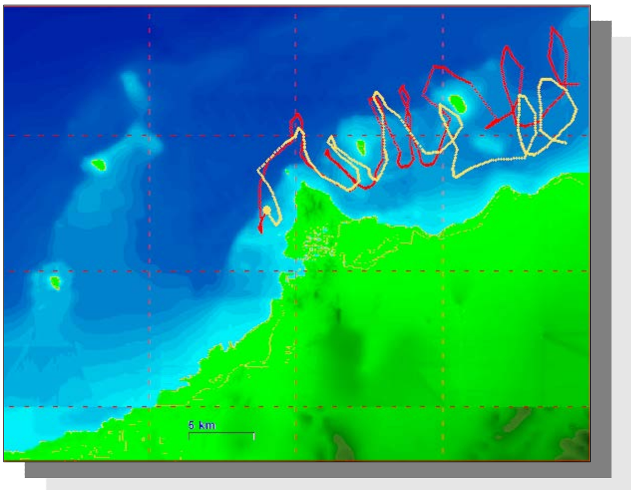
LeProvost Environmental Pty Ltd

Sino Iron Project

Marine Management Plan



Prepared for:

CITIC Pacific Mining Management Pty Ltd on behalf of Mineralogy Pty Ltd by LeProvost Environmental Pty Ltd, in association with GEMS, URS Australia and CITIC Pacific Mining Management Pty Ltd

December 2008

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December 2008

Acknowledgements

CITIC Pacific Mining Management Pty Ltd provided Sections 1, 2 and 4.

URS Australia Pty Ltd provided the majority of Section 3 and Appendix A.

LeProvost Environmental Pty Ltd provided Sections 5, 6 and 7, carried out the benthic habitat loss assessment and managed input from GEMS.

GEMS provided Appendices B, C and D.

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EXECUTIVE SUMMARY

This document

The purpose of this Marine Management Plan (MMP) is to address the requirements of certain items of Condition 7 of Statement 635, and thereby allow construction to commence for the Sino Iron Project (the Project) port at Cape Preston WA. Note that neither dredging nor desalination brine disposal are proposed as part of the port development addressed in this MMP. Both these activities will be addressed in separate documents, and submitted for review at an appropriate time. This MMP should be read in conjunction with the Construction Environmental Management Program – Phase 3 (EMPgm) (LeProvost Environmental, 2008), which addresses the requirements of Commitment 2 of Statement 635.

Background

Mineralogy Pty Ltd (the Proponent) proposes to develop the Project, which is for an iron ore mine, processing plant and port facility in the general location of Cape Preston, approximately 80 km south west of Karratha. CITIC Pacific Mining Management Pty Ltd (CPM) purchased the mining rights for the George Palmer ore-body from Mineralogy Pty Ltd via the Sino Iron takeover agreement that includes the right to proceed with further assessment and development of the Project. CPM will manage the development of the ore-body and associated processing and export infrastructure, and will function as the Project manager, while Mineralogy will remain the Project proponent.

Since the Minister for the Environment approved the Project in 2003, the proponent has carried out extensive port design studies including geotechnical investigations and bathymetric surveys in order to finalise the Project's port design. Based on the results of these studies and Project requirements, the Proponent has designed a port that is consistent in layout with the approved conceptual port.

The preferred port design, based on engineering, operability and economic considerations, consists of:

- a solid rock causeway between Cape Preston and the north-eastern corner of Preston Island
- a solid breakwater extending into deep navigable waters to the west of Preston Island
- barge loading infrastructure and wharves, materials offloading facility (MOF) and tug pens inside the breakwater small boat harbour
- an offshore trestle jetty for loading ocean going vessels with iron ore products extending NNW from the end of the causeway.

This port layout is based on minimising the volume of rock required to construct the port and gaining access to nearest navigable waters. A solid rock causeway is preferred over a trestle structure or culverted causeway because it will allow:

- far greater utility for heavy loads
- less risk of engineering failure (culverts are weak points)
- better spill and water quality protection
- substantially reduced time and cost to build.

The Proponent has carried out the hydrodynamic, and coastal stability investigations into the potential effects of its preferred design as required by Condition 7. These investigations have been undertaken by Global Environmental Modelling Systems (GEMS - Dr Graeme Hubbert and Matt Eliot respectively) who have also assessed the potential effects of the following two additional causeway designs:

- a fully trestled causeway between Cape Preston and Preston Island

- a solid rock causeway between the Cape and Preston Island with a 200 m wide culvert where water depth is greatest.

Hydrodynamic modelling studies

The GEMS hydrodynamic modelling studies carried out by Dr Hubbert (Appendix C) found that the port will not adversely affect regional water flows and tidal levels or flushing characteristics, or coral larvae dispersal from regionally significant reefs. The port will only have an effect locally within several hundred metres of primarily the southern side of the structure in the lee of the breakwater during ebb tides. This is because the vast majority of water flux around Cape Preston occurs in the deeper waters to the north and west of Preston Island. The shallows between the Cape and Preston Island are not a major water flow conduit and only allow flow of low volumes of water during periods of high spring tides.

Furthermore, the localised effects of a solid causeway are not mitigated by the inclusion of a 200 m wide culvert in the causeway, because:

- the tidal flux of water across the shallow platform is negligible in comparison to that around the north and west side of Preston Island
- the breakwater is the dominant feature affecting circulation in its lee; therefore there is no benefit to be gained by inclusion of culverts into the causeway.

Coastal stability assessment

The GEMS coastal stability assessment (Appendix D) concluded that construction of a port facility northwest of Preston Island was likely to cause local changes to the sediment transport regime and affect the beaches to the west of the Cape. A local reversal of sediment transport is expected to occur, causing erosion of the existing southern beach and deposition on the northern beach. The assessment also concluded that of the three causeway options investigated, a solid rock causeway is the preferred structure because it will result in less coastal instability to the beaches on the western side of Cape Preston than is likely to result from an open trestle structure. GEMS also found that a solid causeway with a 200 m wide culvert did not mitigate the effects of a solid causeway.

Although the coastal stability assessment confirmed that the impact to coastal stability associated with the solid causeway was insignificant, the potential worst-case effects of a solid rock causeway were found to be:

- a wedge-shaped deposition to the south of the causeway along a 0.6 km coastal length is expected to occur at an average rate of 5 m per year over 10 years on the basis of estimated longshore transport rates, with potentially greater rates under certain cyclonic conditions. This area is estimated to have a storage capacity of approximately 160,000 m^3 of material
- the deposition is likely to accumulate due to sand supply from the south, which will probably include transfer from the southern beach
- erosion of the existing southern beach may potentially occur around 0.9 m per year for approximately 10 years, along the 3.5 km length, resulting in a shoreward retreat of beach by some 10 m. This is likely to be an upper limit, as it will be reduced by any source of sediment supply.

It should be noted that the scale and rate of shoreline re-alignment anticipated from construction of a solid causeway is not large in comparison to the scale of natural changes that have occurred on the western beach in the last 42 years. It is clear from the mixed pattern of depositional beach ridges that occur landward of the western beach, that Preston Spit and the adjacent beach is highly dynamic and that it has experienced occasional episodes of both erosion and deposition.

The environmental significance of potential shoreline changes to nesting turtles appears to be minimal. In the longer-term, the accumulation on the south side of the causeway is likely to result in an extension of the available beach and dune area suitable for turtle nesting. However, in the short-term, potential erosion of the southern beach may result in extension of scarping already present along the northern section of this beach. The capacity for this to occur is limited along the majority of the beach due to the very low relief. Hence, even if the northern beach does slightly re-align as predicted by GEMS, it is considered most unlikely there will be a reduction in the cross sectional area of beach available for turtle nesting on the west coast of Cape Preston.

Benthic habitat loss assessment

CPM engaged LeProvost Environmental to undertake an assessment of the benthic habitat loss likely to result from construction of the preferred port layout. This assessment was based on habitat mapping undertaken by URS, with the significance of habitat loss being determined through the application of EPA Guidance Statement No. 29.

No indirect loss of coral habitat is anticipated from water turbidity generated during construction of the port. This is because the core material for the causeway will be 150 mm sized cobbles and for the breakwater 1 m sized boulders. Fines will be screened out at the quarry and hence water turbidity is expected to be minimal, transient and intermittent in nature, and will not represent either a sedimentation or light attenuation induced mortality risk to shallow water, wave washed corals. Note that the potential impacts of port construction (and their management) are addressed in the EMPgm (LeProvost Environmental, 2008).

The preferred port layout will sit on habitat types that are widespread in the region and are not considered regionally significant. Most of the habitats affected are not particularly sensitive, nor particularly biologically productive; however, the breakwater will bury coral habitat that occurs on the steep slope that runs along the north side of Preston Island. This habitat varies in coral cover from generally low to high in places (10% to >25%), and is comprised primarily of massive species (e.g. *Favids, Goneastrea* and *Porites*) plus *Turbinaria* recruits.

The proposed MOF located on the inside of the breakwater will also bury similar coral habitat, including the site referred to by the EPA in Condition 7-1 (Item 4). However, note that:

- this site was very small when originally described (refer Figure 12, URS (2008) (Appendix A, legend 21)
- URS (2008) was unable to locate this site, and concluded that it had been heavily damaged during the cyclone season of 2005-6.

As detailed in Section 3.10.5, URS found a number of other regionally significant reefs in the vicinity of Cape Preston that are much larger in area and higher in cover than the small site referred to above. The nearest of these significant reefs to the port layout is approximately 2 km to the south of the breakwater.

The total coral habitat loss from direct burial by construction of the breakwater and MOF landing is estimated to be 1.8 ha. It has also been assumed that a further 1.45 ha of low to high (10 to >25 %) coral cover habitat may be lost in the long term between the end of the MOF landing and the western tip of Preston Island as a result of port operations potentially resulting in silt deposition, spills, or physical damage. Whilst this loss may not happen, it is difficult to be certain that it won't happen, and therefore a conservative approach has been taken by including it at this stage within the habitat loss calculation. Adding these two areas together results in a loss of approximately 2.4 % of high coral cover habitat within the management unit, and approximately 0.7 % of available low to moderate coral cover. Such percentages are well within the EPA's cumulative loss threshold (CLT) of 10 % for Development areas.

Despite this initial impact, the loss of coral habitat at Preston Island is likely to be substantially offset in the medium to longer term (10- 25 years) by the development of a new coral habitat on the outer slopes of the breakwater. The outer edge of the breakwater, from where it starts at the end of the causeway to inside the semi circular nib on the western end, is approximately 1.5 km long. If this length is colonised by corals to the same depth and cover that occurs on the natural reef slope, this translates into a potential coral habitat loss offset of approximately 11.25 ha. If coral colonises the total slope available, the potential offset could be as much as 23 ha.

Furthermore, the breakwater will provide substantial protection from wave energy during cyclones. As a result, the coral habitat that occurs immediately to west and south west of Preston Island is considered likely to develop into a more stable community, with an increase in coral abundance, cover and perhaps even diversity i.e. more fragile species such as staghorn and plate *Acropora* sp. may be able to survive in the protected area.

On the basis of this information, the port is considered likely to deliver a substantial net increase in coral abundance in the vicinity of Preston Island within a period of approximately 10 years. Furthermore, the cryptic habitat provided by the boulders and armouring structures will be colonised by a wide range of marine fauna and develop into a substantial artificial reef that will markedly increase local biological productivity.

In addition, the trestle jetty is also likely to develop into a substantial artificial reef structure as fouling organisms colonise the piles and fish take up residence in their vicinity.

It is therefore considered that the small area of coral habitat that will be lost by direct placement of the breakwater and MOF, plus that which may be lost from ongoing port operations, will be more than offset by the new coral that is expected to develop on the outside of the port in the medium to long term. Given that a substantial offset for coral habitat loss is likely, and given that none of the large and very high cover regionally significant coral reefs in proximity to the port are at risk from its construction, it is considered that the port presents minimal risk to abundance of coral resources in the region.

Monitoring and contingency actions

While it is considered unlikely that the port will result in any significant impacts to coastal stability at Cape Preston, appropriate monitoring and contingency actions to mitigate any potential impacts have been identified (Section 6). In addition, a program will be implemented to monitor the cover and health of corals at sites in proximity to the port and at all regionally significant reefs. Contingency actions to encourage recruitment of corals to the port have also been identified, and will be implemented if necessary.

Conclusion

The Proponent has demonstrated that the Project port will have minimal adverse effect on regional coastal water movements (including coral larvae dispersal), tidal flushing, sedimentology and beach alignment, and both availability of turtle nesting habitat and coral habitat cover. The environmental risks associated with the presence of the port and the changed bathymetry in the vicinity of the Cape and Preston Island are considered to be low and manageable. The benthic habitats that will be lost are not considered regionally significant, are widespread, and will be more than offset by the artificial reef communities that will develop on both the breakwater and offshore trestle jetty.

On the basis of the above information, it is considered that the port meets the relevant EPA objectives described in Statement 635, and in other EPA policies (e.g. EPA Guidance Statement No. 29), and should therefore be considered acceptable to the EPA.

1. INTRODUCTION

1.1 THIS DOCUMENT

The purpose of this Marine Management Plan (MMP) is to satisfy of certain items of Condition 7 of Statement 635, and thereby allow construction of the Sino Iron Project port at Cape Preston to commence. The port construction impacts are addressed in the Project Construction Environmental Management Program - Phase 3 (EMPgm) (LeProvost Environmental, 2008), which should be read in conjunction with this MMP.

1.2 PROJECT BACKGROUND

Mineralogy Pty Ltd (the Proponent) proposes to develop an iron ore mine, processing plant and port facility in the general location of Cape Preston, approximately 80 km south west of Karratha (the Sino Iron Project (the Project) (Figure 1). The Project has been assessed by the Environmental Protection Authority (EPA) at Public Environmental Review (PER) level. The PER (Austeel, 2000) was submitted in December 2000 and a Supplementary Environmental Review (SER) (Austeel, 2002) was submitted in February 2002 to address changes to the original proposal. The Minister for the Environment approved the Project under Statement 635 in October 2003.

As the detailed design and port studies had yet to be completed, the approved Project was described in conceptual terms in the PER, SER and Statement 635. The marine aspects of the Project described in documentation submitted to EPA and in Statement 635 included the construction and operation of a:

- bridging structure or rock causeway between Cape Preston and Preston Island
- small boat harbour and materials offloading facility
- jetty structure for loading large bulk ore carriers in deep waters to the northwest of Preston Island
- seawater intake and brine outfall for an onshore desalination plant
- dredged navigation channel trending north and northwest from the jetty.

CITIC Pacific Mining Management Pty Ltd (CPM) purchased the mining rights for the George Palmer ore-body from Mineralogy Pty Ltd via the Sino Iron takeover agreement that includes the right to proceed with further assessment and development of the Project. CPM will manage the development of the ore-body and associated processing and export infrastructure, and will function as the Project manager, while Mineralogy will remain the Proponent for the Project.

1.3 PROJECT PORT

Since the Minister for the Environment approved the Project in 2003, the proponent has carried out extensive port design studies including geotechnical investigations and bathymetric surveys in order to finalise the Project's port design. Based on the results of these studies and Project requirements, the Proponent has designed a port that is consistent with the approved conceptual port, and that minimises impacts to the marine environment.

This document applies to the port facilities and operations described in Section 4, which do not require dredging. Prior to the commencement of dredging activities, the Proponent will amend this MMP as required, and resubmit it to relevant Government agencies for approval.

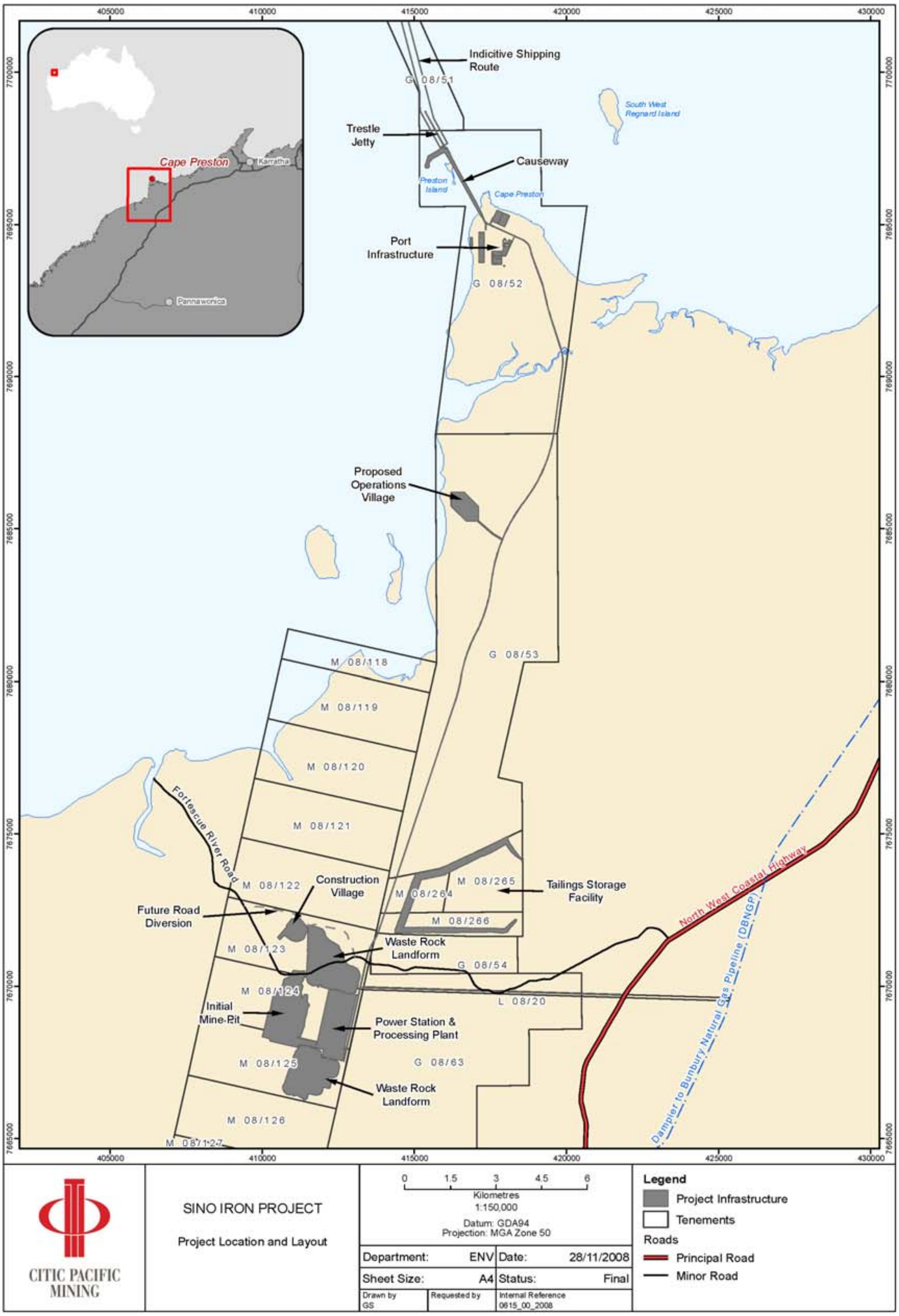

Figure 1 Project location and layout

1.4 BASIS, SCOPE AND STRUCTURE OF DOCUMENT

1.4.1 Statement 635

The requirement for a MMP to be prepared for the Project is established in Condition 7 of Statement 635.

Condition 7 of Statement 635 states:

7 Marine Management Plan

7-1 Prior to commencement of construction of the jetty or commencement of dredging (whichever happens first) at Cape Preston, the proponent shall prepare a Marine Management Plan, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

The objectives of this Plan are:

- *to accurately predict changes in coastal water movements, quality, residence times, bathymetry, sedimentology, beach alignment and habitat cover associated with the project; and*
- *to allow for appropriate management measures to be identified and implemented.*

This Plan shall address, as part of the design process for the project:

1. *detailed marine surveys to establish existing regimes of currents, bathymetry, sedimentology, shore alignment and habitat cover, and modelling to predict the changes to those regimes associated with the construction and operation of a causeway between Cape Preston and Preston Island;*
2. *the design of bridging structures or a rock causeway, including open sections if required, to demonstrate that the regimes described in (1) above will not be adversely impacted;*
3. *the significance of, and changes to, habitats associated with dredging and dredge spoil dumping operations, and strategies to manage any associated environmental impacts;*
4. *the means to avoid significant damage to the high cover coral community at survey Location 9 to the north of Preston Island, including avoidance of dredging and spoil dumping during coral spawning events, from the construction and operational stages of the project;*
5. *detailed modelling of the areas of influence associated with the wastewater outfall location options with regard to temperature, salinity and discharged additives; and associated environmental effects;*
6. *coastal surveys to track changes, carried out for a sufficient period after construction and submitted to the Environmental Protection Authority, to monitor the effects of the bridging structure or rock causeway and the wastewater outfall, together with other potential impacts from emissions and dust, on mangroves, sandy beaches, or other coastal and marine ecosystems, including the corals off Preston Island; and*
7. *strategies to restore environmental quality to acceptable levels if surveys referred to in (6) above demonstrate that significant impacts have occurred to mangroves, corals, beaches, nursery habitats or other sensitive coastal and marine ecosystems.*

7-2 The proponent shall implement the Marine Management Plan required by condition 7-1.

7-3 The proponent shall make the Marine Management Plan required by condition 7-1 publicly available, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

1.4.2 Scope and structure of document

Table 1 shows where in the MMP the requirements of Condition 7 of Statement 635 are addressed.

Table 1 Scope and structure of MMP

Reference in Statement 635	Required content	Section content addressed in MMP
Condition 7-1, Item 1	Detailed marine surveys to establish existing regimes of currents, bathymetry, sedimentology, shore alignment and habitat cover, and modelling to predict the changes to those regimes associated with the construction and operation of a causeway between Cape Preston and Preston Island	Sections 3 and 5, Appendices A - D
Condition 7-1, Item 2	The design of bridging structures or a rock causeway, including open sections if required, to demonstrate that the regimes described in row above will not be adversely impacted	Section 5 Appendices C and D
Condition 7-1, Item 3	The significance of, and changes to, habitats associated with dredging and dredge spoil dumping operations, and strategies to manage any associated environmental impacts	Not addressed at this stage as no dredging currently required.
Condition 7-1, Item 4	The means to avoid significant damage to the high cover coral community at survey Location 9 to the north of Preston Island, including avoidance of dredging and spoil dumping during coral spawning events, from the construction and operational stages of the project	Section 5.6 Appendix A
Condition 7-1, Item 5	Detailed modelling of the areas of influence associated with the wastewater outfall location options with regard to temperature, salinity and discharged additives; and associated environmental effects	Item to be addressed in the project Wastewater Outfall Management Plan
Condition 7-1, Item 6	Coastal surveys to track changes, carried out for a sufficient period after construction and submitted to the EPA, to monitor the effects of the bridging structure or rock causeway and the wastewater outfall, together with other potential impacts from emissions and dust, on mangroves, sandy beaches, or other coastal and marine ecosystems, including the corals off Preston Island	Section 6
Condition 7-1, Item 7	Strategies to restore environmental quality to acceptable levels if surveys referred to in row above demonstrate that significant impacts have occurred to mangroves, corals, beaches, nursery habitats or other sensitive coastal and marine ecosystems	Section 6

1.5 SEQUENCE FOR IMPLEMENTATION OF PROJECT PORT

The port will be designed, constructed and operated in compliance with the Conditions and Proponent Commitments in Statement 635. Statement 635 requires the preparation of the following three marine management plans for the Project:

- Marine Management Plan (Condition 7)
- Wastewater Outfall Management Plan (Condition 8)
- Port Environmental Management Plan (Condition 9).

Recognising the need for these plans to be submitted and approved in a logical sequence, the MMP and EMPgm (LeProvost Environmental, 2008) are the management plans that require approval prior to port construction commencing. Construction and operation of the Project wastewater outfall will be addressed in the Wastewater Outfall Management Plan, and port operations will commence subject to approval of the Port Environmental Management Plan (Figure 2).

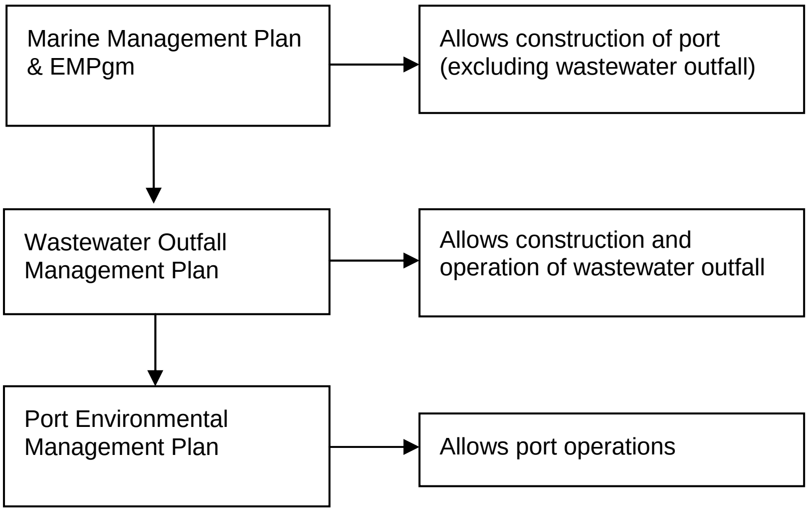

Figure 2 Sequence for implementation of Project port

1.6 APPLICATION OF POLICY AND GUIDELINES

1.6.1 Proposed Regnard Marine Management Area

The proposed Regnard Marine Management Area is mooted for the mainland coastal areas extending from Eaglehawk and West Intercourse Islands westwards to South West Regnard Island (Figure 3). This management area replaces the former proposed Cape Preston Marine Management Area (CALM 2005) that extended to the west of Cape Preston as far as the Fortescue River mouth. The westward extension of the proposed Cape Preston Marine Management Area has now been deleted as this included proposed port facilities and areas covered by State Agreements Acts (pers comm. Dr F Stanley, Department of Environment and Conservation (DEC), 2007).

DEC has been preparing for the formal gazettal of the proposed Regnard Marine Management Area under the provisions of the *Conservation and Land Management Act 1984*. It is understood that gazettal has been delayed to a future date that is yet to be determined (pers comm. Kath Simpson, DEC, October 2008).

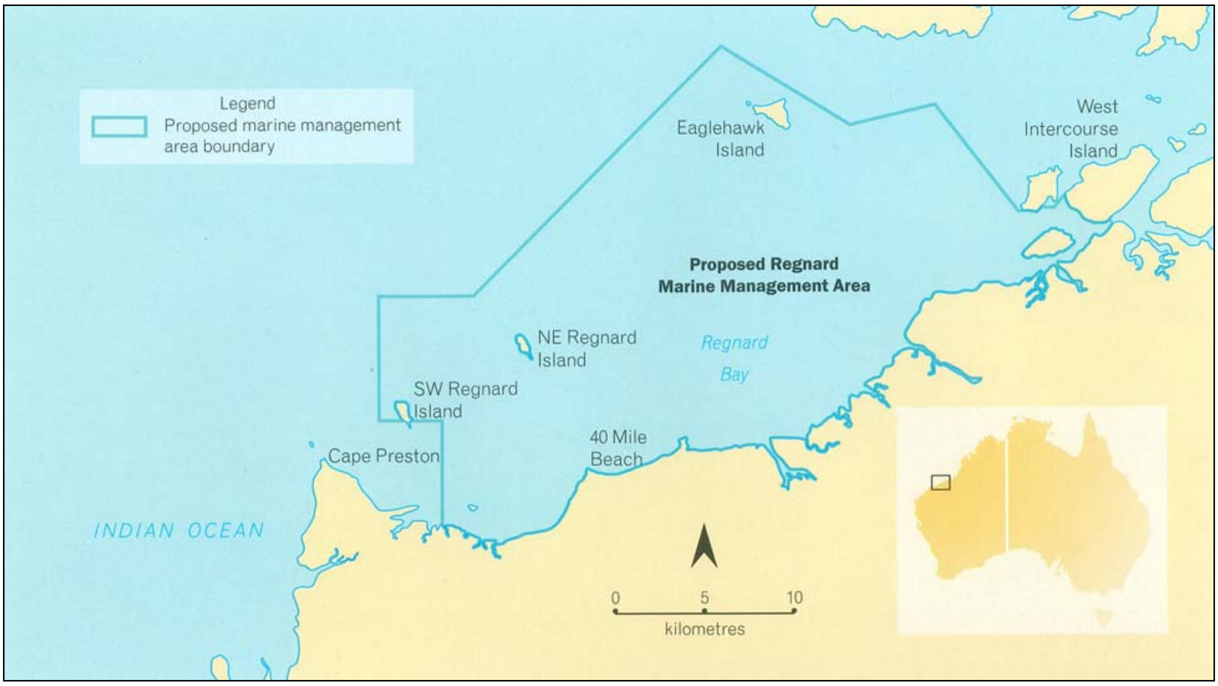

Figure 3 Proposed Regnard Marine Management Area

1.6.2 Pilbara Coastal Water Quality Consultation Outcomes (DEC 2006)

In late 2004 DEC ran a series of targeted workshops on the establishment of environmental values (EVs) and EQOs for the State marine waters between Exmouth Gulf and Cape Keraudren.

The results of consultation undertaken and recommendations to the EPA are published in *Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives* (DEC, 2006). The recommendations of this report have now been endorsed by the EPA as a framework for environmental impact assessment, waste discharge regulation and natural resource management in the Pilbara marine environment. It is understood that the EPA/DEC has recommended the use of DEC (2006) and associated ecological protection maps as a guiding document until such time as more formal government policy, such as a State Environmental Policy, is developed (pers comm. K McAlpine, DEC, April 2008).

The EVs and their associated EQOs as endorsed by the EPA are as follows:

- Ecosystem Health (ecological value)
  - Maintain ecosystem integrity.
- Recreation and Aesthetics (social use value)
  - Water quality is safe for recreational activities in the water (e.g. swimming)
  - Water quality is safe for recreational activities on the water (e.g. boating)
  - Aesthetic values of the marine environment are protected.
- Cultural and spiritual (social use value)
  - Cultural and Spiritual values of the marine environment are protected.
- Fishing and Aquaculture (social use value)
  - Seafood (caught or grown) is of a quality safe for eating

- Water quality is suitable for aquaculture purposes.

- Industrial Water Supply (social use value)
  - Water quality is suitable for industrial supply purposes.

In developing the ecosystem health EV, different levels of ecological protection have been developed for application to Pilbara coastal waters (see Table 2). The spatial application of the EVs and EQOs to the waters around Cape Preston is outlined in Figure 4.

Table 2 Levels of Ecological Protection for Maintenance of Ecosystem Integrity

Level of Ecological Protection	Environmental Quality Condition (limit of acceptable change)	
	Contaminant concentration indicators	**Biological indicators**
Maximum	No contaminants – pristine	No detectable change from natural variation
High	Very low levels of contaminants	No detectable change from natural variation
Moderate	Elevated levels of contaminants	Moderate changes from natural variation
Low	High levels of contaminants	Large changes from natural variation

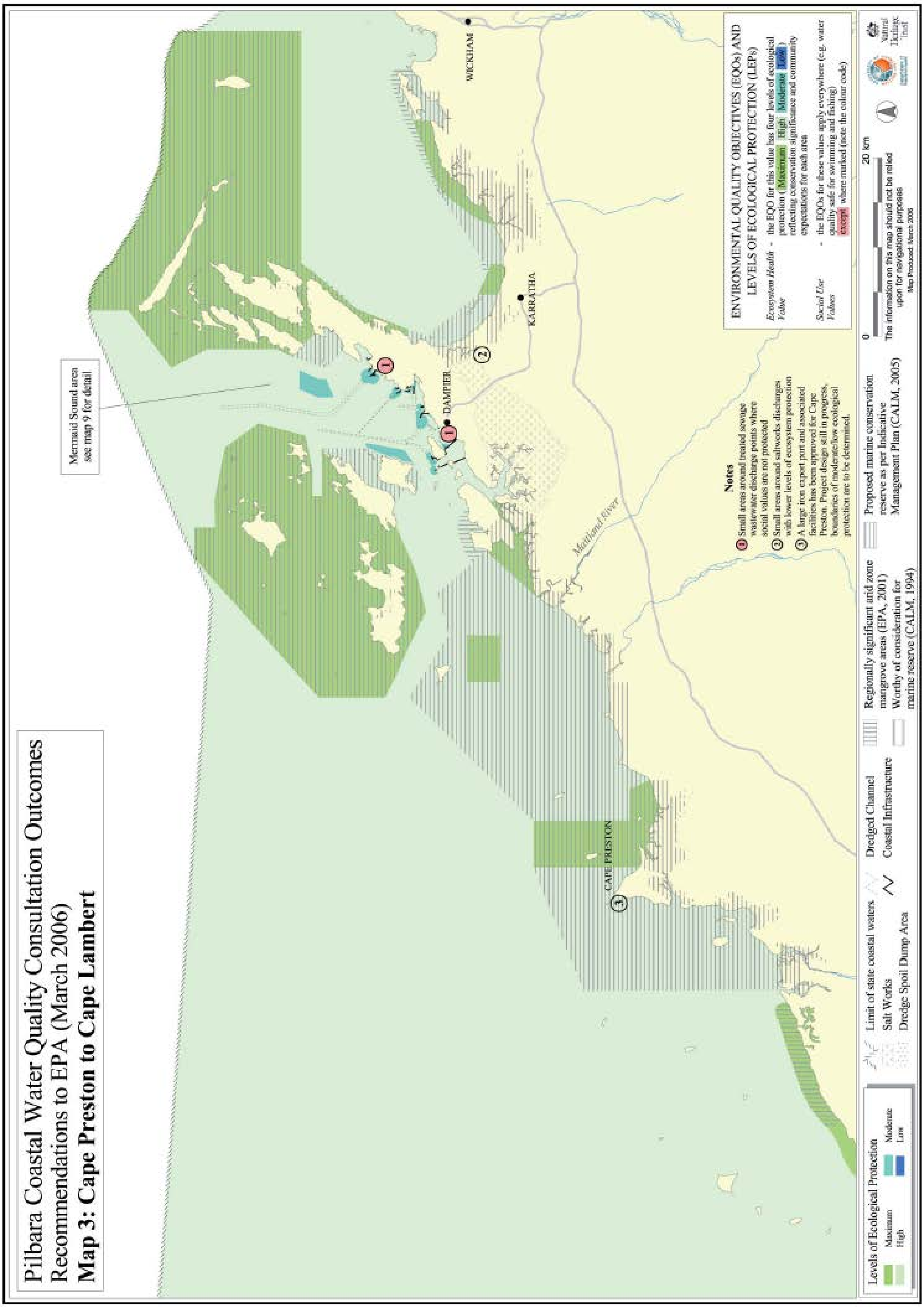

Figure 4 Environmental values and quality objectives developed for Cape Preston waters

Note: Figure 4 shows the former proposed Cape Preston Marine Park, which has now superseded by the proposed Regnard Marine Management Area (see Section 1.5.2 and Figure 3).

1.6.3 EPA Guidance Statement No. 29: Benthic Primary Producer Habitat Protection for WA's marine environment

EPA Guidance Statement No. 29 (EPA, 2004) sets out a framework for the assessment of proposals that may impact on benthic primary producers (BPP) and the habitats that can or do support such communities, termed benthic primary producer habitats (BPPH). (EPA, 2004) considers that BPP are 'predominantly marine plants (e.g. seagrasses, mangroves, seaweeds and turf algae), but include invertebrates such as scleractinian corals...'.

Guidance Statement No. 29's risk-based approach to assessing any implication for BPPH ecosystem integrity sets out several steps. The first is the definition of a 'Management Unit' for the purposes of applying Guidance Statement No. 29. The Guidance Statement considers that "a Management Unit would normally be approximately 50 km² (e.g. a rectangular area defined by a 10 km stretch of coastline extending 5 km offshore" (EPA, 2004). The purpose of the Guidance is to focus the mind of proponents on the need to ensure that a proposed Management Unit is reasonable and defendable when considering the impact of a proposal on the ecological value and function (integrity) of the habitat of a specified BPP.

EPA (2004) defines six categories of marine ecosystem protection and provided guidance on the amount of BPPH that may be lost due to development as a percentage of BPPH within a defined Management Unit for each category. These percentages are termed 'cumulative loss thresholds' (CLT) that, if exceeded, will be used by the EPA as indicative of potential non-acceptability. However, given the difficulty of reliable measurement of the area of some BPPH, and considering the difficulty of quantifying the ecological significance of their loss, these thresholds will not be used as rigid limits. The acceptability of BPPH damage/loss will in all cases be judged by the EPA based primarily on its assessment of the overall risk to the ecosystem integrity within a defined Management Unit if a proposal were allowed to be implemented.

The six categories of marine ecosystem protection, and their corresponding CLTs, are summarised in Table 3.

Table 3 Cumulative loss thresholds for BPPH within defined Management Units for six categories of marine ecosystem protection

Category	Description	**Cumulative loss threshold*** (percentage of original BPPH within a defined Management Unit)
A	Extremely special areas	0%
B	High protection areas other than above	1%
C	Other designated areas	2%
D	Non-designated area	5%
E	Development areas	10%
F	Areas where cumulative loss thresholds have been significantly exceeded	0% net damage/loss (+Offsets)

*Thresholds will be applied only after proponents can demonstrate to the EPA that all options to avoid/minimise damage/loss of BPPH have been considered.

An assessment of BPPH loss from the area surrounding Cape Preston, in the context of Guidance Statement No. 29, is provided in Section 5.6. The Management Unit defined for this assessment remains within the area zoned for industrial development at Cape Preston.

1.6.4 Great Sandy Islands Nature Reserve

The Great Sandy Island Nature Reserve (GSINR) encompasses the islands off the Pilbara coast within an area extending generally from about 15 km east of Cape Preston to the mouth of the Robe River, and ranging from approximately 10 to 35 km offshore. The GSINR covers more than 30 islands, including Preston Island, but does not include the surrounding marine waters.

The Project port includes a rock causeway between Cape Preston and the eastern edge of Preston Island, and a laydown area for the marine construction and operational activities on Preston Island. Preston Island has no sandy beach area to support turtle nesting. In reporting on the Project, the EPA considered that:

> *On its own Preston Island is not considered to have intrinsically high conservation values. It is a small, low rocky platform with little vegetative cover* (EPA, 2002).

2. STAKEHOLDER CONSULTATION

2.1 GENERAL

All relevant stakeholders associated with the Project were consulted during the preparation of the PER and SER. These stakeholders were provided with details of the Project key characteristics, including mining, processing and infrastructure requirements and the environmental studies undertaken.

Agencies/groups consulted included:

- DEC
- Department of Industry and Resources (DoIR)
- Officers of the Shire of Roebourne
- Representatives of local native title claimant groups
- Main Roads WA
- Mardie Station Pastoral Lease Holder
- Local Aboriginal stakeholders
- Mineralogy (tenement holder).

The views of these and other stakeholders were considered by the EPA and the Minister for the Environment in the approval of the Project via Statement 635.

2.2 REVIEW OF PREVIOUS VERSION OF MMP

The DEC reviewed a previous version of the MMP and provided comments to Mineralogy in August 2006. These comments have been taken into account in the preparation of this current version of the MMP.

2.3 IRON ORE PROCESSING (MINERALOGY PTY LTD) AGREEMENT ACT 2002

In February 2008, Mineralogy Pty Ltd and Sino Iron Pty Ltd submitted a Proposal to DoIR under the *Iron Ore Processing (Mineralogy Pty Ltd) Agreement Act 2002*. The Proposal included the port to be implemented under Statement 635. As part of its assessment of the Proposal, DoIR sought comment from the following Government agencies:

- Shire of Roebourne
- DEC
- Department of Agriculture and Food
- Office of Energy
- Main Roads WA
- Australian Quarantine and Inspection Service
- Department of Indigenous Affairs
- Department of Water
- DoIR Environment Division
- Department of Consumer and Employment Protection.

DoIR collated the comments received from these agencies, and submitted these to Mineralogy and Sino Iron for their response. Subsequently, the Minister for State Development approved the Proposal in May 2008.

2.4 DEC AND DOIR SITE VISIT

CPM has hosted a number of Project site visits by Government officers from numerous agencies since 2006. The last such site visit was held on 7 October 2008, when nine representatives from the DEC

(Hayley Valentine, Misty Shipway, Kevin Crane, Cliff Winfield, Ben Drew, Kellie Agar and Steve van Leeuwin) and one representative from DoIR’s Major Projects Branch (Alana Herbert) attended.

The site visit included a bus tour of the mine site and a helicopter flight over the Project area. The group visited Cape Preston, where the port layout and marine environmental management plans were discussed. All Government officers left the Project site with a much better understanding of the construction work being carried out, and of the facilities and infrastructure to be established under the Project.

Such site visits have proved invaluable to the development of a constructive ongoing relationship between CPM and Government agencies responsible for Project regulation.

2.5 MEETINGS WITH EPA SERVICE UNIT

CPM and the Proponent have met with the EPA Chairman and senior officers of the EPA Service Unit on several occasions to discuss the Project port, and finalisation of the marine environmental management plans. The last such meeting was held in November 2008.

3. MARINE ENVIRONMENTAL SETTING

3.1 INTRODUCTION

This section of the MMP addresses the first component of Item 1 of Condition 7-1, and provides a summary description of the key environmental characteristics of the Project area as background to the assessment of effects of the port presented in Section 5.

3.2 MARINE SURVEY WORKS

In accordance with Item 1 of Condition 7-1, the Proponent has conducted detailed marine surveys to establish existing regimes of currents, bathymetry, sedimentology, shore alignment and habitat cover at Cape Preston. The information summarised in this section has been derived from the following documents:

Maunsell (2006) summarised the results of numerous habitat and water and sediment sampling surveys undertaken in the region of Cape Preston over the period 2000-4 in their Marine and Coastal Environmental Report. This report presents a description of the regional geology and geomorphic setting, coastal processes, coastal and marine habitats, water and sediment quality, zooplankton and phytoplankton abundance and diversity, and concentration of metals in fish liver.

Sandwell (2007) undertook a detailed bathymetric survey of the region within 25 km of Cape Preston to set up a bathymetric database for the Project. The bathymetric information presented in this document has all been derived from this work.

URS (2008) reviewed all habitat reports available for the region and subsequently undertook underwater surveys of the broader region in December 2006, and in the immediate vicinity of Cape Preston in June 2007, plus an aerial inspection at lowest astronomic tide (LAT) in October 2007. Their report concludes that there has been a marked change in distribution and abundance of coral communities in the region as a result of an intense cyclone season in 2005-6 when two cyclones (Glenda and Clare) passed very close to Cape Preston. The report presents updated maps of habitat distribution that represent the current condition and distribution of marine habitats in the vicinity of Cape Preston. This report is presented in Appendix A.

GEMS (2008a) monitored water levels, currents and waves using Acoustic Doppler Current Profiler (ADCP) meters at two locations (nearshore Cape Preston and offshore in 23 m depth ~20 km north of Cape Preston) since October 2006 and ongoing. The data collected has been used to verify a mathematical hydrodynamic model (GCOM3D) of the region developed originally to determine design storm wave and surge conditions for the port's coastal engineers (Sandwell Australia). This report is presented in Appendix B.

GEMS (2008b) modelled the effects on water flows around Cape Preston of the preferred port layout, plus alternative layouts, using their GCOM3D model. GEMS' water flow modelling report is presented in Appendix C.

GEMS (2008c) carried out a desktop and field appraisal of geomorphic processes at Cape Preston to assess the potential impacts of the port on coastal processes and beaches at Cape Preston. This report is presented in Appendix D.

3.3 BATHYMETRY

The general bathymetry of the Cape Preston region is shown in Figure 5 of Appendix A. Greater detail in the vicinity of the Project area is shown on Figure 5 below, which is based on hydrographic survey work undertaken by Sandwell (2007). The region can be characterised by extensive intertidal areas particularly to the south and southeast of Cape Preston and a shallow nearshore platform that extends to the southwest of Cape Preston for a few kilometres but extends to the northeast some 30 km to the vicinity of Eaglehawk Island. This platform to the east of Cape Preston is very shallow and drains

Regnard Bay. It contains two small islands (SW and NE Regnard) and shoals. The Maitland River drains into Regnard Bay and the intertidal areas along this stretch of coast support large stands of mangrove habitat.

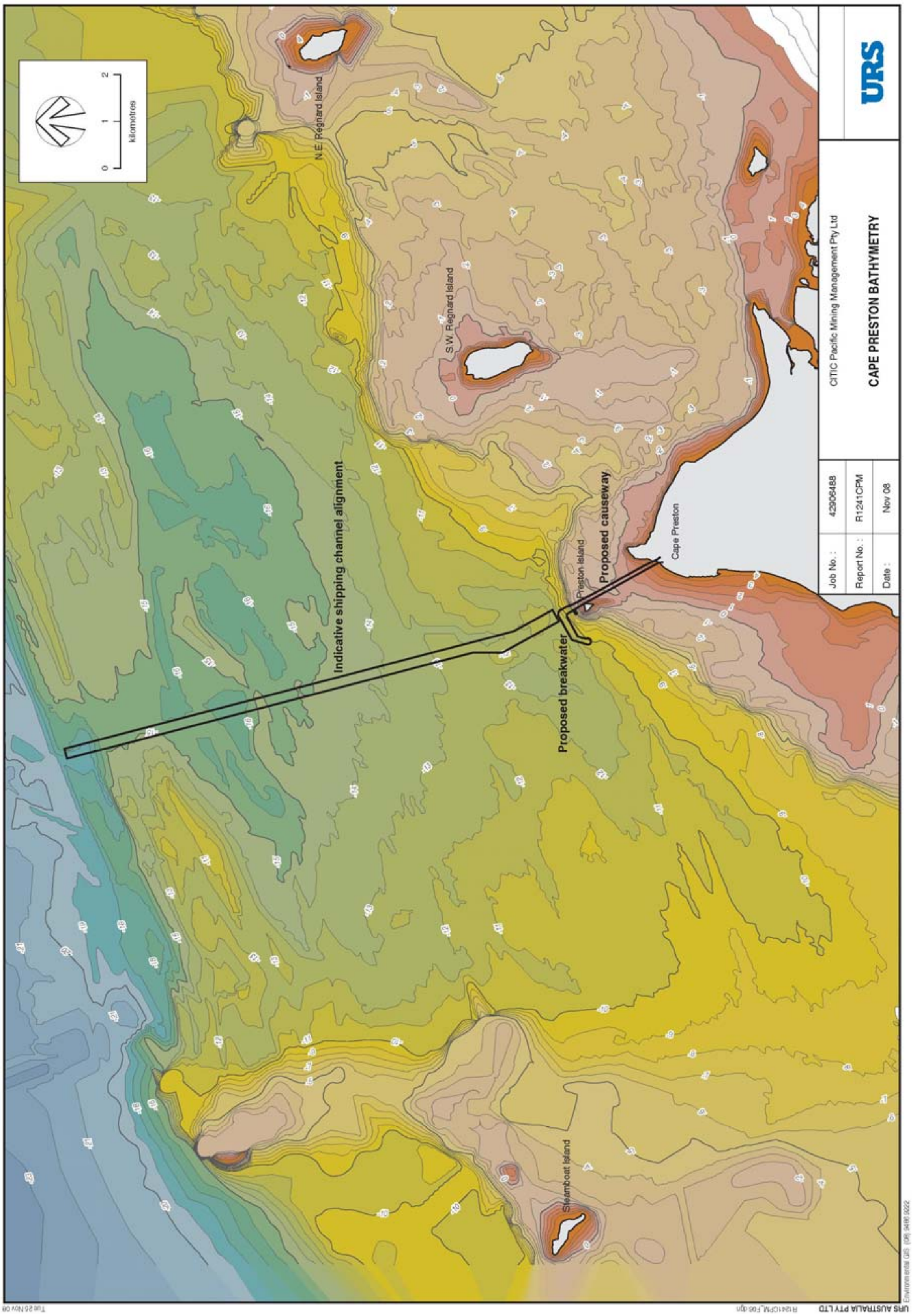

Figure 5 Detailed bathymetry, Cape Preston region (Sandwell, 2007)

To the west of Cape Preston lies a shallow embayment known as Fortescue Roads. The Fortescue River discharges at the base of this embayment. The river is located some 23 km to the south-west of Cape Preston, and is the closest river to the Cape. Both the Maitland and the Fortescue Rivers drain large areas of hinterland, but only flow occasionally in response to cyclonic downpours over the hinterland. On such occasions, these rivers discharge large volumes of fresh and highly turbid silty waters to the nearshore environment. Further to the west lies a shallow promontory on which occur a number of small islands and shoals (e.g. Fortescue and Steamboat Islands). This promontory runs to the north and effectively borders Fortescue Roads to the west.

Fortescue Roads drains northward into a large basin where water depths extend to -16 m chart datum (CD). This basin is relatively flat and slopes gently from the shore out. It is partly enclosed to the north by a low subtidal ridge at -11 m CD. This ridge supports a number of shoals and banks (e.g. McLennan and Cod Banks).

Preston Island is located approximately 1.2 km to the north-west of Cape Preston and is located near the tip of the shallow nearshore platform referred to earlier. At low spring tide it is barely separated from the mainland by very shallow water (<1 m CD). The seabed is relatively shallow (<8 m CD) south-west of Preston Island; however, immediately north to north west of Preston Island (~300 m offshore) the seabed drops rapidly to over 13 m CD, and deep navigable waters (>20 m) occur some 16 km to the north (URS, 2008).

3.4 CLIMATE

Cape Preston is located towards the west of the North West Shelf, experiencing a subtropical (or sub-monsoonal) climate. Synoptically, the region is dominated by relatively diffuse extra-tropical high-pressure systems, although during the Austral summer months, the influence of tropical low-pressure systems increases. The meteorology of the North West Shelf is controlled by two main seasons, referred to here, respectively as ‘cool’ and ‘warm’; there are short transition seasons between these two main seasons. The cool season typically extends from May to August, with the warm season normally from October through March (Pearce *et al.*, 2003).

Overlying the prevailing seasonal winds is local circulation brought about by land/sea breeze cells. These cause a regular diurnal variation in the strength and direction of winds, for approximately five to twenty kilometres both landward and seaward from the coast. Although these cells are strongest during the warm season, they may occur at any time of year. The warm season is largely coincident with the tropical cyclone season, which may produce intense, mobile low-pressure systems. These are capable of producing extreme winds and are generally associated with the most extreme rainfall, wave and surge conditions across the North West Shelf (GEMS, 2008a).

During the cooler months a high-pressure ridge controls the winds over the region; this ridge is a persistent feature over the southern part of Western Australia. The ridge drives easterly winds across the shelf region. Frontal systems moving through mid latitudes periodically erode the ridge; winds then shift to the north-east, with subsequent rotation through south-west to south-east following frontal passage. A new high pressure will then re-establish the pattern; during this phase, periods of more persistent and stronger easterly winds can be expected to influence Cape Preston.

During the warmer months, the sub-tropical ridge migrates southwards and the dominant synoptic feature is a permanent heat trough that develops inland from the Pilbara coast. This pattern produces quasi-permanent south-west wind flow across the Shelf region. Fluctuations in the intensity and location of the heat trough as well as diurnal and local topographic influences affect day-to-day variations in wind direction and speed within the general south-west flow (GEMS, 2008a)

Monthly variation of the wind climate has been described by GEMS (2008a) using the Bureau of Meteorology MesoLAPS dataset. The corresponding monthly wind roses are presented in Figure 6 for the Cape Preston area.

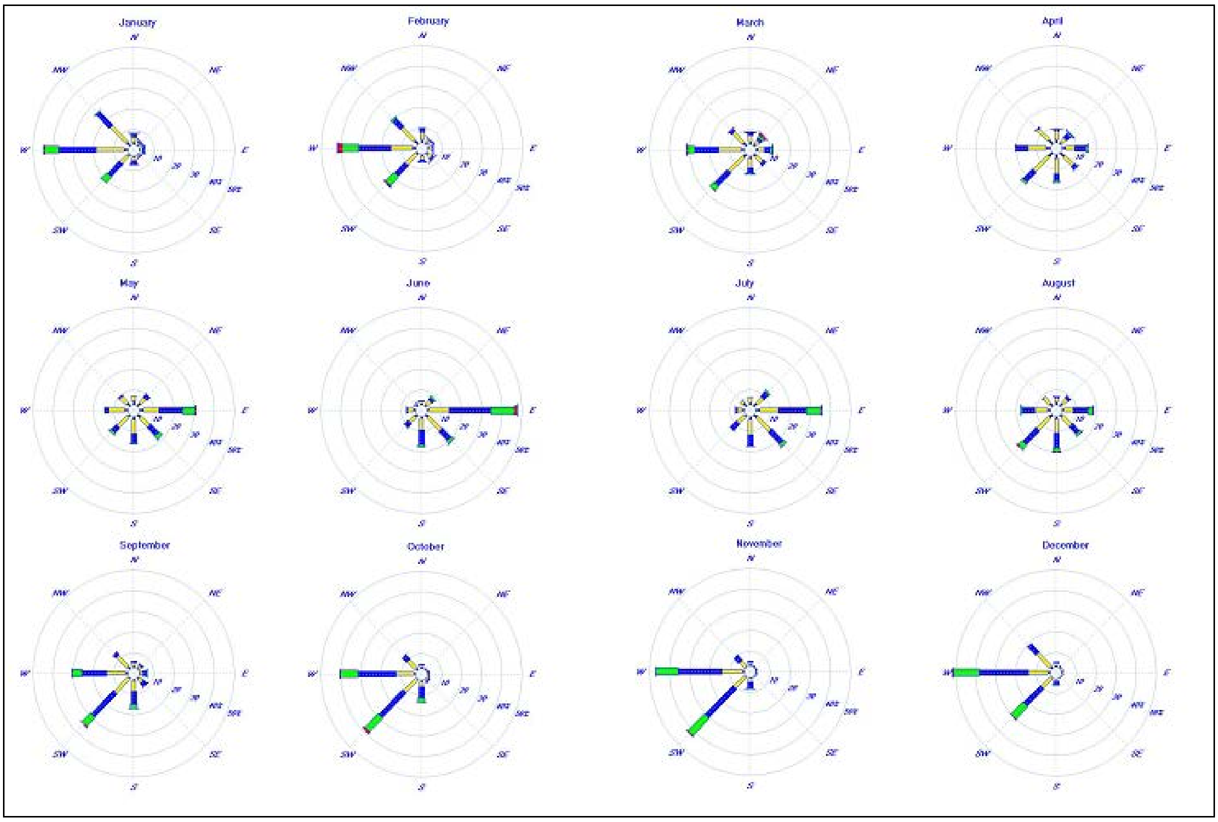

Figure 6 Monthly wind roses for Cape Preston

On average, five tropical cyclones pass through the west Australian region each year, although this may be highly variable on a year-to-year basis. Cyclones are typically generated offshore from the Kimberley, although they may be generated across a broader range of longitudes under suitable conditions. Although the Cape Preston region is to the south of the zone with the highest frequency of cyclone events, it still experiences significant onshore winds and therefore enhanced wave energy.

It is well known that the Cape Preston-Mardie Station region is subject to intense cyclonic activity, with the most severe storm on record, Severe Tropical Cyclone Vance (1999), causing extensive coastal inundation between Onslow and North West Cape. In 1989 another severe cyclone (Orson) crossed the coast close to Cape Preston. More recently, during the 2005-06 season, two cyclones (Clare and Glenda) also crossed the coast in the Cape Preston region. Figure 7 shows the cyclone tracks in the vicinity of Cape Preston since 1950 (GEMS, 2008a).

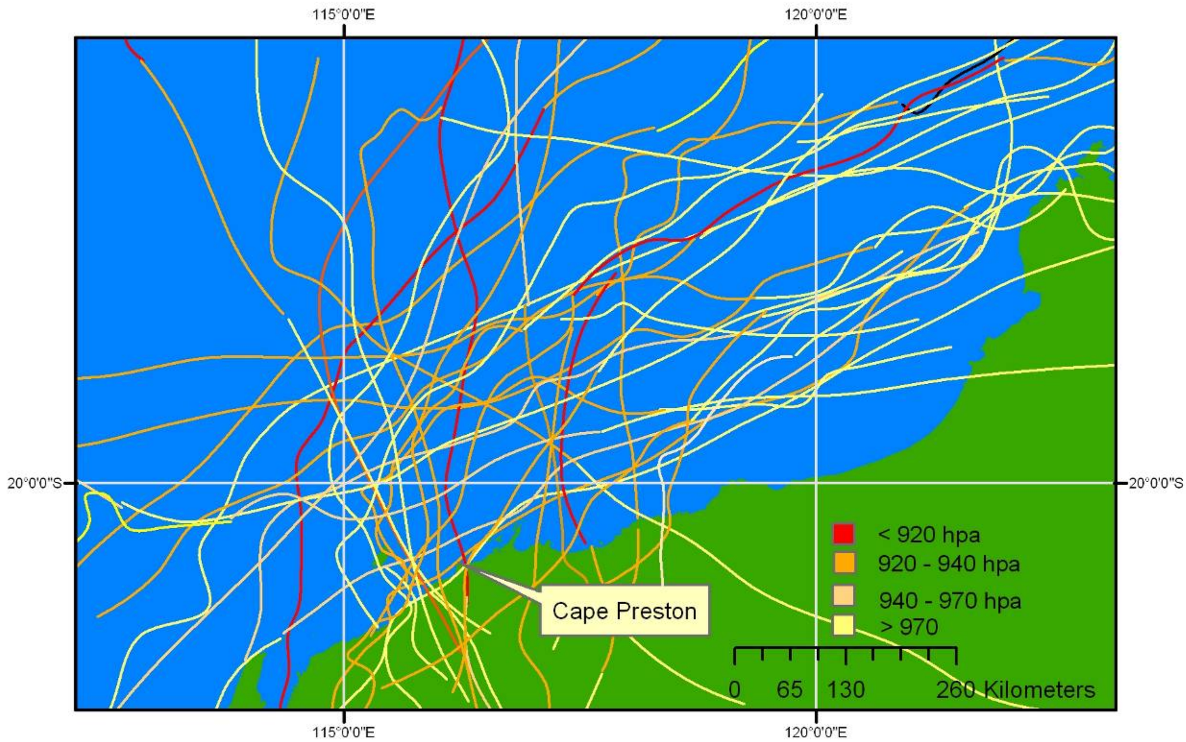

Figure 7 Tracks of cyclones since 1950 in the vicinity of Cape Preston

3.5 TIDAL WATER LEVELS

Water levels have been monitored at Cape Preston since October 2006 by GEMS on behalf of Sandwell Australia. This information has been harmonically analysed to determine principal tidal constituents and corresponding tidal planes (Table 4). The monitoring has determined that Cape Preston experiences semi-diurnal tides, with a lowest to highest astronomical tidal range of 4.75 m. This is similar, but slightly smaller, than the estimated tidal regime for Dampier, which is the nearest standard port noted in the Australian Tide Tables (Department of Defence, 2008).

Table 4 Tidal planes at Cape Preston compared with those at Dampier

Reference Level	Cape Preston (to the nearest 0.05 m)	Dampier (to the nearest 0.1 m)
HAT	2.35	2.5
MHWS	1.75	1.8
MHWN	0.50	0.5
MSL	0.0	0.0
MLWN	-0.50	-0.5
MLWS	-1.65	-1.9
LAT	-2.40	-2.6

3.6 CURRENTS

The dominant influence on the circulation in the waters off Cape Preston is the North West Shelf tides and the regional winds. Tides are relatively strong off Cape Preston with a typical semi-diurnal and spring-neap behaviour and a spring tidal range of 4.75 m. Water movements in the region during spring tides are more influenced by tidal currents than local wind conditions. Surface current velocities during spring tides can reach 0.75 metres/second (m/s) (1.5 knots) whereas during neap tides the peak current velocities are typically 0.25 m/s (0.5 knots).

There is no evidence of sustained stratification in the waters off Cape Preston from the 12 months of data recorded on site (GEMS, 2008a). The combination of relatively strong tidal currents, episodically strong winds producing wave action and surface currents and the relatively shallow bathymetry around Cape Preston tends to limit the opportunity for stratified layers to develop.

The majority of the flood tide reaches Cape Preston from the open ocean by going around the Montebello Islands and then flowing southwards towards the coast. When the flood tide reaches Cape Preston it splits around the Cape with flow occurring to the south-west and south-east along the coast. The ebb tide, whilst not being the exact converse of this process, generally reaches the open ocean by flowing north to north-west around the Montebello Islands.

The dominant mixing and dispersion mechanism off Cape Preston is the strong and varying tidal currents and the episodic influence of strong surface winds.

The dominant flushing mechanism is the ebb tide which generally flows north-north-west from the site. The analysis of the ADCP data (GEMS, 2008a) also highlights a relatively strong residual current to the north-east driven by the south-westerly winds and the ebb tide.

3.7 WAVE CLIMATE

Descriptions of the regional wave climate are available from other studies across the Northwest Shelf (Pearce *et al.*, 2003; Metocean Engineers, 2004). Waves along the North West Shelf are generated from the following sources:

- Southern Ocean swell, propagating past Northwest Cape
- Winter easterly swell generated across the Timor Sea
- Locally generated wind waves
- Wind waves generated by tropical cyclones.

GEMS (2008a) deployed two ADCPs offshore from Cape Preston on behalf of CPM in October 2006. The wave measurements obtained by the ADCP have been used for validation of a hindcast wave model, which was applied over the period 2001 to 2005 (GEMS, 2008a). Results of the modelling have been used in this report. As the hindcast provides limited information on the frequency distribution of extreme cyclonic waves, dedicated modelling was undertaken to produce a synthetic cyclone database and in turn examine cyclonic conditions.

The wave climate during the summer period reflects the prevailing westerly winds, with waves generally approaching Cape Preston from the northwest (Figure 8).

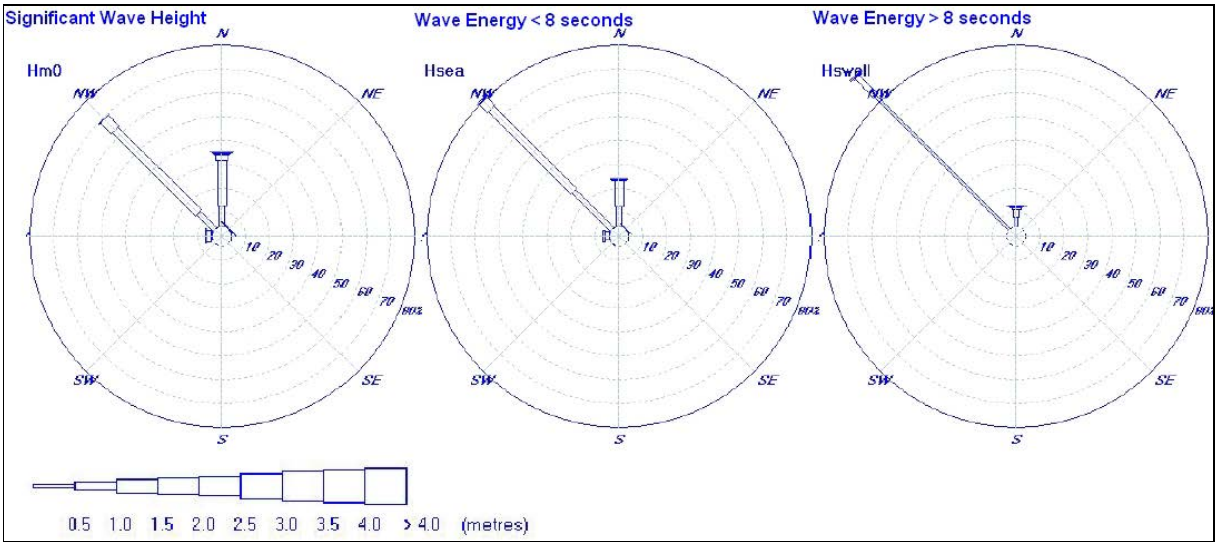

Figure 8 Hindcast wave conditions at nearshore Cape Preston, February 2001-2005

Wave conditions during winter are more variable, reflecting the wider range of potential wave sources. There is a general rotation towards the east, with waves mostly approaching from the north or north-northeast (Figure 9).

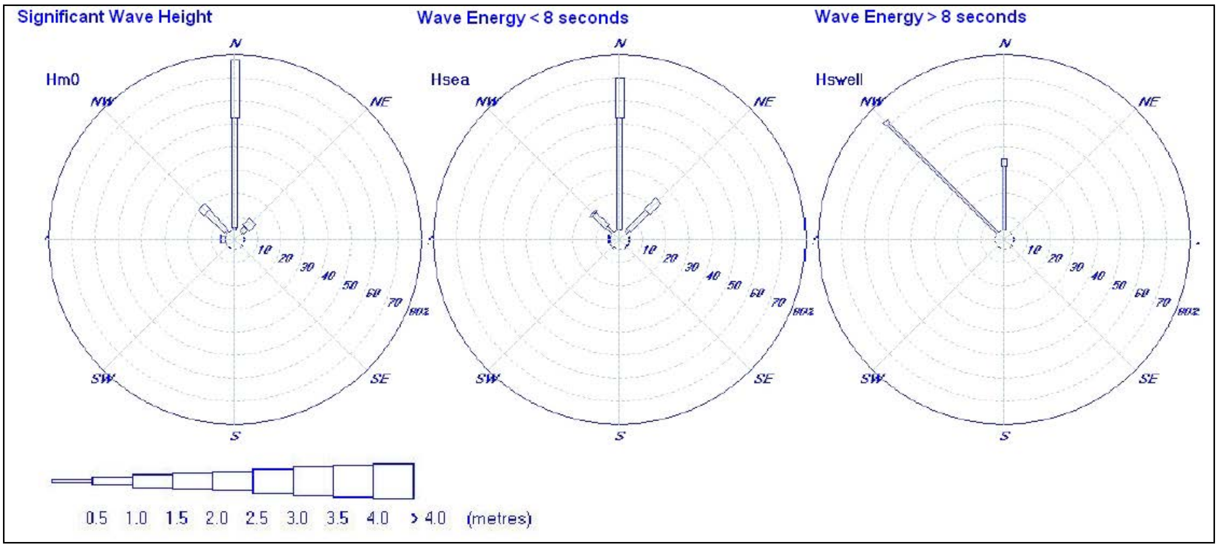

Figure 9 Hindcast wave conditions nearshore Cape Preston, July 2001-2005

3.8 COASTAL PROCESSES

Cape Preston is exposed to a relatively mild ambient wave climate, typically less than 1 m significant wave height, which is predominantly from the west-north-west during the warm season and from the north to east during the cool season. The effect of tropical cyclones is episodic, with the capacity to produce waves from any offshore direction depending on the path of the system. The most severe metocean conditions are produced by cyclones located approximately 20 to 60 km west of Cape Preston, causing extreme wave and surge conditions. These have previously been modelled as up to 6.3 m significant wave height and 4.5 m surge with a 1 in 100 year average recurrence interval (GEMS 2008a).

The structure of Cape Preston and its adjacent coast is largely determined by the presence of its rock features, including the basalt outcrop that forms the Cape and the limestone shore platform extending around the Cape and adjacent beaches. These features provide resistance to the ambient wave climate and moderate to strong tidal currents that affect the region. The shelter provided by the rock platform is potentially less effective during cyclone events, where the combination of high waves and storm surge is capable of rapid redistribution of large volumes of beach sediment (GEMS, 2008c).

Active sediment transport patterns have been inferred on the basis of the present coastal morphology, historic aerial imagery and interpretation of available metocean data. The regional structure suggests a net movement of sediment towards Cape Preston, notably with supply from the Fortescue River during cyclonic flooding. This material accumulates on the western side of the Cape, as a series of low profile dunes, Preston Spit (Figure 10) and a complex structure of shoals across the extensive rock platform. Under ambient summer conditions, there is a general low volume northward sediment transport along the outer edge of the shoals, which is reversed under northerly conditions that occur occasionally throughout the year. Instability of the western beach has been observed over the historic period and is further evidenced by the loss of a mangrove stand on the northern part of the beach. However, it appears likely that this destabilisation was caused by a combination of marine and fluvial sediment transport (GEMS, 2008c).

Figure 10 Cape Preston geomorphic components

Cape Preston and Preston Island are largely bare of sediment, suggesting a limited supply. This reflects a general erosive tendency for the Cape, due to its exposure to strong tidal currents and waves from west through east. Extensive storm deposits including cobbles and boulders were observed high on the beach face; suggesting highly energetic conditions can be experienced during extreme events. The presence of a sandy 'tail' on Preston Island on aerial imagery since 1966 suggests that sediment occasionally bypasses the Cape.

The beach to the east of Cape Preston is controlled by rock features, including basalt ridges that act as groynes (northern beach - Figure 10). These features are fully saturated with sediment on their western side, suggesting a net eastward sediment transport. An extensive scarp runs along the high frontal dune, indicating erosion approximately within the last five years. Recovery of the beach system is apparently low, with only a small ridge of material deposited above the tidal berm. Despite these features, the beach has remained largely stable within the 40 year history of available aerial photography. The beach on the eastern side (eastern beach - Figure 10) of the Cape has also been stable over the historic period, although it exhibits signs of seasonally alternating northward and southward alongshore transport, with net southwards movement. The southern limit of the beach (eastern spit - Figure 10) is controlled by an eastward running rock platform, which apparently represents the limit of sheltering provided by Cape Preston. Consequently, this beach has a structurally limited capacity, and any excess material is readily transported eastwards to the tidal flats and Eramurra Creek floodplain (GEMS, 2008c).

3.9 WATER QUALITY

3.9.1 Temperature and salinity

The following paragraph is a summary of information provided by CALM (2005) in relation to the former (proposed) Cape Preston Marine Management Area.

> *"The waters of the proposed reserves are relatively undisturbed by anthropogenic sources. Near-shore water movements and mixing patterns in the Dampier Archipelago/Cape Preston region are driven primarily by large tidal ranges, local currents and winds, but are also influenced by seabed topography and the steering effect of islands and reefs. Sea-surface temperatures within the Dampier Archipelago range from about 18ºC in winter to 31.5ºC in summer, with near-shore waters having a greater seasonal temperature range than the offshore waters. The smallest range and lowest salinities (35.1 to 36.1 ppt) occur offshore at the 20 m contour, and the largest range and highest salinities (35.45 to 37.1 ppt) occur inshore within 2 km of the Burrup Peninsula. Salinity and temperature differences between the nearshore and mid-shelf regions are expected to drive gentle cross-shelf circulation in the region."*

3.9.2 Turbidity and total suspended solids

According to Maunsell (2006), turbidity in the region is generally high, due to the episodic high volume river flows, dominant marine sediment types, strong local winds, large tides and common occurrences of cyanobacterial blooms (*Trichodesmium* sp.). Turbidity is typically higher in the shallow near-shore areas than in the deeper sites further offshore, and can vary considerably on a spatial scale due to localised re-suspension of sediments and temporally over hours and days depending on wind and tide.

Turbidity data collected by URS ranged from 0 to 23 NTU. The high turbidity readings (>20 NTU) are believed to be associated with an algal bloom event (biological cause – see above) and not caused by a change in tide, water depth, sediment structure, wind and current situations or river inflow. The latter are the observed physical causes responsible for significant changes in turbidity on a spatial and temporal scale.

Total suspended solids (TSS) measured by Maunsell ranged from 1.2 mg/L to 48.1 mg/L. TSS data obtained by URS during 2007 and 2008 indicate that ambient concentrations range between 2 mg/L and 10 mg/L.

3.10 DISTRIBUTION OF MARINE BIOTA AND BENTHIC HABITATS

3.10.1 Macroscale biogeography

Cape Preston is situated on the north-western coast of Australia, in the northern Australian tropical zone. The zone is continuous with the vast Indo-West Pacific biotic province that extends from about 30°N to 30°S of the equator and from the east coast of Africa across the entire tropical portions of the Indian and Pacific Oceans to Hawaii. A few species of marine biota extend even to the west coasts of central and South America (Wilson and Allen, 1987).

Most marine invertebrates and fish, probably more than 95% of the species, have planktonic larvae that live in the water column for periods ranging from a few days to a year or more. This commonly referred to as the "distributional phase" in the life cycle of marine species, during which the larvae are moved about by currents and wave action. Even species that lack a planktonic distributional phase in their life cycle are able to move considerable distances by rafting on floating logs, *Sargassum* algae mats, etc.

Similarly, marine and intertidal plants such as seagrasses and mangroves are able to move over time and over considerable distances by dispersal of seeds or propagules by tides and ocean currents. Hence the seagrass species that occur along the Pilbara coast have, in general, a widespread distribution around the northern coast of Australia and adjacent tropical waters. Nevertheless, community structure and compositions of seagrasses can vary considerably depending on regional and local scale conditions.

The net effect of the patterns of marine biogeography is that species in the Cape Preston area are generally distributed for thousands of kilometres along the northern Australian coastline, and into countries to the north such as Indonesia, Papua New Guinea and the Philippines (Wells, 1990). Some species occur widely across the entire Indo-West Pacific. Relatively few species have restricted ranges, and those that do are on the scale of tens or hundreds of kilometres.

3.10.2 Mesoscale regionalisation

At the Mesoscale (IMCRA 1998), that is broad regional ecosystem scale (regions extending in area between 3,000 km^2 and 240,000 km^2), the Project occurs within two regions, Pilbara Offshore and Pilbara Nearshore.

Pilbara Nearshore, with an area of 13,861 km^2, covers the waters between the shoreline and 10 m depth contour and extends from North West Cape to Cape Keraudren. The intertidal and shallow subtidal habitats are described as supporting a high diversity of infauna on mudflats and sandflats associated with fringing mangals in bays and lagoons. The water is described as highly turbid with a large tidal range. Fringing coral reefs occur around some of the islands.

Pilbara Offshore, with an area of 41,491 km^2, comprises waters seaward of the 10 m depth contour between North West Cape and Cape Keraudren. The water is described as less turbid than in the nearshore region and there are significant differences in marine ecosystems. It includes coral reef ecosystems with Indonesian and Pacific affinities.

Cape Preston occurs roughly in the middle of this broad regional ecosystem type.

3.10.3 Marine flora

The Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area (CALM, 2005) describes the marine flora of the region as follows:

> "*Within the Cape Preston area, macroalgae (seaweeds) dominate submerged limestone reefs and also grow on stable rubble and boulder surfaces. These communities are most commonly found on shallow limestone pavement in depths less than 10 m. Brown algae are the most abundant group of algae in the region, with Sargassum sp., Dictyopteris sp. and Padina sp. being the dominant species. The most common green algae are the articulate coralline Halimeda sp, while prominent red algal species include crustose corallines, non-corallines and algal turf.*
>
> *Seagrass occurs in the larger bays and sheltered flats of the region. Six species of seagrass are present on the subtidal soft sediment habitats, these being Cymodocea angustata, Halophila ovalis, Halophila spinulosa, Halodule uninervis, Thalassia hemprichii and Syringodium isoetifolium. Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgae beds. The most significant areas of seagrass are found between Keast and Legendre islands and between West Intercourse Island and Cape Preston. Macroalgae and seagrasses are important primary producers, trapping light energy from the sun and making it available to the ecosystem. They also provide important habitats for molluscs, sea urchins, sea stars, sea cucumbers, crabs and fishes. Marine turtles feed on algae and seagrass, and the ephemeral seagrass typically found in the area is likely to be the preferred food source for the resident dugong population".*

3.10.4 Sessile marine biota

Fauna of the shallow water limestone reefs and platforms include hard and soft corals, sponges, ascidians, fan worms, molluscs (octopus, gastropods [snails], and bivalves), crustaceans (crabs, rock lobsters), urchins and seastars.

Fifty species of hard coral representing 11 families have been reported off Cape Preston (Campey and Gilmour, 2000). This compares with 229 species reported from the Dampier Archipelago (Griffith, 2004). All species reported by Campey and Gilmour (2000) have been reported from the Dampier Archipelago and other areas of Australia. The dominant families, in terms of species recorded, include Acroporidae, Poritidae and Faviidae. Taxa, such as *Turbinaria, Caulastrea* and *Euphyllia,* which are typically associated with turbid nearshore water (Veron and Marsh, 1988) were also present at Cape Preston. As with many nearshore areas fringing the Pilbara coast, most of the coral assemblages at Cape Preston do not form true coral reefs because erosion exceeds accretion. Instead, corals form assemblages on rock pavement without contributing greatly to the substratum. However, there are some true coral reefs at Cape Preston where living coral cover is very high and based on dead coral substratum. These are discussed in Section 3.10.5.

Veron and Marsh (1988) identified 18 broad coral localities in Western Australia. The coral reefs off Cape Preston form part of the location referred to by Veron and Marsh (1988) as the Dampier Archipelago. All coral species recorded in the Dampier Archipelago (Veron and Marsh, 1988) and most in Western Australian waters are not endemic, rather they are found throughout tropical Australia and, in many cases, more widely throughout the Indo-Pacific region. The wide distribution of most Western Australian scleractinian corals suggest that dispersal mechanisms, availability of suitable colonising substrate, and exposure to wave energy have major influences on coral species composition and distribution along the Western Australian coastline.

3.10.5 Benthic habitats

The distribution of marine benthic habitats in the Cape Preston region has been mapped by CALM (2000), Maunsell (2006) and URS (2008). Figure 11 shows the current distribution of marine habitats in the vicinity of Cape Preston as mapped by URS (2008). Mapping of the distribution of marine habitats in the vicinity of Cape Preston (see Figure 11) is partly based on a review of past mapping in the area, but is mainly based on recent field surveys and aerial inspections by URS. Dense areas of high coral cover are sparsely distributed in the region, whilst areas of low coral cover tend to occur as a thin border along steep slopes that descend from shallow algae dominated pavements around islands to a deep sandy seafloor. The nearest major reefs to Cape Preston which support high live coral cover are located as follows:

- approximately 3 – 5 km to the southwest of Cape Preston
- 4 km to the east-north-east of Cape Preston on the southeast end of SW Regnard Island
- 5 km east of Cape Preston.

These reefs support >50% and in parts up to 100% live coral cover and are comprised primarily of large colonies of massive species such as *Porites, Favites, Lobophylia* and *Goneastera*. These reefs are obviously old and have survived many cyclones although evidence of cyclone damage is abundant. The location of these regionally significant reefs is shown on Figure 11. Plate 1 shows the reef located at the southern end of SW Regnard Island at LAT. Plate 2 shows the reef which occurs about 5 km south west of Cape Preston, also at LAT.

3.10.6 Intertidal habitats

The principal intertidal habitats which occur in the vicinity of Cape Preston (refer Figure 11) include:

- Sand and coral rubble veneered pavement which occurs over large areas of the nearshore platform to the west of the Cape. This habitat is backed by long flat sand beaches. The tidal flats are important during the summer as a resting and feeding stopover area for flocks of internationally protected wading birds before continuing their southern migration. The beaches are used occasionally by nesting turtles, but are not believed to be used heavily.
- Algae covered limestone platform which occurs primarily down the east coast of Cape Preston. This habitat also supports tidal pools and is visited primarily by reef herons.
- Oyster encrusted rocks occur primarily at the Cape and on a few outcrops which stabilise the eastern end of northern beach.
- Extensive sand and mud flats occur to the south and east of Cape Preston. These flats are colonised by mangroves and associated burrowing infauna. These areas are also visited by wading birds and reef herons at appropriate times of year and tide.

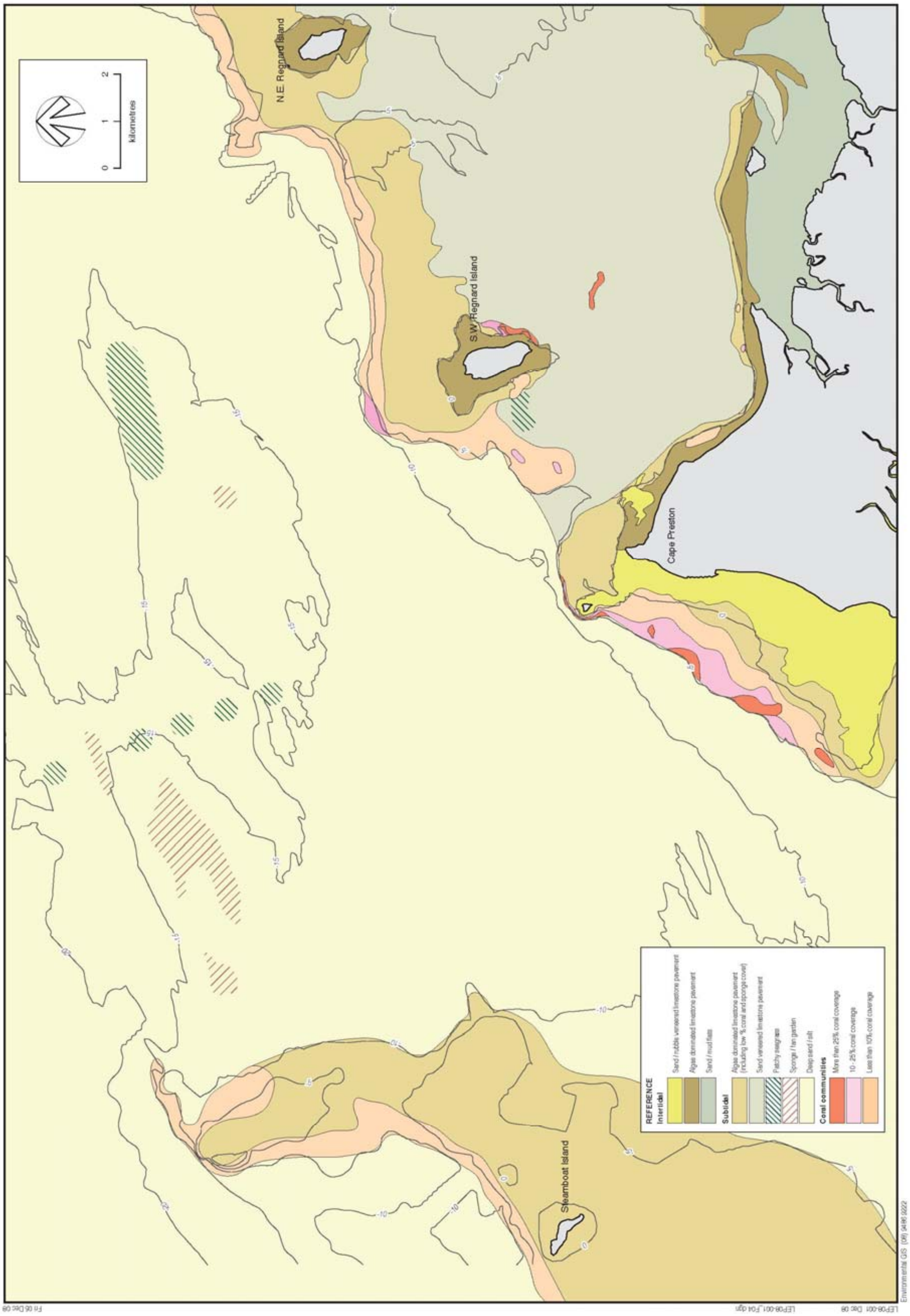

Figure 11 Cape Preston benthic habitats

Plate 1 LAT Aerial Survey October 2007 – the large Goniastera and Lobophyllia reef which is located along the south-eastern shore of SW Regnard Island. The southern part of the reef exhibits up to 100% live coral cover, whilst the northern part has up to 40% live coral cover (location of Site P3 – refer to Figure 15)

Plate 2 LAT Aerial Survey October 2007 – close-up of high cover coral community north of Preston Spit (location of Site P5 – refer to Figure 15)

Coral-supporting habitat of low to moderate percentage cover occurs as a wide belt along the western side of the Cape Preston platform, and gradually thins to a narrow band along the west and north side of Preston Island to the vicinity of the breakwater. This band continues along the slope that passes to the west and north of SW Regnard Island. Most of the habitats in the shallows adjacent to Cape Preston are relatively barren intertidal sand flats or shallow algae dominated pavements.

Recent habitat surveys of this area in December 2006 and June 2007 have not been able to locate the high cover and high diversity coral community previously known to occur to the north of Preston Island. It is evident from these recent surveys that the benthic habitats in the region are recovering from cyclone damage (two intense cyclones - Glenda and Clare - passed very close to Cape Preston in 2005 and 2006), and it is considered that this small community has been significantly impacted by these natural events (URS, 2008).

By comparison, the area of coral community that occurs in the immediate vicinity of the development footprint is very small and of low diversity and live coral cover except in a small fringe along the steep slope that runs around the northwest corner of Preston Island.

Offshore from Cape Preston the seabed shelves rapidly to depths of greater than 10 m and then to a large basin extending to -17 m CD. The substrate in this area (Fortescue Roads) is a relatively barren silty sand substrate with little macrobiota evident on the surface. In the deeper parts of this basin occur scattered and at times dense patches of *Halophila sp* seagrass. Sparse patches of this species of seagrass were also recorded in small areas west of SW Regnard Island and west of Fortescue Island. Further offshore in waters >22 m, the substrate is gravely sand which supports scattered sea whips and fans and the occasional large barrel sponge in low abundance.

3.10.7 Marine fauna

Marine fauna appearing in either Schedule 1 of the *Wildlife Conservation Act 1950*, listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* or DEC's Priority Fauna list are known to occur in near coastal waters or have been recorded locally, and include:

Marine Turtles: Pendoley Environmental (2006) conducted a review of turtle habitat usage reports for the Cape Preston locality on behalf of URS. Sea state and prevailing weather conditions combine to erase evidence of turtle breeding activities at Cape Preston; consequently surveys have had to rely mostly on live sightings rather than remaining signs as used in surveys elsewhere. However, available survey information obtained during three separate seasons indicates that the beaches of Cape Preston are utilised for a very limited amount of turtle breeding activities. The results suggest the northern end of the western beach is a favoured nesting area for hawksbill turtles (*Eretmochelys imbricate*), the eastern beaches are favoured by the green turtle (*Chelonia mydas*) and south western beaches by flatback turtles (*Natator depressus*). Near-shore sub-tidal areas are likely to provide habitat for Turtle feeding activities.

Dugongs: In the Dampier Archipelago/Cape Preston region, small numbers of dugongs (*Dugong dugon*) have been sighted in the shallow, warm waters in bays and between islands, including at East Lewis Island, Cape Preston, Regnard Bay, Nickol Bay and west of Keast Island. Current knowledge on the size of the population, distribution, migratory habits and regional and local importance of the Dampier Archipelago/Cape Preston area for dugongs is limited.

3.11 SOCIAL VALUES AND USES

As indicated in Section 1.5, the shallow waters of Regnard Bay to the east of Cape Preston have acknowledged conservation value as do the nearshore islands that comprise the GSINR.

The waters and shallow marine habitats of Regnard Bay are fished recreationally by low numbers of visitors from Dampier and by itinerant "grey nomads" that occupy the 40 Mile Beach camping area during winter months. The waters on the west side of Cape Preston are similarly fished recreationally by visitors from Pannawonica and by grey nomads that occupy the Fortescue River Mouth camping area during winter (Figure 12).

The deeper waters to the west of Cape Preston are used occasionally by Onslow based prawn trawlers. The Onslow Prawn Managed Fishery operates along the western part of the North West Shelf and targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus spp*.) and banana prawns (*Penaeus merguiensis*) using otter trawl. The governing legislation/fishing authority is the Onslow Prawn Fishery Management Plan 1991 and the Onslow Prawn Managed Fishery Licence. Cape Preston falls in both Fishing Area 3 and the Fortescue Nursery Area of the Onslow Prawn Managed Fishery.

There are two aquaculture lease sites within the vicinity of Cape Preston; one west of Cape Preston and one west of NE Regnard Island (Figure 12). The Project port does not fall within either of these leases.

The mainland immediately adjacent to Cape Preston, Regnard Bay and the Fortescue River is zoned for industrial use, and is covered by *Mining Act 1978* tenements.

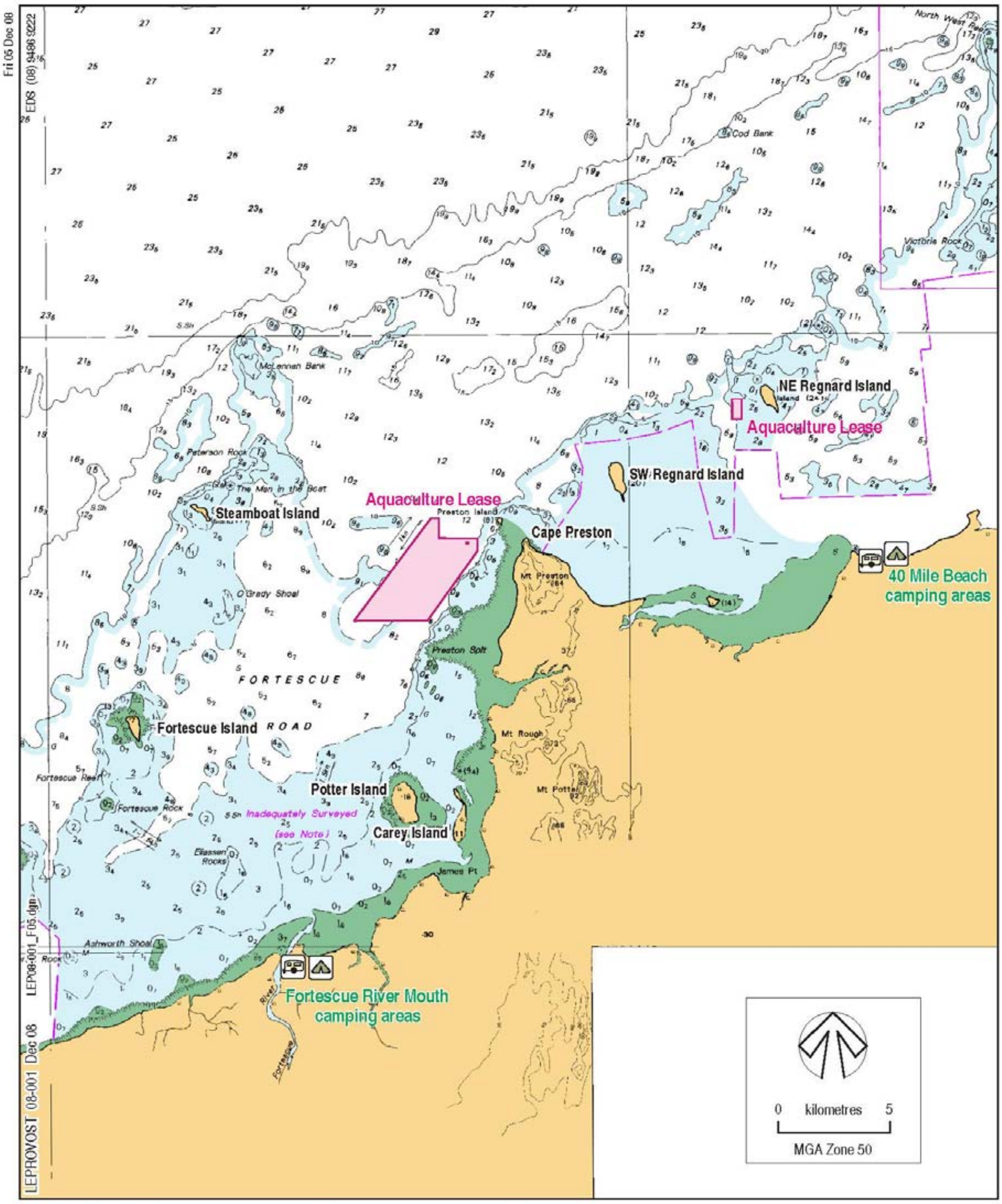

Figure 12 Camping areas and Aquaculture Leases in the vicinity of Cape Preston

4. PORT LAYOUT AND CONSTRUCTION

4.1 PORT COMPONENTS

The Project port infrastructure is required to support a cargo wharf, tug pens, offloading platform and trestle jetty.

Port facilities will consist of:

- Port lay-down and materials handling area, including a stockyard and lay-down area to incorporate all necessary plant and equipment including settlement ponds, motor control centre, control building, electrical substations, laydown areas, topsoil stockpiles, service roads, and mechanical and electrical works such as transfer towers, sampling unit, stack and reclaim conveyors, stacker-reclaimers and site services
- A stockpile yard that will have the capacity to store and handle magnetite products. The following buildings will be provided in the stockyard area:
  - an administration/control centre
  - a transfer tower
  - substations
  - workshop
  - general store with a fenced open storage area
- A solid rock causeway running in a north-northwest direction from Cape Preston to the east of Preston Island
- A breakwater running to the west from the outer end of the causeway to provide protection for vessels
- A small craft harbour and materials offloading facility (MOF) to accommodate the loading or unloading of general cargo
- A heavy lift barge unloading ramp allowing barges to berth and unload (modular) outsize loads onto a ramp
- Associated infrastructure running along the causeway, including:
  - Conveyors between the onshore stockpile and loading facilities.
  - Roadway to allow access to the small craft harbour, import berth and the loading facilities at the end of the breakwater
  - Services to the port in a below-ground services trench on top of the breakwater. These services will include power, water, fire water, telephone, control cables, etc
- Tug pens
- A trestle jetty and indicative shipping route[1] for loading and access of vessels.

Figure 13 shows the port layout.

[1] Dredging of the Project shipping channel to allow access of cape sized vessels to the trestle jetty will be conducted as a separate and later stage of port development. This document will be updated to include discussion and assessment of the dredging operation, and it will be resubmitted to Government for approval.

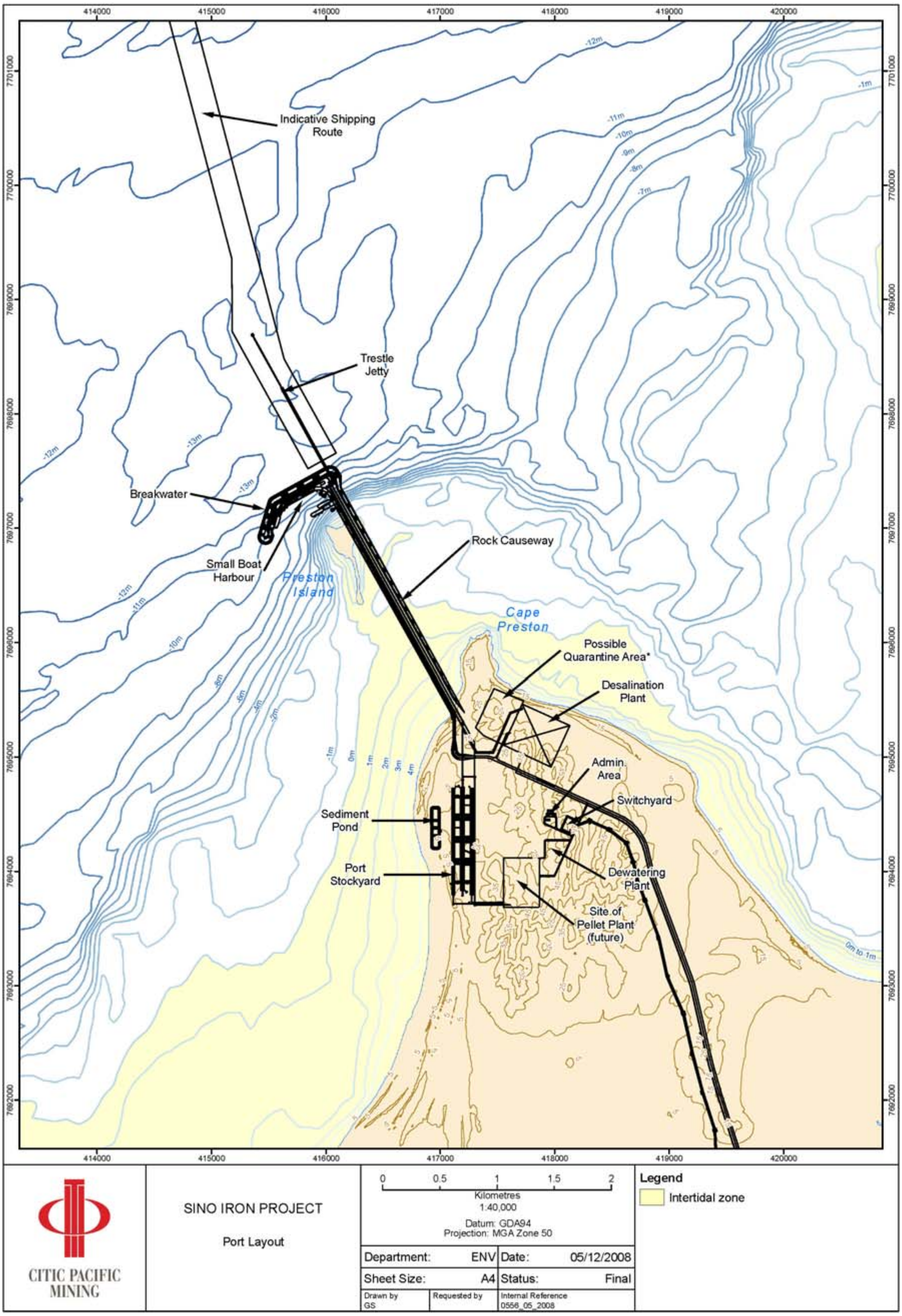

Figure 13 Port layout

4.2 CAUSEWAY

Based on engineering, operability and economic considerations, the Proponent determined that construction and operation of a solid rock causeway between Cape Preston and Preston Island is its preferred option. A trestle jetty or rock causeway with culverts between Cape Preston and Preston Island would require significant additional engineering (and therefore significant additional cost) to ensure such structures remained stable during cyclones, and to give adequate protection to the infrastructure being supported by such structures.

This port layout is based on minimising the volume of rock required to construct the port and gaining access to nearest navigable waters. A solid rock causeway is preferred over a trestle structure or culverted causeway because it will allow:

- far greater utility for heavy loads
- less risk of engineering failure (culverts are weak points)
- better spill and water quality protection
- substantially reduced time and cost to build.

The causeway and breakwater will be constructed of porous rubble mound rock and boulder structures to above the storm surge level (+8 m CD). The structures will be of sufficient strength and integrity to withstand cyclonic waves and support a heavy haulage road as well as services, conveyors and pipelines above storm surge level.

The structures will be built up in layers to allow the staged installation of services and the placement of armour rock and Core-loc[2] armour as construction of the causeway and breakwater progresses. The layered approach will ensure better compaction of the structure and minimise potential for loss of smaller grades of rock. For the purposes of supporting and encapsulating the large seawater intake and outfall pipes within the causeway a bed of crushed rock aggregate (nominal 19 mm diameter) will be placed within the core of the causeway. These pipes will be laid above tidal and wave wetting height (+6 m CD). The core rock in the wave washed profile will be run of quarry with a nominal minimum size of 150 mm.

The causeway construction materials and methodology are described in the EMPgm (LeProvost Environmental, 2008).

4.3 BREAKWATER

Construction of the Project breakwater will commence once the causeway reaches the edge of the shallow platform to the north of Preston Island, where the sub-tidal water depth increases from -3m to -13m CD. The size of the core material to be used within the breakwater will increase to between 250 and 400mm. This larger core material will be covered by larger rock as an underlay to the larger Core-loc armour units. Storm wave protection using Core-loc will extend from -6m to +15m CD on the seaward side. This rock underlay and Core-loc units will be individually placed on the breakwater structure to produce a stable interlocking layer.

Within the port area, the breakwater will be protected using rock armour. Large rock will be placed to support the Core-loc armour layer on the outer side of the breakwater from seafloor -12 m to -6 m CD.

[2] Core-loc is a concrete armour unit for breakwaters and shore protection works.

4.4 OTHER INFRASTRUCTURE

Other port infrastructure includes a cargo wharf, tug pens, and heavy offloading ramp. The cargo wharf will be built by driving piles into the sea bed or breakwater structure and then installing head rails and wharf decking. The tug pens will be built in a similar way using piles driven into the sea bed, with decking attached to enable workforce access to the tugs.

The heavy offloading ramp and platform will be a constructed using a combination of rubble fill of the same grades (>19 mm diameter) used in the causeway/breakwater, but supported and stabilised by reinforced concrete walls and pads.

Construction of the port infrastructure inside the breakwater will require a pile driving barge, a small jack up barge and support vessels for supplies and crew change. It is anticipated that this marine equipment will be sourced locally (from within WA). Once the basic breakwater and jetty structures are completed, services and conveyors will be installed from Cape Preston to the port facility. This work will require primarily truck transport and cranes for lifting prefabricated equipment into place.

The trestle jetty will comprise:

- a 1,400 m long piled approach jetty which will extend northwards from the northern end of the causeway and support conveyors, services, and a roadway
- a 400 m long piled loading platform structure to support a travelling shiploader for loading of wet concentrate and pellets onto export vessels
- “Dolphin” berthing structures with associated catwalks and access ways for mooring of export vessels.

5. ASSESSMENT OF PORT DESIGN

5.1 INTRODUCTION

The purpose of this section is to address the following objectives for the MMP, as specified in Condition 7-1:

- *To accurately predict changes in coastal water movements, quality, residence times, bathymetry, sedimentology, beach alignment and habitat cover associated with the project, and*
- *To allow for appropriate management measures to be identified and implemented.*

This section of the MMP addresses the impact assessment requirements of Items 1 and 2 of Condition 7-1 of Statement 635.

Item 4 of Condition 7-1 relates to protection of a small but high cover coral community located on the north side of Preston Island that, at the time of the EPA's assessment of the Project, was considered to be regionally significant. As indicated in Section 3.10.5, the recent marine habitat surveys completed by URS (2008) determined that, as a result of cyclone damage, this small coral community no longer exists. These marine surveys also identified that other regionally significant high living cover coral reefs exist in proximity to Cape Preston. These coral systems are substantially larger in area in comparison to the small community at Preston Island, and have been identified for protection from the construction works associated with the port.

This section therefore assesses the potential direct effects of the presence of the proposed port on:

- bathymetry in vicinity of Cape Preston Island (Section 5.3)
- water flow and residence times around Cape Preston and Preston Island (Section 5.4)
- sedimentology, coastal processes, shore alignment and turtle nesting habitats along the western beach at Cape Preston (Section 5.5)
- benthic primary producing habitats in the vicinity of Cape Preston (Section 5.6).

Note that the potential indirect effects of constructing the port area are addressed in the EMPgm (LeProvost Environmental, 2008).

5.2 EPA COMMENTS ON APPROVED PORT LAYOUT

The EPA, in Bulletin 1056 (EPA, 2002), made the following comments on the proposed solid rock causeway between Cape Preston and Preston Island:

> *3.4 Coastal features: mangroves, foreshore, dunes, island shores, seabed*
>
> *Detailed hydrodynamic studies have not been carried out for the Cape Preston area. Austeel, in its Supplementary Environmental Review, committed to detailed modelling to demonstrate the environmental acceptability of the causeway and to provide the results to the EPA prior to the start of construction. Were the results to demonstrate the need for maintenance of water flow, pipes would be installed as necessary in the causeway.*
>
> *The EPA has heard of instances where pipes inserted into causeways to mitigate undesirable effects have been ineffective and where the adverse environmental impacts are essentially irreversible unless the structure is removed. The solid causeway linking Cape Preston with Preston Island would alter the coastal current regime in its vicinity. The EPA's objective could be best met by the construction of a trestleway from Cape Preston to Preston Island rather than the solid causeway proposed. The EPA considers that a trestleway should be the initial design*

premise unless hydrodynamic studies are able to demonstrate that some other structure would not cause unacceptable marine environmental impacts.

The EPA considers that a detailed hydrodynamic survey should be carried out prior to the commencement of coastal disturbance. The aims should be:

- *to implement, as soon as possible, careful baseline monitoring in order to establish what is natural seasonal variation in tidal and sedimentation regimes in the vicinity of Cape Preston; and*
- *to determine what changes would occur to these tidal and sedimentation patterns with the imposition of various bridging structures between the Cape and Preston Island, and how these changes would impact on habitats.*

If results indicate adverse impacts are likely to the western beachline, mangals or high-cover coral communities, the proponent should be required to iteratively modify the design of the bridging structure prior to its final design and construction so as to demonstrate that unacceptable impacts as a result of the proposed modifications are unlikely to occur. This would enable the EPA's objective for mangroves (and corals) to be met.

If the project proceeds annual surveys should be undertaken to identify if unforseen adverse changes to coastal regimes and environmentally sensitive habitats are taking place and if so, modifications to the bridging structure should be proposed, submitted to the DEP and CALM for approval, and implemented.

3.5 Marine fauna, including turtles, corals, benthic organisms and introduced marine organisms

The proposed solid causeway could cause geomorphological changes to the beaches to which turtles currently come to nest, because it may change the pattern of longshore drift and sand deposition in the vicinity."

The then Department of Conservation and Land Management (CALM) also made the following comments on the proposed solid causeway in its submissions to the EPA during the Project's public review period:

"76. CALM note the inshore marine areas are significant for wading birds and the beach areas may be important to sea turtle nesting (see below). Tidal currents can be strong in this part of the coast, and the risk of impacts on the nearshore marine environment from the causeway needs to be examined closely before it is approved.

94. CALM believe the construction of a solid causeway from Cape Preston to Preston Island is likely to cause significant changes to the patterns of sedimentation that will result in impacts upon the beach profile (including the dunefield and spit) on adjacent areas to Cape Preston. It has, therefore, the potential to adversely impact upon the geomorphological process which lead to the development of these natural features. There is the potential for other impacts, other than the two listed. Data have been collected which indicate that fish and coral spawn are transported between reef systems in the Pilbara (Dampier Archipelago, Montebellos, Barrow Island, nearshore islands) on ocean currents. A solid rock causeway between Cape Preston and Preston Island may have some impact on this interchange, and hence on biodiversity of nearby reef systems. In relation to marine habitat in the area, further information is required. Whilst we broadly know the distribution of habitats in the area, we do not know whether there are any unique habitats and/or species. This is relevant to the habitats in the area that will be permanently destroyed through construction of the rock causeway (and jetty) and impacted by downstream effects of changes in water circulation, increased turbidity, sedimentation and substrate erosion. As such, some studies of the relative importance of these habitats in a regional sense would be required to assess the full impact of this proposal".

Since the above comments were made, there has been further marine habitat survey work completed (URS, 2008), continuous monitoring of tidal water levels, waves and currents at two locations near Preston Island since October 2006, and development and validation of a hydrodynamic model (GEMS, 2008a). The hydrodynamic model has subsequently been used to assess the effects of both a solid rock causeway and a rock causeway with a 200 m wide culvert (GEMS, 2008b). In addition, GEMS (2008c) is a desktop and field appraisal of geomorphic processes at Cape Preston to determine potential impacts of three port structure scenarios i.e. a solid causeway, a causeway with a 200 m culvert and a trestle structure instead of a causeway. This work is summarized in the sections below, and the GEMS reports are presented in Appendices B, C and D.

5.3 EFFECT ON BATHYMETRY

Figure 5 shows the port layout overlaid on the Sandwell (2007) bathymetric chart of the area, and Figure 14 shows the port layout and bathymetry overlaid on an aerial photograph.

The causeway alignment has been selected to both access the nearest deep navigable waters and minimise the volume of rock required for construction. The causeway's landfall has been determined by the onshore layout of the port infrastructure.

Much of the causeway's footprint occurs on intertidal pavement that is exposed under LAT (CD – 0 m) and forms a natural watershed boundary that divides the platform into a northern and southern component. Further offshore and north of Preston Island, the breakwater extends across and down a steep platform slope onto initially sand veneered pavement, and then deeper sand as the breakwater accesses navigable waters of 10-12 m depth. The structure will present a solid barrier to water flow across the platform between the Cape and Preston Island, and also around Preston Island.

The trestle jetty will extend northwards from the end of the breakwater for some 1,400 m. It occurs on relatively flat featureless sand and (minor) silt habitat. The jetty will be a piled structure and as such will not affect coastal water flows.

5.4 EFFECT ON WATER FLOWS AROUND CAPE PRESTON

5.4.1 Scope of works

The effect of the proposed structure on water flows around Cape Preston has been investigated by Dr Graeme Hubbert of GEMS (GEMS, 2008b). Dr Hubbert's report is given in Appendix C. This subsection presents a summary of the work undertaken by GEMS, the key results and conclusions.

The objectives of the modelling study were to assess the hydrodynamic impacts of the proposed port design. The work has been undertaken using the GEMS 3D Coastal Ocean Model (**GCOM3D**) to simulate the complex three-dimensional ocean currents off Cape Preston.

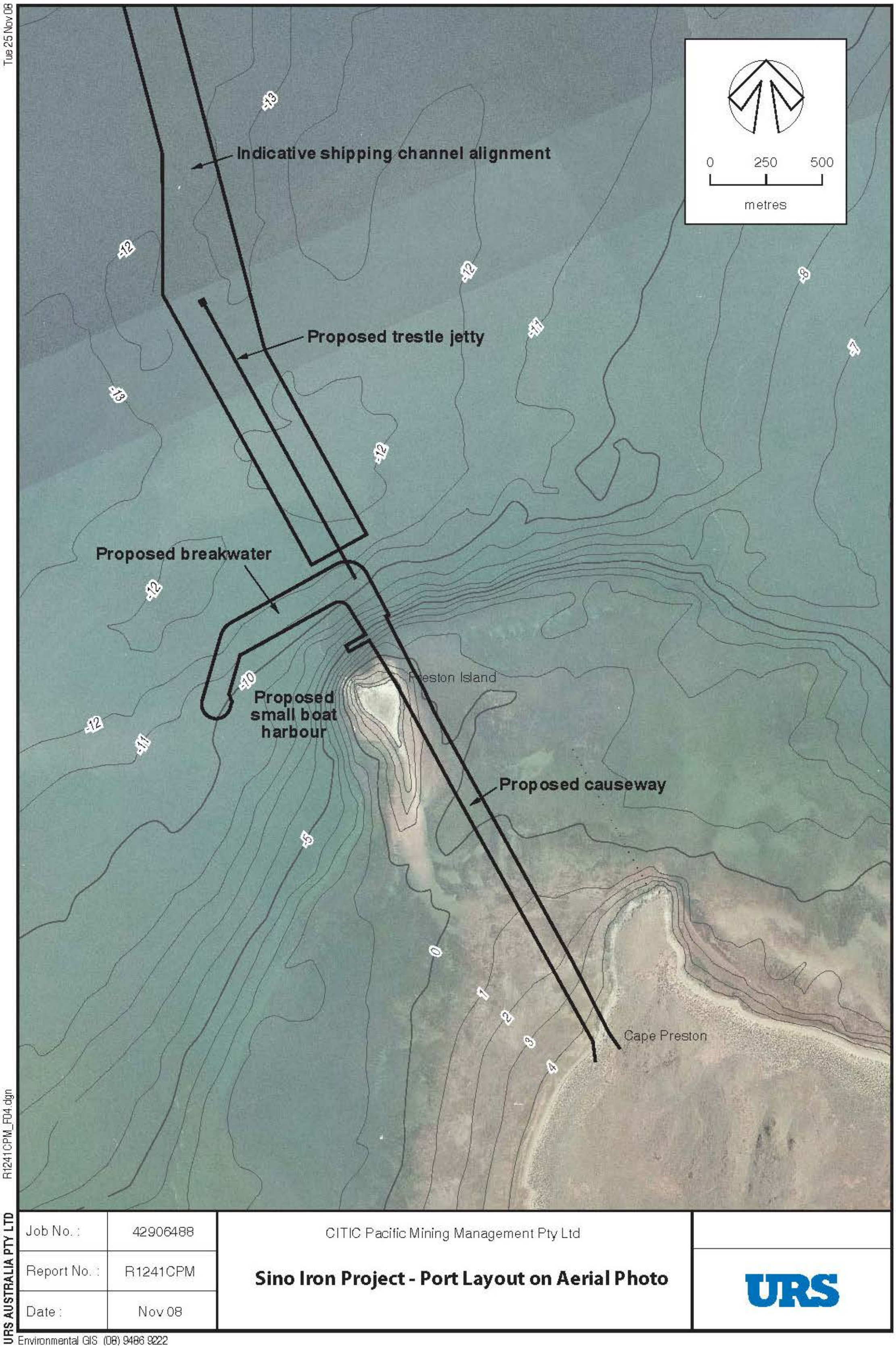

Figure 14 Aerial photo showing port layout

The scope of works requested of GEMS by CPM was to:

- simulate water flow circulation, tidal flushing and marine larvae dispersion around Cape Preston-Preston Island under the following scenarios:
  - as it presently occurs under a range of wind and tidal conditions
  - as it would occur with a solid fill causeway and breakwater as proposed by CPM
  - as it would occur with a solid fill causeway and breakwater which also includes a 200 m wide culvert in the causeway where water depth is greatest
- report the scope and methods of the modelling undertaken, the scenarios simulated and why selected
- present results of each scenario
- determine if local and regional water flows are affected significantly and describe/quantify that effect
- determine if the culvert provides any significant mitigation of the effects of the solid causeway.

The ocean currents and sea levels were modelled on two "nested" grids with GCOM3D. A large scale grid was used to generate boundary conditions for a higher resolution GCOM3D grid. The coarse grid was run at a resolution of 1 km driven by tides and MesoLAPS winds and atmospheric pressures. The finer grids, used to simulate the three bathymetric scenarios, were nested in the larger grid at a resolution of 50 m. It is necessary to run this nested system to fully capture the complex tidal dynamics of the northwest shelf region.

GCOM3D was used on the nested grid system to predict the ocean currents on each of the three high resolution bathymetries for each scenario for:

- One month surrounding the March/April 2008 coral spawning period. The reason for focusing on this time of year was that concern has been expressed by CALM as to whether the establishment of the solid causeway will significantly change the movements of marine larvae released during the coral spawning period. In 2008, coral spawning on the Northwest shelf occurred between 28-31 March, and so the modelling period chosen was 24 March to 24 April 2008.

- For the month of December 2008, which was selected because it was a period of strong southwest winds, which represents an ideal situation for forcing water through the shallow gap between the Cape and Preston Island.

To further focus on the effects of a causeway on the dispersal of marine larvae, five locations (P2, P3, P5, P6 and P7) (see Figure 15) where coral is known to exist on either side of Cape Preston were chosen for studies of variations in the currents and for the release of particles to be tracked. Sites P3, P5 and P6 represent the approximate location of the three regionally significant high cover coral reefs closest to Preston Island (see Figure 11 and Plates 1 and 2). Site P2 is a small area of moderate coral cover on the east side of the Cape (see Plate 3). Site P7, near the southwest corner of Preston Island, supports low to moderate coral cover and was chosen due to its situation in the lee of the port breakwater.

In addition, two locations (P1 and P4), which occur on algae dominated pavement and sand veneered pavement respectively with very low abundance of coral, were established to study variations in ocean currents near the causeway. All locations are shown in Figure 15.

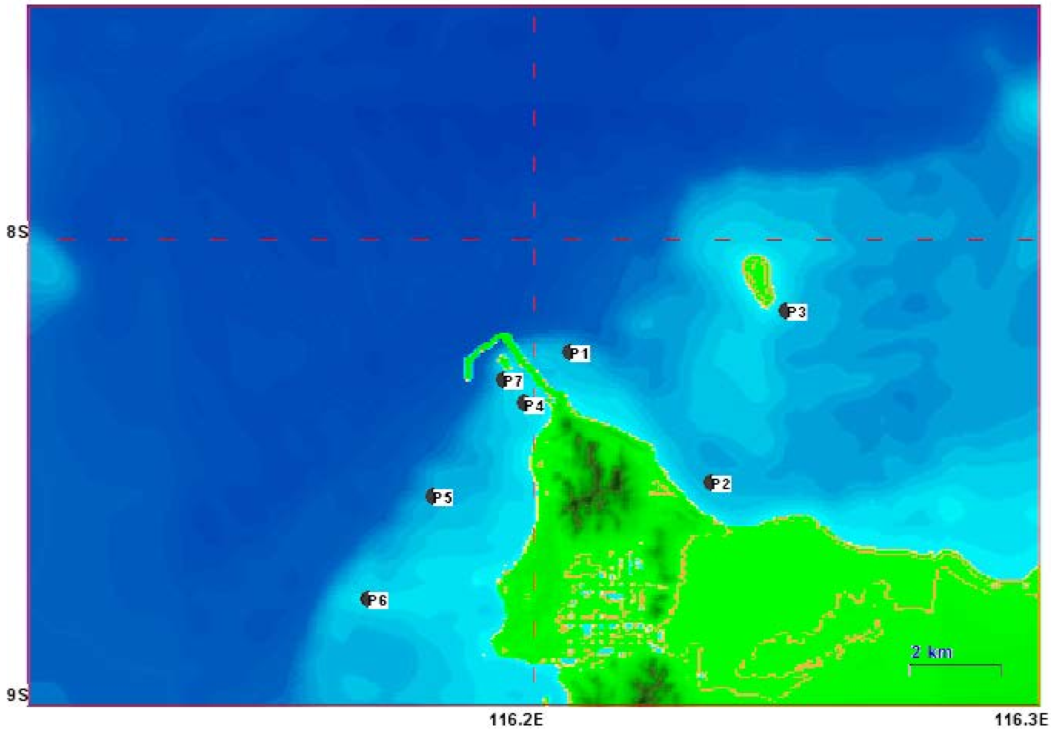

Figure 15 Locations chosen for detailed studies of currents and particle fates

Plate 3 LAT Aerial Survey October 2007 – close-up of edge of platform on east side of Cape Preston showing an isolated small area of moderate cover coral community (location of Site P2 – refer to Figure 15)

The full scope of modelling undertaken and presented in Appendix C includes:

1. Surface water particles (representing coral larvae) were tracked from the above locations (P1-P7) under both flood and ebb tide conditions experienced during March -April 2008.
2. Surface water particles were also tracked from the key reef sites (P5 and P6) to the south of the proposed causeway during December 2008 to see if water could be driven through the gap between the Cape and the island.
3. Tidal levels at Site P1as they presently occur without the causeway, were compared with tidal levels at P1 with the causeway in place.
4. Current speed and direction were simulated at sites P1 and P5 for both the existing situation and with a solid causeway installed.
5. The effect of inserting a 200 m wide gap in the causeway on current strengths and direction during an ebb tide has been compared with effects of a solid fill causeway.

5.4.2 Summary of results

The results of the simulation of tides and currents with and without the solid causeway show that the changes due to the solid causeway are quite local. The time series of the tides and currents before and after the solid causeway showed that there is no detectable effect on sea levels, whilst there is very little change in speed and direction of currents (at sites P1 and P5) on either side of the solid causeway. Changes in current speed and direction only occurred in the shallow areas within several hundred metres of the solid causeway and diminish rapidly with distance from the solid causeway.

The major reason for this outcome appears to be because the majority of the tidally driven water flow around Cape Preston actually passes north of Preston Island and not through the gap between the Cape and Preston Island. As a result the solid causeway only causes a very localised interruption to the circulation around Cape Preston. This finding is understandable when the shallow bathymetry between Cape Preston and Preston Island is taken into account, plus the fact that the causeway is aligned close to the natural tidal watershed boundary on the platform.

These findings were strongly supported by the results of the particle tracking studies where, in all cases, the existence of the solid causeway had minimal effect on the fate of particles released on either side of Cape Preston from the regionally significant coral reef sites (e.g. Figure 16).

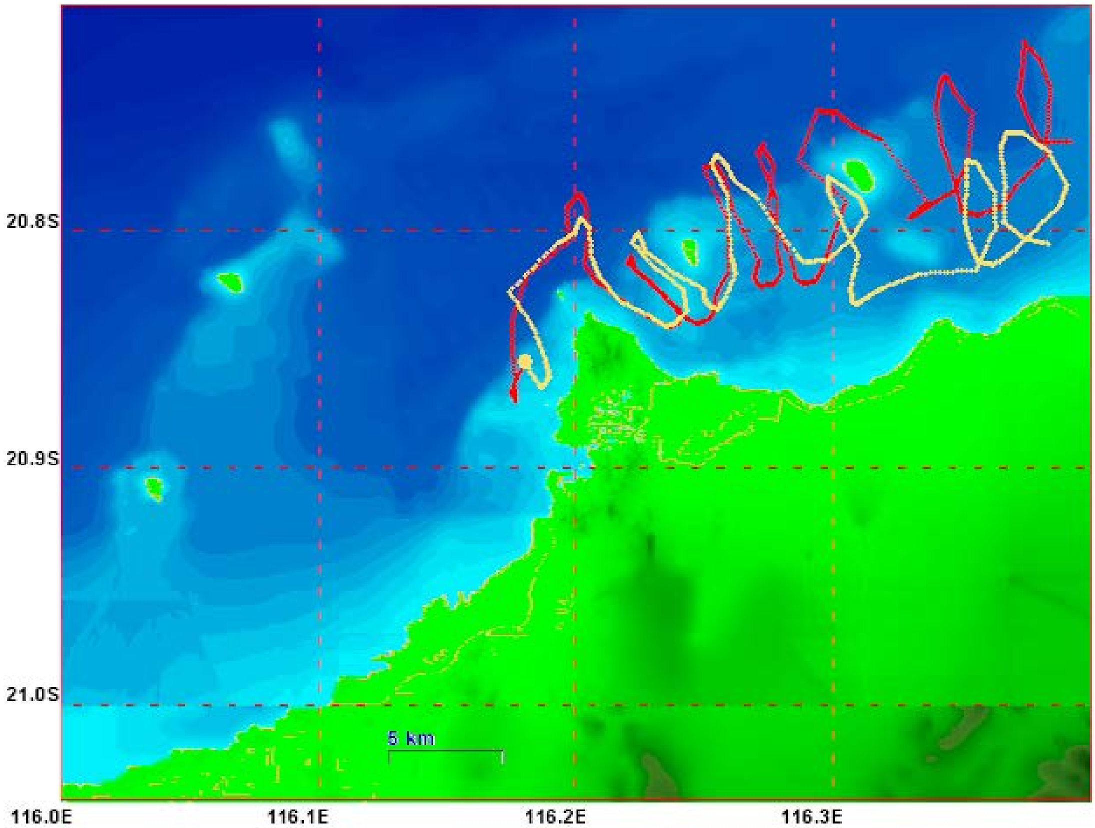

Figure 16 Comparison of particle tracks released on the ebb tide on March 28 at site P5 before (red) and after (yellow) installation of a solid causeway

The only particles which were affected by the insertion of the solid causeway were those released from sites P4 and P7. Particles released at these sites did flow through the gap between the Cape and the island without the causeway in place, but were diverted around the causeway and breakwater with these structures in place. Interestingly however, they still ended up tracking over similar territory in subsequent days (e.g. Figures 17 & 18).

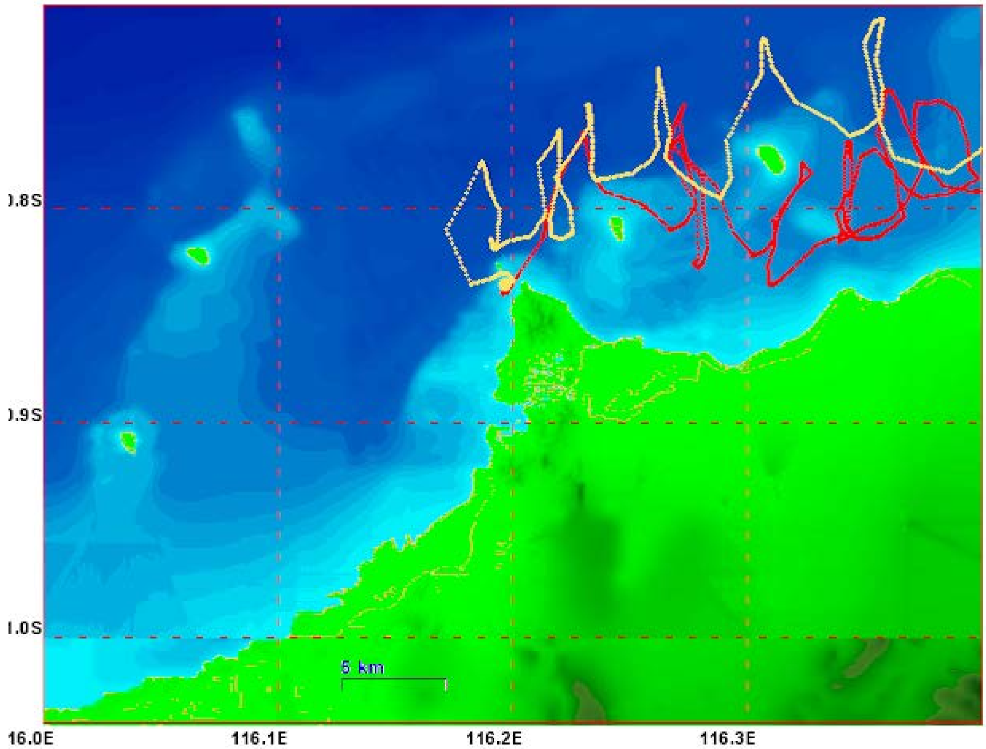

Figure 17 Comparison of particle tracks released on the ebb tide on March 28 at site P4 before (red) and after (yellow) installation of the solid causeway

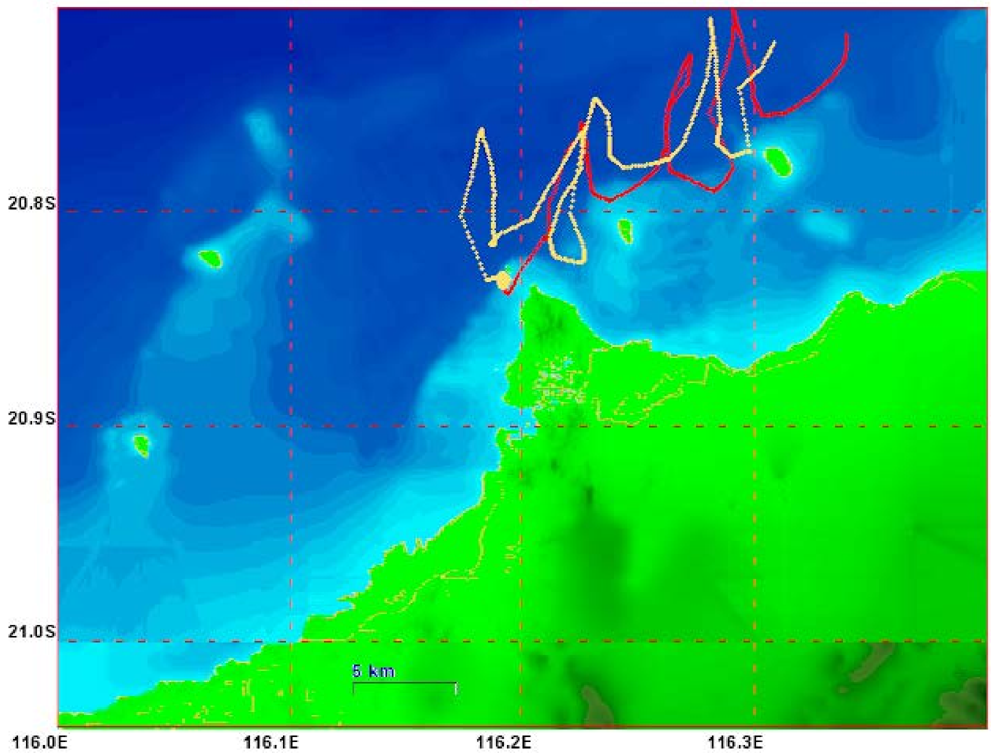

Figure 18 Comparison of particle tracks released on the ebb tide on March 28 at site P7 before (red) and after (yellow) installation of the solid causeway

The results of the December particle track simulations were particularly interesting due to the choice of conditions which might drive particles from the west through the region between Cape Preston and Preston Island. The experiment however failed to result in particles being driven through the gap between Cape Preston and Preston Island, suggesting that this is a difficult outcome to achieve because of the shallow bathymetry at this location and that water born particles, including coral larvae, take the path of least resistance around the western and northern side of Preston Island (e.g. Figure 19).

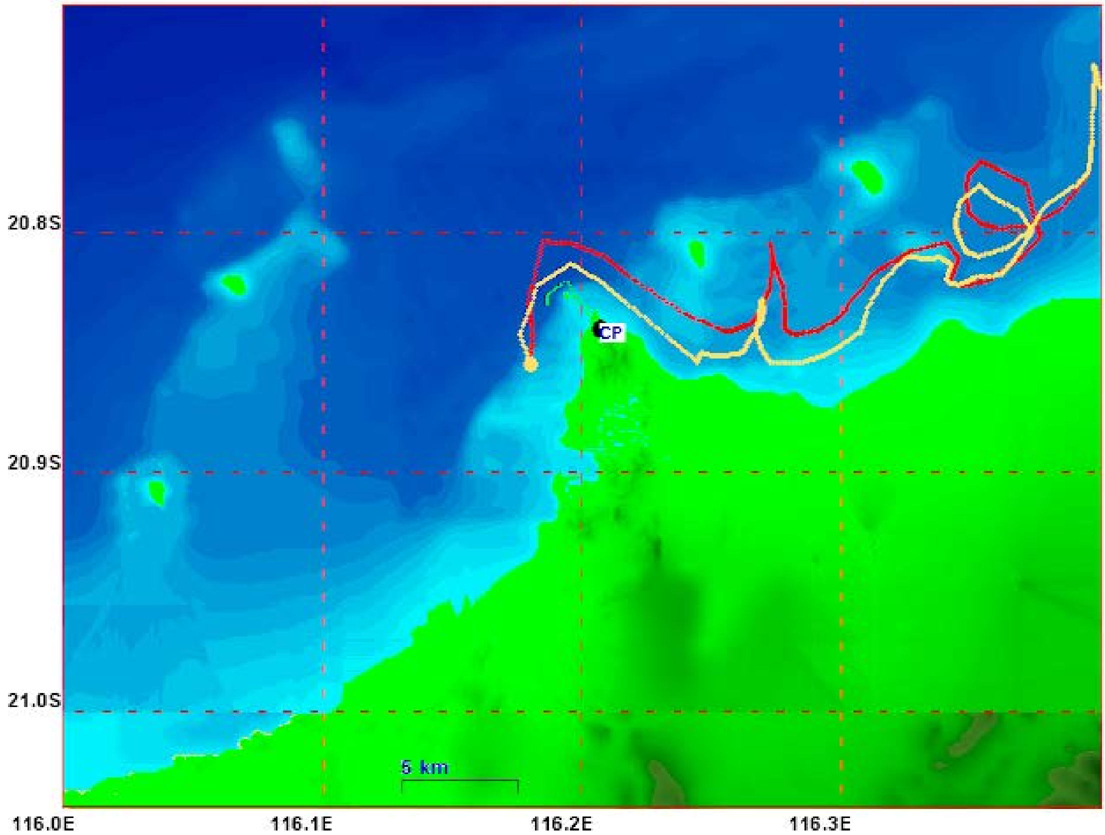

Figure 19 Comparison of particle tracks released on the ebb tide on December 15, 2007 at site P5 before (red) and after (yellow) installation of the solid causeway

The comparisons of the tidal flow around the solid causeway with the flow when the 200 m gap is introduced showed that there is very little change in the overall circulation around Cape Preston.

Some flow passes through the gap but the region is so shallow compared with the depth just north and west of Preston Island, where there is a rapid drop in the bathymetry to depths of 10 m and greater, that it is not physically possible to carry large fluxes of water through the gap.

This result is supported by the time series of current speeds and directions either side of the location of the solid causeway. These results indicated that, even with a much larger gap between Cape Preston and Preston Island (i.e. no solid causeway at all), there is minimal variation in the current directions and speeds on either side of the solid causeway before and after it is in place (e.g. Figures 20 & 21).

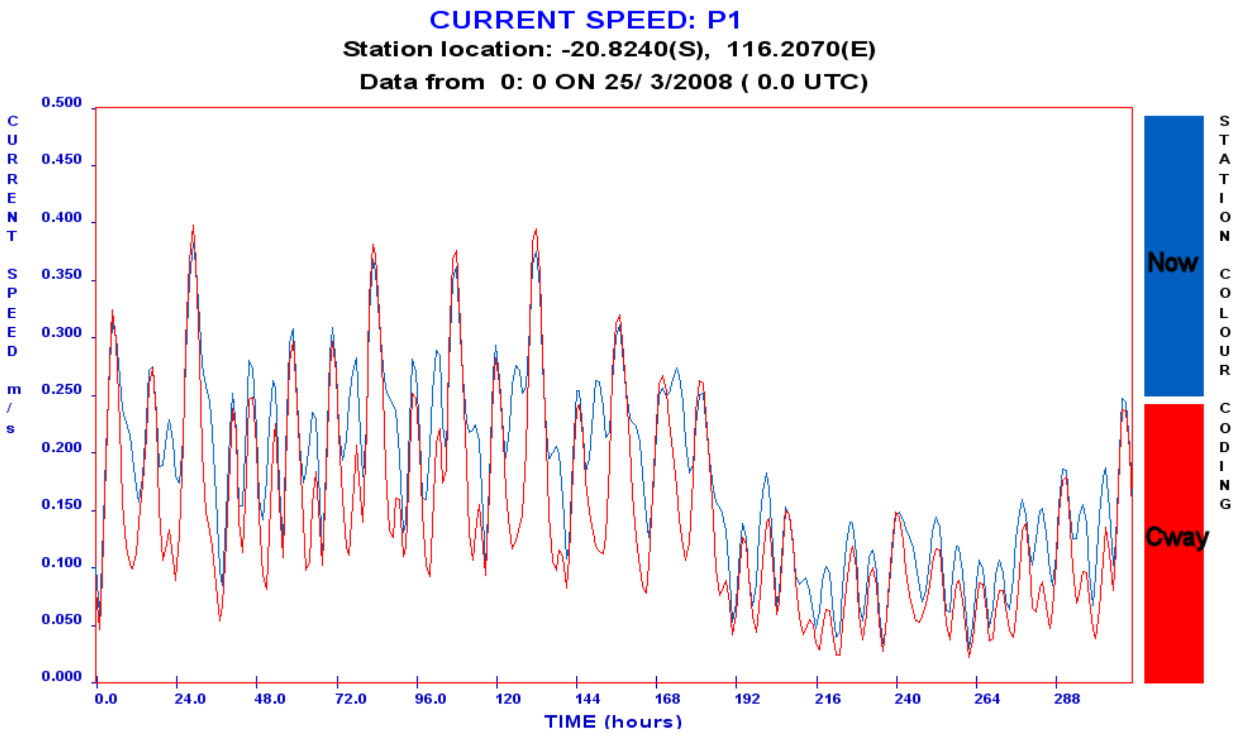

Figure 20 Comparison of current speeds at P1 before (blue) and after (red) the development of the port

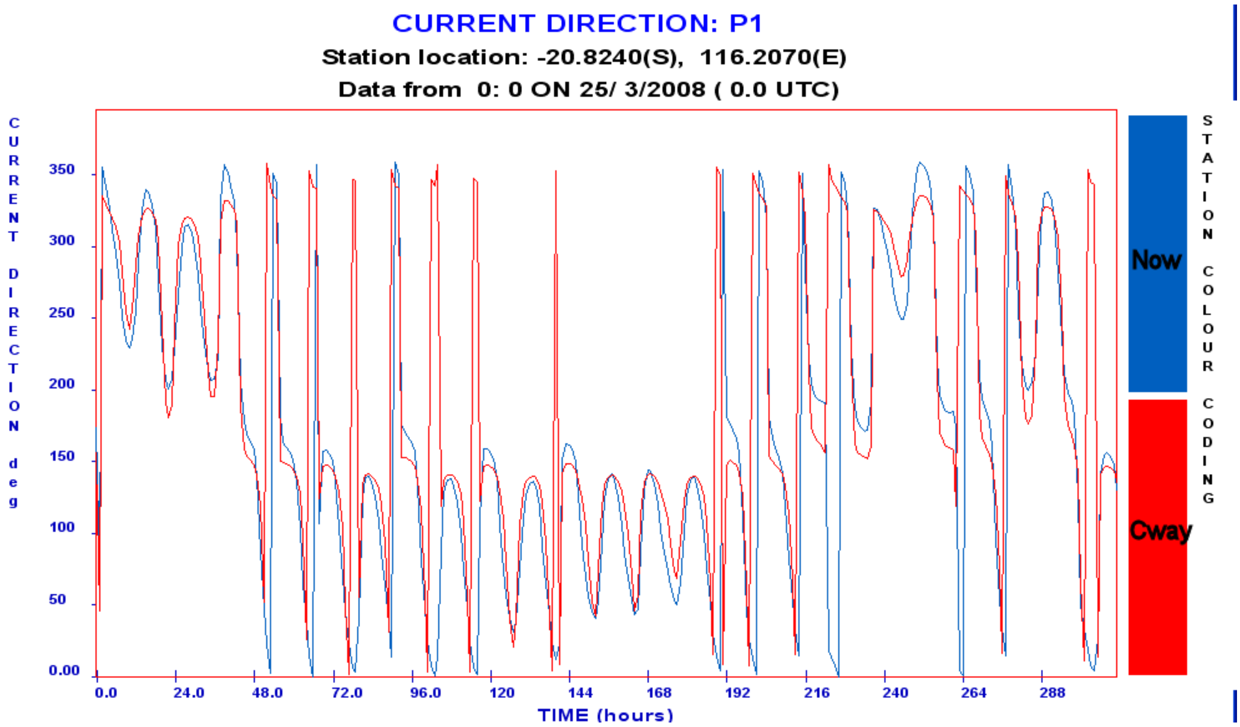

Figure 21 Comparison of current directions at P1 before (blue) and after (red) development of the port

5.4.3 Conclusions

GEMS therefore concluded that the simulation of the hydrodynamics with GCOM3D for the "before" and "after" the solid causeway cases showed that:

1) There will be no impact on tidal levels from the construction of the solid causeway
2) The impact on currents will be very local to the solid causeway and diminish rapidly with distance from the causeway
3) The basic circulation pattern around Cape Preston is maintained with the flood tide splitting either side of Preston Island and the Cape and the ebb tide from the west flowing back around the north and west side of Preston Island
4) Flows near existing beaches are not significantly affected due to the finding that impacts are very local to the location of the causeway.

The overall conclusion from the GEMS studies is that the port layout proposed by CPM will not adversely affect regional water flows and tidal levels or flushing characteristics, or coral larvae dispersal from regionally significant reefs. It will only have an effect locally within a few 100 m of primarily the southern side of the structure in the lee of the breakwater during ebb tides. There are no regionally significant reefs in this area.

GEMS identified that this effect is not mitigated by the inclusion of a 200 m wide gap in the causeway, because: (a) the tidal flux of water across the shallow platform is negligible in comparison to that around the north and west side of Preston Island, and (b) the breakwater is the dominant feature affecting circulation in its lee.

It was therefore concluded by GEMS that there is no benefit to be gained by inclusion of culverts into the causeway.

5.5 EFFECT ON SEDIMENTOLOGY AND COASTAL PROCESSES

5.5.1 Scope of works

The effect of the proposed structure on sedimentology, coastal processes, and shore alignment of the western beach of Cape Preston has been investigated by Mr Matt Eliot of GEMS and reviewed by Dr Bruce Hegge of Oceanica. Their report (GEMS, 2008b; Appendix D) is based on a field inspection, desktop appraisal of aerial imagery and application of models for prediction of shoreline change resulting from coastal structures.

This section presents a summary of the work undertaken by GEMS, some key results and the report conclusions. Subsequently an assessment of the effect on turtle nesting beaches and activities has been undertaken.

The scope of work requested of GEMS was as follows:

- identify the general pathways of sediment transport around Cape Preston
- determine the relative stability of the beaches around the Cape
- predict shoreline changes that may arise as a result of proposed port layout
- recommend further investigations required to increase reliability of above prediction
- design a monitoring program to determine accuracy of prediction, and provide warning of need for contingency actions
- provide a range of contingency actions that could be implemented in the event that monitoring shows that some form of corrective action is desirable.

With the exception of the last two bullet points (which are addressed in Section 6), the findings for each of the above items, as relevant to the western beach on Cape Preston, are summarised in Sections 5.5.2 – 5.5.5 below.

5.5.2 Conceptual sediment budgets

Sediment movement around Cape Preston is driven by a mixture of waves and currents, with winds, tides and surges each contributing to transport. As such, there is a significant difference in sediment transport patterns between seasons, which cause winds to be mainly from the west in warm season and from the east in the cool season. In both seasons, waves have a more northerly aspect due to their offshore generation and near coast refraction.

The warm season is a combination of westerly conditions (Figure 22), with occasional northerlies (Figure 23). The capacity for sediment transport along the shoreline is reduced by shelter provided by the subtidal terrace.

Figure 22 Typical sediment transport under westerly conditions

Figure 23 **Typical sediment transport under northerly conditions**

The cool season is a combination of easterly conditions (Figure 24), with occasional northerlies (Figure 23). In each case, the difference between prevailing and northerly conditions represents a switching of the dominant mode of transport. During the warm season, transport runs along the subtidal terrace between Cape Preston and the end of Preston Spit. During the cool season, transport moves material north and south along the eastern beach. The relative stability of the coast and its features suggests that there is a general balance, although the dune field structure suggests accumulation at Preston Spit over the long term.

Figure 24 **Typical sediment transport under easterly conditions**

The effect of tropical cyclones is variable. Cyclone events that are distant from the site will produce easterly wind before landfall and westerly wind afterwards, with corresponding patterns of transport (see Figures 24 and 22). Cyclones that landfall close to the site will produce northerlies if they pass to the west, or southerlies if they pass to the east. These southerly winds blow offshore and hence would have low wave impact. As indicated by the extreme wave climate, cyclonic winds from the north have the capacity to produce very large waves from the north-northwest through north-northeast. The sediment transport mode largely corresponds to Figure 23, although the capacity is dramatically increased due to the size of the waves and simultaneous storm surge.

Cyclones also have the capacity to generate large river flows on the Fortescue River in the area as a result of extreme rainfall. These flows can deliver large volumes of fine sediments to the coastal region south of Cape Preston. Additional flooding of small gullies in the Cape Preston area can lead to localised, short-term coastal changes as a result of fluvial run-off.

A conceptual net sediment budget has been developed by GEMS (2008c) and is presented in Figure 25. The seasonal patterns have been combined, based upon their relative occurrence, along with the evidence suggested by historic shoreline change and geomorphic features. The presence of structural controls at Cape Preston, the eastern end of the northern beach and at the eastern spit indicate that these zones are at capacity, such that additional material will tend to be bypassed towards the Eramurra Creek floodplain.

Figure 25 Conceptual net sediment budget for Cape Preston

On the west side of the Cape, separation of sediment transport along the outer edge of the subtidal terrace and the shoreline enables a circulation towards Preston Spit, which will continue to accumulate. The subtidal terrace apparently has the capacity to hold additional sediment. This sediment budget is based on site observations and available data. Note that the relative scales of this sediment budget should not be overstated – seasonal or year-to-year variations may depart radically from this generalised conceptual behaviour.

5.5.3 Stability of beaches around Cape Preston

Six sections were evaluated for change over the sequence of aerial photographs (Figure 26). Change in the width of the dune field at each location was considered. However, this evaluation is largely qualitative, as although the available imagery from 2001 onwards is rectified, there are no control points to define a baseline.

Figure 26 Beach sections evaluated for change

Trends in beach stability are slightly unclear due to the uncertainty associated with the uncontrolled measurements. However, the inferred behaviour is as follows:

- Section 1 – stable in the long term, after experiencing erosion between 2001 and 2004, with subsequent recovery
- Section 2 – has retreated in the long term, eroding specifically between 2001 and 2004, with limited recovery
- Section 3 – progressively eroding

- Section 4 – eroding over the long term, with apparent severe retreat between 1966 and 2001, followed by strong recovery. This represents collapse of the creek outlet, with corresponding dramatic local shoreline retreat, subsequent reformation of a southwards aligned spit then closure
- Section 5 – stable in the long term, with mild retreat from 2001 to present
- Section 6 – only recent data available, with a general retreat between 2001 and 2004.

Of particular note is erosion within the period 2001 to 2004, and the unstable character of the northern part of the western beach. It is also notable that relatively little change was observed between the 2004 and 2008 imagery, despite a highly active cyclone season in 2005/06, where five tropical cyclones passed to the northwest of Cape Preston. Four of the cyclones crossed the coast between Onslow and Dampier, including Clare, Emma, Glenda and Hubert. TC Clare and TC Glenda produced extreme surge and wave conditions, but did not occur coincident with high tides.

5.5.4 Effects of port

On behalf of CPM, LeProvost Environmental requested an evaluation of the implications on coastal stability and beach turtle nesting habitat in the vicinity of Cape Preston, of three potential development scenarios. The port layout (see Figure 13) is the same for all three options, differing only with the permeability of the approach causeway as follows:

- construction of a solid rock breakwater approximately 1.2 km long to the northwest of Preston Island, with a trestle structure approach from the shore extending approximately 2 km from a location about 1 km south of Cape Preston
- construction of the above breakwater, but connected to Cape Preston with a solid rock causeway
- construction of the above breakwater and solid rock causeway, but with the inclusion of a 200 m wide culvert section in the middle to allow water flow.

There are several potential effects of the proposed port layout, whether the causeway is a fully permeable (Option 1), impermeable structure (Option 2) or semi-permeable (Option 3):

- Each of the options creates a significant zone of wave sheltering (largely provided by the solid fill breakwater; Figure 27) from the prevailing wave direction. Wave sheltering reduces the potential for sediment transport through this zone and is likely to cause deposition within the sheltered zone.
- The causeway structure has been aligned parallel to the prevailing wave direction, and therefore only creates a separate zone of sheltering when waves arrive from more northerly or westerly directions.
- An impermeable, or semi-permeable causeway provides a trap for alongshore sediment transport in either direction, creating a depositional area on the either side of the Causeway. It is anticipated that this effect would be relatively localised, as the existing landmass of the Cape already provides considerable shelter from wave action to the beaches on its flanks. Supply is expected to be very low from the east, except perhaps during certain cyclone events.

The implications for coastal stability of constructing the three options described above (including the potential loss or creation of turtle nesting habitat), are considered in the following subsections.

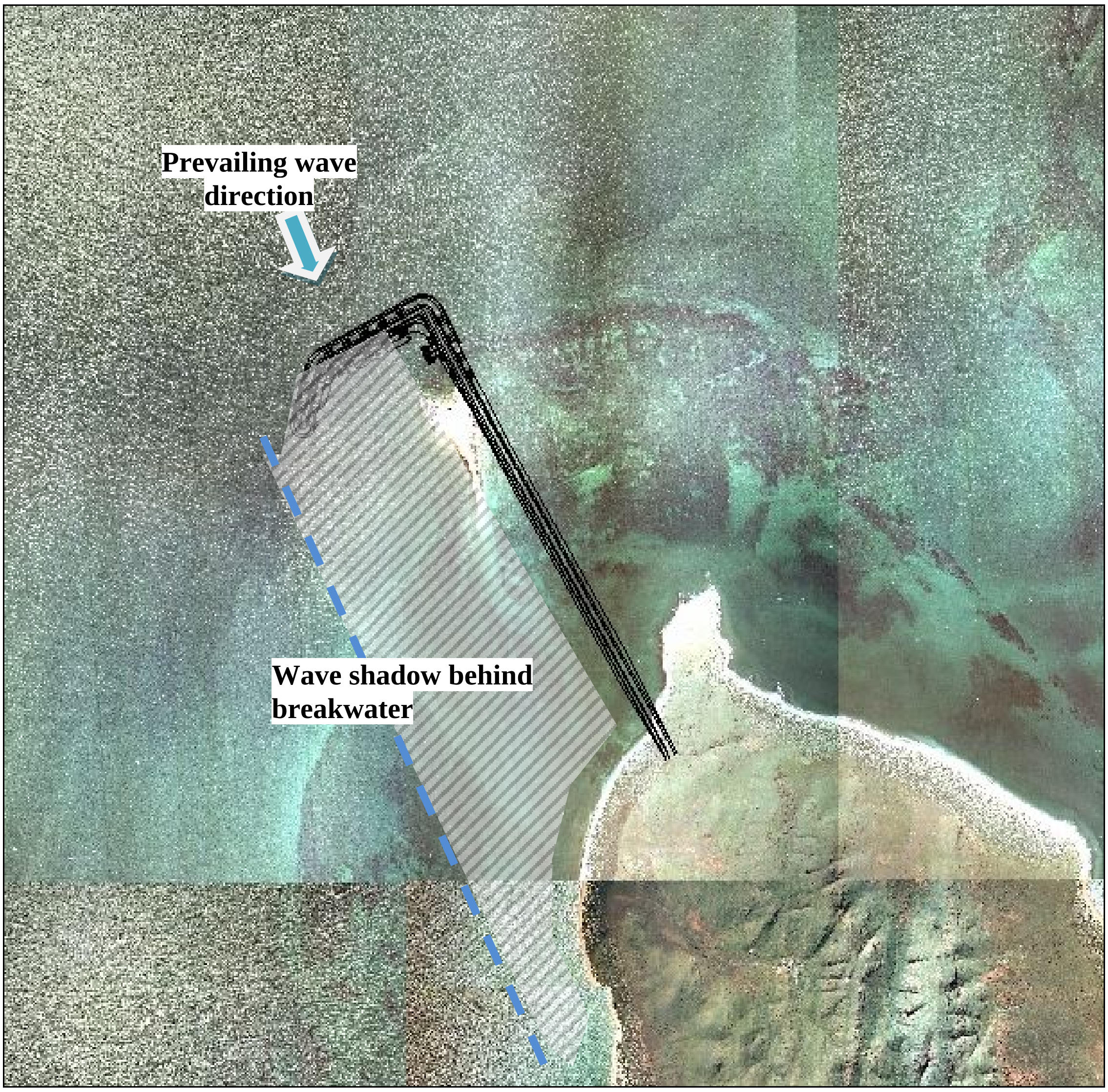

Figure 27 **Schematic illustration of wave shadowing**

Effect of Option 1- Breakwater plus trestle approach structure

Although this option has been proposed as a means of reducing the sediment accumulation associated with the causeway, the port breakwater alone provides considerable sheltering from incident waves. It is expected that the wave shadow produced by the breakwater may result in some sediment deposition along the shore, in the vicinity of the causeway.

Techniques available to estimate the formation of a salient (depositional promontory) behind an offshore breakwater suggest a salient seaward of the shoreline, with a 400 m offshore extent (Silvester and Hsu, 1992). However, because the shelter occurs on an existing promontory, this estimate is a relatively extreme upper limit. An estimate of the accumulation associated with the breakwater sheltering has been produced by assuming that the salient formed will cause reorientation of the shore, until there is a balance of northwards and southwards potential transport. Using the CERC sediment transport formula (United States Army Corp of Engineers, 2002), this balance has been estimated to occur with a clockwise rotation of the shoreline, approximately 3 degrees from the Cape to the landing point of the causeway. This represents a shoreline progression seaward of approximately 50m from the existing shore, with a total volume of accumulation of approximately 280,000 m^3 (Figure 28). A higher volume of accretion is possible if the trestle structure causes further wave sheltering.

Figure 28 Estimate shoreline response to Option 1 (not to scale)

The rate of accumulation within the salient is estimated to be less than the gross northwards transport, as occasional southwards sediment transport is likely to occur. At a rate of 10,000 m^3 per annum, the southern beach would erode at approximately 0.6 m per annum, for a period of approximately 30 years. Under the worst-case assumption of no net sediment supply to the area, the ultimate situation is 20 m of erosion along the southern beach (Figure 28).

Effect of Option 2- Breakwater plus solid causeway approach structure

Construction of a solid fill causeway out to the Port breakwater provides wave sheltering additional to that provided by the Port breakwater, which locally changes the prevailing wave direction on either side; and interrupts alongshore sediment transport. Sediment deposition is expected to occur on either side of the causeway within the sheltered areas. The western side is expected to accumulate under ambient conditions, with the eastern side expected to accumulate only under cyclonic conditions.

The potential for accumulation adjacent to the causeway on its western side has been evaluated using MEPBay (Klein *et al*., 2003; Benedet *et al*., 2004), to determine equilibrium bay shapes. When applied to Cape Preston, for a northwest wave direction, the western beach is comprised of two curves (Figure 29). The shallows off the Cape control the northern section, with the southern section controlled by the offshore reach of Preston Spit. The beach changes alignment approximately 1 km south of Cape Preston (circled in red on Figure 29), and this point acts as the downdrift limit for both sections of beach. Relocating this control point in MEPBay in a cross-shore direction suggests that the southern beach will largely advance or retreat parallel to its existing planform. It is notable that this matches the pattern of deposition indicated by the dune field.

Applying MEPBay to the northern beach, and shifting the updrift control to the breakwater west of Preston Island, suggests there is potential for a sizeable accumulation of sediment on the south side of the causeway (Figure 29). For a 1.3 km long breakwater, this represents approximately 6.5 ha that may be considered within the ‘wave shadow’. Accumulation would be expected to occur from the level of the platform, to the height of the dune field on the existing western beach, which is approximately 3 to 5 m. Although the capacity of this area to accumulate sediment is likely to be reduced by an order of 50% due to wave realignment across the rock platform, this still represents approximately 160,000 m^3 of ‘sediment demand’ that may accumulate in this region in preference to being distributed southward towards Preston Spit in the absence of the breakwater.

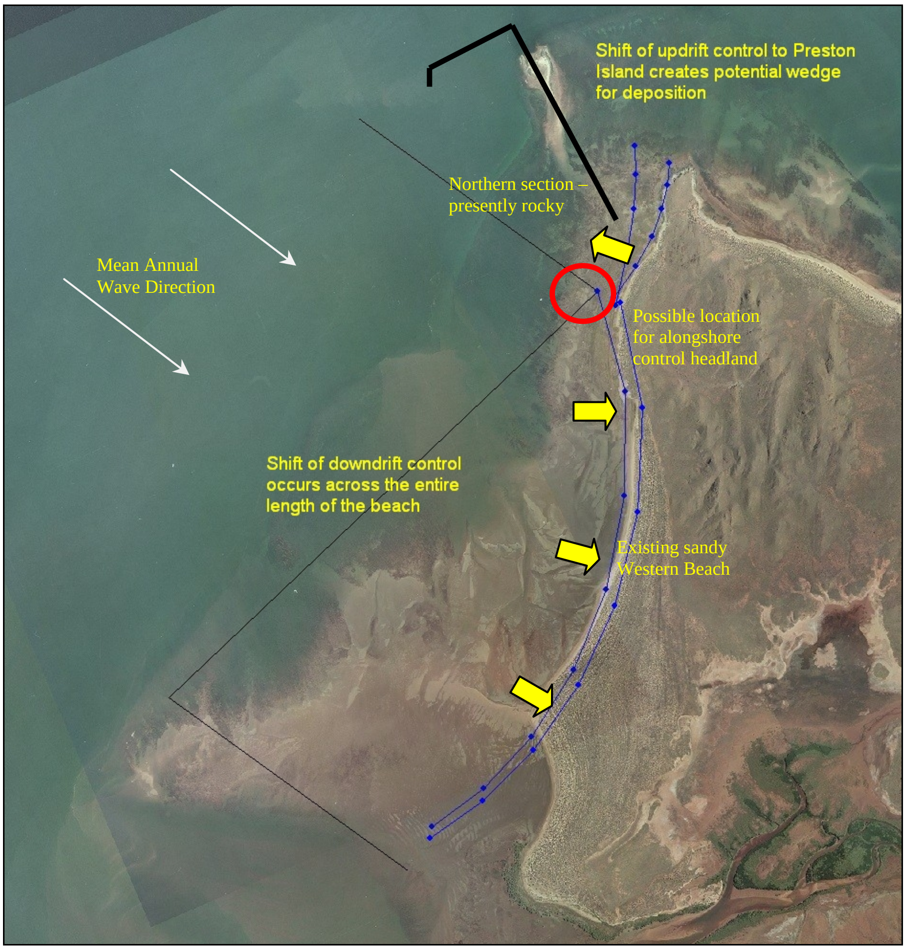

Figure 29 MEPBay stable beach alignments (not to scale)

Sediment will accumulate on the south side of the causeway at approximately 15,000 m^3 per annum for the first decade, which averages 5.0 m/yr accretion along the length of the northern beach. Ultimately, an arcuate beach is expected to develop, approximately 600 long, up to 100 m shoreward of the existing shore at its northern end (Figure 29).

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The response of the beach to the south depends upon the rate of material supply to this section of coast. If no material is available, the southern section of beach will erode at approximately 0.9 m per annum, gradually reducing over the first decade. Subsequently, the beach may be expected to stabilise. As this is a macro-tidal environment, the planar structure of the beach would be expected to remain, thus having relatively low impact on the value of the beach as turtle nesting habitat. A 10 m retreat corresponds to the width of the existing beach flat (Figure 29), and therefore is unlikely to form a significant beach scarp.

The beach flat zone typically represents the area that is affected by short-term fluctuations due to tides and storminess, and hence the potential erosion is of similar scale, albeit over a longer period, than natural shore variability. However, ultimately this variability will be superimposed on the eroded shore, such that both the beach face and the beach flat will retreat shorewards by about 10 m.

Erosion of the southern beach could be partially mitigated through construction of a short groyne or headland at the junction of the two beach sections shown on Figure 30. Such a structure would require careful design to withstand potential cyclonic impact.

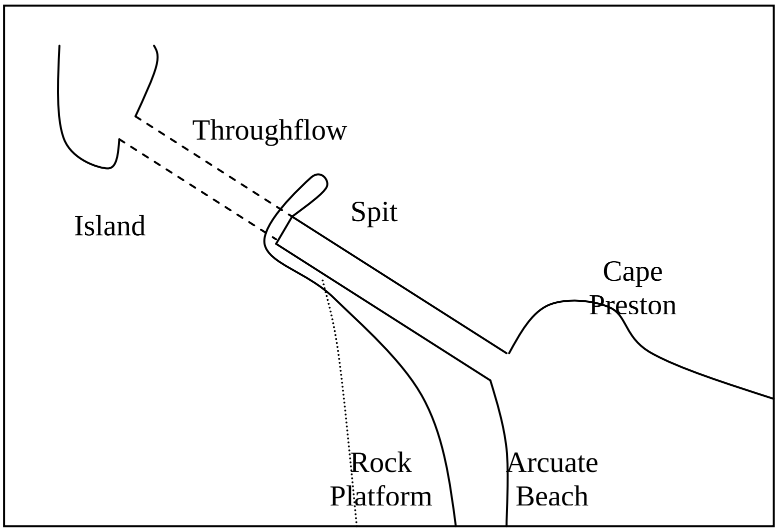

Figure 30 Schematic Illustration of throughflow processes

Effect of Option 3 - Breakwater plus solid causeway with 200 m gap

Modelling of the existing characteristics of water flow around Cape Preston (GEMS, 2008b) has demonstrated that the little volume of flow that does occur between Cape Preston and Preston Island, does so primarily through a 200 m wide deeper section near the island, with limited flow across the shallow rock platform. On this basis, it has been suggested that provision of culverts or a piled section of the causeway would minimise the impact of the causeway upon local flow patterns. However, it is likely that the causeway will still provide a significant barrier to wave action, and that the effects of this option will be very similar to that of Option 2 assessed above.

The effectiveness of a through flow structure within a solid-fill causeway is dependent upon the distance to mobile beach sediments, including accumulation caused by the causeway, and the potential for mass transport into the gap during an extreme event. In this case, the wedge of deposition likely to occur on the south side of the causeway is distant to the proposed culvert section. However, due to the macro-tidal regime and low energy wave climate, there is potential for strong tidal currents to create a narrow strip of sediment deposition parallel to the causeway, enabling sand to enter the gap.

The stability of the through flow and structure of adjacent local sediment features depends upon the relative supply of sediment:

- Under conditions of low sediment supply, such as during the cool season, sediment would be transported towards the through-flow, where the high tidal currents would cause rapid dispersion

- Under conditions of moderate supply, as may occur during strong southwest winds in the warm season, the rate of material dispersion would be relatively low, enabling the formation of a temporary spit on the eastern side of the throughflow (Figure 30)
- For situations of high sediment supply, such as may be caused by cyclone-induced erosion, the material pushed in may close over a section of the through-flow.

The rate of sediment supply towards the through-flow depends on the mass of the deposition to the south of the causeway and will therefore progressively increase through time, until a net balance of supply and loss occurs.

Because the scale of the ‘sediment demand’ substantially exceeds the estimated annual rate of sediment supply, the capacity for material to be transported to the through-flow is limited, particularly for the first 10 years following construction, (based upon estimated rates of transport and potential deposition area). However, it should be recognised that this possibility exists under the influence of extreme conditions. It is therefore considered that construction of a semi-permeable causeway would be unlikely to mitigate the coastal stability impacts of Option 2.

5.5.5 Conclusions

Sedimentology and Coastal Processes

GEMS concluded that construction of a port facility northwest of Preston Island was likely to cause local changes to the sediment transport regime and affect the beaches to the west of the Cape. A local reversal of sediment transport is expected to occur, causing erosion of the existing southern beach and deposition on the northern beach. The long-term impacts are affected by the permeability of the approach structure.

For a permeable (trestle) causeway:

- a salient is expected to occur in the lee of the breakwater, extending up to 50 m offshore from the existing shoreline, and containing roughly 280,000 m^3 of material
- this salient is likely to accumulate due to sand supply from the south, which will probably include transfer from the southern beach
- erosion of the existing southern beach may potentially occur around 0.6 m per year for a period of approximately 30 years, along the 3.5 km length, resulting in a shoreward retreat of beach by some 20 m. This is likely to be an upper limit, as it will be reduced by any onshore feed of sediment to these southern beaches.

For an impermeable (solid rock) causeway:

- a wedge-shaped deposition to the south of the causeway along a 0.6 km coastal length is expected to occur at an average rate of 5 m per year over 10 years on the basis of estimated longshore transport rates, with potentially greater rates under certain cyclonic conditions. This area is estimated to hold approximately 160,000 m^3 of material
- this deposition is likely to accumulate due to sand supply from the south, which will probably include transfer from the southern beach
- accumulation may occur between the causeway and Cape Preston, at a very slow rate, likely to only occur during cyclones
- erosion of the existing southern beach may potentially occur around 0.9 m per year for approximately 10 years, along the 3.5 km length, resulting in a shoreward retreat of beach by some 10 m. This is likely to be an upper limit, as it will be reduced by any source of sediment supply.

Although the area sheltered by the Port structures is greater for an impermeable causeway than a permeable approach structure, sand supply is severely restricted to the majority of this area. Consequently, Option 2 (i.e. for a solid causeway) creates a smaller effective ‘sediment demand’ than Option 1 (trestle structure), and is likely to have a lesser impact on the southern beach. For this to occur, the need for the causeway to be impermeable is stringent, requiring very careful application of appropriate design criteria and corresponding construction management. Constructing a small culvert section of the causeway to enhance flows is unlikely to cause a significantly different beach response to that provided by a fully solid fill causeway.

Turtle nesting habitat

Based on the above assessment of potential shoreline changes, some form of shoreline re-adjustment is likely to occur as a result of establishing the port. It is clear that a solid rock causeway is likely to result in less shoreline re-alignment, and it will stabilise over a shorter period than using a trestle structure approach. A solid rock causeway has an added benefit in that is also likely to protect the western shoreline from erosive forces during the more damaging cyclone events from the north.

The scale and rate of shoreline re-alignment anticipated from construction of a solid causeway is not large in comparison to the scale of natural changes that have occurred on the western beach in the last 42 years (GEMS, 2008c). It is clear from the mixed pattern of depositional beach ridges that occur landward of the western beach, that Preston Spit and the adjacent beach is highly dynamic, and that it has experienced occasional episodes of erosion and deposition. The present head of the Spit is located to the south of previous positions as indicated by beach ridge alignments.

On the basis of the above, the environmental significance of potential shoreline changes to nesting turtles is likely to be minimal. In the longer-term, the accumulation on the south side of the causeway is likely to result in an extension of the available beach and dune area suitable for turtle nesting. However, in the short-term, potential erosion of the southern beach may result in extension of scarping already present along the northern section of the beach. The capacity for this to occur is limited along the majority of the beach due to the very low relief. Hence, even if the northern beach does slightly re-align as predicted by GEMS, it is considered most unlikely there will be a reduction in the cross sectional area of beach available for turtle nesting on the west coast of Cape Preston.

5.6 EFFECT ON BENTHIC PRIMARY PRODUCER HABITATS

5.6.1 Introduction

The objectives of this section are to:

- define the scale, boundaries and type of direct BPPH loss and modification anticipated as a result of placement of the Project port
- apply EPA Guidance Statement No. 29 (EPA, 2004) to determine the likely acceptability of the anticipated BPPH loss.

5.6.2 EPA guidance from Bulletin 1056

From Bulletin 1056 (EPA, 2002), it is clear that the EPA understood that the dredging works and breakwater construction works associated with the small boat harbour and import berth north west of Preston Island would result in the loss of approximately 10 ha of coral habitat (6 ha from dredging and a further 4 ha from breakwater and import berth construction). Additional impacts anticipated included temporary water turbidity and perhaps sedimentation locally arising from dredging and breakwater construction. Depending on the timing and scale of these works, they could result in additional coral habitat loss adjacent to Preston Island.

The EPA expressed particular concern regarding a small but high cover coral community located on the north side of Preston Island that, at the time of the EPA's assessment of the Project, was considered to be regionally significant. As indicated in Section 3.10.5, the recent marine habitat surveys completed by URS (2008) determined that, as a result of cyclone damage, this small coral community no longer exists.

It is therefore considered that the EPA anticipated the loss of approximately 10 ha of coral habitat in proximity to Preston Island, and that this is a recognised detrimental effect of the original proposal. However, it is equally clear that the EPA wanted regionally significant reef in the vicinity of the port to be protected from harm.

5.6.3 EPA guidance from Guidance Statement 29

The Proponent considers that the EPA cumulative loss threshold (CLT) Category E "Development areas" (refer Section 1.6.3) applies to the waters in the immediate vicinity of the port, and that as such, the applicable CLT is 10 % of the habitat occurring within the Management Unit.

EPA Guidance for Category E assessments is:

- *Moderate damage/loss of BPPH and/or their associated BPP communities may be acceptable where proponents can demonstrate that there are no feasible alternatives to avoid/damage/loss and where proposals are consistent with relevant management plans or with a use of a Management Unit that is consistent with a State Government decision.*
- *The EPA expects the proponent to apply the **general principles of assessment** and develop and commit to the implementation of a comprehensive environmental management plan with an objective of protecting and maintaining ecosystem integrity.*
- *The acceptability of any damage/loss in these areas will be a judgement of the EPA.*

The **general principles of assessment** referred to above include the following hierarchy of principles to be addressed by all proponents:

- *All proponents should demonstrate consideration of options to avoid damage /loss of BPPH.*
- *Where avoidance of BPPH is not possible, then design should aim to minimise damage/loss of BPPH and proponents will be required to justify the need for that damage/loss of that area of BPPH.*
- *Proponents will need to demonstrate 'best practicable design', construction methods and environmental management aimed at minimising further damage/loss of BPPH through indirect impacts.*
- *The EPA's judgement on environmental acceptability with respect to damage/loss of BPPH… will be based primarily on its consideration of the proponents calculations of loss of BPPH within a defined management unit.*

The above principles have been addressed in Section 5.6.4 below.

5.6.4 Habitat loss assessment

Determination of direct habitat loss from the port involved overlaying the port footprint onto a habitat distribution map of the Project area (see Figure 31). The significance of that habitat loss has been determined through the application of the EPA Guidance Statement No. 29.

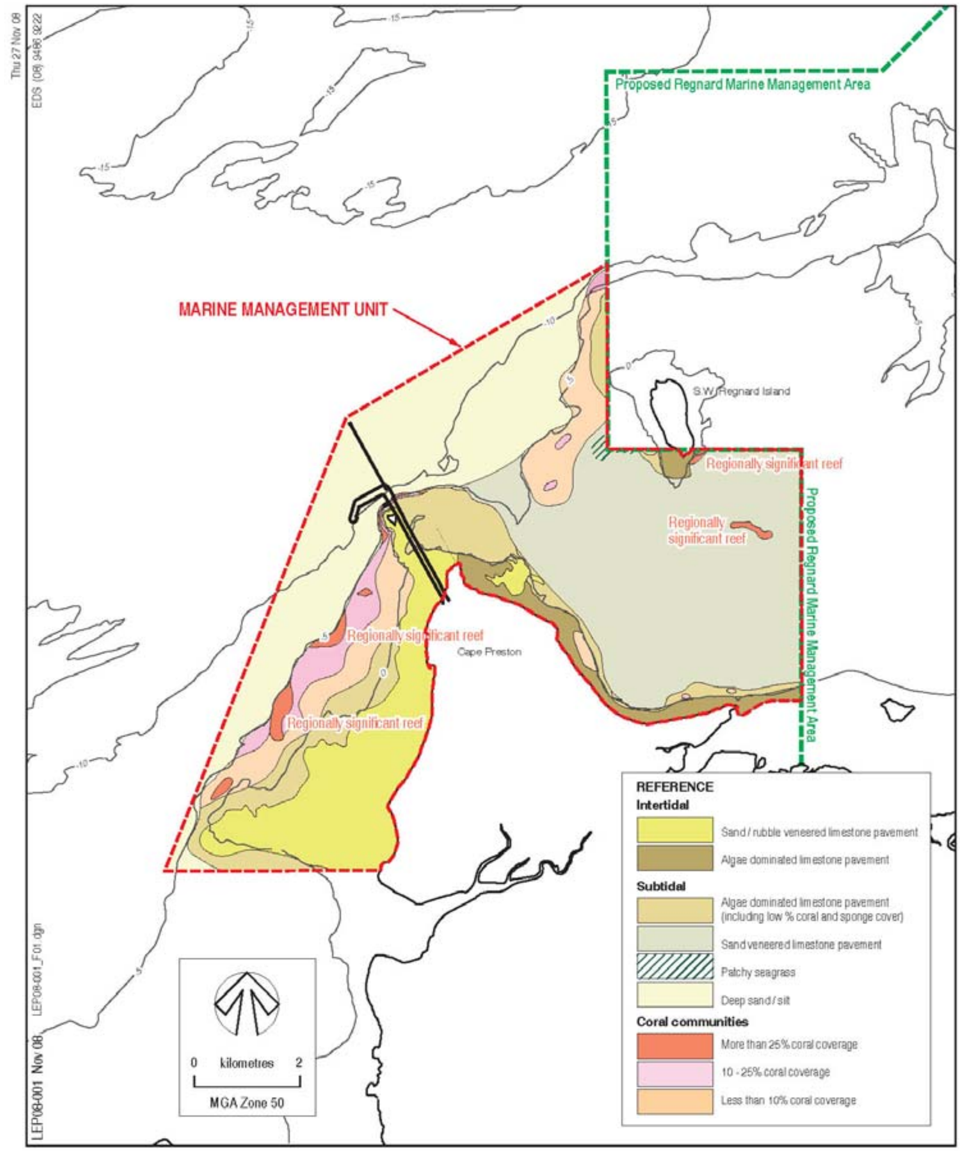

Figure 31 Proposed BPPH Management Unit at Cape Preston

Note that no indirect loss of coral habitat is anticipated from water turbidity generated during construction of the breakwater and causeway. This is because the core material for the causeway will be 75 - 410 mm sized cobbles and for the breakwater 250 - 410 mm sized boulders. Fines and smaller rocks (<75 mm) will be screened out at the quarry and hence water turbidity is expected to be minimal, transient and intermittent in nature, and will not represent either a sedimentation or light attenuation induced mortality risk to shallow water, wave washed corals. Note that the potential indirect impacts of port construction (and their management) are addressed in the EMPgm (LeProvost Environmental, 2008).

Also note that no cumulative habitat loss assessment is provided because the site is remote from developed settlements and has not suffered historical losses of benthic habitats as a result of anthropogenic disturbance.

Figure 31 shows the proposed boundary for the BPPH Management Unit, within which percentage habitat losses have been calculated as required by EPA Guidance Statement No. 29. The Management

Unit has been centred on the port at Preston Island, and has been sized to include all regionally significant coral reefs and shallow waters in the vicinity of Cape Preston that are outside the Proposed Regnard Marine Management Area. The total area of marine habitat within the Unit is ~65 km^2.

The principal BPPH that occurs within this Management Unit are as follows:

- Intertidal algae dominated limestone platform
- Subtidal algae dominated limestone pavement
- Subtidal coral communities (of various coral cover)
- Subtidal patchy seagrass communities (ephemeral species near SW Regnard Island).

Figure 32 is a close up view of the port overlaid on the habitat map, and shows the area (in ha) of habitat affected by the port footprint (see black text). Areas given in red text refer to the coral habitat that occurs west of the MOF landing that is potentially at risk from long term port operations.

As stated in Section 4.2, the Proponent has based the port design on the need to minimise the volume of rock required for construction by gaining access to the nearest navigable water. In an effort to minimise rock volume, the proponent has chosen an alignment that follows the shallowest bathymetry available between the Cape and navigable waters. As shown in Figure 31 (and in greater detail in Figure 32), the principal habitat beneath the causeway alignment is a barren intertidal sand/rubble veneered pavement that is exposed at lowest astronomical tides (LAT: 0 m CD; see Plate 4).

Plate 4 LAT Aerial Survey October 2007- looking north from near Preston Spit up the west coast of Cape Preston with the Cape shown at top right and Preston Island at top left. Sand predominates close to shore. The dark platform to seaward is algae covered. Low to moderate coral cover habitat occurs in shallow waters further west

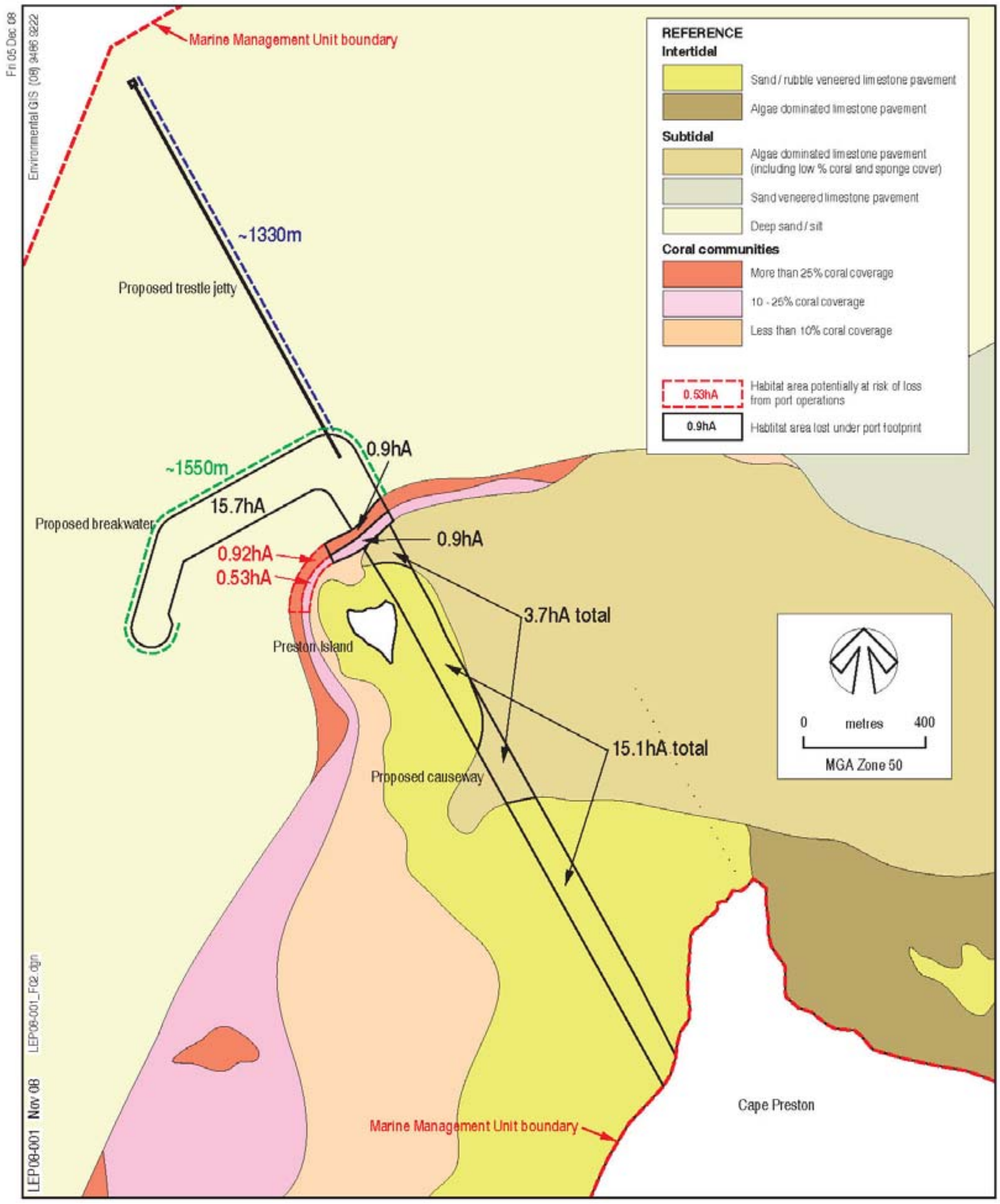

Figure 32 Area of habitat loss arising from preferred port layout

Figure 32 also shows that most of the breakwater and the offshore trestle jetty will sit on relatively barren deep sands and silts habitat. Neither of these habitats are considered to be BPPH, and both are widespread in the region. Hence, the majority of the Proponent's port design footprint has avoided the loss of BPPH.

However, some loss of BPPH is unavoidable as shown in Figure 32. Some 3.7 ha of shallow subtidal algae dominated pavement will be buried beneath the causeway, and the breakwater will bury coral habitat which occurs on the steep slope that runs along the north side of Preston Island. This habitat varies in coral cover from generally low to high in places (10% to >25%) and is comprised primarily of cyclone resistant massive species (e.g. *Favids*, *Goneastrea* and *Porites*) plus *Turbinaria* recruits.

The proposed MOF located on the inside of the breakwater will also bury similar coral habitat, including the site referred to by the EPA in Condition 7-1 (Item 4). However, note that:

- this site was very small when originally described (refer Figure 12, URS (2008) Appendix A, legend 21)
- URS (2008) was unable to locate this site and concluded that it had been heavily damaged during the cyclone season of 2005-6.

As indicated in Section 3.10.5, URS found a number of other regionally significant reefs in the vicinity of Cape Preston that are much larger in area and higher in cover than the small site referred to above. The nearest of these significant reefs will be approximately 2 km to the south of the breakwater (refer Figure 31).

Table 5 presents the direct habitat loss calculations used to determine the percentage loss within the designated management unit. The areas were digitally calculated by Environmental GIS using Microstation software. Note that the bottom two lines in the table refer to coral habitat at risk over the long term. This has been included as a separate assessment because the area of coral habitat indicated to the west of the materials offloading facility landing is considered at risk of potential loss from port operations over the long term as a result of perhaps physical damage, spills, or siltation.

Table 5 Percentage habitat loss within designated Management Unit (see Figure 32)

Habitat Type	Area of loss (ha)	Area in Management Unit (ha)	% of Management Unit
Intertidal sand and rubble veneered pavement	15.1	944	1.6
Subtidal algae dominated pavement	3.7	695	0.5
Subtidal deep sand/silt (beneath breakwater)	15.7	1689	0.9
Subtidal deep sand/silt (beneath trestle jetty)	46.5	1689	2.7
Low to moderate coral cover (10-25%) beneath breakwater	0.9	188	0.5
Moderate to high coral cover (>25%) beneath breakwater	0.9	73	1.2
Low to moderate coral cover (10-25%) at risk over long term	0.5	188	0.2
Moderate to high coral cover (>25%) at risk over long term	0.9	73	1.2

The trestle structure has also been presented as a separate assessment because it will not bury habitat, but instead shade the seafloor and modify the habitat. It has been assumed that the length of the jetty plus a 35 m width of seafloor will be modified (the jetty will be 25 m wide with 5 m buffer either side).

Table 5 indicates that the percentages of habitat loss within the designated Management Unit are all very low, and well below the EPA's cumulative loss threshold (CLT) of 10 % for development areas. The total coral habitat loss from direct burial by construction of the breakwater and MOF landing is estimated to be 1.8 ha. It has also been assumed that a further 1.45 ha of low to high (10 to >25%) coral cover habitat may be lost in the long term between the end of the MOF landing and the western tip of Preston Island as a result of port operations. Whilst this loss may not happen, it is difficult to be certain that it won't happen, and therefore a conservative approach has been taken by including it within the habitat loss calculation. Adding these two areas together results in a loss of 2.4 % of high coral cover habitat within the Management Unit, and 0.7% of available low to moderate coral cover. Such percentages are still well within the EPA's CLT target of 10%.

The loss of coral habitat at Preston Island is likely to be substantially offset in the medium to longer term (10- 25 years) by the development of a new coral habitat on the outer (and perhaps inner) slopes of the breakwater. There are a number of examples along the WA coast of corals having recruited onto artificial rock structures. One of the better examples is the rubble mound rock armour that covers the NW Shelf gas pipeline to North Rankin A Platform as it passes through the shallow waters of Mermaid Sound at Dampier. Another example is the shallow water nearshore breakwater located in Geraldton harbour. The outer edge of this breakwater is heavily colonized by massive species of coral, and is a local diving attraction, despite having been subjected to 15 months of dredge induced turbidity during the 2002-3 Port Enhancement Project (LeProvost *et al*., 2007).

It is recognized that there are not many breakwater structures in WA armoured by concrete locking structures. A brief review of available literature indicates that such structures are commonly used in the Pacific by the Japanese. Ooka *et al*., (2006) report that such concrete armoured structures in Naha port on the island of Okinawa do in fact make good artificial reef habitat and support similar species and percentage coral cover to that found on natural reef edges at the same depth within 10 years of construction. Wen *et al*., (2007) surveyed two cement armoured breakwaters in Taiwan and found that they supported upwards of 100 species of coral, with cover ranging from 25 to 40 %. They expressed surprise to find such a high cover of corals because the breakwaters were surrounded by sandy seafloor and were over 100 km away from the nearest known coral community.

Hence it is considered very likely that the proposed breakwater near Preston Island will be colonised by corals that can withstand cyclone action within a period of approximately 10-15 years. The outer edge of the breakwater, from where it starts at the end of the causeway to inside the semi circular nib on the western end, is approximately 1.5 km long. If this length is colonised by corals to the same depth and cover that occurs on the natural reef slope, this translates into a potential coral habitat loss offset of approximately 11.25 ha. If coral colonises the total slope available, the potential offset could be as much as 23 ha.

Furthermore, the breakwater will provide substantial protection from wave energy during cyclones. As a result, the coral habitat that occurs immediately to west and south west of Preston Island is considered likely to develop into a more stable community, with an increase in coral abundance, cover and perhaps even diversity i.e. more fragile species such as staghorn and plate *Acropora* sp. may be able to survive in the protected area.

The port is therefore considered likely to deliver a substantial net increase in coral abundance in the vicinity of Preston Island within a period of approximately 10 years. Furthermore, the cryptic habitat provided by the boulders and armouring structures will be colonised by a wide range of marine fauna and develop into a substantial artificial reef that will markedly increase local biological productivity.

In addition, the trestle jetty is also likely to develop into a substantial artificial reef structure as fouling organisms colonise the piles and fish take up residence in their vicinity.

It is therefore considered that the small area of coral habitat that will be lost by direct placement of the breakwater and MOF, plus that which may be lost from ongoing port operations, will be more than offset by the new coral that is expected to develop on the outside of the port in the medium to long term. Given that a substantial offset for coral habitat loss is likely, and given that none of the large and very high cover regionally significant coral reefs in proximity to the port are at risk from its construction, it is considered that the port presents minimal risk to abundance of coral resources in the region.

5.6.5 Conclusions

It is considered that the port presents minimal risk to abundance of coral and BPPH resources in the region because:

- the area of coral habitat loss is smaller than originally anticipated by the EPA and equates to a small percentage (2.4%) of the amount of similar habitat available within the Management Unit
- the percentage loss is well within the EPA's CLT target of 10%
- no regionally significant coral reefs are at risk from construction of the port
- a substantial offset is likely as a result of natural coral recruitment to the outer slopes of the breakwater
- the Proponent has avoided as much BPPH as possible consistent with his need to access nearest navigable water.

6. MONITORING AND MITIGATION OF THE EFFECT OF PORT PRESENCE

6.1 INTRODUCTION

This section addresses the requirements of Items 6 and 7 of Condition 7-1 by:

- presenting a monitoring program to monitor the effects of the port structure on coastal stability, shore alignment and coral habitat
- detailing strategies to restore environmental quality to acceptable levels if the monitoring demonstrates that significant impacts have occurred to coastal stability, shore alignment and coral habitat.

Note that Items 6 and 7 of Condition 7-1 also refer to mangroves. There are no mangrove habitats within the immediate vicinity of the port, and none along the western coast of Cape Preston that is the area primarily affected by construction of the causeway. Therefore they have not been addressed in this document.

This section focuses on the monitoring required to both validate the assessment presented in Section 5, and provide warning of the need for remediation action. The following two monitoring programs will be implemented for the Project:

- coastal stability and shore alignment of western beach on Cape Preston
- coral habitat condition within and adjacent port, and at regionally significant reefs, plus coral recruitment to breakwater.

Note that the EMPgm (LeProvost Environmental, 2008) contains a separate monitoring and management program to address potential impacts associated with construction of the port.

6.2 MONITORING AND CONTINGENCY ACTIONS FOR COASTAL STABILITY

Within a cyclonic region, there is capacity for severe reversals of long-term patterns of behaviour, including dramatic shoreline change due to both coastal and terrestrial flooding. Such an event has apparently occurred on the western beach, as illustrated by the residual mangrove beds 30 m from the existing shore (Section 5.3.6). This capacity for variability creates a relatively high level of uncertainty when estimating future behaviour, and it should be recognised that the future projection represents a conservative ‘best estimate’ of how the coast may respond. In a cyclonic region, it is appropriate to undertake management within a framework of uncertainty, planning for a wide range of possible coastal evolution scenarios and using coastal monitoring to inform strategic decision-making.

Table 6 details the program for monitoring of coastal stability and shore alignment of western beach on Cape Preston (see Figure 6). Contingency strategies proposed in the event that monitoring shows that some form of intervention is required to restore environmental quality to acceptable levels are presented in Table 6.

Table 6 Monitoring of coastal stability

Location	Timing	Parameter(s)	Procedure	Purpose(s)	Responsibility
Cape Preston	Prior to construction	Calculated rates of erosion	Quantitative photogrammetric analysis of aerial photo record	For validation of qualitative assessment undertaken to date	Environmental Manager
Cape Preston beaches	Prior to construction and then semi-annual (Oct and Apr)	None	Obtain aerial photography of all beaches around Cape Preston at low Spring tide	To obtain record of shoreline location on a regular basis	Environmental Manager
Refer Figure 33	Prior to of construction and then semi annually during first five years after commencement of construction, and annually thereafter	Shoreline coordinates, and levels along a number of transects	Establish long term beach profile monitoring stations along the entire west coast of Cape Preston. Beach profiles to extend from 50 m behind primary dune to 0 m CD on nearshore platform. Survey marks will be obtained at 5 m intervals horizontally and at 0.5 m vertical reductions in elevation.	To establish a baseline from which to ensure that the western sandy shoreline of Cape Preston does not re-adjust further than predicted, or at a rate faster than predicted, as a result of non-cyclonic processes	Environmental Manager
Refer Figure 33	Where practicable, on an opportunistic basis after cyclones	Shoreline coordinates and levels along a number of transects	Obtain aerial imagery after cyclones and re-survey beaches if measurable cyclone induced changes occur	To determine the scale of effect on coastal stability produced by cyclonic events	Environmental Manager
Refer Figure33	Semi-annually	Shoreline coordinates	Evaluate area on north side of causeway to determine if appreciable volumes of sediment are being transported through the permeable structure	To confirm that beach sediment is not leaking through the causeway	Environmental Manager
Refer Figure 33	Annually within 3 months of 2nd semi-annual beach survey	Shoreline coordinates	Report data obtained to DEC on an annual basis	To inform relevant regulators of monitoring results	Environmental Manager
Refer Figure 33	Five and a half years after commencement of construction of causeway	Shoreline coordinates	Review all data five years after commencement of construction	Inform relevant regulators of findings	Environmental Manager

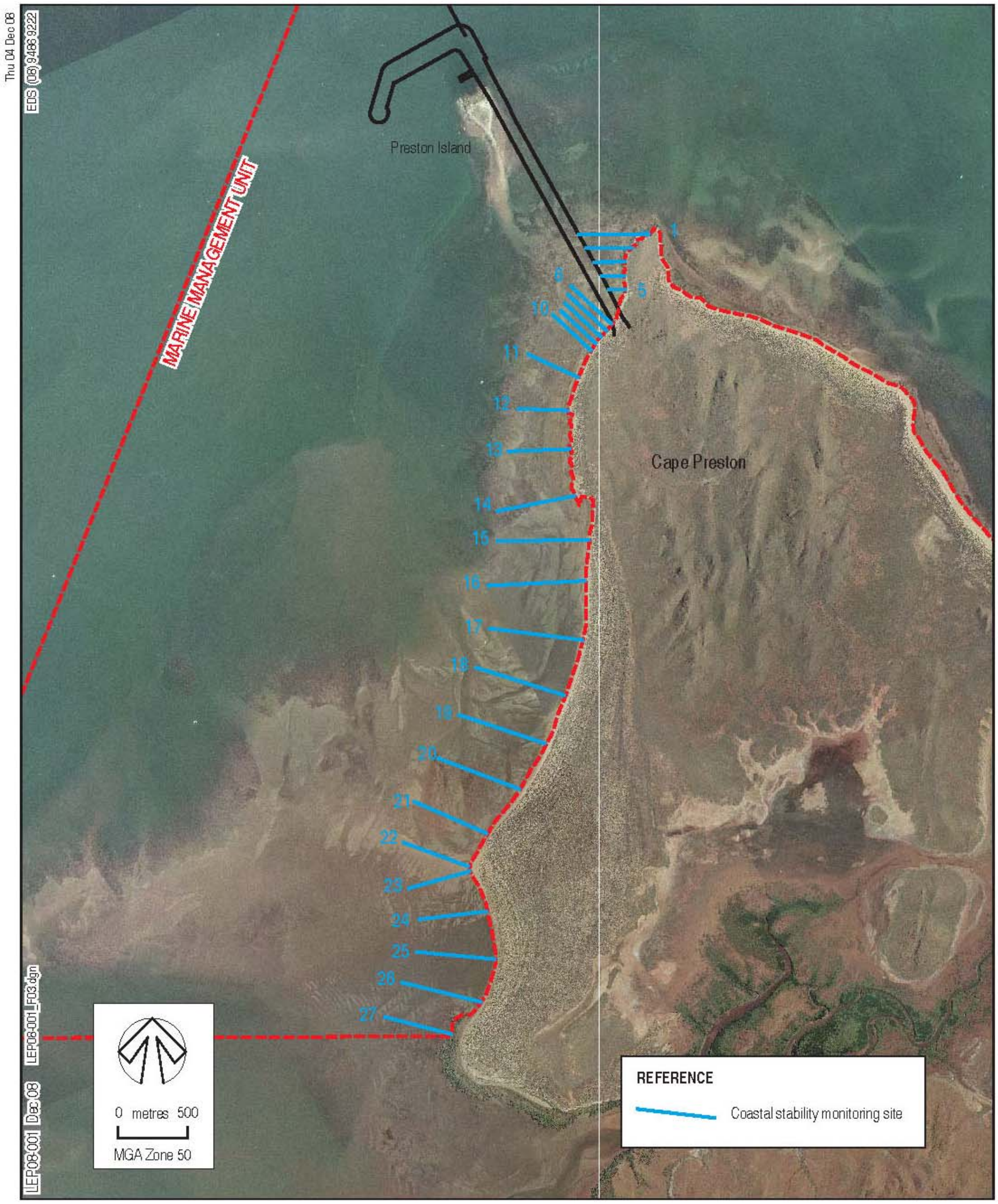

Figure 33 Location of coastal stability monitoring sites

Table 7 Contingency actions for maintenance of coastal stability

Trigger	Action	Responsibility
Commencement of construction of causeway	1. Stockpile rock sizes if groyne structure (Action 5 below) is required	Project Manager
Scarping has occurred to such an extent that **20 %** by length of the available turtle nesting habitat that presently occurs along the west coast of Cape Preston is no longer accessible to sea turtles	2. Review monitoring results to identify cause of scarping	Environmental Manager
	3. Amend monitoring and contingency actions if required	Environmental Manager
Scarping has occurred to such an extent that **30 %** by length of the available turtle nesting habitat that presently occurs along the west coast of Cape Preston is no longer accessible to sea turtles	4. Submit a proposal to DEC Conservation Branch for either use of earthmoving machinery to reshape the foredune to make it more accessible to turtles	Environmental Manager
	5. Construct a small groyne/headland near the northern end of western beach (see location shown in Figure 28)	Environmental Manager

6.3 MONITORING AND CONTINGENCY ACTIONS FOR CORAL HABITATS

The environmental objectives and targets for long term monitoring of coral habitats in the vicinity of the port are given in Table 8. The approximate location of proposed coral monitoring sites is shown in Figure 34. Note that this monitoring programme is aimed at determining the abundance (percent cover) and health of coral resources in the vicinity of the port on an annual basis. A separate monitoring programme is proposed in the EMPgm (LeProvost Environmental, 2008) for managing the effects of causeway and breakwater construction activities. The EMPgm will use the same existing coral habitat sites as established for this programme but the frequency of monitoring will increase when construction activity occurs in the more immediate vicinity of coral habitats at Preston Island.

Contingency actions proposed in the event that monitoring shows that some form of intervention is required to protect the availability of coral habitat outside the designated impact zone are presented in Table 9.

Table 8 Monitoring of coral habitats

Location	Timing	Parameter(s)	Procedure	Purpose	Responsibility
Refer Figure 34	As soon as practicable and prior to commencement of causeway construction	Coral health and abundance	Obtain water penetrating aerial photography of the shallows around Cape Preston, Preston Island and SW Regnard Island	To accurately record the baseline surface cover of the shallow platform prior to construction	Environmental Manager
Refer Figure 34	No later than two weeks prior to commencement of causeway construction	Coral health and abundance	Establish quantitative coral baseline at the sites shown on Figure 34	To establish quantitative baseline against which to validate the scale of coral habitat loss predicted to occur over the long term from port presence	Environmental Manager
Refer Figure 34	Monitor during May - June each year and deliver report to DEC within 3 months of survey completion	Coral health and abundance	Monitor coral cover and species diversity at all sites on an annual basis and report findings to DEC	To validate the scale of coral habitat loss predicted to occur over the long term from port presence	Environmental Manager
Refer Figure 34	On an opportunistic basis after cyclones and report in annual report to DEC	Coral health and abundance	Monitor coral cover and species diversity at all sites after passage of severe cyclone	To record the scale of coral habitat loss after the passage of severe cyclones	Environmental Manager
Refer Figure 34	Six months after completion of fifth annual coral habitat survey	Coral health and abundance	Review success of achieving objectives and targets after five years and report to DEC	To validate the scale of coral habitat loss predicted to occur over the long term from port presence	Environmental Manager

Table 9 Contingency actions for maintenance of coral habitat

Trigger	Action	Responsibility
Coral mortality outside of designated Project impact zone	1. Identify cause of coral mortality	Environmental Manager
	2. If coral mortality is determined to be related to port operations, undertake appropriate remedial action required to stop cause	Environmental Manager

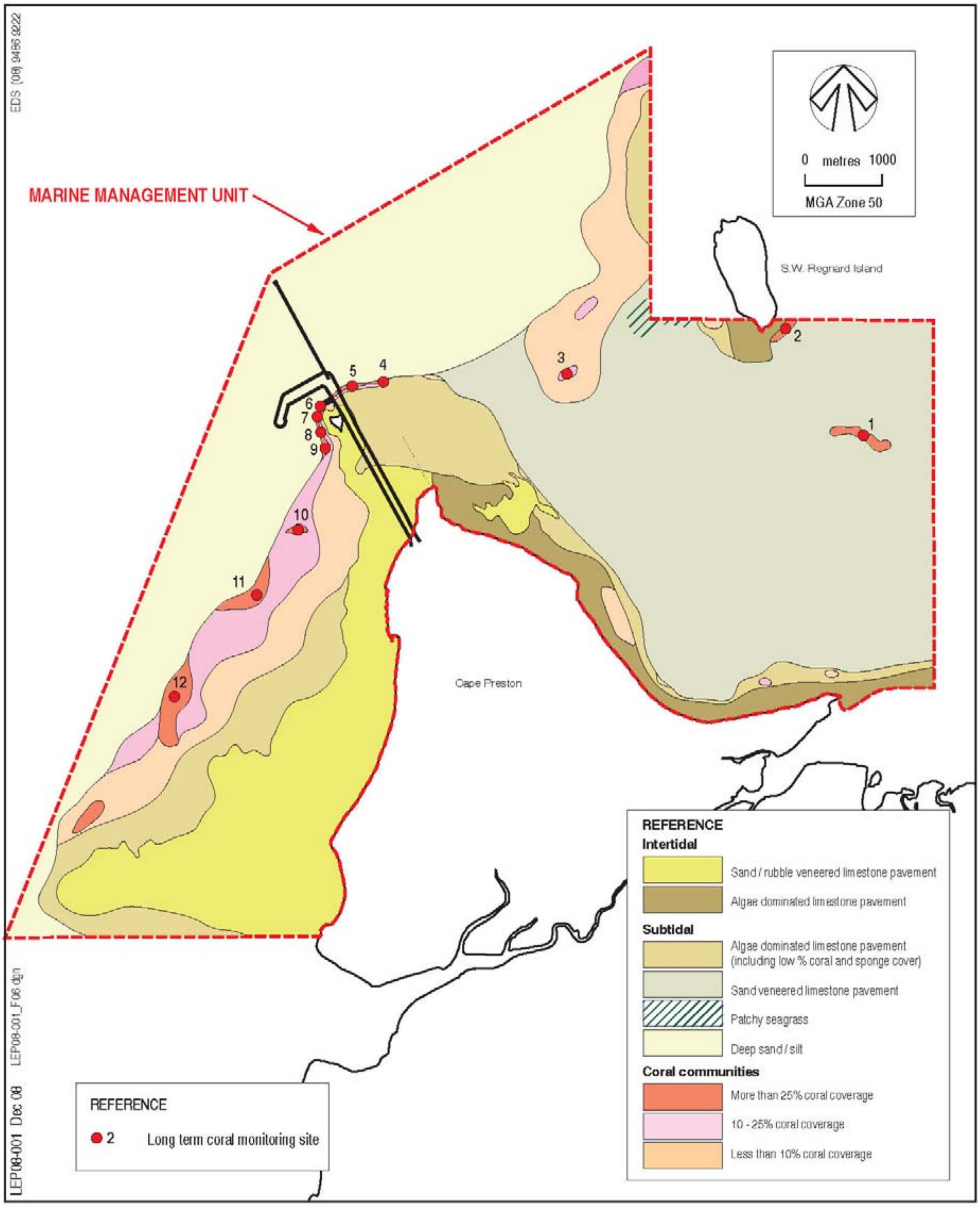

Figure 34 **Location of coral monitoring sites**

7. CONCLUSION

The Proponent has demonstrated that the Project port will have minimal adverse effect on regional coastal water movements (including coral larvae dispersal), tidal flushing, sedimentology and beach alignment, and both availability of turtle nesting habitat and coral habitat cover. The environmental risks associated with the presence of the port and the changed bathymetry in the vicinity of the Cape and Preston Island are considered to be low and manageable. The benthic habitats that will be lost are not considered regionally significant, are widespread, and will be more than offset by the artificial reef communities that will develop on both the breakwater and offshore trestle jetty.

On the basis of the above information, it is considered that the port meets the relevant EPA objectives described in Statement 635, and in other EPA policies (e.g. EPA Guidance Statement No. 29), and should therefore be considered acceptable to the EPA.

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Appendix A

Cape Preston Benthic Habitats (URS, 2008)

Appendix B

Analysis of Cape Preston Meteorological and Oceanographic Conditions (GEMS, 2008a)

Appendix C

Cape Preston Design Impact Hydrodynamic Modelling Study (GEMS, 2008b)

Appendix D

Cape Preston Coastal Stability Study (GEMS, 2008c)