100 km of the Griffin field and rapid access to additional assistance is assured.

Specific plans and manuals for the Griffin oilfield and the gas pipeline development will be produced prior to initiation of field works and submitted to appropriate government authorities for evaluation and approval.

### 8.2.3 Marine Monitoring

All accidental spills or releases of fuels, lubricants or hydraulic fluid will be recorded by on-site supervisors, who will also elicit appropriate responses, including monitoring of slick movements. The length and direction of sediment plumes generated by pipelay operations will be inspected and photographed by BHPP personnel or delegated contractors to obtain estimates of the size and behaviour of plumes during spring and neap tidal conditions.

BHPP will also arrange for photographs of the plume to be taken from the air, the beach and at deck-level on an *ad hoc* basis when pipelaying is being undertaken near the mainland shoreline.

Potential mortality to hard corals which colonise the shallow subtidal limestone platforms at the mainland coast near Urala Station from pipelay sedimentation events will be monitored. Immediately prior to pipeline construction, the coverage, size and type of hard coral colonies will be determined using replicate line-intercept or belt transects. These transects will be inspected during pipeline installation to assess sedimentation, and then re-inspected immediately after inshore pipelay activities have been completed.

Results from the marine monitoring programme will be made available to the EPA and interested members of the public at the end of the offshore pipeline construction phase.

### 8.2.4 Project Decommissioning

Present data indicate that the life of the Griffin oilfields and their gas supply is approximately 15 years. It is possible that field life may be extended by field work-overs and technological improvements in resource recovery, or by the addition of new or existing fields.

However, whenever the offshore gas supply becomes eventually exhausted and abandoned, the oilfield and gas pipeline will be decommissioned as follows:

- o wells will be plugged and sealed with concrete and the casings cut off at 4 m below the seafloor, as is presently required by the WADME;
- o wellhead structures, the floating riser, subsea tethered buoys and umbilicals and flowlines will be disconnected and removed to storage on land, re-use elsewhere or sold as scrap; and
- o the submarine gas pipeline will be flooded with seawater, plugged and abandoned.

The costs of decommissioning the field have been included in the total development estimate and provision for field abandonment has been incorporated into the design.

## 8.3 Terrestrial Management

### 8.3.1 Introduction

It is the intent that destruction of flora, fauna and landform be minimised by ensuring processing plant size and easement widths are kept as small as is practically, and safely possible and where ever possible utilise previously disturbed areas.

Upon approval of the project and appointment of a construction contractor, a set of environmental rules and procedures pertinent to construction activities, including those required by government, will be produced. The intent of this document is to make the many commitments made in this CER, readily available and simply understood by construction personnel.

It is intended that penalties, including dismissal, for breaking environmental regulations shall be included in the contract documents.

### 8.3.2 Management of Physical and Biological Impacts

#### 8.3.2.1 Clearing and rehabilitation

All disturbance to vegetation must be done in accordance with the environmental management and rehabilitation programme summarised below. The intent is to facilitate the rapid regrowth of plants, thus preventing erosion, minimising pastoral impact and producing an aesthetically pleasing return to a vegetated appearance.

**(a) Clearing and rehabilitation - general principles**

Clearing of the pipeline easement and all areas which do not require excavation will include removal to ground level of trees, stumps and other obstacles, excluding those identified for preservation. This will retain the maximum amount of root stock. Grubbing of stumps will occur only at excavation areas (e.g. the trench line) and where stumps are likely to impede the movement of construction vehicles.

Small items of cleared vegetation will be processed through mechanical chipping equipment, or through a scrub roller. The resulting material will be stockpiled near to the work (for example on the western side of the right-of-way) and respread after completion of construction. Larger items of vegetation, such as logs, branches and grubbed stumps will be returned to the cleared areas where possible to act as a refuge for fauna.

Where excavation is required, topsoil will be removed, as outlined in Section 8.3.2.7. It will be replaced after backfill is complete, spreading it evenly over the re-contoured surface, with larger items of vegetation on top, to minimise wind erosion.

Crossing points with major roads will be designed such that the cleared easement is concealed.

Clearing will be done such that drainage is adequate during construction. Care will be taken to ensure that natural drainage flow can continue to occur across rehabilitated areas. Finished contours will emulate pre-construction contours as far as practicable, and if necessary, drains will be constructed to dispose of concentrated water flows in a way that will prevent erosion. Design of earth work will endeavour to ensure that no areas are starved of natural watering. Should excessive bulldust occur on access tracks, the problem area will be boxed out and replaced with an appropriate select fill, properly compacted. Less difficult bulldust areas will be watered, compacted and closed to traffic.

Should rutting and bogging of vehicles be a problem, the affected areas will be covered with gravel obtained from an approved site.

**(b) Sand dunes**

To maintain a smooth vertical alignment, excavations of up to 5 metres depth may be required in some areas. An example of such situations occurs when the pipeline crosses claypans around which a low perimeter dune is almost always encountered. In these areas, the top 200 mm of vegetated sand will be removed and stockpiled as near as possible to the right of way. Where *Acacia coriacea* or other large shrubs which are difficult to regenerate exist, consideration should be given to cutting back to ground level only, to allow regrowth from root stock.

Restoration will proceed by replacing plain sand to approximate the original line of the dune. Where necessary, the dunes will be stabilised to prevent wind erosion and to ensure seeds or runners germinate. While each particular dune type will require different management techniques, generally vegetated topsoil will be pushed aside before earthworks begin, then replaced on their completion. Rootstock of larger shrubs (particularly *Acacia coriacea*), will be left if possible. Dunes may require stabilisation using gravel, bitumen emulsion, hydromulch, netting, cut vegetation, matting or some other such method. Where necessary, dunes shall be seeded to promote regrowth. Traffic over the area will be prohibited.

**(c) Access tracks, laydown areas and campsite**

Campsites and laydown areas will be located close to the easement on well drained land, with suitable access during all weather conditions. Campsite locations will be subject to environmental advice and approval by the landholder. It is likely that the Tubridgi Pipeline construction campsite on Minderoo Station will be re-used for the Griffin gas pipeline project. Vegetation will be cut to ground level and reinstated at the end of construction in accordance with the principles above.

Rehabilitation of access tracks will involve ripping to overcome compaction and placement, if practical of soil and cleared vegetation originally removed from the area on the surface to promote regrowth. If bulldust exists it will be watered and rolled, prior to re-spreading of cut vegetation. Consideration will be given to re-seeding and stabilisation.

#### 8.3.2.2 Noxious weeds

Introduced noxious weeds observed during or after construction may be the result of seeds or propagules carried on construction machinery. It will be the responsibility of the pipeline owner to control these in a manner prescribed by the Agricultural Protection Board.

All construction machinery utilised in areas infected by mesquite will be quarantined as it moves out of the infested area so as to prevent the persistent seeds being carried along the route into uninfested areas. This will be done in accordance with procedures laid down by the Agricultural Protection Board.

#### 8.3.2.3 Fauna

Impact on fauna will be monitored by environmental consultants during regular field visits to the site. This will involve, a preliminary reconnoitre along the entire route to examine habitat, observation, and occasional pit trapping.

#### 8.3.2.4 Erosion

Permanent facilities will be surfaced such that wind and vehicle traffic causes a minimal amount of dust. Adequate slope will be incorporated into the design to promote drainage but prevent erosion of bare soils. Drains will prevent concentrated flows eroding the natural landscape and where necessary will contain silt traps to prevent silting downstream of the new drain. Pipes will be placed where necessary to replicate natural drain lines and prevent erosion.

Drains shall be designed to prevent natural runoff patterns being substantially changed. Rain shadow, the reduction in natural watering caused by permanent facilities, will be overcome by placement of spill drains as necessary.

Erosion will be managed by spreading gravel, constructing furrows and placing rocks and rip-rap as required. Repair of rain-induced erosion will be done as soon as possible after it occurs.

A survey of the existing easement will be undertaken before the new pipeline is installed, to identify all areas which eroded during the previous rains. Measures to prevent recurrence of such erosion will be undertaken. The revegetation program will be instigated as soon as practicable after construction.

#### 8.3.2.5 Compaction

All tracks and work areas which have soils compacted such that revegetation will be difficult, will be ripped when work is complete, to facilitate regrowth.

#### 8.3.2.6 Surface water, groundwater and river banks

Care will be taken to avoid muddying or polluting in any way, water sources, whether surface or ground water. Surface waters will be monitored for any undesirable affects. It is not anticipated that ground water table will be intersected. Should this occur, the excavation will be isolated from the aquifer by sheet piling, a grout curtain or other such method. Aquifer purity would, in such a case, be monitored.

Care will be exercised to minimise damage to banks of surface water sources.

Vegetation damage at all waterway crossings will be minimised and tree removal avoided as far as is practicable. River banks will be seeded with *Cenchrus ciliaris*.

The one major river crossing on the right-of-way is anticipated to involve similar techniques to the previous pipeline crossing. A trench shall be excavated to a depth sufficient to avoid flood scour. The pipe will be laid in this trench and backfilled. Banks will be reinstated to their original contour using trench breakers. Moonscaping, rock gabions, sheet piling or seeded mesh mattresses will be used to prevent erosion.

#### 8.3.2.7 Excavation and backfill

Topsoil will be removed from all areas where excavation is to occur, including the pipeline trench. It will be stockpiled separately from other excavated materials, for subsequent replacement in its original position. Topsoil will be defined as the top 200 mm of surface soil.

All excavated material from the pipeline trench will be placed on the eastern side of the easement (see Figure 8.2). Stones, wood, concrete, vegetation, clods of earth, debris and water will be removed from all excavated materials prior to backfilling. Sand embedment for the pipeline will be used where required at the discretion of the Company Representative. Trench backfill will comprise excavated subsoil which shall be fully compacted to minimise trench erosion.

Topsoil will be placed over backfill at all excavated areas. To guard against a linear depression occurring above the trench due to fill settlement, a small crown will be left. This will be penetrated at 20 m intervals to prevent interruption to surface water flows.

#### 8.3.2.8 Borrow pits

Although none were required during the Tubridgi Gas Project, borrow pits may be necessary to obtain suitable sand padding, suitable backfill or erosion protection for the right-of-way over sandy areas. Where possible, sand will be removed from the easement itself and failing that source, the bed of the Ashburton River may be used. Should access to the river be difficult, sand may be removed from sites agreed to by the pastoralist after appropriate Government approvals have been obtained.

Backfill and gravel borrow pits will be established in areas which are not likely to erode further and at an approved location agreed to by the pastoralist. Before creation of the pit, all topsoil shall be removed to a depth of 200 mm and stockpiled nearby. At the end of construction, excess trench spoil may be placed in the pit. The excavation will be re-contoured to minimise erosion and unsightly depressions or levee banks. The removed topsoil will be spread over the re-contoured excavation to promote revegetation. Seeding will be considered.

#### 8.3.2.9 Mudflats and claypans

No removal of soil on mudflats other than that for the trench excavation itself shall be made.

If rutting and bogging becomes a problem, rocks or gravel shall be imported from an approved borrow pit to provide a stable surface. Reinstatement shall involve grading at the right-of-way to its original contour.

### 8.3.3 Management of Discharges

#### 8.3.3.1 Gaseous emissions

All vehicles and construction equipment will be monitored to ensure that exhaust fumes are within regulatory requirements. Gas venting may be a one-off event associated with pipeline purging at the end of the construction phase or due to an emergency shutdown. In either case gases will be allowed to dissipate to the atmosphere. The discharge of other toxic gases is so low that monitoring is not regarded as necessary.

#### 8.3.3.2 Dust

Dust from cleared tracks will be minimised by restricting vehicle speeds, and watering down as necessary. Water used for dust suppression will be obtained from sources identified after environmental advice and, in liaison with the landholder. Access to the water source will be such as to minimise erosion and vegetation destruction and, access tracks will be reinstated when they are no longer required. In heavily trafficked areas, gravel may be spread to provide a firm, dust-free pavement. The use of chemical dust suppressants will be trialled if adequate sources of suitable gravel can not be readily obtained.

Once the construction phase is complete, dust production is anticipated to be minimal, with the exception of the main access road to the gas plant which will be used by up to three LPG tankers per day in the event that the pipeline option is not practical.

#### 8.3.3.3 Liquids

All tanks and vessels which contain liquids, will be bunded to contain spilt liquid that would occur in case of a fracture. Laydown and other areas where there is a possibility of oil or chemical spills will have oil traps such that no oil or chemical can be washed into the natural drainage system. Valves and sample points which are likely to drip or be places of spillage will have a bunded concrete slab beneath them with appropriate traps to prevent pollution during heavy rains.

Hydrostatic test water will be obtained either from the Onslow town supply or from surface water sources that are easily accessible and large enough not to be seriously depleted by its removal. Water shall be re-used for various sections of the pipeline and will be inhibited with a bio-degradable corrosion inhibitor.

Hydrotest water will be disposed of by evaporation in an open area such that it will not enter the surface drainage system.

Sewage will be treated in a septic tank and the outlet monitored for biological pollution and erosion.

Brine will be produced from reverse osmosis water makers. It will be disposed of in an evaporation dam at the plant site.

Drainage sediment will be minimised through erosion protection and revegetation. Nevertheless, some will occur. This is not regarded as a significant problem, however sediment traps, if required, will be placed across drainage lines at areas which cannot be rehabilitated.

#### 8.3.3.4 Wastes

All wastes shall be removed from site, to be disposed of at the Onslow tip or the nearest licensed land-fill designed to accept such materials.

### 8.3.4 Management of Impacts to Pastoralists

It is the intention of this plan that all construction and operations activities relevant to the use of the land as a pastoral lease will be discussed with the lease-holder in an effort to ensure that the aesthetic and agricultural values of the area are not compromised. Advice of pastoralists is regarded as an important input into the successful management of the project.

#### 8.3.4.1 Access limitations

The inconvenience of access limitations due to the open trench will be minimised by discussions with the pastoralist, to ensure his needs are appreciated and if possible, accommodated. Otherwise, cross-overs will be erected across the trench. These will be either plant bridges or a temporary backfilling of the trench.

#### 8.3.4.2 Loss of natural feed

Some loss of fodder is inevitable, but as noted in Section 7.2.3.1, the majority of the new work will take place on previously disturbed ground. The loss of feed above the previous project impact is insignificant.

### 8.3.5 Management of Archaeological Impacts

Aboriginal sites have been avoided in the existing pipeline easement routing. The shore crossing portion of the new pipeline does not impact sites which have been identified as significant. Other sites will be treated in accordance with the Aboriginal Heritage Act. Any further Aboriginal relics discovered during the work will also be treated in accordance with the Act.

### 8.3.6 Management of Social Impacts

Because social interaction between the workforce and local population will be minimal, no regulations other than those typically required for proper administration of a construction camp are anticipated. The proponent intends to communicate regularly with all interested parties with respect to land use, employment and other issues in a similar manner to that undertaken for the Tubridgi Gas Project.

### 8.3.7 Management of Emergency Incidents during Construction

#### 8.3.7.1 Fire

In the event of a fire being started at a welding station or elsewhere along the pipe route, the alarm shall be raised by radio. All vehicles will have portable fire extinguishers and if these are inadequate for the occurrence, a centrally located water truck shall be driven to the site to assist. Should a fire become large enough to threaten human life, evacuation along the pipe route to the first access track will occur.

Should a bush fire start away from the work and impinge on the route, the alarm shall be raised by radio and evacuation will proceed immediately. Evacuation and fire-fighting procedures will be implemented prior to the commencement of construction activities.

#### 8.3.7.2 Flooding

Flooding in this area normally occurs in the January to April period associated with cyclones (surge and rainfalls) although rainfall localised flooding events at any time of the year. Precipitation inland may also cause downstream flooding of the Ashburton River. Rainfall and river levels will be monitored daily. Abandonment of the work will occur before the access tracks or the right-of-way become impassable.

#### 8.3.7.3 Cyclones

Updates of any cyclone will be obtained. Specific criteria for continuous wind speed and distance/time to an approaching cyclone will be set for initiating the various stages of the contingency plan.

### 8.3.8 Personnel Management and Education

To maintain an appropriate environmental awareness, a set of easily understood regulations will be developed and set out in a pamphlet for distribution to all involved with the project. All field personnel will be given an environmental induction based on this pamphlet when they arrive on site. Environmental specialists will brief all supervisory staff who will then provide the induction to their own personnel.

## 8.4 Operations Management

### 8.4.1 Terrestrial Operations

#### 8.4.1.1 Emergency response procedures

Doral will modify the existing, approved safety and emergency response procedure for the Tubridgi pipeline to include the new pipeline. In particular, the Safety Manual, Hazardous Area Manual and an Emergency Procedures Manual which provide operational directions in case of pipeline damage, system rupture, fire and flooding will be updated. BHPP will produce a Safety Manual and Emergency Response Manual for the Griffin Gas Processing facilities. These documents will be provided to the relevant Government Departments to ensure compliance with all appropriate Acts and Regulations.

#### 8.4.1.2 Education

All operators will be given an environmental induction, which will be based on the relevant sections of this CER and include a pamphlet similar to that used for the construction personnel.

## 8.5 Terrestrial Monitoring

Terrestrial monitoring of construction will involve compliance and biological monitoring. Compliance monitoring will involve regular visits to the construction site by environmental personnel to ensure contractors adhere to the environmental regulations. Ongoing monitoring during operations will include biological monitoring will involve a vegetation and fauna monitoring program. Species lists will be regularly updated and information presented as required to the responsible authority.

Monitoring will include wet and dry season vegetation transect mapping of rehabilitated areas to determine increases in ground cover, regular records of major rehabilitating species and their abundance, and counts of shrub and tree species in transects and on random areas. Areas will also be monitored for noxious weeds.

# 9. SUMMARY OF COMMITMENTS

## 9.1 Overview

The Griffin gas pipeline development will be undertaken by each proponent (i.e. the Griffin Project Venturers or the Tubridgi Project Venturers, as the case may be) using the design criteria, construction methods and management actions as described in this document. Each proponent is committed to undertaking its stage(s) of the project in a manner that will maximise the safety of operations, the health of the workforce, and the protection of the environment.

General commitments have been listed in Section 8.1, and each proponent will also undertake specific commitments as summarised in the following sections.

## 9.2 Offshore Pipeline - Griffin Project Venturers

1. The offshore pipeline will be installed along the preferred route, and therefore no pipe-laying activities will be carried out within 1.2 km of islands and major coral reef areas (Section 7.2).

2. The offshore pipeline will avoid traversing isolated limestone platform reefs near the mainland coastline (Section 4.2.2).

3. An Emergency Response Plan (incorporating a cyclone contingency plan as appropriate) will be implemented for the pipelay fleet and for normal operations (Section 8.2.1).

4. An Oil Spill Contingency Plan for the Griffin oil fields development will be submitted to Government for approval. The Emergency Response Plan for the construction phase will address oil spills (Section 8.2.2.).

5. The beach site used to pull the offshore pipeline on to the mainland shore will not exceed an area of 150 m x 150 m on the toe of the foredune (Section 5.3.4).

6. Reasonable efforts will be made to bury the pipeline where it crosses the Area 1 fishing grounds, so that present prawn trawling activities can continue (Section 5.2.5). Should burial not be practical for environmental or technical reasons, discussions will be held with potentially affected fishermen to determine arrangements for a 500 m exclusion zone.

7. It is intended that seawater used to hydrotest the offshore pipeline will be discharged in deep water, i.e. at the FPSO end of the pipeline (Section 5.2.6).

8. A marine monitoring programme (covering routine operational procedures, sediment plume monitoring, and corals colonising nearshore limestone reefs near the mainland coast) will be designed in consultation with and implemented to the requirements of the EPA prior to the start of offshore construction activities. Results from the marine monitoring programme will be made available to the EPA and any interested members of the public at the end of the construction period (Section 8.2.3).

9. When the Griffin development is finally complete, operations finished and abandoned, in accordance with the requirements of WADME and the gas pipeline is no longer required it will be flooded with seawater, plugged and abandoned.

## 9.3 Onshore Pipeline - Tubridgi Project Venturers (Export pipeline) Griffin Project Venturers (Shoreline to gas treatment plant)

10. Disturbance to flora, fauna and landform will be minimised by utilising previously disturbed areas wherever practical, and by ensuring easement widths are kept as small as is practically, and safely, possible (Section 8.3.1).

11. A set of environmental rules and regulations will be established for education of all those involved on site including the onshore construction workforce (penalties will be applied to any contractor who breaks these regulations; Sections 8.3.1 and 8.3.8).

12. The entire onshore pipeline route will be rehabilitated using the methods as detailed in Section 8.3 (Sections 4.2.4 and 8.3.2.1).

13. Dune disturbance and erosion will be minimised by (a) allowing the pipeline to follow the existing topography, (b) erecting temporary fences to keep vehicles, equipment and workforce within 60 m of the centreline of the pipeline corridor, and (c) rehabilitating the pipeline corridor to its original condition or better, wherever possible (Sections 5.3.4, 5.3.5 and 7.2.2.3).

14. The pipeline trench across the dunes will not be allowed to intersect known freshwater aquifers that are used for pastoral operations (Section 5.3.4). If an accidental breach occurs, it will be isolated from the excavation and water purity monitored (Sections 7.2.2 and 8.3.2.6).

15. The onshore gas pipeline will be installed along existing easements between Tubridgi gas well No. 5 and the proposed gas plant, and between the gas plant and SECWA's Dampier-Perth gas pipeline.

16. Clearing of vegetation and disturbance to landforms will be done such that adequate drainage remains available to the remaining vegetation and rehabilitated areas during both the construction and operational phases (Section 8.3.2.1).

18. Prior to construction, a survey of the existing onshore pipeline easement will be undertaken to identify any erosion areas that may have occurred, and measures will be implemented to prevent their re-occurrence (Section 8.3.2.4).

19. Erosion and rutting of soils along vehicular tracks during the construction phase will be minimised by undertaking regular track inspections and maintenance (Section 7.2.2.1).

20. Pipeline route inspections by operators will occur at approximately two-monthly intervals (Section 7.2.2.2).

21. Erosion will be managed by spreading gravel, constructing furrows and placing rocks and rip-rap as required (Section 8.3.2.4).

22. Erosion of new work (e.g. unvegetated areas) by natural flood events will be made good, and improved drainage provided (Section 7.3.2.5). This includes the repair of any rain-induced erosion during the construction or operational phases, which will be undertaken as soon as possible after it occurs (Section 8.3.2.4).

23. Areas where soil compaction has occurred will be ripped at the end of the construction phase to promote re-vegetation (Sections 7.2.2.1 and 8.3.2.5).

24. The river bank at the pipeline crossing will be reinstated to its original contour, and erosion prevented by moonscaping, rock gabions, sheet piling or seeded mesh mattresses. River banks will be seeded with *Cenchrus ciliaris* (Section 8.3.2.4).

25. Clearing of dense stands of *Eucalyptus coolabah* and *Grevillea* spp. will be avoided (Section 7.2.2.3).

26. Any accidental fuel or lubricating oil spillage causing soil pollution will be treated by removing the contaminated soil for burial at an approved land fill site (Section 7.3.2.3).

27. Naked flames will be banned during periods of high fire risk, and the importance of fire prevention will be incorporated into the environmental education of the construction workforce (Section 7.3.2.4).

28. Fire-fighting equipment will be available during construction (Section 7.3.2.4).

29. Surface waters will be monitored for any undesirable effects (Section 8.3.2.6), and if surface water supplies are used during the construction period, any accidental damage to the banks of rivers or pools will be rectified, if necessary by hand (Section 7.2.2.1).

30. Any aboriginal relics discovered during the work will be treated in accordance with the *Aboriginal Heritage Act* 1972. Potential accidental

damage to known or unknown Aboriginal sites will be minimised by secrecy and workforce education (Section 7.3.3.1).

31. If a borrow pit is required, it will be located at a site agreed to by local pastoralists after appropriate Government approval has been obtained, and the borrow pit will be managed as detailed in Section 8.3.2.8.

32. Approval from the landholder and advice from environmental consultants will be sought if any water from bores is required in the onshore section of the pipeline.

33. Any accidental damage to pastoral station property (e.g. fences, wells, outbuildings) will be rectified and appropriate compensation paid (Section 7.3.3.3).

34. Hydrotest water requiring disposal near the gas plant site will be allowed to evaporate within a suitable low lying area (Section 5.3.6).

35. The onshore pipeline will be not be exhumed as part of normal operations (routine maintenance is not required and inspections will be internal; Section 5.3.7).

36. Firearms will be banned from all construction camps (Section 7.2.2.3).

37. At the end of the project the pipeline will be left in situ to minimise disturbance. All surface facilities will be removed.

38. A monitoring program will be implemented, and will focus on rehabilitation as outlined in this CER.

## 9.4 Gas Plant - Griffin Project Venturers

39. Destruction of flora, fauna and landform will be minimised by ensuring the gas plant site is kept as small as is practically, and safely, possible. As far as practical it will be located to minimise impact on significant archaeological and environmentally sensitive areas. Any aboriginal relics discovered during the work will be treated in accordance with the *Aboriginal Heritage Act* 1972.

40. Apart from domestic greywater and sewage, all liquid and solid wastes produced at the gas plant will be transported by road for disposal at approved land-fill sites or for recycling (Section 5.5.3).

41. The sewage treatment facility and septic tank at the gas plant site will be sufficiently big enough to cope with domestic wastes produced during both the construction and operation periods (Sections 5.5.3 and 5.5.7).

42. Flaring at the gas plant will be minimised by efficient plant design and by ensuring that operational and maintenance procedures are maintained at a high standard (Section 5.5.3).

43. Noise levels will be kept below 85 dB(A) at 1 m from all ground level equipment, and below 75 dB(A) at 100 m from the plant boundary (Section 5.5.6). Noise monitoring will be undertaken prior to construction, during construction and during operation of the gas plant.

44. All wastes and discharges will be managed as detailed in Section 8.3.3.

45. All tanks and vessels that contain liquids will be bunded (Section 8.3.3.3).

46. At the end of the project the gas plant will be decommissioned, dismantled, and demobilised.

47. Construction and operations will be monitored by the Operator to ensure compliance with environmental obligations.

48. All personnel employed on the project will be educated about the environmental management practices outlined in this CER.

49. Firefighting facilities will be available during construction and within the plant boundary during operation.

50. Construction work on Urala station will be scheduled to minimise the impact on station activities as far as possible.

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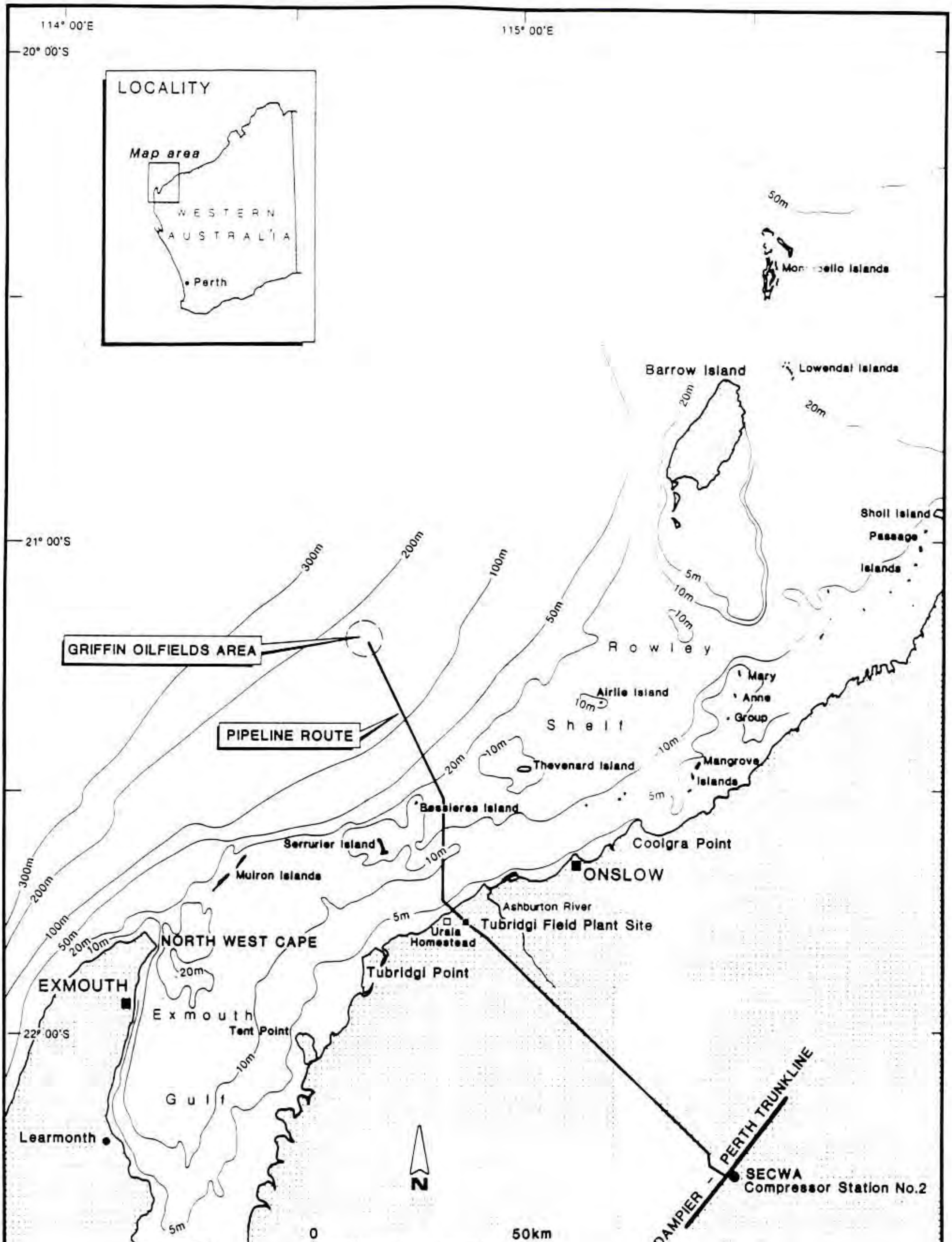


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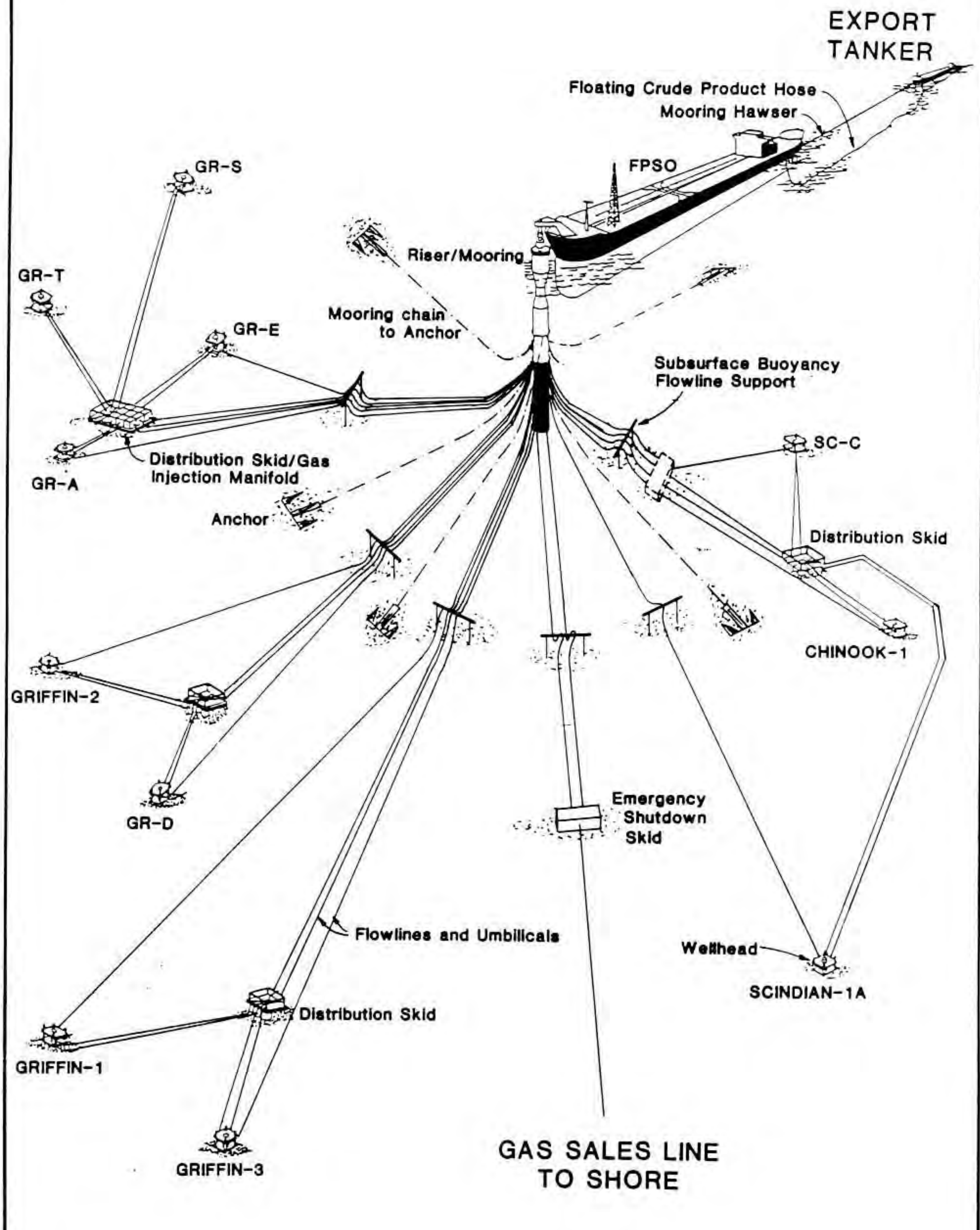
GRIFFIN GAS PIPELINE DEVELOPMENT

**LOCALITY DIAGRAM**

Figure **1-1**

Environmental Drafting

J249 R393 RWH 9/92

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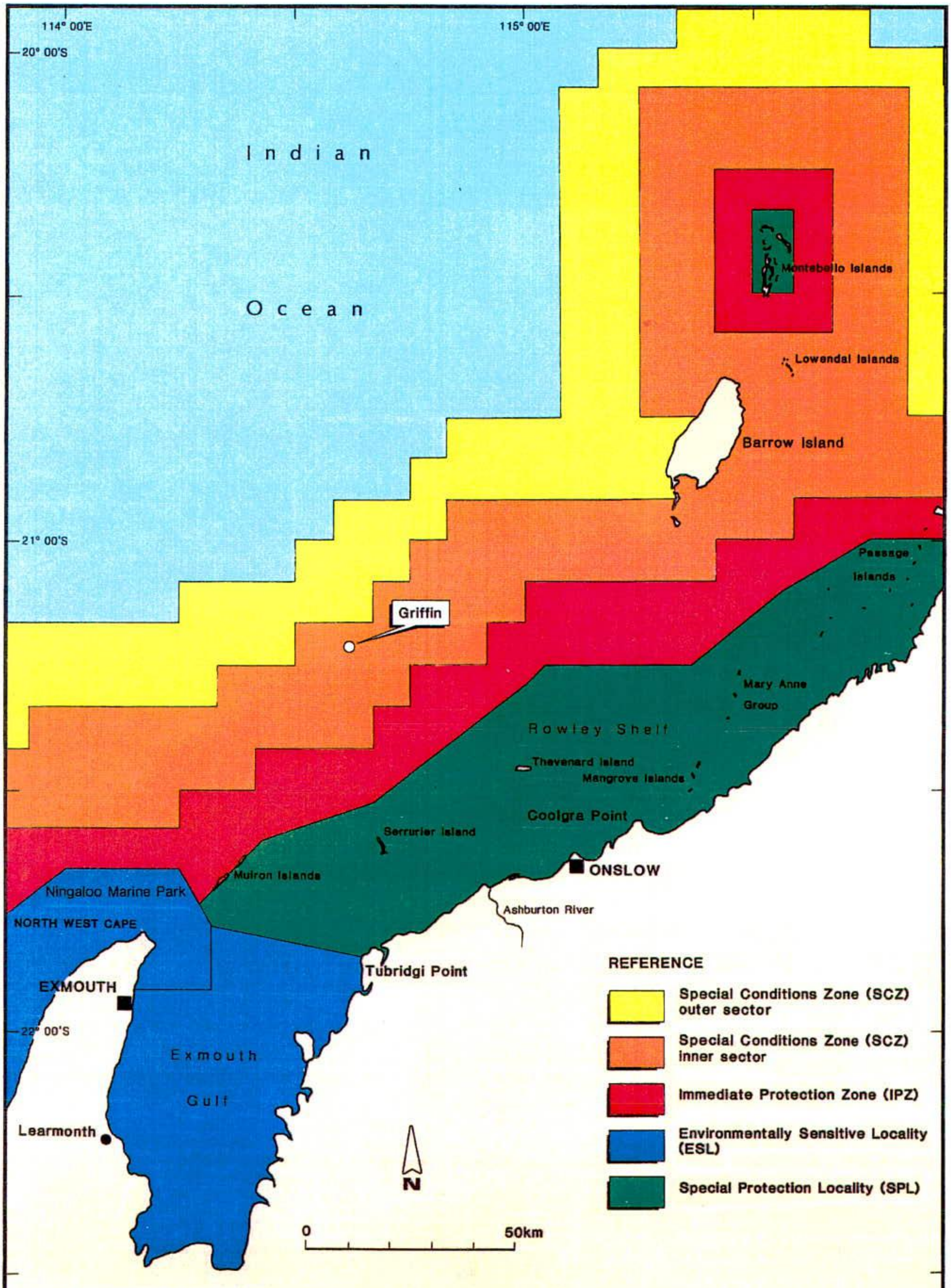
**SCHEMATIC DIAGRAM OF GRIFFIN OIL FIELD FPSO**

Figure **1-2**

J249 R393 RWH 9/92

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## ENVIRONMENTALLY SENSITIVE AREAS

Figure **1-3**

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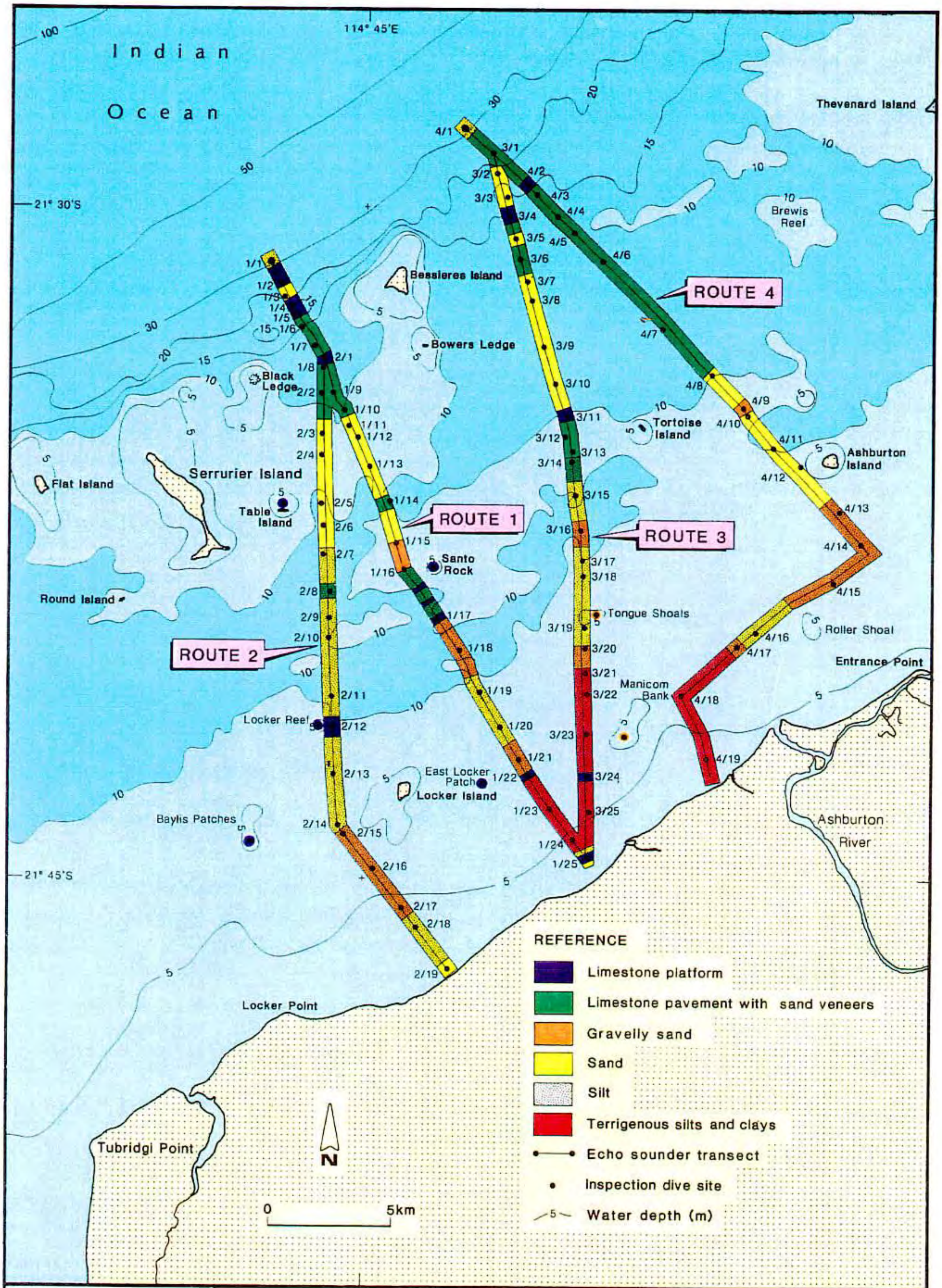


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**HABITAT DISTRIBUTION ALONG POTENTIAL PIPELINE ROUTES**

Figure **4-1**

Environmental Drafting

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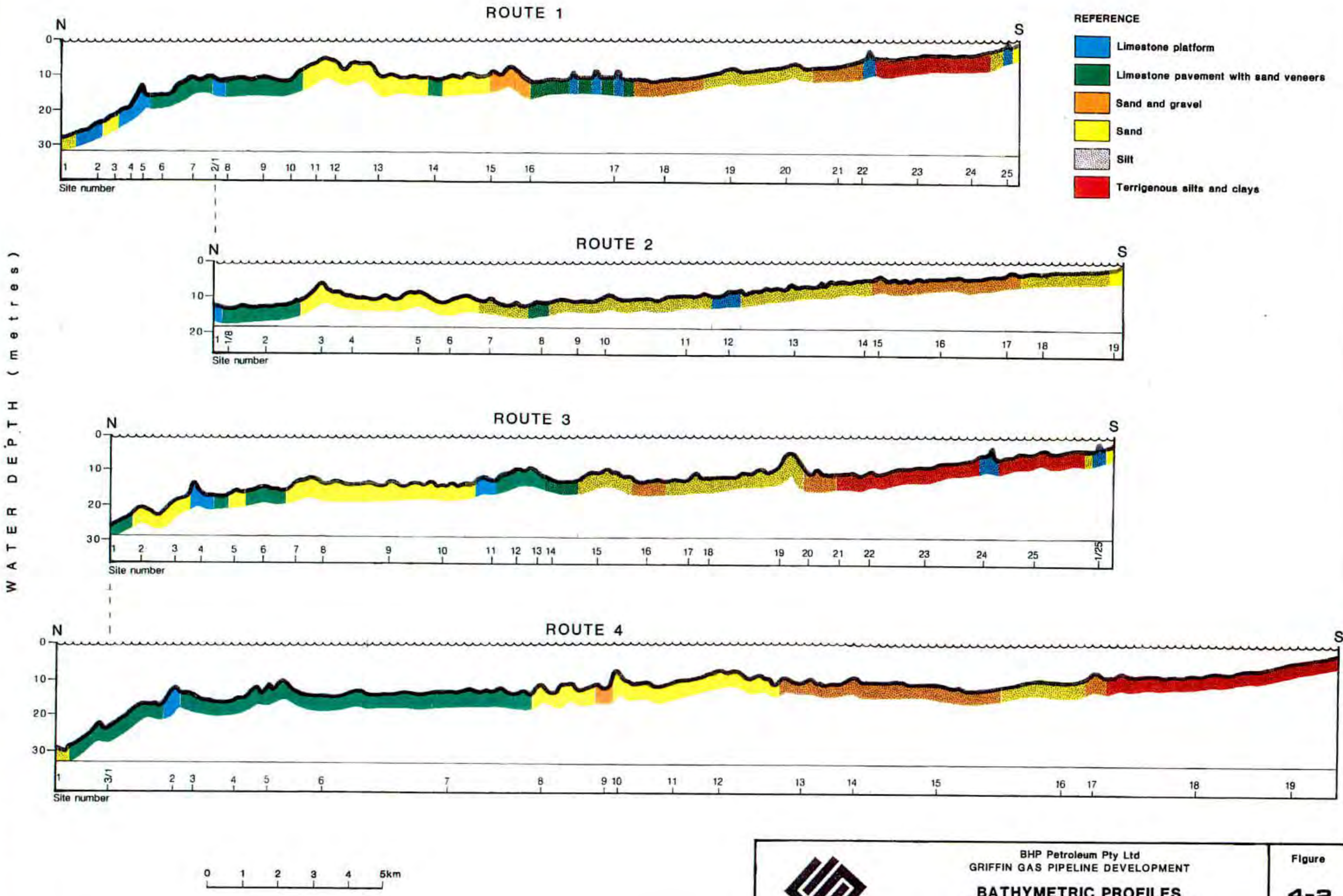


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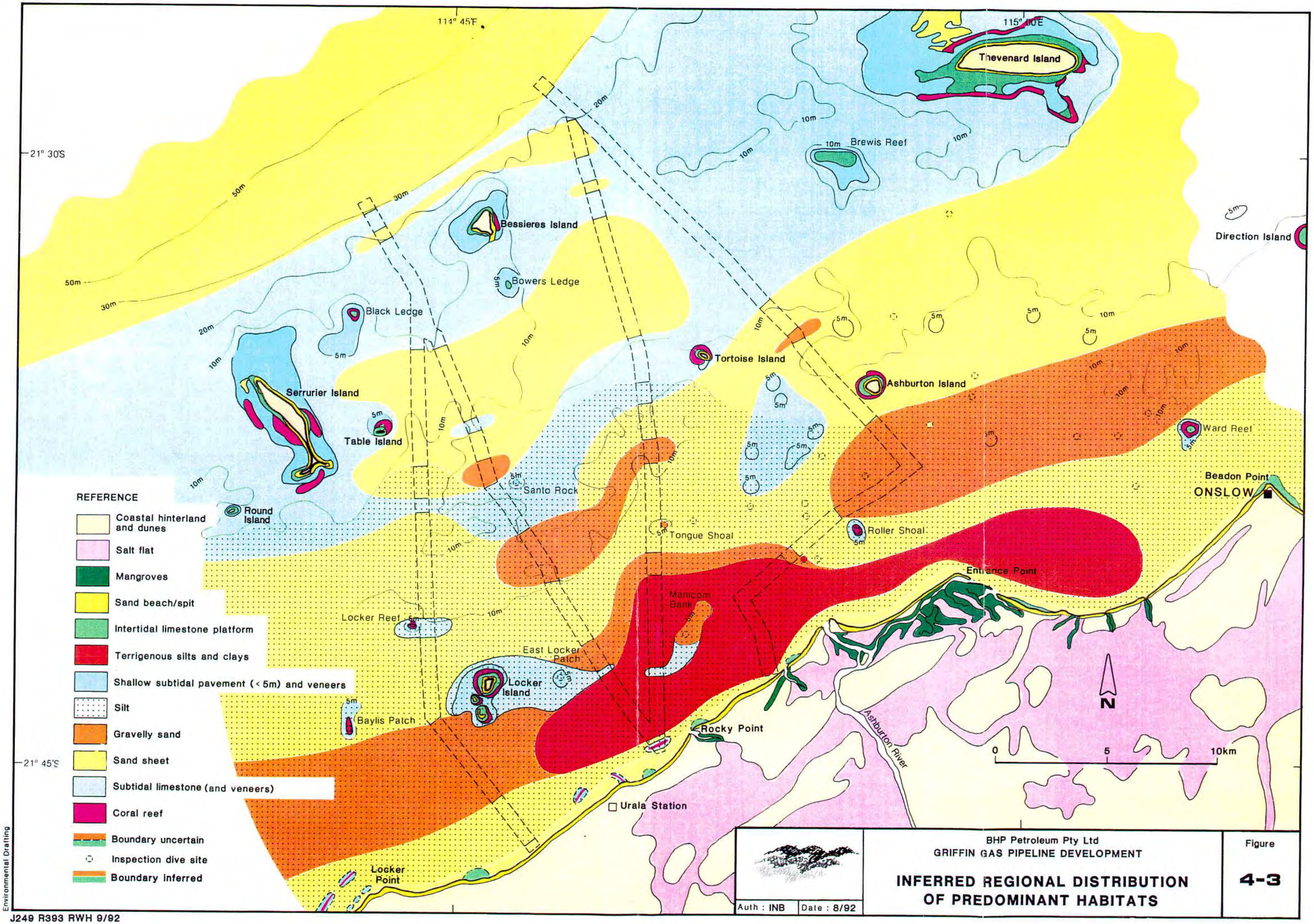
**BATHYMETRIC PROFILES AND HABITAT DISTRIBUTION ALONG POTENTIAL PIPELINE ROUTES**

Figure 4-2

Environmental Drafting

J249 R393 RWH 9/92

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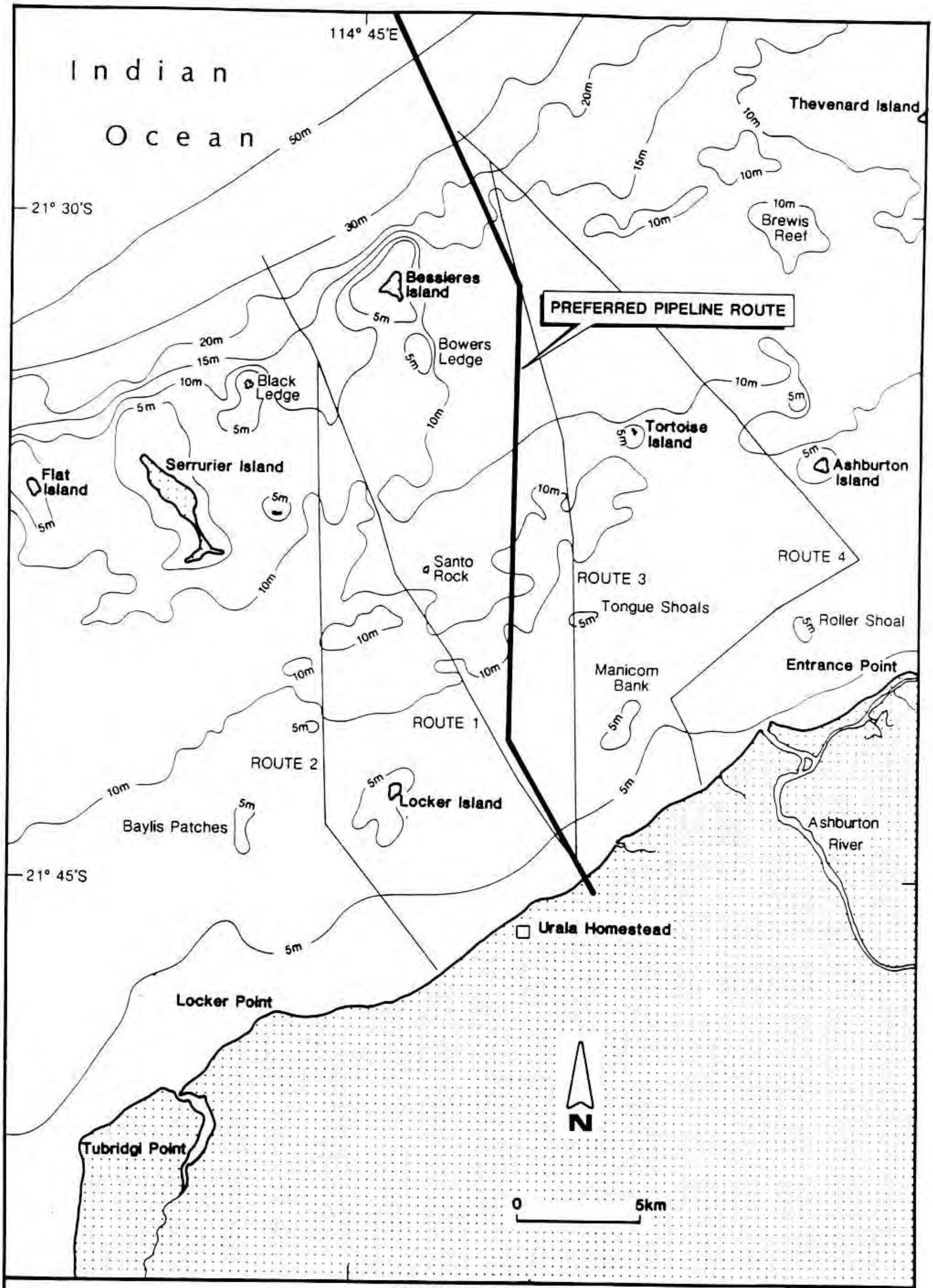
**INFERRED REGIONAL DISTRIBUTION OF PREDOMINANT HABITATS**

Figure 4-3

J249 R393 RWH 9/92

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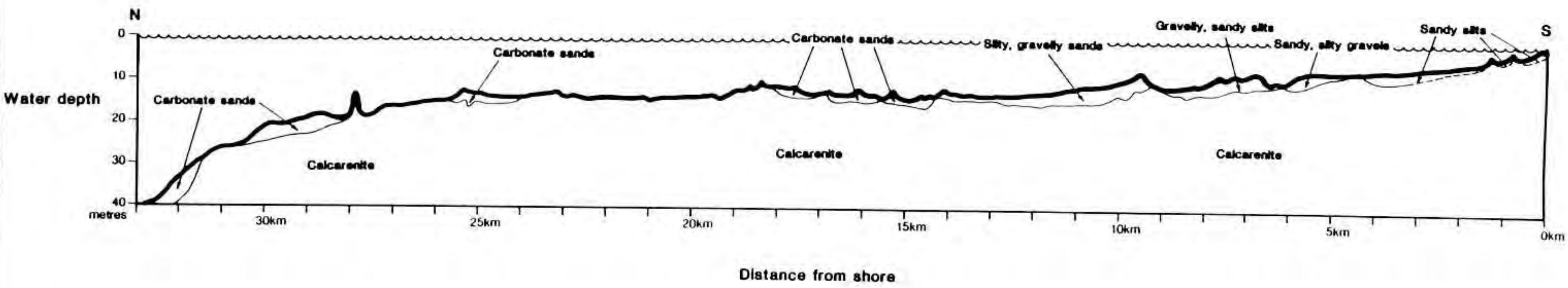
**PREFERRED ROUTE OF OFFSHORE PIPELINE**

Figure **4-4**

Environmental Drafting

J249 R393 RWH 9/92

BATHYMETRIC PROFILE ALONG PREFERRED PIPELINE ROUTE

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**BATHYMETRIC PROFILE AND SUBSTRATE TYPE ALONG PREFERRED PIPELINE ROUTE**

Figure **4-5**

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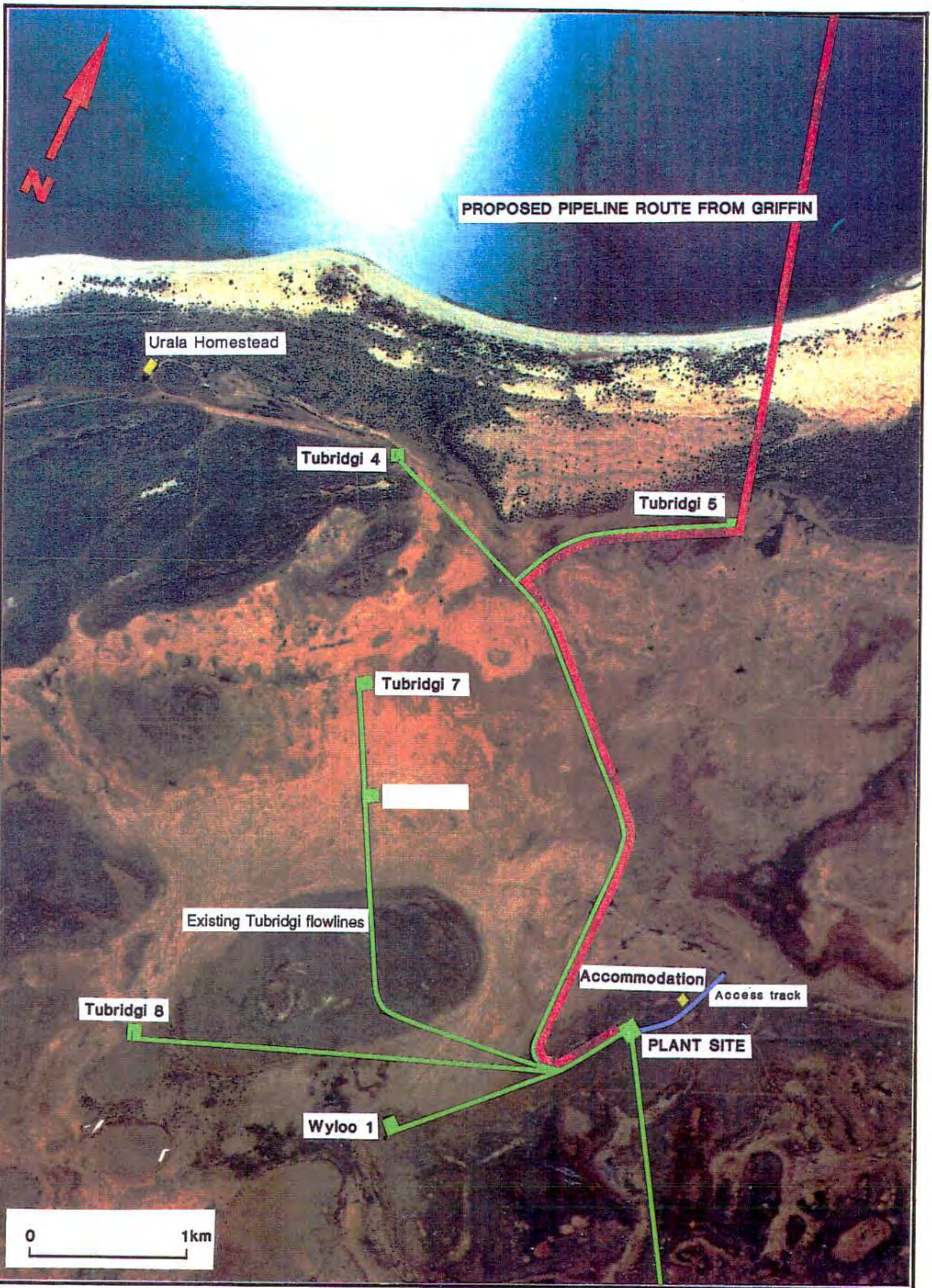


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GRIFFIN GAS PIPELINE DEVELOPMENT

**AERIAL VIEW OF SHORELINE CROSSING AND LOCATION OF PROPOSED GAS PLANT**

Figure **4-6**

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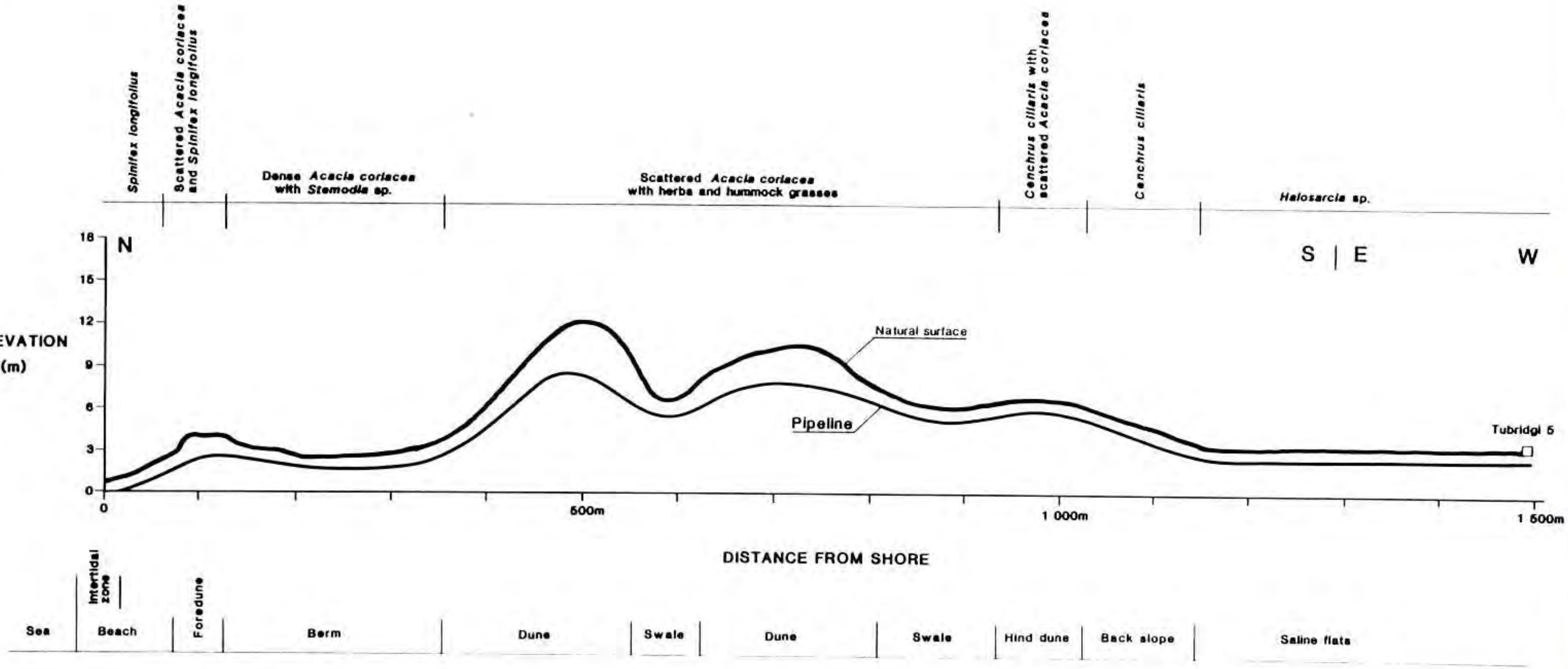


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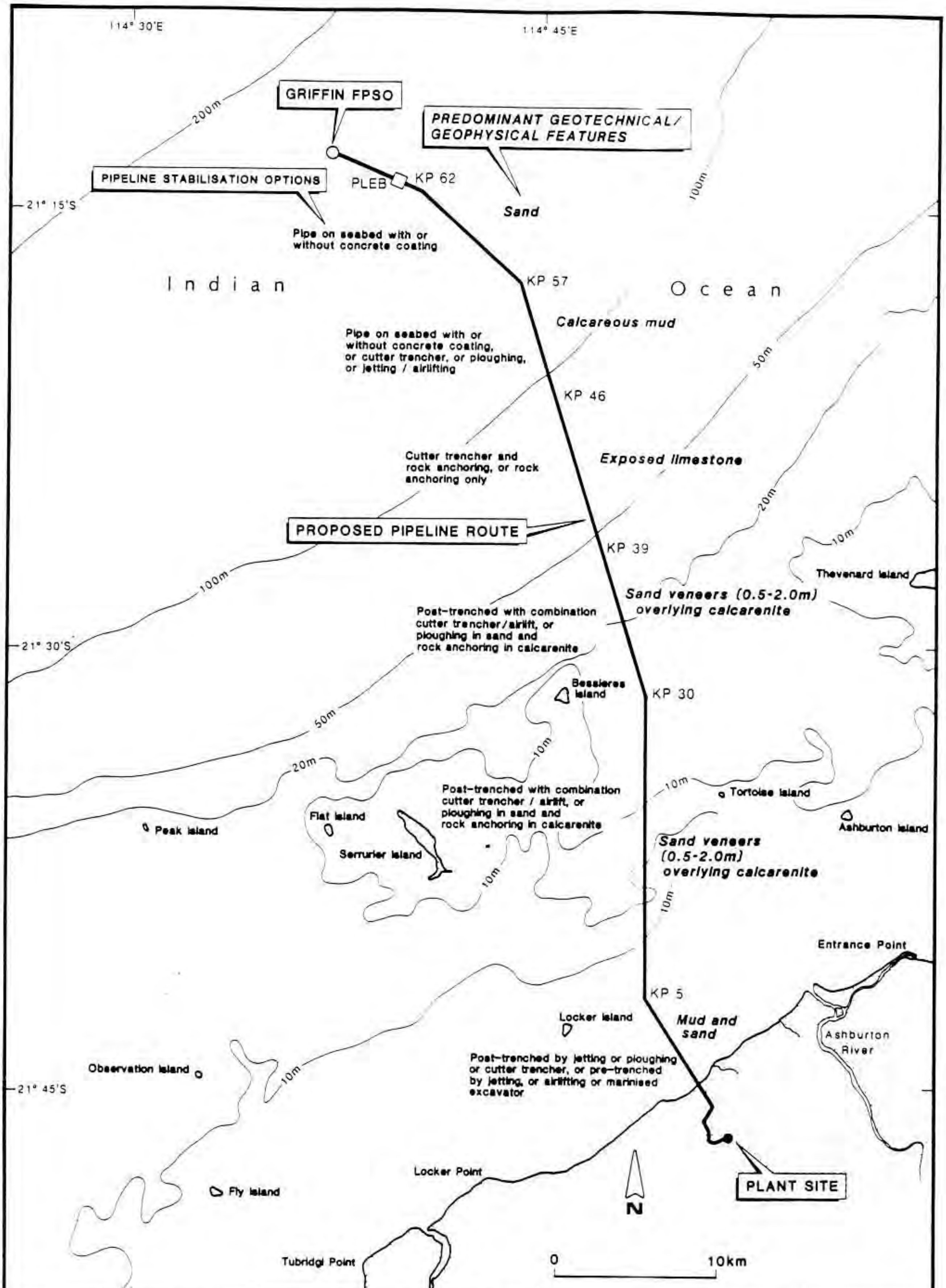
**PROFILE OF THE SHORELINE CROSSING ALONG THE PROPOSED ROUTE**

Figure **4-7**

Environmental Drafting

J249 R393 RWH 9/92

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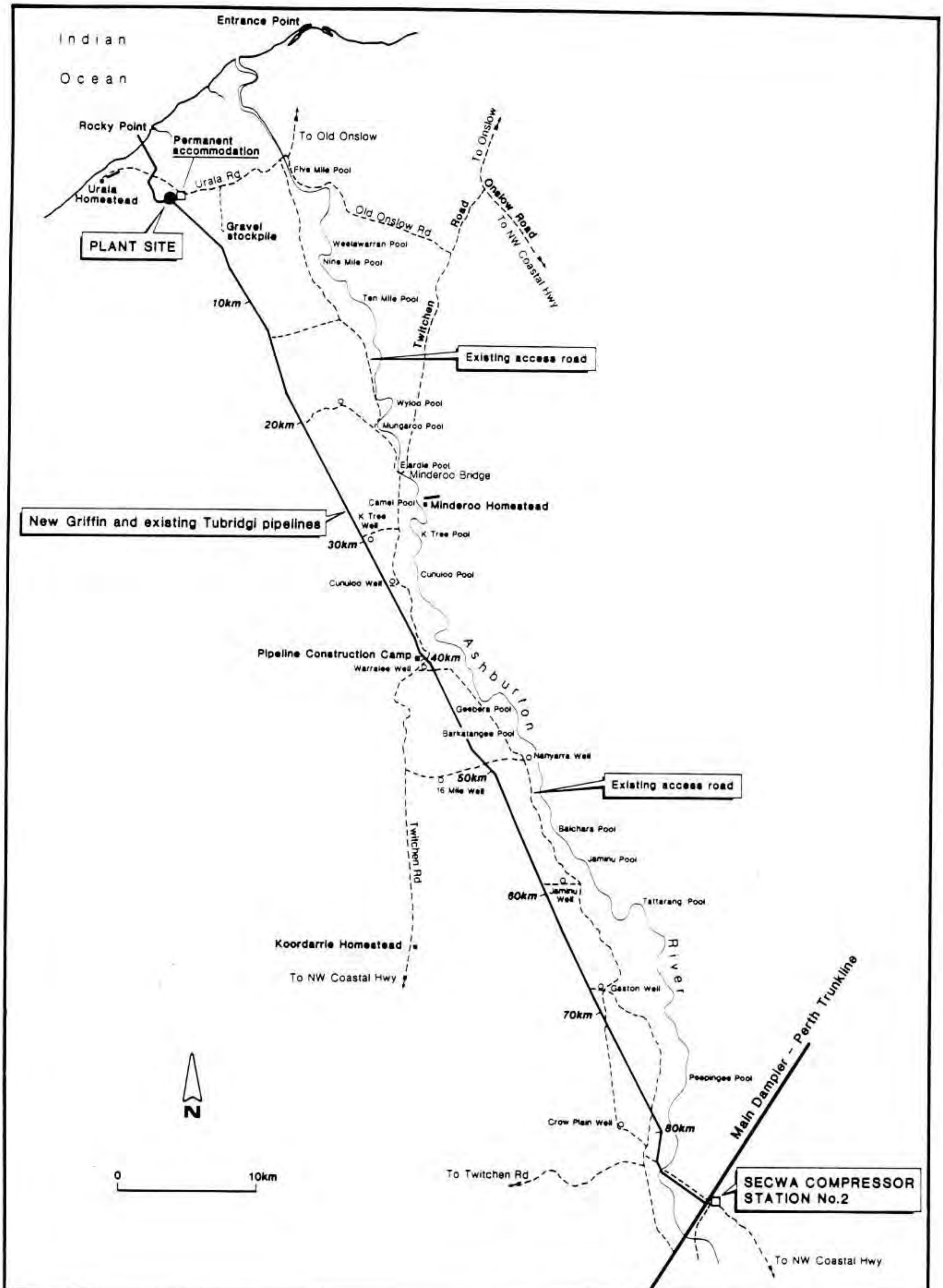
# STABILISATION OPTIONS FOR PROPOSED OFFSHORE PIPELINE

Figure 5-1

Environmental Drafting

J249 R393 RWH 9/92

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GRIFFIN GAS PIPELINE DEVELOPMENT

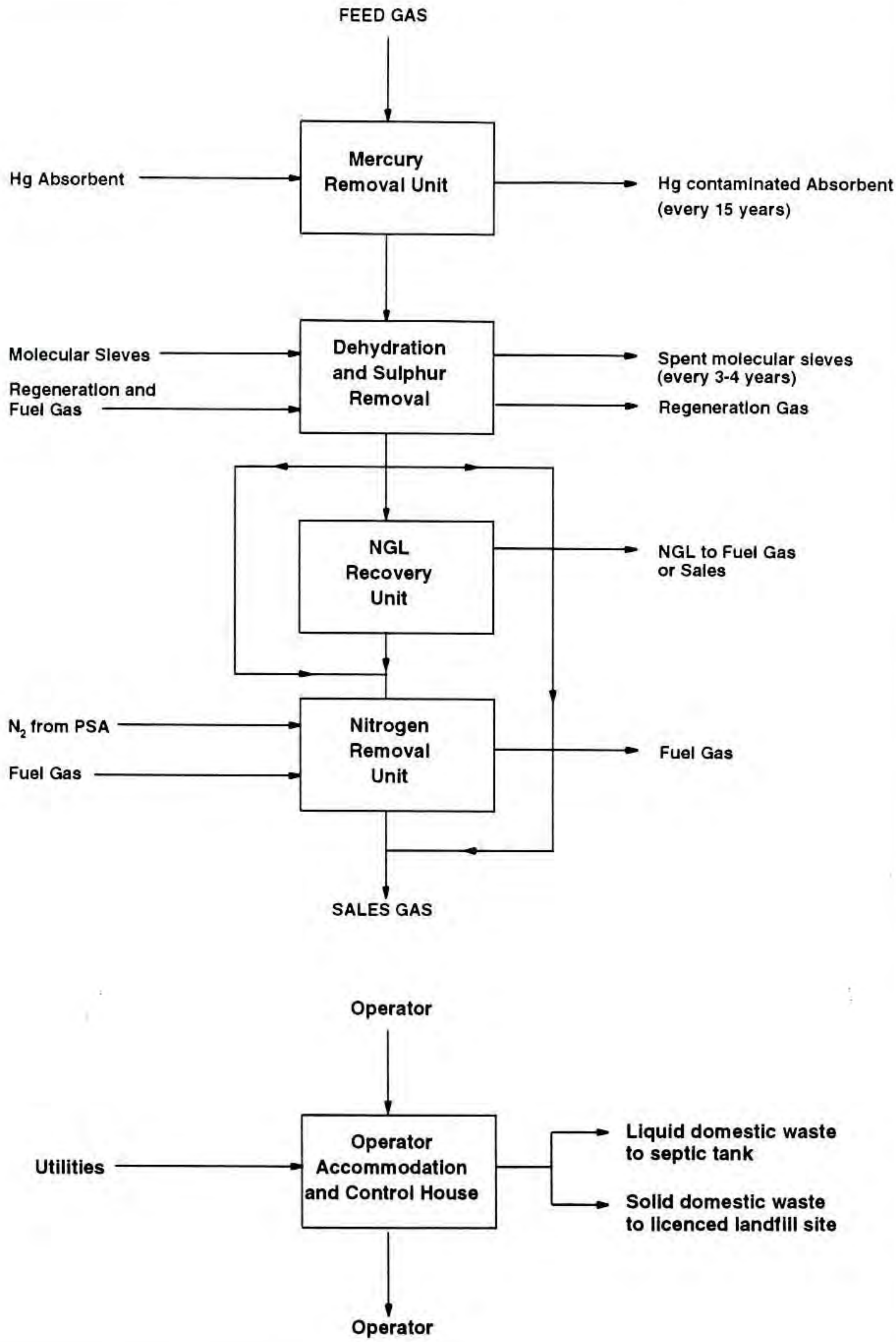
# PIPELINE EASEMENT FROM GAS PLANT TO SECWA GAS PIPELINE

Figure

**5-2**

Environmental Drafting

J249 R393 RWH 9/92

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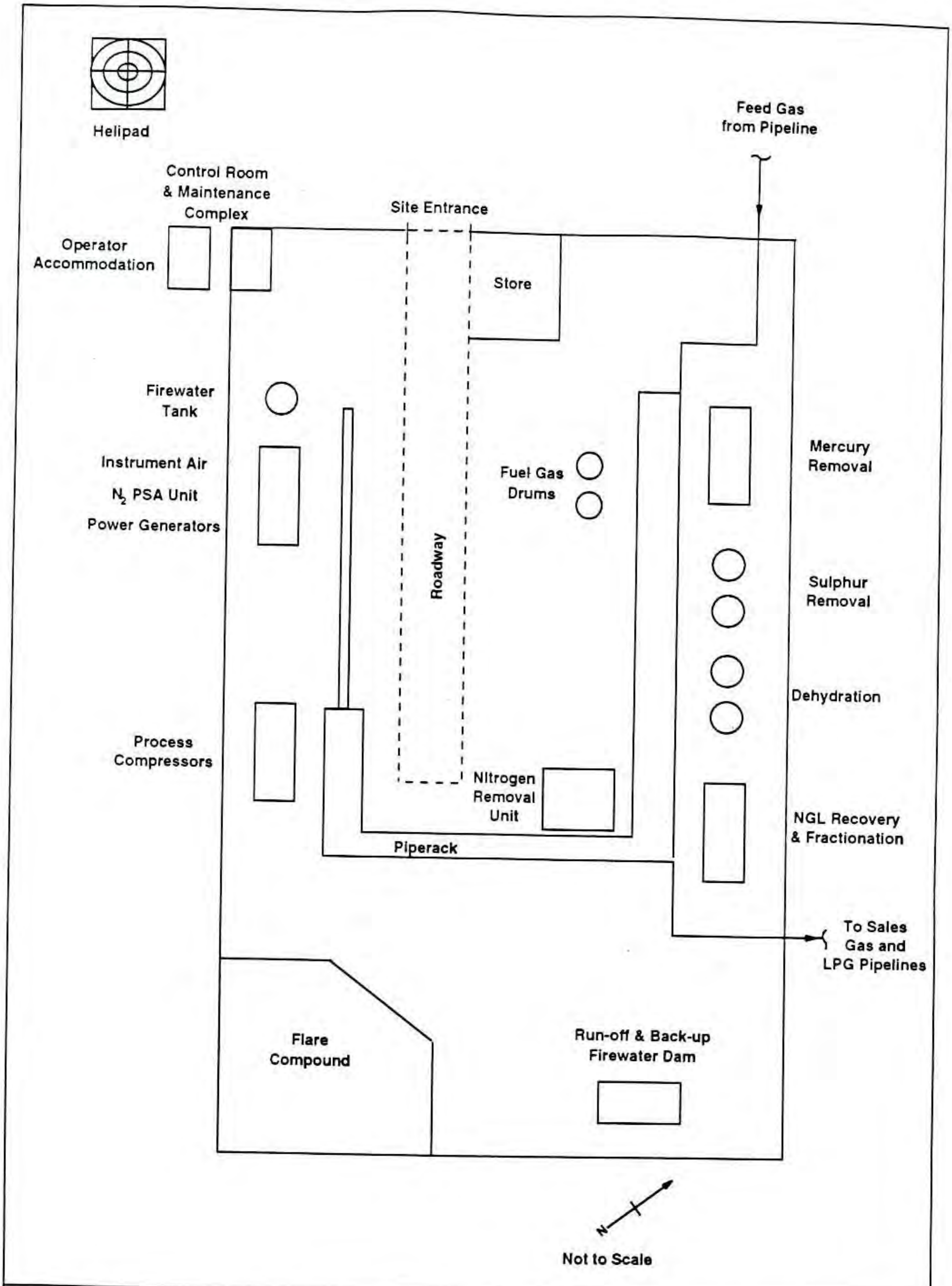
**ONSHORE GAS PLANT FLOW DIAGRAM**

Figure 5-3

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GRIFFIN GAS PIPELINE DEVELOPMENT

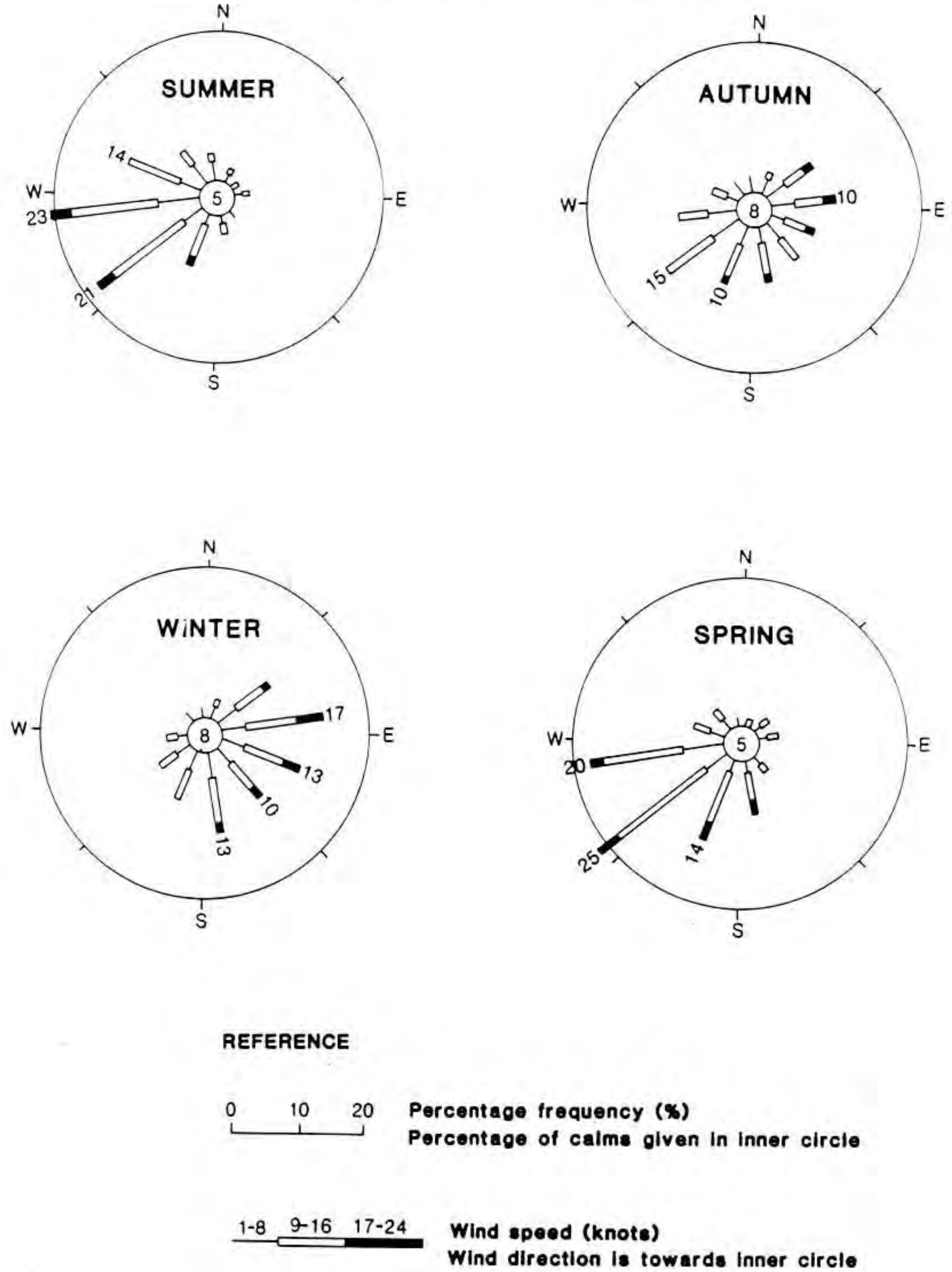
ONSHORE GAS PLANT LAYOUT

Figure 5-4

Plate 1: Visual Impression of Griffin Gas Treatment Facilities

# OFFSHORE WIND ROSES

20° - 23° S   114° - 120° E




Source : Jones, 1986

Environmental Drafting

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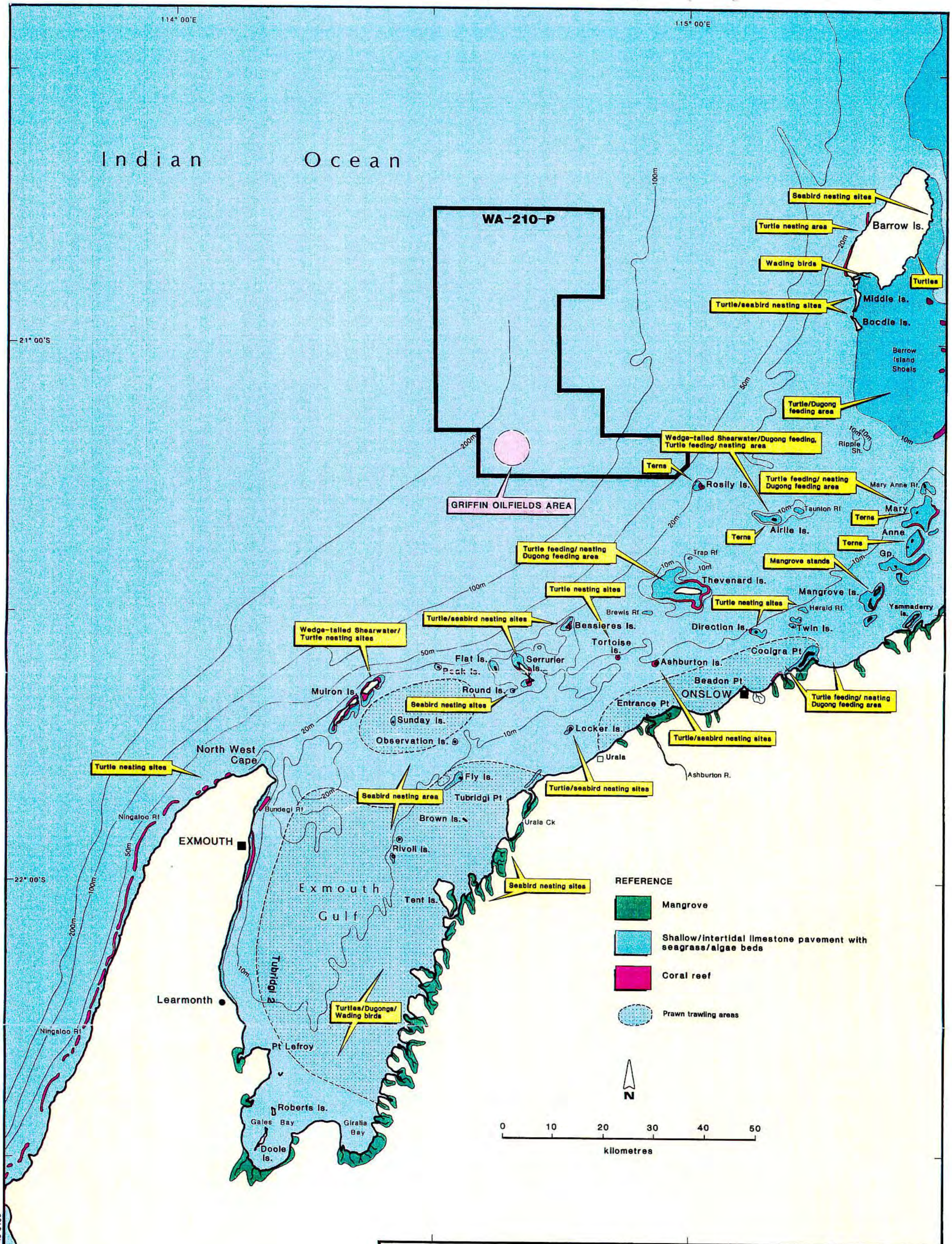
**OFFSHORE WIND ROSES**

Figure **6-1**

J249 R393 RWH 9/92

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**GENERALISED DISTRIBUTION OF SENSITIVE MARINE RESOURCES**

**North West Cape to Barrow Island**

Figure 6-2

Environmental Drafting (098) 40 8105

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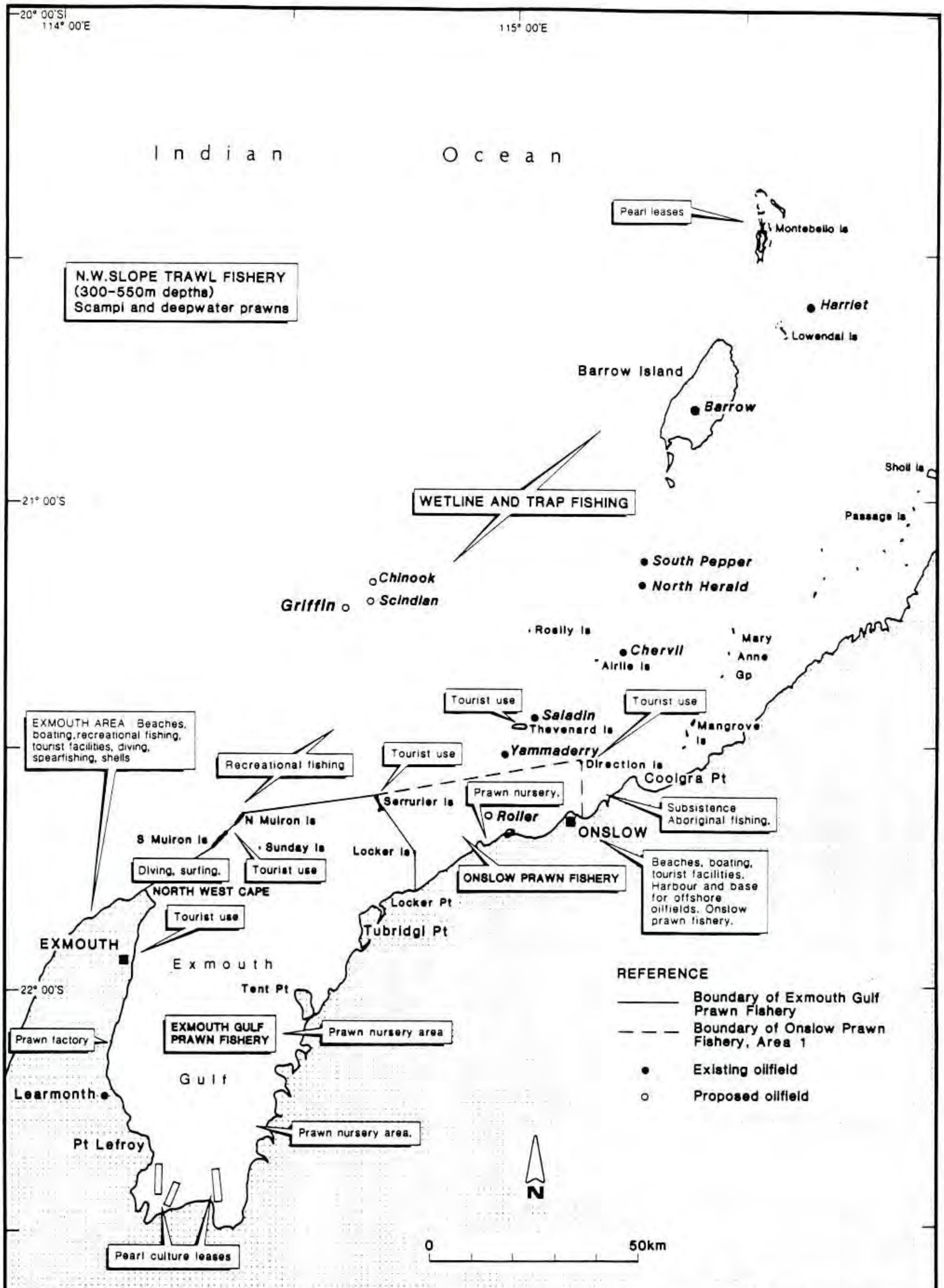
Prepared by LeProvost Environmental Consultants (09) 474 1933

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# HUMAN USES OF THE MARINE RESOURCES IN THE VICINITY OF THE PROPOSED PIPELINE

Figure 6-3

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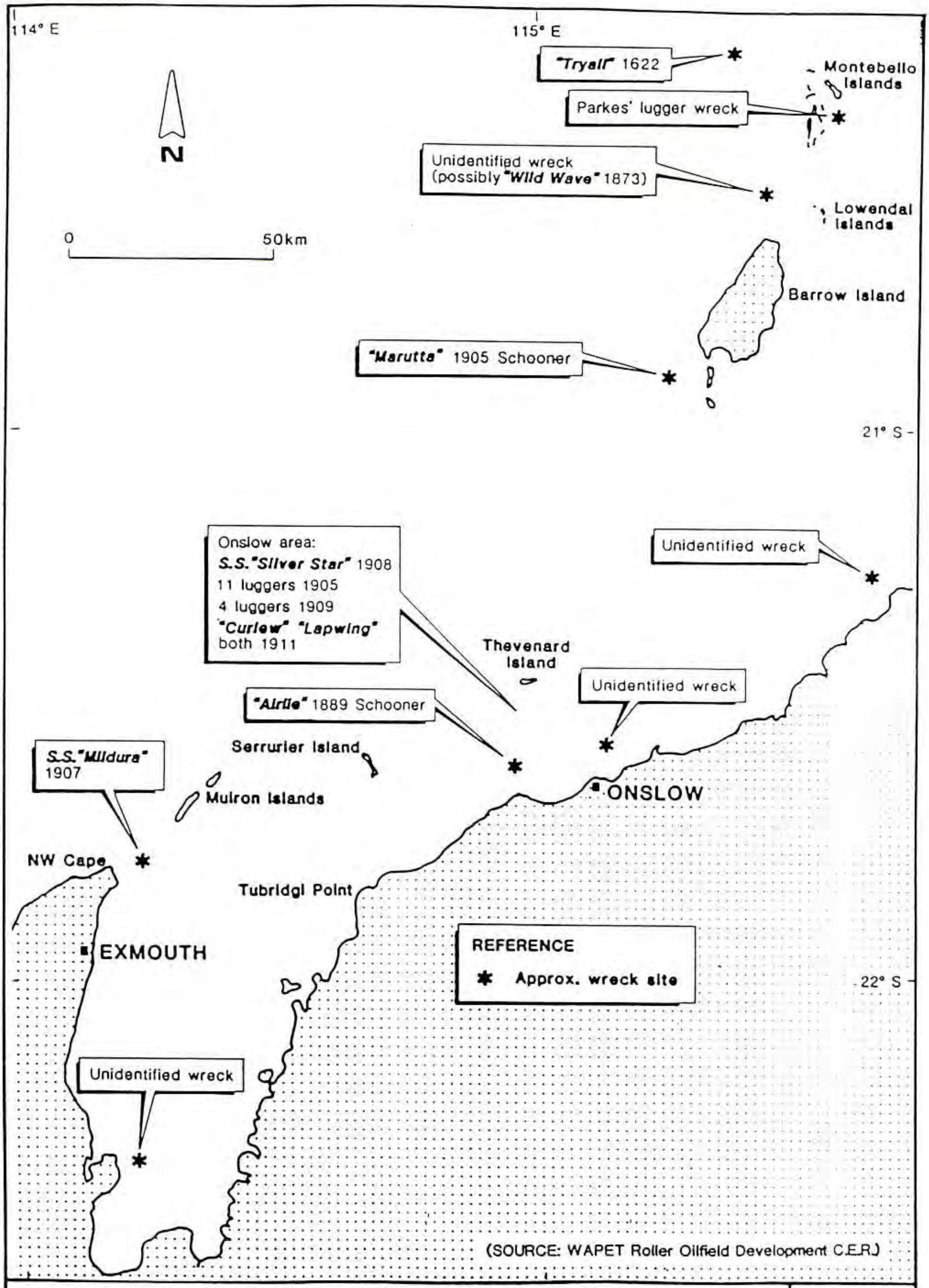


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## HISTORIC SHIPWRECKS IN THE AREA

Figure 6-4

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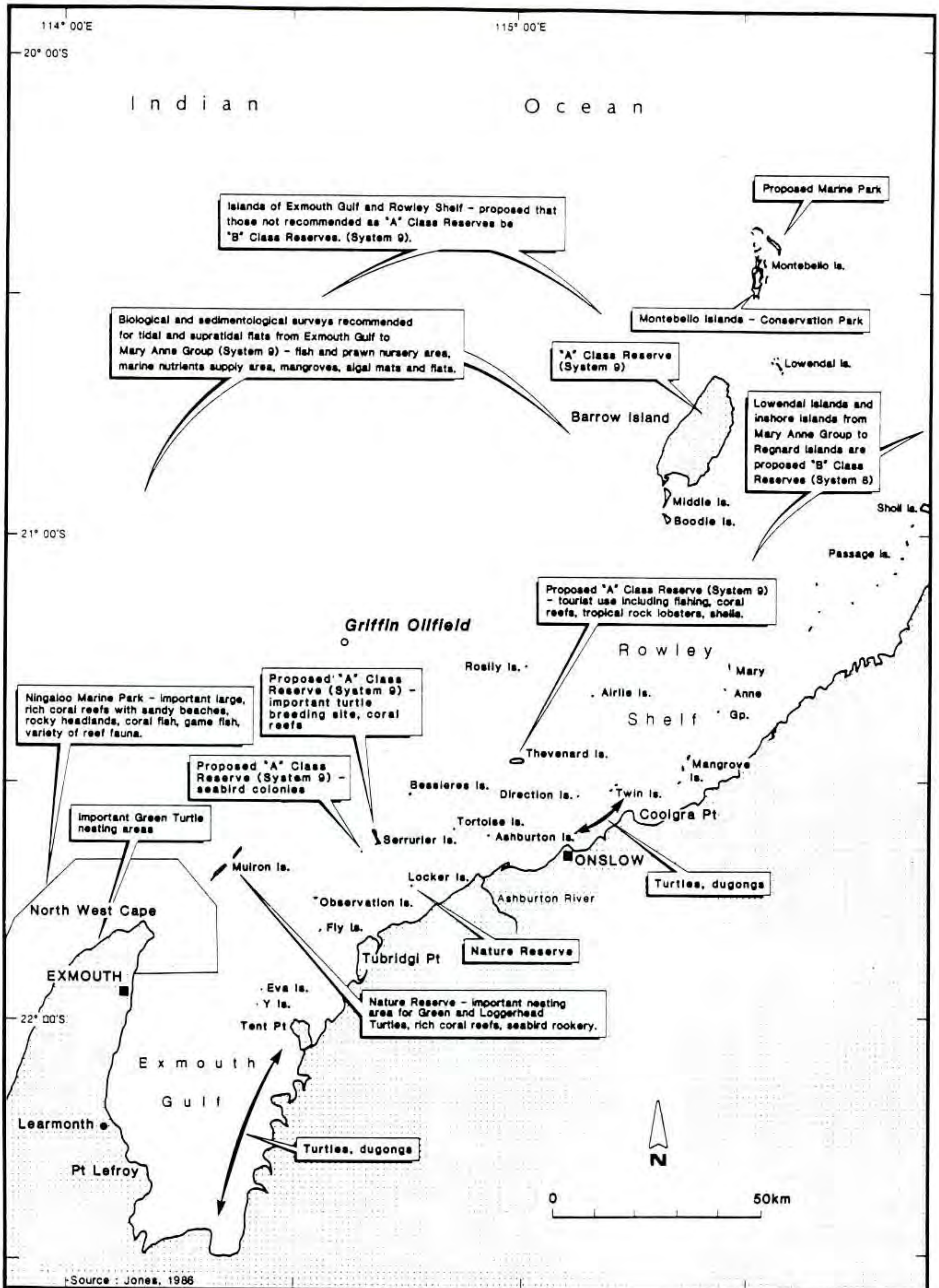


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# REGIONAL CONSERVATION ASSESSMENT

Figure 6-5

Environmental Drafting

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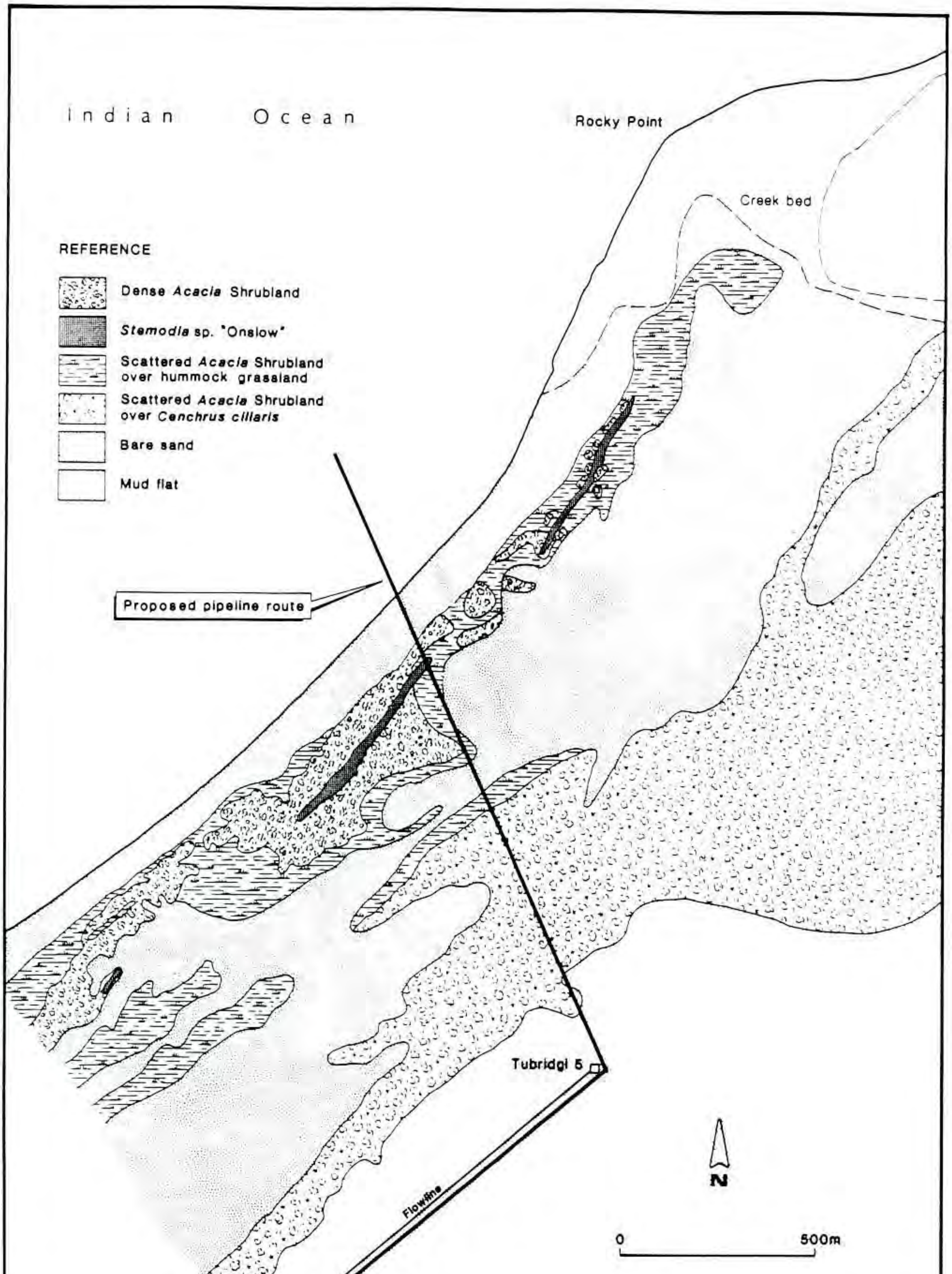


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**EXTENT OF Stemodia sp. "ONSLOW" AND ASSOCIATED VEGETATION AT SHORELINE CROSSING**

Figure 6-6

Environmental Drafting

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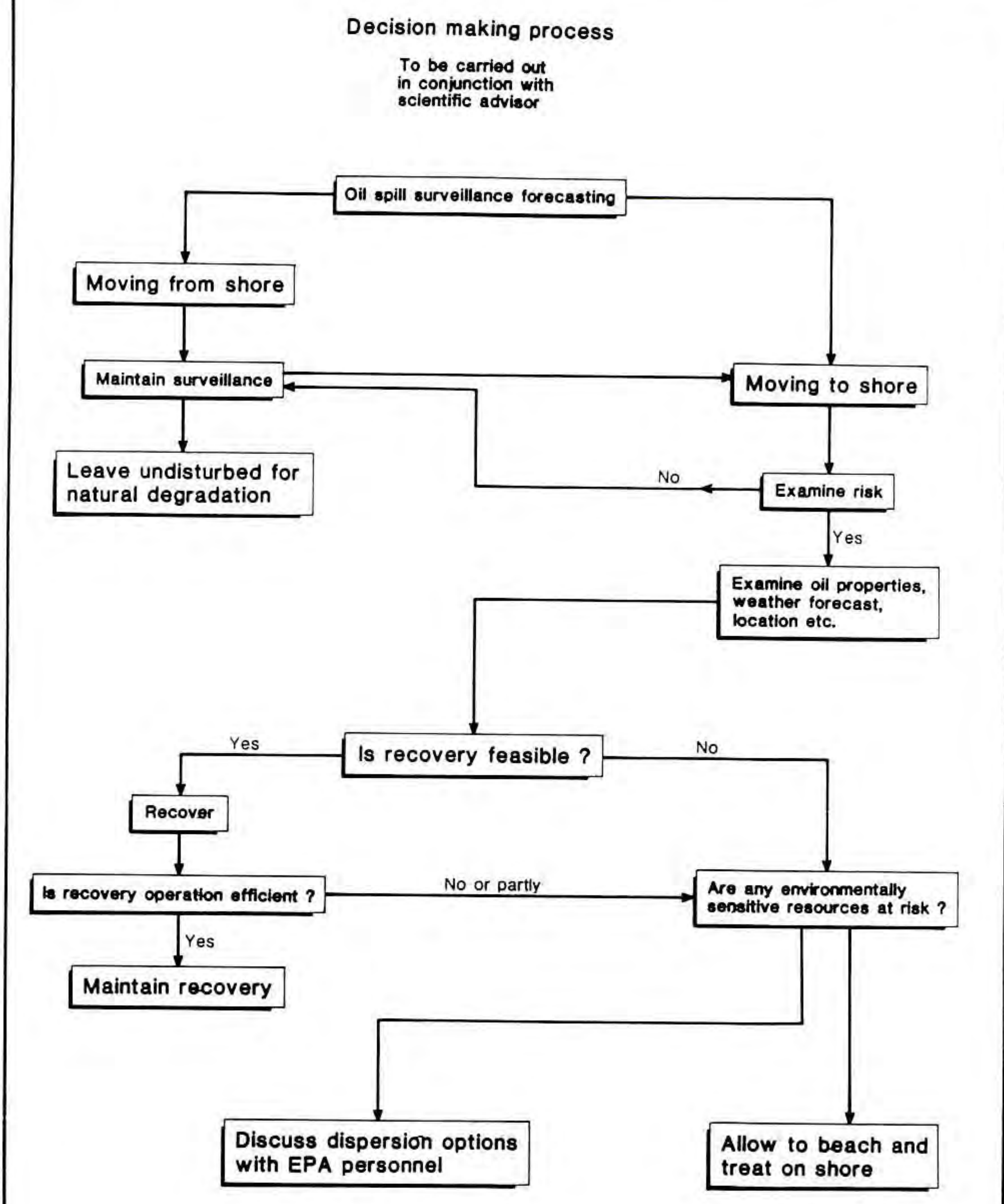


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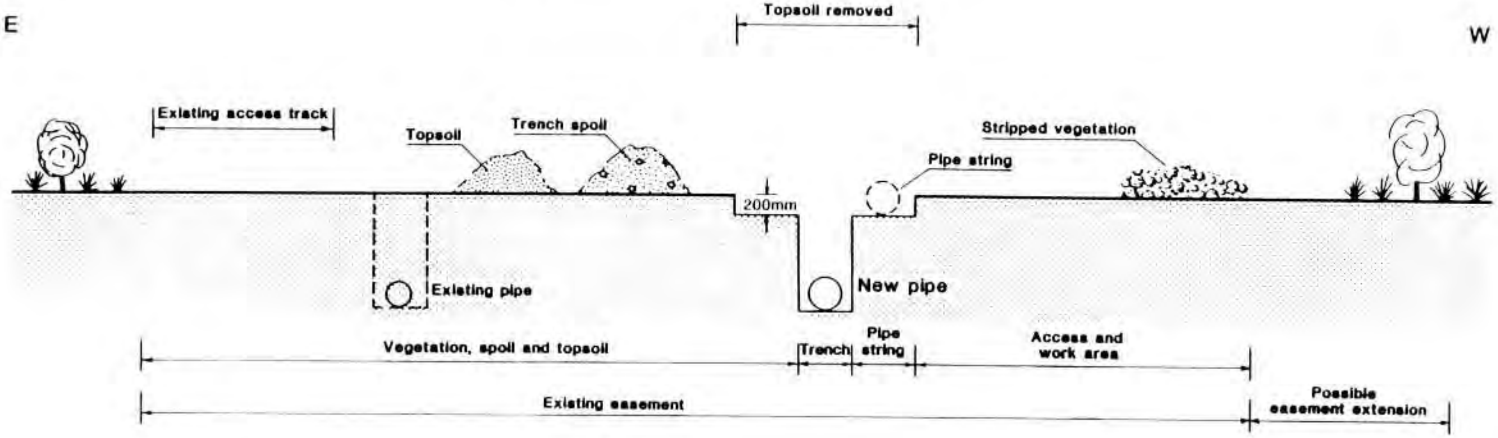
**EXAMPLE OF OSCP DECISION MAKING FLOW CHART**

Figure **8-1**

Environmental Drafting

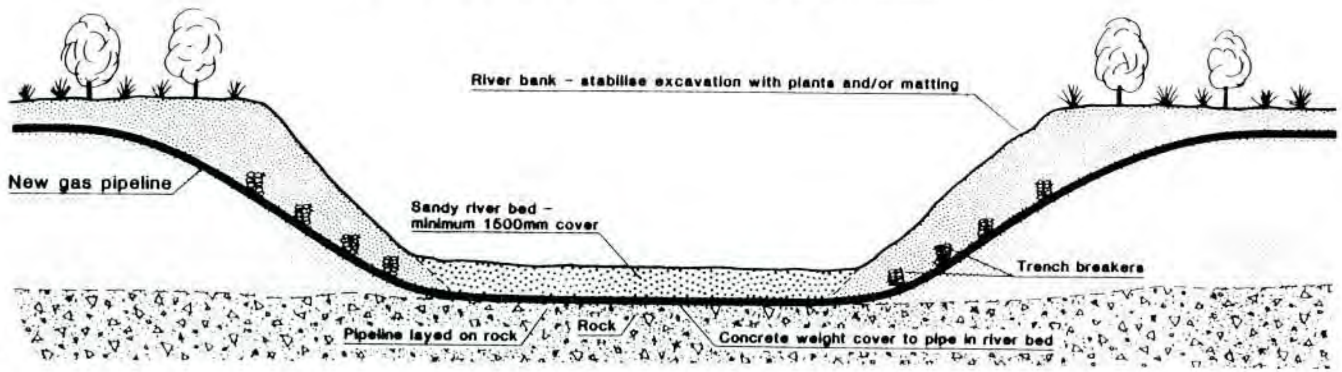
J249 R393 RWH 9/92

## VIEW SOUTH DOWN PIPELINE EASEMENT

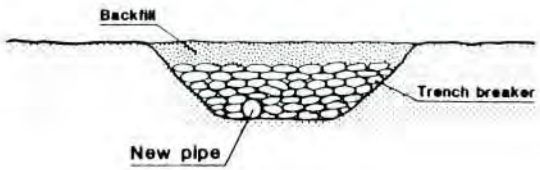





## TYPICAL CROSS-SECTION OF RIVER CROSSING




## TYPICAL CROSS-SECTION THROUGH TRENCH ON RIVER BANK




Not to scale

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GRIFFIN GAS PIPELINE DEVELOPMENT

**CROSS-SECTIONS OF THE PROPOSED PIPELINE EASEMENT AND RIVER CROSSING**

Figure **8-2**

Environmental Drafting
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