



**Port of Hay Point Apron Area and
Departure Path Capital Dredging**
Draft Environmental Impact Statement

August 2005



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Volume 2 – Appendices

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- C Spoil Disposal Options Assessment
- D Port of Hay Point Seagrass, Algae and Benthic Macro-invertebrate Community Survey (July 2004)
- E Benthic Survey of Fringing Coral Reefs of Victor Islet, Round Top and Flat Top Islands
- F Hydrodynamic and Water Quality Modelling
- G Sediment Sampling and Analysis Report
- H Cultural Heritage Management Plan



Glossary of Terms

ANZECC	Australian and New Zealand Environment and Conservation Council
AHD	Australian Height Datum
ASS	Acid sulphate soil
BPA	Beach Protection Authority
CAMBA	China–Australia Migratory Bird Agreement
DEH	Department of the Environment and Heritage, Commonwealth
DNR&M	Department of Natural Resources and Mines, Queensland
DPI&F	Department of Primary Industries and Fisheries, Queensland
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP Act	Environmental Protection Act 1994
EPA	Environmental Protection Agency
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EPP	Environmental Protection Policy
ESD	Ecologically sustainable development
GBRMP	Great Barrier Reef Marine Park
GBRMP Act	Great Barrier Reef Marine Park Act
GBRMPA	Great Barrier Reef Marine Park Authority
HAT	Highest astronomical tide
IPA	Integrated Planning Act 1997
JAMBA	Japan–Australia Migratory Bird Agreement
LAT	Lowest astronomical tide
LGA	Local government area
MSL	Mean sea level
NODGDM	National Ocean Disposal Guidelines for Dredge Material
PCQ	Ports Corporation of Queensland
QPWS	Queensland Parks and Wildlife Service
RL	Reduced Level



SAP	Sediment Sampling and Analysis Plan
ToR	Terms of reference
TPA	Total potential acidity
TSA	Total sulphidic acidity



Abbreviations

Prefixes

M	mega	1,000,000
k	kilo	1,000
c	centi	0.01
m	milli	0.001
μ	micro	0.000 001
n	nano	0.000 000 001

Units of measure

a	annum
d	day
dB	decibel
dB re 1 μPa	decibels referenced to 1 micro Pascal
g	gram
h	hour
ha	hectare
L	litre
m	metre
m/s	metres per second
mg/l	milligrams per litre
Mt	Million tonnes
mtpa	Million tonnes per annum
nm	nautical mile
NTU	Nephelometric Turbidity Units
Pa	Pascal
ppt	parts per thousand
s	second
t	tonne
wmt	wet metric tonnes

Executive Summary

ES1 Introduction

The Port of Hay Point (the Port) is now the world's largest coal port, exporting 85.5 million tonnes of coal in 2004/05 from the two coal ports. Currently, large ships are departing the Port short-loaded due to draft depth restrictions, which is affecting port efficiency. In response to the increased demand worldwide for Queensland coal, the Ports Corporation of Queensland (PCQ) is proposing capital dredging works to increase port efficiency and capacity and increase competitiveness:

- ▶ A ship manoeuvring apron immediately adjacent to and parallel to the existing terminals. The apron will be 500 m wide and dredged to achieve a minimum declared depth of – 14.9 m (Lowest Astronomical Tide).
- ▶ A Departure Path from apron to sea. The path width will be 500 m wide for the first 500 m then taper to a width of 300 m over the next 3 km. There will be a transition zone between the apron and path. The remainder of the path will be 300 m wide and continue until a minimum natural depth of –14.9 m is achieved. The total path length is approximately 9.5 km (refer Figure ES1).

The entire Departure Path remains within port limits but a large part will also be in the Great Barrier Reef Marine Park (GBRMP).

Ongoing maintenance dredging will be required to be carried out approximately every two - three years. Clean dredged material for both the capital and maintenance works will be disposed of at sea at a proposed new spoil disposal ground because the existing sea disposal site is reaching minimum depths for navigation. The new spoil ground is within the port limits and within the GBRMP. The Project includes the installation of four to six beacons to mark the Departure Path for shipping. These beacons are likely to be installed prior to commencement of dredging.

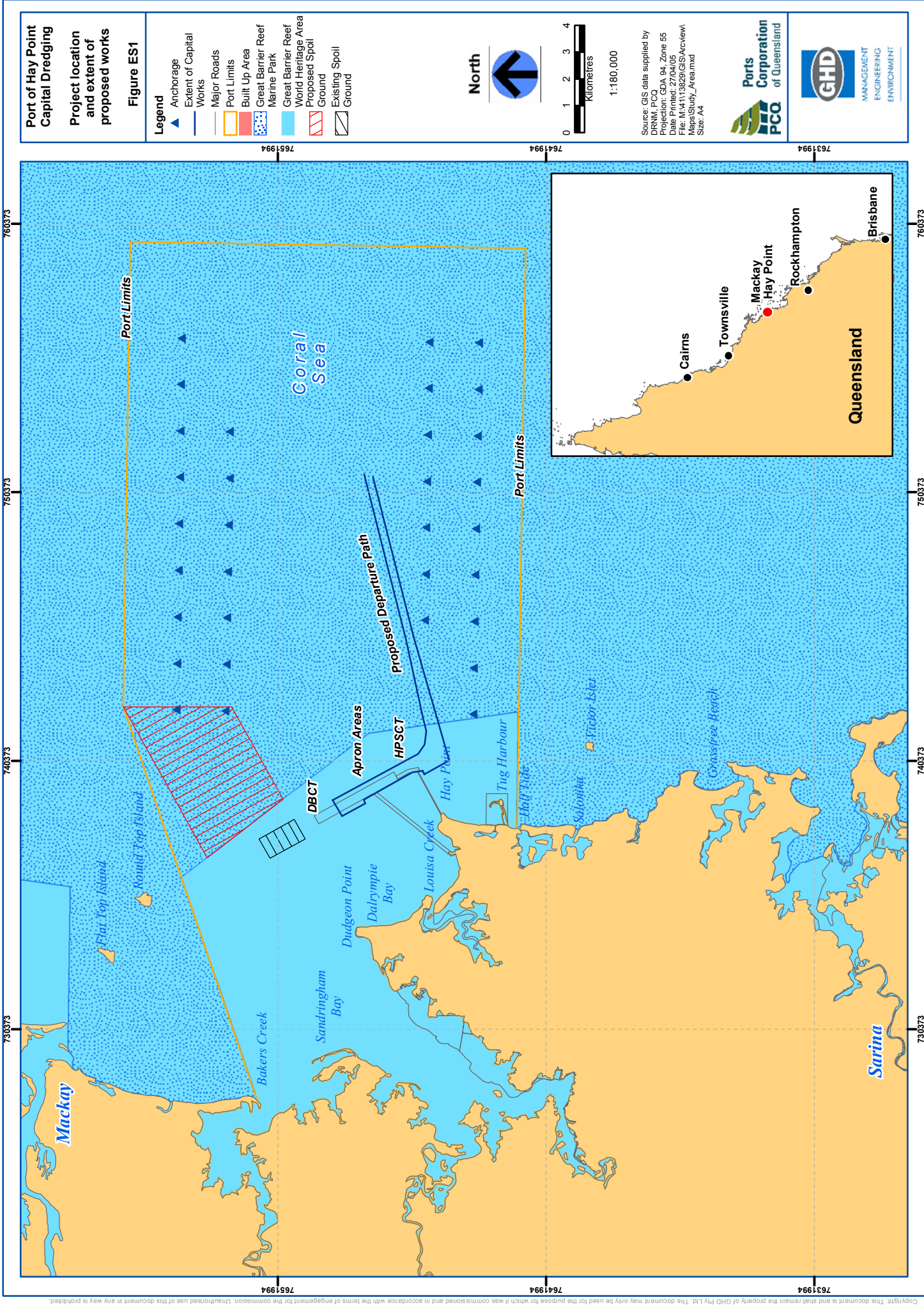
The capital dredging works are expected to commence in April/May 2006 but may continue in 2007.

ES2 Benefits of the Undertaking the Project

The Port of Hay Point generated approximately \$5 billion in revenue in 2003/04 and current predictions forecast tonnage to grow to over 125 mtpa in the next five years. The proposed 1.8 m increase in declared sailing draft will provide major benefits to port users in:

- ▶ Reduced short loading, resulting in an additional 1.7 million tonnes per annum (mtpa) of coal exports worth \$100 million per annum.
- ▶ Earlier sailing times, equivalent of up to \$60 million of infrastructure investment.
- ▶ Dead freight savings of \$55 million per annum. Dead freight is the term used to describe lost opportunity of transport product due to shortloading.

Not undertaking the Project would see the State of Queensland and the national economy forego these economic benefits.



ES4 Departure Path and Spoil Disposal Options

An investigation of Departure Path options was undertaken in consultation with the Maritime Safety Queensland (MSQ) Regional Harbour Master and Port Pilots. The preferred route chosen provided the optimum manoeuvring path and least risk for ships departing the port. The route was then reviewed to ensure it would not affect any environmentally sensitive areas – there were no environmental issues with the proposed route. Land and off-shore spoil disposal options were also investigated. Land disposal was not feasible due to environmental, land use and topographic constraints. Disposal of clean dredge spoil at sea is the preferred method in this instance, with the proposed spoil ground selected following navigational and environmental reviews.

ES5 Equipment and Method of Dredging

It is expected that works will be undertaken by a trailer suction hopper dredger (TSHD), with a bed leveller utilised within the dredge area. Two dredgers may be used, if available, to minimise the period of dredging. The dredger will relocate the dredged material to the sea disposal site where the material is released by bottom dumping. The disposal site is accurately defined by GPS. The dredger used will employ turtle excluding devices and operating procedures.

ES6 Key Findings of the EIS

ES6.1 Marine Flora and Fauna

Mangrove and Saltmarsh Communities

Mangrove communities exist within the port at Louisa Creek, Sandringham Bay, Bakers Creek and north-west of the Tug Harbour. The Sandringham Bay flats are listed as nationally important wetlands. These areas are not expected to be impacted by the proposed works.

Turtles and Marine Mammals

Six species of turtle have been recorded utilising the off-shore, inter-tidal, estuarine and shoreline habitats in the area, with green turtles (*Chelonia mydas*) most frequently observed within the Port, and Flatbacks (*Natator depressus*) predominantly nesting on local beaches. Turtle nesting occurs between October and February, with the hatchlings emerging until April.

Seven species of dolphins, five species of whales and dugong potentially occur in waters encompassing Hay Point. The Spotted Bottlenose Dolphin is considered likely to occur within the study area and Humpback Whales are present off-shore from the Port between June and August.

Marine fauna such as dolphins, whales and dugong are mobile and can generally avoid impacted areas for the duration of dredging activities. Turtles may be captured during dredging, however, this is a low risk given there is little evidence of resident populations in the port and management and operational practices will be utilised by the dredging vessel to minimise turtle capture.

The generation of underwater noise and vibration from the dredge is considered to be low. Cetaceans are highly mobile and generally avoid impacted areas for the duration of dredging activities. Given the inshore location of works, it is unlikely that dredging will impact on the migratory patterns of whales, as they tend to migrate further off-shore and will avoid contact with the dredge.

Seagrass and Algae

Seagrass identified in the port limits comprised predominantly of the deepwater, ephemeral *Halophila decipiens* with some areas of *Halophila spinulosa*. The percentage cover of seagrass in these meadows was low-medium (< 1% - 35% cover). Seagrass occurs within the proposed spoil ground and areas to be dredged at low density (< 5%). Algal communities in the port comprise erect macrophytes, encrusting, erect calcareous and filamentous algae. Algae are present in the spoil ground and areas to be dredged with 5-20 % cover.

Approximately 1,565 ha of seagrass will be physically disturbed, equating to approximately 28% of total seagrass cover recorded within the port limits. Of the area to be disturbed, approximately 70% is recorded as low density (<5%) cover. The species that will be disturbed are pioneering species and the area does not contain unique species that are not widely represented in surrounding areas.

Approximately 2,365 ha of algae will be physically disturbed during the proposed works of which only 1% has a coverage of >5%. The algal communities that will be disturbed represent a small proportion of the total habitat within the study area and do not contain unique species that are not widely represented in surrounding areas.

The removal of sparse seagrass is not considered to represent a significant impact on the ability of the region to support its current turtle population as the percentage cover is relatively low and the species represent opportunistic colonisers (Rasheed *et al.* 2004). Any seagrass loss in the broader port area due to the dredging plume is predicted to be transient.

Coral Reefs

Fringing reefs exist around Round Top, Flat Top and Victor Islet. There are no reefs in the areas to be dredged or at the spoil disposal site. The following provides a summary of community characteristics:

- ▶ **Victor Islet:** Hard and soft corals were not abundant and benthos was dominated by macroalgae. Hard coral, algal and invertebrate diversity was low.
- ▶ **Round Top Island:** Macroalgae were generally not common with some turfing algae present. Silt tolerant hard corals with high site variability dominated the site, with coral cover highest on the eastern side of the island. Overall however, coral diversity was low, as was algae and invertebrate diversity.
- ▶ **Flat Top Island:** Macroalgae were rare with turfing algae was more common than on the other islands. Hard corals were most abundant on the east facing sites with approximately 20 % comprising silt tolerant species, however, diversity overall was low. The diversity of other invertebrate groups was relatively high.

Conservation Value of the Marine Habitats

Although it is very sparse in the port area, seagrass may provide a seasonal food source for any dugong passing through the area (Rasheed *et al.* 2004) between the Dugong Protection Area to the north and south.

According to the Department of Primary Industries and Fisheries (DPI&F) (2005) “very little is known about the dynamics of these types of these deepwater seagrass and algae communities or the role they play in primary and fisheries production. It is likely that they vary significantly from year to year and between seasons and are usually considered to be ephemeral in nature”. At this stage, the conservation value of the seagrass and algae in the port, is undefined.

In comparison to coral cover of other fringing reef areas in the GBR region, the conservation value of the hard coral cover at the three Hay Point island fringing reefs was generally low. Furthermore, the benthic communities do not represent regionally unique communities not present elsewhere within the GBR region.

ES6.2 Marine and Coastal Processes

The following summarises tide and current characteristics of the area:

- ▶ The general directions of the off-shore currents during:
 - spring flood tides are south southwest with an eddy occurring at Round Top Island and north northeast during spring ebb tides.
 - neap flood tides is south, with a small eddy forming at Round Top Island and east during neap ebb tides.

A low energy wave climate exists during winter, with no sand particles likely to re-suspended from seabed. Finer material may still be subject to re-suspension. Changes to coastal processes are expected to be minimal following completion of the capital works with a maximum change of 0.06 m/s in current velocity and typically 6 degrees in current direction. These changes are confined to the vicinity of the Departure Path and spoil ground. No impacts on the local beaches are predicted.

ES6.3 Water Environment

The Port experiences minimal water quality impacts due to the relatively undeveloped catchment. The waters of Hay Point have naturally low turbidity and clear waters particularly in winter months.

Modelling of dredging indicates that whilst a turbid plume will be visible and cover a significant area of the coast, the majority of the plume is at a concentration of less than 5 mg/L. The maximum concentration predicted after 50 days during a spring tide:

- ▶ At Round Top Island is ~26 mg/l with a maximum of ~146 NTU (Nephelometer Turbidity Unit).
- ▶ At Victor Islet is ~9 mg/l with a maximum of ~65 NTU.

During neap tide conditions the turbid plume contracts south with the majority of the plume concentration being less than 5 mg/L. The higher concentration bands (>10 mg/L) are restricted to a smaller area around the dredge and disposal site.

Maximum concentrations reached in the waters surrounding Round Top Island and Victor Islet are generally less than 8 mg/L. Elevated suspended sediment concentrations oscillate with the tide, hence marine communities are unlikely to be subjected to constant elevated turbidity levels.

The use of non-overflow dredging was investigated and found to not only significantly increase timing and costs of the Project, but also the environmental impacts and that greater turbidity would occur at the spoil ground, closer to sensitive environs than if non overflow dredging was undertaken.

ES6.4 Sediment Quality

Investigation of sediment to be dredged was undertaken in accordance with a Sediment Sampling and Analysis Plan (SAP) approved by the Department of the Environment and Heritage. Results show that sediment meets the requirements of the National Ocean Disposal Guidelines for Dredged Material for unconfined sea disposal and is considered not contaminated. Sediment investigations also indicate nutrient concentrations are low in comparison to similar coastal environments.

As material is uncontaminated, remobilisation of sediments into the water column and the placement of dredge spoil at the spoil ground will not result in the introduction of chemical contaminants to the receiving environment. The introduction of clay lumps to the spoil ground will alter the seafloor surface. These lumps are expected to remain intact and not hinder the recovery of benthic epifauna and macroinvertebrate communities. Experience at the existing spoil ground indicates that the spoil ground could form an area richer in fish and invertebrates than the surrounding area.

ES6.5 Meteorological Environment and Climate

The Mackay region has a tropical monsoonal climate with distinct wet and dry seasons. The wet season occurs between December and March and tropical cyclones regularly pass within 150 km of Mackay during this period.

The constant presence of other commercial and recreational vessels in the port means that the presence of the dredge will not add significantly to the existing greenhouse gas emissions generated by port activities. Greenhouse calculations indicate that a six-month dredging campaign would result in 14,000 t of greenhouse gas emissions. Greenhouse gas emissions are being minimised by concentrating solids in the dredger hopper (overflow dredging) to transport to the spoil ground.

ES6.6 Air Quality

The only significant pollutant emitted from the port operations at Hay Point is coal dust. Windblown material from stockpiles or dust emitted during material handling activities is fine to coarse. Non-dust pollutant sources include emissions from vehicular traffic, including shipping, rail and road vehicles and machinery at coal terminals. The existing operational impacts of the Port on air quality will not alter as a result of the dredging of the Departure Path and Apron Area.



ES6.7 Noise and Vibration

Noise and vibration within the marine environment can impact the behaviour of marine mammals within the vicinity of the noise source. Specific information on the levels of noise emitted from dredges is limited, however, given the number of shipping movements and anchored vessels within the port it can be expected that ambient noise levels are significantly elevated when compared to surrounding regions which have fewer shipping movements.

The effect of underwater noise on marine mammals ranges from severe to no effect depending on the noise level (McCauley 1994). There has been no documented evidence of any lethal effects for most whale species resulting from exposure to noise. Studies show that whales avoid areas with exposure levels of 110 dB. As shipping occurs continuously within the port area, producing an acoustic intensity greater than 110 dB it is unlikely that dredging will result in a specific change to whale behaviour within the vicinity of the Port.

ES6.8 Cultural Heritage

Consultation has been undertaken with the native title claimants for the area. Both the Yuibera and Wiri#2 representatives stated that the study area was within the marine part of their country, and as such was of significance to them.

Both aboriginal parties were concerned about the impact of the Project on their traditional rights, especially those of fishing and hunting marine animals, as well as the general impact on the marine environment of their country. In response to the concerns of both aboriginal parties, a Cultural Heritage Management Plan has been developed and agreed to by all parties. This plan generally reflects the measures proposed as part of the Project Environmental Management Plan.

ES6.9 Land Use and Land Use Planning

Works associated with the Project are exclusively ocean-based. The Project is consistent with the relevant land use planning documents and the planning framework operating within the area of proposed works.

ES6.10 Socio-economic Environment

The communities of Half Tide, Salonika Beach and Louisa Creek are characterised by small population bases (approximately 1,300 residents in total). Recent population growth and new residential development has been focussed on the Half Tide / Salonika Beach area. Louisa Creek is a smaller, longer established community. The residential communities adjacent to the Port utilise the coastal waters for recreational fishing and diving. The Port is a significant contributor to the local, state and national economies, providing direct and flow-on value to the regional estimated at over \$200 million (PCQ 2002a).

It is unlikely the Project will have a discernable impact on the socio-economic profile of the immediate region. The proposed development will further enhance the economic base of the region and provide significant benefit to the State and national economy. To minimise the impact of a Departure Path on local fishing, changes to the restricted area imposed for navigational purposes has been reviewed and generally eased.

ES7 Matters of National Environment Significance

ES7.1 World Heritage

The Project will occur partially within the GBRMP and wholly within the GBRWHA. The following table summarises the world heritage values of the GBRWHA which may be negatively affected by the proposal.

Table ES-1 World heritage values of the GBR and potential impacts

World Heritage values of the GBR relevant to the study area and project	Project related matters which may negatively affect these values
The GBR is by far the largest single collection of coral reefs in the world.	There are no reefs in the route of the Departure Path or new spoil ground. Coral communities around Round Top Island and Victor Islet will experience some chronic impacts associated with sediment deposition and reduction of light. A reduction of up to 20% coral coverage may be experienced at Round Top Island. The area impacted is ~1,565 ha.
Biologically the GBR supports the most diverse ecosystem known to man and its enormous diversity is thought to reflect the maturity of an ecosystem, which has evolved over millions of years on the northeast Continental Shelf of Australia. The heterogeneity and interconnectivity of the reef assemblage.	Changes in bathymetry will have an insignificant impact on current magnitudes and directions in the region. The risk of turtle captured during dredging is low, given there is little evidence of resident populations in the port and management and operational practices will be utilised to minimise turtle capture. Turtle deflecting devices will be used on the dredge suction head. Cetaceans are highly mobile and can generally avoid impacted areas for the duration of dredging activities. Considering the inshore location of the dredging activities, it is considered unlikely that dredging will impact on the migratory patterns of whales. Seagrass in the port area is generally sparse. Seagrass may provide a seasonal food source for any dugong and turtle passing through the area. Some seagrass loss will occur but it is expected to return with appropriate climatic conditions.
The Great Barrier Reef provides some of the most spectacular scenery on earth and is of exceptional natural beauty.	Short-term aesthetic impacts will result from the generation of a turbid plume during dredging and disposal, which will be highly visible given the generally natural clarity of port waters. This impact is expected to cease within a relatively short period of time following cessation of works. There will be no long term aesthetic impact.
The Great Barrier Reef contains many outstanding examples of important and significant natural habitats for <i>in situ</i> conservation of species of conservation significance, particularly resulting from the latitudinal and cross-shelf completeness of the region	Coral communities found at Round Top Island and Victor Islet are small in area and are not considered to be regionally significant within the GBRWHA when compared within similar in-shore reef communities occurring within the world heritage area. Approximately 1,565 ha of seagrass will be acutely impacted, of which ~ 70% is recorded as low density (<5%) cover. The species that will be disturbed do not contain unique species that are not widely represented in surrounding areas. Approximately 2,365 ha of algae will be acutely impacted of which only 1% has a coverage of >5%. The algal communities disturbed represent a small proportion of the total habitat within the study area and do not contain species unique species that are not widely represented in surrounding areas. The material to be dredged is clean sediment suitable for uncontained ocean disposal in accordance with the requirements of the NODGDM. Based on the analyses undertaken it is concluded that the material to be dredged is of a standard suitable for disposal within the GBRWHA.

ES7.2 Listed Threatened Species

Six species of turtle, the Flatback (*Natator depressus*), Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*) and the Olive Ridley (*Lepidochelys olivacea*), have been recorded utilising the off-shore, inter-tidal, estuarine and shoreline habitats in the area. All of these species of turtle are listed as either Endangered or Vulnerable under the *EPBC Act 1999* and the NC Act.

There is little evidence of a large resident population of turtles in the Hay Point area, and relatively low numbers of nests recorded on local beaches. Turtles have not previously been captured during dredging at the Port, and relatively low numbers of turtles are captured by dredgers compared to other maritime activities. Turtle impacts will also be minimised through the use of effective management and operational practices to reduce the potential for turtle capture. Based on these considerations, it is not expected that the proposed dredging and spoil disposal will have a significant impact on turtle populations in the study area. The removal of sparse seagrass that has recently been identified within the proposed spoil ground and area to be dredged is not considered to represent a significant impact on the ability of the region to support its current turtle population as the percentage cover is relatively low and the seagrass species represent opportunistic colonisers (Rasheed *et al.* 2004). Despite the low risks to turtles, it is important to apply best practice dredging techniques.

The main measure to protect turtles is to ensure turtle excluding devices are fitted to the dredge draghead. As a secondary measure, dredging will be minimised during the turtle nesting season by commencing as early as possible following the cyclone season (end of April) and a large dredge will be used to minimise the period of dredging. Dredging is expected to be completed by the end of October, which is the start of the turtle nesting season.

Seven species of dolphins, five species of whales and dugong were identified as potentially occurring in the waters around Hay Point. The Spotted Bottlenose Dolphin is considered likely to occur within the study area and the Humpback Whale may transit the area off-shore from the port facilities. The primary potential impact of dredging and spoil disposal on cetaceans is considered to be the generation of underwater noise and vibration. Underwater noise associated with dredging is not considered to represent a significant impact for cetaceans. Cetaceans are highly mobile and can generally avoid impacted areas for the duration of dredging activities. Considering the inshore location of the dredging activities, it is considered unlikely that dredging will impact on the migratory patterns of whales as they tend to migrate further off-shore (URS 2000) and will avoid contact with the dredge.

ES7.3 Listed Migratory Species

The turtle and cetacean species identified as threatened species within the study area are also migratory species. In addition to the discussion of potential impacts and mitigation measures relevant to listed threatened species the following provides a summary of potential impacts associated with dugong.

Sightings of dugong within the Port area are infrequent, indicating that the area is not a critical habitat for this species. However, seagrass beds within the Hay Point region may provide a seasonal food source for any dugong which may pass through the area (Rasheed *et al.* 2004) although the deep water location of the seagrass in the broader port area makes it less attractive.

The seagrass meadows recently identified within the port limits contain species which are a preferred food type for dugong and may provide a food source for dugong moving between the Dugong Protection Areas located to the north and south of the Port (Rasheed *et al.* 2004). However, as the seagrass beds are highly ephemeral and are not considered critical habitat or food source. Dugongs are mobile and can generally avoid impacted areas for the duration of dredging activities. It is considered that there is little risk of injury from direct contact with the dredge head.

ES7.4 Commonwealth Marine Environment

The proposed action occurs within the Commonwealth marine area. The following provides a summary of the cultural heritage and economic considerations of the Project.

Consultation has been undertaken with the native title claimants for the area. Both the Yuibera and Wiri#2 representatives stated that the study area was within the marine part of their country, and as such was of significance to them. Both groups were concerned about the impact of the Project on their traditional rights, especially those of fishing and hunting marine animals, as well as the general impact on the marine environment of their country. In response to the concerns of both aboriginal parties a CHMP has been developed and agreed to by all parties.

The proposed development will provide significant benefit for the regional and National economy. The proposed 1.8 m increase in declared sailing draft will provide major benefits to port users in:

- ▶ Dead freight savings.
- ▶ Increased terminal capacity.
- ▶ Additional coal sales due to reduced short loading of ships.

The net economic benefit of the Project is estimated to be a maximum of \$155 million per annum and the equivalent of \$60 million of infrastructure investment.

ES8 Environmental Management Measures

An environmental management plan has been developed for the Project, which outlines specific actions and measures, designed to mitigate potential impacts identified through the environmental assessment process. The environmental management plan is implemented in addition to existing management policies and regulations.

Several detailed monitoring studies are also proposed to be undertaken in order to assess potential impact and to provide an indication of the longer-term impacts

associated with the Project and recovery of impacted areas. These studies will include:

- ▶ **Seagrass monitoring:** a detailed seagrass monitoring program is being developed in conjunction with the DPI&F. The purpose of the study is to fill knowledge gaps on how seagrass and algae communities in the port change naturally through time, their roles in fisheries productivity and their resilience and capacity for recovery from disturbance associated with dredging. It will also provide direct information on the impact of the dredging works on seagrass and algae, and monitor recovery. Monitoring will occur before and after dredging and monthly during dredging.
- ▶ **Benthic monitoring of fringing reef communities at Round Top Island and Victor Islet:** This study will provide an effective mechanism to monitor potential changes in the reef communities of Round Top Island and Victor Islet, the islands most likely to be impacted by the dredging. The study will include a baseline survey followed by routine monitoring surveys to be conducted for the duration of capital works. A final post dredge survey will then be undertaken to determine any changes in the composition of the reef communities.
- ▶ **Hydrodynamic model validation:** The sedimentation model developed for the impact assessment will be validated based on the collection of turbidity data following the commencement of capital works. The validation of the model will then enable a review of expected turbidity levels to be undertaken to verify expected turbidity levels at key sensitive habitats.
- ▶ **Turbidity, photosynthetic active radiation and sedimentation monitoring:** Remote monitoring devices will be deployed at three locations; Round Top Island, Victor Islet and a control site. These devices will be monitored via telemetry, which can be accessed 24 hours a day. The data gathered from these devices will be utilised for the validation of the hydrodynamic model and to provide ongoing data in the analysis of survey findings from the benthic and seagrass monitoring programs.

The principal impacts of concern associated with the proposed works are in relation to marine fauna and flora. Effective mechanisms are in place to manage potential impacts on marine fauna and the studies identified above will assist in the monitoring of predicted impacts on marine flora. However, the most effective mitigation measure identified to manage potential impacts is to minimise the period of works.



1. Introduction

1.1 Project Proponent

The Project proponent is Ports Corporation of Queensland (PCQ), a Government Owned Corporation and a Port Authority under the *Transport Infrastructure Act 1994*. PCQ is the Port Authority responsible for managing 12 ports throughout Queensland, including the Port of Hay Point, where this Project is being undertaken.

PCQ has commissioned GHD Pty Ltd to prepare the Environmental Impact Statement (EIS) for the proposed Port of Hay Point Apron Areas and Departure Path Capital Dredging (the Project).

1.2 Project Description

1.2.1 Overview

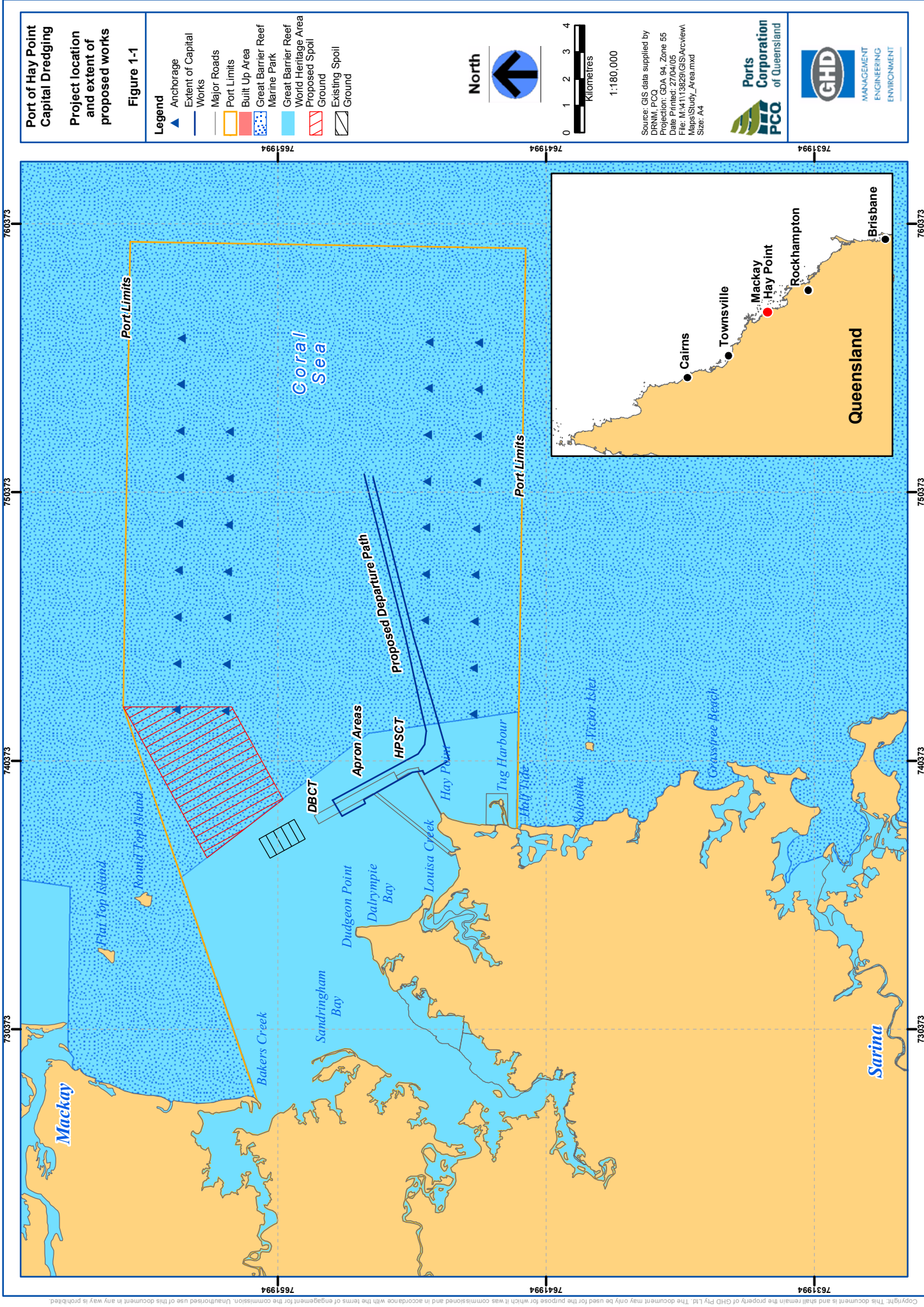
The Port of Hay Point (the Port) is located in the Shire of Sarina on the central Queensland coast, approximately 40 km south of Mackay as shown in Figure 1-1. The Port is Queensland's largest coal export port. Two coal terminals export coal through the Port, the Dalrymple Bay Coal Terminal (DBCT) and the Hay Point Coal Terminal (HPCT). DBCT is the larger of the two coal terminals. It is owned by DBCT Holdings (DBCTH) and operated by the Dalrymple Bay Coal Terminal Pty Ltd (DBCTPL) under contract to the lessee, Babcock and Brown Infrastructure (previously Prime Infrastructure Limited). HPCT is owned by Central Queensland Coal Associates (CQCA) and operated by Hay Point Services Pty Ltd (HPS).

The Port of Hay Point is the world's largest coal port, exporting 85.5 millions tonnes of coal in 2004/2005, with coal export volumes planned to increase significantly in the next five years. Currently, large ships are departing the Port short-loaded due to draft depth restrictions. This has an impact on the efficiency of exports through the Port and increases the number of ship visits required to export the coal.

An opportunity exists to increase the allowable sailing draft of vessels from the Port which will have three main benefits:

- ▶ Reduced transport costs and ship visits
- ▶ Increased coal sales
- ▶ Increased terminal capacity

The Project includes three key aspects, capital dredging, maintenance dredging and disposal of dredged material.



1.2.2 Capital Dredging

Capital dredging of material in the order of nine million m³ will be required. The dredging will include works:

- ▶ To provide a ship manoeuvring apron immediately adjacent to and parallel to the existing DBCT and HPCT dredged berths. The apron will be at least 500 m wide and dredged to achieve a minimum declared depth of RL -14.9 m LAT. Actual dredging depth will vary according to the amount of overdredging which may be required to achieve the proposed average declared depth. Overdredging depths will vary from 0 – 600 mm.
- ▶ To provide a Departure Path from apron to sea. The Departure Path width will be 500 m wide for the first 500 m then taper to a width of 300 m over the next 3,000 m. There will be a transition zone between the apron and path. The remainder of Departure Path will be 300 m wide and continue until a minimum natural depth of RL -14.9 m is achieved. The total path length is expected to be approximately 9,500 m long. The widths referred to relate to the base of the apron and path. Both have sloped sides and the width of the seabed will be greater and will vary depending on the actual depth of material removed.
- ▶ The entire Departure Path remains within port limits, but a large part will also be in the Great Barrier Reef Marine Park (GBRMP) due to an overlap of the two areas.

1.2.3 Maintenance Dredging

Ongoing maintenance dredging will be required to be carried out within the Departure Path and Apron Area approximately every two to three years. The maintenance works schedule is expected to comprise annual dredging of the Apron Area and Departure Path with an expected quantity of up to one million m³ of material being dredged each campaign. This material will also be disposed of in the new spoil ground.

1.2.4 Disposal of Dredged Material

Dredged material will be disposed of at sea at a proposed new spoil disposal ground. This material will be clean marine sediment only, which has undergone full sediment testing as required by the National Ocean Disposal Guidelines for Dredged Material (NODGDM). Testing shows that the sediment meets the requirements of the NODGDM for unconfined sea disposal (see Section 3.5). It is proposed to dispose of the dredged material at a new spoil ground located seaward of the existing spoil disposal ground, which has insufficient capacity to accommodate the expected volume of material to be dredged. The new spoil ground is within the port limits and within the GBRMP.

The dredging contractor will be required to demonstrate best practice in implementation of measures to reduce plume generation from spoil disposal. Options to achieve a reduction in the plume from spoil dumping may include varying the area of disposal according to prevailing seastate conditions. That is, disposal at the seaward extent of the spoil ground may be preferable during heavy seastates. However,



implementation of these procedures will be at the discretion of the Master of the vessel.

1.2.5 Establishment of Navigational Aids

The Project will include the potential installation of four to six fixed navigational aids along the Departure Path, plus one temporary aid. The temporary navigational aid will be installed initially to provide a fixed point of reference for survey work during dredging. Installation of permanent navigation aids will be conducted as part of the capital dredging works program. MSQ is currently carrying out a review to determine if installation of fixed navigational aids can be limited through the use of computer-aided navigation tools.

1.2.6 Project Timing

The capital works are expected to occur in 2006 but may continue in 2007. It is expected that works will be undertaken within a six month schedule. Maintenance works are expected to occur every two to three years following completion of the capital works.

1.3 Project Objectives and Scope

The Project will result in the development of a permanent Apron Area and Departure Path within the port limits. The Project has been identified as a major reduction to overall shipping costs and therefore increased in Port competitiveness can be achieved through its implementation. In addition the increased capacity at both terminals is a further benefit.

It is expected that the capital costs of carrying out dredging will be approximately \$70 million (excluding GST). Ongoing maintenance dredging of the Apron Area and Departure Path are expected to cost approximately \$4 million every three years.

To date a number of studies have been undertaken in order to progress the Project. These include:

- ▶ identification and assessment of Departure Path options, including modelling of these options at the Australian Maritime College in Launceston;
- ▶ engineering design for the preferred Departure Path option;
- ▶ seismic and geotechnical studies to determine the type of material to be dredged; and
- ▶ environmental studies associated with the development of this EIS.

1.4 Environmental Impact Assessment Process

1.4.1 Overview of Legislative Processes

On 16 September 2004, the Project was declared a 'significant project' pursuant to Section 26 of the *State Development and Public Works Organisation Act 1971*

(SDPWOA). The Project requires approvals by the Australian Government and Queensland State Government. The proposal was determined to be a 'controlled action' under the EPBC Act on 7 October 2004 and the controlling provisions for the proposal are Sections 12 and 15A (World Heritage), Sections 18 and 18A (Listed threatened species and communities), Sections 20 and 20A (Listed migratory species) and Sections 23 and 24A (Marine environment).

On 12 October 2004, a delegate of the Commonwealth Minister for the Environment and Heritage determined that the Bilateral Agreement between the Australian Government and Queensland (*An Agreement between the Australian Government and the State of Queensland under Section 45 of the Australian Government Environment Protection and Biodiversity Conservation Act 1999 Relating to Environmental Assessment*) is applicable. The level of assessment for the proposal has been set at EIS under Part 4 of the *Queensland State Development and Public Works Organisation Act 1971*.

The Great Barrier Reef Marine Park Authority (GBRMPA) and the Commonwealth Government Department of the Environment and Heritage subsequently received applications for permits under the *Great Barrier Reef Marine Park Act 1975* and the *Environment Protection (Sea Dumping) Act 1981* for related parts of the proposal. These agencies have referred these actions to the Commonwealth Minister for the Environment and Heritage under Section 161 of the EPBC Act for advice. In the case of these EPBC Act Section 161 referrals, the scope of the environmental impact assessment must address all relevant aspects of the environment. The delegate of the Minister subsequently determined that the referred actions under the GBRMP Act and the Sea Dumping Act should be assessed by accredited assessment, namely by EIS under Part 4 of the *Queensland State Development and Public Works Organisation Act 1971*.

The assessment is required to be conducted in accordance with Schedule 1 of the Bilateral Agreement. Amongst other things, Schedule 1 includes the requirement for the assessment to contain enough information about the action and its relevant impacts to allow the Commonwealth Minister for the Environment and Heritage to make an informed decision whether or not to approve the action under the EPBC Act. This requirement also includes the need for enough information about the direct and indirect impacts of the action.

1.4.2 Methodology for the Environmental Impact Statement

The EIS has been developed in the following phases:

- ▶ **Development of Initial Advice Statement:** This phase included an initial review of available documentation to determine the key issues that should be addressed in the development of terms of reference for the Project. The final Terms of Reference (ToR) for the Project provide the guidelines for the development of the EIS and are included as Appendix A.
- ▶ **Data Collection and Review:** This included collation of all available relevant data for the Project area from previous studies specific to the development of the Port or

general studies within the region. New data was also collected where existing references were insufficient.

- ▶ **Specialist Studies:** Several specialist studies were undertaken to provide input into the EIS. These included:
 - Sediment sampling and analysis
 - Hydrodynamic and water quality modelling
 - Sampling of background turbidity
 - Sampling and analysis of sediment settling velocities
 - Benthic survey of fringing coral reefs of Victor Islet, Round Top and Flat Top Islands
- ▶ **Description of the Existing Environment:** Based on the data collection and specialist studies conducted for the Project and detailed description of the existing environment including, the area to be dredged and spoil disposal locations, was prepared. The purpose of this phase is to provide a baseline from which to determine potential impacts associated with the Project.
- ▶ **Description of Potential Environmental Impacts:** The identification and quantification of potential impacts that may result from development of the Project is based on an analysis of known impacts associated with the proposed works, from previous knowledge and experience, and the characteristics of the areas to be impacted. From this analysis, potential impacts can be identified and quantified (where possible) and possible mitigation strategies developed where necessary to minimise the potential impacts.
- ▶ **Development of the Environmental Management Plan:** The Environmental Management Plan details the implementation strategies for the development of the Project to achieve the mitigation strategies identified to minimise potential impacts.

1.4.3 Objectives of the Environmental Impact Statement

The objectives of the EIS are as follows:

- ▶ to provide information on the proposal and development process to the community and decision makers;
- ▶ to comprehensively identify and evaluate all relevant issues associated with the proposal;
- ▶ to identify all potential environmental, cultural, social, transport and land use planning impacts of the preferred concept, and recommend infrastructure and facilities needs together with other design and operational measures required to minimise or compensate for adverse impacts and enhanced benefits;
- ▶ to consult with the community and relevant stakeholders in the process of identifying, assessing and responding to the impacts of the proposal;
- ▶ to identify all necessary licences, planning and environmental approvals; and

- ▶ to provide an input to 'State and Australian Government' decision-making processes, assisting with the determination of whether to accept or modify the proposal, approve it with conditions or carry out further studies.

1.5 Approval Requirements

1.5.1 Australian Government Approvals

Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) establishes a Commonwealth process for environment assessment and approval of proposed actions that are likely to have a significant impact on matters of national environmental significance or on Commonwealth land. The purpose of the proposal referred by PCQ under the EPBC Act is to increase the water depth for vessels departing the Port of Hay Point, Dalrymple Bay, Queensland by conducting capital dredging to create a new Departure Path and apron area at the Port. The proposal includes the relocation of clean dredged material to an ocean disposal ground within the port limits and also involves subsequent maintenance dredging required for the apron area and Departure Path.

Environment Protection (Sea Dumping) Act 1981

The *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) regulates the deliberate loading and dumping of wastes and other matter at sea. It applies to all vessels, aircraft or platforms in Australian waters and to all Australian vessels or aircraft in any part of the sea.

An application for a permit for disposal of capital dredged material and five years of maintenance dredged material was lodged with the DEH and referred to the Minister for the Environment and Heritage under Section 161 of the EPBC Act for advice. The scope of the environmental impact assessment must address all relevant aspects of the environment. The delegate of the Minister subsequently determined that the referred actions under the Sea Dumping Act should be assessed by accredited assessment, namely by EIS under Part 4 of the *Queensland State Development and Public Works Organisation Act 1971*.

Great Barrier Reef Marine Park Act 1975

The *Great Barrier Reef Marine Park Act 1975* (GBRMP Act) establishes a framework for the establishment, control, management and development of the Great Barrier Reef Marine Park (GBRMP). The Act is administered by the GBRMPA.

Regulation 61 of the *Great Barrier Reef Marine Park Regulations 1983* states that the GBRMPA must assess any project that has the potential to impact on the marine park. Approvals for the proposed works have been sought from the GBRMPA in accordance with the requirements of Regulation 74 (5) of the GBRMPA Act.

An application for a permit under the GBRMP Act has been lodged and the GBRMPA has referred the authorisation decision to the Minister for the Environment and

Heritage under Section 161 of the EPBC Act for advice. The delegate of the Minister has determined that this Section 161 referral should be assessed by accredited assessment, namely by EIS under Part 4 of the *State Development and Public Works Organisation Act 1971*. The matter protected is the environment.

Historic Shipwrecks Act 1976

The *Australian Government Historic Shipwrecks Act 1976* provides for the protection of historic shipwrecks and relics in waters under Commonwealth responsibility. All wrecks that have been sunk for more than 75 years are deemed to be historic shipwrecks. Waters under Commonwealth responsibility extend from the astronomical mean low water mark to the outer edge of the continental shelf. Wrecks above the astronomical mean low water mark or within particular gulfs, bays, or estuaries fall within the responsibility of the individual States and Territories. The objective of the Act is to ensure the protection and conservation of maritime archaeological sites while encouraging responsible public access. The Act prohibits damage, interference, removal or destruction of a historic shipwreck or associated relics. The Act is administered by the Australian Government in conjunction with the States, the Northern Territory and Norfolk Island. All States and the Northern Territory have complimentary legislation in place to protect wrecks and relics in State waters.

There have been no issues relevant to this legislation identified through the current EIS process.

1.5.2 Queensland State Government Approvals

State Development Public Works Organisation Act 1971

The *State Development and Public Works Organisation Act 1971* (SDPWOA) establishes an environmental assessment process for projects declared to be a 'significant project'. This process removes duplication with the *Environment Protection and Biodiversity Conservation Act 1999*, where the process is accredited by the Commonwealth Department of the Environment and Heritage (DEH), and streamlines approval processes under the *Integrated Planning Act 1997*.

On 16 September 2004 the Project was declared a 'significant project' pursuant to Section 26 of the *State Development and Public Works Organisation Act 1971* (SDPWOA). The EIS for the Project will comply with all EIS requirements specified in the SDPWOA.

Integrated Planning Act 1997

The *Integrated Planning Act 1997* (IPA) establishes the Integrated Development Assessment System (IDAS) which integrates a range of development approvals including the *Coastal Management and Protection Act 1995* and *Fisheries Act 1994*.

Under Schedule 8, development which is a material change of use and which is inconsistent with a land use plan approved under the *Transport Infrastructure Act 1994*, Section 171 triggers assessment under the IPA. The proposal is consistent with the Land Use Strategy for the Port of Hay Point and will therefore not require a development approval for material change of use.

Dredging by a port authority is not a designated Environmentally Relevant Activity (ERA) under the Environment Protection Regulation. Therefore, PCQ is not required to seek a specific permit in relation to an ERA, under the IPA.

Coastal Protection and Management Act 1995

The *Coastal Protection and Management Act 1995* (CP&M Act) provides a framework for the development of regional plans which regulate development in coastal areas. The regulatory mechanisms are administered under the IPA. An assessment under the CP&M Act is triggered in relation to assessable development within tidal waters. This includes dredging and disposal of dredge material within tidal areas.

An IDAS application for operational works in relation to works within tidal waters and disposal of dredged material in tidal waters will be required.

Fisheries Act 1994

The *Fisheries Act 1994* was rolled into the IPA on 1 March 2003. Approval may be required in relation to damage or removal of a marine plant such as seagrass or marine algae.

1.6 Stakeholder Consultation Process

1.6.1 Overview

The stakeholder consultation process is outlined in the Stakeholder Consultation Plan included as Appendix B. The plan identifies the communications and interactions proposed for the Project. It was developed by GHD in collaboration with PCQ.

Specifically, the plan provides details of the following:

- ▶ Identification of Key Stakeholders.
- ▶ Media Protocol.
- ▶ Risk and Issues Management Plan.
- ▶ Consultation Action Plan.
- ▶ Consultation Materials and Progress Reporting.

1.6.2 Aims of Consultation

The aims of the consultation process as defined by the consultation plan are to:

- ▶ raise awareness and understanding about the Project;
- ▶ provide information on the Project to the key stakeholders and other members of the community;
- ▶ seek stakeholder and community participation, input and feedback; and
- ▶ incorporate stakeholder feedback into the development of the Project.

Accordingly, the consultation process is underpinned by the following goal:

To facilitate the active participation of stakeholders and the community in the Project, whereby their ideas, views, issues, concerns and interests are taken into account, and the participants kept informed about how their input has influenced the development of the EIS.

1.6.3 Stakeholder Identification

Key stakeholders (including interest groups) for the EIS include:

- ▶ Commonwealth approval agencies, including DEH, GBRMPA and CSIRO.
- ▶ State Government Departments, including EPA, DPI&F, MSQ/QT and DSDI.
- ▶ Sarina Shire Council (elected representatives and officers).
- ▶ Relevant elected representatives of State and Commonwealth Governments.
- ▶ Environment / conservation groups.
- ▶ Social / community / recreational fishing groups.
- ▶ Tourism industry and professional associations.
- ▶ Marine industry and professional associations.
- ▶ Industry, including the coal terminal lessees.
- ▶ Media.
- ▶ General community.

1.7 Project Need and Alternatives

1.7.1 Introduction

This section of the EIS provides details, which justify the need for the Project with particular reference, made to the environmental, economic and social costs and benefits. Several alternatives to the Project have also been considered and are discussed to demonstrate the proposal is the preferable alternative.

The discussion includes:

- ▶ the alternative of taking no action; and
- ▶ identification of feasible spoil disposal alternatives, including:
 - options for dredge spoil re-use;
 - land based disposal;
 - alternative dredge material placement areas; and
 - an analysis of the impact of the various alternatives on the operational capacity of the Port.

1.7.2 Benefits of Undertaking the Project

The Port of Hay Point is now the largest coal port in the world and therefore, a significant contributor to the local, regional and national economy. In the financial year



2004/2005, 85.5 Mt of coal was exported from the Port, generating approximately \$5 billion in revenue. This was achieved via 965 ship visits. The PCQ Economic Impact Study in 2002 showed that the Port of Hay Point alone contributed a total of 1,952 full time equivalent jobs and provided \$85 M in household income. Current predictions forecast tonnage to grow to over 125 mtpa in the next five years. The proposed 1.8 m increase in declared sailing draft will provide major benefits to port users in:

- ▶ Dead freight savings.
- ▶ Increased terminal capacity.
- ▶ Additional coal sales due to reduced short loading of ships.

The ability of a vessel to benefit from extra draft (water depth) depends on a number of factors including the available draft at the receiving port, stockpile capacity at the export and destination port and the nature of the coal sale contract.

Dead Freight Savings

When vessels are not fully loaded, the lost opportunity to transport product is termed 'dead freight'. Freight costs to Europe for coal vary significantly but are of the order of AUD\$15 to AUD\$32 /t. Typically a cape class ship can load 1,200 t for each 0.1 m of additional draft. Therefore, an extra 1.8 m of draft could provide an additional 21,600 t of coal on a single voyage. An additional 21,600 t of coal to Europe could save AUD\$320,000 to AUD\$700,000 in dead freight.

Not all vessels using the Port of Hay Point can take advantage of any increase in port depth as it is generally the cape class vessels that utilise the maximum available port depth. Other factors previously mentioned is the available draft in the receiving port and the contractual arrangements under which the coal is sold.

However, to provide an illustration of how substantial the dead freight benefits could be if the draft at the port is increased by 1.8 m, the following scenario sets out the potential savings in freight costs:

- ▶ Number of annual cape class vessel visits (about 30% cape class at DBCT and 40% at HPCT) – one third of 965 ship visits or 320 vessels.
- ▶ Assume only 50% of vessels can utilise the 1.8 m additional draft ie 160 vessels.
- ▶ Each of the 160 vessels loads an extra 21,600 tonne of coal and average freight cost is AUD \$15.
- ▶ Resultant annual dead freight benefit is AUD \$52 million.

This analysis is based on a number of assumptions that need to be tested. In the real world, the benefits of the additional draft will vary from ship to ship and freight costs will vary between asian and european destinations. In addition, ship hire rates vary substantially given market demands.

To better understand the dead freight benefits, BMA, Prime Infrastructure and DBCT P/L worked together to quantify these benefits based on the actual shipping using the port. Due to the commercial in confidence nature of the coal customer arrangements



and their contracts, BMA, Prime and DBCT P/L engaged Connell Wagner to prepare a model of the shipping arrangements and input the commercially sensitive information along with variables such as the draft restrictions at the receiving ports and tidal variations at Hay Point.

With this model, Connell Wagner then worked with the two terminal operators to optimise the dredging costs versus dead freight savings. Connell Wagner's analysis concluded that the optimum dead freight saving was achieved with a declared port depth of 14.9 m and the estimated dead freight savings would be \$55 million per annum. The analysis also showed that 17 fewer vessels would be needed to ship the 2003/2004 coal exports.

Increased Terminal Capacity

Sailing time for fully loaded cape size vessels is currently restricted by the tide and which typically need to wait for the high high tide on a given day. Extra depth at the apron area and a Departure Path will allow vessels to sail earlier than is currently possible. This earlier sailing time can be as much as 12 hours where a cape class vessel could sail on the low high tide rather than waiting for the high high tide. Earlier sailing time frees up the berths at the two Terminals to load the next ship increasing capacity.

Connell Wagner also analysed these Terminal capacity benefits and concluded that the increased capacity for the two terminals combined is about 1.8 Mtpa. Based on current coal terminal infrastructure costs, this capacity increase would otherwise require a capital investment of AUD\$50 to AUD\$60 million in new terminal infrastructure.

Additional Coal Sales due to Reduced Short Loading of Ships

Existing cape size vessels are being short loaded due to the draft restriction at the Port. It is estimated that a 1.8 metre deepening will reduce short loading by 1.7 Mtpa and this is coal that would generally not be otherwise sold. The value of an additional 1.7 Mt in coal is approximately AUD\$100 million based on a long term average price of AUD\$60 per tonne. Current prices are well in excess of this amount.

1.7.3 Alternative of Taking No Action

The alternative of not undertaking this Project would see the State of Queensland and national economy forego:

- ▶ an estimated AUD\$55 million per annum in dead freight savings;
- ▶ an opportunity for additional coal sales of approximately AUD\$100 million per annum;
- ▶ the opportunity to substantially improve the competitive position of the Port of Hay Point by reducing the overall coal transport costs; and
- ▶ the opportunity to increase coal terminal capacity at the Port of Hay Point at a time when there is high demand and an urgent need for additional export capacity.

1.7.4 Departure Path Options

An investigation of Departure Path route locations was undertaken to determine the most appropriate route for ships departing the Port. Five options were developed and initially reviewed based on engineering constraints, principally the volume of material required to be removed to achieve each option and an initial review of navigational constraints.

Following the initial review Option 3 and 5 were identified as the preferred options. These two options were subsequently simulated at the Australian Maritime College in Launceston in consultation with the MSQ Regional Harbour Master and Port Pilots to determine the operational performance of each.

The simulation undertaken over a three and half day period indicated that Option 5 provided the optimum manoeuvring path and least risk for ships departing the Port. The simulation also supported the development of the 500 m wide Apron Area for the manoeuvring of vessels and 500 m reducing to 300 m width of the Departure Path.

1.7.5 Feasible Spoil Disposal Alternatives

PCQ commissioned two studies for the investigation of suitable spoil disposal options at the Port. These included land based and off-shore disposal options.

Investigations conducted by WBM (2004) for land based disposal options focused on land at Hay Point and Dudgeon Point. Full details of the investigations are included in Appendix C and summarised below.

- ▶ All terrestrial areas investigated are highly constrained due to:
 - environmental values;
 - topographical characteristics;
 - existing or proposed land uses of the sites; and
 - potential to impact on adjacent land uses.
- ▶ Two potential reclamation areas were identified adjacent to the HPCT and DBCT stockyards. Both these sites are of insufficient size to accommodate the total volume of dredged material and would require implementation in conjunction with a second strategy.
- ▶ Engineering constraints associated with pumping dredge material long distances from the off-shore dredge areas to on-shore or near-shore disposal represent a significant constrain.
- ▶ Two preferred options for ocean disposal were identified. The first was adjacent to and extended landward of the existing spoil ground and the second adjacent to and extending seaward of the existing spoil ground.
- ▶ Following discussions with the GBRMPA, DPI&F and the Maritime Safety Queensland (MSQ) Regional Harbour Master, the seaward location was considered preferable due to:
 - capacity, based on available area and water depth; and



- potential to impact upon environmental sensitive areas, being further seaward and less likely to impact upon Round Top and Flat Islands and surrounding seagrass and algal communities.
- A greater footprint with shallower depth of spoil disposition was preferred for navigational safety reasons.
- ▶ The spoil ground location was further refined to exclude an area of medium density seagrass adjacent to the existing spoil ground.

2. Description of the Project

2.1 Introduction

The purpose of this section of the EIS is to provide a description of the Project through its lifetime of construction, operation and maintenance.

2.2 Location and General Description

2.2.1 Introduction

This section of the EIS provides a general description of the area to be dredged and spoil disposal location.

In accordance with the requirements of clause 75(5)(g) of the GBRMP Regulations 1983, the means and transport for entry into, use within, or departure from, the port limits and the adequacy of provisions for vessel mooring is also described.

Requirements of Section 1.01(f) of Schedule 4 of the EPBC Regulations are outlined and a discussion of how the Project relates to other associated projects that are, or may be undertaken in the region affected by Project is also provided.

2.2.2 Project Site

The study area being considered for the EIS includes the Port of Hay Point port limits, as well as the off-shore and coastal marine environments that could potentially be impacted by dredging and spoil disposal. The study area is shown in Figure 1-1.

The Port is situated at the eastern tip of Dalrymple Bay, a shallow (6 – 10 m) embayment with a northeast aspect, into which Louisa Creek drains. It is an exposed coastal port with a strong oceanic influence providing a current declared depth of RL -13.1 m. Dudgeon Point separates Dalrymple Bay from Sandringham Bay to the north. The Sandy, Alligator and Bakers Creek systems flow into Sandringham Bay and support extensive mangrove communities.

The shipping berths of the Port are located approximately 3 km off-shore. They are connected to the land based coal stockpiles and rail facilities by jetty structures with conveyors. Numerous anchorages lie to the north and south of the off-shore coal terminals.

The Port is located within the Great Barrier Reef World Heritage Area and the area immediately surrounding the port limits is the Mackay / Capricorn Management Area of the GBRMP. Round Top and Flat Top Islands are located to the north of the port limits and Victor Islet to the south. Under the GRRMP Zoning Plan, the areas to the immediate north and south of the port limits are zoned Habitat Protection and the area to the east of the port limits is zoned General Use. Several small residential communities surround the Port. Louisa Creek is immediately adjacent to the northern boundary of the Port, with the Tug Harbour and Salonika Beach being located to the south.

2.2.3 Access Provisions

The MSQ Regional Harbour Master and MSQ Pilotage Services manage all shipping movements within the Port. Ships entering the Port anchor within identified areas to the south and north of the berth facilities prior to loading. Marine Pilots board each ship prior to berthing.

The Project may result in one or more of the current anchorage areas being relocated or restricted to shallow draft vessels. The MSQ Regional Harbour Master having regard to navigational safety will determine these restrictions.

2.2.4 Relationship to Other Associated Projects

Section 1.01(f) of Schedule 4 of the EPBC Regulations require that the Project be discussed in the context of other associated projects that are, or may be undertaken in the Hay Point region. Projects that may occur within the region that the Proponent is aware of are described below.

HPCT are currently undertaking an approved expansion of current operations. The expansion involves extending two existing coal stockpiles as well as constructing an additional bund and Stacker/Reclaimer. The expansion will increase the capacity of the coal terminal from the existing 34 Mtpa to 39.5 Mtpa (plant operational optimisation may allow 41 Mtpa to be achieved). The expansion works are completely land based and are located between the current HPCT stockyards and the adjoining DBCT. HPCT is also investigating a possible future expansion involving construction of a third berth. This Project is currently only in the investigation stage.

DBCT are also currently investigating the opportunity to expand current operations. The proposal includes a staged development comprising land based and off-shore operations. DBCT have an existing approval for dredging of a fourth berth immediately north of the existing Berth 3. This operation will include dredging and disposal of dredged material as well as the construction of coal loading infrastructure.

It should be noted that each of the above projects is not reliant upon this Project or either of the other projects to develop. Each project has been considered independently and can proceed to construction independently.

2.3 Construction Phase – Capital Dredging

2.3.1 Design Objectives

The plan layout for capital dredging has been determined from a navigation assessment undertaken in conjunction with the MSQ Regional Harbour Master and port pilots.

An assessment of design options has been undertaken to derive a capital dredging profile considering the results of site investigations, hydrodynamic modelling and anticipated siltation.

2.3.2 Existing Configuration

The existing approaches to the Port consist of a recommended approach corridor (undredged) at a bearing of 65 degrees, roughly inline with the Hay Point Services trestle. In addition there are 16 designated anchorages situated north and south of the approach corridor. The existing apron is approximately 2.2 km wide and is dredged to –13.1 m. The existing spoil ground falls within the port limits, approximately 1.8 km north of the existing apron.

The existing configuration experiences relatively mild siltation with maintenance dredging of the berth pockets required irregularly and the berth approach area has remained stable with little dredging required since capital development. The last maintenance dredging campaign of the berth approach area was undertaken in September 2004.

2.3.3 Equipment and Method of Dredging

It is expected that the proposed works will be carried out by a trailer suction hopper dredger (TSHD). This is a self propelled dredger which removes material from the seabed using a trailing suction pipe, pumping material to its hopper for temporary storage and then sailing to the disposal site where dredged material is disposed by bottom dumping. Bottom dumping is the release of dredge spoil from a hopper dredge through the hull by either; hopper doors, valves or a split hull arrangement to allow the hopper contents to fall to the seabed.

Based on the material to be dredged and the timeframe available to undertake the works it is considered most efficient for the dredger to operate in the standard overflow mode. This involves continued filling of the hopper allowing water from the top of the hopper (which in many cases contains some suspended solids, depending on material being dredged) to flow out of the hopper (overflow) while solids accumulate in the hopper. The overflow release is at the bottom of the dredgers hull via a release valve.

Non-overflow dredging is not considered appropriate or necessary for this project. Non-overflow dredging involves the cessation of dredging as soon as the hopper is full and not allowing water to flow out of the hopper.

A bed leveller may also be utilised within the dredge areas to remove small peaks on the seabed following work by the TSHD. Bed levellers are normally suspended from a tug, which then sweeps the seabed pulling surplus material to deeper areas or into areas accessible to another dredger such as TSHD for removal and transport to disposal site.

For the purpose of hydrodynamic modelling conducted for this EIS it has been assumed that a larger dredger of approximately 18,000 m³ capacity would undertake the work, possibly in conjunction with another large (but smaller) vessel.

2.3.4 Expected Dredging Schedule

The proposed works will commence in 2006 but may continue into 2007. It is expected that the works will have six month schedule. In seeking contractors to undertake the



works, contractors will be required to demonstrate how the six month schedule can be achieved.

Works will be commenced in April or May according to weather and operational considerations. Whilst the dredger is not generally restricted to seastate conditions, pre-dredge surveying can only be completed during calm conditions.

2.3.5 Volume of Material to be Dredged

The volume of material to be dredged to obtain and declared depth of –14.9 m LAT at both the Apron Areas and Departure Path is estimated to be 9 million m².

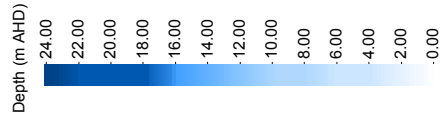
Approximately 80% of the material will be removed from the Apron Area with the remaining being in the Departure Path. The expected maintenance dredging volume from Section 2.4.4 is 200,000 m³ per annum, however a higher figure has been utilised for permit purposes to allow for unusual cyclonic events.

Port of Hay Point
Capital Dredging

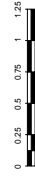
Apron Areas and
Departure Path
Geometry and
Design Areas

Figure 2-1

Legend



North

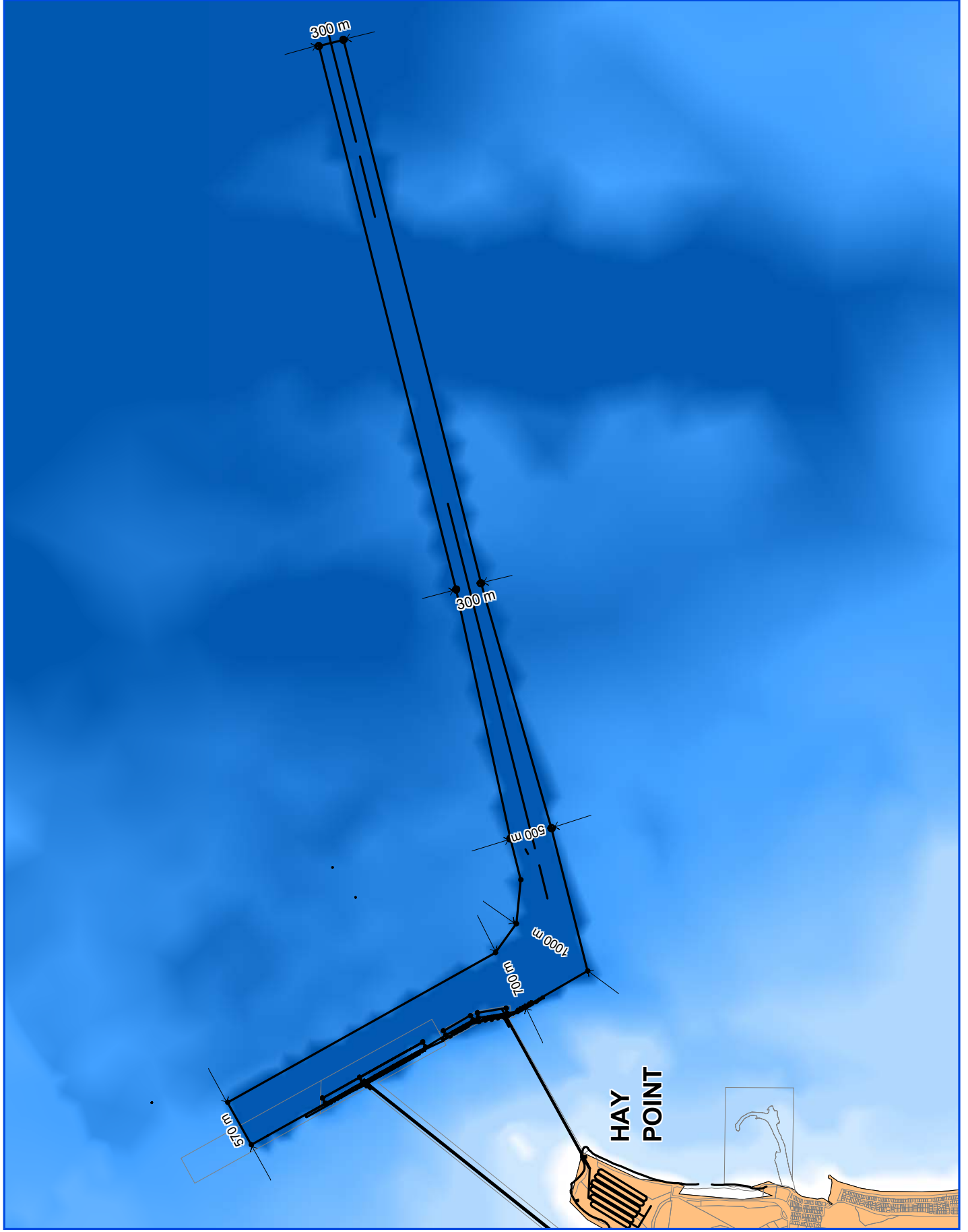


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Source: PCQ, Chart AUS 249, Australia
East-Coast - Approaches to Hay Point &
Mackay, DNRM, Zone 55
Report Number: GHD/PCQ/2019/005
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MANAGEMENT
ENGINEERING
ENVIRONMENT



2.4 Maintenance Dredging

2.4.1 Assessment of Channel and Apron Siltation Rates

An estimate of siltation volumes has been undertaken to estimate the expected volume of material, which will require maintenance dredging. The estimate is based on sediment transport potential and trapping efficiency, utilising the methods of Van Rijn and Eysink – Vermaas¹.

2.4.2 Model Parameters

Model input has been derived to be representative of a typical annual climate and consists of:

- ▶ Characteristic currents and associated water levels derived from RMA2 modelling for a mean amplitude tide (24 hours (2 cycles), amplitude = 3.76 m). Peak current velocities varying with time and water level up to a maximum magnitude of 0.3 m/s at the apron and 0.44 m/s at the outer end of the Departure Path were utilised.
- ▶ A series of runs representative of a typical annual wave climate were assessed and the resulting siltation accumulated to determine an average annual siltation.

The varying bathymetry along the Departure Path and apron was characterised by assessing the proposed dredge area as seven (7) separate sections (2 x apron, 5 x Departure Path).

The assessment considers sand, silt and clay as separate components. A summary of characteristic parameters derived from particle size distributions is included in Table 2-1.

Background concentrations of suspended sediment of 2 – 7 mg/l have been measured in earlier studies (WBM, 2000) with turbidity measurements indicating a trend to increasing sediment concentrations with depth. Consequently, a concentration of 9 mg/l has been utilised to characterise the near bottom sediment concentrations for the siltation estimate.

Table 2-1 Sediment parameters

	Channel Area					Apron Area	
	1	2	3	4	5	Apron N	Apron S
Sample Area	DP1	DP2	DP2	DP3	DP3	A1	A2
D50 Sand (mm)	0.3	0.5	0.5	0.2	0.2	0.3	0.6
D90 Sand (mm)	1.1	2.3	2.3	0.7	0.7	3.2	4.3
% Sand	69.1%	74.7%	74.7%	79.5%	75.0%	48.0%	56.0%

¹ The Van Rijn and Eysink–Vermaas methodologies have been developed to determine siltation due to channel trapping.

2.4.3 Calibration

A calibration of siltation depths was performed to the upper bound of berth siltation from historical dredge records. Calibration was undertaken by adjusting settling velocities for both the Van Rijn and Eysink – Vermaas methodologies. A good correlation with historical berth siltation depths was achieved for both methods utilising settling velocities within the suggested theoretical range.

Utilising calibrated parameters an assessment of apron and channel siltation was prepared. The Eysink – Vermaas method returned a more conservative estimate of siltation than the Van Rijn method and the Eysink – Vermaas values were adopted as a conservative estimate of siltation.

2.4.4 Siltation Assessment Results

Data in Table 2-2 were derived from the siltation assessment for a typical annual climate (for a nominal seabed level = 15.2 m LAT).

The estimate indicates that an average accretion depth of less than 60 mm / annum can be expected for the inshore end of the Departure Path (Sections 1 – 3 of the Departure Path), with very nominal siltation occurring across the natural deep trench (< 10 mm / annum, Section 4 of the Departure Path) and less than 20 mm / annum in the outer end of the Departure Path (Section 5 of the Departure Path). Approximately 25 mm / annum average accretion depth is expected across the apron area.

The total annual accretion is estimated to be approximately 200,000 m³.

Table 2-2 Annual siltation estimates

	Departure Path Sections					Apron Sections		Calibration
Section	1	2	3	4	5	North	South	Berths
Siltation Depth (mm)	55	36	46	8	20	24	24	43
Siltation Volume (m ³)	75,400	32,000	19,200	5,350	13,200	21,900	27,300	-

2.4.5 Equipment and Method of Dredging

The proposed maintenance works are also expected to be carried out by a trailer suction hopper dredger (TSHD). However, it is expected that a smaller capacity dredger than that required for the capital works, would be utilised.

2.4.6 Volume of Material to be Dredged

The assessment of annual siltation indicates that relatively minor accretion of material can be expected and as a consequence maintenance dredging can be scheduled on fairly infrequent intervals. However, final determination of maintenance regimes will be developed in consultation with the MSQ Regional Harbour Master.



2.5 Spoil Disposal

Based on the outcomes of the spoil disposal studies (see Appendix C) and consideration of navigational and safety issues, it was determined that an off-shore disposal area seaward of the existing spoil ground represented the optimum outcome in relation to environmental, social, economic and safety issues. The location is shown in Figure 1-1 of Section 1.

The proposed spoil ground varies in depth from approximately –10.9 to –13.3 m LAT. It is proposed to disposal of up to 14 million ³ of dredged material at the spoil ground to a depth of approximately 800 mm. Navigational restrictions imposed by the Regional Harbour Master dictate that the depth of water at the spoil ground must be retained to at least –10 m LAT to ensure safety. These requirements necessitated the development of a larger spoil ground to accommodate all material and achieve the minimum depth requirements.

Details in relation to the sediment quality and physical characteristics of the material to be dredged and the spoil ground are discussed in Section 3.5.

3. Description of the Existing Environment

3.1 Introduction

This section of the EIS provides information on the biophysical, social, cultural and economic environment in the vicinity of the proposal (the study area). Aspects of the environment are described to the extent necessary for the assessment of potential beneficial or adverse impacts of the proposed capital dredging of the Apron Area and Departure Path at the Port of Hay Point. Baseline information from other relevant studies has been referenced where appropriate.

Information presented in the following discussions is drawn from numerous reports on current and historic marine monitoring programs undertaken in the study area. Many of these monitoring programs were commissioned as part of the assessment and monitoring of previous capital and maintenance dredging programs undertaken at the Port. Where adequate information was not available to describe the existing environment in sufficient detail to allow the potential impacts of the proposed dredging to be evaluated, specific studies were commissioned to provide this information and the results are presented in this EIS.

3.2 Marine Flora and Fauna

3.2.1 Introduction

This section of the EIS details the existing marine flora and fauna and biodiversity conservation values within the area directly or potentially impacted by dredging and spoil disposal, it includes the following:

- ▶ native and introduced marine flora and fauna (including introduced marine pests);
- ▶ marine ecosystems;
- ▶ integrity of ecological processes;
- ▶ habitats of significance, rare or threatened species; and
- ▶ integrity of natural habitats:

Flora and fauna species and marine habitats within the study area have been defined through searches of the appropriate State and Commonwealth databases, review of previous studies and with field studies undertaken where inadequate information is available to sufficiently describe the marine communities for the purposes of the current impact assessment.

Specific issues include:

- ▶ presence of turtles and other marine mammals within the study area;
- ▶ sea floor habitat and benthic macroinvertebrate communities in the vicinity of the spoil ground; and

- an assessment of the value of the marine habitats/ecosystems to fauna of conservation significance such as turtles, dugongs and whales.

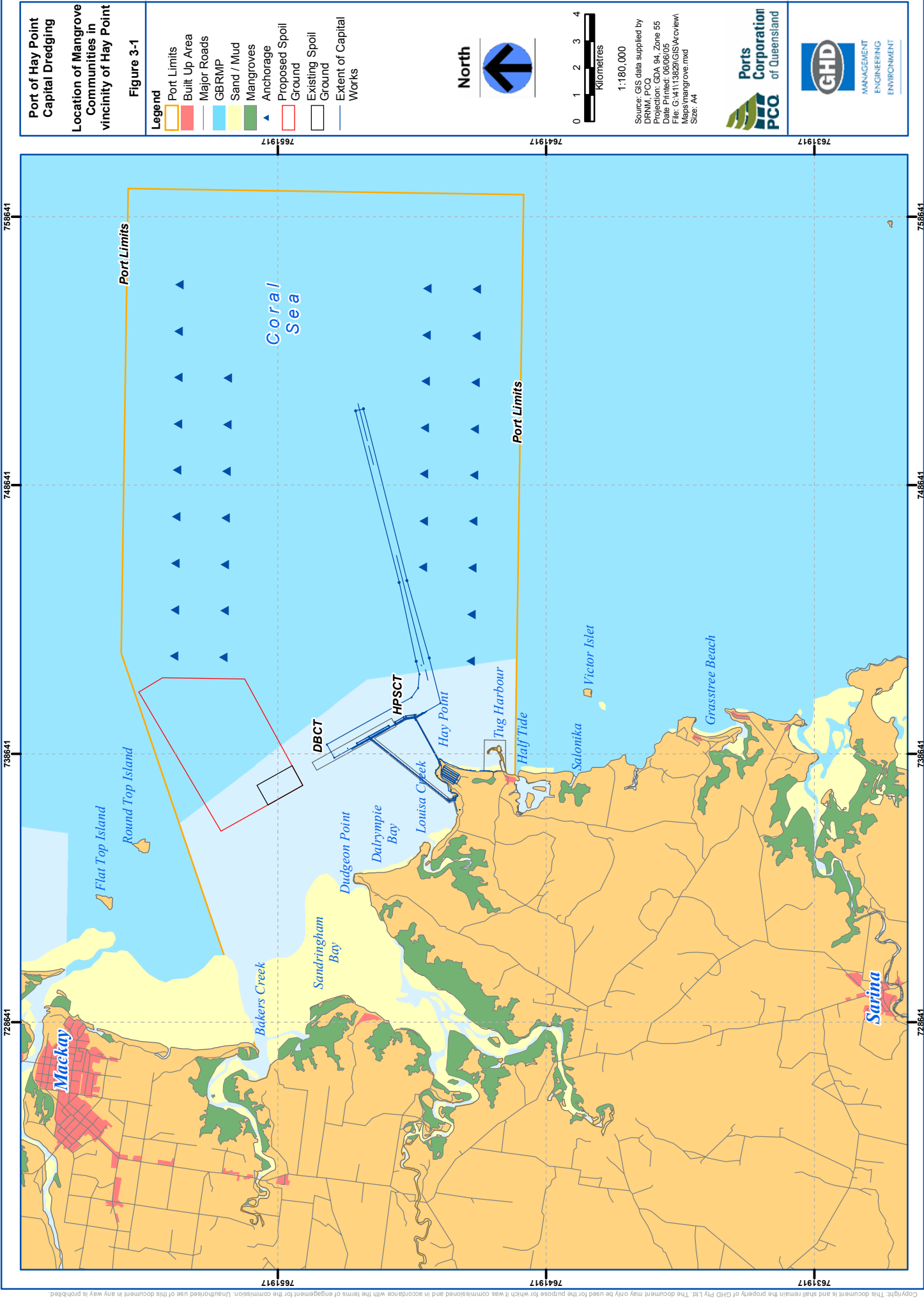
3.2.2 Mangroves and Salt Marsh Communities

Mangrove communities have significant ecological importance as they provide habitat for various marine fauna including mud crabs, prawns, barramundi, birds and saltwater crocodiles.

Much of the northwestern and eastern sides of Hay Point have been modified by concrete shoreline reclamation works during past expansion of the coal terminal (URS 2000). However, there are several large mangrove communities within the port limits (see Figure 3-1). Dalrymple Bay is relatively shallow (6 – 10 m), with the mangrove lined Louisa Creek flowing into the centre of the Bay. Dudgeon Point separates Dalrymple Bay from Sandringham Bay to the north. The Sandy, Alligator and Bakers Creek systems flow into Sandringham Bay and support extensive mangrove communities, which comprise the majority of the mangrove systems in the Hay Point region. South of Dudgeon Point, the best developed mangrove system is in Louisa Creek and, further south past Hay Point, in Breens Creek.

Mangrove communities on the Hay Point peninsula itself consist of 22 ha of many species of mangroves in an enclosed wetland on the southeast side of the peninsula, and minor stands which have colonised rocky shorelines on both the north-western and south-eastern shores. There are minor stands of mostly *Avicennia* mangroves on the eastern and southern sides of Hay Point (PCQ 2002b).

Sand and mud flats are present in Dalrymple Bay, however, these are much less extensive than those that are present in Sandringham Bay to the north. The Sandringham Bay flats are listed as nationally important wetlands (URS 2000).



3.2.3 Seagrass Communities

Seagrass meadows form an important component of coastal ecosystems and perform important functions such as nutrient trapping and recycling, providing food and shelter for many marine organisms, and assist sediment stabilisation (Roelofs *et al.* 2003).

Several surveys for sediment sensitive communities in the Hay Point / Dalrymple Bay area between 1993 and 2000 found no evidence of seagrass beds within the area, although a small patch of *Halophila* seagrass was found off the northeast side of Dudgeon Point during a port wide survey by WBM (PCQ 2002b). Low biomass coastal meadows of approximately 2.2 ha consisting of *Halophila ovalis* and *Halophila uninervis* have been identified on the north west tip of Round Top Island, approximately 5 km north of the existing spoil ground (Rasheed *et al.* 2001).

A detailed survey of seagrass, algae and benthic macro-invertebrates was conducted in July 2004 by the DPI&F and covered the proposed Apron Area and Departure Path and the current and proposed spoil disposal grounds. The survey was undertaken using a combination of a CCTV camera system with real time monitor, sled and sled net and van Veen grab (refer to Appendix D for survey location details).

The July 2004 survey identified seagrass within the port limits for the first time. The seagrass species from four individual seagrass meadows (see Figure 3-2). These seagrass meadows predominantly consisted of *Halophila decipiens*, with a few areas of *Halophila spinulosa*. The percentage cover of seagrass in these meadows was generally low, ranging from less than 1% to 35% of the seafloor (see Figure 3-3).

Seagrass meadows are located within both the existing and proposed spoil grounds, with a higher density meadow of *H. decipiens* ($\geq 20\%$) located to the south and east of the current spoil ground (Area 2 on Figure 3-2). The proposed spoil ground shape has been selected to avoid this higher density meadow and a higher density algal community in the same area by being seaward of existing spoil ground. Some areas of the Departure Path and Apron Area contain seagrass, however, the percentage cover is $<5\%$.

The two species of *Halophila* found at Hay Point are typical of deep-water seagrasses occurring between the mainland and the Great Barrier Reef and are considered highly ephemeral and seasonal in their occurrence, particularly in deep water locations. They are also rapid colonisers and are often the first species to occur following a disturbance. The presence of *H. decipiens* in the existing Hay Point spoil ground is a good indication of its ability to colonise disturbed areas and coexist with this type of disturbance (Rasheed *et al.* 2004). The peak season for growth of these species is considered to be between late spring and early summer (Rasheed *et al.* 2004).

The removal of sparse seagrass is not considered to represent a significant impact on the ability of the region to support its current turtle population as the percentage cover is relatively low and the species represent opportunistic colonisers (Rasheed *et al.* 2004). Any seagrass loss in the broader port area due to the dredging plume is predicted to be transient.

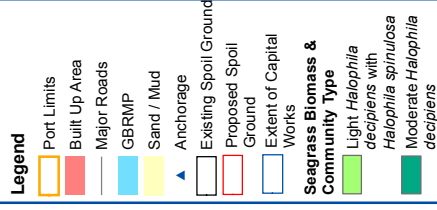


According to the DPI&F (2005) “very little is known about the dynamics of these types of these deepwater seagrass and algae communities or the role they play in primary and fisheries production. It is likely that they vary significantly from year to year and between seasons and are usually considered to be ephemeral in nature”. At this stage, the conservation value of the seagrass and algae in the Port is undefined.

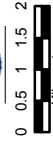
Port of Hay Point Capital Dredging

Seagrass Biomass and Community Types in the Port of Hay Point, July 2004

Figure 3-2

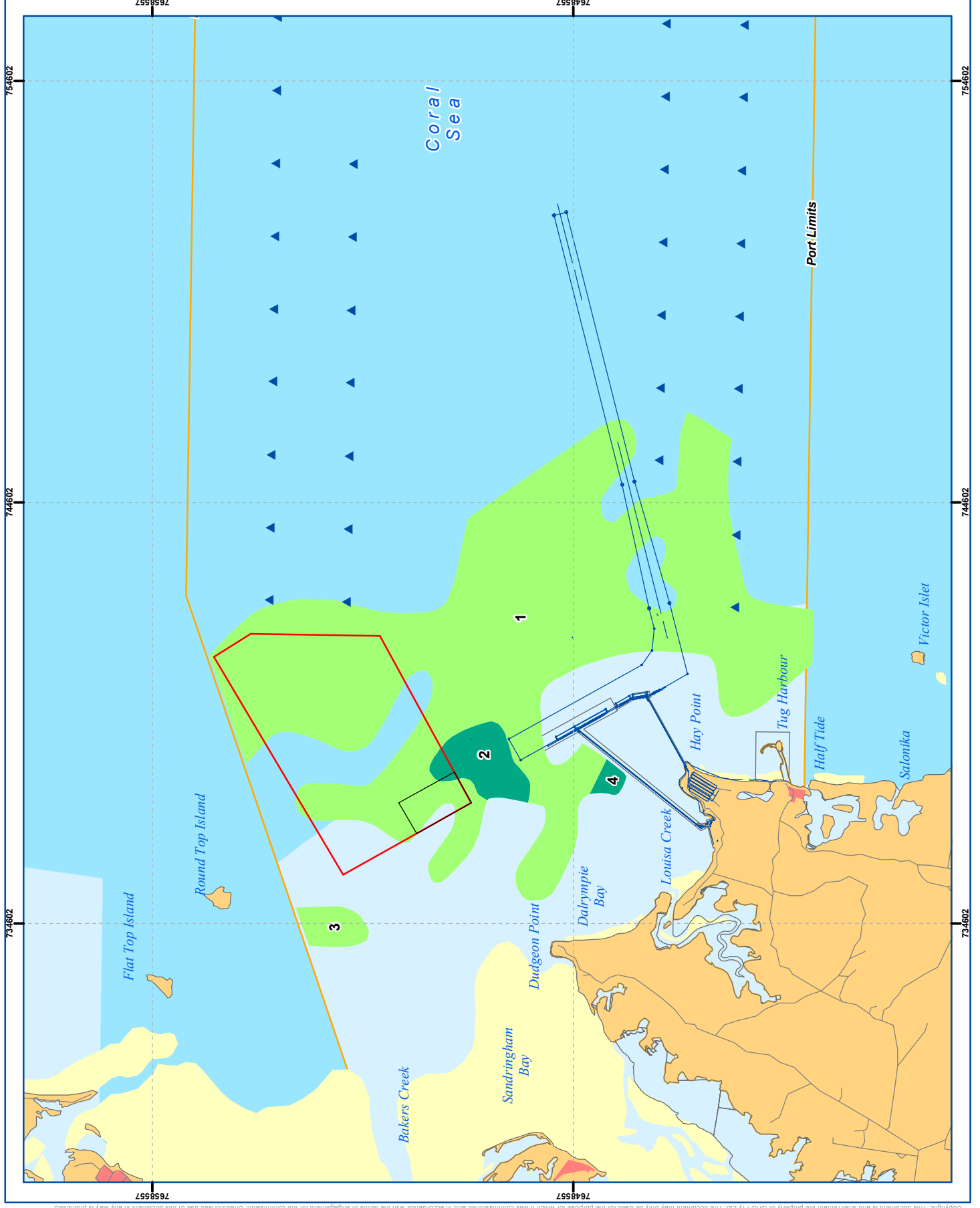


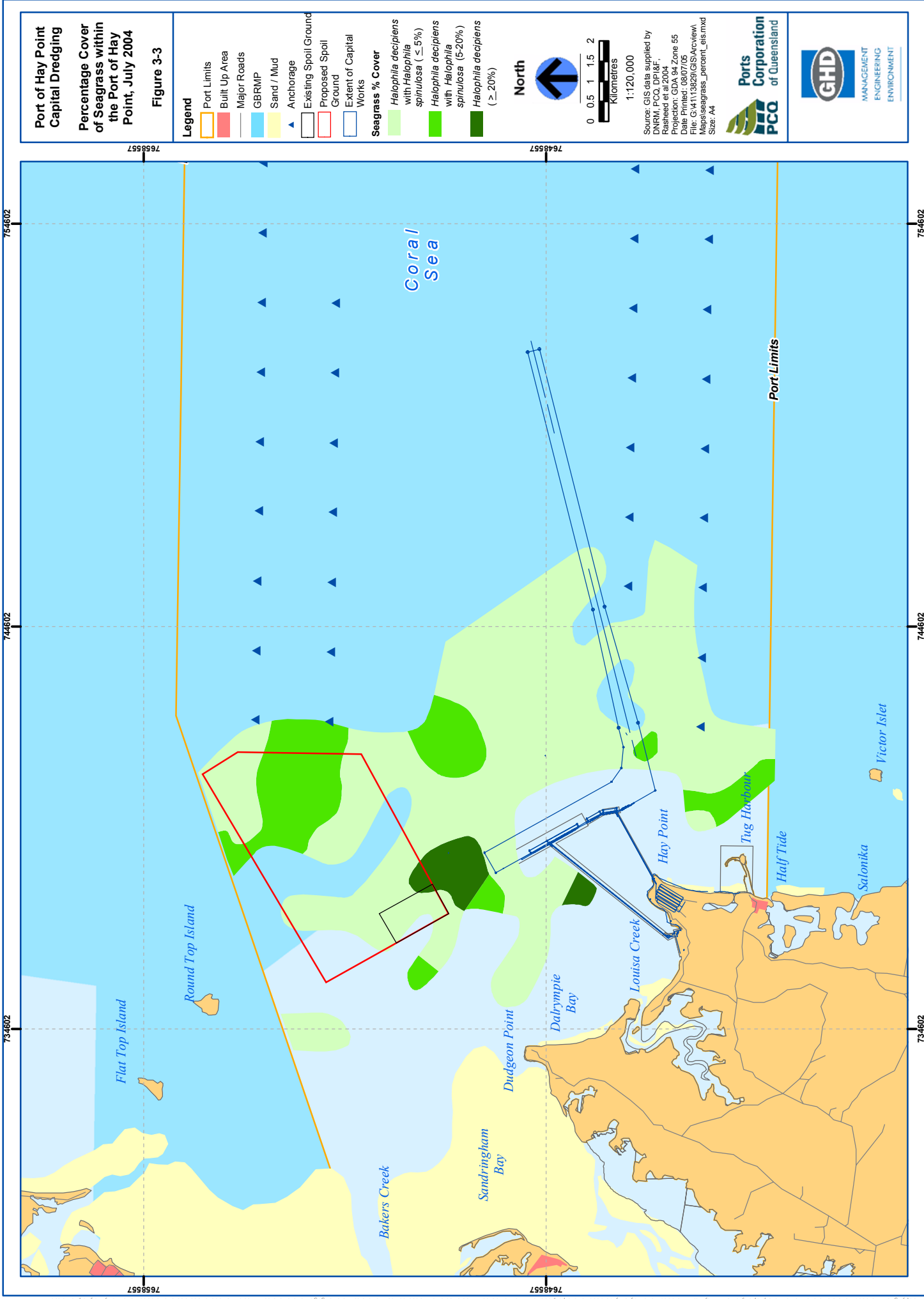
North



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Source: GIS data supplied by
DNRM, PCQ, DP&F,
Business and
Infrastructure
Planning
Date Printed: 08/07/05
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3.2.4 Algal Communities

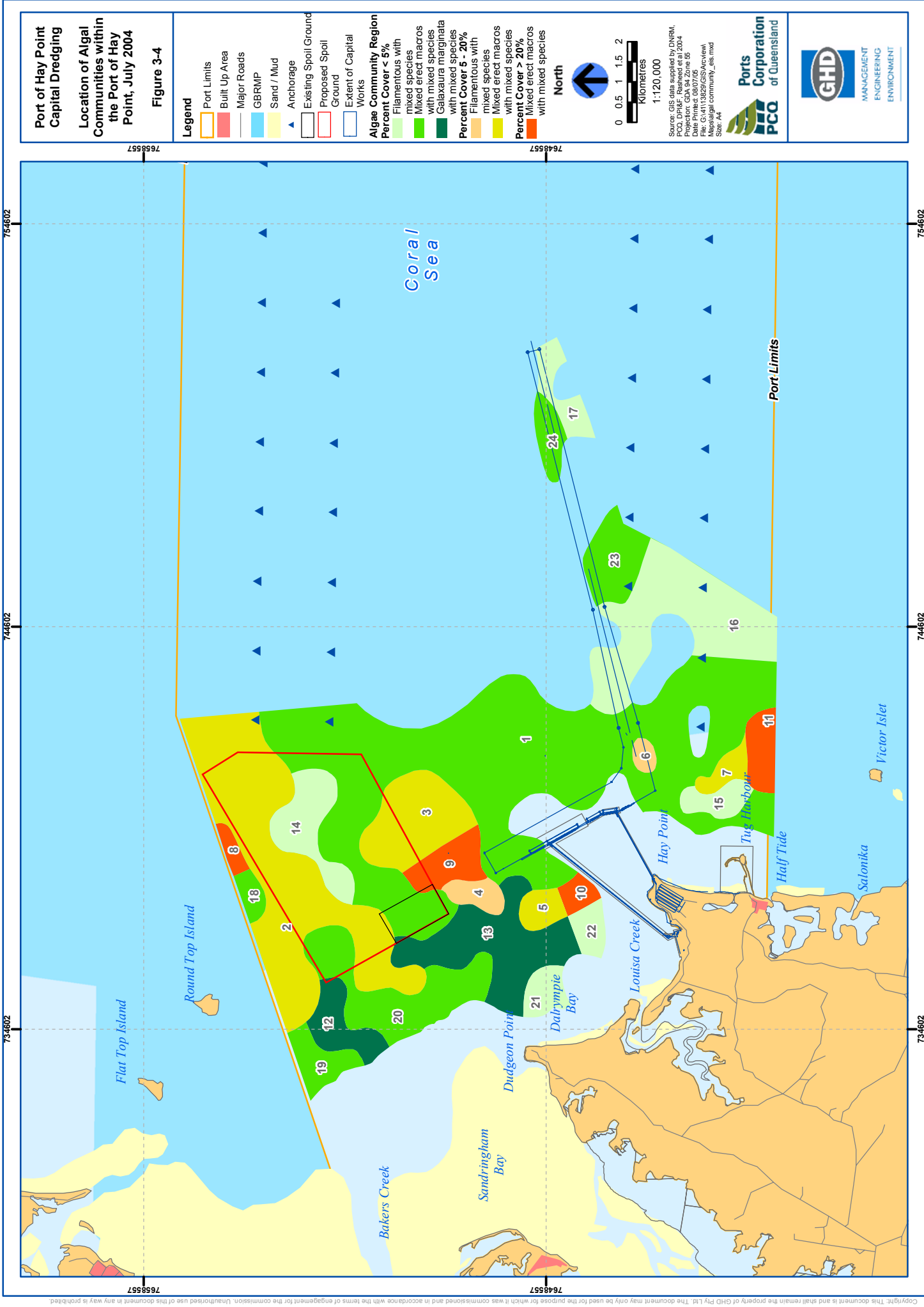
Algal communities were assessed as part of the detailed survey of benthic communities conducted by DPI&F in 2004 (refer to Appendix D for survey location details). Algal communities within the port limits consist of four functional groups; erect macrophytes, encrusting, erect calcareous and filamentous algae. Although they occurred in the 80.4% of the survey area, these algal communities typically do not form dense beds with over 70% of the algal regions having less than 5% cover (Figure 3-4).

Six community types were identified, within three density categories (Table 3-1). These six community types were identified in twenty-four different regions throughout the survey area (Figure 3-4). The most common types of erect macrophytes present were species of *Sargassum*, *Caulerpa*, *Galaxaura*, *Udotea* and *Hypnea*. Four regions of medium percent cover (>20%) were recorded, however, these covered only 3.6% of the survey area. These communities consist of filamentous algae with mixed species and are located adjacent to the main wharf (region 10), in the proposed spoil disposal ground (region 9), and adjacent to the northern and southern port limits (regions 8 and 11) (Rasheed *et al.* 2004). The removal of sparse algal communities is not considered to represent a significant impact on the habitat on the region.

Table 3-1 Summary of algal community types at the Port of Hay Point

Category	Algal Community Type	Map Region	Taxa identified
Low percent cover (<5%)	Filamentous with mixed species	14 – 17, 21, 22	<i>Udotea</i> , <i>Hypnea</i> and unidentified
	Mixed erect macros with mixed species	1, 18 – 20, 23, 24	<i>Caulerpa</i> , <i>Udotea</i> , <i>Halimeda</i> , <i>Galaxaura marginata</i> , <i>Dictyota</i> , <i>Sargassum</i> , <i>Hypnea</i> , unidentified red, brown and green algae
	<i>Galaxaura marginata</i> with mixed species	12, 13	<i>Galaxaura marginata</i> , <i>Udotea</i> , <i>Caulerpa</i> , <i>Halimeda</i> , <i>Sargassum</i> and unidentified
Low/Medium percent cover (5 – 20%)	Filamentous with mixed species	4, 6	Unidentified filamentous algae
	Mixed erect macros with mixed species	2, 3, 5, 7	<i>Caulerpa</i> , <i>Udotea</i> , <i>Halimeda</i> , <i>Galaxaura marginata</i> , <i>Sargassum</i> , <i>Hypnea</i> , unidentified red, brown and green algae
Medium percent cover (>20%)	Filamentous with mixed species	8 – 11	<i>Caulerpa</i> , <i>Halimeda</i> , <i>Galaxaura marginata</i> , <i>Sargassum</i> , unidentified filamentous and red and brown algae

Modified from Rasheed *et al.* (2004)



3.2.5 Benthic Communities

Overview

This section provides an overview of the benthic communities within the Hay Point area, including coral, benthic infauna and epifaunal communities.

Several fringing reefs are located within the greater Hay Point area (see Figure 3-5). This includes two reefs within the vicinity of the Port of Hay Point; one surrounding Victor Islet approximately 2 km south of Hay Point and reefs associated with Round Top and Flat Top Islands, approximately 11 km and 13 km north north-west of Hay Point respectively. There are also areas of minor reef development supporting sediment tolerant hard corals on some of the intertidal platforms and inshore rocky shoals (URS 2000). Previous surveys have described the benthic infaunal and epifaunal communities for proposed dredging areas and the current spoil ground and surrounds.

To ascertain the abundance, diversity and condition of the benthic communities within the Hay Point area prior to the proposed capital dredging, as well as predict the potential tolerance of these communities to dredging and disposal impacts a review of surveys undertaken in conjunction with previous capital dredging campaigns, a survey undertaken by DPI&F in 2004 and a field survey conducted by GHD in May 2005 has been undertaken.

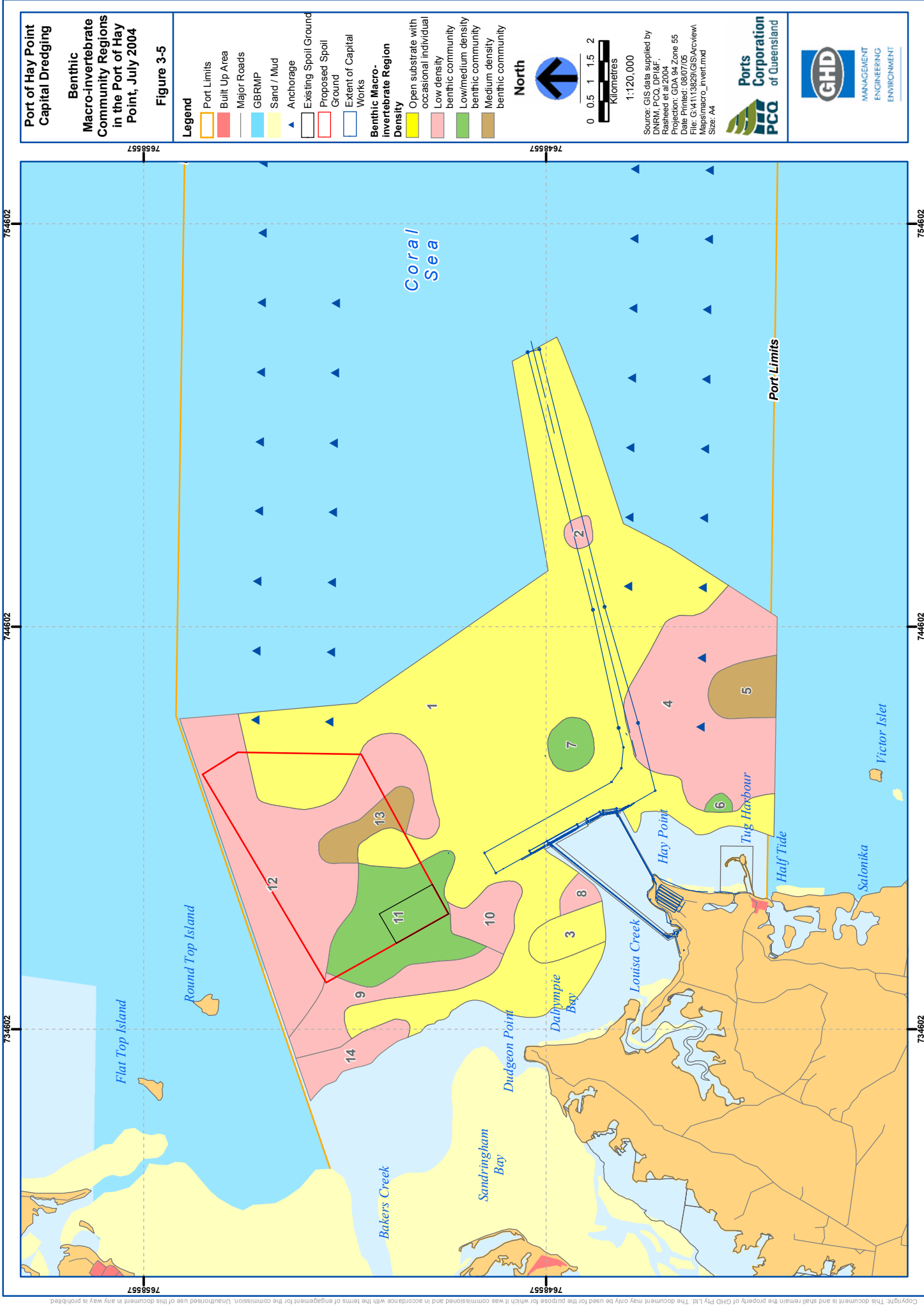
Density of benthic communities within the spoil ground is generally low with a small area of medium density cover present in the eastern part of the proposed spoil ground. Given the density of cover this habitat is not considered to be of regional conservation value. Rasheed (2005) states the community was not unique or regionally significant and is typical of such benthic communities in the inter-reef waters of the GBR.

Previous Surveys

A number of surveys of benthic infauna and epibenthic fauna have been undertaken in association with previous capital dredging programs at the Port of Hay Point. These surveys have sampled both the areas to be dredged and the existing spoil ground and surrounds. The surveys include:

- ▶ 1992 pre-dredging survey (prior to 1993 capital dredging of DBCT Berth 2) (WBM 1993a);
- ▶ 2000 pre-dredging survey (prior to 2001 capital dredging of DBCT Berth 3) (URS 2000); and
- ▶ 2001 and 2003 pre and post-dredging surveys (immediately before and after 2001 capital dredging and 2 years post-dredging in 2003) (Hydrobiology 2004).

The nature, extent and results of the surveys are summarised in the following sections.



**Port of Hay Point
Capital Dredging**

**Benthic
Macro-invertebrate
Community Regions
in the Port of Hay
Point, July 2004**

Figure 3-5

- Legend**
- Port Limits
 - Built Up Area
 - Major Roads
 - GBRMP
 - Sand / Mud
 - Anchorage
 - Existing Spoil Ground
 - Proposed Spoil Ground
 - Extent of Capital Works
- Benthic Macro-invertebrate Region Density**
- Open substrate with occasional individual benthic community
 - Low density benthic community
 - Low/medium density benthic community
 - Medium density benthic community

North

0 0.5 1 1.5 2
Kilometres

1:120,000

Source: GIS data supplied by
DNRMP, PCQ, DPI&F,
Brisbane and
Project Area
Project ID: 04-04-05
Date Printed: 08/07/05
File: G:\11\3829\GIS\Arcview
Map\macro_invert.mxd
Size: A4



1992 Pre-Dredging Survey

Grab sampling was undertaken at 12 sites within the current spoil ground and 12 sites in the vicinity of the spoil ground. Several diver transects were undertaken within and adjacent to the current spoil ground. Two grab samples were taken from the proposed berth (Berth 2, DBCT) and four diver transects were undertaken within and adjacent to the berth pocket. Two grab samples were also taken in the inshore environment, adjacent to Dudgeon Ledge.

Samples were classified according to the major taxonomic groupings (Polychaeta, Bivalvia, Crustacea and Gastropoda) and abundance was recorded as shown in Table 3-2.

Table 3-2 Mean abundance of benthic infauna per grab, within and 1992 pre-dredging survey

Site Grouping	Mean Abundance Per Grab					Total
	Polychaeta	Bivalvia	Crustacea	Gastropoda	Other	
Within Spoil Ground	23.8	3.5	8.4	1.5	3.0	40.3
Adjacent to Spoil Ground	37.4	6.0	8.3	1.4	7.1	60.2
Within Proposed Berth Pocket (Berth 2, DBCT)	28.7	3.2	4.7	1.8	1.7	39.8
Inshore environment	3.8	3.3	0.5	0.7	1.3	9.7

Source: WBM (1993a).

The following conclusions were drawn after statistical analysis of the data (WBM 1993a):

- Sites within the spoil ground had significantly lower total abundance of benthic infauna than sites adjacent to the spoil ground;
- Sites within the spoil ground had significantly lower abundance of polychaetes, bivalves and 'other' benthic infauna than sites adjacent to the spoil ground;
- Epibenthic communities within and adjacent to the current spoil ground described by divers included ascidians, sea pens, starfish, razor clams, small crabs, sea cucumbers, bryozoans, gorgonian corals, nudibranch;
- The mean abundance of total benthic individuals and bivalves per grab at the new berth site was equivalent to that from areas adjacent to the current spoil ground;
- The mean abundance of crustaceans and 'other' benthic infauna at the proposed berth pocket was generally lower than sites within and adjacent to the current spoil ground;

- ▶ Overall, the abundance and diversity of benthic infauna in the proposed berth pocket (Berth 2, DBCT) was comparable to the spoil ground, but somewhat lower than sites adjacent to the spoil ground;
- ▶ Diver surveys indicated that the areas surrounding the moorings for DBCT supported an abundant and diverse epibenthic community, while the proposed berth pocket was comparatively depauperate; and
- ▶ Relatively low abundance of benthic infauna was recorded at the inshore sites adjacent to Dudgeon Ledge. This was thought to be because the sample sites were located in high wave energy environments where sediment mobility would have been high (WBM 1993a).

Overall, the survey concluded that the spoil ground had recovered since its last use in 1983, with the abundance of individuals not indicating an impoverished benthic community structure (WBM 1993a).

2000 Pre-Dredging Survey

A survey of 26 sites was undertaken using underwater video and diver observations (URS 2000). Grab samples to identify and enumerate benthic infauna were not undertaken in this survey. Sites were located in the following areas:

- ▶ The existing (at the time) approach channel, swing basin and berths;
- ▶ Areas to be dredged (DBCT Berth 3 and northward extension to apron area);
- ▶ The area between the DBCT and HPCT; and
- ▶ Sites within and adjacent to the current spoil ground (as sampled by WBM in 1992).

The key results and conclusions of this survey were as follows:

- ▶ No epibenthic communities were identified in the areas to be dredged, with burrow densities ranging from 10 – 30 per m² in the proposed berth pocket; and
- ▶ Epibenthic organisms in the current spoil ground and adjacent areas were of relatively low abundance, with species including grey and white sponges, hydroids, anemones, soft corals (including gorgonians and sea whips), black crinoids, urchins, holothurians, sea stars, bryozoans and ascidians.

The 2000 survey concluded that the spoil ground had been recolonised by both burrowing and surface fauna since the 1993 dredging campaign (URS 2000).

2001 and 2003 Pre- and Post-Dredging Surveys

Benthic infauna sampling was undertaken at the current spoil ground and two control locations immediately before (June) and after (July) the 2001 capital dredging, and again in 2003, 2 years after the 2001 dredging campaign (Hydrobiology 2004). Twelve sites were sampled in the current spoil ground and 12 sites were sampled in each of the control locations (western and eastern), giving a total of 36 sites.

The results of this study indicated that while the benthic community at the current spoil ground did not return to baseline (pre-dredging) conditions, there has been no long-

term impact of dredge spoil disposal on the benthic community for the following reasons:

- ▶ While decreases in abundance and diversity and changes in taxonomic composition were recorded between the 2001 and 2003 surveys, these changes were consistent between the spoil ground and two control locations, indicating that they were unrelated to dredge spoil disposal;
- ▶ Densities of two polychaete families considered to be pollution / disturbance tolerant have decrease significantly since the 2001 surveys, indicating that there has been no shift towards pollution / disturbance tolerant communities at the spoil ground;
- ▶ In the 2003 survey, there was no significant difference in abundance, diversity or composition between the current spoil ground and the two control locations; and
- ▶ The abundance amongst taxa is more even in the 2003 survey compared to the 2001 surveys at the spoil ground and control locations. This indicates that the community is not stressed (Hydrobiology 2004).

Benthic Survey of the Fringing Reefs of Victor Islet, Round Top and Flat Top Island, May 2005

Method

Fringing reef benthic communities were surveyed on SCUBA surrounding the three islands using line transect methods. Line intercept surveys were undertaken to provide an assessment epibenthic habitats of the fringing reef adjacent to Victor, Round Top and Flat Top Island. The key objective of the survey was to assess the cover, abundance and diversity of epibenthic fringing reef communities at the three survey locations.

Surveys were conducted over a 3-day period between May 14 - 16, 2005. The conditions experienced during the survey enabled excellent video footage to be recorded and accurate analysis to be undertaken. Each island required between 6-8 hrs of shallow water diving to complete the survey.

For the purpose of characterisation of current condition, the survey located four survey stations within the near-shore waters adjacent to each island. Four transects located at depth ranges of 4-6m and 8-10m respectively were completed at each location (refer to Table 3-3). The replicate transect provided the study with the appropriate consideration of natural variation while being expansive enough to gain an appreciation of the detailed make up of the coral community (refer Appendix E for survey location details for each island).

Transects of 20 m length were run out using a length of reinforcing rod driven into the substrate and a fibreglass measuring tape. The survey tapes were laid on the substratum and the length of intercept with the tape of all benthic organisms directly beneath it measured. Intercept lengths for all colonies of a species or benthic group were totalled, and converted to a percentage cover measurement. In addition, the benthic community, approximately 50 cm wide along the tape was recorded using a

vertically held high definition digital video camera (Sony TRV-950 digital video camera with Amphibico underwater housing). This video footage provides a permanent record for archive, and allows an improved appreciation of overall ecosystem condition.

Each survey station covered an area of approximately 320 m². Each transect ran parallel to the shoreline so that the depth contour was maintained. A diver swam each transect and the length of intersection of all benthic organisms immediately beneath the tape was recorded.

Table 3-3 Design for Hay Point coral survey

Location	Station (depth)	Number of Transects
Flat Top Island	4-6 m	16
	8-10 m	16
Round Top Island	4-6 m	16
	8-10 m	16
Victor Islet	4-6 m	16
	8-10 m	16

Benthic categories were recorded to family or higher levels in the field. Digital video photography of each transect was taken to allow for detailed post survey evaluation and archiving as a permanent record of the current condition of the site. Groupings used in this survey are shown in Table 3-4. These groupings are consistent with the standard line transect method employed within the GBR. A general video of each station was also made for the purpose of recording the presence of fish species at the time of survey.

Table 3-4 Taxonomic groups recorded during the benthic surveys

Taxonomic Group	Species/groups included
Total Algae	Turf algae; crustose corallines; all <i>Sargassum</i> species;
<i>Sargassum</i>	All <i>Sargassum</i> species
Sponges	All Sponges
Total Hard Coral	All species of hard corals.
Acroporids	All pocilloporids; all corymbose plate, staghorn, tabulate and bottle brush <i>Acropora</i> species; <i>Astreopora</i>
<i>Montipora</i>	All <i>Montipora</i> species
Poritids	All <i>Porites</i> species; all <i>Goniopora</i> species; all <i>Alveopora</i>
Fungiids	All siderastreids; all agaracids (<i>Pavona</i> , <i>Pachyseris</i>); all fungiids (<i>Fungia</i> , <i>Podabacia</i>); all pectiniids (<i>Echinophyllia</i> , <i>Mycedium</i> , <i>Pectinia</i>); all mussids (<i>Lobophyllia</i>).

Taxonomic Group	Species/groups included
Faviids	All faviids (<i>Favia</i> , <i>Favites</i> , <i>Goniastrea</i> , <i>Platgyra</i> , <i>Cyphastrea</i> , <i>Moselya</i> , <i>Echinopora</i>); all merulinids (<i>Merulina</i> , <i>Hydnophora</i>).
<i>Turbinaria</i>	All <i>Turbinaria</i> species
Total Soft Corals	All soft coral species

Results of the survey are included as Appendix D and summarised in the following discussion.

Victor Islet Benthic Communities

Figure 3-6 shows a cross section of the typical species recorded at sites surrounding Victor Islet. The band of colonisation around the islet ranges in width from approximately 55 m to approximately 675 m when measured from the seaward edge of the inter-tidal area to open substrate.

Benthic communities around Victor Islet were dominated by macroalgae, with over 25% mean cover. *Sargassum* was the most abundant algal species with a mean of almost 24% cover, but *Hormophysa triquetra*, *Cystoseira trinodis* and *Halimeda* sp. also occurred. Turfing algal species covered another 12% of the substratum around Victor Islet, with *Lobophora variegata* the dominant species.

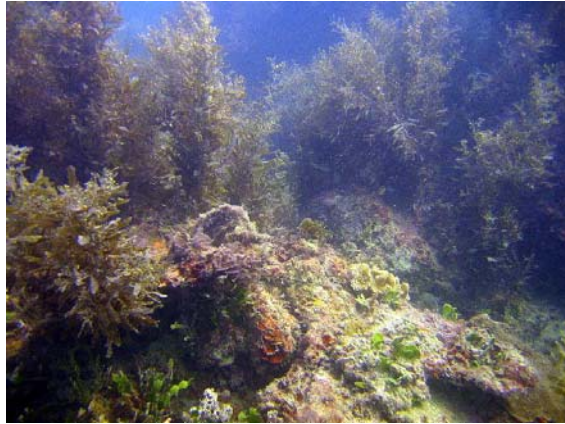
Hard corals were not abundant at most sites around Victor Islet with a mean of only 13% cover. However, abundance at the site level was variable with very significant, almost order of magnitude differences, among sites. Classification of hard coral cover is included in Figure 3-7.

Silt tolerant *Turbinaria* spp. corals were the dominant hard coral group with a mean of over 4% cover, but acroporids, siderasterids and faviids were also present. Acroporids were rare except at site 4 where explanate *Montipora* species covered over 20% of the substratum, and corymbose and staghorn *Acropora* species covered a further 2% of sub-stratum. Pocilloporid and poritid corals were uncommon as were all other coral groups. Hard coral diversity was low with a total of only 41 species being recorded during approximately four hours of observations.

Soft corals were not common on the Victor Islet reef representing only 1% of the substratum. Encrusting *Briareum* soft corals were the most frequently encountered species, but *Sinularia*, *Sarcophyton*, *Lobophytum* and four species of gorgonians also occurred. A variety of sponge species also covered around 1% of the substratum on this reef with hydroids and ascidians forming an even smaller part of the benthic community.

A number of mobile invertebrate species were present in the Victor Islet reef community, including a single species of seastar, several crinoid species, the black holothurian *Holothuria atra* and several species of nudibranchs. Overall, algal and invertebrate diversity was low with only 82 species recorded, including all hard and soft corals and other benthic and mobile invertebrates.

Figure 3-6 Representative photographs of Victor Islet reef communities



a) Macroalgae, especially *Sargassum* (brown) and *Halimeda* (green) dominated the benthic community on Victor Islet fringing reefs with a mean cover of over 26%.



b) Hard corals only covered about 13% of Victor Islet reefs with *Turbinaria* (bottom and left) and faviids (centre) both common.



c) Victor Islet reef were shallow, reaching the sand in only 2-4 m depth. *Turbinaria* hard corals, *Sarcophyton* soft coral (centre top) and *Sargassum* near the reef/sand border



d) At site 4 on Victor Islet expanse *Montipora* corals (foreground) covered 20% of the substratum amongst the *Sargassum* macroalgal forest. Bengal sergeant fish (top centre).



e) The scalyfin *Parma microlepis* (centre) was a southern fish species common on these three fringing reefs. *Turbinaria* and faviid corals are also shown (foreground).



f) The well camouflaged ornate wobbegong *Orectolobus ornatus* was also relatively common on these reefs. Green *Halimeda* algae (left) and faviid coral (foreground)



Legend

+ Dive site location

Hard Coral Cover (%)

< 5	10 - 30
5 - 10	> 30

North



1:12,000

**Port of Hay Point
Capital Dredging**

**Classification of Hard Coral
Cover, May 2005, on Victor Islet**

Figure 3-7

Round Top Island Benthic Communities

Figure 3-8 shows a cross section of the typical species recorded at sites surrounding Round Top Island. Reef communities range in width from approximately 55 m to approximately 190 m when measured from the landward edge of the inter-tidal area to open substrate.

Macroalgae were not common in most Round Top Island sites with a mean cover of less than 3%, this being significantly lower than macroalgae cover recorded around Victor Islet. *Sargassum* was most abundant on the protected western facing rubble site, where this species covered over 10% of the substratum, but was rare elsewhere. Turfing algae, mainly *Lobophora variegata*, covered a mean of almost 14% of Round Top Island reef substratum.

Round Top Island benthic communities were dominated by hard corals with a mean cover of almost 30%. Hard coral cover was significantly higher than on the other two islands. As was the case on all three islands the site variability was high, with site cover ranging from 1% to over 50% and strongly significant differences between sites. Coral cover was highest on the more exposed eastern face of the island and lowest on the protected west facing rock rubble reefs. Silt tolerant *Turbinaria* spp. corals were also dominant on this island, accounting for 26% of hard coral cover. Acroporids, siderasterids, faviids and poritids were also common. Hard coral diversity was higher on Round Top than on the other two survey islands but was still relatively low compared with other GBR fringing reefs with only 61 species being recorded during this survey. Classification of hard coral cover is included in Figure 3-9.

Soft corals were moderately common on this reef, covering a mean of almost 4% of the substratum. The genus *Sinularia* was the most abundant soft coral group but *Sarcophyton*, *Briareum*, *Dendronephthya*, *Lobophytum* and seven species of gorgonians were also present. Sponges covered a mean of 1.3% of these reefs, with the large orange-brown cup sponge *Xestospongia testudinaria* forming a prominent part of the benthic community. Hydroids and ascidians were also present in the benthic community but at covers of less than 0.1%.

Overall algal and invertebrate diversity, including a similar suite of mobile invertebrates to that recorded on Victor Islet, was also relatively low on Round Top Island with a total of only 107 species being encountered during this survey.

Figure 3-8 Representative photographs of Round Top Island reef communities



a) Hard corals covered almost 30% of the substratum on Round Top Island. A number of species of *Acropora* corals dominated some shallow water areas of this reef.



b) A distinctive *Acropora solitaryensis* colony (centre left) with *Pocillopora* (centre right), *Psammocora* (bottom right) *Montipora* (right) and *Platygyra* (bottom left) on Round Top.



c) Four species of *Turbinaria* on Round Top, along with *Platygyra* (lower left) and *Acropora* corals. *Turbinaria* spp. corals were the dominant coral group on all the islands.



d) *Turbinaria* corals on Round Top with *Montipora* and *Goniopora* (bottom left). Three gold-striped butterflyfish can be seen on the centre left, with chinese demoiselles behind.

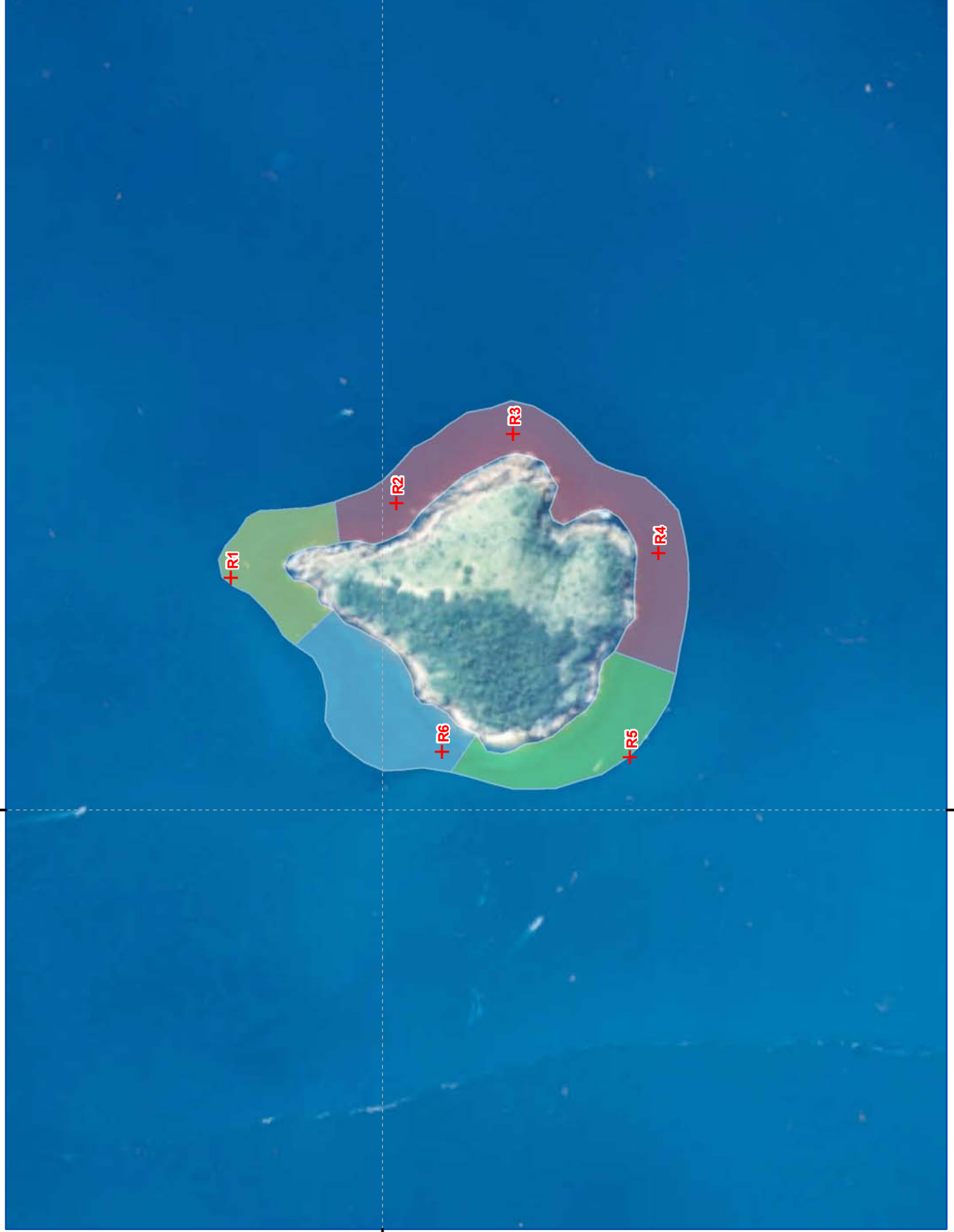


e) Several species of gorgonians were common on deeper sections of Round Top reefs, including *Ctenocella* sp. (centre), *Junceella* sea whips (right) and *Eplexaura* sp. (bottom).



f) Macroalgae only covered a mean of 3% of Round Top Island reefs and were only common at site 6. *Sargassum* sp. on the rubble bank at site 6, with *Padina* alga (centre).

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Flat Top Island Benthic Communities

Figure 3-10 shows a cross section of the typical species recorded at sites surrounding Flat Top Island. Reef communities range in width from approximately 10 m to approximately 300 m when measured from the landward edge of the inter-tidal area to open substrate.

Macroalgae were rare around Flat Top Island with a few patches of *Sargassum* recorded on the more sheltered west facing rubble reef sites. There was significantly lower cover of macroalgae on Flat Top and Round Top Islands than on Victor Islet. The brown turfing alga *Lobophora variegata* was more common than on the other two islands, although the combined turf cover of 16% on Flat Top Island reefs was not significantly higher than on the other two islands.

Hard corals were most abundant on the east facing sites, and site differences were significant but the mean cover of 9% was much lower than on adjacent Round Top Island. Coral cover on Flat Top and Victor was significantly lower than on Round Top Island. *Turbinaria* spp., siderasterids, faviids and poritids all accounted for about 20% of hard coral cover, while pocilloporids, *Acropora* and *Montipora* were all rare on Flat Top Island. Hard coral diversity was very low and only 33 species were recorded during the surveys around this island. Classification of hard coral cover is included in Figure 3-11

Soft corals covered over 2% of the substratum, with the dominant group being 11 species of gorgonians. *Sinularia*, *Sarcophyton*, *Briareum* and *Dendronephthya* soft corals were also recorded on these reefs. A distinctive feature of the Flat Top Island reefs was the relative abundance of hydroids, ascidians and bryozoans in the benthic community. Although not all these organisms were recorded along the survey transects, observations suggested that the combined cover of these groups was more than that of hard corals. At least six hydroid species were present covering a mean of 3% of the substratum, and hydroid cover on Flat Top was significantly higher than on the other two islands. Although not recorded in the transects, 11 species of ascidians and at least four species of bryozoans probably covered similar areas of the substratum to hydroids around this island.

Mobile invertebrates were a distinctive feature of Flat Top Island reefs, especially crinoids and three species of filter feeding holothurians. Although hard coral diversity was low the diversity of other invertebrate groups was relatively high and the overall number of algal and invertebrate species recorded during this survey was 104.

Figure 3-10 Representative photographs of Flat Top Island reef communities



a) Hard corals only covered 9% of Flat Top reefs (faviid colony centre), but hydroids (right) and ascidians (left) were relatively common. Scribbled angelfish were also common.



b) Eleven species of gorgonian fans were recorded on Flat Top reefs while *Turbinara* spp. was the dominant hard coral group (bottom centre).



c) Eleven species of ascidians were recorded on Flat Top (red and blue) along with bryozoans (underneath and below seastar) and many other filter feeding invertebrates.



d) Filter feeding crinoids were common on Flat Top as was the red gorgonian *Melithaea* sp.



e) The colourful filter feeding holothurian *Pseudocolochirus violaceus* was common on Flat Top Island as was the brown disc-shaped alga *Lobophora variegata* (lower left and right).



f) Bar-cheeked coral trout *Plectropomus maculatus* were common on all three islands. A few large *Porites* massive coral colonies were also present on all islands.

**Port of Hay Point
Capital Dredging**

**Classification of Hard
Coral Cover, May 2005,
on Flat Top Island**

Figure 3-11

Legend

+ Dive site location

Hard Coral Cover (%)

< 5

5 - 10

10 - 30

> 30

North



Meters

1:8,000

Source: GIS data supplied by
SunMap, DNRM, Field Data
Projection: GDA94, Zone 55
Date Printed: 27/06/05
File: g41113829\GIS\Arcview\Maps
Flat_Top_reef_class_EIS.mxd
Size: A4



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Summary of Coral Communities

The coral communities around these islands had many unusual features. The normally uncommon coral genus *Turbinaria* was the dominant coral group with six species represented including the common species *T. frondens*, *T. stellulata* and *T. peltata*. Pocilloporids were only represented by a single species *Pocillopora damicornis* that was only found commonly on Round Top Island. *Acropora* species were also only common on Round Top Island with only 14 species represented in this normally very diverse genus. This included some unusual species such as *A. solitaryensis* and *A. glauca* that are usually only common on reefs to the south of the GBR region. Several other commonly recorded coral species included *Acanthastrea lordhowensis* and *A. hillae*, which are usually found on reefs south of the GBR region. Massive *Porites* colonies were not common on these reefs and the largest encountered were only between 1-2 m diameter. The most abundant poritids were members of the genus *Goniopora* and the majority of these colonies were small, being less than a metre in diameter. Siderasterid corals are normally rare on GBR coral reefs but on these islands, this group was second in overall abundance to *Turbinaria* spp. A species of *Psammocora* was the most abundant representative in this group with a grand mean cover over the three islands of almost 3%.

A number of coral groups that are usually common on all fringing reefs were notably absent or very rare on the Hay Point island reefs. This included all fungiid corals, most agariciids (a single small *Pavona varians* colony was recorded), most pectiniids, most merulinids and the genus *Echinopora*.

Very few coral colonies over 1 m in diameter were encountered during this survey suggesting that historical disturbance has been high in this area.

Relationship Between Benthic Communities and Physical Conditions

The Hay Point area is a harsh environment for corals and other reef organisms to live in. The tidal range during spring tides is between 6 – 7 m and currents are strong, resuspending fine silt. The three islands are fully exposed to the predominant SE winds: wave action also resuspends sediment and causes turbid water conditions. This survey was carried out in a neap tide, low wind situation with underwater visibility ranging from 5 – 10 m, but these conditions were probably unusual. There were a number of features of the marine communities around these three islands that suggested the water conditions were normally extremely turbid.

Many of the common fish species encountered during this survey are only found on very silty coastal or near-shore reefs. The complete absence of the common coral trout *Plectropomus leopardus*, and the rarity of parrotfishes, surgeonfishes and emperors are also typical features of very turbid reefs (A.M. Ayling personal observations). The low fish diversity is also indicative of very silty inshore conditions (Ayling and Ayling 1999, Williams 1982).

Many of the coral species in this area were also typical of very turbid reefs including *Turbinaria* spp., *Duncanopsammia axifuga*, *Plesiastrea versipora*, *Goniastrea palauensis*, *Moseleya latistellata* and *Trachyphyllia geoffroyi* (Veron 2000). Other common corals from these three islands are usually only common where turbid

conditions are normal, especially *Cyphastrea* spp. and explanate *Montipora* species. The low coral species diversity of these islands is also normal for very silty coastal or near-shore reefs (Ayling *et al.* 1998).

These features suggest that the marine communities of these islands are very silt tolerant and well adapted to low light, turbid water conditions.

Shallow exposed coastal reef areas such as these are also susceptible to physical extremes, including cyclonic and storm wave action, freshwater inundation and high water temperatures (Berkelmans and Oliver 1999, Ayling and Ayling 1997, 2004). This probably leads to regular disturbance and damage of the reef communities. The absence of large coral colonies on these reefs does indicate that frequent disturbance is a feature of the study area.

Regional Value of the Benthic Communities

A comparison of coral cover on the three Hay Point island reefs with other fringing reef areas in the GBR region assists in establishing the regional value of these reef communities (see Table 3-5). Hard coral cover on these reefs was generally lower than that recorded during previous fringing reef surveys from the GBR region, with the exception of those other reefs that lie within the area between Mackay and Port Clinton where the maximum tide range is greater than 5 m. Van Woesik (1992) surveyed a large number of sites within this area and recorded coral cover values ranging from 5.3% around Percy Isles to 41% around Prudhoe Island. Most reefs in this area were algal dominated. Coral cover on the reefs of Victor Islet and Flat Top Island was at the low end of that recorded on other strong tide area reefs but Round Top Island was at the high end of this range. Coral cover from the Keppel Islands to the south of this strong tide area is comparable to that from the other fringing reefs to the north of this area (see Table 3-5). Hence, it is likely that the strong tidal currents and resulting silt movement are the major factor responsible for the low coral cover in this area, rather than lower sea temperatures.

Table 3-5 Summary of hard coral cover on GBR fringing reefs

Region	Date	Latitude°S	No. sites	Hard coral cover	
				mean	sd
Cape Flattery ¹	Feb 1996	14.9	5	46.2	12.2
Cape Tribulation ²	Jan 2004	16.0	12	49.3	25.9
Cairns Section Nth ³	Jan 1995	16.5	34	81.0	7.5
Frankland Islands ²	Mar 2005	17.2	6	35.6	17.2
Magnetic Island ⁷	Jan 2003	19.2	26	34.9	17.2
Middle Reef ⁴	Aug 1993	19.2	5	74.6	3.9
Hamilton Island ⁷	Sep 2001	20.3	16	51.1	21.2
Sir James Smith Gp. ⁶	1991	20.7	56	22.0	na
Keswick Is. ⁵	Oct 2001	20.9	18	26.8	na
Flat Top Is. ⁸	May 2005	21.2	6	9.0	9.7
Round Top Island ⁸	May 2005	21.2	6	29.2	21.1
Victor Islet ⁸	May 2005	21.3	6	12.9	11.1
Northumberland Is. ⁶	1991	21.5	20	11.7	na
Shoalwater Bay ⁹	Dec 1995	22.3	34	37.8	16.2
Keppel Islands ⁶	1991	23.2	8	54.3	na

Note:

Figures show grand mean percentage cover from groups of 20 m line transects.

1 Ayling *et al.* 1997;

2 Ayling and Ayling 2004;

3 Ayling and Ayling 1995a;

4 Kaly *et al.* 1993; 5 Ayling & Ayling 2002;

6 Van Woesik 1992;

7 A.M. Ayling 2005;

8 This study;

9 Ayling *et al.* 1998.

na = not available.

Turbinaria spp. is usually only a major component of the coral community on fringing reefs in very turbid situations (K. Anthony personal communication, A.M. Ayling personal observations). On more normal fringing reefs this group accounts for less than 5% of overall coral cover. In previous surveys the highest component of these corals has been recorded at Cape Flattery (8% of coral cover), Shoalwater Bay islands (17% of coral cover) and Magnetic Island (25% of coral cover). For the three Hay Point islands the *Turbinaria* component accounted for 28% of hard corals, the highest level that has been recorded in available results.

Biodiversity, recorded as the number of coral species encountered at each location, was also lower on these Hay Point island reefs than on most other GBRMP region

fringing reefs. A combined total of only 67 species were recorded over 12 hrs of diving compared with:

- ▶ 87 species recorded over 25 hrs of diving in the Shoalwater Bay region (Ayling *et al.* 1998);
- ▶ 92 species recorded during 8 hrs of diving in the Cape Flattery area north of Cooktown (Ayling *et al.* 1997);
- ▶ 131 species recorded during 2 hrs of diving around Dent Island in the Whitsunday Group of Islands (Ayling and Ayling 1995b);
- ▶ 120 species from 30 hrs of diving on 17 Cairns Section fringing reefs (Ayling and Ayling 1995a);
- ▶ 90 species recorded from the Keppel Islands by Van Woesik (1992); and
- ▶ 143 species from 10 hrs of diving around Cape Tribulation fringing reefs (Veron 1987).

The number of coral species at each Hay Point island was also low (33-61), comparable with the low diversity recorded in Shoalwater Bay from 18 island reefs where the diversity ranged from 23-58, but much lower than the 131 from one location at Dent Island and 93 from one location at Hamilton Island (Ayling and Ayling 1995c).

Another feature of the reefs around these three Hay Point islands was the common presence of a number of southern species that are common on fringing reefs south of the GBRMP region and on southern reefs such as Lord Howe Island, but normally rare on the GBRMP. A similar situation was recorded on Shoalwater Bay island reef corals by Ayling *et al.* (1998) and for Shoalwater Bay fish communities by Ayling and Ayling (1999). The Hay Point reefs also share with Shoalwater Bay the complete absence of a number of coral and fish groups that are usually common on reefs in other areas.

The Hay Point reefs were generally similar to those surveyed around islands in Shoalwater Bay in late 1995 (Ayling *et al.* 1998). The Shoalwater Bay islands also did not support true coral reefs but were rock reefs and rock rubble banks, had low coral diversity, supported southern coral species, exhibited large between location differences (range of coral cover from 8 – 67%) and had a large *Turbinaria* spp. component. However, the Hay Point island reefs differed in having a lower mean coral cover and having a large component of siderasterid corals. Although the mean coral cover on these Hay Point islands was lower than on the 18 Shoalwater Bay islands surveyed in 1995, these differences are probably not significant. Near-shore reefs have suffered two severe bleaching episodes since 1995 that has probably reduced coral cover on Shoalwater Bay reefs since the surveys were made. The Shoalwater Bay surveys were made in two sites per island on the most exposed face of each island. Selecting the three most east facing sites from each Hay Point island gives a mean coral cover of 25%, well within the 1995 Shoalwater Bay range.

Summary of Benthic Infauna and Epibenthic Communities

It is apparent from a review of the historical and current surveys of benthic macroinvertebrates and epibenthic fauna that the current spoil ground, which has been utilised for three previous capital dredging campaigns and a number of maintenance dredging campaigns, has been recolonised between dredging campaigns. Post dredging surveys, which have been undertaken from anywhere between a few weeks to almost a decade after a dredging campaign, have indicated that the existing spoil ground is recolonised with epibenthic and burrowing communities that are of a similar density and structure to those that were present pre-dredging and to those that are present adjacent to the spoil ground. This indicates that the current spoil ground is capable of recolonisation from the effects of dredge spoil disposal (URS 2000). The 2003 post-dredging survey indicated that the abundance, diversity and composition of the benthic macroinvertebrate community at the current spoil ground has not been significantly altered by dredge spoil disposal (Hydrobiology 2004).

The current epibenthic community at the spoil ground is similar to that which has been identified in previous pre-dredging surveys, with low (<5%) to medium (20%) density coverage of individuals. These individuals are neither large, nor abundant, which is not surprising given the nature of the substrate, water depth and the location of the current and proposed spoil grounds in a relatively open environment that does not provide shelter or many opportunities for attaching to structures.

3.2.6 Introduced Marine Fauna

There are three main mechanisms by which exotic species are likely to have been introduced to the Port, these being:

- ▶ natural range expansion of species introduced to other parts of the Australian mainland;
- ▶ direct importation into the Port by shipping either in the ballast water or from fouling of the hull; and
- ▶ by domestic translocation from fishing and recreational vessels.

A port wide survey conducted in 1998 by the Centre for Research on Introduce Marine Pests (CRIMP), a division of CSIRO Marine Research for PCQ, found no evidence of any targeted marine pest species. The survey did identify numerous introduced or cryptogenic species including bryozoan, hydroids, isopods, ascidians, barnacles and polychaetes. However, none of these species are considered pests within Australia (CRIMP 1998).

3.2.7 Listed Marine Fauna

A search of the EPBC Act database identified approximately 100 listed marine species that may occur within the study area. Of these, there are 19 threatened species that are likely to occur within the region. Table 3-6 summarises the EPBC Act status of the 19 threatened species.

Table 3-6 Species listed in the EPBC Act likely to be found within region

Species	EPBC Act Status	Type of Presence
Birds		
Red Goshawk (<i>Erythrotriorchis radiatus</i>)	Vulnerable	Species or species habitat likely to occur within area
Southern Giant-Petrel (<i>Macronectes giganteus</i>)	Endangered	Species or species habitat may to occur within area
Kermadec Petrel (Western) (<i>Pterodroma neglecta neglecta</i>)	Vulnerable	Species or species habitat may to occur within area
Australian Painted Snipe (<i>Rostratula australis</i>)	Vulnerable	Species or species habitat may to occur within area
Mammals		
Blue Whale (<i>Balaenoptera musculus</i>)	Endangered	Species or species habitat may to occur within area
Humpback Whale (<i>Megaptera novaeangliae</i>)	Vulnerable	Species or species habitat may to occur within area
Reptiles		
Loggerhead Turtle (<i>Carreta carreta</i>)	Endangered	Species or species habitat may to occur within area
Green Turtle (<i>Chelonia mydas</i>)	Vulnerable	Species or species habitat may to occur within area
Leatherback Turtle (<i>Dermochelys coriacea</i>)	Vulnerable	Breeding may occur within area
Hawksbill Turtle (<i>Eretmochelys imbricata</i>)	Vulnerable	Species or species habitat may to occur within area
Olive Ridley Turtle (<i>Lepidochelys olivacea</i>)	Endangered	Species or species habitat may to occur within area
Flatback Turtle (<i>Natator depressus</i>)	Vulnerable	Breeding likely to occur within area
Sharks		
Whale Shark (<i>Rhincodon typus</i>)	Vulnerable	Species or species habitat likely to occur within area

The listed migratory species that may occur within the study area include:

- ▶ 7 species of migratory birds;
- ▶ 12 species of migratory wetland birds;
- ▶ 3 species of migratory marine mammals; and
- ▶ Saltwater Crocodiles.

The listed marine species which may also utilise the area include:

- ▶ numerous species of pipefish;
- ▶ several species of seahorse;
- ▶ several sea snake species;
- ▶ several bird species;
- ▶ several mammal species; and
- ▶ one frog species.

A search of the Wildnet database, maintained by QPWS, identified 211 species that may exist within the Hay Point area. Of these, 209 are birds, including 5 species classified as Rare under the *Nature Conservation Act 1992* (NC Act). These are:

- ▶ Cotton Pygmy Goose (*Nettapus coromandelianus*);
- ▶ Rajdah Shelduck (*Tadorna radjah*);
- ▶ Black-necked Stork (*Ephippiorhynchus asiaticus*);
- ▶ Sooty Oystercatcher (*Haematopus fuliginosus*); and
- ▶ Eastern Curlew (*Numenius madagascariensis*),

The Beach Stone Curlew (*Esacus neglectus*) is classified as Vulnerable under the NC Act, and the Little Tern (*Sterna albifrons*) is classified as Endangered.

Two species of mammal were also identified including the False Water Rat (*Xeromys myoides*), which is listed as vulnerable in both the NC Act and the EPBC Act. A further 34 taxon have been identified as being having significant conservation status. Conservation significant species include those that are listed as rare or threatened under the NC Act or threatened under the EPBC, have a management status of rare or threatened, or are listed under an international agreement (such as JAMBA, CAMBA and Bonn Convention) (EPA 2005). The following discussion focuses on those species which are likely to occur within the study area based on the habitat present in the port region.

3.2.8 Turtles

Six species of turtle, the Flatback (*Natator depressus*), Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*) and the Olive Ridley (*Lepidochelys olivacea*), have been recorded utilising the off-shore, inter-tidal, estuarine and shoreline habitats in the area.

All of these species of turtle are listed as either Endangered or Vulnerable under the *EPBC Act 1999* and the *NC Act* (Table 3-7).

Table 3-7 Conservation status of marine turtles in the Hay Point area

Species	<i>EPBC Act 1999</i>	<i>Nature Conservation Act 1992</i>
Flatback	Vulnerable	Vulnerable
Green	Vulnerable	Vulnerable
Loggerhead	Endangered	Endangered
Leatherback	Vulnerable	Endangered
Hawksbill	Vulnerable	Vulnerable
Olive Ridley	Endangered	Endangered

Marine turtles are generally solitary with the exception of breeding females, which may aggregate in near-shore waters at Hay Point from September to breed before the nesting season. The nesting season occurs between October and February, with the hatchlings emerging until April. Of the species recorded within the area, Green turtles are most frequently observed within the Port, with Flatbacks the predominant species nesting on local beaches. During a 2002/03 survey, five green turtles were observed within the Hay Point area, but none were captured within the port limits (Bell 2003). The inshore areas of Hay Point support a small foraging population of green turtles, which are likely to be feeding on the algal covered substrates (Bell 2003). These turtles may also feed on deeper water seagrass and algal populations (Bell 2003).

Flatback turtles nest primarily on the beaches of inshore continental islands and the mainland between Gladstone and Mackay between October and February, with the females coming ashore two to three times during the season to lay their eggs. The major rookeries are located at Peak, Wild Duck and Avoid Islands, 80 km south-east of Hay Point, with low density nesting also taking place on mainland beaches between Bundaberg and Cairns. Flatback turtles are of special significance as they are endemic to Australia (GBRMPA 2005).

Green turtles, the most frequently observed species within the port area, have a breeding season that commences in September and ends in March with the hatchlings emerging from December to May (GBRMPA 2005). Green turtles have been occasionally recorded nesting on local beaches between November and April (URS 2000).

The first recorded sighting of a Loggerhead turtle nesting within the region occurring in the 2004/2005 season (Mackay Turtle Watch 2005). Loggerheads have occasionally been sighted nesting within the Mackay region (Gallagher pers comm. 2005). None of the remaining three species of turtles have been recorded as nesting within the vicinity of Hay Point (GBRMPA 2005).

Table 3-8 summarises the number of nests recorded each year for the three closest beaches to Hay Point. The most heavily utilised beaches for nesting have been identified as those at Hay Point and Salonika with limited nesting observed on McKewans, Louisa, Ballykeel and Far Beaches. Turtle nesting data from Mackay Turtle Watch indicates that the average number of turtle nests over a six-year period for Louisa Creek and Hay Point combined was seven nests. In five of six years surveyed to the end of 1999, no turtle nests were observed on Louisa Creek Beach by Mackay Turtle Watch.

Table 3-8 Number of turtle nests identified at beaches near Hay Point

Beach Year	Hay Point	Salonika	Louisa
1993/1994	NR	11	NR
1994/1995	5	10	1
1995/1996	7	13	NR
1996/1997	10	4	NR
1997/1998	2	3	NR
1998/1999	14	20	3
1999/2000	3F – 1G	1G	NR
2000/2001	4	7	2
2001/2002	7	18	0
2002/2003	9	6	NR
2003/2004	7	13	2

Note:

NR = None Recorded (either the beach was not monitored or no nests were sighted);
F = Flatback turtles;
G = Green turtles.

Source: Mackay Turtle Watch 2005

The presence or otherwise of seagrass beds within the Hay Point area may be of less importance during the breeding season as breeding females tend to reduce their food intake during this time. As well, breeding turtles may feed in one area and migrate to another area to nest (Gallagher pers. comm. 2005)

Unrestricted use of lighting and vegetation clearing on beach areas are a common threat to sea turtles during nesting season. Nesting female turtles and hatchlings become disorientated by unrestricted light causing mortality. Nesting females may be deterred from emerging from the sea onto beaches where uncontrolled lighting is present. This may cause her to abort eggs at sea (Mackay Turtle Watch 2005).

3.2.9 Cetaceans

Seven species of dolphins and five species of whales were identified as potentially occurring in the waters around Hay Point through a search of the EPBC Act database (Table 3-9). The status of the identified species under the NC Act is also presented.

The majority of species listed above have been identified as species that may occur within the study area, or that may have habitat within the study area. The Spotted Bottlenose Dolphin is considered likely to occur within the study area.

All the species of dolphin identified as potentially occurring in the area tend to be nomadic and are likely to visit the area infrequently (WBM 2004).

The Humpback Whale recovery plan identifies the study area as a migratory path for whales. This species is identified as endangered under the NC Act and vulnerable under the EPBC Act. Blue whales, which are listed as Endangered under the EPBC Act, are rarely found in Queensland waters and are therefore not scheduled in the NC Act. Two further species of whale, the Sei and Fin whales, were identified occasional visitors to the area in a previous report (URS 2000). However these species were not identified in the search of the EPBC Act Protected Matters Database for the current EIS.

Table 3-9 Cetaceans likely to occur in the vicinity of the Port of Hay Point

Species Name	Common Name	Status		Comment
		NC	EPBC	
<i>Megapteranovaeangliae</i>	Humpback Whale	E	V	Species or species habitat may occur within area
<i>Balaenoptera musculus</i>	Blue Whale		E	Species or species habitat may occur within area
<i>Balaenoptera edeni</i>	Bryde's Whale			Species or species habitat may occur within area
<i>Orcinus orca</i>	Killer Whale			Species or species habitat may occur within area
<i>Balaenoptera acutorostrata</i>	Minke Whale			Species or species habitat may occur within area
<i>Delphinus delphis</i>	Common Dolphin			Species or species habitat may occur within area
<i>Grampus griseus</i>	Risso's Dolphin			Species or species habitat may occur within area
<i>Orcaella brevirostris</i>	Irrawaddy Dolphin	R	V	Species or species habitat may occur within area
<i>Sousa chinensis</i>	Indopacific Humpback Dolphin	R	V	Species or species habitat may occur within area

Species Name	Common Name	Status		Comment
		NC	EPBC	
<i>Stenella attenuata</i>	Spotted Dolphin			Species or species habitat may occur within area
<i>Tursiops aduncus</i>	Spotted Bottlenose Dolphin			Species or species habitat is likely to occur within area
<i>Tursiops truncatus s. str.</i>	Bottlenose Dolphin			Species or species habitat may occur within area

Notes:

Commonwealth Status: *Threatened Species* – endangered (E), vulnerable (V), *Environment Protection and Biodiversity Conservation Act*.

Queensland Status: endangered schedule 2 (E), vulnerable schedule 3 (V), rare schedule 4 (R), common with declared management intent (D), *Nature Conservation Regulations 1994*.

3.2.10 Dugong

The Dugong (*Dugong dugon*) are listed as vulnerable to extinction by the International Union for the Conservation of Nature and Natural Resources and the EPBC Act. Dugong are herbivorous mammals that feed exclusively on seagrass. Dugong are generally sparsely distributed throughout the southern Great Barrier Reef region. Small populations of Dugong have been reported near Port Newry to the north and Ince Bay 20 km to the south with the areas around Llewellyn Bay and Ince Bay having been declared Dugong Protection Areas Type B and Type A respectively under the NC Act and the *Fisheries Act 1994* (WBM 2004).

The most important dugong habitats along the east coast of Queensland are the Hinchinbrook Island area, Cleveland Bay and Shoalwater Bay in the Great Barrier Reef region, and Hervey Bay and Moreton Bay to the south. These are typically large, northward facing bays, which are sheltered from the prevailing southeast winds. These bays support much of the large areas of seagrass along this area of the Queensland coast. The Port is outside these areas and is not known as an area of importance habitat for dugong.

There have been few sightings of dugong within the study area. However, seagrass beds within the Hay Point region may provide a seasonal food source for any dugong which may pass through the area, particularly during the normal 'high season' of late spring and summer (Rasheed *et al.* 2004). The presence of these Dugong Protection Areas to the north and south of Hay Point may indicate that dugong transit the region. The low density of seagrass within the area would be unlikely to support other than dugong transiting the area.

3.2.11 Fisheries

The Mackay region supports important commercial fishery grounds. Prawn trawling, coastal net setting and crab pot fishing occurs on a commercial scale in and beyond Dalrymple Bay (including the current spoil disposal ground). The net and crab pot

fisheries target species such as mud crabs, barramundi, threadfin salmon, grunter and flathead (URS 2000).

All commercial fishing activities conducted within the Dalrymple Bay area are monitored by the DPI&F, who maintain a database of all compulsory log book records made by fishermen in the Commercial Fisheries Information System (CFISH) database. It should be noted that the data available from this database has limitations when applied to this EIS. The data obtained represents an area of 30 nautical miles by 30 nautical miles (CFISH grid O25) that includes not only the fish catches from within Dalrymple Bay but also other areas, including the Port of Mackay (WBM 1993b).

The data from the CFISH program is made available online through DPI&F's Coastal Habitat Resources Information System (CHRIS) web database (DPI&F 2005). A review of the total catch for CFISH grid O25 by fishing method indicates that the trawl and net fisheries within the area dominate the catch (Figure 3-12). Figure 3-12 also indicates that the catch varies considerably between years. This is likely to be related to population dynamics and fishing effort.

Trawling is focussed on the coastal areas near the mouths of estuaries and creeks to target the mangrove nursery areas for banana prawns. Banana and King prawns are the two major prawn species, comprising an average of 37% and 52% of the local catch respectively between 1988 and 2003 (DPI&F 2005). Tiger, endeavour and coral prawns comprise the remaining catch (DPI&F 2005). Review of catch data from 1988 – 2003 indicates that the prawn catch is highly variable between years (Figure 3-13). The fishing effort, measured by the number of boats, is also highly variable between years and species and is likely to be connected to the variable nature of the prawn stocks (Figure 3-14). A review of catch data for four selected commercial species also indicates that the catch varies substantially between years (Figure 3-15).

Banana prawns are generally caught in near-shore coastal waters, particularly near estuaries. Most banana prawns are caught during a short fishing season in late summer and autumn, with catches generally being dependent on rainfall. Banana prawns spawn in near-shore coastal areas with juveniles growing to maturity in estuarine areas. Heavy rainfall flushes banana prawns out into the coastal trawl fishing grounds. Banana prawns are traditionally regarded as a variable resource as they show a large degree of annual fluctuation in catch (WBM 1993b and Figure 3-13).

A review of the CHRIS Web database for recreational fishing in the Mackay area indicates that recreational shoreline and boat fishing occurs in the area with catches including whiting, snapper, cod, grunter, mackerel, sweetlip and trevally. It should be noted that data from 1997 only was available within this database.

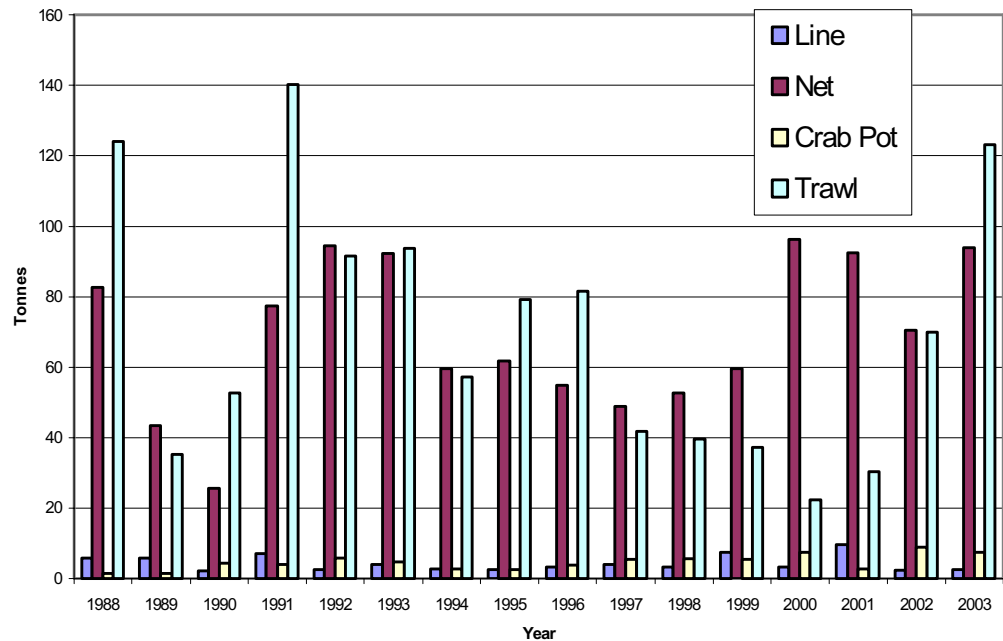


Figure 3-12 Summary of the total catch (tonnes) by fishing method from 1988 – 2003 in CFISH grid O25.

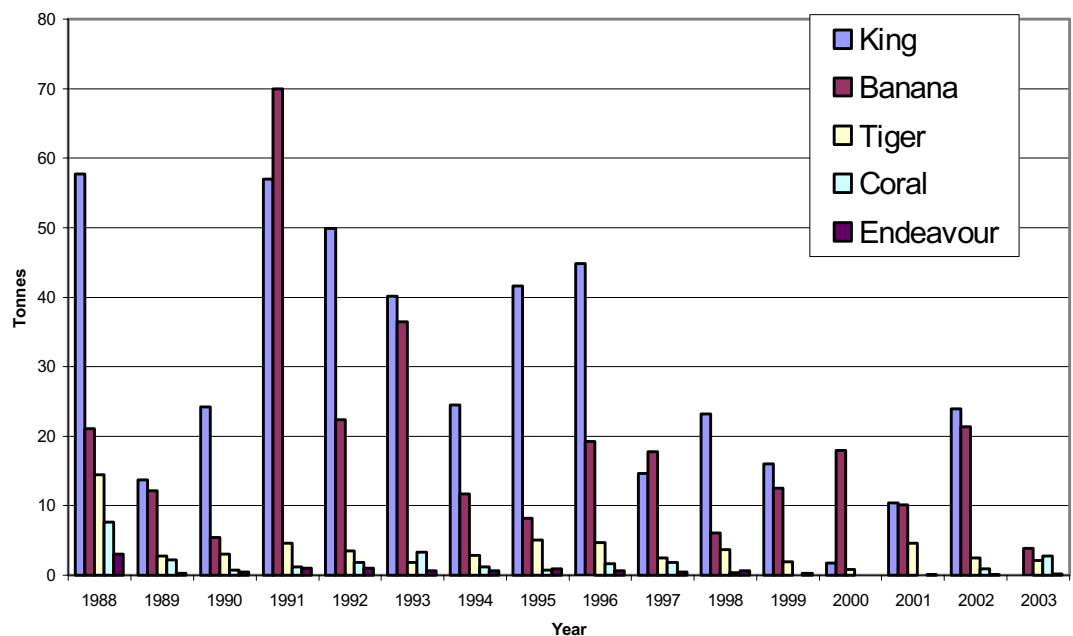


Figure 3-13 Total prawn catch (tonnes) by species from 1988 – 2003 in CFISH grid O25

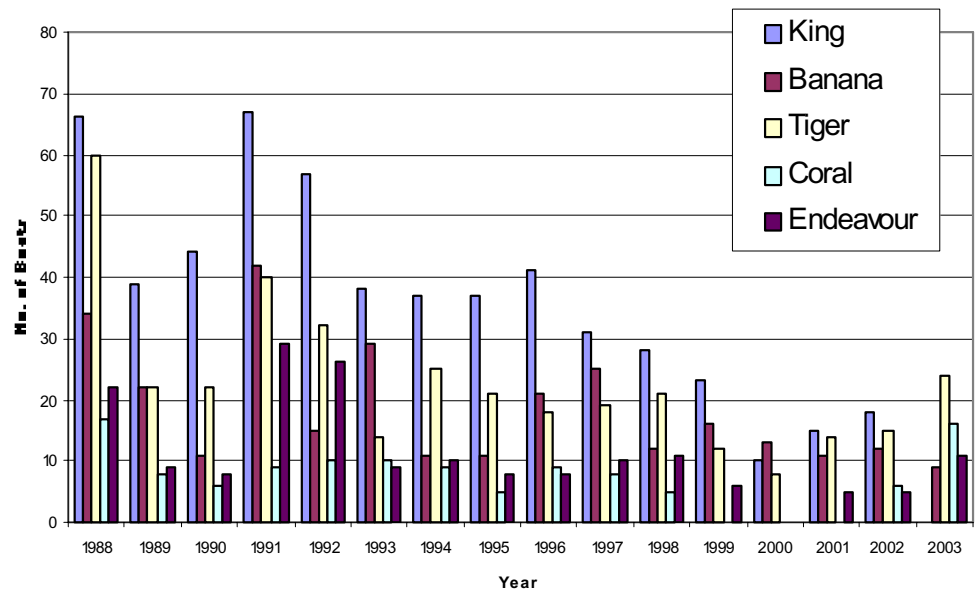


Figure 3-14 Number of boats trawling in grid O25 by species from 1988 – 2003

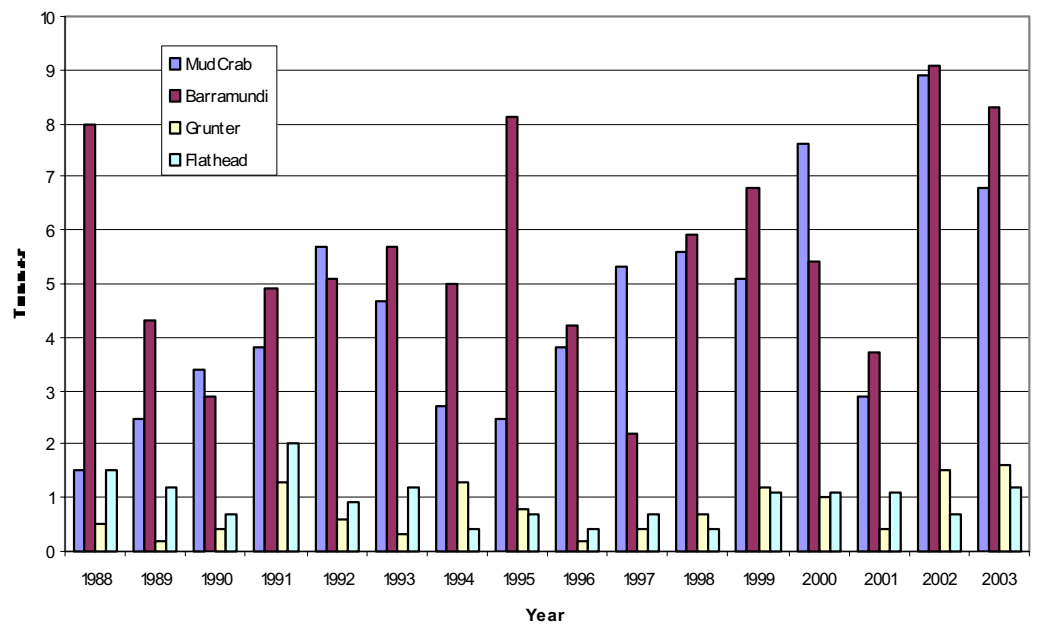


Figure 3-15 Total catch (tonnes) for selected commercial species in CFISH grid O25 from 1988 – 2003

3.3 Marine and Coastal Processes

3.3.1 Introduction

This section of the EIS identifies the marine and coastal processes of the study area relevant to the proposed dredging and spoil disposal. The information is based on a review of data from previous studies and assessment of the validity of previous modelling based on monitoring data, especially in relation to movement of turbid waters. Primary hydrodynamic modelling has also been undertaken to supplement existing knowledge. A full report on the hydrodynamic and water quality modelling are contained in Appendix F. The model provides a means to assess the following:

- ▶ Prediction of the currents that will arise in the future, and hence, how a sediment plume may behave;
- ▶ Prediction of sediment deposition during dredging and spoil disposal;
- ▶ The changes in hydrodynamics that may result from the altered bathymetry that will result from the proposed dredging and spoil disposal; and
- ▶ The potential for sediment resuspension.

The purpose of the section is to:

- ▶ provide details of local and regional coastal processes including details of current (direction and velocity over a range of tide levels), waves, and potential sediment transport rates and directions for the study area and surrounding coastline;
- ▶ investigate the geomorphodynamics of the area to provide an understanding of the past and present day coastal processes; and
- ▶ identify sediment movement in relation to proposed channel and any sea or near-shore-based disposal area(s).

The results of hydrodynamic modelling have been used to assess the following in other sections of the EIS:

- ▶ Assess the sedimentation rates of the apron and departure channel and provision of details of the assessment method and/or comparison with historical siltation rates (see Section 2.4);
- ▶ Identify sedimentation and turbidity as a result of dredging activities (and potential natural environment impacts) (see Section 4.4.4);
- ▶ Identify the point source location, concentrations and movement of total phosphorous and nitrogen (nutrients) that may result from dredging or sea disposal of sediment (see Section 4.4.4);
- ▶ The potential impacts of these processes on marine flora and fauna and biological processes within the study area (see Section 4.3); and
- ▶ Investigate the retention or otherwise of dredge spoil within the spoil disposal area.

3.3.2 Local and Regional Coastal Processes

Tides and Tidal Currents

In coastal environments, sediment transport rates are partially governed by the tidal flows and as such are continuously changing in magnitude and direction as the tidal flow alternates between ebb and flood. The situation is further complicated due to the fact that sediment transport also follows the neap-spring tidal cycle. These effects are particularly important for the Hay Point site characterised by abnormally high tidal range. The maximum tidal range is 7.14 m with the mean spring tidal range being 4.88 m. The tides are semidiurnal with a small diurnal inequality (AGSO 1998).

The Australian Geological Survey Organisation (AGSO 1998) reports that strong currents flowing parallel to the coast in the area may reach speeds of up to 2 knots (approximately 1.0 m/s) on springs. Typical characteristics of the tidal currents as identified in previous reports are as follows:

- ▶ Peak current velocities vary from about 0.20 m/s during neap range periods to about 0.50 m/s for spring tides; and
- ▶ The tides generally flood towards the south-southeast (165° true) and ebb towards the north-northwest (345° true) with slight variations from tide to tide.

Waves

The following comments can be made with respect to the wave climate at Hay Point:

- ▶ The site is exposed to a varying wave climate which is influenced by the Great Barrier Reef, the Northumberland Isles and associated with shoals to the south-east and the occurrence of tropical cyclones (WBM 2000).
- ▶ The site is subject to wind-waves and swell with spectral peak periods ranging from about 2 seconds to 18 seconds. Wind waves predominate and typically have a spectral peak period from 3 to 6 seconds. During significant meteorological events, the maximum height of wind-waves could reach as high as 4.5 to 5.0 m with a corresponding peak period of 6.0 to 6.5 seconds.
- ▶ Overall, waves (swell and wind) affecting the area lie predominantly in the range 2 to 8.5 seconds with significant wave heights not exceeding 2.5 m.

3.3.3 Hydrodynamic Modelling

Model Establishment

A hydrodynamic model covering an area approximately 34 km off-shore and 71 km alongshore was developed for the Hay Point area. The extent of the model is shown in Figure 3-16. The RMA suite of models was chosen for this Project. RMA2 is a 2-dimensional finite element model capable of modelling hydrodynamic processes in coastal systems and can also model water quality/sediment transport processes.

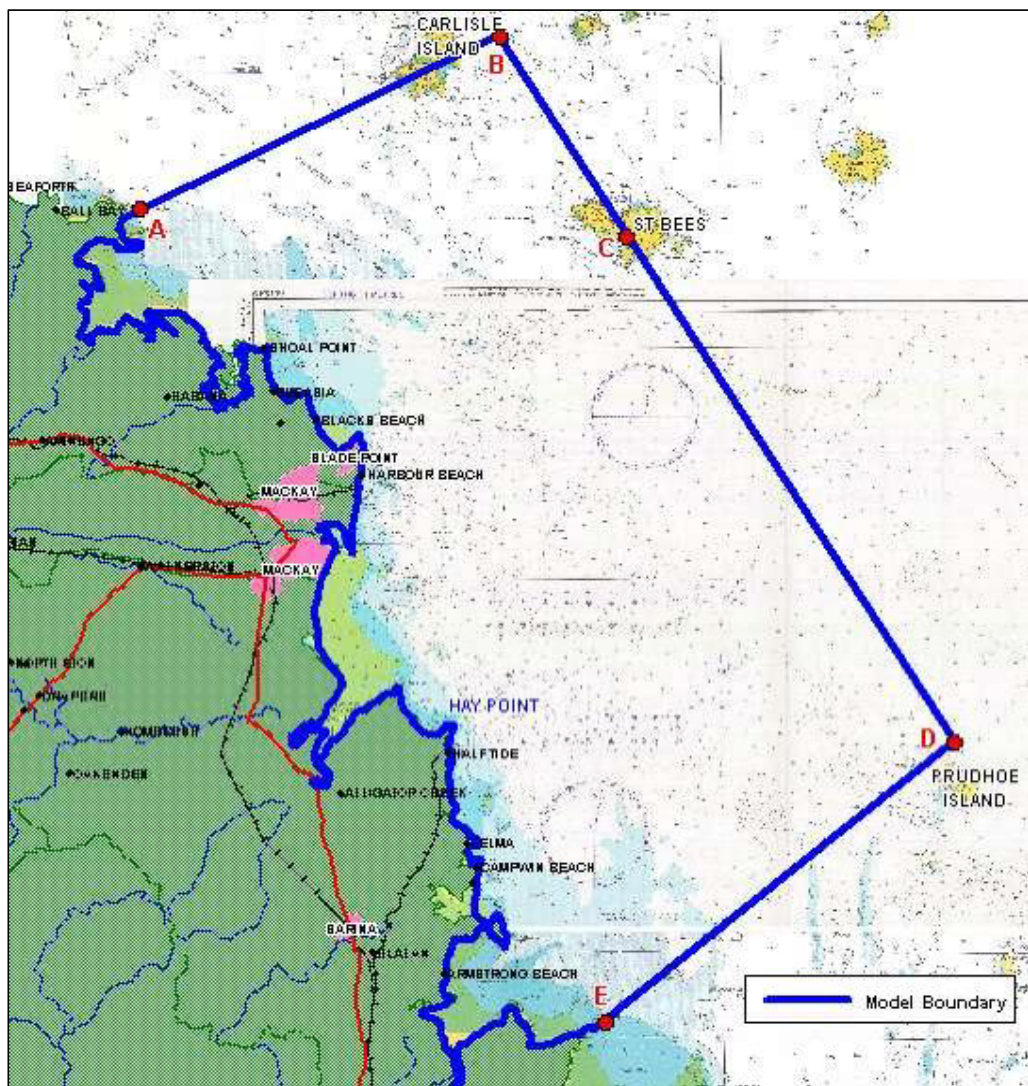


Figure 3-16 Extent of model and time-series boundary

Model Calibration

Tide

The National Tidal Centre (NTC) supplied predicted tide levels for Oom Shoal Mackay (100056). A comparison of the tides predicted by NTC and the tides predicted by the RMA model shows excellent agreement (see Figure 3-17).

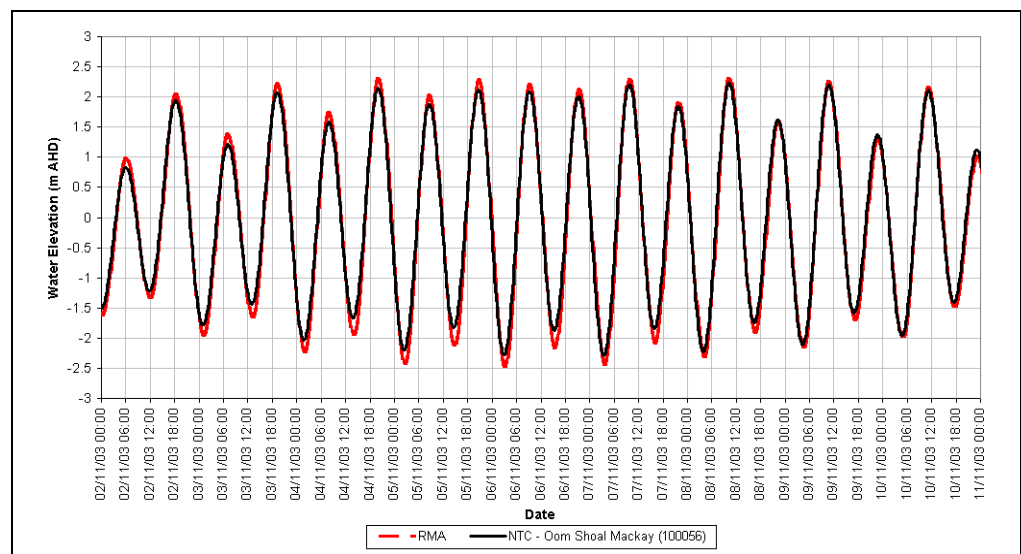


Figure 3-17 Comparison of predicted tides at Oom Shoal Mackay

Tidal Current

Comparison of predicted (modelled) versus measured current velocities and direction were undertaken for both spring and neap tide cycles (see Figure 3-18 and Figure 3-19). The predicted current velocities and direction show good correlation.

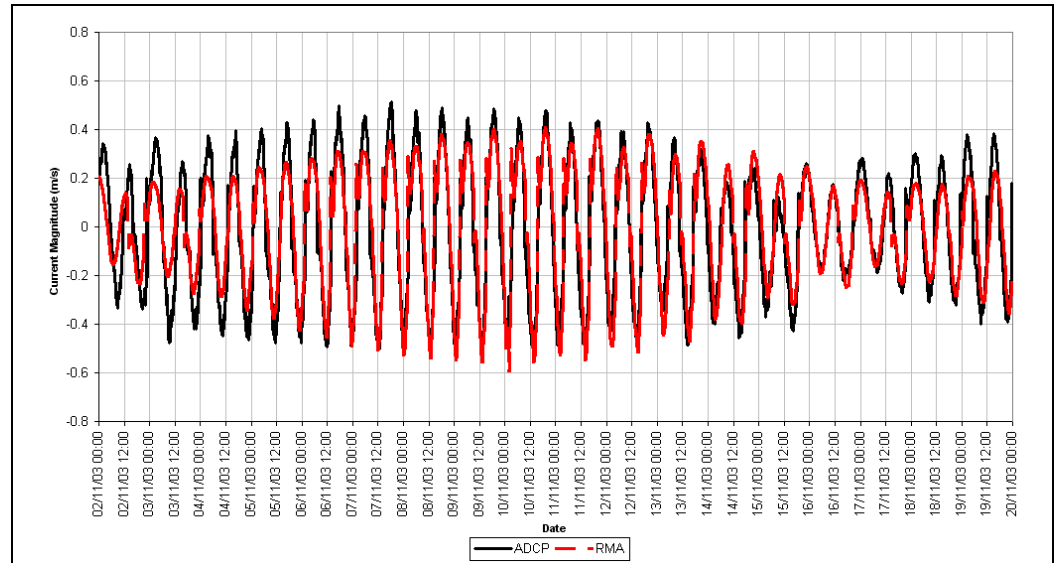


Figure 3-18 Predicted and measured current velocity during spring and neap tides

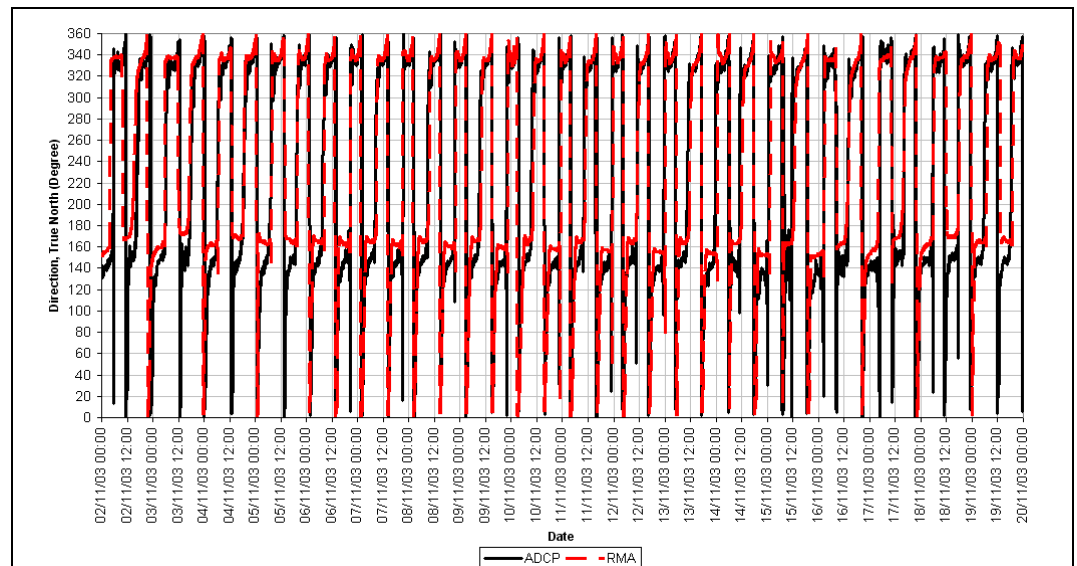


Figure 3-19 Predicted and measured current direction during spring and neap tides

Model Results

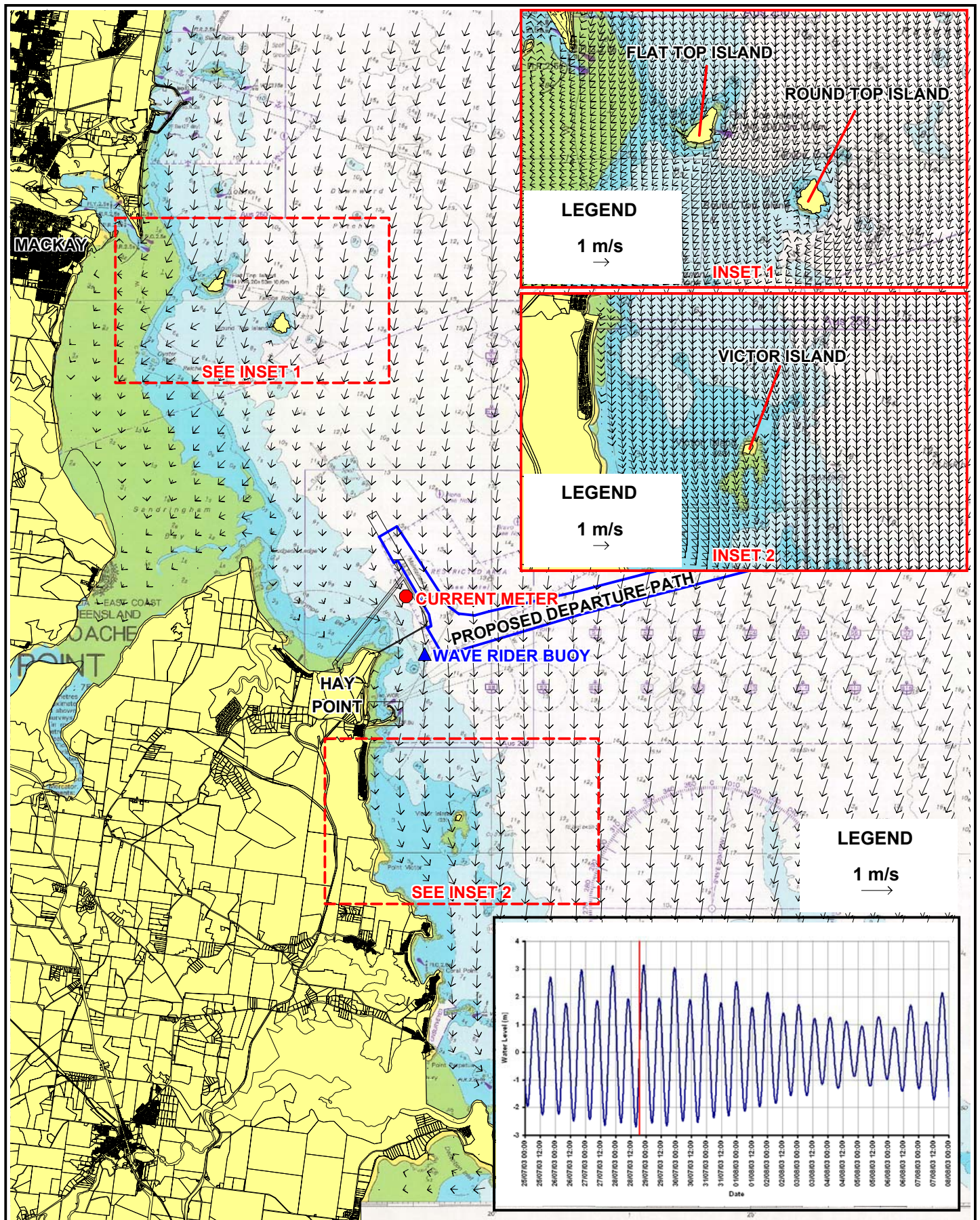
The results from the model were found to be consistent with evidence collected in the field. Animations of tidal currents were also created and viewed as part of the verification process. It should be noted that whilst the following figures indicate the prevailing direction of tidal flows, different directions of flow occur during the change of tide (i.e., from flood to ebb and ebb to flow).

Figure 3-20 shows the general directions of the off-shore current during spring flood tides are south southwest. An eddy is shown to occur in the wake of Round Top Island. Low velocities can be expected around Dalrymple Bay and the tidal flat in Sandringham Bay.

Figure 3-21 shows the general directions of the off-shore current during spring ebb tides are north northeast. Low velocities are shown in the wake of the islands, and around Dalrymple Bay and Sandringham Bay.

Figure 3-22 shows the general direction of the off-shore currents during neap flood tides is south. A small eddy is shown to form in the wake of Round Top Island. Low velocities can be expected around Dalrymple Bay and the tidal flats in Sandringham Bay.

Figure 3-23 shows the general direction of the off-shore current during neap ebb tides is east. Low velocities are shown in the wake of the islands, Dalrymple Bay and around the tidal flats in Sandringham Bay.



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North



0 1500 3000 4500 6000
METRES

Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

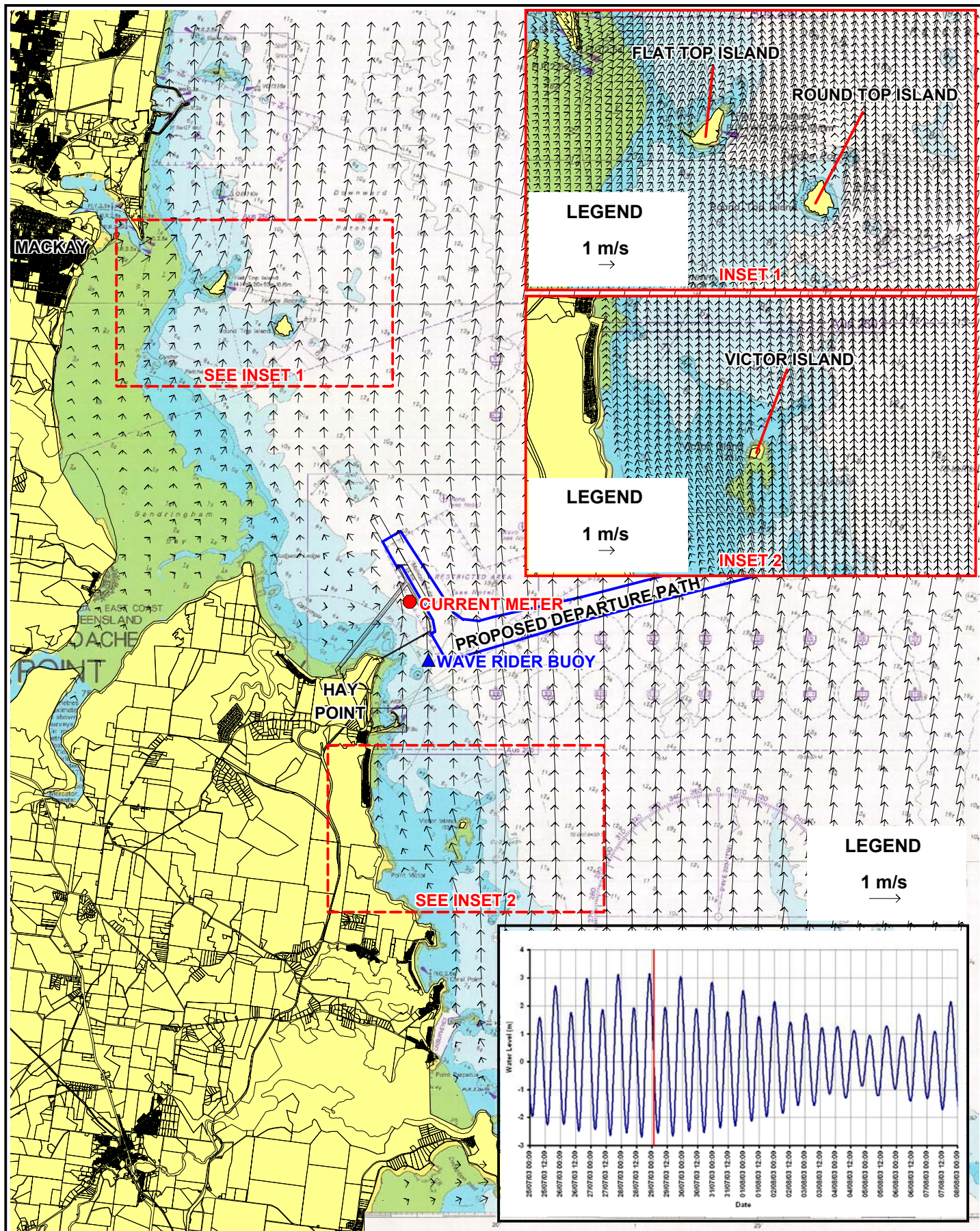
Port of Hay Point Capital Dredging

Current Magnitude and Direction
Spring - Flood Tide
27 July 2003

Figure 3-20



Ports
Corporation
of Queensland



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North



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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

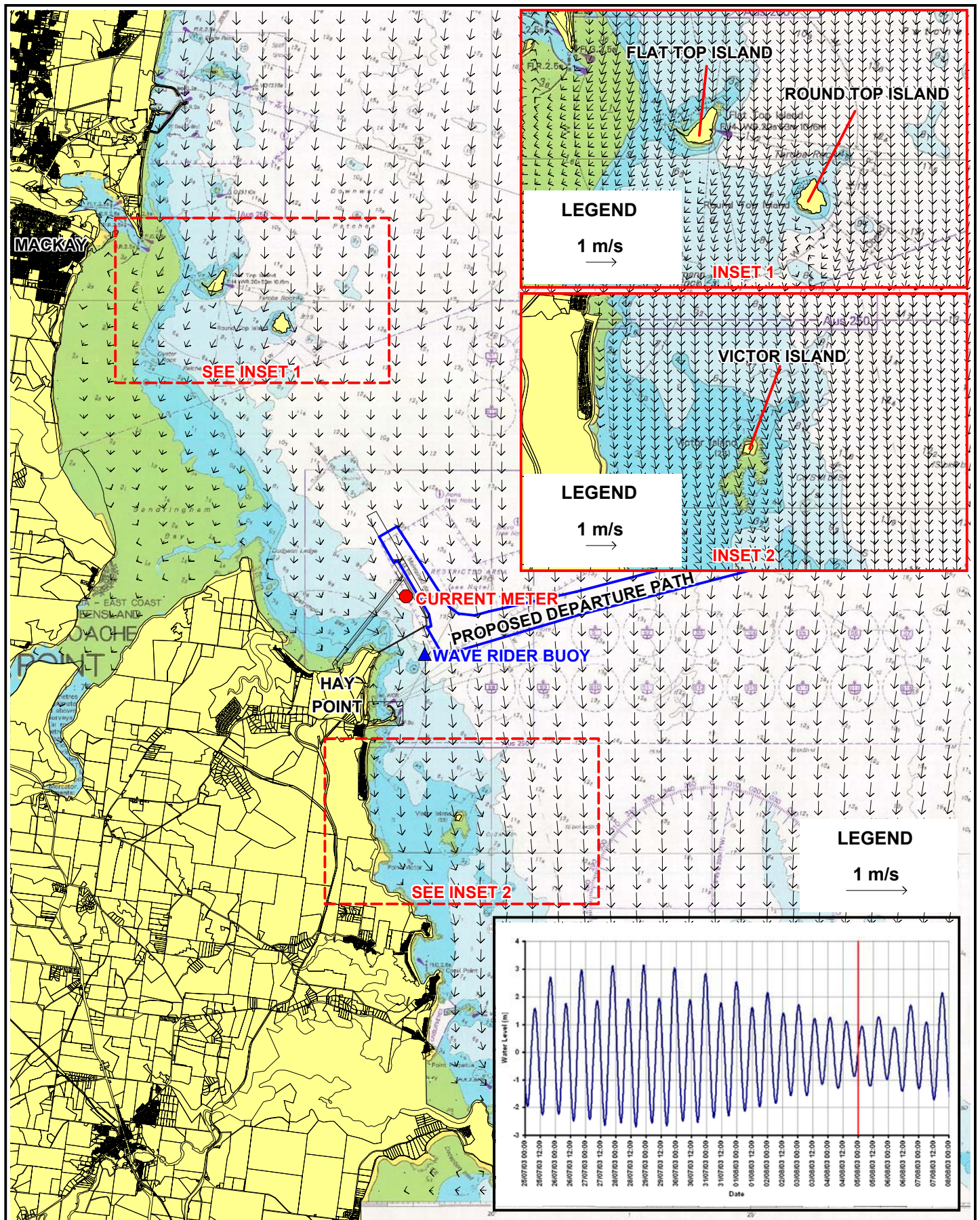
Port of Hay Point Capital Dredging

Current Magnitude and Direction
Spring - Ebb Tide
27 July 2003

Figure 3-21



Ports
Corporation
of Queensland



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North



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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

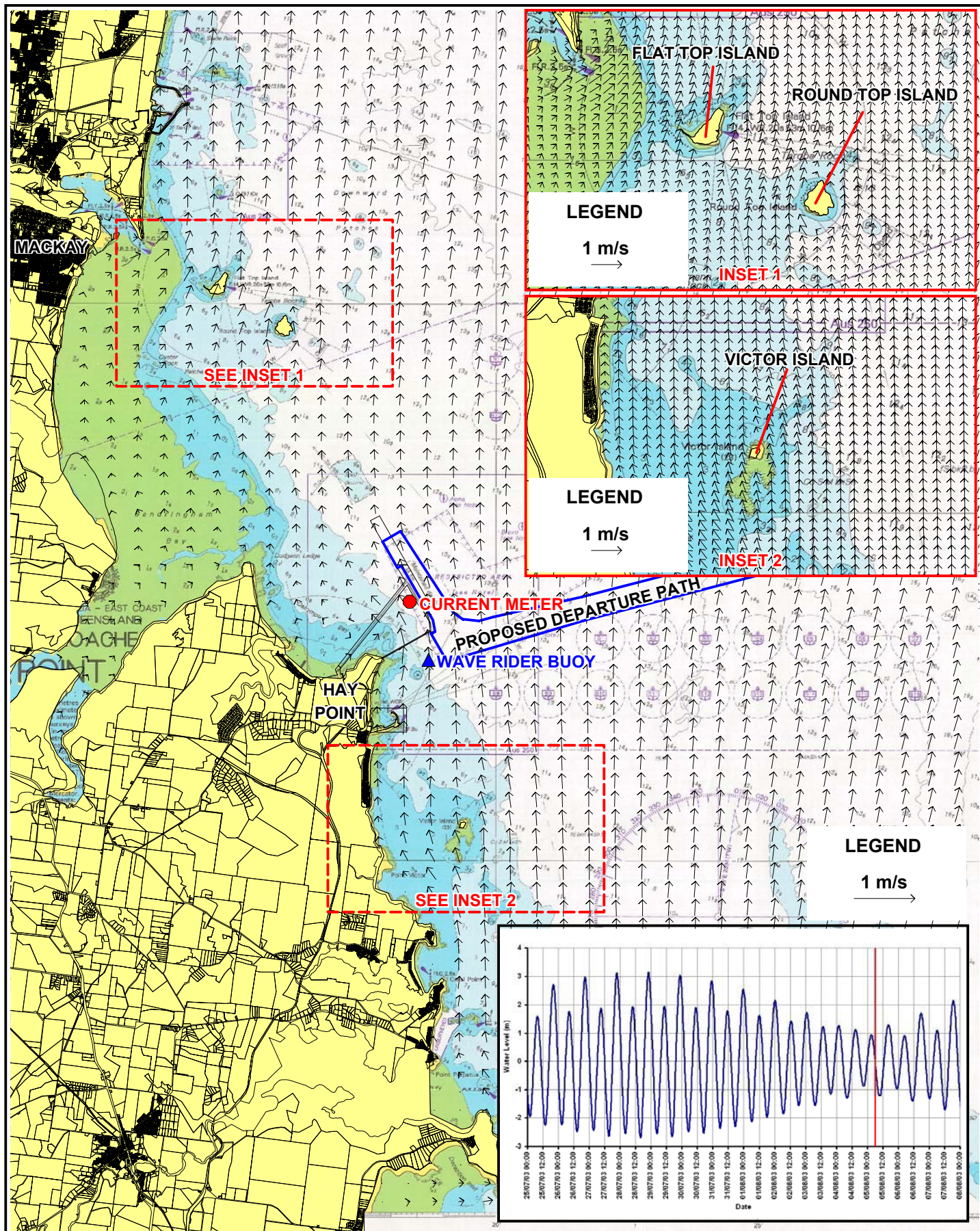
Port of Hay Point Capital Dredging

Current Magnitude and Direction
Neap - Flood Tide
5 August 2003

Figure 3-22



Ports
Corporation
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METRES

Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Current Magnitude and Direction
Neap - Ebb Tide
5 August 2003

Figure 3-23



3.3.4 Wave Modelling

Overview

In addition to tidal currents, wave processes often provide another important physical mechanism for moving sediment through the coastal zone. A wave model (SWAN, developed by Delft University of Technology) was established to:

- ▶ Represent the near-shore wave transformation process (resulting from refraction, shoaling and breaking) for the typical wave climate near Hay Point; and
- ▶ Evaluate the near-bed wave orbital velocity (a key parameter for re-suspension of bed sediment) and compare against the threshold orbital velocity for motion of sediment by waves.

Model Establishment

The wave model grid stretches from north to south along the Queensland coast between approximately $-20^{\circ} 55'$ and $-21^{\circ} 30'$ degrees of latitude and reaches beyond $150^{\circ}00'$ east (see Figure 3-24).

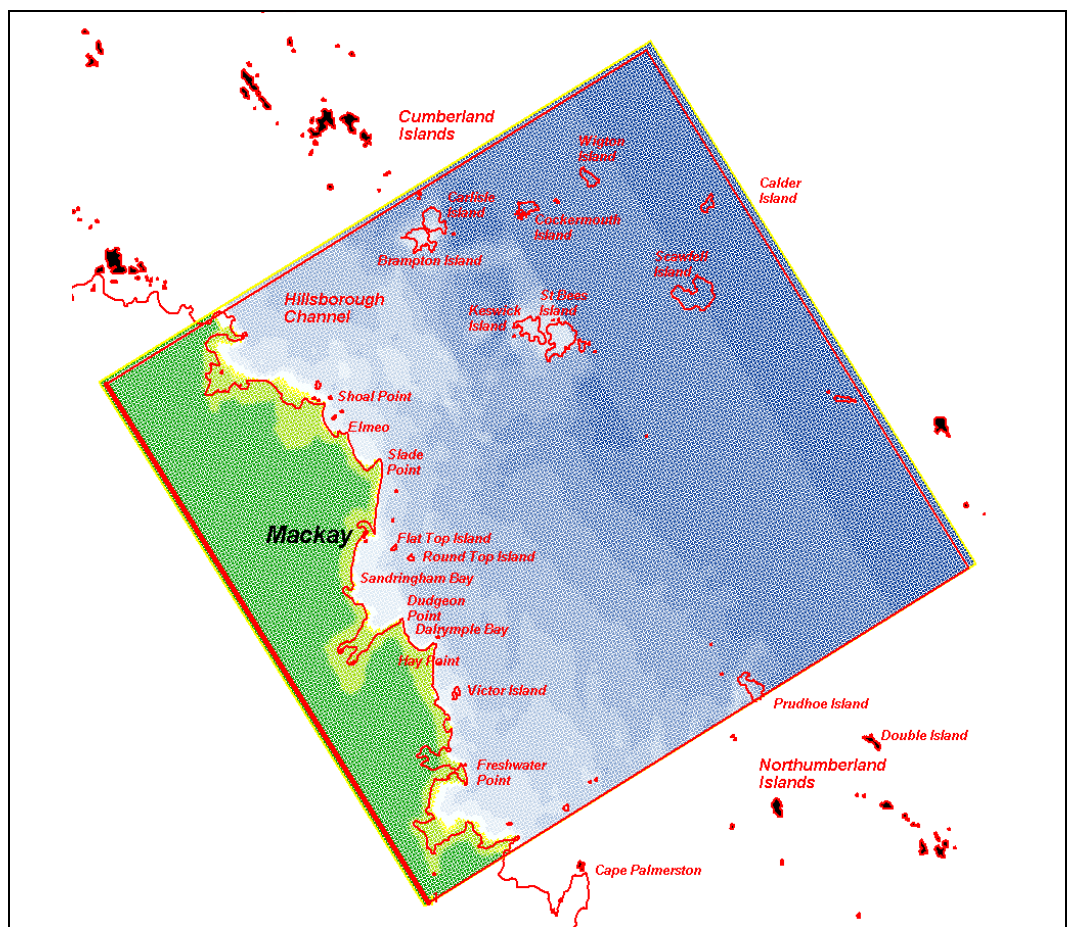


Figure 3-24 Wave model and bathymetry

Model Results

Significant wave height, mean wave period and bottom orbital velocity have been calculated along five near-shore transects oblique to the coast and uniformly distributed to capture the trend and rate of transformation of wave parameters within the study area (numbered dotted lines in Figure 3-26).

The implications of the wave modelling results with respect to sediment transport can be assessed using the relationship between sediment particle size (non-cohesive material) and threshold orbital velocity for motion of sediment by waves presented in Figure 3-25. Under the prevailing low energy wave climate (i.e. typical for the winter period when dredging operations are being undertaken) no sand particles are likely to be re-suspended from the surface of the seabed. However, finer material (silt and clay), if unconsolidated (i.e., loose particles dispersed on the seabed following a placement operation) may still be subject to re-suspension in shallow waters.

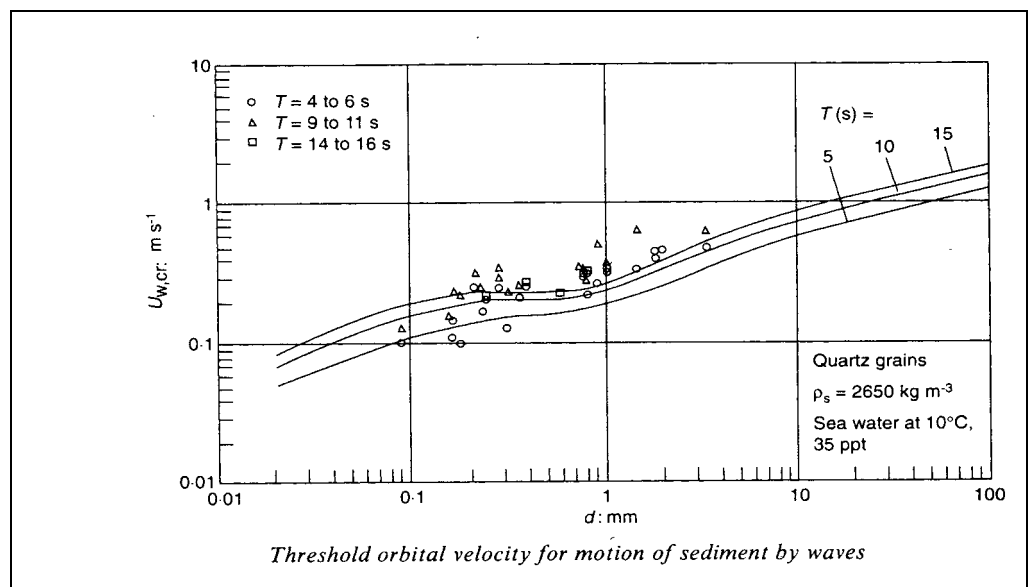
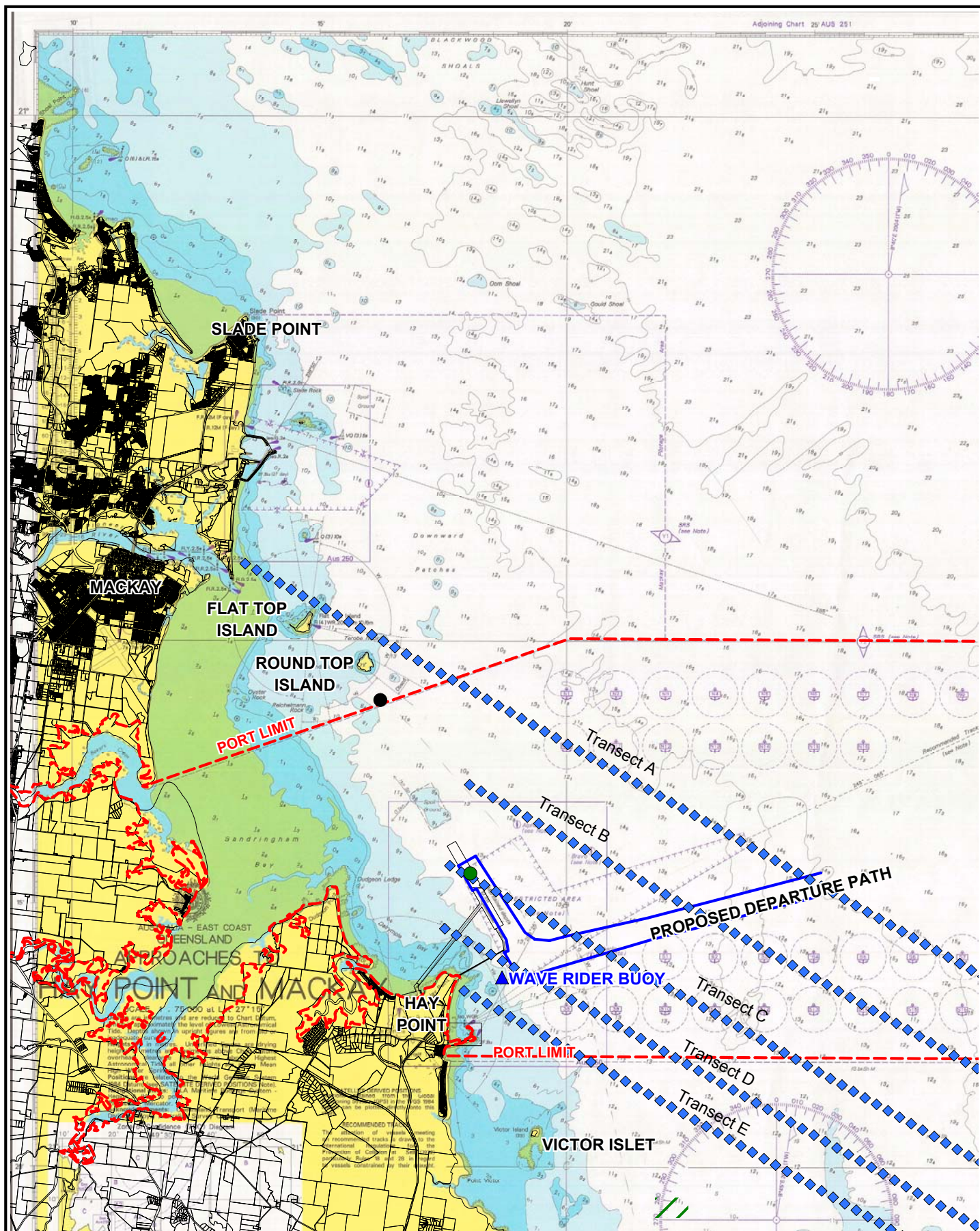


Figure 3-25 Threshold orbital velocity for motion of sediment by waves



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WORK

North



0 2000 4000 6000 8000
METRES

Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Location of monitoring stations for wave modelling

Figure 3-26



3.4 Water Environment

3.4.1 Introduction

This section of the EIS details the existing characteristics and condition of marine waters, including:

- ▶ description of surrounding marine waters in terms of physical, chemical and biological characteristics;
- ▶ identification of potential sources and nature of pollutants to the marine environment; and
- ▶ description of current water quality.

The coastal environment surrounding the Port has experienced minimal water quality impacts due to the relatively undeveloped catchment, a low population and lack of other industries with the potential to release pollutants into the surrounding waterways. The main potential water quality impacts are stormwater discharges from port land and residential communities of Louisa Creek and Salonika Beach. Potential minor impacts are associated with coal dust and coal spillages from port activities, releases of ballast water and oil and fuel spills. However, the environmental efforts of the terminal operators and implementation of the Port of Hay Point Environmental Management Plan (PCQ 2002b) has resulted in the introduction of measures to manage these impacts, leading to a reduced potential for impacts on water quality at the Port.

Physicochemical water quality was measured in both the near-shore environment in the berth basin and adjoining areas and in the vicinity of the proposed spoil ground were surveyed over a 1 week period prior to the capital dredging of the second DBCT berth.

3.4.2 Salinity

Salinity in the waters of Hay Point was investigated in the short-term survey conducted by WBM in 1992. Off-shore salinity concentrations, measured at the spoil ground, were 36.9 ppt at all depths and average near-shore concentrations, measured at the proposed DBCT Berth 2, were 37.0 ppt at all depths (range 36.9 ppt to 37.0 ppt).

The salinity values within Dalrymple Bay are not expected to be influenced by freshwater flows as there are no major rivers near Hay Point, although there are various tidal creeks and streams which have limited input into the region, primarily over the summer monsoonal period between November and April (WBM 1993c).

3.4.3 Turbidity

Short term surveys of turbidity concentrations within the Port of Hay Point have been conducted to obtain background turbidity readings for one or two days prior to the commencement of any maintenance dredging / bed levelling at the Port. These measurements are generally taken at the spoil ground, within the area to be dredged / bed levelled, and in the vicinity of Victor Islet and Round Top Island.

A longer term survey was conducted over a 1 month period during April / May 2005 to determine background levels based on continuous measurements spanning a full tidal cycle.

1992 Pre-dredge Survey

The short-term survey (1 – 2 weeks) conducted by WBM in 1992 included spot measurements of turbidity in two areas; the first area was located at the existing spoil ground where dredged material was to be deposited and the second area was in the near-shore environment in the berth basin and adjoining areas.

Measurements at the spoil ground were taken on 21 and 22 December 1992. The survey recorded mean turbidity concentrations of:

- ▶ 14.2 NTU (range 10.1 – 18.4 NTU) within the 0 – 5 m depth range;
- ▶ 15.6 NTU (range 12.1 – 22.7 NTU) within the 5 – 10 m depth range; and
- ▶ 49.4 NTU (range 20.1 – 86.3 NTU) at depths of greater than 10 m (WBM 1993c).

Data from the berth basin and adjoining areas was also collected over the period 17 – 21 December 1992. Mean turbidity levels were as follows:

- ▶ 25.7 NTU (range 1.9 – 59.2) within the 0 – 5 m depth range;
- ▶ 31.3 NTU (range 3.7 – 84.4) at 5 – 10 m; and
- ▶ 44.2 NTU (range 3.2 – 145.5) at depths greater than 10 m (WBM 1993c).

It was concluded that these findings illustrated an elevated range of turbidities coinciding with moderate to strong on-shore (south-easterly) winds over the period 19 – 23 December 1992 and spring range tides over the period 20 – 25 December 1992 (WBM 2004). Median turbidity was during this period was approximately 15 NTU, with peaks of up to 30 NTU (WBM 2004). Thus, inshore waters within the Hay Point area are naturally turbid during periods of elevated on-shore winds.

Further to this investigation, the Port of Hay Point Environmental Management Plan (EMP) identifies that *‘Depending on the time of the year, the waters can be naturally turbid from silt from local creeks dumping into the Bay. Background turbidity in winter is typically 14 NTUs, with higher levels in summer after storm events’* (PCQ 2002b).

2005 Pre-dredge Survey

In addition to a review of historical turbidity data, GHD undertook field surveys utilising *in situ* logging instruments. Three bed-mounted nephelometers (turbidity loggers) supplied by James Cook University (JCU) were deployed from 14 April to 14 May 2005. These instruments record turbidity via optical backscatter sensors (OBS) providing a continuous dataset for analysis (Figure 3-27).

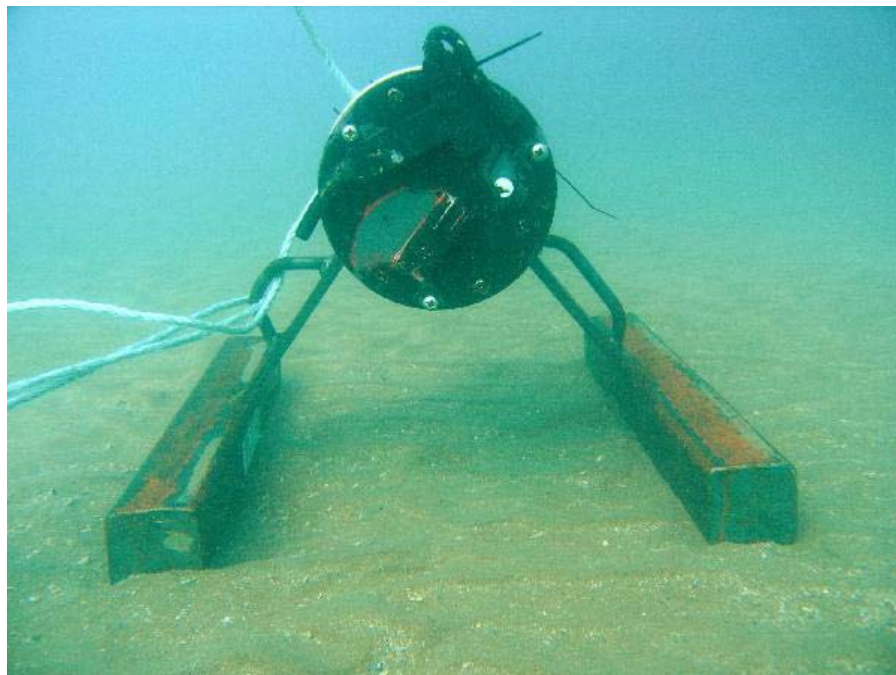


Figure 3-27 Bed mounted nephelometers recording turbidity via optical backscatter sensors (OBS)

Methodology

Turbidity loggers were deployed by GHD at three locations on 14 April 2005; Victor Islet, the proposed Spoil Ground and Round Top Island (Table 3-10). Both Victor Islet and Round Top Island represent fringing coralline habitats. The logger deployed at the proposed spoil ground provides an assessment of turbidity experienced naturally over the deeper water environments at the proposed spoil ground.

In excess of 4,000 turbidity readings were captured from each location. The period of deployment coincided with both elevated and calm sea conditions and neap and spring tides. This means that the key factors which influence ambient turbidity in near-shore environments, namely, tidal condition (flood, ebb, spring and neap) and sea state (wind and wave action), are represented in the data set.

Table 3-10 Location of the bed mounted nephelometers

Location of Logger	Location (Lat/Long – WGS 84)
Round Top Island	S21 10.156 E149 15.970
Victor Islet	S21 19.146 E149 19.451
Disposal Ground	S21 13.283 E149 16.900

Results

Data for all three sites surveyed between 14 April and 14 May 2005 recorded a mean turbidity concentration of 5 NTU and standard deviation of 9.2 NTU (Table 3-11 and Figure 3-28). Turbidity ranged between 0 to ~300 NTU. While variation between monitoring sites appears small, each site recorded significantly different turbidity levels (ANOVA: $F_{(2,13170)} = 29.15$, $p < 0.0001$). *Post hoc* testing indicated that during this study, turbidity at the proposed Spoil Ground was significantly lower than at Round Top Island and turbidity at Round Top Island was significantly lower than at Victor Islet.

Table 3-11 Summary statistics for turbidity (NTU) recorded at Round Top Island, proposed spoil ground and Victor Islet between 14 April – 14 May 2005

Location	Valid N	Mean	Median	Min	Max	20th %	80th %	Std. Dev.
Victor Islet	4391	5.8	3.7	0.00	64.5	1.3	10.0	7.0
Round Top Island	4390	5.0	2.6	0.02	146.2	1.0	7.7	6.2
Spoil Ground	4394	4.3	2.3	0.00	294.2	1.5	4.8	12.8
Total	13173	5.0	2.7	0.00	294.2	1.3	7.1	9.2

Time series

Presentation of the data as a time series indicates that turbidity concentration at all monitoring sites displayed the same pattern over the monitoring period (Figure 3-29). Comparison between observed turbidity and wind speed was also undertaken. Despite strong graphical correlation, statistical analysis did not identify a strong correlation between turbidity and the temporal variable, wind speed ($r=0.41$). The lag between an elevation in wind speed and resulting sediment mobilisation often creates this anomaly (Dr Peter Ridd pers. comm. May 2005).

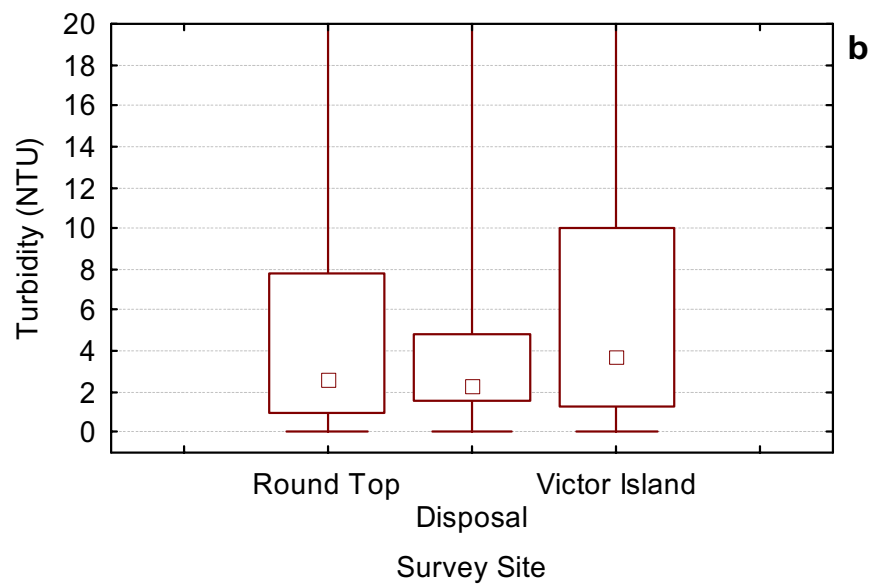
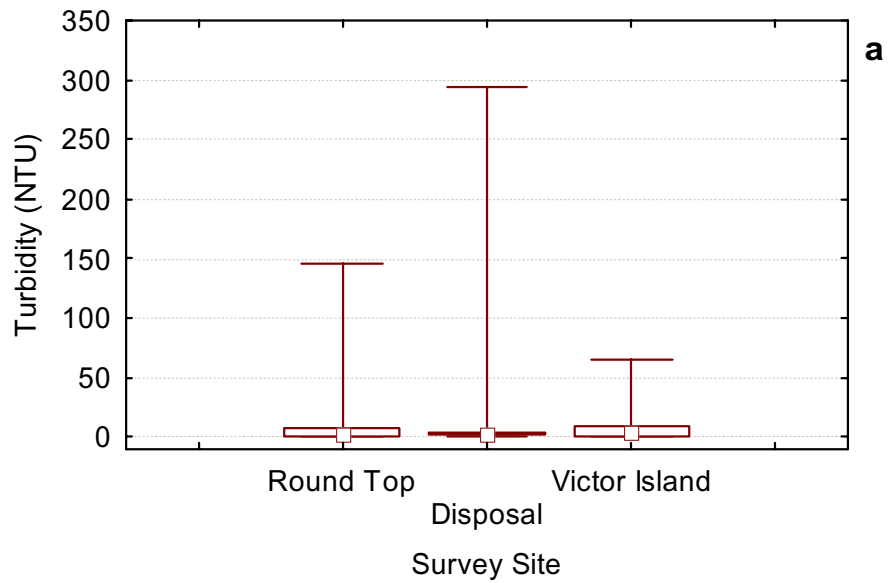


Figure 3-28 Turbidity (NTU) concentration recorded at Round Top Island, Victor Islet and the proposed Spoil Ground. a) Entire data set, b) Detailed data set

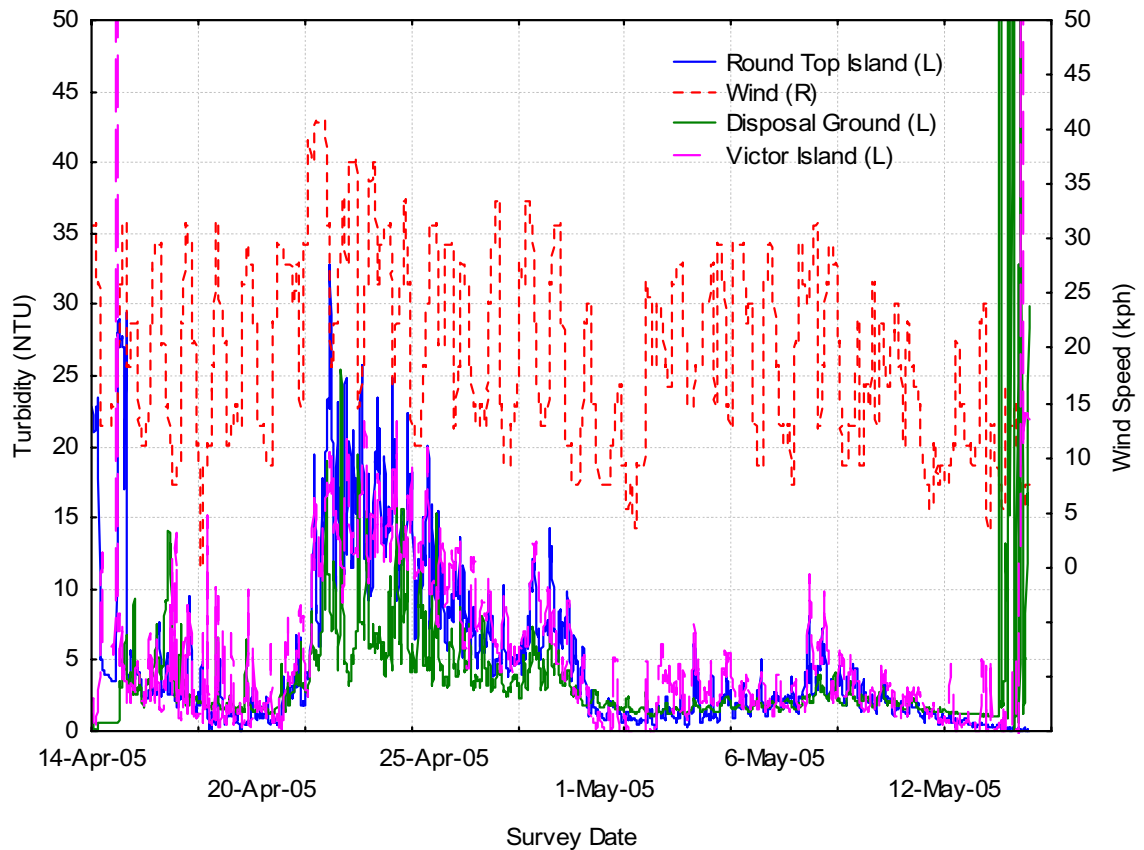


Figure 3-29 Turbidity (NTU) time series data recorded from Round Top Island, Victor Islet and the Spoil Ground and corresponding wind speed

3.4.4 Review of Turbidity and Plume Migration During Previous Dredging

Overview

A review of monitoring undertaken during previous dredging and bed levelling campaigns at the Port was undertaken. The following sections provide an overview of the spatial extent and concentration of turbid plumes generated during four previous dredging and bed levelling campaigns at the Port of Hay Point:

- ▶ 1993 Capital Dredging of Berth 2, DBCT;
- ▶ 2001 Capital Dredging of Berth 3, DBCT;
- ▶ 2003/2004 Bed Levelling of the Apron Area; and
- ▶ 2004 Maintenance Dredging of the Apron Area.

A summary of the predictions of previous modelling and water quality criteria that have been applied to previous dredging campaigns is also provided.

Water Quality Criteria

Approvals granted for previous dredging campaigns have been subject to a number of environmental criteria. These criteria are designed to protect nominated environmentally sensitive areas such as Round Top and Flat Top Islands to the north and Victor Islet to the south from the potential effects of the plume created during dredging and ocean disposal.

For the 2001 dredging campaign, the criteria relating to turbidity was, “The dredging activities shall not cause the dredge plume from the dredge head and the deposition site to be either 1) within 3 km of Round Top Island or Victor Islet, or 2) more than 1 km from the location of the dredging activities towards the coastline of Dalrymple Bay” (WBM 2004). Aerial surveillance and water quality monitoring are typically undertaken to determine whether the dredging and ocean disposal activities are compliant to these criteria. For the 2001 dredging campaign, the background turbidity was very low and the visible dredge plume extended into these zones. Turbidity measurements at the time in these areas were low, often only 1 NTU. Both Commonwealth and State agencies subsequently revised these criteria, because there were no environmental impacts occurring and, with the recognition that the criteria were not appropriate or practicable.

A further criteria from the most recent maintenance dredging of the Apron Area (2004) was that “Dredging activities shall not cause turbidity levels more than 1 km towards the coastline of Dalrymple Bay from the location of dredging works to exceed the best estimate of natural ambient seasonal turbidity by more than 25%” (PCQ 2004). A mean ambient seasonal turbidity level of 12 NTU was nominated (WBM 2004). This gives a trigger value of 15 NTU (25% above ambient natural seasonal turbidity).

Previous Water Quality Modelling

The nature and extent of dredging and placement related plumes is dependent upon the characteristics of the sediment being dredged as well as the type of dredging equipment being used. Results of previous monitoring and modelling have indicated that turbid plumes generated by dredging and spoil disposal are likely to move in a north-northwest to a south-southeast direction in accordance with tidal currents (URS 2000). During periods of sustained strong on-shore winds, the plume may be deflected towards the coastline and/or have a weak component directed to the shore for a short period of time around the change of tide.

Based on modelling undertaken for the 2001 capital dredging campaign at the Port, the initial concentration of such plumes was expected to be less than 100 mg/L, with the concentration decreasing to approximately 5 – 10% of the initial value within about half an hour and return to essentially background conditions within 2 – 3 hours of the generation of the plume (WBM 2001).

1993 Capital Dredging of Berth 2, DBCT

Monitoring undertaken during the 1993 capital dredging of Berth 2 at DBCT involved vertical turbidity profiles within dredge plumes, drogue tracking and aerial surveillance (WBM 1993c). The spoil ground utilised for this dredging campaign was the existing

spoil ground. The following conclusions were presented with respect to turbid plumes during dredging and disposal:

- ▶ Slight elevations in the peak suspended sediment concentrations were observed at the spoil ground (from <4 mg/L to < 6 mg/L) during disposal;
- ▶ Visual observations indicated the presence of a sediment plume at the spoil ground during disposal. The plume became indistinguishable within 1 – 2 hours;
- ▶ Measurements undertaken inshore of the spoil ground in Dalrymple Bay and Sandringham Bay indicated that the mean concentrations of suspended solids during dumping were no greater than ambient concentrations;
- ▶ During flooding tides, the drogue tracks moved to the south and west of the spoil ground; and
- ▶ Suspended solids concentrations decreased to ambient concentrations within 2 – 3 hours of dumping.

2001 Capital Dredging of Berth 3, DBCT

Aerial surveillance undertaken during the dredging associated with the expansion of the Dalrymple Bay Coal Terminal conducted in June 2001, indicated that the turbid plume encompassed the waters to the north of both Round Top and Flat Top Islands on the ebbing tide and extended within the 3 km radius of Victor Islet on the flooding tide. However, turbidity within the bulk of the visible plume was less than 10 NTU. The ambient turbidity during this time was also found to be very low, typically around 0 – 0.2 NTU (WBM 2001).

2003/2004 Bed Levelling of the Apron Area

The spatial extent of the plume was observed during aerial surveillance during ebbing tides on 21, 22 and 23 December 2003 (GHD 2004a) (see Figure 3-31). A plume was generated in the vicinity of the bed leveller and the ebbing tide also resulted in the northward migration of the plume.

The visible spatial extent of the plume generated in the immediate vicinity of the bed leveller along the entrance channel was small. Although this plume migrated in the direction of key sensitive habitats, it was not visible further than 4 km north of the coal terminal. The plume did not travel to within 3 km of Round Top Island, located 9 km north of DBCT. It should be noted that turbid plumes generated through bed levelling activities are generally expected to be less significant than those occurring during dredging (A Geelhoed pers comm. 2005). The method of bed levelling confines disturbance to the seabed and does not include the generation of 'dredge overflow' associated with dredging.



Figure 3-30 Aerial surveillance of plume, June 2001



a. Plume extends north however is less than half way to Round Top Island.



b. The bed leveller is observed along the DBCT entrance channel. The plume is visible 4 km from the berths.

Figure 3-31 Aerial surveillance of plume, December 2004

Water quality monitoring was undertaken during the ebbing tide on one day prior to bed levelling, seven days during bed levelling and 2 days after bed levelling. Median turbidity concentrations were compared to the ANZECC (2000) guideline range for turbidity in estuarine and marine waters in tropical Australia (1 – 20 NTU). Results were as follows:

- ▶ Median turbidity concentrations at all monitoring stations were below 20 NTU for all monitoring events; and
- ▶ Maximum turbidity concentrations exceeded 20 NTU at the bottom of the water column at a few monitoring stations on 5 of the 7 days of monitoring.

Median turbidity concentrations recorded during bed levelling were also compared to trigger values that were set at 25% above the background turbidity concentration recorded adjacent to Round Top Island and Victor Islet prior to bed levelling. Turbidity monitoring indicated that elevations in turbidity above the trigger values were not recorded in the vicinity of the sensitive habitats. Slight elevations in turbidity were recorded at the bottom of the water column during some monitoring events. It is likely that these elevations were related to natural elevations in bottom turbidity caused by tidal currents and elevated sea states experienced during the monitoring program.

2004 Maintenance Dredging of the Apron Area

Visual aerial surveillance and water quality monitoring were conducted over the first three days of dredging (28, 29, 30 September 2004) (SKM 2004). Visible sediment plumes were not observed within a 3 km radius of the environmentally sensitive areas of Round Top Island and Flat Top Island on 28 and 30 September. On 29 September the plume was observed to encroach approximately 1 km into the nominal 3 km buffer zone around Round Top and Flat Top Islands.

Mean and median turbidity levels did not exceed the trigger value of 15 NTU at any stage of the monitoring program (SKM 2004). This is despite the plumes being highly visible during aerial surveillance (see Figure 3-32). Higher levels of turbidity were observed at sampling points in the immediate vicinity of the dredging area, however the turbidity levels were generally found to be in the range of 1 – 4 NTU.

An additional round of aerial surveillance and water quality monitoring of the plume generated by dredging activities was undertaken on 14 October 2004 during the ebbing tide (GHD 2004b). A plume was generated in the vicinity of the dredge and the ebbing tide resulted in the northward migration of the plume. Figure 3-32 shows the plume movement over time. Although the plume migrated in the direction of key sensitive habitats, such as Round Top and Flat Top Islands, it did not appear to travel within 3 km of these islands.



a. Photo 1: 3:30 pm – The dredger was operating along the DBCT



b. Photo 2: 3:31 pm – The plume from the dredger is visible out the front of HPCT and DBCT



c. Photo 3: 3:42 pm – The dredger is observed along the DBCT entrance channel. The plume is visible and is migrating north.



d. Photo 4: 3:43 pm – The dredger is observed along the DBCT entrance channel. The plume is visible directly around the dredger.

Figure 3-32 Aerial surveillance of plume migration, October 2004

Water quality monitoring was undertaken in conjunction with aerial surveillance, with turbidity compared to the trigger value of 15 NTU (GHD 2004b). The following observations were made:

- ▶ Mean turbidity concentrations were below 15 NTU for all monitoring stations for the duration of monitoring, with values ranging from 0 – 4 NTU; and
- ▶ The highest turbidity concentrations, while well below 15 NTU, were measured at monitoring stations located between the apron area and the spoil ground. This is directly related to the visible plume from the dredging works.

As in 2001, while sediment plumes were visible from the air, turbidity values within the plume remained low and was well below the trigger value of 25% above the best seasonal estimate of natural turbidity (i.e. 15 NTU).

Summary

For the four dredging / bed levelling campaigns, a turbid plume has been observed to migrate north from the apron area towards Round Top and Flat Top Islands on the ebbing tide. The high visibility of the plume is likely to be related to the naturally low turbidity and clear waters, however, concentrations have remained below the specified trigger values. The visible plume migrated to within the 3 km buffer zone around Round Top and Flat Top Islands during maintenance dredging of the apron area in September 2004 and during the 2001 capital dredging, however turbidity did not exceed the nominal trigger value of 15 NTU. The plume has not been observed in the vicinity of Victor Islet, however, monitoring is generally undertaken on the ebbing tide as the islands to the north are closer to the dredging and disposal areas and therefore more at risk of impact.

The use of the nominal buffer around the islands was not a practicable control mechanism, with the dredge plume regularly extending into this area but at low levels of turbidity. The use of the buffer area therefore did not add to the management of potential environmental impacts. Considering that potentially sensitive areas extend only 190-675 m from the island the use of such a large buffer zone would seem inappropriate for managing environmental impacts for this Project.

3.4.5 pH

The pH of the water around the spoil ground and berth basin were also analysed in the WBM water quality survey in 1992. pH was 8.3 throughout the Port, which is consistent with the expected pH of marine waters (WBM 1993c). Localised, short-term changes in pH may occur when freshwater flood plumes discharge from the surrounding rivers.

3.4.6 Dissolved Oxygen

Dissolved Oxygen (DO) concentrations within the Port were investigated during the WBM 1992 study. This study found average DO concentrations of 96% saturation (range 95 – 101%) at the berth basin and surrounds and the spoil ground (WBM 1993c). Dissolved oxygen concentrations in oceanic waters are influenced by biological activity, which both consumes (respiration) and produces (photosynthesis) oxygen. The solubility of oxygen in water changes with temperature and salinity. Therefore, substantial changes in temperature, salinity or biological activity have the potential to result in changes in dissolved oxygen concentrations.

3.5 Sediment Quality

3.5.1 Introduction

The section of the EIS describes the sediment characteristics based on the results of sediment sampling and analysis conducted as per a Sampling and Analysis Plan approved by the DEH under the Sea Dumping Act. Suitability of the material for unconfined ocean disposal has been determined using the framework within the NODGDM.

Sediments act as a sink for contaminants in the aquatic environment (Whittemore 2002). In cases where current and historical anthropogenic activities have the potential to introduce contaminants into the water column, these may accumulate in the seabed sediments. The disturbance of these sediments by dredging and ocean disposal has the potential to remobilise contaminants into the water column and to introduce contaminants into the ocean disposal ground. Also, the chemical and physical similarity of dredge spoil to the sediments in the receiving habitat will influence the impact of spoil disposal on benthic macro-invertebrates at the spoil ground.

Sampling and analysis of sediments has been undertaken at the Port of Hay Point on a number of occasions for both capital and maintenance dredging campaigns. The following sections discuss the results of historical and current sediment sampling and analysis and the potential source of contaminants of concern.

3.5.2 Contaminants of Concern

The main land uses in the Hay Point region are:

- ▶ Conservation Areas and Environmental Buffers.
- ▶ Coastal Communities (Louisa Creek, Half Tide, Salonika).
- ▶ Port activities at the Port of Hay Point (coal stockpiles, buildings, conveyors, off-shore berths and ship loading facilities).
- ▶ Rural residential areas and rural land.
- ▶ Commercial services and community facilities.
- ▶ Tourist activities.
- ▶ Indigenous practices.

The main land use activities with the greatest potential to introduce contaminants into the local marine environment are agricultural and port activities, including coal stockpiles and ship loading. There are no major urban or industrial pollutant sources in the area that are likely to result in the introduction of significant quantities of contaminants into the environment. The location of the coal terminals more than 3 km off-shore in an open water environment means that this area does not accumulate silty, organic rich sediments in which contaminants generally accumulate. Table 3-12 provides a summary of the potential contaminants of concern and their known or likely sources.

Table 3-12 Potential contaminants of concern and sources

Potential Contaminants	Known or Likely Sources	Notes
Organotins ▶ Monobutyltin (MBT) ▶ Dibutyltin (DBT) ▶ Tributyltin (TBT)	▶ Antifouling paints.	▶ Can occur as paint flakes in sediments. ▶ May dissolve into the water column and attach to sediment particles, which later settle out. ▶ Likely to be present in shipping berths and potentially present in the southern anchorage area.
▶ Metals ▶ Arsenic ▶ Mercury ▶ Cadmium ▶ Chromium ▶ Copper ▶ Lead ▶ Nickel ▶ Manganese ▶ Zinc ▶ Silver ▶ Antimony	▶ Antifouling paints. ▶ Stormwater and catchment runoff. ▶ Trace levels present in coal particles. ▶ Pesticides and fertilisers. ▶ Marine fabrication metals.	▶ Some levels of Cu, Cr and Zn likely from antifouling paints and corrosion of marine metals. ▶ Coal particles are considered biologically inert and coal generally contains concentrations of metals below ISQG (Hydrobiology 2004). ▶ Hg low risk, only from historic usage. ▶ Low levels of some metals likely to be present within and adjacent to the berths. ▶ Catchment, urban and industry sources are not significant.
Hydrocarbons ▶ TPH ▶ PAHs ▶ BTEX ▶ Total Hydrocarbons	▶ Fuel oils. ▶ Lubricants. ▶ Ballast water.	▶ Unlikely to be present in elevated concentrations due to an absence of fuelling facilities at the berths and management measures in place for the discharge of ballast water.
Pesticides ▶ Organochlorine ▶ Organophosphorus	▶ Runoff from agricultural areas	▶ Some catchment inputs, but unlikely to be found in off-shore areas.
Nutrients ▶ Phosphorus ▶ Nitrogen	▶ Fertiliser runoff from agricultural areas. ▶ Nutrients attached to sediment eroded from catchment. ▶ Natural presence in marine sediments.	▶ Some catchment inputs, but of low natural concentrations in off-shore areas.
Coal Particles	▶ Coal spillage during ship loading and inputs from dust and stormwater runoff.	▶ Previous studies have shown coal to be biologically inert and contains only trace concentrations of metals Hydrobiology (2004).

Source: Adapted from URS 2002

3.5.3 Previous Sampling

Numerous studies undertaken at the Port of Hay Point have included sediment quality investigations of relevance to the proposed capital dredging. These include:

- ▶ Sediment Sampling and Analysis to Support a Sea Dumping Permit Application – Port of Hay Point (Terra Search 1995).
- ▶ Dalrymple Bay Coal Terminal Expansion Stages 6 & 7 Draft Environmental Impact Statement (URS 2000).
- ▶ Port of Hay Point Seafloor Survey for Stage 6 and 7 Expansions of Dalrymple Bay Coal Terminal (Le Provost Dames & Moore 2000).
- ▶ Port of Hay Point (Departure Apron Area) – Maintenance Dredging SAP 2004 (Hydrobiology 2004).
- ▶ Maintenance Dredging SAP Implementation (May 2004) for the Departure Apron Area, Port of Hay Point (Hydrobiology 2004).

The following sections provide a summary of available information regarding the likely physical and chemical sediment quality in the proposed Apron Area and Departure Path.

Chemical Characteristics

Testing of sediment contamination to assess suitability of sediments for ocean disposal under the NODGDM (EA 2002) has been undertaken at the Port of Hay Point on a number of occasions. Of relevance to the proposed capital dredging are the 2000 and 2004 sampling programs conducted prior to previous dredging of the berths and departure apron areas.

A total of 51 samples were collected as part of the sampling undertaken prior to the Stage 6 & 7 expansion of the Port (URS 2000). All contaminants of concern were below the Interim Sediment Quality Guidelines (ISQG) low screening values.

Surface grab samples were taken at 26 sites undertaken prior to the 2004 maintenance dredging of the existing Departure Apron Area (Hydrobiology 2004). The existing Departure Apron Area forms part of the Apron Area for the proposed capital dredging program. Results were as follows:

- ▶ Five samples exceeded the ISQG low screening level for TBT after normalisation to 1% total organic carbon.
- ▶ Two samples slightly exceeded the ISQG-low screening level for arsenic.
- ▶ The 95% upper confidence limits (UCL) for arsenic and TBT were below the ISQG-low screening levels.
- ▶ No other contaminants of concern exceeded the ISQG-low screening levels in the 2004 sampling program.

Sediment Grain Size Analysis

Testing undertaken as part of the Stage 6 & 7 Expansion EIS (URS 2000) indicated that the sediments in the area to be dredged consist of silts and fine sands of variable thickness (1 – 30 cm) underlain by stiff clays. Sampling was conducted in the current Departure Apron Area, which also overlaps part of the proposed Departure Path areas to be sampled.

A review of grain size analysis undertaken for the 2004 Departure Apron Area maintenance dredging campaign indicates that surface sediments within the current Departure Apron Area were predominantly sandy – gravels. The particle size distribution for each size class in all samples was as follows:

- ▶ Clay (<0.002 mm): 3 – 21%.
- ▶ Silt (0.06 – 0.002 mm): 2 – 17%.
- ▶ Sand (2 – 0.06 mm): 57 – 86%.
- ▶ Gravel (>2 mm): 3 – 55%.

3.5.4 Sampling and Analysis for Proposed Capital Dredging

Guideline Requirements

Sea dumping regulations aim to protect the marine environment from pollution by contaminated dredged spoil. Physical and chemical analysis of sediment to be dredged can identify whether the dredged material is suitable for ocean disposal or requires special management. In Australia, ocean disposal of dredged material outside inland State and Territory waters is regulated by the DEH under the Sea Dumping Act. Where disposal of dredge spoil will occur within the GBRMP, the GBRMPA are the determining authority for permit applications. To gain a permit for ocean disposal of dredged material under the Sea Dumping Act, the NODGDM require that sediment be analysed for potential contaminants. The results of sediment sampling are assessed against the Interim Sediment Quality Guidelines (ISQG), which set two trigger levels: low (screening) and high (maximum).

The NODGDM require the development of a Sampling and Analysis Plan (SAP) detailing the methods and protocols to be adopted when assessing the contamination status of material to be dredged. The Port of Hay Point Capital Dredging SAP was prepared in accordance with the requirements of the NODGDM and approved by DEH (see Appendix G). The SAP detailed the proposed extent of sampling, the specific analyses to be undertaken and sampling and analytical quality control procedures.

Summary of Sediment Sampling Program

Sediment sampling and analysis for this Project was conducted in accordance with the approved SAP in October / November 2004. Sampling of the Apron Area was conducted between 29 October and 5 November 2004 and sampling of the Departure Path occurred between 12 and 22 November 2004. A separate report detailing the results of this program was prepared and is presented in full in Appendix G. The following sections summarise the results of the sampling program.

Methods

Samples were collected from 56 locations within the area to be dredged (see Figure 3-33). Sites 1 to 28 were located in the proposed Apron Area in front of the berths, and sites 29 to 56 were located in the proposed Departure Path Investigation Area. It should be noted that the areas indicated on Figure 3-33 (A1 – A3 and DP1 – DP3) were used for the purposes of assessing sediment particle size characteristics throughout the area to be dredged. A reduced number of sampling locations were required in accordance with the DEH approved SAP, included in Appendix G. The reduction in sample locations was based on the material being previously undisturbed seabed.

Sediment cores were collected using a vacuum vibrocorer, operated by a professional geotechnical crew. Sediment cores were retrieved using stainless steel drill rods (60 mm internal diameter) and placed into a PVC core catcher where they were logged and photographed before being split and sub-sampled. Cores were collected to 2.0 m with sub-samples taken from 0 – 0.5 m, 0.5 – 1.0 m and 1.0 – 2.0 m.

Samples were dispatched to Advanced Analytical (AA), Sydney for analysis. All samples were analysed for a basic suite of contaminants including particle size distribution, moisture content, total organic carbon, heavy metals (As, Cr, Cd, Cu, Fe, Pb, Mn, Ni and Zn) and organotins (TBT, DBT and MBT). In accordance with the SAP, 20% of samples were randomly chosen and also analysed for trace metals (Ag, Hg and Sb), polyaromatic hydrocarbons (PAHs), organochlorine and organophosphorus pesticides (OC/OP), total petroleum hydrocarbons, BTEX and nutrients.

To provide an indication of the physical characteristics of the sediments at the proposed spoil grounds, a van Veen grab was employed to collect surface sediment samples at 30 locations (Figure 3-34). Ten sampling locations were placed at 500 m intervals along each of three transects. The transects were approximately 500 m apart and 5 km long running perpendicular to the coastline across the current and proposed spoil grounds.

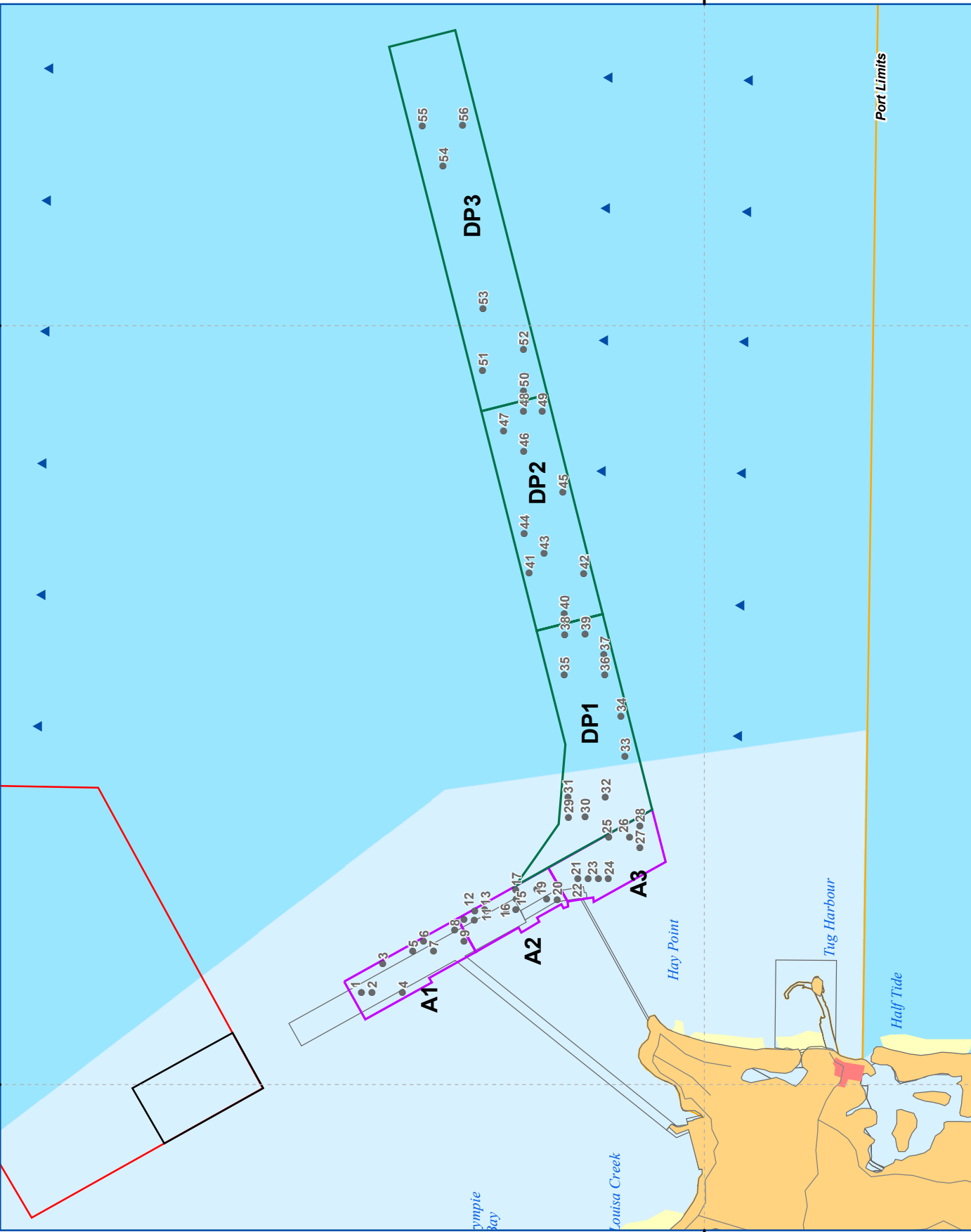
Of the 30 samples collected, only 9 were characterised below 0.075 µm due to the very low percentage of fine material (<10%). For the remaining samples, the silt and clay fractions were not characterised separately, with the smallest fraction being <0.075 µm.

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Port of Hay Point
Capital Dredging

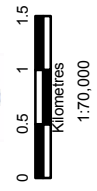
Sampling Locations
in the Apron and
Departure Path
Investigation Area

Figure 3-33

Legend

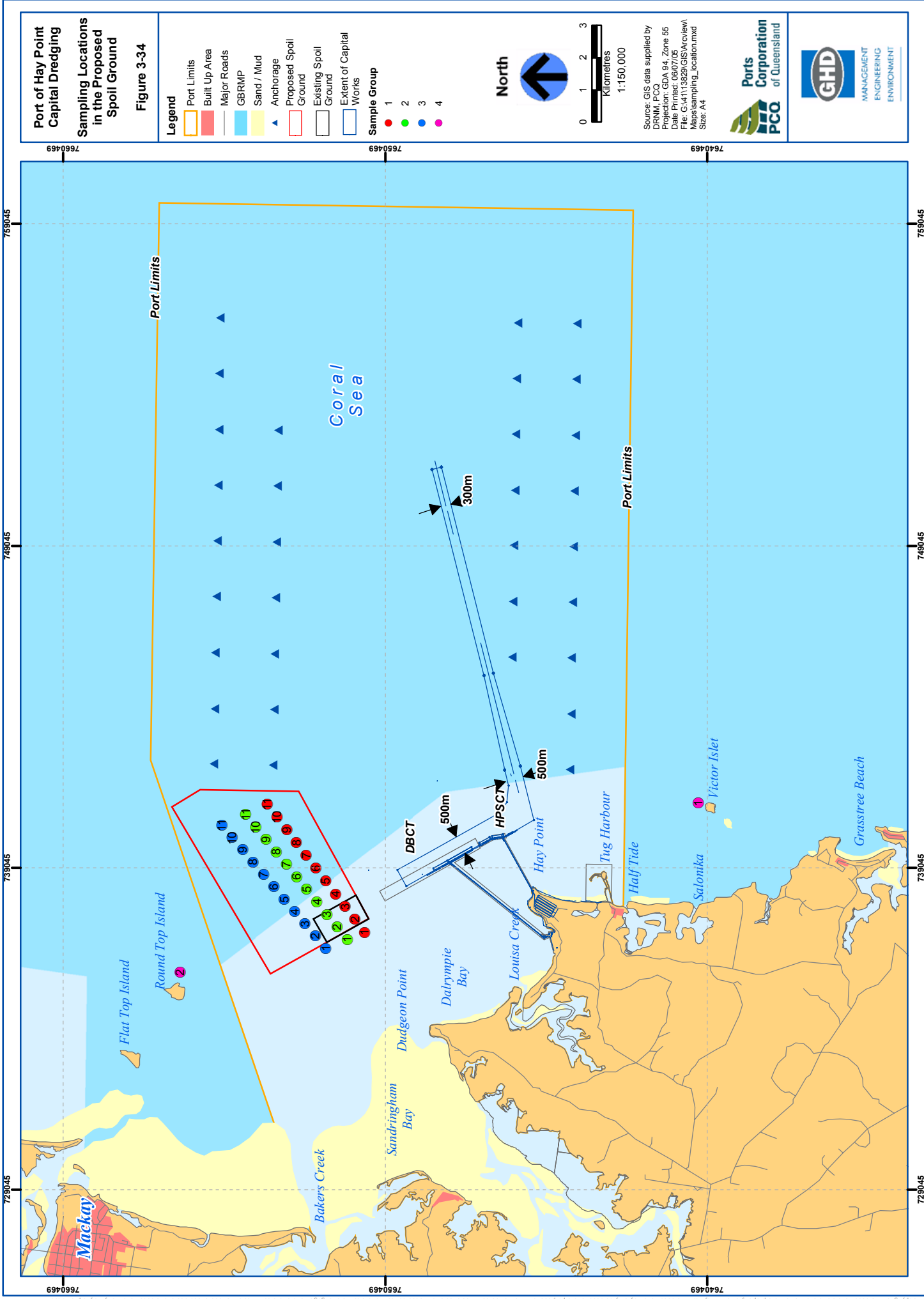
- Port Limits
- Built Up Area
- Major Roads
- GBRMP
- Sand / Mud
- Anchorage
- Sample Locations
- Proposed Spoil Ground
- Existing Spoil Ground
- Extent of Capital Works
- Investigation Area
- Apron
- Departure Path

North



Source: GIS data supplied by
DRNM, PCQ
Projection: GDA 94, Zone 55
Date Printed: 06/07/05
File: G:\1113829\GIS\Arcview\MapInvestigation_area.mxd
Size: A4





Particle Size Characteristics

Particle size distribution (PSD) results were summarised into four size classes, with the particle diameters for each class determined from Section 3.6.1 of AS 1289 – Method for Testing of Soil for Engineering Purposes:

- ▶ Gravel: 2.36 mm – > 63 mm
- ▶ Sand: 0.075 – 2.36 mm
- ▶ Silt: 0.075 – 0.001 mm
- ▶ Clay: < 0.001 mm

Material to be Dredged

Summary statistics of the percentage of the material to be dredged that falls into each of these size classes are presented in Table 3-13 for the three sections within the Apron Area and Departure Path Investigation Area with the average percentages displayed graphically in Figure 3-35.

There was no significant difference in the percentage of gravel, sand, silt and clay between the 0 – 0.5 m, 0.5 – 1.0 m and 1.0 – 2.0 m depth layers. However, the particle size characteristics of the material to be dredged varied spatially, with the sediments to be dredged in the Apron Area being significantly different to those in the Departure Path ($F_{(3, 142)} = 37.99$, $p < 0.0000$). *Post hoc* analysis (Tukey's HSD) indicated that the percentage of sand in the Departure Path was significantly higher than in the Apron Area ($p < 0.000$), and consequently, the percentages of gravel, silt and clay in the Departure Path were significantly lower than in the Apron Area ($p < 0.0000$, $p < 0.0000$ and $p < 0.001$ respectively).

Within the Departure Path, there were slight significant differences in the particle size distribution between the landward (DP1) and seaward (DP3) ends ($F_{(6, 138)} = 3.224$, $p < 0.005$; Figure 3-36). *Post hoc* tests indicated that the percentage of sand was slightly higher at the seaward end compared to the landward end of the Departure Path ($p < 0.04$), but there was no difference in the percentage of sand between sections DP1 and DP2.

There were slight but significant differences in particle size distribution between the northern and southern sections of the Apron Area ($F_{(6, 138)} = 2.247$, $p < 0.04$; Figure 3-37). *Post hoc* tests indicated that the percentage of clay was significantly higher in the northern section of the Apron Area (A1) ($p < 0.04$).

Proposed Spoil Ground

Analyses of the surface sediment within the current and proposed spoil grounds identified that the sea floor in this area is dominated by sand, with the mean sand fraction being approximately 70% in all three transects. Gravel constituted an average of approximately 26% and silt/clay an average of only 4%.

There is substantial variation in the size fractions along each transect, particularly in the gravel and sand fractions (Figure 3-38, Figure 3-39 and Figure 3-40). This indicates that despite the overall dominance of the sand fraction, the seafloor is fairly



variable within the proposed spoil ground. There is no significant difference in the average particle size characteristics between transects, although Transect C displays a slightly lower percentage of sand than the other two transects.

A comparison of the particle size characteristics of the material to be dredged and the seafloor at the proposed spoil ground was undertaken. As surface measurements only were collected at the proposed spoil ground, this comparison utilised surface measurements from the area to be dredged only. As there is no significant difference between depths in the material to be dredged, the use of surface measurements from the area to be dredged should not affect the validity of the comparison. Also, as the silt and clay fractions were reported together for the proposed spoil ground, these fractions were combined for the area to be dredged for comparative purposes.

There is a significant difference between the material to be dredged and the seafloor at the proposed spoil ground ($F_{(2,175)} = 51.24$, $p < 0.0000$). *Post hoc* analysis (Tukey's unequal N HSD) indicated that the mean percentage of gravel and sand in the material to be dredged is significantly lower than at the proposed spoil ground ($p < 0.0000$ and $p = 0.006$ respectively) and the mean percentage of silt/clay in the area to be dredged was significantly higher than in the proposed spoil ground ($p < 0.0000$). The material in the area to be dredged is significantly finer than the material in the proposed spoil ground.

Table 3-13 Physical characteristics of sediment within the areas to be dredged

Area	Percent Passing																			
	Gravel (2.36 – 63 mm)					Sand (0.075 – 2.36 mm)					Silt (0.001 – 0.075 mm)					Clay (<0.001 mm)				
	Min	20 th %	Mean	80 th %	Max	Min	20 th %	Mean	80 th %	Max	Min	20 th %	Mean	80 th %	Max	Min	20 th %	Mean	80 th %	Max
Apron Area																				
A1	0.33	2.40	9.32	18.45	38.25	8.33	32.10	41.82	55.86	70.16	6.30	11.57	19.77	24.34	37.13	1.07	1.956	9.56	16.59	34.95
A2	0.27	4.40	14.72	21.77	42.13	16.98	32.33	46.09	61.62	79.27	5.23	10.26	18.94	25.31	44.89	6.03	15.62	20.26	25.21	33.65
A3	2.13	4.04	15.97	27.11	30.90	15.22	31.58	46.34	66.97	74.19	5.29	8.55	18.01	29.69	31.63	7.15	10.96	19.68	19.79	49.21
Departure Path Investigation Area																				
DP1	0.15	0.65	6.59	9.65	38.66	30.89	59.44	64.99	72.68	76.44	3.00	5.38	9.59	11.94	29.98	6.90	15.05	19.50	22.88	31.34
DP2	0.16	0.67	9.08	9.88	52.09	32.30	54.27	66.87	78.64	89.32	1.79	4.24	6.19	8.41	11.35	4.61	8.30	17.87	25.84	48.41
DP3	0.39	0.48	4.49	7.09	15.65	42.05	65.54	75.91	88.64	92.41	1.92	3.29	5.64	7.87	13.95	3.75	5.79	13.96	20.93	43.57

% = percentile

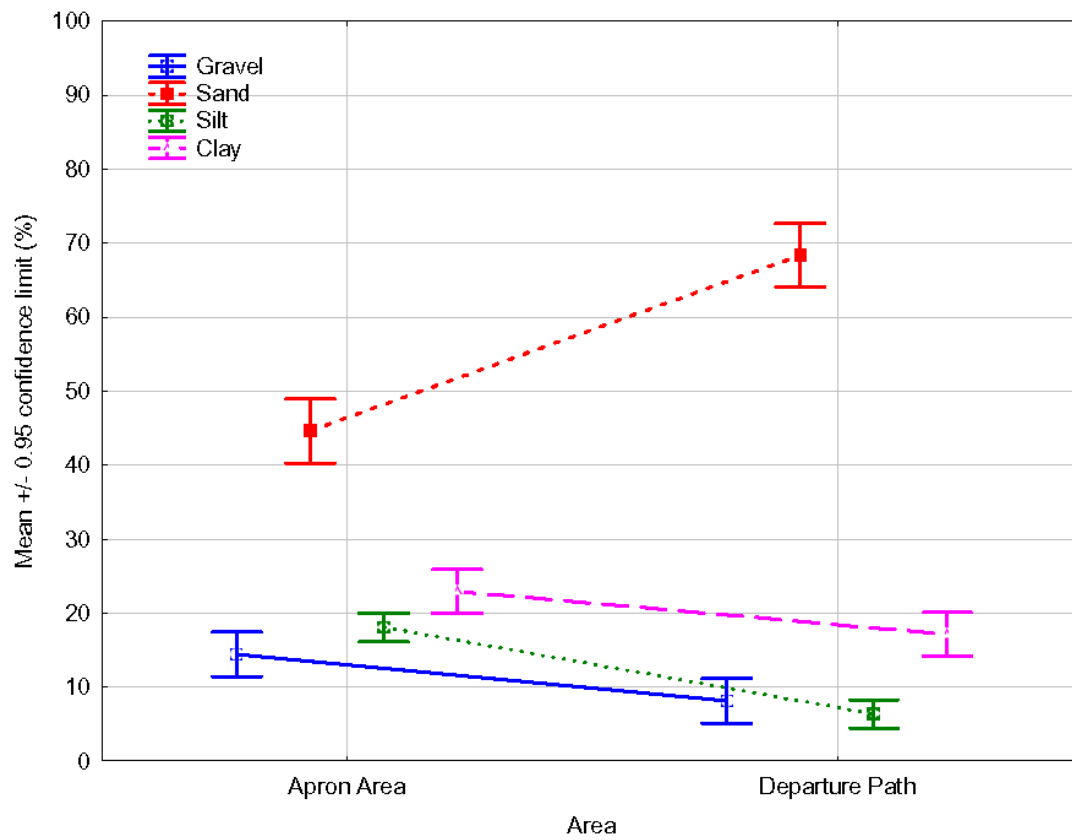


Figure 3-35 Mean percentage of gravel, sand, silt and clay in the Departure Path and Apron Area

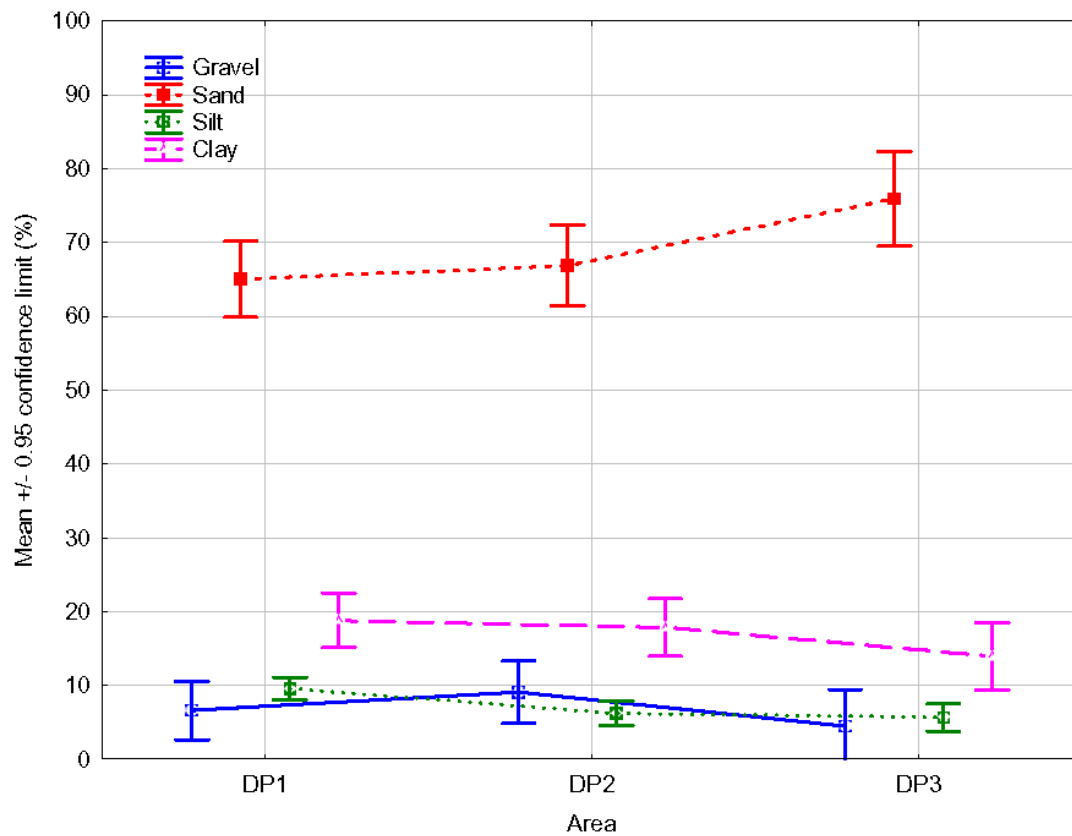


Figure 3-36 Mean percentage of gravel, sand, silt and clay in the three sections within the Departure Path

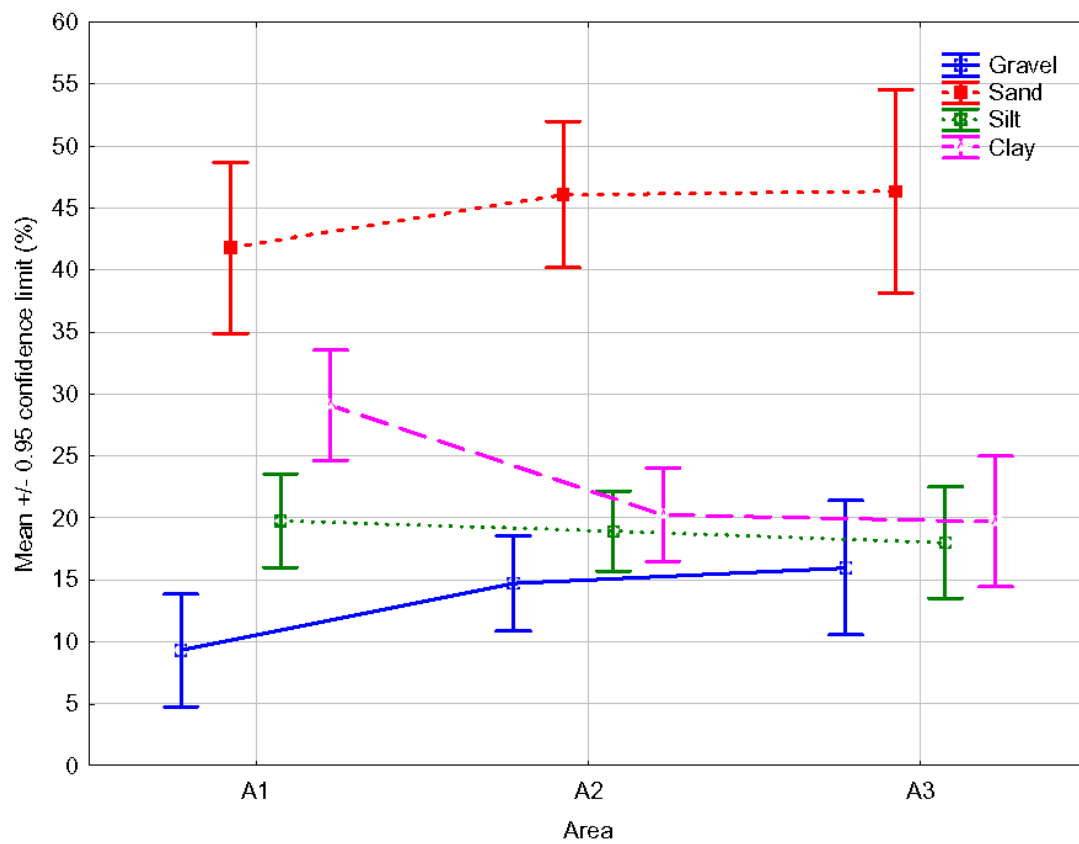


Figure 3-37 Mean percentage of gravel, sand, silt and clay in the three sections within the Apron Area

Table 3-14 Physical characteristics of surface sediment within the current and proposed spoil grounds

Spoil Ground Transects	Percent Passing											
	Gravel (2.36 – 63 mm)						Sand (0.075 – 2.36 mm)					
	Min	20 th %	Mean	80 th %	Max		Min	20 th %	Mean	80 th %	Max	
Transect A	6.42	10.64	23.98	31.32	43.43	53.86	53.86	65.83	72.46	84.18	87.79	1.12
Transect B	2.24	5.33	21.68	42.76	45.95	52.64	55.31	55.31	73.31	86.46	93.37	1.41
Transect C	1.62	11.98	31.91	49.85	71.60	25.52	46.31	46.31	64.70	83.40	95.72	1.16

% = percentile

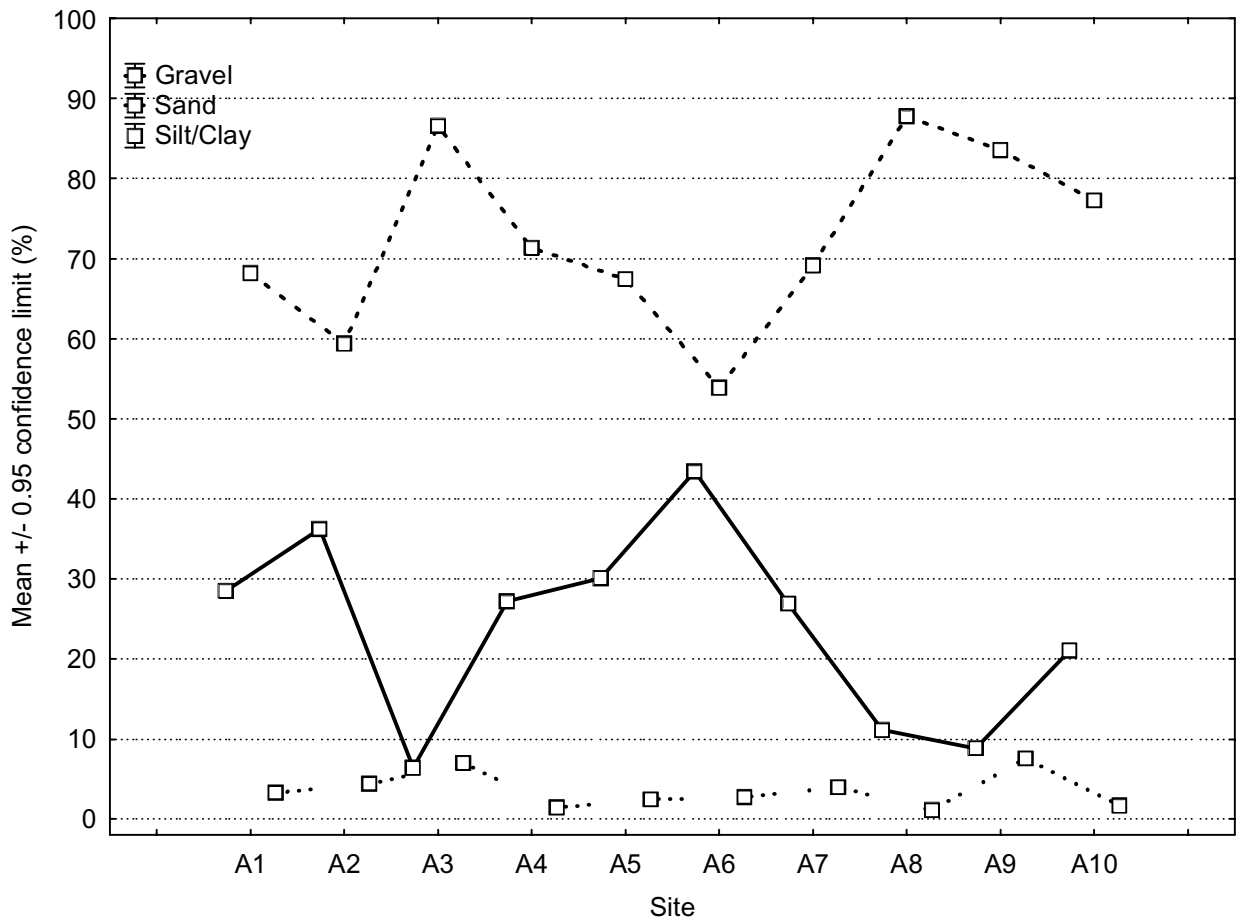


Figure 3-38 Variation in mean particle size at each site along Transect A

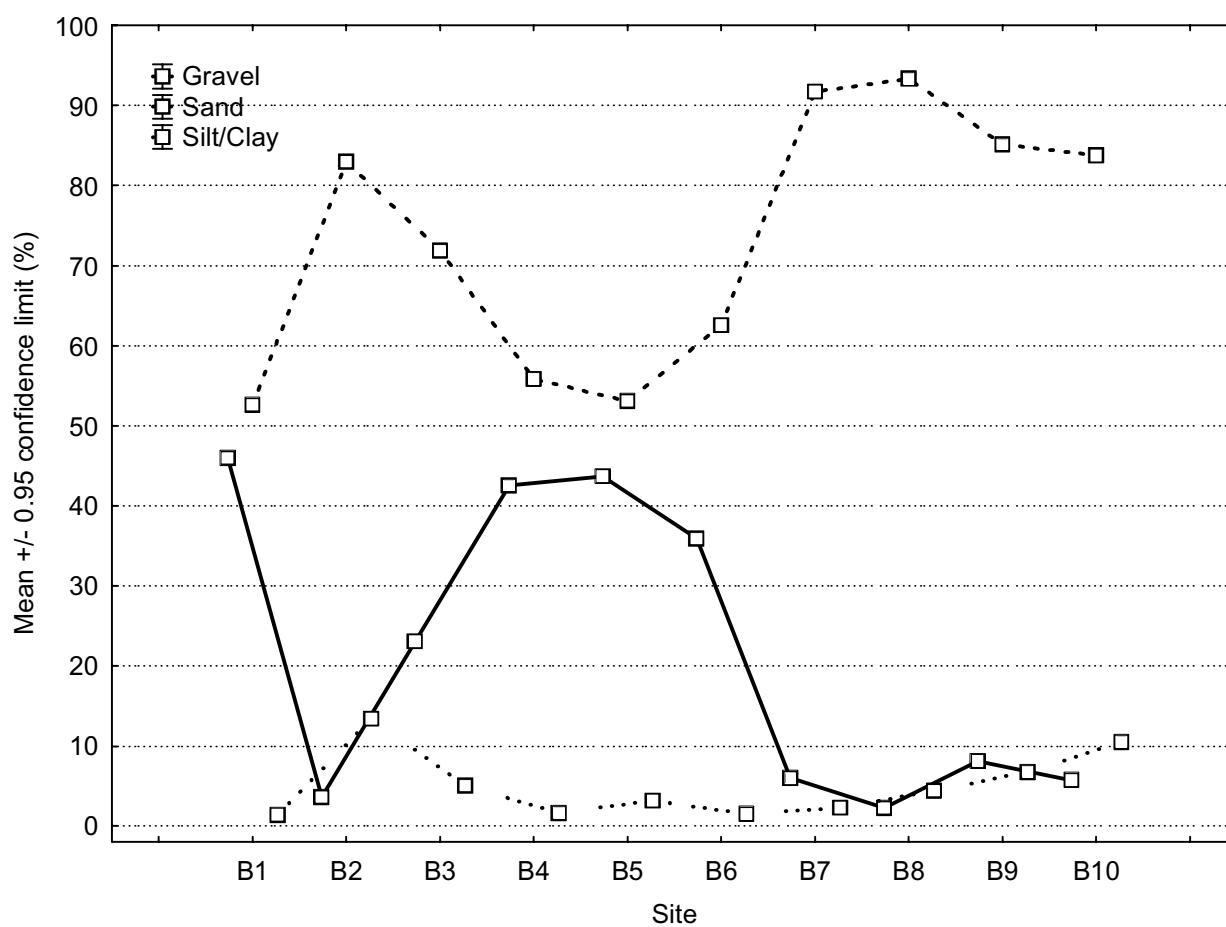


Figure 3-39 Variation in mean particle size at each site along Transect B

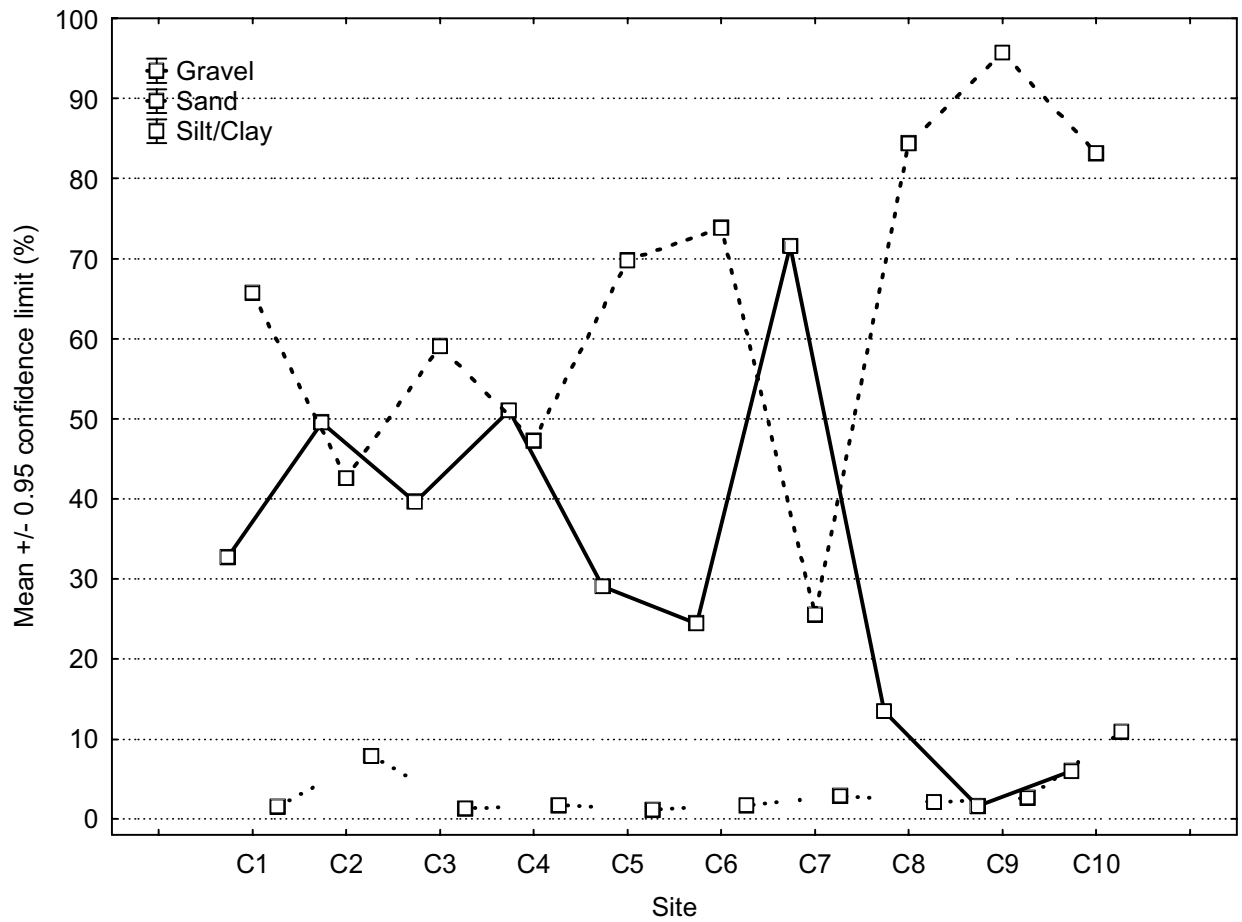


Figure 3-40 Variation in mean particle size at each site along Transect C

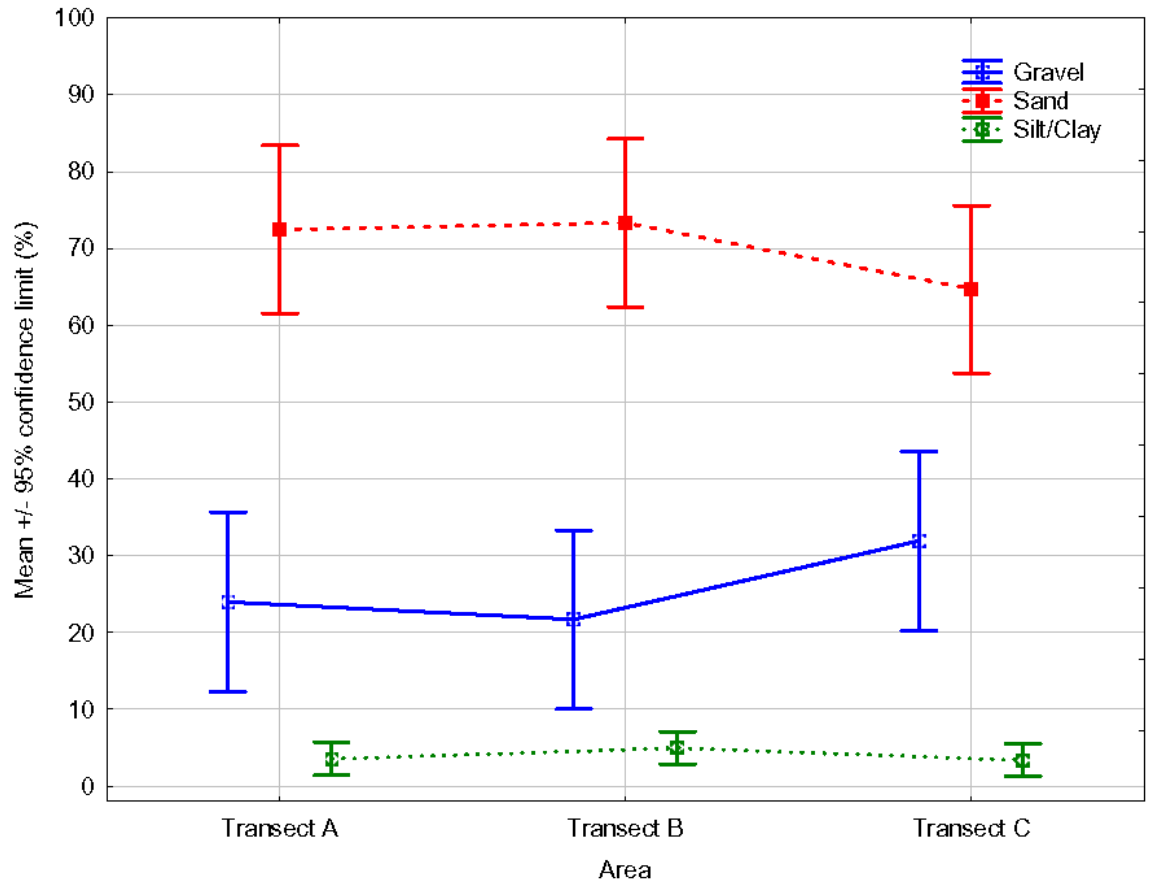


Figure 3-41 Mean percentage of gravel, sand and silt/clay in the three transects within the proposed Spoil Ground

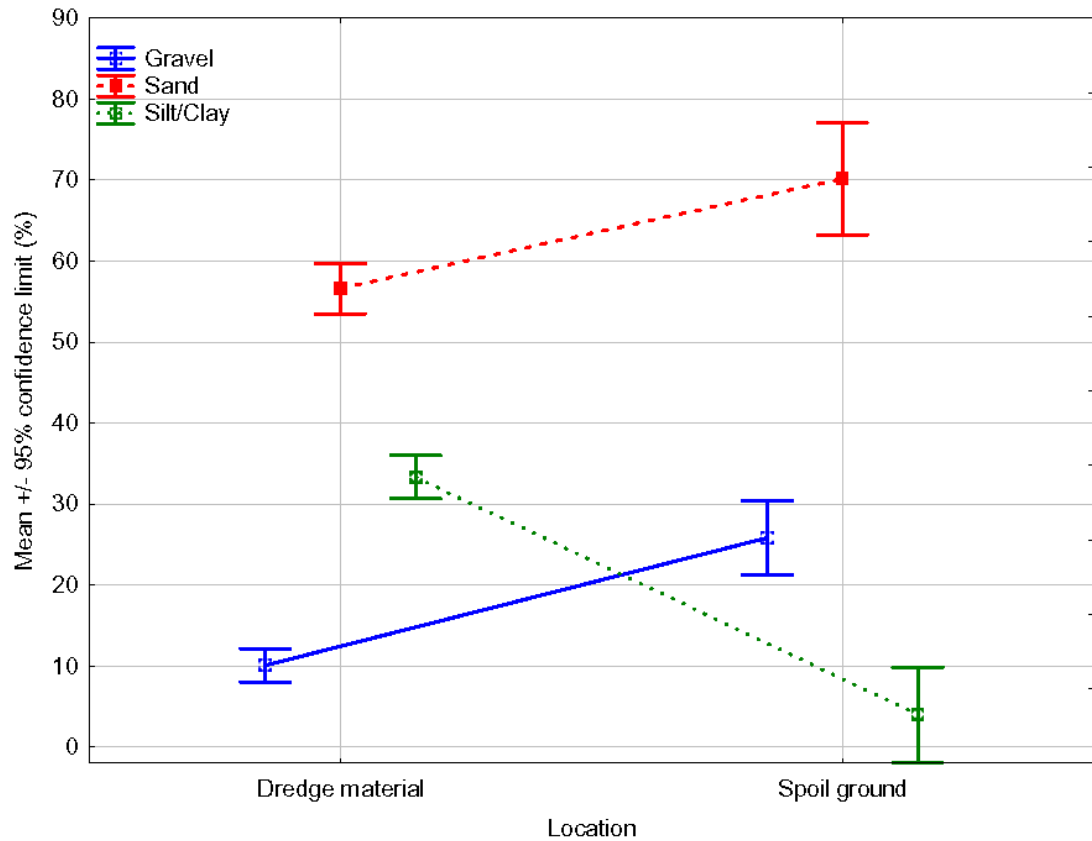


Figure 3-42 Mean percentage of gravel, sand and silt/clay in the dredge material and spoil ground

Benthic macroinvertebrate sampling, including particle size analysis of the surface grab samples, was undertaken at the current spoil ground and two control locations immediately before (June) and after (July) the 2001 capital dredging, and again in 2003, two years after the 2001 dredging campaign. Twelve sites were sampled in the current spoil ground and each of the control locations (western and eastern), giving a total of 36 sites.

Comparison of particle size pre-and post dredging was undertaken, giving the following results:

- ▶ Comparison of particle size characteristics within the spoil ground immediately pre and post-dredging in 2001 indicated that the average silt/clay content increased by 18.8% and the average gravel content decreased by 22.9%. This represents a substantial alteration to the sea floor at the spoil ground.
- ▶ A comparison of particle size characteristics between the pre-dredging and two years post-dredging surveys indicated that the longer term changes in spoil ground

sediment composition were less, with the average silt/clay content increasing by 9.3% and the average percentage of gravel decreasing by 13.1%.

- ▶ A comparison of total organic carbon content, moisture and redox potential measured in the 2003 post-dredging survey did not indicate substantial differences between the spoil ground and 2 control locations.

Chemical Characteristics

Concentrations of contaminants of concern were compared to the ISQG. Results are summarised below.

Organotins:

- ▶ One sample exceeded the ISQG-low screening level for tributyl tin (TBT) ($5 \mu\text{g Sn/kg}$) recording a concentration of $36.32 \mu\text{g Sn/kg}$ (normalised to 1% total organic carbon).
- ▶ Nine samples recorded concentrations of TBT above the laboratory limit of reporting ($0.5 \mu\text{g Sn/kg}$) but below the ISQG-low screening level ($5 \mu\text{g Sn/kg}$).
- ▶ The remaining samples recorded TBT concentrations below the laboratory limit of reporting ($0.5 \mu\text{g Sn/kg}$).

Heavy metals:

- ▶ The concentrations of all metals in all samples were below the relevant ISQG-low screening levels except for:
 - Nickel in one sample = 28 mg/kg (ISQG-low = 21 mg/kg); and
 - Arsenic in one sample = 31 mg/kg (ISQG-low = 20 mg/kg).
- ▶ Replicate samples for these sites were analysed with concentrations being below the ISQG-low screening levels.

Polyaromatic Hydrocarbons:

- ▶ The concentrations of all PAHs were below the ISQG-low screening levels in all samples. All but two of the samples recorded concentrations of PAHs below the laboratory limits of reporting.

Organochlorine and Organophosphorus Pesticides:

- ▶ The concentrations of organochlorine and organophosphorus pesticides in all samples were below the laboratory limits of reporting and are therefore below the ISQG-low screening levels.

In accordance with the NODGDM, the 95% upper confidence limit of the mean was calculated for each contaminant of concern to determine compliance of the material to be dredged to the ISQG. The 95% UCL concentrations of potential contaminants in the sediment to be dredged were below the ISQG low screening values (see Table 3-15 and Table 3-16). Therefore, according to the requirements of the NODGDM, the sediment to be dredged is considered non-toxic and suitable for unconfined ocean disposal.

Table 3-15 Apron Area – Upper 95% confidence limits for metals, polyaromatic hydrocarbons and tributyl tin

Parameter	ISQG-low screening level	Mean	Standard Deviation	Count	Confidence Limit	95% UCL
Metals						
	mg/kg					
Arsenic	20	4.11	4.68	81	1.02	5.13
Cadmium	1.5	0.05	0.01	80	0.00	0.05
Chromium	80	15.01	5.67	80	1.24	16.25
Copper	65	5.94	4.27	80	0.94	6.87
Iron*		14,743.75	7,512.47	80	1,646.21	16,389.96
Mercury	0.15	0.01	0.01	14	0.01	0.01
Manganese*		278.80	247.99	80	54.34	333.14
Nickel	21	8.63	4.46	81	0.97	9.60
Lead	50	5.06	3.41	80	0.75	5.81
Antimony	2	0.37	0.51	15	0.26	0.63
Zinc	200	19.24	9.53	80	2.09	21.32
Polyaromatic Hydrocarbons						
Fluoranthene (normalised to 1% TOC)	600	3.26	2.83	14	1.48	4.74
Pyrene (normalised to 1% TOC)	665	3.08	2.16	14	1.13	4.21
Organotin compounds						
	µg/kg					
TBT (normalised to 1% TOC)	5	0.81	4.21	74	0.96	1.77

Notes:

Green = compliant to the ISQG-low screening value, Black = no ISQG

No guideline is available for these parameters as they are naturally occurring elements in marine sediments.

Table 3-16 Departure Path – Upper 95% confidence limits for metals and polyaromatic hydrocarbons

Parameter	ISQG-low screening level	Mean	Standard Deviation	Count	Confidence Limit	95% UCL
Metals						
	mg/kg					
Arsenic	20.0	4.82	2.75	76	0.62	5.44
Cadmium	1.5	0.05	0.00	76	0.00	0.05
Chromium	80	12.48	2.79	76	0.63	13.10
Copper	65	3.83	3.69	76	0.83	4.66
Iron*		10,759.21	4,962.64	76	1,115.72	11,874.93
Mercury	0.15	0.01	0.01	10	0.00	0.01
Manganese*		142.97	167.24	76	37.60	180.57
Nickel	21	6.09	2.47	76	0.56	6.64
Lead	50	4.17	2.05	76	0.46	4.63
Antimony	2.0	0.29	0.30	10	0.18	0.47
Zinc	200	9.68	4.78	76	1.07	10.76
Polyaromatic Hydrocarbons						
Phenanthrene (normalised to 1% TOC)	240	5.90	10.75	10	6.66	12.56
Fluoranthene (normalised to 1% TOC)	600	4.75	7.12	10	4.41	9.16
Pyrene (normalised to 1% TOC)	665	6.60	12.97	10	8.04	14.64
Benz(a)anthracene (normalised to 1% TOC)	261	5.40	9.17	10	5.68	11.08
Chrysene (normalised to 1% TOC)	384	7.25	15.02	10	9.31	16.56

Notes:

Green = compliant to the ISQG-low screening value, Black = no ISQG

No guideline is available for these parameters as they are naturally occurring elements in marine sediments.

3.5.5 Nutrients

An ongoing concern for the management of the GBRMP is the inputs of nutrients (phosphorus and nitrogen) from anthropogenic activities such as agriculture and wastewater. As required by the SAP, 20% of samples collected were randomly chosen and analysed for the following nutrients:

- Total nitrogen
- Total Kjeldahl nitrogen (sum of organic nitrogen and ammonia)
- Nitrate (NO_3^-)
- Nitrite (NO_2^-)
- Ammonia (NH_4^+)
- Total Phosphorus
- Phosphate (PO_4^{3-})

Summary statistics for nutrient concentrations in the sediments to be dredged are presented in Table 3-17. The concentrations of nitrate, nitrite and ammonia were less than the laboratory limits of reporting in all samples.

Table 3-17 Summary statistics for nutrient concentrations in sediments to be dredged

Parameter	Valid N	Mean	Median	SD	Min	Max	20th %	80th %
Total Nitrogen (mg/kg)	24	163.58	180.00	71.81	24.00	350.00	84.00	220.00
Calculated Organic Nitrogen (mg/kg) ¹	24	163.58	180.00	71.81	24.00	350.00	84.00	220.00
Total Phosphorus (mg/kg)	24	191.33	175.00	138.55	30.00	640.00	85.00	230.00
Phosphate (mg/kg)	24	0.63	0.5	0.3	<0.50 ²	1.5	0.5	0.5
Calculated Organic Phosphorus (mg/kg) ³	24	190.71	174.25	138.57	29.50	639.50	84.50	229.50
Total Organic Carbon (%)	24	0.16	0.13	0.09	<0.10*	0.52	0.10	0.18

Note:

SD = Standard Deviation

¹ Organic nitrogen is calculated by subtracting ammonia concentration from total Kjeldahl nitrogen. As the concentration of ammonia was below the laboratory limits of reporting in all samples, the total Kjeldahl concentration was used as the organic nitrogen concentration.

² The concentration of phosphate and total organic carbon was less than the limit of reporting in a number of samples. These concentrations were entered as the limit of reporting for statistical analyses.

³ Organic phosphorus is calculated by subtracting phosphate concentration from the total phosphorus concentration. Where the concentration of phosphate was below the laboratory limits of reporting, the total phosphorus concentration was used.

The sediments in the area to be dredged at the Port of Hay Point displayed a total nitrogen concentration range of 24 – 350 mg/kg. These concentrations are low when compared with total nitrogen concentrations found in estuary sediments, such as those recovered from Shoalwater Bay (130 – 3,200 mg/kg, GHD 2002a) or western Moreton Bay (600 – 1400 mg/kg, Dennison and Abal 1998). Total phosphorus concentrations within the area to be dredged ranged from 30 – 640 mg/kg. This is somewhat less than the total phosphorus range detected for either the Fitzroy River (480 – 960 mg/kg, Douglas *et al.* 2005) or western Moreton Bay (200 – 800 mg/kg), but was similar to that detected for Shoalwater Bay (46 – 320 mg/kg). The presence of low nutrient concentrations in the sediments of the area to be dredged are not surprising given the dominance of nutrient-depleted coastal sands in the material to be dredged and the lack of a marine mud layer within core profiles.

3.5.6 Settling Velocity

Methodology and Data Analysis

Settling velocity analysis was conducted over 9 discrete samples (S1 – S8) and a replicate (S1R) obtained from unconsolidated surface sediments within the proposed Apron Area (Table 3-18). Samples were collected within water depths of 12 – 14 m using a stainless steel van Veen grab. Sufficient sample quantity was obtained by repeat deployment of the grab.

Dr Peter Ridd and Alessandra Mantovanelli (James Cook University) undertook analysis of settling velocity using an automated settling tube with an immersed mass balance to detect settling rates. Odin Theory was then applied to invert the data and provide a settling velocity distribution for sediment particles below 108 µm (Figure 3-43). This range equates to the clay and silt size fractions normally considered within the hydrodynamic modelling process as cohesive particles. This is the fraction that was of interest for this study.

Table 3-18 Survey site locations

Site	Location (Lat/Long WGS 84)
S1	S21 14.510 E149 18.125
S1R	S21 14.510 E149 18.125
S2	S21 14.675 E149 18.386
S3	S21 14.832 E149 18.607
S4	S21 15.910 E149 18.980
S5	S21 15.566 E149 18.937
S6	S21 15.345 E149 18.920
S7	S21 15.166 E149 18.633
S8	S21 14.954 E149 18.458

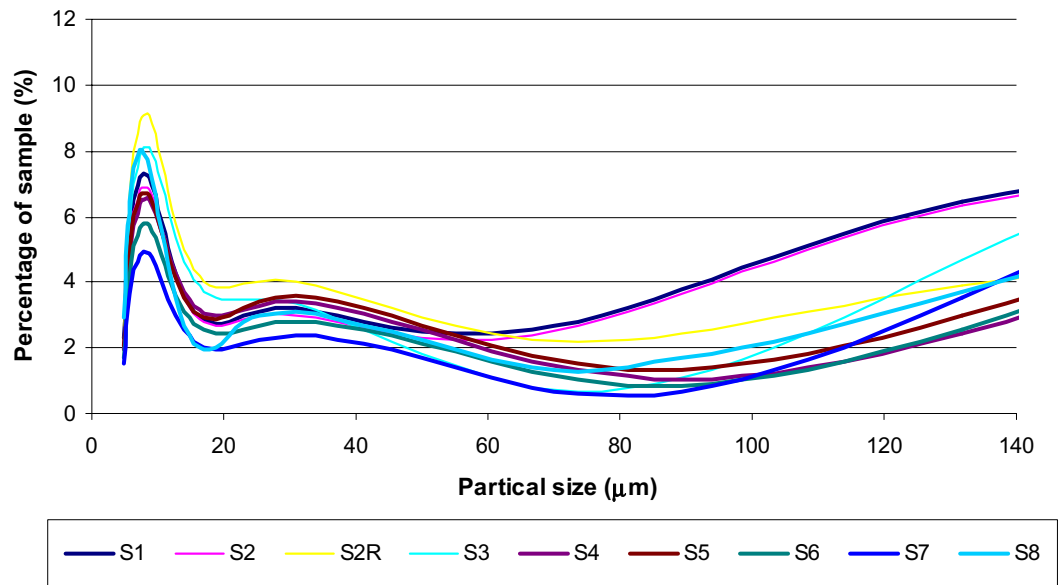


Figure 3-43 Particle size distribution within the clay and silt fractions (<~108 µm) for surface samples obtained from the Apron Area

Results

Surface sediments collected from the Apron Area displayed a distinct similarity in particle size distribution, with all samples having larger proportions of sediment within the 10 µm, and 200 µm – 300 µm range, and to some extent, the 800 µm – 1,000 µm range.

Settling velocities for the sediments <108 µm in diameter (silt and clay fractions) have been placed within 21 categories, ranging from 0.01 mm/sec to 15.85 mm/sec (Table 3-19). Hydrodynamic modelling conducted as part of this EIS utilises a settling velocity of 0.06 mm/sec for the description of the behaviour of silt and clay particles within the water column. Analysis of surface sediments from within the Apron Area suggests that this value applies to approximately 81% of the material within the silt and clay size fraction (<108 µm) (Table 3-20). The average proportion of sediments <108 µm in diameter that recorded settling velocities slower than 0.06 mm/sec was 18% (range of 0% to ~45%, Table 3-20).

The calculation of settling velocities was conducted on the finer sediment fraction, which represents between 40 – 77% of the sample (Table 3-21). The overall proportions of material demonstrating settling velocities less than 0.06 mm/sec are somewhat reduced when considering the entire sample from each site. The average proportion of sediments with a settling velocity <0.06 mm/sec reduces from an average of approximately 18% to 11% (range of 0 – 27%) when considering all particle size fractions (Table 3-21).

Table 3-19 Settling velocity (mm/sec) expressed as a proportion of the sediment sample (%)

Velocity (mm/sec)	S1	S1R	S2	S3	S4	S5	S6	S7	S8
15.85	9.5	11.12	3.88	2.70	16.15	19.61	22.47	5.65	6.91
12.68	1.2	1.45	0.67	0.41	1.12	1.53	1.47	0.65	1.07
10.57	1.1	1.31	0.64	0.39	0.97	1.33	1.27	0.58	1.00
9.06	1.0	1.21	0.61	0.37	0.86	1.19	1.12	0.54	0.94
7.93	0.9	1.12	0.59	0.35	0.78	1.07	1.01	0.50	0.89
7.04	0.9	1.05	0.57	0.33	0.71	0.98	0.92	0.47	0.85
3.96	5.0	6.01	3.57	2.05	3.85	5.31	4.94	2.68	5.10
3.02	2.9	3.38	2.24	1.27	2.04	2.82	2.61	1.54	3.05
2.05	4.7	5.46	3.97	2.26	3.21	4.40	4.06	2.56	5.18
1.51	4.3	4.74	3.79	2.18	2.75	3.74	3.46	2.32	4.74
1.24	3.0	3.24	2.77	1.62	1.87	2.54	2.35	1.65	3.35
1.01	3.5	3.69	3.32	1.99	2.15	2.90	2.69	1.95	3.93
0.50	13.2	13.17	13.21	8.54	8.03	10.58	9.94	7.76	14.84
0.25	15.2	13.56	15.45	11.75	9.42	11.86	11.52	9.75	16.33
0.10	21.5	16.75	20.74	20.25	14.94	17.43	18.02	15.94	21.05
0.06	12.2	0.00	0.00	0.00	0.00	0.00	12.14	0.00	10.79
0.05	0.0	0.00	0.00	0.00	0.00	12.70	0.00	0.00	0.00
0.04	0.0	12.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.0	0.00	23.95	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.0	0.00	0.00	43.54	31.13	0.00	0.00	0.00	0.00
0.01	0.0	0.00	0.00	0.00	0.00	0.00	0.00	45.46	0.00

Note: Analysis undertaken on proportion of sample that was <108 µm.

Table 3-20 Summary of settling velocity of unconsolidated surface sediments within the Apron Area – particle size <108 µm

Settling Velocity (mm/sec)	S1	S1R	S2	S3	S4	S5	S6	S7	S8	Mean
% of whole sample	66.82	63.65	77.44	63.44	56.87	58.99	48.52	40.59	59.15	
>=0.06 mm/sec	100.0	87.3	76.1	56.5	68.9	87.3	100.0	54.5	100.0	81.2
<0.06 mm/sec	0.0	12.7	23.9	43.5	31.1	12.7	0.0	45.5	0.0	18.8

Table 3-21 Summary of settling velocity of unconsolidated surface sediments within the Apron Area – whole sediment sample

Settling Velocity (mm/sec)	S1	S1R	S2	S3	S4	S5	S6	S7	S8	Mean
% of sample <108 µm	66.82	63.65	77.44	63.44	56.87	58.99	48.52	40.59	59.15	59.50
>15 mm/sec	33.18	36.35	22.56	36.56	43.13	41.01	51.48	59.41	40.89	42.33
15 – 0.06 mm/sec	66.82	55.57	58.93	35.84	39.18	51.50	48.52	22.12	59.12	46.83
<0.06 mm/sec	0.00	8.08	18.51	27.60	17.69	7.49	0.00	18.47	0.00	10.84

3.6 Meteorological Environment and Climate

3.6.1 Introduction

This section of the EIS describes the existing meteorological environment and climate relevant to the identification of elements that may influence the proposal. This includes a brief description of the following:

- ▶ local and regional climatic conditions;
- ▶ meteorological environment; and
- ▶ topographic and development/land use factors.

3.6.2 Local and Regional Conditions

The Mackay region has a tropical monsoonal climate with distinct wet and dry seasons. The wet season occurs between December and March and tropical cyclones regularly pass within 150 km of Mackay during this period. Average annual rainfall in Mackay, the closest monitoring station to Hay Point, is approximately 1,585 mm. A large

proportion of the annual rainfall is received during the summer months, with the driest months being August and September (BoM 2005). Temperatures range between 13 and 25°C in winter and 23 and 30°C in summer (BoM 2005). Relative humidity ranges from 66% in October to 80% in April/May (Katestone Scientific 2000).

3.6.3 Meteorological Environment

The region lies in the trade wind belt for most of the year resulting in south to southeast winds. During the warmer months afternoon northeast sea breezes are common. Fresh south-easterlies can blow along the coast for lengthy periods during summer and autumn, but gale force winds are rare and normally only occur with a tropical cyclone (BoM 2005). Being located on the coast, the site is strongly influenced by the ocean. These coastal influences also affect humidity, the frequency of relatively stable on-shore flows and sea breezes, temperature and the presence of thermal and terrain induced boundary layers. There is little topographic impediment to on-shore sea breezes in the Hay Point area, with few off-shore islands present in the area.

3.6.4 Topographic and Development/Land Use Factors

The Port area and adjacent communities of Half Tide, Salonika and Louisa Creek are relatively flat, with a 55 m hill overlooking the Port (Katestone Scientific 2000). A natural ridge at the foot of this hill has been extended to form a 35 m bund between the Port at Louisa Creek.

The Pioneer River, south of Mackay, has a quite well recorded flood history with documented evidence of flooding as far back as 1884. The largest recorded flood occurred in February 1958, with a peak height of 9.14 m on the Mackay flood warning gauge at the Forgan Bridge (BoM 2005).

3.7 Air Quality

3.7.1 Introduction

This section of the EIS provides a general description of the local air environment, including:

- ▶ the existing air shed environment; and
- ▶ emission sources and climatic conditions that may influence air quality.

3.7.2 Existing Air Shed Environment

Wind speed and direction at the 10 m level is collected continuously at four dust monitoring sites. Data from one of these monitoring sites shows that the predominant winds in the area are ESE to SSE with wind speeds commonly between 11 km/hr to 29 km/hr (Katestone Scientific, 2000). There are few topographical features either on-shore (significant mountain ranges) or off-shore (islands) to impede on-shore winds. The coal terminals and surrounding coastal areas are generally low-lying and flat.



Behind the terminals, a hill rises to around 55 m with a ridge at the foot of the hill extending to form a 35 m high environmental barrier.

Data from the nearest Bureau of Meteorology station at Mackay taken over the past 45 years shows that the mean 9 am wind speed ranges from 16.5 km/hr in August up to 20.4 km/hr in April (Table 3-22). Wind speed generally increases in the afternoon, with 3 pm wind speeds ranging from 20.1 km/hr in July up to 23.3 km/hr in March. There is little variability in average wind speed throughout the year. Wind gusts of up to 140.8 km/hr have been recorded. Mean 9 am relative humidity ranges from 66% in October to 80% in April. These values decrease slightly in the afternoon, with the mean 3 pm relative humidity being between 64% in September and October and 73% in February (BoM 2005). This is probably the result of the increased on-shore wind speeds generally experienced in the afternoon.

Table 3-22 Selected characteristics of the Mackay airshed

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9 am relative humidity (%)	75	79	78	80	79	77	76	74	68	66	67	70
Mean 9 am wind speed (km/h)	17.6	18.4	20	20.4	19.3	18.3	17	16.5	16.6	17.8	18.1	17.9
Mean 3 pm relative humidity (%)	70	73	72	72	71	68	68	67	64	64	65	67
Mean 3 pm wind speed (km/h)	22	22.3	23.3	22.8	21.6	20.9	20.1	20.6	21.4	22.3	22.8	22.1
Mean monthly rainfall (mm)	274.8	311	260.5	149.6	107	61.2	39.6	32.8	15.9	36.3	91.4	187.2
Highest monthly rainfall (mm)	1034	1071.4	920.8	521.4	545.6	392.1	269.2	207.8	58.4	152.4	503	1158.6
Lowest monthly rainfall (mm)	15.4	29.2	36.4	9.2	15.8	2.4	0.9	1.2	0	0	0	5.9
Mean no. of clear days	4.9	3.4	6.6	7.9	9.4	12.9	15.6	17.3	15.2	12.9	9	7.3
Mean no. of cloudy days	12.9	13.5	12.4	9.8	10.6	6.6	6.2	4.6	3.1	4.2	6.2	9
Highest recorded wind gust (km/h)	98.3	114.8	140.8	101.9	92.5	83.5	83.5	85.3	79.6	90.7	133.6	98.3

3.7.3 Emission Sources and Climatic Conditions Influencing Air Quality

The only significant pollutant emitted from the port operations at Hay Point is dust, and almost all of this is coal dust (URS 2000). Windblown material from stockpiles or dust emitted during material handling activities is fine to coarse, with particle diameters typically being in the range of 10 to 50µm. Other potential sources of dust include sand and fine dust from wind erosion of beaches and non-vegetated surfaces, salt-spray and carbonaceous material from fires (Katestone Scientific 2000). The importance of these components varies with season and meteorological conditions.

3.7.4 Air Quality Monitoring

Overview

An air quality monitoring program first commenced in the port area in the mid 1970s and was expanded in 1993, when a comprehensive air quality monitoring program and network of monitoring sites was implemented. This program has since been reviewed and improved to ensure the Port continues to meet 'best practice' standards. The existing dust monitoring network consists of:

- ▶ *Four residential monitoring sites*, which are within the adjoining residential areas in Louisa Creek (2 sites), Half Tide and Salonika. At each site, airborne dust is measured every 10 seconds as total suspended solids. Dust fall-out gauges also measure depositional dust on a monthly basis at these sites. This depositional dust is analysed for its components, including coal dust and insoluble solids. Each station also monitors real-time noise and meteorological conditions.
- ▶ *17 secondary sites and 2 control sites* are monitored around both coal terminals and in the local communities. Depositional dust is measured at these sites on a monthly basis. Continuation of this monitoring program is a condition of both coal terminal operators' environmental licenses and the IPA development approval conditions for the operation on the DBCT site (PCQ 2002b).

Pre-2001 Capital Dredging Program Air Quality Assessment

Analysis of the data recorded by the Tapered Element Oscillating Microbalance (TEOM) at sites P1 to P4 between May 1998 and November 1999 were used to assess the dust exposure in the residential areas surrounding Hay Point (Katestone Scientific 2000). Dust concentrations for maximum 24 hr PM₁₀, annual PM₁₀, annual TSP (µg/m³) and dustfall (mg/m²/day) were determined, with the results indicating that the Environmental Protection (Air) Policy guidelines were being met in all the monitoring locations within residential areas. A summary of the findings is given in Table 3-23.

Table 3-23 Summary of dust monitoring undertaken between May 1998 and November 1999 at four long-term residential monitoring sites

Site	Max. 24hr PM ₁₀ (µg/m ³)	Annual PM ₁₀ (µg/m ³)	Annual TSP (µg/m ³)	Dustfall (µg/m ² /day)
P1	18	10	38	25
P2	45	19	70	83
P3	20	11	42	26
P4	25	13	47	34
EPP guidelines	150	50	90	No guideline

Source: Katestone Scientific (2000).

A comparison of dust monitoring results from before and after the Stage 3 and 4 expansions indicated that the dust control measures implemented during the expansion were successful in mitigating the impacts of the expansion as dust emissions from the coal terminals had not increased despite the increased capacity of the terminal (Katestone Scientific 2000). Dust control measures were also implemented as part of the Stage 6 expansions completed in 2001.

Routine Monitoring

Regular reports are prepared summarising the results of routine air quality monitoring at the Port. The most recent of these was prepared in April 2005 (HLA 2005). The following conclusions were made:

- There were two exceedances of the monthly management objective level (68 mg/m².day²) for dust deposition were recorded. Louisa Creek site P2 recorded a slight exceedance of this level (72 mg/m².day), while secondary site S3 recorded a peak concentration of 253 mg/m².day.
- Site P2 recorded a moderate visible percent coal value (11 – 20%), indicating that emissions from the coal terminals may have contributed to the exceedance at site P2.
- The average fallout levels for other Louisa Creek sites ranged from 10 - 43 mg/m².day. Fallout levels at Half-Tide and Salonika sites ranged between 12 – 42 mg/m².day.
- Average TEOM at the four primary sites were 20, 20, 21 and 26 mg/m².day.
- Review of real time TEOM data indicated one period of sustained high airbourne dust at site P2 ranging from 80 – 200 µg/m³. This occurred during a period of strong on-shore SE winds (30 – 40 km/hr), indicating coal terminal emissions may have contributed to the high values.

² Monthly management objective level set based on dust fallout levels recorded at 2 control sites (4 and 11 mg/m².day for March 2005).

- One dust complaint was received in the month of March. This corresponded with the strong SE winds on 21 April (HLA 2005).

Figure 3-44 shows the highest levels of dust deposition within the monitoring areas for the 12 months to June 2005.

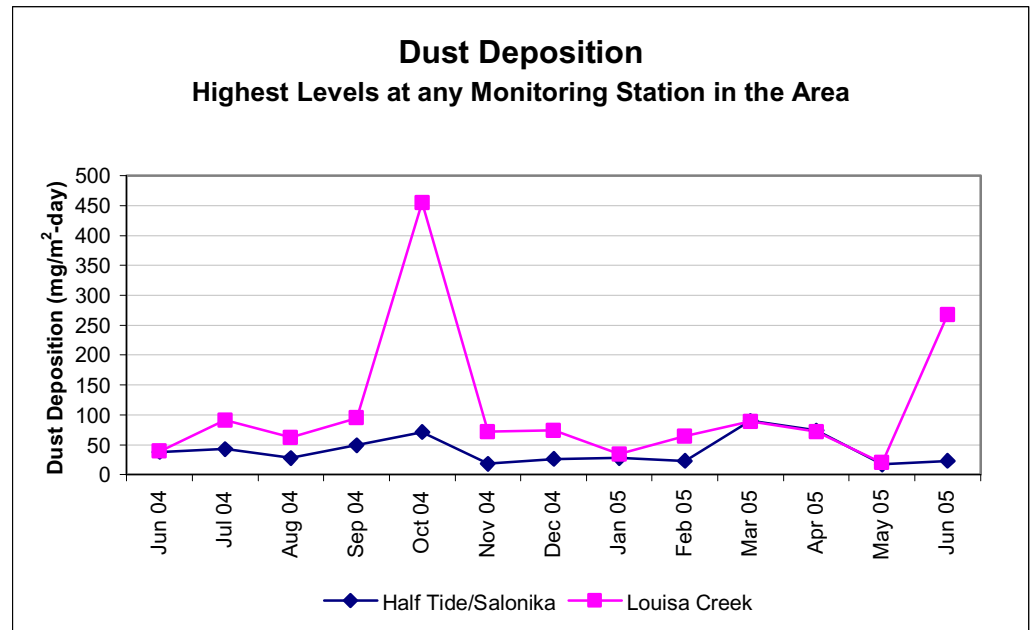


Figure 3-44 Dust deposition at Half Tide / Salonika and Louisa Creek

3.7.5 Greenhouse Gas Emissions

Potential non-dust pollutant sources at the Port include emissions from vehicular traffic within the area, including shipping, rail and road vehicles and machinery at coal terminals. Common emissions from these sources include greenhouse gases such as NO_x, SO_x, carbon dioxide and carbon monoxide. The presence of the port operations in an open, coastal environment strongly influenced by sea breezes means these emissions are unlikely to have a significant impact on the air quality of the local area.

3.8 Noise and Vibration

3.8.1 Introduction

This section of the EIS describes the existing noise and vibration environment as it relates to the Project, including a description of the equipment and plant to be used to conduct dredging and the noise and vibration they are likely to generate and an assessment of sensitive receptors within the area.

A literature review and risk assessment on noise impacts in relation to marine mammals has been undertaken including a review of previous noise assessments undertaken for

the area. The review concentrated on those species known to be active in the study area (particularly during the proposed periods of dredge activity) and their sensitivity to the expected noise and vibration emission from the proposed dredge activities. The purpose of the review is to determine the need for quantitative modelling of potential noise impacts on marine mammals. There are no specific guidelines relate to dredge noise or vibration within the marine environment.

3.8.2 Noise Impacts Associated with Marine Mammals

Introduction

The following section contains a review of literature relating to the impact of noise on marine mammals, namely cetaceans and dugong. A risk assessment based on this literature review is also provided to assess the potential impacts of dredging associated with the Project.

Information for this review has been sourced from:

- ▶ primary scientific literature;
- ▶ The review: The potential sensitivity of marine mammals to mining and exploration in the Great Australian Bight Marine Park Marine Mammal Protection Zone (Pidcock *et al.* 2003);
- ▶ The review: Draft Review of DEH Guidelines on the Application of the EPBC Act to Interactions between Off-shore Seismic Operations and Larger Cetaceans (URS 2004);
- ▶ Twofold Bay Navy Ammunitioning Facility Environmental Management Whale Management Plan (Dredging) (Boulderstone Hornibrook 2002); and
- ▶ Dalrymple Bay Coal Terminal Expansion Stages 6&7 – Draft Environmental Impact Statement (URS 2000).
- ▶ Recovery Plan for Humpback Whales (DEH 2005)

Marine Mammals Occurring in the Vicinity of Hay Point

The marine mammal species identified as likely to occur in the vicinity of the Port were identified through a search on the EPBC Act database search of the area. These are discussed in Section 3.2.7. The majority of species identified in the database are identified as species that may occur within the study area, or that may have habitat within the study area. Two species, the Dugong and the Spotted Bottlenose Dolphin are considered likely to occur within the study area.

The Humpback Whale recovery plan identifies the study area as a migratory path for whales. While Dugong is considered likely to occur within the study area on the EPBC Act database, there have been few sightings of Dugong within the port area (URS 2000).

Sources of Noise in the Marine Environment

The ocean has a base level of background or ambient noise that can be categorised into natural and human induced sound sources. Natural noise sources are divided into

physical (wind, sea state, swell and earthquakes) and biological (whales, fish and invertebrates) in origin, producing a range of frequencies and power levels (McCauley 1994; McCauley & Duncan 2001). At any one time several of these sources are likely to contribute to ambient noise. Ambient noise varies with season, location, time of day and frequency, and has the same attributes as other sounds including transient and continuous components, tones, hisses and rumbles. Additional to these natural sources are human induced sources (for example, shipping, small vessel traffic, seismic and drilling).

Natural Physical Sources of Noise

Weather, particularly wind, is the dominant natural underwater noise source in the ocean. As the wind blows across the ocean surface, small bubbles that are pushed into the water by wave action produce noise. These air bubbles then collapse under the pressure of the surrounding water, producing noise (Banner & Cato 1988). As wind speed increases, so too does the resulting underwater noise. The sound of raindrops falling onto the sea surface is another natural source of underwater noise (Cato 1978).

High underwater noise levels at frequencies < 50 Hz may be produced by earthquakes. Small earthquakes of magnitude 4 or less are comparatively frequently recorded around Australia. These moderate earthquakes produce sound levels ranging from 35 to 199 dB re 1 μ Pa at 10 – 50 Hz within several km of their epicentre.

Natural Biological Sources of Noise

Cetaceans (whales and dolphins) create sounds to communicate the presence of danger, food, an individual of the same species or other animal; and about their own position, identity and territorial or reproductive status (Richardson *et al.* 1995). In addition, toothed cetaceans use echolocation to detect, locate, and characterise underwater objects, including obstacles, prey and one another. Another identified source of natural biological noise is from fish that may use noise during breeding, or territorial or other behavioural displays.

Humpback whales produce a variety of sounds including tones, high-frequency tonal sweeps, complex amplitude – modulated pulsatile sounds, mixtures of amplitude and frequency modulation, noisy broadband blows and impulsive slaps, all with major energy at 50-1,000 Hz (Richardson *et al.* 1995). McCauley *et al.* (1988) reports the song components of humpback whales reaching 192 dB re μ Pa.

Blue whales are known to frequent Australian waters and have been identified within the EPBC Act database as being likely to occur in the Hay Point area. It is well known that blue whales make high-energy low frequency calls (Mc Donald *et al.* 1995; Rivers 1997; Stafford *et al.* 1998; Ljungblad *et al.* 1998; McCauley *et al.* 2001).

The presumed 'pygmy' blue whales produce a repertoire of sounds, the dominant types being a series of three long tonal signals spread over nearly two minutes and repeated every 78 seconds (between end/start of consecutive sequences) (McCauley *et al.* 2001). McCauley *et al.* (2001) estimated the source level of these calls at 183 dB re 1 μ Pa. They also found this type of calling to be twice as frequent during the night compared to the day and estimated the maximum daily numbers of callers at 14-28% of

the total population in an area. These authors found that the prolific blue whale calling produced increases in ambient noise to high levels for sustained periods (weeks).

Human Induced Sources of Noise

Noise produced from small vessels is expected to be variable, depending on the vessel class, its speed and maintenance state. A study of the noise measurement of a fleet of whale-watching vessels in Hervey Bay in Queensland, found that the primary predictor of radiated underwater noise for a small vessel was its speed (McCauley *et al.* 1996). Small vessels steaming had strong noise directionality patterns, radiating more noise in the forward and aft directions, than across the beam. This was attributed to a lack of hull noise shielding in the forward direction and limited attenuation by bubble clouds of propeller noise in the aft direction.

Other studies show a positive correlation between vessel size and noise production. That is the larger the vessel the greater the noise produced (McCauley 1998).

McCauley and Duncan (2001) describe merchant shipping (larger ships) noise in two general categories: distant shipping noise and nearby shipping noise. Distant shipping causes elevated sea noise levels across a defined frequency band (5-100 Hz), and in regions of Australia with high numbers of shipping movements and good sound propagation the noise levels will be high within the defined frequency band. Nearby shipping is readily discernable, with each ship having a different noise spectrum, depending on such attributes as vessel speed and tonnage, the number, depth and type of propellers and number of blades.

Dredging as a Human Induced Source of Noise

Specific information on the levels of noise emitted from dredges is limited. Received sound levels from some large trailer suction hopper dredges operating in rocky areas have been recorded in excess of 150 dB re 1 μ Pa at 1 km, while large cutter suction dredges can emit strong tones from the water pumps that are audible to 20-30 km ranges (Richardson *et al.* 1995; Dames & More 1996b, *cited in* URS 2004). Underwater noise levels from the self-propelled hopper barges engaged in transferring dredge spoil are often higher than the noises from the dredge itself, particularly during the loading and dumping operation of rocky material (URS 2004).

The nature of noise from dredges is described as aperiodic continuous, meaning the sound has a discrete frequency spectrum, and is not necessarily a regular source of anthropogenic sound relative to other sources such as shipping noise, for example (URS 2004).

Propagation of Noise in the Marine Environment

Determining the way in which sound may travel through the marine environment, and the factors acting upon the sound waves as they travel is extremely complex, and the subject of many predictive models (McCauley & Duncan 2001; Erbe & Farmer 2000; Erbe 2002).

The propagation of sound underwater is influenced by a complex mix of factors, including:

- ▶ the frequency of the sound of interest;
- ▶ the energy of the sound source;
- ▶ absorption losses to the environment, which are negligible at low frequencies (5–20 Hz) but increase with increasing frequency to become critical for frequencies above 2–3 kHz;
- ▶ the sound speed profile throughout the water column, which is influenced by salinity, pressure and temperature. For a specified frequency the vertical sound speed structure determines how a travelling sound wave refracts or bends as it travels horizontally, which defines interactions with the seafloor and sea surface;
- ▶ the bathymetry path along the sound wave direction of travel;
- ▶ interactions with the sea surface; and
- ▶ the nature of the seabed (sound energy may directly reflect off the sea bed or penetrate the sea floor, travel through the sea bed and be reflected or refracted back into the water column).

The source level, the propagation efficiency, the ambient noise and the hearing sensitivity of the subject species combine to determine the apparent loudness of a noise source. The local sound transmission conditions are also very important. In practice, the decay rate of a sound wave will be dependant on the frequency, the local conditions such as water temperature, depth and bottom conditions as well as the depth at which the signal is generated (Gausland 1998). In deep water, depth variations in water properties strongly affect sound propagation, while in shallow water, interactions with the surface and bottom have strong effects (Richardson *et al.* 1995).

In general sound level decreases with increasing distance from the source. To compare different sound sources, it is necessary to refer to a standard distance at which source levels will be determined (Richardson *et al.* 1995). The loudness of each source is then estimated by adjusting the measured level to allow for transmission loss between the standard reference range and the range where the sound was measured. Transmission loss can depend upon a number of things, including medium (air, water, soil), temperature and topography (ground or seabed).

From noise modelling previously undertaken at the Port, it was estimated, using the parabolic equation (PE) approximation method, that noise levels will diminish by about 43 dB at 1 km radius (URS 2004).

3.8.3 Terrestrial Noise Environment

Overview

The terrestrial noise and vibration environment within the Port of Hay Point region is dominated by shipping related activities and the coal exporting activities such as the outloading conveyor. Noise sources include large vessels, pilot helicopters, commercial and recreational fishing vessels within the general vicinity and the equipment used to load coal onto the ships. Noise generated from these sources is periodic.

The current approach to noise impact assessment, defined in Queensland legislation through the *Environmental Protection (Noise) Policy 1997*, is to assess the significance of environmental noise exposure with regard to a target “acoustic quality objective” which is “a noise level of 55 dB(A) L_{eq} (24 hour) or less for most of Queensland’s population”. In addition, it is not intended that in achieving the acoustic quality objective, that any part of the existing acoustic environment be allowed to significantly deteriorate. No numeric value is given to “significant deterioration”, however 5 dB(A) has often been found to be reasonable and acceptable (Huson & Associates 2000).

Noise monitoring has been undertaken at the four residential monitoring sites used for dust monitoring since 1993. Acoustic surveys are also carried out every three months, during which significant noise sources are identified and recorded (PCQ 2002). Sites P1 and P2, located at both ends of the Louisa Creek community, and P3, located at Half Tide, are representative of residential monitoring sites that can be affected by noise emanating from the coal terminals, whereas it is not possible to discern this terminal noise at site P4, located in Solonika Beach, because the area is dominated by surf noise (Huson & Associates 2000).

Pre-2001 Capital Dredging Program Noise Assessment

Table 3-24 provides a summary of the data recorded by the ambient noise monitoring program for the period 8 – 31 December 1999. Ambient noise refers to the sound recorded from all sources. Sound levels from midnight to 4 am were designated as ambient as they were considered to be the most representative of the emissions attributed to the coal terminal operations, which continue 24 hours a day, and are less affected by extraneous noise (Huson & Associates 2000). Table 3-25 presents the 24-hour ambient noise levels recorded for the same period. These levels represent an integration of all noise sources over a 24-hour period. The noise levels were below the acoustic quality objective of 55 dB(A) specified in the *Environmental Protection (Noise) Policy 1997* at the four residential monitoring locations.

Table 3-24 Ambient noise levels at four monitoring stations, 12 am – 4 am

Location	Statistic	L_{eq}	L_{10}	L_{90}	No. of samples
P1 Louisa Creek	Mean	46.5 dB(A)	47.6 dB(A)	44.7 dB(A)	152
	SD	7.1	7.8	2.9	
P2 Louisa Creek	Mean	49.9 dB(A)	50.7 dB(A)	48.6 dB(A)	559
	SD	3.2	3.5	2.9	
P3 Half Tide	Mean	49.9 dB(A)	52.0 dB(A)	49.1 dB(A)	591
	SD	4.6	4.7	4.4	
P4 Solonika	Mean	50.6 dB(A)	51.6 dB(A)	49.5 dB(A)	584
	SD	3.9	4.0	3.8	

Source: Huson & Associates (2000)

Table 3-25 24 hour ambient noise levels at the four monitoring stations

Location		L_{eq}
P1	Louisa Creek	52 dB(A)
P2	Louisa Creek	52 dB(A)
P3	Half Tide	53 dB(A)
P4	Salonika	53 dB(A)

Source: Huson & Associates (2000)

Routine Monitoring

Monthly reports are prepared summarising the results of routine noise monitoring at the Port. The monitoring shows:

- ▶ The residential monitoring sites are in most cases below the 'acoustic quality objective' of 55dB(A);
- ▶ Monthly average L_{Aeq} data for all sites and periods typically ranged between 48 and 55dB(A); and
- ▶ Noise complaints occur rarely.

3.9 Cultural Heritage

3.9.1 Introduction

This section of the EIS details the outcomes of consultation with Traditional Owners, including details of all consultation undertaken and identified sites of significance. The assessment of cultural heritage values has been undertaken having regard to the clause 74(5)(b) of the GBRMP Regulations 1983 and the need to protect the cultural heritage values held in relation to the Marine Park by Traditional Owners.

3.9.2 Consultation with Traditional Owners

In accordance with the requirements of the ACHA notification, to the registered Native Title Claimants, who are the Aboriginal Parties under the ACHA was undertaken. Two parties, the Yuibera and the Wiri#2, responded to the notification and were endorsed as parties to be consulted in the development of the CHMP.

Site survey was conducted by boat with both parties. The purpose of the survey was to give an opportunity to the Aboriginal Parties to see the development area, and to discuss any sites or places of cultural heritage significance that may be impacted on by the Project.

Following the site survey both parties were provided copies of sea bed surveys conducted in July 2004 and May 2005 along with the reports which describe the potential areas of impact

Further discussions were held with the Traditional Owners on 12 July 2005 to confirm and agree on the content of the CHMP.

3.9.3 Cultural Heritage Values

Both the Yuibera and Wiri#2 representatives stated that the study area was within the marine part of their country, and as such was of significance to them. No specific sites of cultural heritage significance were identified though. The cultural heritage values generally related to those of protecting the natural environment.

3.10 Land Use and Land Use Planning

3.10.1 Introduction

This section of the EIS provides a discussion in relation to terrestrial land uses in regard to both function and planning intent. The Port, Departure Path, shipping and commercial uses of waterways are discussed. All such discussions should be limited to relevance to the proposal and potential impacts.

Land based disposal of dredged material is not being proposed therefore no discussion in relation to these matters is relevant. Works associated with the Project are exclusively ocean based.

3.10.2 Land Use

Land use within the vicinity of the Port is generally a mix of low density residential, semi-rural and port related activities. Areas to the northwest and southeast of the strategic port land are dominated by land subdivided for single residential dwellings. Land directly to the west is designated as an environmental area for the purpose of providing a buffer between the above-mentioned sensitive receptors and the Port's land based activities. Areas to the southwest and west of the strategic port land are of a rural residential nature, large land parcels with single detached residential dwellings and onsite water and sewerage services.

3.10.3 Land Tenure

The area of the proposed works is within the port limits. Whilst some are of water within the Port are designated Strategic Port Land, the area of the proposed Departure Path and Apron Areas is not. The State and Commonwealth own this land.

3.10.4 Planning Framework

The following discussion describes the planning context in which the proposal will occur. The purpose of the discussion is to identify the suitability of the proposal with regards to land use planning policy in terms of physical and economic attributes.

The principal land use planning documents which set the framework for development of the Port are:

- Port of Hay Point Land Use Strategy Plan;

- ▶ Great Barrier Reef Marine Park Plan;
- ▶ Great Barrier Reef Coast Marine Park; and
- ▶ Whitsunday Hinterland and Mackay Regional Plan 2015.

Port of Hay Point Land Use Strategy

PCQ has developed the Hay Point Land Use Strategy (PCQ 2003) (the Strategy), which is intended to provide a framework to guide the future planning and development of the Port.

The objectives of the strategy are to:

“accommodate the growth of the port services and facilities to maximise its contribution to the economic development of the region; and manage the impacts of port expansion on the environment and adjacent residential areas, and its relationship with the recreational port users.”

The Strategy identifies a number of Land Use Areas, these include:

- ▶ port handling activities area;
- ▶ port related and support industry area;
- ▶ harbour and access area;
- ▶ environmental buffer area; and
- ▶ general buffer area.

Development within these designated areas is guided through an intent statement identifying specific development outcomes for the specified area. The intended development outcomes are supported by a number of performance criteria. The Strategy also identifies a range of indicative uses for each of the areas.

The proposed Apron Area will occur adjacent to the port access area. The intent of this area is to:

- ▶ protect the existing facilities and structures below high water mark that provide access to infrastructure; and / or
- ▶ assist in the efficient operation of the Port.

The proposal will meet both the intended outcomes through enhancing access to the berth facilities and facilitating greater efficiency in the operation of the Port. Currently vessel movements are restricted by tidal conditions. The proposal will allow unrestricted vessel movements, resulting in a significant reduction in the time a vessel is in dock, reducing vessel-operating cost per ton of coal loaded and transported.

The indicative uses identified for the study area are:

- ▶ navigational equipment or aids;
- ▶ dredge channels;
- ▶ swing basins;
- ▶ wharfage/ docking facilities;

- ▶ tug facilities; and
- ▶ recreational and leisure facilities (fishing and sailing).

The proposed development is consistent with:

- ▶ the intent of the Port and Access area;
- ▶ the performance criteria of the area; and is
- ▶ identified as an extension to an indicative use.

Great Barrier Reef Marine Park Zoning Plan 2003

The *Great Barrier Reef Marine Park Zoning Plan 2003* (GBRMPA 2004) is the primary planning instrument for managing activities within the Marine Park.

The 'Zoning Plan' is comprised of:

- ▶ Zoning plans – which identify a number of area use zones within the Marine Park; and
- ▶ Overlay Areas – which regulate activities within specific areas of the marine park.

Zoning

The Study Area is located within the General Use Zone of the Marine Park. The objective of the General Use Zone is to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use.

A permit is required for carrying out work for a purpose that is consistent with the objective for the zone, including:

- ▶ dredging; or
- ▶ dumping of spoil; or
- ▶ reclamation; or
- ▶ beach protection works; or
- ▶ harbour works;

Overlay / Designated Areas

The Zoning Plan identifies three kinds of designated areas:

- ▶ Shipping Areas
- ▶ Special Management Areas
- ▶ Fisheries Experimental Areas

Of these only the first is relevant to the Project. Part 10 of Schedule 1 of the Plan identifies shipping areas that facilitate passage of commercial vessels through the Marine Park. Whilst outside the port limits this area is an important operational element of the Plan and enables access to the Port.

Great Barrier Reef Coast Marine Park

The GBRMPA boundary overlaps in boundary with the Great Barrier Reef (GBR) Coast Marine Park, a state marine park. The Queensland Parks and Wildlife Service (QPWS) is responsible for the day-to-day management of the park environs and the regulatory authority responsible for issuing state permits.

Marine parks are established over tidal lands and waters to protect and conserve special areas while allowing for the planned use of marine resources. Multiple-use management allows for many different activities in marine parks. Zoning plans set out the kinds of activities that can occur within each area. The zoning plan for the GBR Marine Park reflects that of the GBRMP.

Whitsunday Hinterland and Mackay (WhaM) Regional Plan 2015

The objective of the Whitsunday Hinterland and Mackay (WhaM) Regional Plan 2015 (DLGPSR 2002) (the Plan) is to provide a formal framework to manage and guide ecological sustainable development within the context of the WHaM Region. The region includes the Whitsunday area, including Sarina Shire and Mackay City. The Plan identifies the vision for the WHaM Region within 80 desired regional outcomes and also identifies 360 key regional issues. In addressing these regional issues a number of goals and strategies have been developed to facilitate the achievement of the desired regional outcomes.

Relevant to this Project are the achievement of goals in relation to infrastructure and transport. The Project will increase efficiency in operation of the Port's existing infrastructure. The proposed dredging will increase the declared depth of the Departure Path to 14.9 m depth enabling visiting ships to depart fully loaded and improve shipping movements.

3.11 Socio-economic Environment

3.11.1 Introduction

This section of the EIS details the existing socio-economic environment that may be affected by the Project. Issues to be addressed include:

- ▶ community infrastructure and services;
- ▶ community profile, providing information on the following characteristics:
 - demography and family structure;
 - housing;
 - economic stability
- ▶ recreational, leisure and sporting activities which may be affected in particular relating to recreational fishing;
- ▶ the character and basis of the local and regional economies; and
- ▶ future economic opportunities.

3.11.2 Community Profile

Sarina Shire has a current population of about 9,980 people, with approximately one-third residing in Sarina Township. The balance is dispersed throughout the Shire's beach communities and smaller rural hamlets.

The Shire experienced reasonable growth between 1991 and 2001, increasing from 8,081 to 9,637 persons at a rate of 1.8% p.a., compared with the Mackay Statistical Division at 1.2% p.a. and Queensland at 2.1% p.a. The State Government's medium series projections suggest that the Shire's population growth will be moderate in future, reaching about 13,000 by 2026.

In terms of age profile, Sarina Shire has a median age of 35.8 years old and a high representation of adults aged over 40 at 44% (ABS, 2001). This reflects the Shire's appeal for retirees, particularly in beach settlements.

The communities of Half Tide, Salonika Beach and Louisa Creek are characterised by small population bases (approximately 1,300 residents in total) and a mix of housing stock, including both permanent residents and holiday homes. Recent population growth and new residential development has been focussed on the Half Tide / Salonika Beach area.

Louisa Creek is a smaller, longer established community, comprising approximately 90 residential dwellings and the Hector Sports Ground facility, including a community hall.

3.11.3 Recreational Activities

The residential communities adjacent to the Port utilise the coastal waters for recreational fishing and diving. Anecdotal evidence from discussion with members of the local community during the initial community consultation phase indicate that access for recreational fishing and diving, specifically at the existing spoil ground, are the principle concerns of the community.

Access to the Port is determined based on the designation of restricted areas by the MSQ Regional Harbour Master. Currently a single restricted area covers the Ship Loading Facility and part of the existing departure track. Within this area, un-authorised vessels are prohibited from mooring, anchoring or manoeuvring. Current gazetted restrictions are shown in Figure 3-45.

3.11.4 Regional Economic Context

The Port contributes significantly to the local, state and national economies. Locally the Port provides direct employment in port related activities for 764 full-time equivalent jobs. Port related activities are also credited with generating a further 1,188 flow-on jobs. The total of 1,952 full-time equivalent jobs earned an estimated \$85 million in household income in 2001/02. Direct and flow-on value added by the Port to the region has been estimated at over \$200 million (PCQ 2002a). There were 965 ship visits to the Port of Hay Point in 2003/04. The results of the analysis indicate that, on average, each ship call at the Port involved the following impact on the economy of Queensland:

- \$577,000 of output



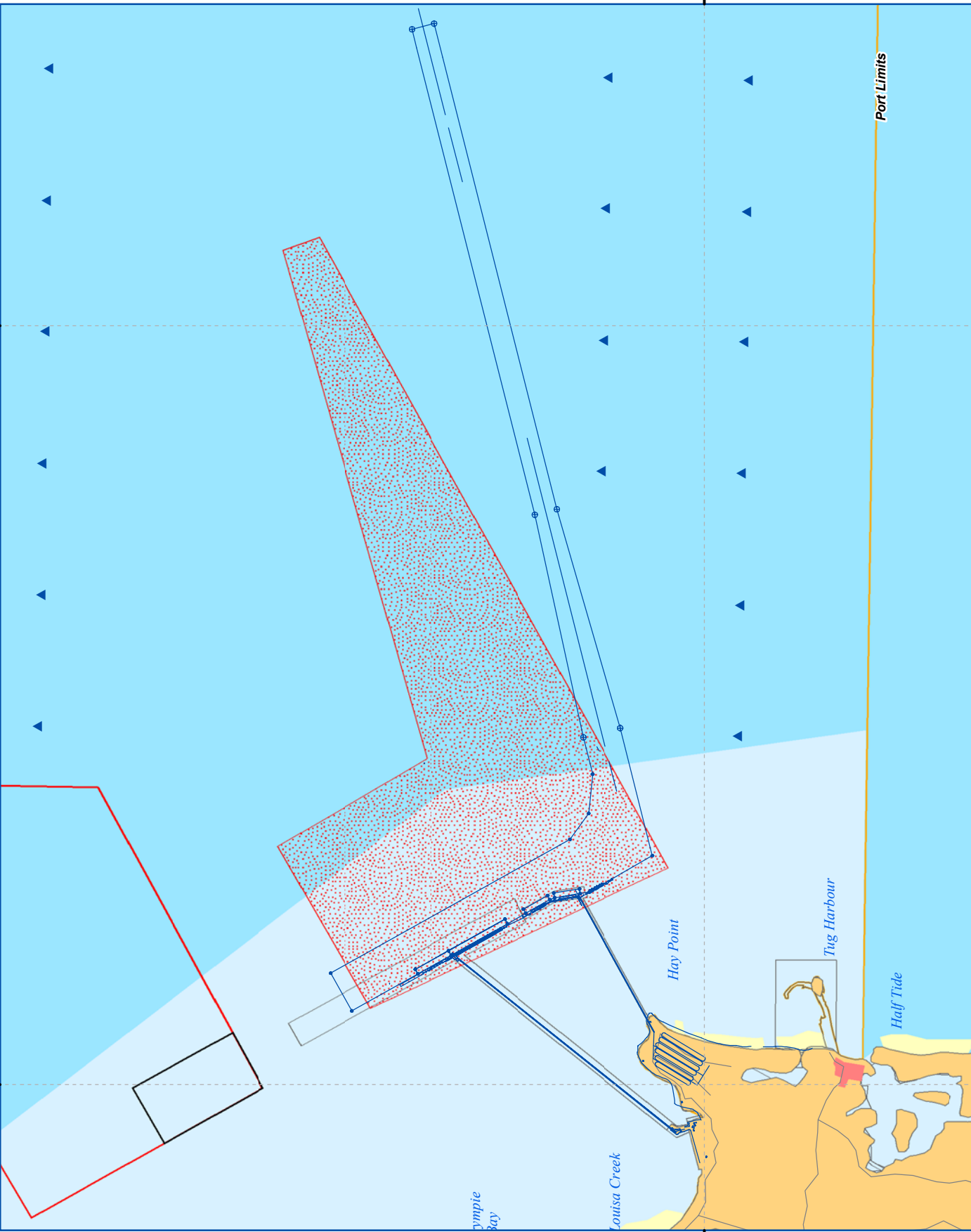
- ▶ \$268,000 of value added
- ▶ \$113,000 of household income
- ▶ 2.6 full-time equivalent jobs for one year.

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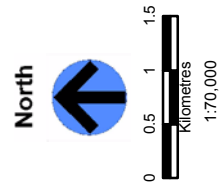
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**Port of Hay Point
Capital Dredging
Current Navigation
Restriction Area**

Figure 3-44

- Legend**
- Port Limits
 - Built Up Area
 - Major Roads
 - GRRMP
 - Sand / Mud
 - Anchorage
 - Proposed Spoil Ground
 - Existing Spoil Ground
 - Extent of Capital Works
 - Current Restricted Area



Source: GIS data supplied by
DRNM, PCQ
Projection: GDA 94, Zone 55
Date Printed: 06/07/05
File: G:\4113829\GIS\Arcview\Map\current_nav_restrict.mxd
Size: A4



3.12 Safety and Emergency Strategies

3.12.1 Overview

Safe operation is maintained through the implementation of a number of strategies developed by PCQ and MSQ. PCQ has statutory responsibility and powers under the *Transport Infrastructure Act 1994* to maintain the safety and security of the Port. MSQ has statutory responsibility for the safety of shipping across the State and is responsible for the safe pilotage of vessels entering the port and berthing facilities. Commercial and recreational fishing vessels have restricted access to parts of the port where they could affect the safety of shipping.

PCQ has in place an Emergency Response Plan designed to manage emergency events, including cyclones, marine incidents, bomb threats, fire, explosion or fatalities at the Port. Specific procedures referenced under this plan relevant to the proposed works include:

- ▶ Maritime Cyclone Contingency Plan developed and implemented through the MSQ Regional Harbour Master.
- ▶ Queensland Fire and Rescue Service from Sarina and Mackay would respond to any ship fire situation. Both coal terminals have fire mains on the wharves for use in fire situations. Emergency services in the Port are considered appropriate.

3.12.2 Oil Spill Response

PCQ has developed an Oil Spill Contingency Plan for the Port of Hay Point. However, MSQ is preparing an update to replace this plan, which will be documented in the Queensland Coastal Contingency Action Plan (QCCAP). QCCAP provides a risk assessment of ports across Queensland and documents response to oil spills in Queensland waters.

PCQ has a store of oil spill equipment for a first-strike response based in Mackay. This is complemented by MSQ's own equipment for use in a larger spill. MSQ staff from Mackay supplemented by PCQ's local staff person, will provide the initial response to an oil spill situation. Back-up resources if required will come from other MSQ bases in Queensland.

The equipment and resources for an oil spill response in the port have been assessed by MSQ and are considered appropriate. Because the proposed project does not involve any significant increase in shipping traffic, the existing response strategies are considered appropriate.

3.12.3 Maritime Security

The Port of Hay Point is a security regulated port under the Commonwealth *Maritime Transport Security Act 2003*. Security risk assessments on the port have been carried out and a security plan for the Port has been prepared and approved by the regulator,



the Commonwealth Department of Transport and Regional Services. Both internal and external audits of compliance with the plan are carried out annually.

PCQ has established a Port Security Committee involving Maritime Industry Participants in the Port. Meetings are held six monthly to coordinate an effective security response across the Port.

4. Description of Potential Impacts and Mitigation Measures

4.1 Introduction

The analysis of impacts should cover all aspects of the physical, social and economic environment. Impacts can be:

- ▶ adverse or beneficial;
- ▶ direct or indirect;
- ▶ short or long term; and
- ▶ local or regional.

Impacts should be considered for both the dredging and spoil relocation activities, including the construction, operation and maintenance phases of the Project. The local and regional cumulative effects of potential impacts should also be considered.

For each identified impact, a summary of the level of actual or potential harm or benefit should be provided in an appropriate level of detail.

Information on proposed mitigation measures and design requirements to mitigate negative impacts and enhance positive impacts should be provided for the issues identified.

Section 3.01 of Schedule 4 of the EPBC Regulations requires the following information relating to relevant impacts to be provided:

- ▶ a description of the relevant impacts of the action;
- ▶ a detailed assessment of the nature and extent of the likely short term and long term relevant impacts;
- ▶ a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
- ▶ analysis of the significance of the relevant impacts;
- ▶ any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

Section 4.01 (a), (b), (c), (e) and (f) of Schedule 4 of the EPBC Regulations requires the following information relating to proposed safeguards and mitigation measures to be provided:

- ▶ a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;
- ▶ any statutory or policy basis for the mitigation measures;
- ▶ the cost of the mitigation measures;
- ▶ the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;

- ▶ a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent.

The National Shipwreck Database records the location of known wrecks and the suspected locations of undiscovered wrecks around Australia. There is the potential for previously unrecorded shipwrecks to be found along any stretch of Australian coastline and as such the proponent needs to consider potential impacts and mitigation for this eventuality and their obligations under the *Historic Shipwrecks Act 1976*.

4.2 Discussion of General Impacts Associated with Dredging and Disposal of Dredged Material

4.2.1 Overview

Direct physical impacts will result from the dredging and disposal of dredged material (USEPA and USACE 1992). The likelihood of environmental impacts from the conduct of dredging operations varies according to key physical and operational factors (USACE and US EPA 2004, MEMG 2003). These can include:

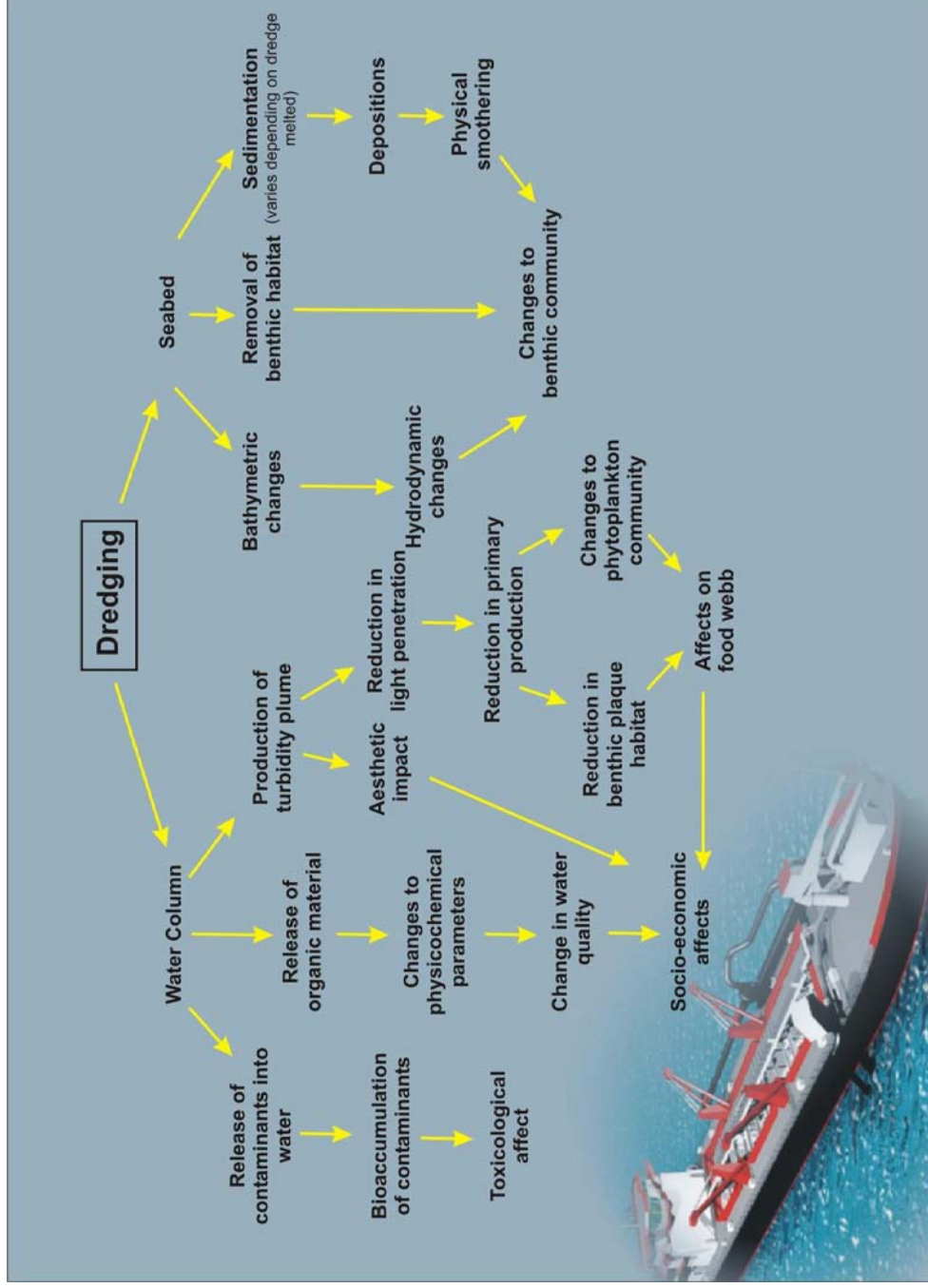
- ▶ the distribution and proximity to sensitive habitats;
- ▶ the style of dredging and disposal equipment used;
- ▶ physical nature of sediments being dredged and those of the spoil ground;
- ▶ quantity and quality of dredged materials;
- ▶ hydrodynamics of the spoil ground, including currents, depth, bathymetry and influence of wave action; and
- ▶ natural turbidity regimes and the adaptation of local flora and fauna to pulsed turbidity events.

As these variables change, so to do the likely ecological and socio-economic impacts of the dredging Project.

4.2.2 Dredging

The process of dredging releases previously stable sediments to the surrounding water column, resulting in a combination of water column and benthic impacts. The consequence of these processes on the marine environment is well understood (USACE 2005, MEMG 2003). The extent and nature of these impacts varies according to dredging methodologies, size of the dredge campaign, materials to be dredged, prevailing environmental conditions and location of sensitive receptors.

Capital dredging alters the seabed and removes benthic biota. The process of deepening channels and altering bathymetry has the potential to result in changed hydrodynamic regimes, alter the natural mobilisation of fine sediments and / or affect large-scale coastal processes. The following conceptual diagram describes the typical impacts of dredging (Figure 4-1) for this Project.

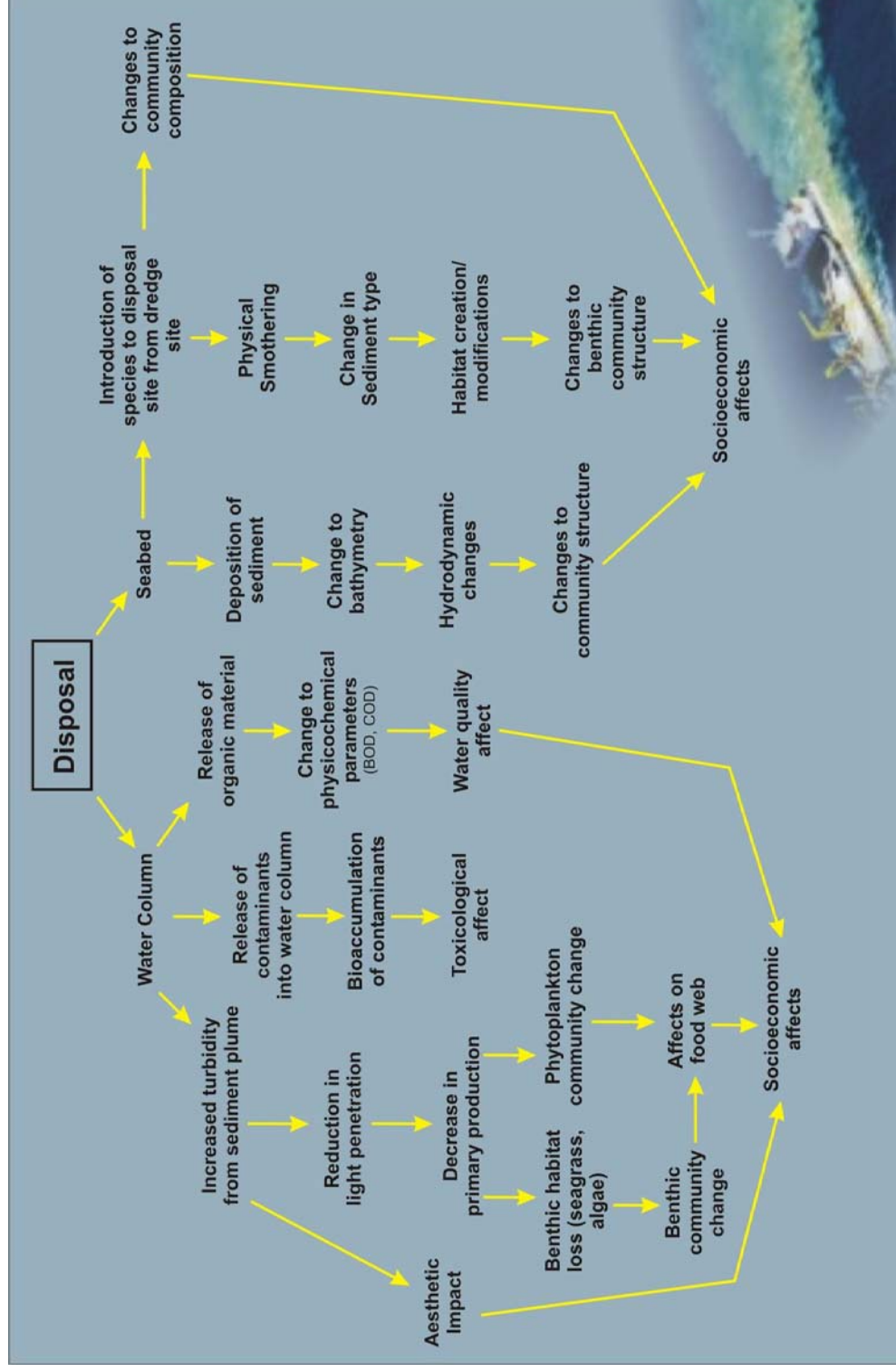


Source: after Elliot and Hemingway (2002)

Figure 4-1 Conceptual diagram illustrating the impacts of dredging

4.2.3 Spoil Disposal

The ocean disposal of dredged material from capital and maintenance dredging projects at a designated spoil ground will generate impacts to the marine environment, and has the capacity to influence a range of socio-economic factors. The magnitude of the impact will vary depending on amount of sediment dredged, frequency, localised physical conditions (currents, wind and wave action), chemical and physicochemical makeup of disposed sediment, type of ecological communities present and the anthropogenic use of the area. The disposal of material can impact on the environment by physically disturbing the benthic habitat and by causing changes to the water and sediment quality. The following conceptual diagram describes the potential impacts of spoil disposal (Figure 4-2) for this Project.



Source: after Elliot and Hemingway (2002)

Figure 4-2 Conceptual diagram of the impacts of the disposal of dredge derived spoil

4.2.4 Key Impacts of Dredging and Spoil Disposal

The following are considered key impacts of dredging and spoil disposal:

- ▶ Dredging of the sediments removes benthic habitats and the associated species;
- ▶ Alterations to the bathymetry affect re-establishment and suitability for biota changing likely future community structure;
- ▶ Sediment composition is changed. In the case of capital dredging, depth to unconsolidated materials is reduced. Consolidated material may now be exposed and be of reduced value as infauna and epibenthic fauna habitat. Natural processes of siltation will occur over time, introducing finer material to the dredged areas and facilitating recolonisation;
- ▶ Sediment mobilisation increases turbidity and displays potential ecological impacts;
- ▶ If contaminated, dredging and disposal of sediment has the capacity to release toxicants into the water column and increase overall bioavailability;
- ▶ Fine fractions of sediment can be available for migration over significant distances. In the appropriate conditions and over extended dredging periods, the impact of these fine particulates can be a significant ecological risk;
- ▶ Where sediments contain elevated nutrient concentrations, nutrient availability may increase during dredging and may cause some level of short-term eutrophication;
- ▶ Within heavily utilised port facilities, risks of the dredging and distribution of invasive or exotic pest species should be considered;
- ▶ Impacts on water quality can include oxygen depletion. In tidally affected waters with significant currents and flushing capacity, this risk is considerably reduced;
- ▶ Both pelagic and benthic organisms can be impacted from increased suspended solids and subsequent deposition. Impacts may be more significant at the disposal ground (covering with sediment) rather than the dredging location; and
- ▶ Dredging, mixing and deposition of sediments has the capacity to change chemical relationships, influence the availability of toxicants and change resulting benthic community structure.

4.2.5 Impact Assessment

The following sections provide a review of key impacts associated with the proposed works for the Port of Hay Point. The environmental impacts of capital and maintenance dredging at the Port of Hay Point have been studied and documented during past dredging campaigns. As such, the following assessment of potential impacts and recommended mitigation measures are based on information drawn from studies undertaken during previous dredging campaigns, coupled with a detailed literature review on the impacts of dredging and consideration of the results of detailed hydrodynamic modelling undertaken for this Project (see Section 4.4).

Assessment of impacts of the proposed capital dredging must be undertaken in the context of historical dredging and spoil disposal activities and the ongoing requirements for maintenance dredging of the Departure Path and Apron Area.

4.3 Marine Flora and Fauna

4.3.1 Introduction

The area proposed to be dredged is relatively undisturbed areas, particularly within the Departure Path. The following provides an assessment of the potential impacts of the Project on the marine flora and fauna within the study area, in particular, increased sediment deposition resulting from dredging, dredge spoil disposal, and resuspension of spoil, and potential impacts on marine biodiversity or biological processes should be discussed.

4.3.2 Mangroves and Salt Marsh Communities

Impact Summary

Impacts on mangrove and salt marsh communities resulting from dredging and spoil disposal potentially include physical removal and elevated turbidity and sedimentation.

Physical Removal

As there is no on-shore component to the proposed works associated with the dredging of the Departure Path and Apron Area, there will be no physical removal of mangrove and salt marsh communities associated with the Project.

Elevated Turbidity and Sedimentation

Mangrove communities at the Port of Hay Point are adapted to the turbid near shore environments of Dalrymple and Sandringham Bays. These communities are adapted to estuarine environments that are typically turbid and generally act as traps for fine sediments in near-shore environments.

Hydrodynamic modelling undertaken for the Project demonstrates that sediment plumes are not expected to migrate over these inshore communities and that significant changes to current direction and velocity are not expected (Section 4.4). Consequently, it is not anticipated that dredging will have a detrimental impact on the mangrove communities of the study area.

Mitigation Measures

As no impacts on mangrove and salt marsh communities are anticipated from this Project, no mitigation measures are proposed.

4.3.3 Seagrass Communities

Impact Summary

The distribution of seagrass within the port limits includes low to moderate cover over the soft sediment habitats within the inner Departure Path and proposed spoil ground.

Key potential impacts on these communities related to the proposed dredge works include:

- ▶ Physical removal; and
- ▶ Elevated turbidity and sediment deposition or burial.

Seagrass communities are an important part of coastal ecosystems. Seagrass beds slow water movement, causing suspended sediment to fall out of the water column and trapping nutrients that would otherwise disperse into the surrounding ocean (McKenzie and Campbell, 2002). Several key functions of seagrass communities are summarised as follows:

- ▶ Seagrasses are the primary producers that contribute to the large quantities of fixed carbons, the basis of all food chains to coastal ecosystems;
- ▶ Seagrasses are important in stabilising bottom sediment as they slow water movement, promoting the sedimentation of particulate matter;
- ▶ Seagrasses are a part of the nutrient cycle in the aquatic system;
- ▶ Seagrasses supply shelter and refuge for both adult and juvenile animals; they also contribute large amounts of substrate for encrusting animals and plants; and
- ▶ Seagrasses are essential food for dugongs and also green turtles.

The distribution and growth of seagrasses is regulated by a variety of water quality characteristics such as temperature, salinity, nutrient availability, turbidity, and submarine irradiance (Dennison and Kirkman 1996; Abal and Dennison 1996). For example, it is well documented that the availability of nutrient resources affects the growth, distribution, morphology and seasonal cycling of seagrass communities (Short *et al.* 1995). In addition, seagrasses depend on an adequate degree of water clarity to sustain productivity in their submerged environment (Short and Wyllie-Echeverria 1996). Increased turbidity and sedimentation reduce water clarity, which can affect the health and productivity of seagrass communities (Abal and Dennison 1996).

The following details the likely impacts on seagrass communities associated with physical removal and elevated turbidity and sediment deposition.

Physical Removal

Burial, removal or direct disturbance of the seagrass identified within the dredging areas and adjacent to the proposed spoil ground will occur as a result of the proposed dredging and spoil disposal (WBM 2004 and Rasheed *et al.* 2004). The predicted extent of these impacts is outlined within Table 4-1. These communities represent low to moderate density seagrass habitats dominated by *Halophila decipiens* and *Halophila spinulosa* (Figure 4-3).

Table 4-1 Summary of seagrass directly impacted

Community \ Location	Departure Path	Proposed Spoil Ground
<i>Halophila decipiens</i> & <i>Halophila spinulosa</i> (<5%)	~118 ha	~965 ha
<i>Halophila decipiens</i> & <i>Halophila spinulosa</i> (5 – 20%)	~11 ha	~441 ha
<i>Halophila decipiens</i> & <i>Halophila spinulosa</i> (<20%)	0 ha	~30 ha



Halophila decipiens



Halophila spinulosa

Figure 4-3 Primary seagrass species recorded at the Port of Hay Point

Elevated Turbidity

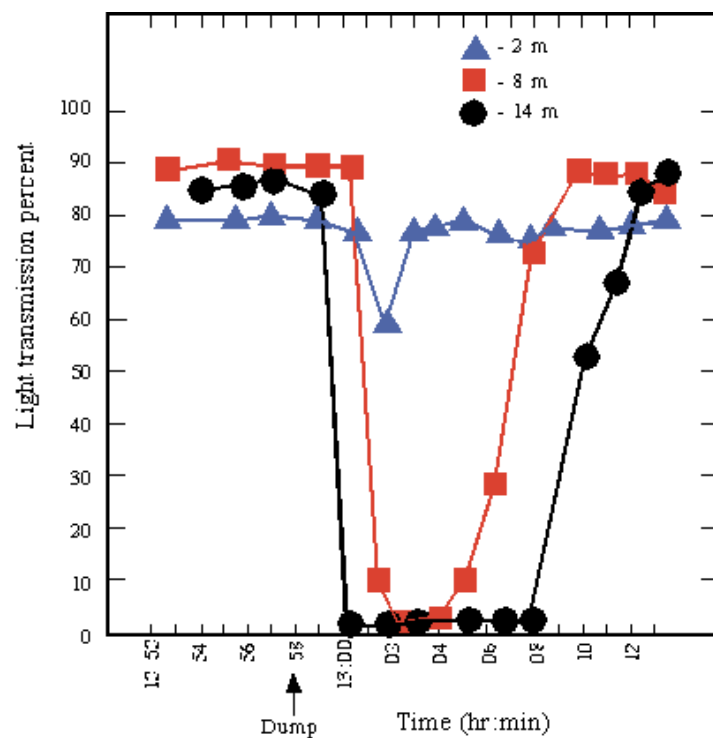
The level of impact that elevated turbidity during dredging and the disposal of dredged material will have on the seagrass will depend on the type of community that is present. Some seagrass species may be better adapted to variable light regimes and therefore tolerate high levels of suspended sediment and turbidity.

Variable turbidity regimes in the study area suggest that existing seagrass species distributions are adapted to temporal changes in turbidity. High levels of turbidity for long periods can place a major stress on primary producers such as algae, phytoplankton, and seagrasses. Seagrass has a relatively high light requirement, with most species requiring between 15 and 25% of surface irradiance to maintain key physiological processes (Biber *et al.* 2005, Cheshire *et al.* 2002).

The reduction in light due to turbidity plumes from dredging has been previously documented as a key factor in seagrass mortality in Australia (Shepherd *et al.* 1989). Issues related to the maintenance of light availability are paramount to managing

seagrass habitats (Deocadiz and Montano 1999). Prolonged turbidity such as that generated from extended dredging programs can lead to the attenuation of light, limiting photosynthesis and subsequently elevate the stress experienced by seagrass meadows.

Figure 4-4 shows the light reduction resulting from the typical passage of the turbid plume associated with the open water disposal of dredged sediments. Near the surface, at 2 m depth, the turbidity persisted at a location down current from the dump site for approximately 2 minutes. Near the bottom of the water column at 14 m, the turbid plume persisted for approximately 7 minutes.



Source: Lee & Jones 1992

Figure 4-4 Light transmission percentage during typical passage of the turbid plume associated with the open water disposal of dredged sediments

Sedimentation

Seagrass may suffer impacts resulting in the smothering of existing substrates by sediments settling from the water column during the dredging and disposal process. Smothering of seagrass can weigh down leaves, restrict light penetration and cause stress on the plants.

Dumping of dredge spoil in the proposed spoil ground will result in the total smothering of existing seagrass communities in this area. Communities directly adjacent to the spoil ground, but within the influence of the predicted fallout of fine sands may also be

affected. Importantly, modelling shows that the very mobile clay and silt size fractions are not at significant risk of deposition over seagrass habitats.

It is also important to consider the current sediment type at the spoil ground to the sediment to be dredged as changes to particle size can alter the suitability of the habitat for some species to recolonise. Reduction of a seagrass community was observed in one study when the substrate changed from sand to mud (Hopkins and White 1998).

Recovery of Seagrass Communities from Sedimentation

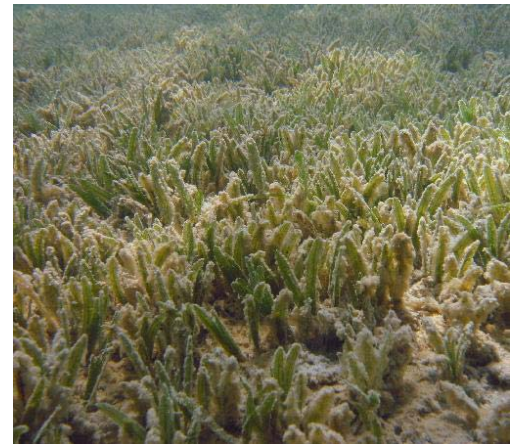
Despite the physical impact of sedimentation, seagrass communities maintain a natural resilience to the mobilisation and deposition of sediments (Figure 4-5). Physical disturbance is considered one of most important factors affecting the spatial structure and species diversity of seagrass communities (Fonseca and Kenworthy 1987, Clarke and Kirkman 1989). While disturbance is considered a significant factor in the distribution of species, tolerances to disturbance and sediment deposition vary between species. For example, large seagrass species such as *H. decipiens*, present at Hay Point, can maintain substantial photosynthetic surface even after large-scale burial. Small species such as *Halodule sp.* or *Halophila sp.* are often completely removed after very small sedimentation events. However these species tend to grow very quickly and recover to pre-event abundances in a short period of time (Duarte *et al.* 1997).

In a study undertaken by Sheridan (2004), the impact of sediment disposal from maintenance dredging on adjacent benthic habitats was measured. The study showed that seagrass populations in the area of disturbance were well established three years after dredging.

Despite the periodic impact of spoil disposal, the identification of seagrass communities within the existing spoil ground demonstrates the capacity for local species, under local environmental conditions and constraints, to recover and develop communities which reflect habitats outside the current spoil ground.



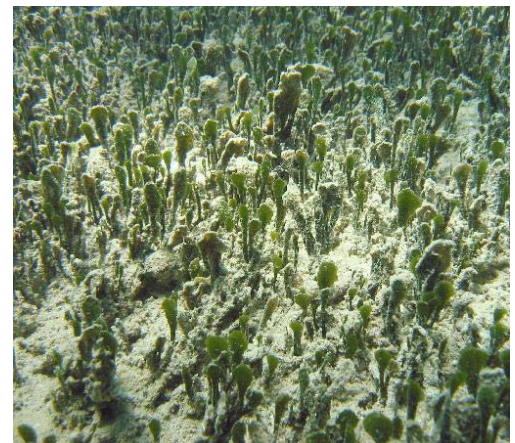
Fine sediment deposition following suction dredge disposal (30 mm – 50 mm) (GHD 2002b)



Natural deposition over near-shore seagrass beds (GHD 2004c)



Natural deposition over near-shore seagrass beds (GHD 2004c)



Natural deposition over near-shore algal bed (*Codium* sp.) (GHD 2004c)

Figure 4-5 Seagrass and algal tolerance to sediment deposition events

Conclusions

Hydrodynamic modelling predictions indicate that turbid plumes generated by dredging and spoil disposal are likely to migrate over seagrass beds located within the port limits. The concentration and movement of sediment plumes is likely to be such that any significant reduction in light penetration caused by the increase in turbidity will be of relatively short duration and within the natural range of turbidity experienced by these seagrass communities. Modelling demonstrates a strong tidal influence (spring/neap) on the predicted concentrations of the plume, with turbidity increasing as tidal range and flow increase. *In-situ* turbidity meters deployed at the spoil ground, Round Top Island and Victor Islet recorded similar results during a spring tide in the absence of dredging. Both the model predictions and data observed in the field show cyclical elevations in turbidity, typically extending over a 10-day period.

Seagrasses established within the near-shore coastal waters surrounding the Port experience fluctuations in physical extremes, including variable salinity, light penetration, turbidity and sediment deposition regimes. Significant episodic elevations in turbidity occur naturally during wet season storm events and the passage of catastrophic events such as tropical cyclones. Despite these factors, and the history of dredging and disposal at the Port, seagrass communities have colonised the existing spoil ground and adjacent substrate.

Short term increases in turbidity associated with dredging and disposal are considered unlikely to impact significantly on the broader distribution of seagrass within the study area for the following reasons:

- ▶ The documented survivorship of seagrasses in reduced light environments;
- ▶ The pulsed nature of turbidity impact over the dredging period resulting from broken cycles of dredging and disposal and the physical influence of neap and spring tide variations on predicted/observed turbidity;
- ▶ Natural variability of the existing turbidity regime within the near-shore waters surrounding the Port; and
- ▶ Demonstrated colonisation of the existing disposal ground following previous dredging activities.

Approximately 1,565 ha of seagrass will be physically disturbed during the proposed works, with ~129 ha attributable to dredging and 1,436 ha to disposal. This equates to approximately 28% of total seagrass cover recorded within the port limits (Rasheed *et al.* 2004). Approximately 70% of the impact due to dredging and disposal (1,083 ha) equates to low density habitat (<5% cover). Low to moderate cover communities (5 – 20% cover) represent approximately 28% of the impact area (452 ha), while the remaining 2% (30 ha) relates to higher density habitat (20% cover). The communities present within the spoil ground and Departure Path do not appear to contain unique species that are not widely represented in surrounding areas.

While seagrass communities within the proposed spoil ground and Departure Path will be impacted, the recovery of seagrass is likely to occur over a period of years (Sheridan 2004, Longstaff & Dennison 1999, Vermaat *et al.* 1996 and Kaldy *et al.* 2004). The identification of seagrass communities within the current spoil ground at the Port of Hay Point (Rasheed *et al.* 2004), and other Queensland Ports (Rasheed *et al.* 2003, 2004, Neil *et al.* 2003 and GHD 2005) confirms that the ongoing practice of capital and maintenance dredging should not be considered mutually exclusive to the continued colonisation of seagrass. Rather, the identification of low to medium density benthic communities within the existing spoil ground suggests a long-term compatibility between spoil disposal and the subsequent colonisation of this modified habitat by benthic biota (GHD 2005).

The ephemeral nature of the species identified within the port limits and the fact that this is the first detailed survey to identify the presence of seagrass, suggests that the presence or absence of seagrass within the port limits is likely to be attributed to environmental parameters unrelated to spoil disposal. It was suggested that atypical climate conditions in central Queensland may have created conditions suitable for the

establishment of these species (Rasheed *et al.* 2004). Therefore, the extent to which these communities will recover and the timeframe in which this occurs are likely to be influenced by local environmental and climatic conditions.

Acute Impacts

The process of dredging and spoil disposal is expected to cause immediate mortality in seagrass located within the dredge footprint and proposed spoil ground as a result of physical disturbance and smothering. As described in Table 4-1 this is expected to total ~1,436 ha of predominantly low density seagrass.

Chronic Impacts

As previously discussed, the benthic survey associated with the present study has identified low-density seagrasses on the seabed surrounding Hay Point. It is expected that this seagrass is likely to be occupying a depth strata that is at the lower limit of its range for the study area. It is also expected that this seagrass will undergo natural mortality during the winter period (Rasheed pers. comm. 2005).

As outlined for benthic infauna, sediment deposition associated with plume migration is not expected to be of a sufficient rate to markedly influence seagrass mortality, distribution or abundance through smothering. However, impacts associated with the reduction in light penetration (light attenuation) are expected as a result of increased turbidity within the path of plume migration. Modelling indicates that a turbid plume will reside in coastal waters between Victor Islet and Round Top Island. At deeper locations, such turbidity is likely to cause measurable light attenuation. This may interfere with the photosynthetic processes of seagrasses residing at their lower depth range thus impacting on the long-term metabolic maintenance of this flora. It is difficult to attribute the relative likely contribution of natural seasonal dieback in seagrass during the dredge window with that resulting from plume-generated light attenuation. Implementation of a seagrass monitoring program during the dredging operation may assist in such determinations.

The existing spoil ground that was last used in 2001 and 2003, had a medium density seagrass coverage in parts of it in the 2004 survey. This indicates the seagrass in the area being a pioneering species, can recover relatively quickly from dredging disturbance, given the appropriate climatic conditions. Impact on seagrass is expected to be transient except in the narrow Departure Path route, which will be regularly dredged.

Mitigation Measures

The main mitigation measure proposed is to limit the period of dredging to as short as possible. A large dredge (to be sourced from overseas) will be used to minimise the dredging period and the possibly a second dredge will be investigated. Dredging will also be limited as far as practicable to the cooler months during which time seagrass is more dormant and recovery of seagrass is to be expected by avoiding the summer months. Another measure to reduce the period of impact is to operate the dredge in a standard overflow mode. The use of non-overflow dredging considerably increases the duration of dredging from and expected 6 months up to 18 months. This longer period

of dredging could have a chronic impact on seagrass. Non-overflow dredging is further discussed in Section 4.4.

The proposed spoil ground has been located further seaward to avoid the area of medium density seagrass present adjacent to the existing spoil ground. This location places the spoil in deeper waters where the seagrass density is limited due to the naturally lower levels of light penetration through the water column.

Mitigation of impacts to seagrass communities will be incorporated into the monitoring process controlling dredging and disposal activities. Monitoring will be undertaken in accordance with DPI&F policies and requirements and serve to denote likely risks of broad scale seagrass impact via the assessment of available light, a key factor in the determination of seagrass community health. The conduct of field validation sampling during the dredging campaign will allow recalibrated model runs to provide an improved estimate of light limitation over the dredging period. Further details of the proposed monitoring program are referenced in Section 5.

4.3.4 Algal Communities

Impact Summary

The distribution of algae within the port limits includes low to moderate cover over the soft sediment habitats within sections of the proposed dredging and spoil ground. Key potential impacts on these communities related to the proposed dredge works include:

- ▶ Physical removal; and
- ▶ Elevated turbidity and sediment deposition.

The potential impacts of dredging and spoil disposal on algal communities are similar to those discussed in detail for seagrasses in Section 4.3.3. The following details the likely impacts on algal communities associated with physical removal and elevated turbidity and sediment deposition.

Physical Removal

Burial, removal or direct disturbance of the algae identified within and adjacent to the proposed spoil ground and dredging areas will occur as a result of the proposed dredging and spoil disposal. The predicted extent of these impacts is outlined within Table 4-1. These communities represent low to moderate density algal communities containing various filamentous and erect species of red, green and brown algae.

Table 4-2 Summary of algae to be removed

Location	Apron Area	Departure Path	Spoil Ground
Filamentous with mixed sp. (< 5%)	0 ha	~95 ha	~305 ha
Filamentous with mixed sp. (5 – 20%%)	0 ha	~25 ha	0 ha

Location	Apron Area	Departure Path	Spoil Ground
Mixed erect macros with mixed sp. (<5%)	~95 ha	~185 ha	~710 ha
Mixed erect macros with mixed sp. (<5%)	0	0	~910 ha
Mixed erect macros with mixed sp. (<5%)	0	0	~35 ha
G. marginata with mixed sp. (<5%)	0	0	~5 ha

Elevated Turbidity and Sedimentation

The impact of elevated turbidity and sedimentation on algae is similar to that documented for seagrasses. While the algal communities present within the port limits are likely to be adapted to variable turbidity regimes experienced in the study area, prolonged high levels of turbidity have the potential to place stress on these communities.

Dumping of dredge spoil in the proposed spoil ground will result in the total smothering of existing algal communities. Communities directly adjacent to the spoil ground, but within the influence of the predicted fallout of fine sands will also be affected. Importantly, modelling shows that the very mobile clay and silt size fractions are not at significant risk of deposition over algal habitats.

A change in sediment type within the spoil ground post-dredging may also alter the suitability of the habitat for some species.

Recovery of Algal Communities from Sedimentation

Despite the periodic impact of disposal, the identification of algal communities within the existing spoil ground demonstrates the capacity for local species, under local environmental conditions and constraints, to develop communities which reflect habitats outside the current spoil ground.

Conclusions

The communities present within the spoil ground represent a small proportion of the overall habitat within the study area and these communities are not considered to represent unique species or habitats that are not represented in the surrounding areas. As was discussed in reference to seagrass communities, it is anticipated that, depending on local environmental conditions, the algal communities will display the same level of recovery from dredging and spoil disposal as has been noted after previous dredging campaigns.

Mitigation Measures

The main mitigation measures for algal communities are the same as those for seagrass communities. The duration of dredging will be minimised as far as practicable.

and the location of the spoil ground avoids areas of medium density algae adjacent to the existing spoil ground.

As is the case for seagrasses, mitigation of impacts to algal communities will be incorporated into the monitoring process controlling dredging and disposal activities in accordance with DPI&F policies and requirements. The conduct of field validation sampling during the dredging campaign will allow recalibrated model runs to provide an improved estimate of light limitation over the dredging period.

4.3.5 Coral

Impact Summary

Reef environments are considered sensitive to changing sediment regimes. Although corals colonising near-shore shallow systems surrounding the Port of Hay Point have evolved a natural tolerance to increased turbidity (Section 3.2.4), additional turbidity and sedimentation resulting from dredging activities has the capacity to present added physiological stressors. Increased turbidity reduces light penetration, reduces growth and over the longer term may even influence the survival of a community. Increased sedimentation may smother corals, lead to increased energy consumption via cleaning processes, reduce fecundity and limit the viability of recruitment by reducing suitable substrate for colonisation. Depending on the scale of dredging operations, proximity to coral habitats and operational processes, coral system can demonstrate a combination of lethal and sublethal effects to these stressors.

This section details the key impacts anticipated from the proposed dredge and disposal program on coral habitats within the vicinity of the Port of Hay Point. The possible risks to the short and long-term condition of these habitats are discussed, along with the significance of the likely impacts and proposed mitigation measures.

The distribution of coral in the wider Hay Point area is limited to low to high percentage cover communities at Victor Islet, Round Top and Flat Top Islands. As well as occasional scattered individual soft corals over the soft sediment habitats within the area to be dredged and the proposed spoil ground.

Specific potential impacts on these communities relate to:

- ▶ Physical removal;
- ▶ Elevated turbidity and sedimentation; and
- ▶ The risk of elevated nutrients and toxicants within the water column and deposited sediments (see Section 4.5 and 4.6).

The following sections detail the likely impacts on coral communities associated with physical removal and the processes of elevated turbidity and sediment deposition.

Physical Removal

Removal or direct disturbance of coral communities is expected within the soft sediment habitats adjacent to or within the proposed spoil ground and proposed Departure Path (Rasheed *et al.* 2004). These communities represent low to moderate

density habitats for hard and soft coral taxa. While the removal and disturbance of a very small number of individual soft corals within the spoil area and dredging areas will be total and complete, recovery of biota within the proposed spoil ground is likely to occur within a period of month to years. Section 4.3.11 outlines the process of spoil ground recovery following dredge disposal.

Fringing coral reef communities located at Victor Islet, Round Top and Flat Top Islands will not be affected by physical removal or spoil disposal. Predicted impacts to these communities have been based on the plume modelling completed by GHD (2005) and previous plume monitoring works (Section 3.5).

Elevated Turbidity and Sedimentation

Excessive sedimentation from human activities constitutes one of the largest sources of coral reef degradation (Rogers 1990). Anthropogenic sources include, construction activities, dredging, drilling at sea and runoff from river catchments through the removal of riparian vegetation, upstream deforestation and agriculture. Primary responses of coral communities to elevated turbidity and sediment loads include:

- ▶ Changes in community composition (species distribution and abundance);
- ▶ Partial mortality (bleaching) or mortality as a result of smothering and light attenuation;
- ▶ Bacterial infection;
- ▶ Disturbed energy budgets (heterotrophy/autotrophy);
- ▶ Increased energy demand to maintain sediment rejection mechanisms; and
- ▶ Impact upon fecundity, fertilisation and recruitment/settlement.

Corals are adapted to the periodic elevation in turbidity and sediment deposition. The extent to which turbidity and sedimentation influences these stress responses relates to the temporal occurrence of the impacts. In the case of dredging, extended changes in suspended sediment and deposition regimes have the capacity to affect coral community health.

Sedimentation

Various studies have recorded reductions in coral cover and diversity from increased sediment loads resulting from dredging and construction activities (Brown *et al.* 1990, Cortes and Risk 1985). Amerson and Shelton (1976) recorded a 40% reduction in coral cover due to siltation resulting from airfield construction activities. Such impacts have the capacity to change coral community composition in the short term due to increased mortality, and also to produce chronic impacts, which favour the establishment of sediment tolerant species (Cortes and Risk 1985).

Although most coral species can withstand low sedimentation rates, high sedimentation or extended turbidity events introduce sediment particles, which reduce available light for photosynthesis. Zooxanthellae, located within the coral polyps, provide the majority of energy for reproduction, feeding and growth in many coral species. Reduction in available light and the associated decrease in photosynthesis,

increases the overall respiration of by coral polyps (Reigal and Branch 1995, Yentsch *et al.* 2002). With increasing sedimentation, and increasing stress, growth, reproduction and the ability of colonies to maintain metabolic processes such as feeding decline. Dodge *et al.* (1974) recorded low growth rates of the hermatypic coral *Montastrea anularis* in areas of high resuspension of bottom sediments. Where elevated sediment and low light conditions remain for extended periods, zooxanthellae cells can be released from the polyp resulting in bleaching (Bak 1978, Lasker 1980 and Rogers 1983).

Modelling of expected sedimentation (see Section 4.4) identifies minor sedimentation of the fringing coral reefs at Round Top and Flat Top Islands over the modelling period. The depth of sedimentation is not predicted to exceed ~2 mm over 50 days and will occur only on the southern side of the islands. This level of sedimentation is considered minor and within the natural range of conditions likely to be experienced by these reef systems due to storm events.

Sediment Removal

The processes of wind, wave and tidal exchange generate a continual flux of suspended sediment over reef communities. The intensity of these variations depends largely on the location of coral systems and leads, over time, to the establishment of systems adapted to the prevailing sediment regimes. Near-shore and shallow water corals, such as those identified at Hay Point, remain exposed to the processes of land based sediment mobilisation, while off-shore systems are less influenced by catchment-derived impacts. Natural conditions, such as spring tides, high wind and increased outflow from rivers and estuaries, increase sediment loads and sediment resuspension. Depending on prevailing sediment characteristics and tidal conditions, increased catchment flows can produce naturally turbidity with suspended sediment concentrations approaching 100 mg/L (Nightingale and Simenstad, 2001).

Sedimentation rates of up to 200 mg/cm² are not uncommon on Australian reefs for short periods (days-weeks) (Stafford-Smith 1993). Hydrodynamic modelling (see Section 3.3 indicates that the reef communities at Flat Top and Round Top islands are subject to strong currents and tidal movements which act to remove sediment deposition naturally. This processes is most noticeable on the eastern side of each island where currents are stronger than those on the leeward side of the islands.

To cope with these pressures, corals maintain a range of different mechanisms by which sediments can be removed (Figure 4-6). Key processes include either 'active' (behavioural) or 'passive' measures. Passive measures include colony morphology, skeletal structure, turbulence, and gravity (Stafford-Smith 1993). Active sediment rejection from corals surfaces occurs through the following key processes:

- ▶ Ciliary action;
- ▶ Mucus entanglement;
- ▶ Polyp or tissue expansion; and
- ▶ Tentacle activity.



Importantly, although corals display adaptations to sediment removal, the maintenance of these processes place a stress on the polyps and coral colonies in terms of energy consumption, which diverts resources that may otherwise be applied to reproduction, feeding activity or growth (Abdel-Salem and Porter 1989, Barnes and Lough 1999 and Bak 1978). Demonstrated effects of energy consumption due to increased turbidity have been shown by Stafford-Smith (1993), where the continued sedimentation over *Fungia* sp. corals caused tissues to slow in mucus secretion and ultimately cease production altogether.

Whilst short-term event based deposition may affect particular parts of the coral colony (i.e. upper surfaces), light and continuous 'rains' of fine sediments from extended turbidity events may require a consistent and broader involvement of all coral tissues, resulting in a wide energy drain on the colony. Maintenance of these conditions over an extended period has the capacity to further stress corals making them at risk of chronic sediment exposure effects (Stafford-Smith & Ormond 1992).



Figure 4-6 Occurrence of fine sediment deposition over scattered corals within 80 m of a subsurface pipeline sediment discharge from cutter suction dredging

Elevated Turbidity

Modelling of expected turbidity (see Section 4.4) shows the predicted elevations in turbidity that will be experienced by the fringing coral reef communities at Round Top and Flat Top Islands and Victor Islet in detail. Sediment plumes will extend over these communities, but at relatively low concentrations.

High natural background turbidity should be taken into account when assessing the impact of elevated turbidity resulting from dredging and spoil disposal on coral communities. High turbidity due to the influence of wind and wave action on localised sediments is likely to affect coral diversity and abundance compared to other reefs in less turbid areas (Endean 1976, Stoddart 1969 and Johannes 1972, 1974). High levels of turbidity limit reef development by decreasing light penetration and restricting the depth range at which corals can develop (Rogers 1990, Hopley 1994). Roy and Smith (1971) discovered that high turbidity decreased coral coverage compared to a nearby clear water areas. Lower coral species diversity was found on a Puerto Rico reef because of sedimentation and turbidity in the water (Loya 1976).

Analysis of natural variability in suspended sediment regimes confirms that the coral communities at Hay Point regularly experience pulses of elevated turbidity ranging from very short duration (10 – 20 mins) at concentrations of >50 NTU to longer duration (~10 days) at concentrations of between 5.3 NTU and 9.5 NTU. These concentrations represent mean turbidity recorded during elevated sea conditions between 20 and 30 May 2005.

Fecundity and Recruitment

Suspended sediment has been shown to affect coral fecundity (Tomascik & Sander 1987), fertilisation, larval survival, and larval settlement in scleractinian (hard coral) species (Gilmour, 1999). Decreased coral fecundity and larval survivorship subject to elevated suspended sediment loads is likely to result in decreased rates of recruitment for coral species (Gilmour, 1999).

Increased turbidity, and associated deposition, either natural or anthropogenically derived, can affect the recruitment of corals. Gilmour (1999) identified during experiments, that increased sediment loads (100 mg/L – 50 mg/L) influenced successful fertilisation and subsequent larval settlement onto substrates. If dredging and disposal activities were to continue through the coral spawning and post spawning periods, the viability of Hay Point coral systems as successful donor and receiving sites for recruitment may be affected for the year of dredging.

Tolerance and Recovery Background Literature

Depending on the levels of heterotrophy and autotrophy, coral species are likely to demonstrate wide variations in sediment tolerance (Stafford-Smith 1993). Stafford-Smith (1993) explored the relationships between increased sedimentation and removal efficiencies of several coral species. Of all the species surveyed, investigations concluded that both *Montipora* and *Porites* colonies recorded < 50% sediment clearance after two days, as compared with other corals which cleared >50 – 90% of sediment. Both species are represented within the fringing reef communities of Hay Point.

Porites and *Montipora* recorded tissue damage as bleaching in approximately 80% of the replicates studied. Interestingly, neither *Porites* nor *Montipora* exhibited tissue mortality while several other species, which successfully cleared up to 90% of their tissues after 2 days, later experienced tissue death. These species included *Favia stelligera*, *Gardineroseris planulata* and *Leptoria phrygia*, where between 5 – 20% of tissue died following sedimentation tests. Despite the extensive bleaching recorded in *Montipora* and *Porites* colonies, these test species recovered fully following completion of the study.

Rice and Hunter (1992) conducted burial trials of several coral species, recording the lethal response of 50% (LT50) of the population to sediment stress. LT50 was reached for all corals between 7 – ~15 days, suggesting a relatively high tolerance to sedimentation of corals associated with near-shore shallow reef systems. Telesnicki and Goldberg (1995) identified that after 2 – 3 days exposure to turbidity of 28 – 30 NTU, corals showed a significant increase in respiration activity. Higher metabolic rates described during this study are likely to be related to energy consuming behaviour such as mucus production and increased ciliar activity in an attempt to clean sediment from the coral surface.

Brown *et al.* (1990) monitored coral growth rate, abundance and diversity of intertidal reefs during a dredging operation in a tropical area. Results indicated significant reductions in abundance and diversity but no change in growth rate. The recovery of reef flats damaged by sedimentation during dredging recovered to pre-dredging levels 22 months after dredging had been undertaken. The rapid recovery was thought to be due to the presence of massive species that were only partially damaged and have the ability to regenerate tissue over formally dead surfaces (Brown *et al.* 1986).

In another investigation *Porites*, *Galaxea* and *Heliopora* sp. were found to be tolerant of burial up to 20 hours. Extended burial (68 hours) resulted in larger scale colour discoloration and bleaching. However, after 3 – 4 weeks considerable recovery was prominent due to regrowth of surrounding healthy tissues. The proposed dredging activities represent a potential environmental risk to sensitive marine habitats. In addition to direct impacts associated with the footprint of dredging and spoil disposal, impacts on benthic communities may be experienced through the migration of sediment plumes mobilised during the dredging and disposal process. Such plumes have the capacity to impact sensitive habitats outside the port boundaries.

Two principal concerns are associated with plume migration. Firstly, that increased turbidity within the water column may result in the attenuation of light to the seabed to such an extent that photosynthetic processes critical to the maintenance of benthic marine plants or corals are disrupted. Secondly, that seabed biota may be smothered by sediment that settles out of suspension during the dissipation of the plume. According to these potential impacts, two habitat types would appear to be of potential vulnerability during dredge activities; these being seagrass and coral.

Modelling undertaken as part of this EIS indicates that migration of the plume will extend northwards from the dredge area to Round Top Island, and southwards to Victor Islet. Fringing reef habitats exist around Round Top Island and Victor Islet. Modelling indicates that turbidity at these locations may be periodically altered by

plume migration, with turbidity being most elevated at Round Top Island. The tolerance of these coral communities to elevations in turbidity and their maintenance during the course of dredging is examined in the following sections.

Tolerance Thresholds and Curves

The capacity for a coral community to tolerate a particular regime of turbidity in the season monitored or sedimentation can be expressed as a set of tolerance thresholds or curves. These thresholds or curves reflect an acceptable range of variation, intensity, duration and frequency in turbidity or sedimentation for which the coral community is usually exposed. Although, there is inference that exposure to conditions outside the natural range may result in stress or impact to the community, this is not necessarily the case.

While such curves and thresholds are not commonly applied, they have been utilised in a number of major marine dredging projects to delineate and mitigate ecological impacts of sediment plumes on benthic communities (Grey & Jensen, 1993; Bach *et al.* 1997; Koskela *et al.* 2003; GHD 2003; McArthur *et al.* 2004). This section explores the natural tolerances of coral communities around Hay Point, and in conjunction with the modelled predictions of plume migration and intensity, will elucidate potential impacts associated with the dredging activity.

Natural Tolerance to Suspended Sediment

The Hay Point area is a harsh environment for corals and other reef organisms to live. The tidal range during spring tides is between 6 – 7 m and currents are strong and capable of resuspending fine silt. The three islands within the study area, these being Round Top Island, Flat Top Island and Victor Islet, are fully exposed to the predominant SE winds. Wave action also resuspends sediment and causes turbid water conditions. As a result, the fringing reef communities of these islands contain marine communities that are very silt tolerant, being well adapted to this low light, turbid environment.

Shallow exposed coastal reef areas such as those found within the study area are also susceptible to physical extremes, including cyclonic and storm wave action, freshwater inundation and high water temperatures (Berkelmans & Oliver 1999, Ayling & Ayling 1997, 2004). This probably leads to regular disturbance and damage of the reef communities. The absence of large coral colonies on these reefs indicates that frequent disturbance is a feature of the study area. The information presented in this EIS provides strong evidence that the coral communities of the study area are highly resilient to the potential impacts associated with the dredge process.

Development of Turbidity Tolerance Values

There is no direct information available on the physiological tolerance of sediment-tolerant corals of the study area to increased intensities, frequencies and durations of turbidity. However, indirect information can be obtained by examining the natural fluctuations in ambient conditions under which the coral communities are presently maintained. According to McArthur *et al.* (2004), the 95th percentile turbidity value represents a suitable tolerance threshold for a coral community in the absence of direct

physiological response data. This approach recognises that sediment concentrations below this threshold are not of ecological significance, as the coral community has adapted to deal with the more frequent intensities and durations to which they are exposed, including accompanying regimes of light attenuation and sediment deposition. The McArthur *et al.* (2004) approach also considers intensities and durations to which the 95th percentile is exceeded and provides for these elevations as a set of allowable additional tolerance levels to which a duration of exposure is designated. It is this method that has been chosen for the present evaluation.

Interactions with Wind, Tidal Cycle and Tidal Phase

As previously described within this EIS, nephelometers were deployed to determine ambient turbidity of the study area. The data from these instruments indicates that turbidity is highly variable in the vicinity to the fringing reefs. This variability is strongly related to the flood and ebb of the tide, the spring and neap tidal phases, and the interaction of wind speed. Figure 4-7 illustrates these relationships. At Round Top Island (a), wind speed is a principal driver of sediment mobilisation, but is strongly influenced by tidal phase with turbidity being naturally more elevated during the spring tides. The relationship with tidal phase is somewhat less clear at Victor Islet (b), with significant elevations in turbidity present in both the spring and neap tides. There also appears to be a substantial interaction with tidal depth as illustrated in Figure 4-8. In such instances the capacity of wind speed to elevate turbidity is magnified during the bottom half of the tide. This is logical, given that water depth across the reef slope may be reduced by two thirds at low tide. The interaction of the tidal cycle will also work to bring cleaner water across the reef during the flood.

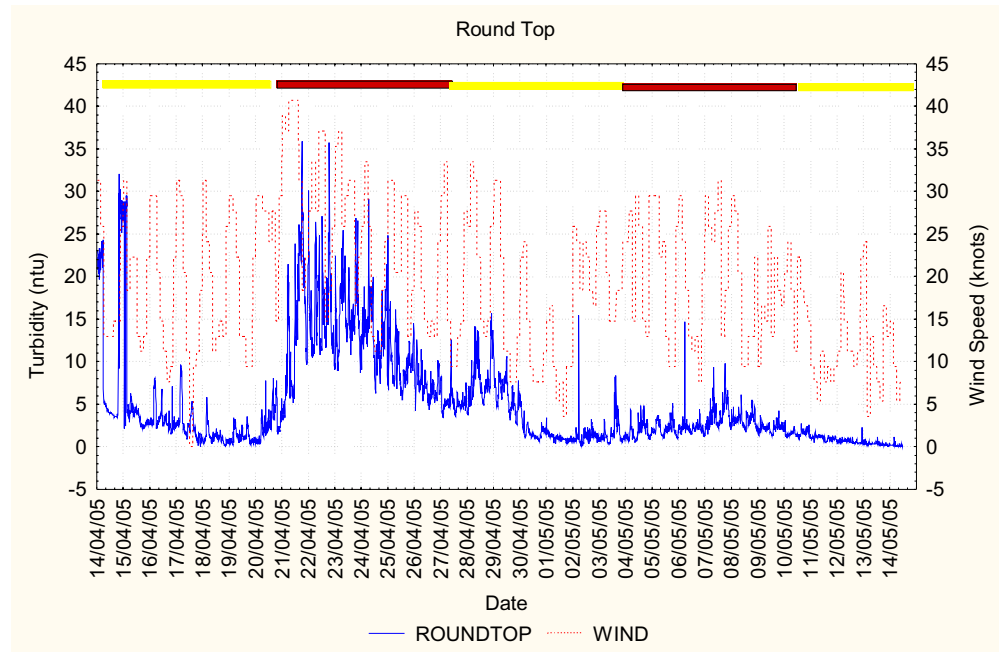
Intensity, Frequency and Duration

It is evident from the data for Round Top Island, that natural turbidity fluctuated markedly during the monitoring period and ranged from 1 to 36 NTU during spring tidal phase, and from 0.0 to 32 NTU during neap tidal phase. During spring tides, high wind action (> 20 knots) caused elevations in turbidity greater than 10 NTU that could be sustained indefinitely irrespective of the tidal cycle. Elevations in the range of 20 - 36 NTU for Round Top Island, and greater than 60 NTU for Victor Islet, were sustained for two to six hours at a time. In these instances, tidal regimes appeared to directly contribute to the duration of these events (see Figure 4-9).

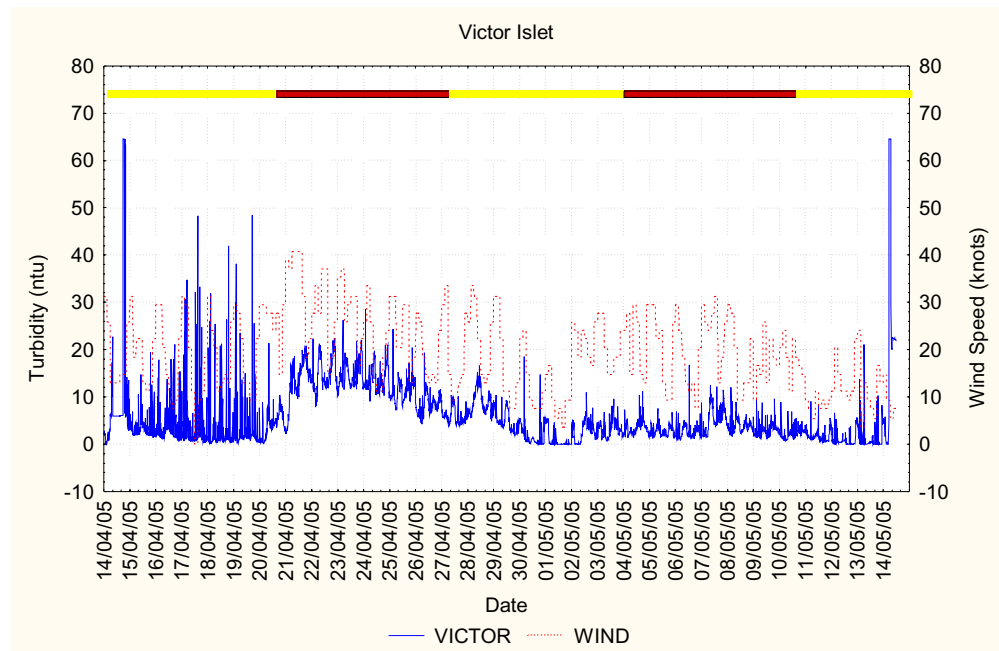
The extend to which such conditions operate was identified by examining wind data taken from the Mackay Airport over the 55 year period from 1950 to 2005. This data is presented for the 2000-2005 period in Table 4-3 and indicates that for at least 20 percent of the time, the study area experiences high wind conditions. At these times the fringing reef habitat would experience turbidity ranging from 14 to >65 NTU, according to the nephelometer data collected for the present study. Wind speeds for April through September, recorded during the 2002, 2003 and 2004 years, are presented in Figure 4-10. During these periods, wind speeds in the range of 20 to 40 knots were common, and were demonstrated to be maintained for periods of 3 to 11 days without significant respite. It is logical to assume that the coral communities of

the study area have a capacity to tolerate highly turbid conditions for a sustained period of at least 11 days.

(a) Round Top Island



b) Victor Islet



Note: Spring tide designated by red bar, neap tide designated by yellow bar

Figure 4-7 Relationship between turbidity, wind speed and tidal phase at a) Round Top Island and b) Victor Islet

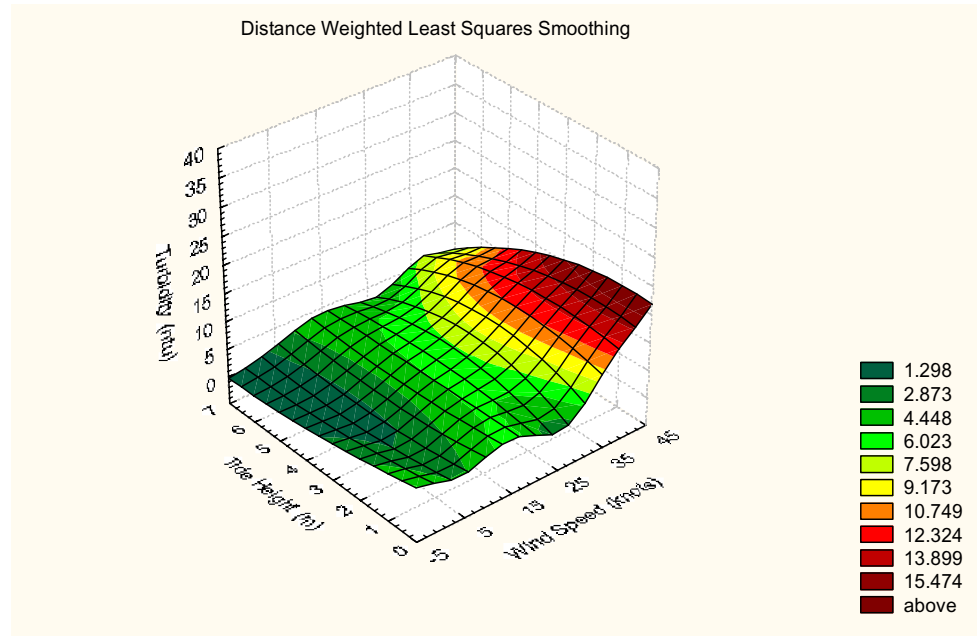


Figure 4-8 Relationship between turbidity, wind speed and tidal height

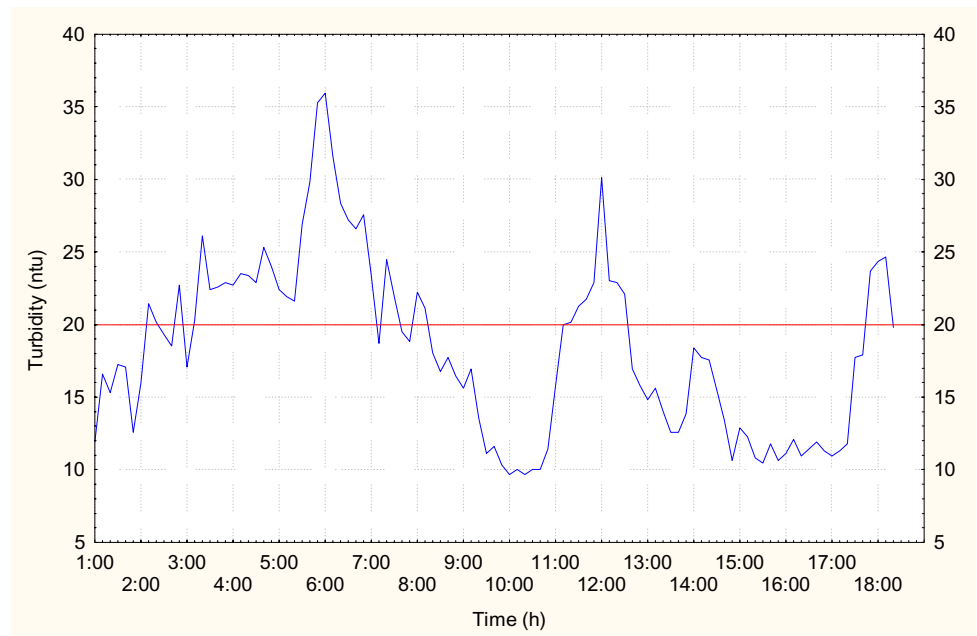


Figure 4-9 Fluctuations in turbidity over the tidal cycle during high wind conditions



Table 4-3 Wind speed (knots) recorded at Mackay Airport, period 2000- 2005

Percentile	Wind Speed (knots)
50 th	16.6
80 th	24.1
90 th	29.5
95 th	33.5
99 th	38.5

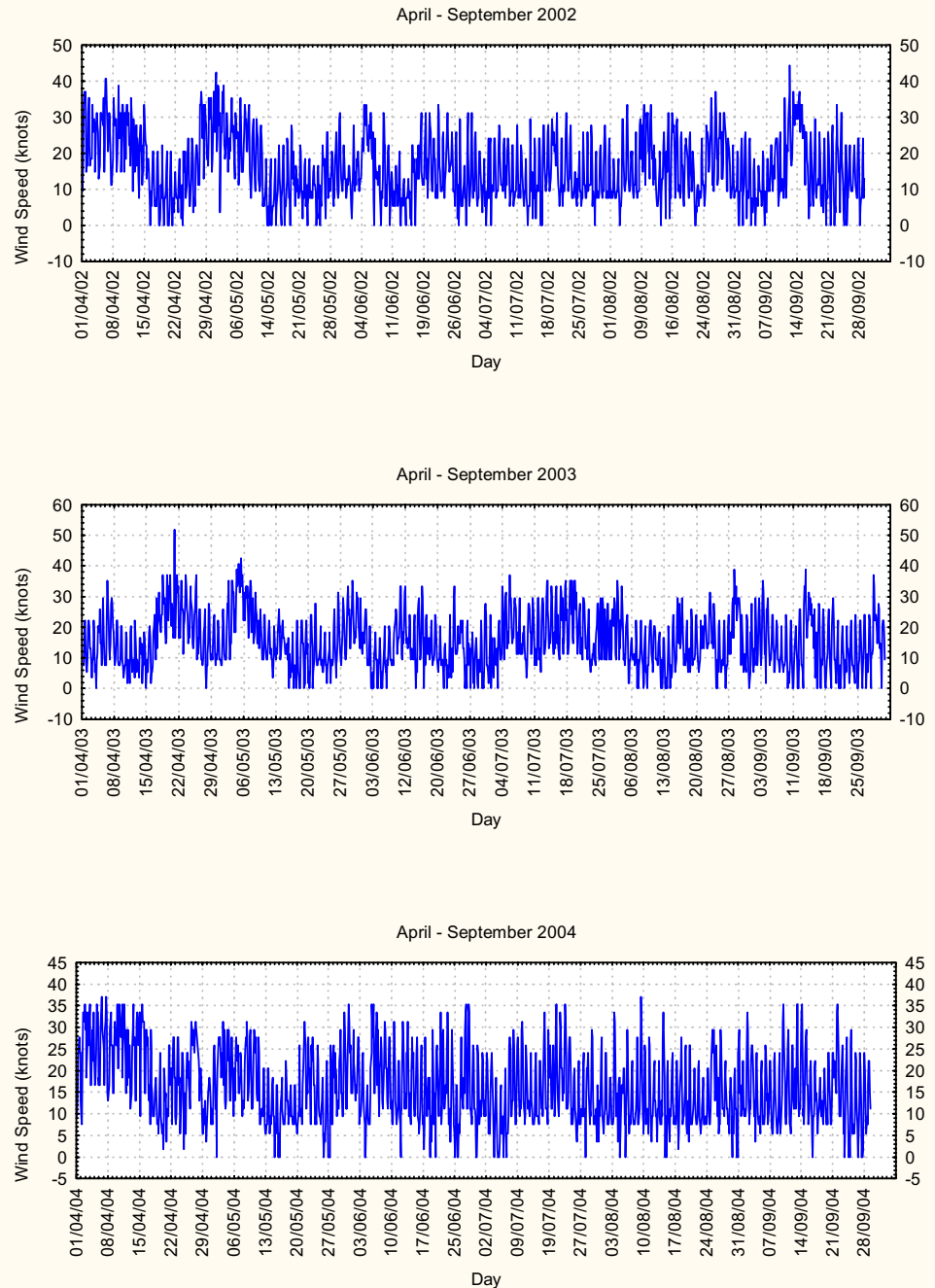


Figure 4-10 Wind speed (knots) recorded at Mackay Airport for the months of April through to September for 2002, 2003 and 2004

Summary of Tolerance

These ranges in turbidity, discussed in terms of their intensity, duration and frequency, and derived from a combination of nephelometer data and historical wind speed, are summarised in Table 4-4. Given this information, and taking the approach of McArthur *et al.* (2004), it can be assumed that the coral communities of Victor Islet and Round Top Island have the capacity to tolerate turbidity concentrations of < 20 NTU during spring tides and <11 NTU (Round Top) and <18 NTU (Victor) during neap tides, with only intermittent period of respite to lower concentrations. Moreover, data indicates that these corals will also tolerate inordinate elevations in turbidity in the range of 20-60 NTU for periods of 6 hours at a time with only one tidal exchange respite, sustaining such elevations for durations of 3 to 11 days. Elevations in turbidity that are wind related may exceed 60 NTU for periods of at least 2h according to the nephelometer data. Given the small amount of this data collected for the Hay Point study area, it is likely that elevations greater than 100 NTU naturally occur (as previously recorded at other inshore reef systems such as Nelly Bay).

Table 4-4 Turbidity tolerance for Round Top Island and Victor Islet, expressed in terms of intensity, duration and frequency

Spring Phase Turbidity Tolerance Values (ntu)	Neap Phase Turbidity Tolerance Values (ntu)	Duration
<20	<11 Round Top <18 Victor	Duration of tidal phase
20 to 60	11 to 60	6h followed by one tidal cycle exchange providing respite, in continuous repetition for 3 to 11 days.
>60	>60	2h

Summary

Acute Impacts

Acute impacts on coral communities resulting from dredging operations are principally derived from physical disturbance associated with the migration of sediment plumes and subsequent high rates of deposition. Instances of rapid partial mortality of corals as a result of such interactions are well documented (i.e. Nelly Bay IMP, GHD 2003). Examination of modelling results indicate that turbidity concentrations associated with the dredge plume will fall within the likely tolerances of the fringing reef communities of Round Top Island and Victor Islet (Figure 4-11 and Figure 4-12 respectively). Elevations in turbidity, similar to those experienced during high wind action, are likely to occur at the peak of the spring tidal phase. During the neap phase, substantial relief from these elevations will be experienced with dredging activities providing a 2 to 8 NTU elevation in turbidity at Round Top Island and less than 2 NTU elevation at Victor Islet.

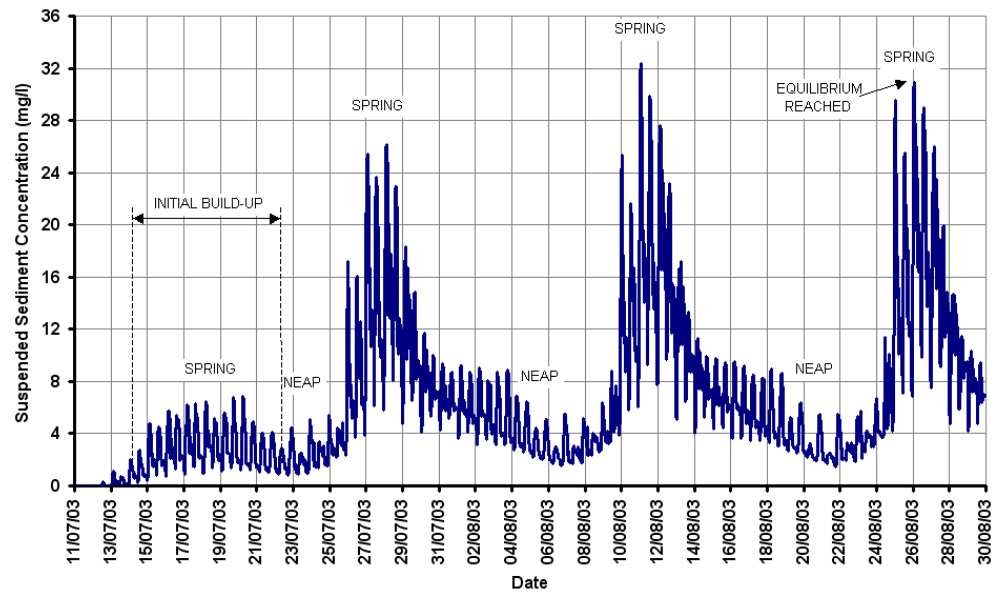


Figure 4-11 Suspended sediment concentration in vicinity of Round Top Island

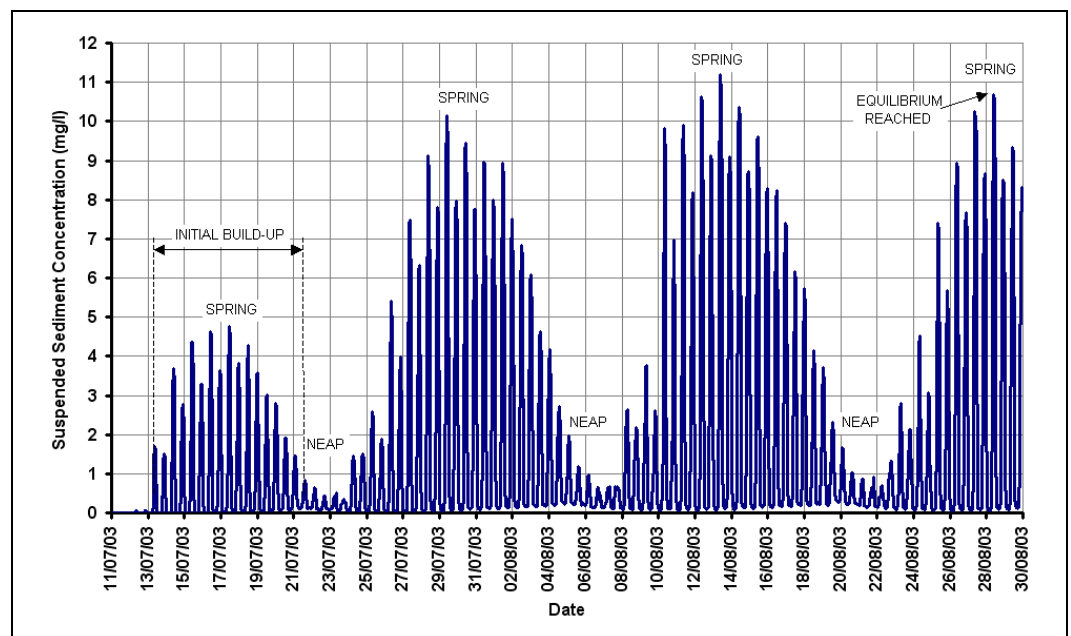


Figure 4-12 Suspended sediment concentration in vicinity of Victor Islet

Given that the coral community is well conditioned to deal with such turbidity; actual sediment deposition associated with dredging is expected to be very small in the immediate vicinity of the fringing reefs (<1 mm per 50 days for Round Top Island); and that currents associated with the large tidal range will actively promote removal of deposited sediments; it is expected that dredging activities are unlikely to produce discernable acute impacts.

Chronic Impacts

While the elevation in turbidity during neap tides is expected to be negligible at Flat Top Island and Victor Islet, there is a capacity that turbidity will range from 2 to 12 NTU during the neap tide at Round Top Island. This elevation in turbidity, if sustained for the entire six-month dredging window may have the capacity to exert some chronic impacts on coral condition, mortality, distribution and abundance through light attenuation. The level of such impact can be predicted by examining the fringing reef community of Victor Islet.

Victor Islet experiences a neap turbidity range of 2 to 13 NTU, similar to that expected for Round Top Island during dredging. While sedimentation is likely to be naturally much greater than that which will be experienced at Round Top Island during dredging, influence of light attenuation is probably similar. The fringing reef community of Victor Islet is dominated by Sargassum (macroalgae), with only 13% mean coral cover. This compares to the coral-dominated community of Round Top Island with mean coral cover of 29%. While increased sedimentation probably plays a large role in these differences, a conservative approach may attribute this difference to altered light attenuation. As such, it may be that percentage coral cover at Round Top Island will reduce by as much as 16%, with a shift in community structure favouring the growth of macroalgae, such as Sargassum.

The capacity to detect chronic impacts and shifts in community structure of the fringing corals reefs during dredging activity is a principal focus of the integrated monitoring program outlined in the Environmental Management Plan. This monitoring program will examine coral condition (bleaching), mortality, diversity and abundance, rates of sediment deposition, real-time turbidity and real time PAR (photosynthetically active radiation). In this way, actual environmental responses that may be associated with the dredging activity can then be properly evaluated.

High Wind Conditions

The influence of high wind conditions on turbidity will be magnified during the spring tide. At times when dredging, high winds and spring tide combine, turbidity will become elevated into the range of 30 to 60 NTU for a period of three days. This elevation is unlikely to provide acute impacts on corals, given that:

- ▶ Suspended sediments are unlikely to settle out in such conditions, and
- ▶ The coral community is likely to be periodically exposed to this type of short duration elevation under natural conditions.

As demonstrated in Figure 4-10, wind speeds during the selected dredging period are likely to exceed 30 knots during most weeks (14 to 20 weeks during the working

window). This will probably act to dramatically minimise the duration with which sediment may settle on corals.

Storms and Floods

It is likely that these fringing reef communities experience greater elevations in turbidity for extended periods during storm and flood events. Such conditions have not been taken into account for the purpose of the present study given that the dredging window is outside the normal wet season for the study area.

Mitigation Measures

The main mitigation measures proposed is to limit the duration of dredging as much as practicable to minimise the period of potential stress for existing coral communities. Coral spawning occurs in late September to November, however it is does not appear practical for this Project to avoid all of this period due to the length of dredging and the need to commence dredging following the cyclone season (ending April) for safety reasons. Efforts will be made as to avoid as much as of the coral spawning period as possible.

It is recommended to apply a dynamic trigger value for monitoring of turbidity at the key habitats of Round Top Island and Victor Islet. The trigger values are based on the existing knowledge of near-shore coral systems, the effects of wind and tidal regimes on sediment mobility and the duration of these events recorded locally at Victor Islet, Round Top and Flat Top Islands. Further details of the proposed monitoring program are reference in Section 5. The following interim threshold curve for the determination of impacts associated with dredging operations within the study area and is based on the Cumulative Frequency and Decision Curve Analysis of Stafford Smith *et al.* (1994). In these analyses, the percentage of bleaching per colony (x-axis) is plotted in relation to the percentage of colonies affected (y-axis). In this way, warning and critical thresholds are presented, which take account the natural expected occurrence of both bleaching and mortality within a coral community (Table 4-5).

Table 4-5 Warning and critical thresholds for % coral bleaching and % partial mortality

% bleaching observed	“Warning” Thresholds: For nominated % of corals	“Critical” Thresholds: For nominated % of corals	%Partial mortality observed	Warning” Thresholds: For nominated % of corals	“Critical” Thresholds: For nominated % of corals
05.00%	100.00%		05.00%	100.00%	
10.00%	50.00%	100.00%	10.00%	25.00%	50.00%
20.00%	25.00%	50.00%	20.00%	12.50%	25.00%
40.00%	12.50%	25.00%	40.00%	06.25%	12.50%
80.00%	06.25%	12.50%	80.00%	03.125%	06.25%

Note: Warning and critical thresholds are exceeded when the observed % bleaching or % partial mortality are breached in at least the nominated % of corals within the study site. i.e. if 100 % of all corals display a % bleaching of 5%, then a warning threshold has been exceeded.

4.3.6 Introduced Marine Fauna

Impact Summary

Where marine pests are located in areas to be dredged, there is a risk that these pests would be transferred to the spoil ground via dredging and spoil disposal. In the absence of identified marine pest species at the Port of Hay Point, the translocation of pest species from the area to be dredged to the spoil ground is not considered to be a risk for the current Project.

Mitigation Measures

As there are no predicted impacts from the translocation of introduced marine fauna during dredging and spoil disposal, no mitigation measures are proposed.

4.3.7 Turtles

Impact Summary

Marine fauna are mobile and can generally avoid impacted areas for the duration of dredging activities. However, dredging occasionally results in injury or death of marine fauna such as turtles when they are hit or captured by the dredge head. To date there have been no capture of turtles during capital or maintenance dredging at the Port.

Other activities with the potential to impact turtle populations along the Queensland coast include fisheries bycatch, harvesting of individuals and eggs by Traditional Owners and predation of eggs by feral animals (Hart 2002, EA 2003). Trawling and ghost nets kill approximately 100 – 200 per year each, while boats strike probably kill many adults (Limpus pers. comm. 2004; Limpus & Chatto 2004). In comparison, very low numbers of turtles are impacted by dredging.

The numbers of turtles captured during dredging across all Queensland Ports is decreasing, with an average of 1.7 loggerhead turtles per year being captured across all ports (Limpus pers. comm. 2004). The continued use of management and operational practices to reduce the possibility of turtle capture is consistent with the stance taken by the DEH on the protection of loggerhead and other listed marine turtles in the Recovery Plan for Marine Turtles in Australia (EA 2003).

Current research indicates that the impact of dredging on the overall viability of turtle populations is very low compared to the numbers killed by boat strikes, trawling, fishing, ingestion of marine debris and indigenous hunting (Limpus pers. comm. 2004). When considering the sustainability of dredging impacts on turtles, the age and sex of the turtles being captured must also be taken into account. For example the capture of breeding females will have a greater impact on a species than the capture of juvenile males. However, there is little data available on the age and sex of turtles captured during dredging.

Given that there is little evidence of a large resident population of turtles in the Hay Point area, the relatively low numbers of nests recorded on local beaches, the knowledge that turtles have not been captured previously during dredging at the Port, the relatively low numbers of turtles captured by dredgers compared to other activities

and the use of effective management and operational practices to reduce the potential for turtle capture, it is not considered that the proposed dredging and spoil disposal will have a significant impact on turtle populations in the study area. The removal of sparse seagrass that has recently been identified within the proposed spoil ground and area to be dredged is not considered to represent a significant impact on the ability of the region to support its current turtle population as the percentage cover is relatively low and the species represent opportunistic colonisers (Rasheed *et al.* 2004). Despite the low risks to turtles it is important to apply best practice dredging techniques.

Mitigation Measures

The main measure to protect turtles is to ensure turtle excluding devices are fitted to the dredged draghead. As a secondary measure to minimise the risk of turtle capture during dredging is the avoidance of the turtle nesting season. Dredging will therefore be commenced as early as possible following the cyclone season (end of April) and a large dredge will be used to minimise the period of dredging. Current estimates indicate dredging will take approximately six months, which will complete the dredging around the end of October. This marginally extends the period of dredging into the turtle nesting season (commencing mid October), but numbers of turtles present in the area are low at the start of the nesting season. Also, the peak nesting period occurs during the last week of November and the first week of December (Bell 2003).

Management and operational practices also to be employed include controlling the dredge pumps to minimise operation while the dredge head is on the seafloor (pumps need to be operated for a short time to clear sediment from the pump with clean water).

Areas to be dredged can also be checked daily during the turtle nesting season to avoid areas where turtles may be observed to be present.

4.3.8 Cetaceans

Impact Summary

The primary potential impact of dredging and spoil disposal on cetaceans is considered to be the generation of underwater noise and vibration. These impacts are discussed in Section 4.9.

Cetaceans are highly mobile and can generally avoid impacted areas for the duration of dredging activities. The dredging process will not directly impact cetaceans. Considering the inshore location of the dredging activities, it is considered unlikely that dredging will impact on the migratory patterns of whales as they tend to migrate further off-shore (URS 2000) and will avoid contact with the dredge.

Mitigation Measures

As no significant impacts on cetacean populations are predicted, no mitigation measures are proposed.

4.3.9 Dugong

Impact Summary

Potential impacts on dugong from dredging and spoil disposal include:

- ▶ Loss of habitat and food source, changes to the abundance and distribution of seagrass beds will affect the abundance and distribution of dugong; and
- ▶ Physical injury from direct contact with the dredge head.

These impacts are discussed in the following sections.

Habitat Loss

The seagrass meadows recently identified within the port limits contain species which are a preferred food type for dugong and may provide a food source for dugong moving between the Dugong Protection Areas located to the north and south of the Port (Rasheed *et al.* 2004). Therefore, the removal of these communities by dredging and spoil disposal has the potential to impact on this species. However, as the seagrass beds have not previously been identified and are of an ephemeral nature, they are not considered critical habitat or food source. Also, the proposed dredging will not result in complete loss of these seagrass communities from the port area, as only 28% of total seagrass cover recorded within the port limits will be removed, with 70% of this being low density (<5% cover).

Sightings of dugong within the Port area are infrequent, indicating that the area is not a critical habitat for this species.

Physical Impacts

Dugong are mobile and can generally avoid impacted areas for the duration of dredging activities. It is considered that there is little risk of injury from direct contact with the dredge head and no previous dredging campaigns at the Port have reported dugong strikes.

Overall, it is considered that dugong populations will not be significantly affected by the Project.

Mitigation Measures

As no significant impacts on dugong populations are predicted, no mitigation measures are proposed.

4.3.10 Fisheries

Impact Summary

Pelagic Impacts

In general, adult and juvenile fish can visually detect and swim away from temporarily elevated turbid water, thus avoiding most negative impacts (Wilber *et al.* 2005). However, some fish, such as coral reef fish, are territorial and spend most of their time in a particular area, which they depend upon for food and shelter. This type of behaviour may result in prolonged exposure to large volumes of sediment that could

ultimately cause death through gill clogging and disease (Deocadiz and Montano 1999). Fish have been shown to have a wide range of sediment tolerance however continuous exposure for days to very high sediment concentrations ($>1,000$ mg/L) have been found to kill most species of adult fish (Deocadiz and Montano 1999), although sediment concentrations are expected to be below 100 mg/l in all areas of the Port and below 10 mg/l in most areas. While adult fishes demonstrate an increased capacity to minimise the effects of increased turbidity, larval stages may be considered more at risk. Studies completed by Davis and Hidu (1969), Rosenthal (1971) and Loosanoff (1962) suggest that significantly elevated turbidity can harm egg development larval growth. However, Davis and Hidu (1969) also noted that slight increases in turbidity actually stimulated larval growth. In general, acute sediment exposure between 50 to 500 mg/L is thought to provide limited ecological effect (Morgan *et al.* 1983 and Jokiel 1989).

In turbid conditions predatory fish species catch efficiency is reduced due to the decrease in visibility (Deocadiz and Montano 1999). Thresher (1984; cited in Deocadiz and Montano 1999) reported that mating and territorial behaviour patterns are highly dependent on visual cues. Turbid water conditions could disrupt these behaviour patterns and in turn result in a reduced growth and/or reproductive rate that would eventually reduce the abundance and diversity of fish (Deocadiz and Montano 1999). However, anecdotal evidences suggests that some fish species school around turbid plumes, which can lead to more fish being present within the immoderate area of dredging and spoil disposal.

The relatively short-term nature (six months) of the proposed dredging operations at the Port and localised nature of the impacts restricts the overall spatial and temporal impacts to pelagic communities. The naturally occurring fluctuations in turbidity at a range of temporal scales highlights the adaptation of the resident species to changes in suspended sediment regimes. Considering the recorded variability of prevailing conditions and absence of contamination within the materials to be dredged, the likely impacts to pelagic fauna associated with the dredge and disposal operations are considered minimal.

Benthic Impacts

Previous studies at this and other ports indicate that there will be short term reductions in the abundance of benthic macroinvertebrates within the proposed spoil ground post-dredging. These species form a food source for juvenile prawns and commercial and recreational fishing species.

Juvenile prawns feed on benthic fauna in the seabed sediments as they migrate from the shallow estuary to the deeper water trawling grounds, which include areas within the port limits and proposed spoil ground. Two CSIRO studies on prawn dietary requirements undertaken using prawns from various Queensland locations indicated that tiger and banana prawns do not rely on one species or group of species as a food source (URS 2001). Therefore, any short term or longer term changes to the composition of the benthic fauna community at the spoil ground resulting from spoil

disposal are not considered to impact the suitability of the community as a food source for prawn populations (URS 2001).

Although the abundance of benthic fauna at the spoil ground and adjacent areas within the influence of predicted fallout of fine sands would decrease immediately post dredging, the area affected by spoil disposal is relatively small in the context of the total area of similar habitat available within the region. Also, it has been demonstrated that the abundance of benthic fauna recovers between dredging campaigns (WBM 1993c and Hydrobiology 2004), therefore, a short term reduction in the abundance of benthic organisms at the spoil ground immediately post-dredging is not considered likely to represent a significant impact on prawn or commercial fish populations. The spoil ground does not represent unique habitat within the region, and the area that will be impacted represents a relatively small proportion of overall similar habitat available in the study area. The banana prawn catch is primarily influenced by the flushing of the juveniles from estuaries during rainfall events, as opposed to the availability of off-shore habitat (WBM 1993b).

Overall, it is considered unlikely that the proposed dredging and spoil disposal will result in significant impacts to fisheries populations within the area.

Interruptions to Fisheries and Fishing Activity

Current navigation restrictions within the Port as identified in Section 3.11.3 prohibit unauthorised vessels from mooring, anchoring or manoeuvring in the Ship Loading Facility Area. These safety restrictions ensure ships are able to approach and depart the berths safely without interference from other vessels. While approaching and leaving the berths ships operate at slow speeds and are not manoeuvrable. It is proposed that the existing restricted areas will be revised following development of the Project to include two restriction areas as shown in Figure 4-13 (Ellyett pers. comm. 2005):

- ▶ Restricted Area A: Unauthorised vessels are prohibited from mooring, anchoring or manoeuvring in the Ship Loading Facility Area
- ▶ Restricted Area B: Unauthorised vessels are prohibited from mooring or anchoring in this area. Vessels may transit the restricted area when no large ship is manoeuvring in the area.

The proposed changes to restricted areas within the vicinity of the ship loading facility and Departure Path will enable recreational fishers to traverse areas which are currently restricted as currently gazetted (see Figure 3-45), therefore improving access within the port limits for these users.

The relatively localised nature of dredging and spoil disposal activities means that they are unlikely to cause significant interruptions to commercial and recreational fishing activity. Fish tend to school around turbid plumes produced by the dredge as these provide a food source, therefore recreational fishers may benefit from the transient plumes generated by dredging activities.

The proposed spoil ground is within an area used for trawling. As discussed above, spoil disposal will result in a temporary decrease in the abundance and diversity of



benthic infauna, which form a food source for juvenile fish and prawn species. However, as the spoil ground is expected to recover from this disturbance, it is not anticipated that this will have a significant impact on the viability of the commercial fishing in the area.

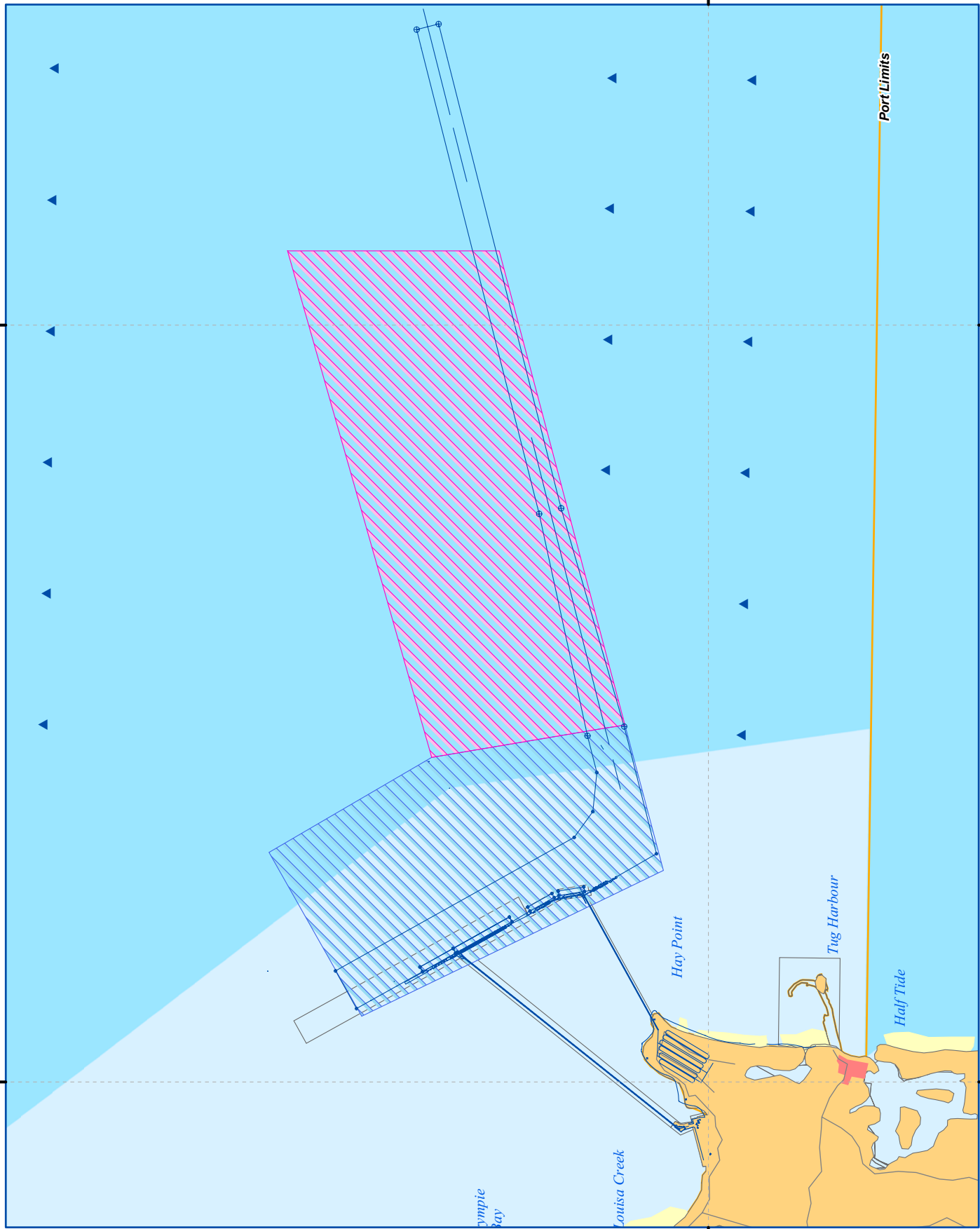
Mitigation Measures

The extent of the restricted access area of the Port is to be reduced to avoid the need for recreational craft to travel well off-shore to avoid the currently gazetted restriction area.

No other impacts on fisheries or fishing activity are predicted, therefore, no mitigation measures are recommended.

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Port of Hay Point Capital Dredging

Proposed navigation restriction area

Figure 4-13

Legend

- Port Limits
- Built Up Area
- Major Roads
- GBRMP
- Sand / Mud
- Anchorage
- Extent of Capital Works

Proposed Navigation Restriction Areas

- Area A
- Area B

North



Source: GIS data supplied by
DRNM, PCQ
Projection: GDA 94, Zone 55
Date Printed: 06/07/05
File: G:\113829\GIS\Arcview\Map\proposed_nav_restrict.mxd
Size: A4



4.3.11 Benthic Macroinvertebrates and Epibenthic Fauna

Impact Summary

Spoil Ground

The dumping of dredge spoil in the proposed spoil ground during the capital dredging Project is likely to result in the temporary smothering of benthic infauna and epifauna. A number of factors influence the impact of spoil disposal on benthic fauna such as the chemical and physical similarity of dredge spoil to the sediments in the receiving habitat, period of burial, depth of spoil and community composition at the receiving habitat (WBM 2004).

Areas to be Dredged

The benthic infaunal and epibenthic communities in the Apron Area and Departure Path will be removed during dredging. The physical substrate in these areas will be permanently altered through the removal of seafloor sediments, in some areas to consolidated materials.

The habitat value of the medium density cover located at site 13 on Figure 3-5 is limited due to the isolated nature of the habitat. In addition the species present in this area are not regional unique or significant (Rasheed M. pers comm. 2005).

The potential for recovery of these areas is discussed in the following sections.

Recovery and Recolonisation from Dredging and Disposal

Natural processes of colonisation and recruitment of marine benthic biota, lead, over time, to the recovery of ecological processes from the impacts associated with spoil disposal and dredging. Recovery of marine benthos following the initial physical disturbance from dredging can occur within a few months to several years, depending on the adaptations of the organism and physical conditions of the disposal ground (Roberts and Forrest 1999, McCall 1977, Pagliai *et al.* 1985, Richardson *et al.* 1995, Hinton *et al.* 1992, McCabe *et al.* 1996 and Van Dolah *et al.* 1984).

Due to physical processes of wind, wave and tidal disturbance, benthic communities of near-shore and shallow water environments display natural adaptations to frequent perturbations. In these situations benthic invertebrate communities may be dominated by small bodied, short-lived biota, with high fecundity, efficient dispersal mechanisms, dense settlement, and rapid growth rates (MacArthur 1960, MacArthur and Wilson 1967, Odum 1969, Pianka 1970 and Grassle and Grassle 1974). In contrast, organisms populating a more stable substrate may tend to be larger, longer lived with lower fecundity, reduced dispersal mechanisms, slow growth rates, and adaptations for non-reproductive processes such as competition and predator avoidance.

The soft sediment habitats surrounding the dredge and spoil ground locations at the Port of Hay Point are generally of sufficient depth for a range of longer-lived epibenthic flora and fauna to colonise effectively (Rasheed *et al.* 2004). The Mackay region is often impacted by the passage of significant storm and cyclonic events, which provide a natural redistribution of these biota and effect a change in overall benthic conditions.

Specifically, these events result in episodic natural increases in turbidity through disturbance of the seafloor sediments. The combined effect of natural large-scale events and periodic dredging and disposal leads to the mosaic of benthic habitats described from the near-shore environments surrounding the Port of Hay Point.

The rate at which biota recolonise an area is dependent on several physical and biological factors, including:

- ▶ time of year (season);
- ▶ depth;
- ▶ complexity of adjacent habitats;
- ▶ water currents and quality;
- ▶ sediment composition (particle size and contaminant status);
- ▶ bed shear stress and transport;
- ▶ temperature and salinity;
- ▶ natural energy levels in the area (wave and currents);
- ▶ frequency of disturbance; and
- ▶ latitude.

As with many ecological systems recovering from a disturbance, epibenthic and infaunal communities demonstrate a naturally occurring process of succession. This process of change can be generally described as having three stages (Rhoads *et al.* 1978, Rhoads and Germano 1982) (Table 4-6).

Table 4-6 Dominant stages of benthic community succession

Stage	Description
Stage 1	▶ Pioneer community of small and densely populated organisms which appear rapidly following a disturbance. ▶ Dominance by opportunistic species with high tolerance to disturbance factors such as variable sediment regimes, organic enrichment and chemical contamination of sediments. ▶ Organisms display high rates of recruitment. ▶ Pioneer organisms develop an increased stability within the sediment profile, reducing sediment mobility and developing a stable substrate. These may include tube-dwelling polychaetes or oligochaetes that build mucous lined tubes. ▶ Communities are often dominated by filter feeders and surface deposit feeders which reside at or near the sediment-water interface.

Stage	Description
Stage 2	- As physical conditions improve, communities may begin to demonstrate an increase in burrowing deposit feeders. These animals further mix sediment and increase available oxygen via improving the sediment water interface. - Biota are recorded during Stage 2 are often larger with lower population densities.
Stage 3	- Stage 3 represents a mature and stable environment, and may include an increased diversity of epibenthic and infaunal communities. - Burrowing animals are well established acting to rework sediments to depths of 3 to 20 cm. - An increased sediment water interface facilitates active nutrient cycling. - Biota representing Stage 3 communities provide an indication of increased periods between disturbances, and demonstrate increased benthic stability. - The recovery of Stage 3 biota following a disturbance may require an extended period.

Importance of Adjacent Habitats

The condition and proximity of adjoining habitats is considered an important factor in the ultimate timing and extent of benthic community recovery (McCabe *et al.* 1996 and Van Dolah *et al.* 1984). Hinton *et al.* (1992) recorded a significant increase in benthic invertebrate densities following dredging and concluded that rapid decolonisation may have occurred via vertical migration of invertebrates within the sediments or via recruitment from surrounding areas. Massachusetts Office of Coastal Zone Management (2005) recorded that sand spoil capping with trace silt, was colonised by the same organisms (polychaetes and bivalves) as a nearby site that consisted of an entire silt cap.

These results suggest that larval recruitment and emigration from surrounding areas was likely to play a significant factor in recolonisation, regardless of the physical characteristics of the dredge spoil. However, key differences in long term species diversity and abundance may be skewed towards those organisms that prefer particular physical sediment/habitat types (i.e. silt, sand and cobble, or reef).

Sediment Quality

Factors affecting habitat quality and subsequent post disturbance recolonisation at disposal grounds commonly relate to either chemical or physical conditions of the sediment, or a combination of both (USACE 1996). Chemical contaminants associated with the disposal of sediments from industrialised coastlines or long-term port facilities can impact on the recovery of benthic assemblages following dredging (USEPA and USACE 1992). Chemical impacts leading to slow benthic recolonisation may include the presence of hypoxic water, high organic content or elevated levels of sediment contaminants.

The material to be dredged in the current Project is considered to be suitable for unconfined ocean disposal according to the NODGDM (Section 2). Therefore the remobilisation of sediments into the water column and the placement of dredge spoil at the spoil ground will not result in the introduction of chemical contaminants to the receiving environment.

Physical composition of the sediment to be dredged and the sediments at the proposed spoil ground are discussed in Section 3.5. The material to be dredged is significantly finer than the material at the spoil ground. However, a proportion of the finer fraction will be deposited as cohesive clay lumps, reducing the differences between the non-cohesive fractions of the sediment to be dredged and the seafloor at the spoil ground. Therefore, the key alteration to the current spoil ground sediment characteristics as a result of spoil disposal will be the introduction of clay lumps to the spoil ground. Previous experience suggests that it is likely that these lumps will remain relatively intact, with those at the surface potentially eroding slowly over time. Post-dredging, the spoil would be expected to settle into a structure with a relatively smooth surface, with finer material filling any gaps created by the larger clay lumps. Similar clay lumps have been introduced into the spoil ground in previous dredging campaigns (2001 & 2004) and have not appeared to hinder recovery of benthic epifaunal and infaunal communities.

Potential for Recovery with the Proposed Spoil Ground

Surveys undertaken at the nearby Mackay Harbour spoil ground identified similar habitats to those recorded from the existing and proposed Port of Hay Point disposal grounds (Rasheed *et al.* 2001). Results from this study suggested that similar habitat conditions occurred both inside and outside the spoil ground area, with no apparent differences between the surveyed communities. In this instance it was suggested that existing dumping regimes are unlikely to have had a major impact on the benthic communities of the Mackay Harbour spoil ground.

Evidence from recent surveys within the Port of Hay Point also indicated a successful recruitment of epibenthic flora and fauna within the existing spoil ground, last used for capital dredging during 2001 and maintenance dredging in early 2004 (Rasheed *et al.* 2004). In fact, the current spoil ground contained some of the highest diversity and abundance of biota recorded within the Port limits and displayed no differences from the surrounding areas. It was also suggested that the occurrence of communities such as seagrass within the Port limits may be more strongly related to environmental parameters such as clearer waters resulting from low rainfall and catchment run off, than to impacts from spoil disposal. Previous monitoring of benthic infaunal communities has also demonstrated the capacity of the spoil ground to recover from spoil disposal (Section 3.2.5). Feedback from local recreational divers during the consultation process for the Project indicated that the existing spoil ground was one of the most abundant areas of benthic communities within the Port.

When viewed in a longer term context, spoil disposal has been occurring in the current spoil ground since the 1983 capital dredging campaign. Consequently, the benthic community at the current spoil ground has been influenced by both natural

environmental fluctuations, as well as 20 years of episodic spoil disposal, yet it displays no significant variation to that of surrounding areas within the Port limits.

While the nature of the seafloor at the spoil ground will change somewhat as a result of spoil disposal, previous sampling has indicated that its ability to support a benthic community will not alter, although the community may not return to its pre-dredging state. When considering the impacts of spoil disposal on benthic infaunal and epifaunal communities, it should be noted that there is no ecological reason why benthic communities should return to a particular state after disturbance, as these communities are naturally dynamic over space and time (Hydrobiology 2004). Previous sampling indicates that the spoil ground will recover sufficiently to support a benthic infaunal community between dredging campaigns and will still provide a food source for epibenthic and pelagic organisms. As well, the area encompassed by the proposed spoil ground forms only a small part of the soft bottom habitat available in the region, therefore, potential changes to the community at the spoil ground are not considered ecologically significant in the context of the study area.

Future maintenance dredging will result in ongoing impacts to the benthic epifaunal and infaunal communities of the spoil ground, however, maintenance dredging will utilise smaller areas of the proposed spoil ground and recovery should still continue. Proposed measures to reduce these impacts are discussed in further sections.

Potential for Recovery within the Areas to be Dredged

It is expected that as soft sediment builds up in the Apron Area and Departure Path post-dredging, benthic infauna will recolonise these habitats. These areas currently experience disturbance due to shipping movements and are expected to continue to experience a similar level of disturbance after dredging as the depth of clearance on ships exiting the Port is not expected to change. These areas will also be subject to periodic disturbance from maintenance dredging.

While the periodic disturbance of these areas will increase due the increased frequency of maintenance dredging, these communities have been shown to recover. In the context of the wider study area, the area to be disturbed by the dredging of the Departure Path and Apron Area do not contain any species or habitat of conservation significance and are considered inconsequential in a regional context.

Conclusions

Acute Impacts

The process of dredging and spoil disposal is expected to cause immediate mortality in the benthic infauna located within the dredge footprint and proposed spoil ground as a result of physical disturbance and smothering.

Chronic Impacts

There is potential for chronic impacts on benthic infauna associated with migration of the dredge plume and subsequent deposition of suspended sediments. Modelling indicates that sediment deposition associated with dredging (>1mm per 50 days) will only occur in the immediate near-shore waters of Hay Point and in the waters

immediately south of Round Top Island. In these instances the extent of such deposition, being less than 4 mm per 50 days, is not expected to be sufficient to cause smothering mortality in motile benthic organisms.

Mitigation Measures

The impacts on benthic epifaunal and infaunal communities resulting from dredging and spoil disposal are considered unavoidable. However, particularly in the proposed spoil ground, it is apparent that these communities are likely to recover to a level where their ecological significance as habitat or a food source will not be compromised. The following sections discuss ongoing management measures that may reduce the ongoing impacts of future maintenance dredging.

As part of a strategic long-term approach to spoil disposal, it is considered important that the system of ocean disposal that minimises on-going impact to the benthic environment. Following the expansion of the spoil ground, it is proposed to formulate a 'mosaic' style approach to future ocean disposal at the Port of Hay Point. Following conduct of the capital dredging works, disposal of maintenance material at the spoil ground would be planned so as to minimise ongoing benthic disturbance. The following sections outline a strategic direction of spoil disposal, and introduces the 'mosaic' approach for consideration during the on-going operation and management of the spoil ground.

Strategic Disposal Design

Habitat development and augmentation is often considered as one of the more favourable beneficial approaches to bulk spoil disposal (USACE & US EPA 2004). However, typical applications include submerged or aquatic modification.

Aquatic habitat augmentation may simply seek to maximise benthic diversity and community abundance, or promote a specific benefit or use as a community resource. Nightingale and Simenstad (2001) concluded that the beneficial use of dredged material represents a significant management tool where emphasis is placed on planning at the ecosystem and landscape-scale. Within an appropriately managed system, disposal regimes can be directed to favour the specific life-history needs of benthic biota. In the case of the Port of Hay Point, planning and design requirements may focus on the establishment of a disposal regime that maximises benefits to the adjacent seagrass, algae and epifaunal assemblages presently colonising the area.

Spoil Ground Mosaic

Under the existing system of spoil disposal, benthic communities within the spoil ground at the Port of Hay Point experience a recurrent cycle of disturbance and recovery. The extent of this disturbance varies between maintenance and capital dredging activities. Maintenance dredging would typically introduce finer sediments, while capital dredging requires the disposal of a mixture of materials, from unconsolidated sands and silts to consolidated clays. A disposal mosaic approach would provide an opportunity to help mitigate the scale and frequency of future disposal impacts.

For example, where maintenance dredging is conducted every 2-3 years, a mosaic disposal regime consisting of 5 'cells', within an enlarged disposal ground, would limit the recurrent impacts from disposal. Under this regime of disposal, dredging impacts from each event could be extended from ~2 years to over ~10 years. Key advantages associated with the application of a disposal ground mosaic include the manipulation of both spatial and temporal scales of impact. By reducing the scale of impact, managers maximise the potential for recruitment from adjacent assemblages (McCabe *et al.* 1996, Van Dolah *et al.* 1984, Hinton *et al.* 1992 and Rhoads *et al.* undated, cited in Massachusetts Office of Coastal Zone Management, 2005).

4.4 Marine and Coastal Processes

4.4.1 Introduction

This section of the EIS describes the impacts that development of the Apron Areas and Departure Path may have on the hydrodynamic processes within the study. The assessment is based on the outcomes of the hydrodynamic modelling described in Section 3.3.

Impacts on siltation and implications for marine flora and fauna and/or biological processes are discussed, including generation and migration of turbid plumes.

4.4.2 Impact of 'Post-dredge' Bathymetry on Coastal Processes at Hay Point

As a consequence of capital works dredging, there will be two major changes to the bathymetry in the vicinity of Hay Point. These changes are listed below and selected representative cross-sections plotted in Figure 4-14:

- ▶ The formation of the Departure Path and apron (invert -14.9 m LAT), and
- ▶ A raised spoil ground (+820 mm) at completion of the capital dredging campaign.

The potential effects of those changes on hydrodynamics (currents) were assessed through the creation of a difference map obtained by subtracting 'post-dredge' from 'pre-dredge' results (refer to Figure 4-15 to Figure 4-18).

It is apparent from Figure 4-15 to Figure 4-18 that changes to the coastal processes in Hay Point are minimal. The following conclusions are reached:

- ▶ Maximum change in velocity does not exceed 0.06 m/s and maximum change in direction does typically does not exceed 6 degrees over the area of interest with one or two maximums reaching 30 degrees;
- ▶ The changes in current magnitude are confined to the vicinity of the Departure Path and spoil ground;
- ▶ Maximum changes to current direction are observed during the flood phase of the tide near the coast at Hay Point (Figure 4-16) and during the ebb phase of tide in Dalrymple Bay (Figure 4-18). It is worth noting that these changes are associated with low current magnitudes (less than 0.01 m/s) developing at the core of the two eddies presented in Figure 3-21 and Figure 3-22 respectively. For the purpose of

the present study, changes in current direction at the core of the eddies are considered minor instabilities that can be safely neglected. These changes are not a trustworthy indicator of the potential impact of bathymetric changes on the hydrodynamics. It is also noted that the intensity of the changes decreases with the increase of current magnitude towards the outer boundary of the eddies; and

- Dredging of the Departure Path results in a decrease in current magnitude.

In summary, it is concluded that the change in bathymetry as a result of the dredging operations will not have any significant impact on current magnitudes and directions at the Port.

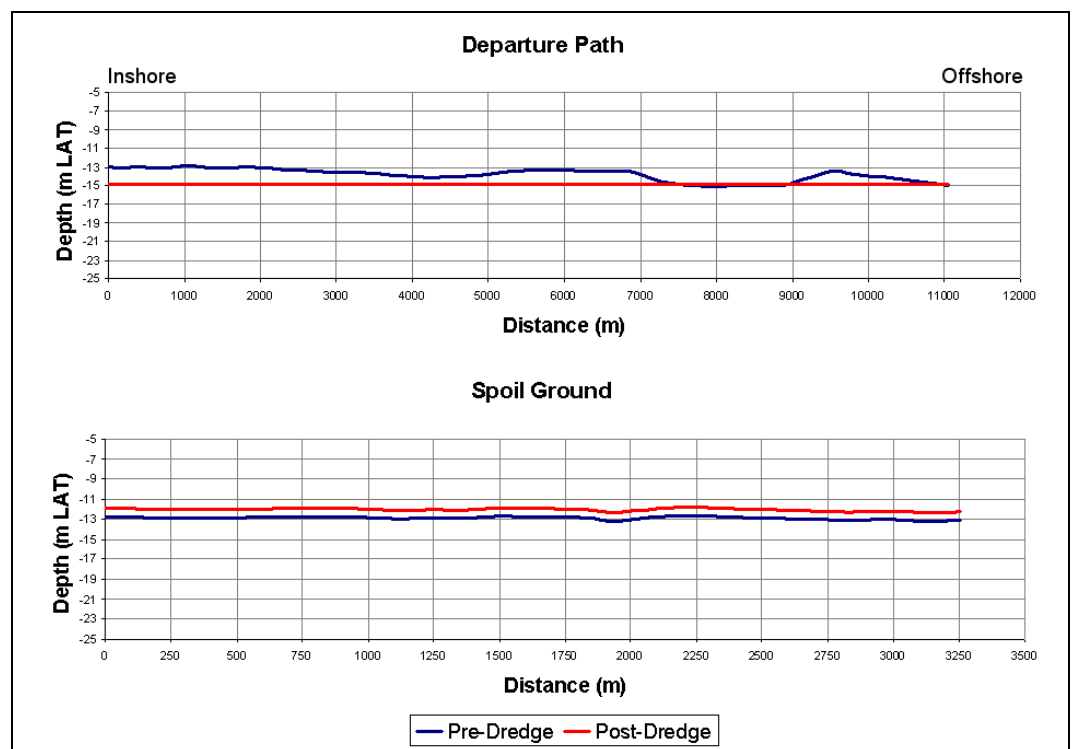
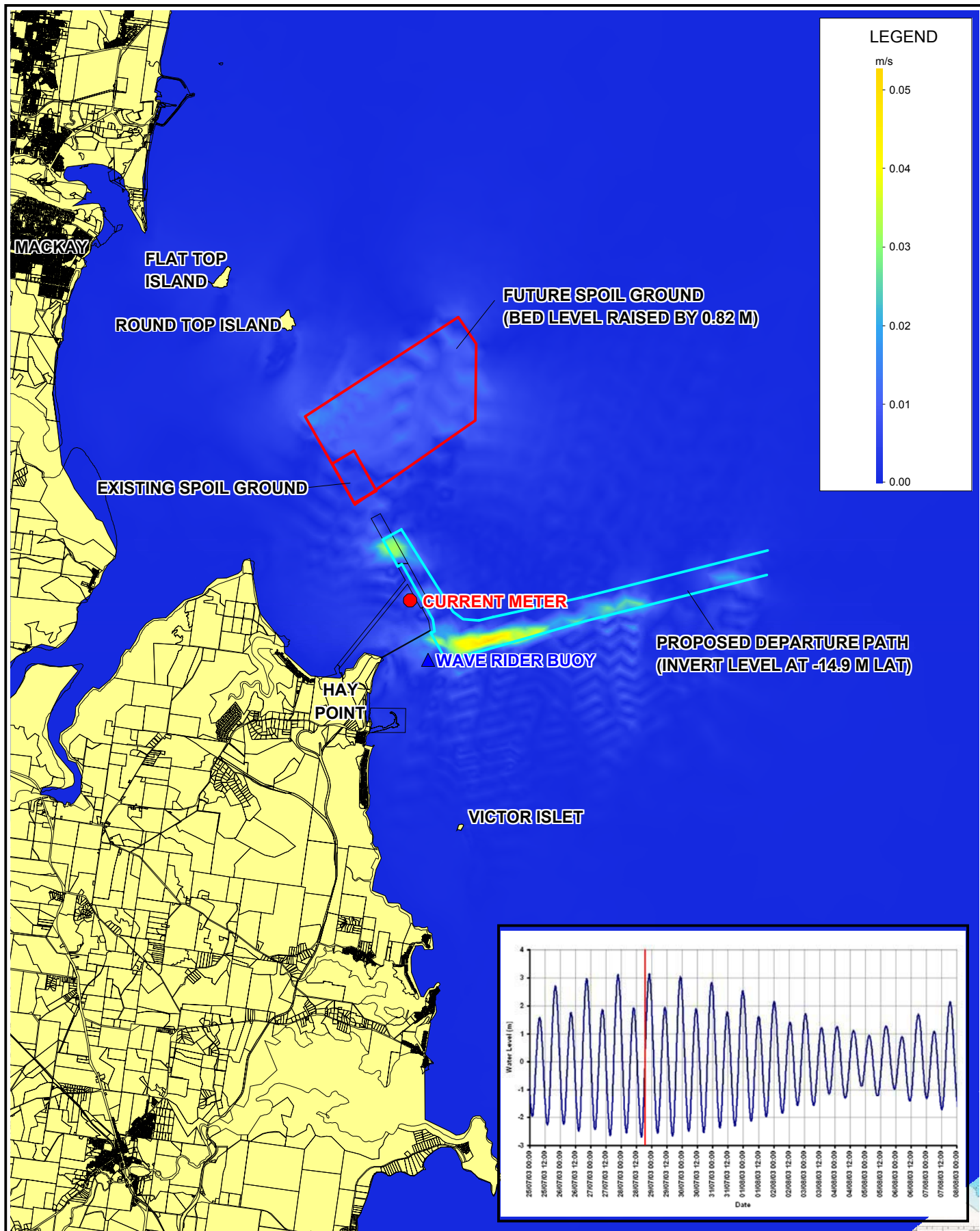


Figure 4-14 Change in bathymetry for Departure Path and Spoil Ground



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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

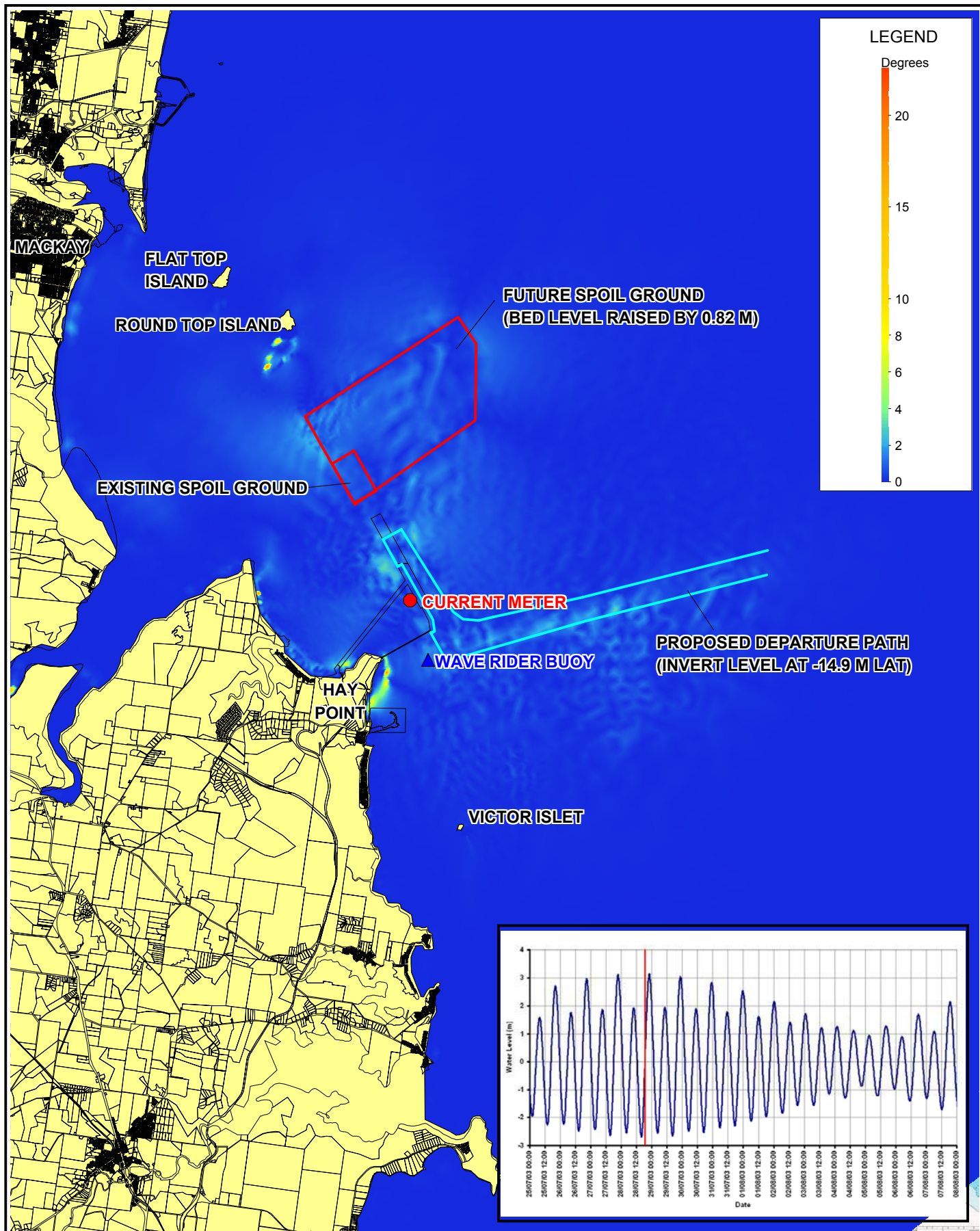
Port of Hay Point Capital Dredging

Change in Current Velocity During Flood Phase of the Spring Tide, 27 July 2003

Figure 4-15



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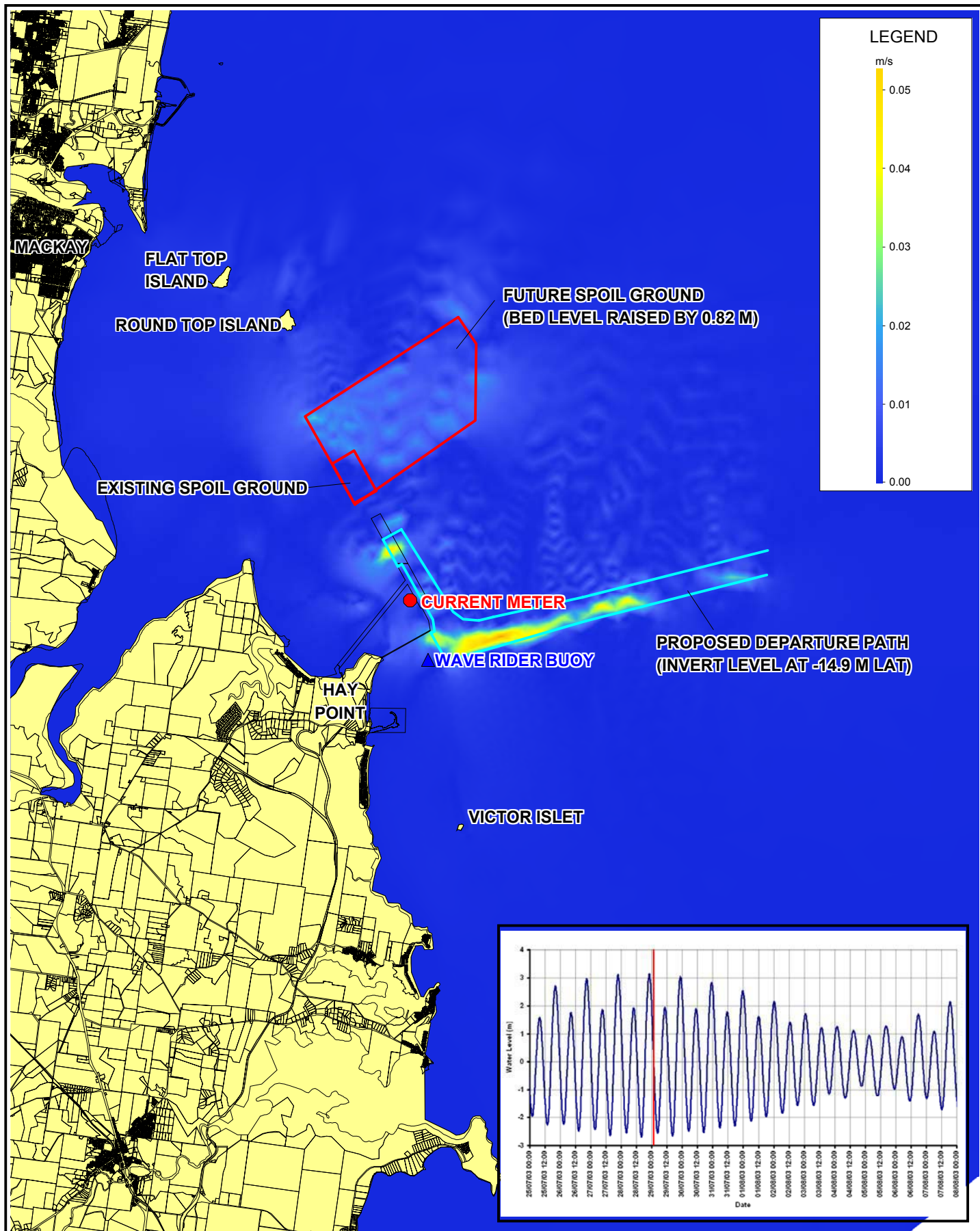
Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Change in Current Direction
During Flood Phase of the
Spring Tide, 27 July 2003

Figure 4-16





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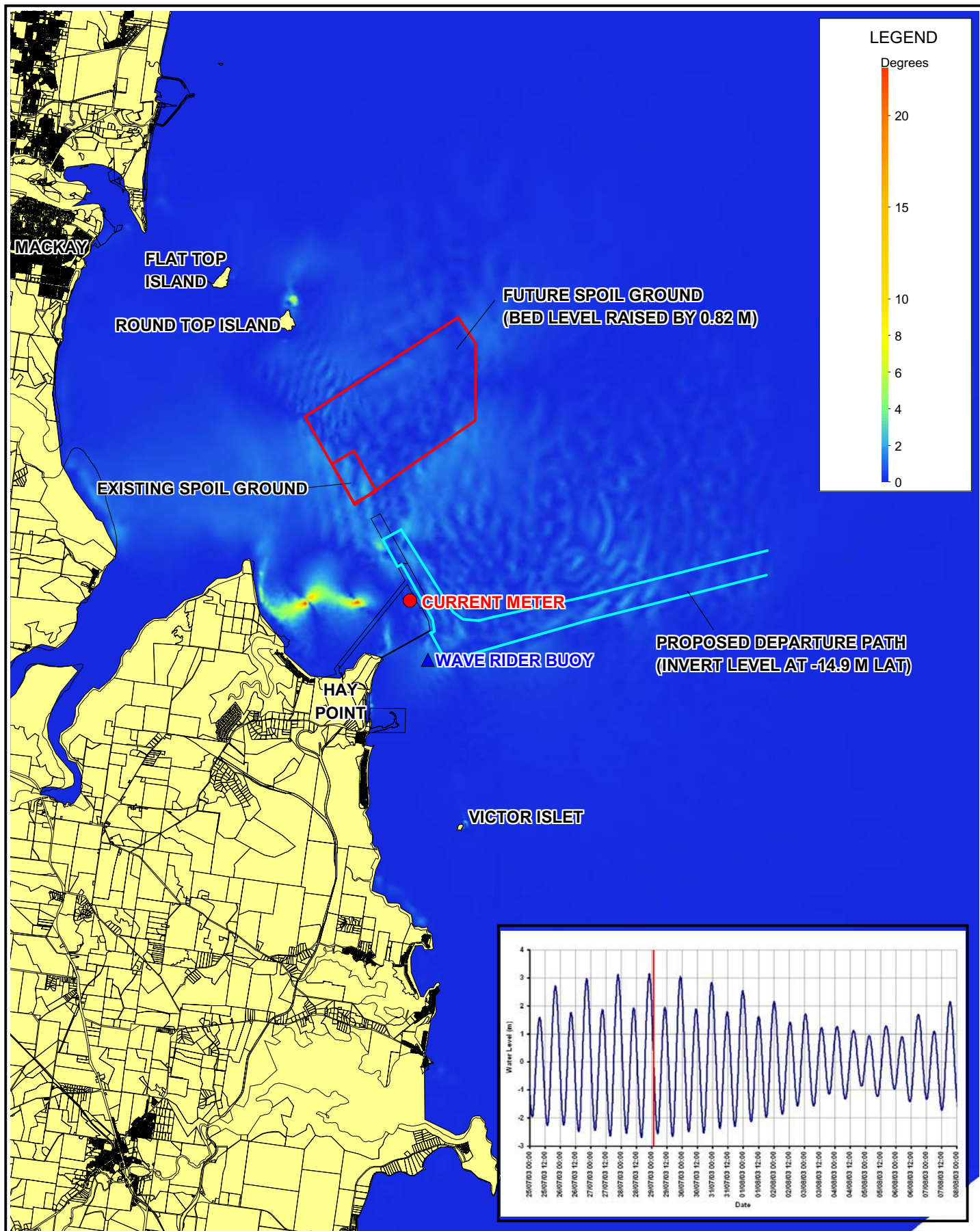
Port of Hay Point Capital Dredging

Change in Current Velocity During Ebb Phase of the Spring Tide, 27 July 2003

Figure 4-17



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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Changes in Current Direction
During Ebb Phase of the
Spring Tide, 27 July 2003

Figure 4-18



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Sediment Deposition

The estimated sediment deposition at Hay Point after the modelling period of 50 days of dredging and disposal at the spoil ground are illustrated in Figure 4-19 for the first case (single dredge), and Figure 4-20 for the second case (two dredges).

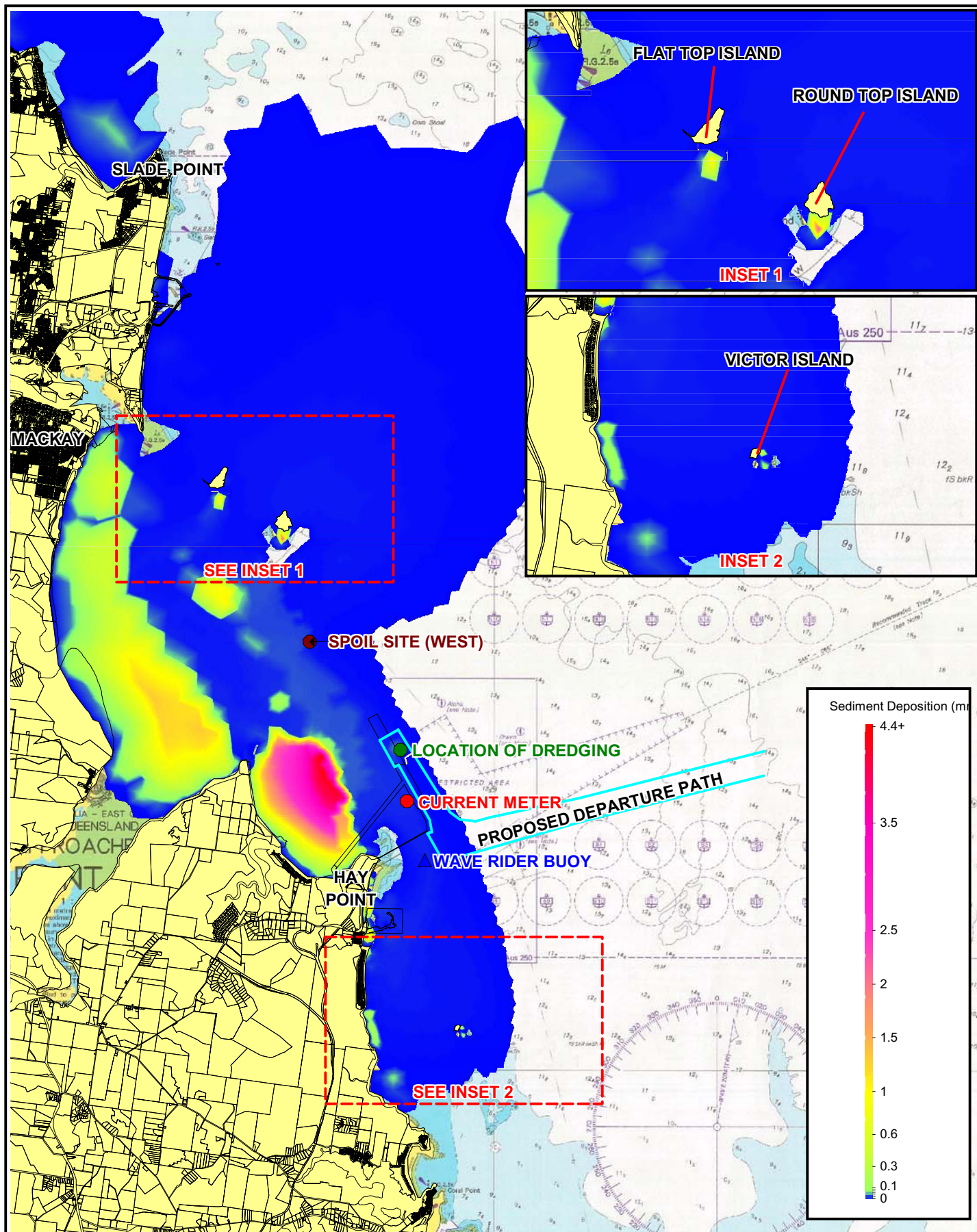
Figure 4-19 shows small but detectable accretion occurring at Dalrymple Bay (4.4 mm) and around the tidal flats in Sandringham Bay (1.4 mm). Smaller accretions (0 to 1.5 mm) are shown south of the islands owing to the naturally occurring eddies at those locations. Elsewhere, deposition depths are less than 0.1 mm after 50 days of dredging and disposal activities.

Figure 4-20 exhibits a similar pattern of accretion and depths to Figure 4-19. The main difference is the more widespread accretion (< 0.1 mm) in deeper waters as result of dredging along the Departure Path.

The model predicts accretion around Sandringham Bay as a result of introducing suspended sediments into the water column. This prediction is consistent with the fact that this area is prone to naturally occurring build up of silt, and to the resuspension of sediments under various wave conditions.

4.4.3 Mitigation Measures

The proposed development of the Departure Path and Apron Areas has a limited impact on existing bathymetry. No mitigation measures are relevant in relation to the change in bathymetry.

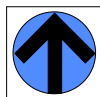


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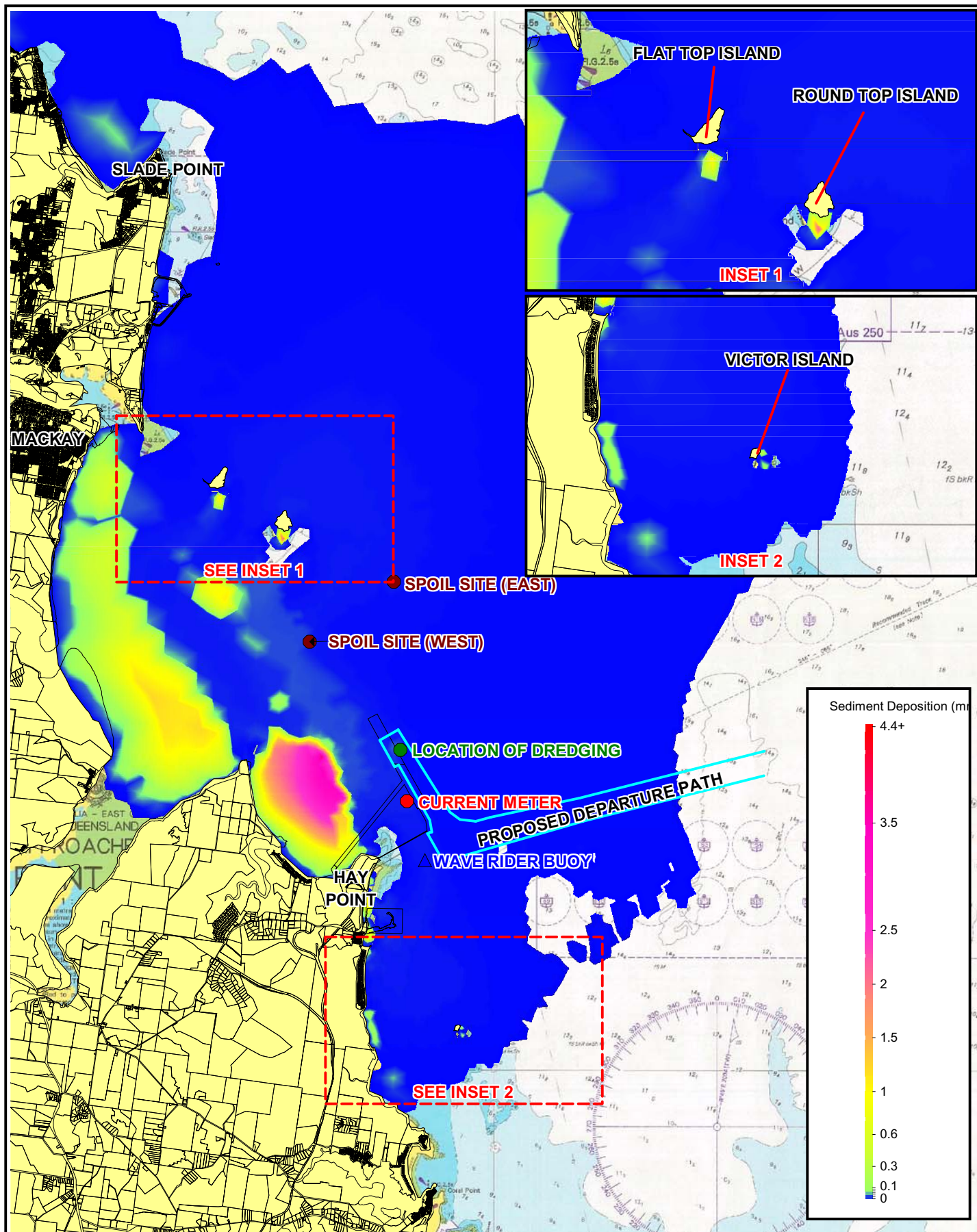
Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Deposition After 50 Days of Dredging Case 1 (Single Dredge)

Figure 4-19



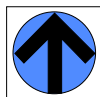


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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Deposition After 50 Days of Dredging Case 2 (Two Dredges)

Figure 4-20



4.4.4 Re-mobilisation of Spoil Ground

Overview

Previous studies (WBM 2004) have assessed the potential for spoil remobilisation from the existing spoil ground based on:

- ▶ Comparison of historical survey
- ▶ Bed sampling within the existing spoil ground
- ▶ Physical capacity of the bed sediments to be mobilised due to hydrodynamic processes prevailing at the site.

The existing spoil ground is located to the north of the existing berth aprons and covers an area of 127.5 ha (1,500 m x 850 m).

The existing spoil ground occurs in adjacent water depths of approximately -12.0 m LAT with the maximum level within the spoil ground of approximately -9.7 m LAT. (Note: subsequent to the previous study minimum depths of -9.0 mLAT have been recorded by the most recent survey following dredging in 2004.)

Key conclusions of the previous analysis include;

- ▶ Hydrographic survey comparison indicates very little remobilisation of sediment from the spoil ground.
- ▶ Bed materials are clearly remnants of dumping of dredge spoil. A substantial amount of clay material dredged remains in cohesive lump form and minimal quantities of loose, unbound silts and clays are present.
- ▶ Substantial suspension and transport of material from the spoil ground would require waves in excess of 1.5 m (Hsig) and these wave heights occur less than 2% of the time.
- ▶ Transport of loose fine silt / clay material in the dumped spoil may occur under less extreme wave/current action. The mobilisation of these sediments will be a gradual process occurring in parallel with natural sediment transport of fine sediments. Both water column concentration and deposition depths of this resuspended fine material is considered to become very low with distance from the spoil ground and hydrodynamic processes are likely to, over time, move fine materials into areas where significant bed sediment is found naturally.

The study essentially concludes that the majority of spoil material will remain within the spoil ground and that any deposition of resuspended fine material will be negligible in thickness and occur in areas where such deposition occurs naturally.

Comparison of the Existing Spoil Ground Assessment to the Apron and Departure Path Spoil Dumping

The proposed spoil ground for dumping of dredged material from the Apron and Departure Path expansion is significantly larger than the area of the existing spoil ground.

The proposed spoil ground is located to the north and east of the proposed Apron area and covers an area of approximately 1,969 ha.

The proposed spoil ground is located east of the existing spoil ground and extends to the east and north (no further dumping will occur in the existing spoil ground) and occurs in water depths varying from approximately –12.0 m LAT to –13.5 m LAT. On completion of dumping of the dredged material the seabed levels will have been raised on average by approximately 820 mm resulting in seabed levels of between –11.2 m LAT and –12.7 m LAT (excluding the existing spoil ground). These levels are significantly deeper than the –9.0 m LAT level recorded within the existing spoil ground.

Hydrodynamic modelling conducted in support of this EIS (Appendix F) confirms that bed shear stresses in the vicinity of the proposed spoil ground are less than those occurring at the existing spoil ground due to the comparatively deeper water depth. Consequently, the potential for wave/current action to remobilise spoil material from the proposed spoil ground is less than that experienced at the existing spoil ground.

The dredge material to be removed from across the Departure Path and apron area is similar to materials that have been dredged from previous capital development of the existing apron and berth areas and it is expected that spoil from the capital development of the apron and Departure Path will behave in a fashion similar to that deposited in the existing spoil ground from previous campaigns.

In summary the potential for migration of material from the proposed spoil ground is considered to be similar or lower (ie more stable) to the migration of material from the existing spoil ground because;

- ▶ The dredge spoil is similar in composition to the material deposited from past campaigns.
- ▶ The bed level of the proposed spoil ground is deeper than the existing spoil ground and as a consequence bed shear stresses are lower.

As a result, conclusions from previous analysis of the existing spoil ground are appropriate for the proposed spoil ground and have been adopted as representative of the likely behaviour of the spoil material from the proposed spoil ground.

4.5 Water Environment

4.5.1 Introduction

The purpose of this section is to assess the following:

- ▶ Potential impacts of dredging, spoil disposal, and spoil resuspension on water quality with particular attention to suspended solids, pH, dissolved oxygen, phosphorus and nitrogen;
- ▶ Relevant guidelines and standards, such as the Environmental Protection (Water) Policy 1997, and any recent or proposed amendments that incorporate recommendations of the National Environment Protection Measures and the ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters (2000);
- ▶ Amelioration or mitigation measures to address each activity identified to impact on local and regional water quality; and
- ▶ Any monitoring of water quality recommended during the dredging activities to ensure environmental values are protected.

The potential impacts of elevated turbidity on marine flora and fauna are discussed in Section 4.3), thus addressing the following matters, as required by clauses 75(5)(d), (f) and (j) of the GBRMP Regulations 1983:

- ▶ the methods for conservation of the natural resources of the Marine Park;
- ▶ the likely effects of the proposed use on adjoining and adjacent areas and any possible effects of the proposed use on the environment and adequacy of safeguards for the environment; and
- ▶ any other requirements for ensuring the orderly and proper management of the Marine Park.

4.5.2 Impact Summary

The potential impacts of dredging and spoil disposal on water quality are:

- ▶ the generation and migration of turbid plumes; and
- ▶ the mobilisation of contaminants into the water column.

The potential for migration and dispersion of turbid plumes during the proposed capital dredging has been determined using predictive modelling.

4.5.3 Water Quality Guidelines

For the 2001 dredging campaign, the criteria relating to turbidity was, “The dredging activities shall not cause the dredge plume from the dredge head and the deposition site to be either 1) within 3 km of Round Top Island or Victor Islet, or 2) more than 1 km from the location of the dredging activities towards the coastline of Dalrymple Bay.” (WBM 2004). Aerial surveillance and water quality monitoring have typically been undertaken to determine whether the dredging and ocean disposal activities are compliant to these criteria. This criterion was subsequently relaxed by Commonwealth

and State agencies because the visible plumes while extending as close as 1 km to the islands, was at very low levels of turbidity (< 1 NTU) and did not represent a threat to the environmentally sensitive areas. Modelling of the proposed dredging, as described in the following section, indicates that the plume will again extend to within approximately 1 km of Round Top Island under some tidal conditions. However based on the previous experience, the use of the previously imposed criteria for dredging is not considered practicable or relevant for the proposed works.

A further criteria from the most recent maintenance dredging of the Apron Area (2004) was that “Dredging activities shall not cause turbidity levels more than 1 km towards the coastline of Dalrymple Bay from the location of dredging works to exceed the best estimate of natural ambient seasonal turbidity by more than 25%” (PCQ 2004). A mean ambient seasonal turbidity level of 12 NTU was nominated (WBM 2004). This gives a trigger value of 15 NTU (25% above ambient natural seasonal turbidity).

The ANZECC (2000) guideline range for turbidity in estuarine and marine waters in tropical Australia is 1 – 20 NTU. Background water quality monitoring undertaken at the Port of Hay Point has recorded mean and maximum turbidity concentrations exceeding this guideline range at both the existing and proposed spoil grounds and in inshore areas (see Section 3.4) and natural turbidity in local waters have been recorded up to 500 NTU. During recent monitoring (April to May 2005) the maximum recorded turbidity was 146 NTU near Round Top Island.

The ANZECC (2000) guidelines favour the development of site-specific water quality objectives, based on natural conditions and known tolerances of key sensitive species and habitats. Therefore, the water quality guidelines adopted for the management and mitigation of potential impacts on key sensitive habitats for this Project have been based on the predicted tolerance levels of key coral communities in the vicinity of the Port (see Section 3.2).

4.5.4 Sediment Modelling and Potential Impacts

Overview

Sediment modelling was undertaken using RMA 11, a 2D/3D water quality model. RMA 11 is capable of modelling a range of processes including the sediment transport of non-cohesive (sand) and cohesive sediments (clay or silt).

RMA 11 uses the hydrodynamic results from RMA 2 to produce a solution for the advection diffusion constituent transport equation. Therefore, RMA 11 was run in 2D mode for this Project.

Dredge Scenarios

The Hay Point model was applied to a number of different dredging scenarios, with greater emphasis placed on those cases most likely to generate the highest concentrations of suspended sediment plumes. Adopted dredge scenarios are summarised in the following tables:

Table 4-7 Dredge scenarios for sediment modelling

ID	Scenario	Description	Comment
P1	Departure path	Dredging along proposed Departure Path	Area to be dredged is long and narrow extending to sea (i.e. the proposed Departure Path). Accounts for 20% of proposed capital dredging.
P2	Apron	Dredging within apron area	Apron area is closer to shoreline, and to identified areas of sensitivity. Approximately 80% of dredging works are proposed in the apron.
P3	Western spoil ground	Apron dredging with disposal at existing (west) spoil ground	Existing spoil ground. Closer to Round Top Island, with currents passing this area passing close to the island.
P4	Eastern spoil ground	Apron dredging with disposal at a new (eastern) spoil ground	Disposal area is further to sea, and hence would nominally be less likely to impact on Round Top and Flat Top Islands.
F1	Apron – single dredge	Dredging of apron dredging combined with deposition at western spoil ground	As for Scenario P3 above (i.e. Western Spoil Ground)
F2	Two dredges	Simultaneous dredging of path and apron, with disposal at both of the spoil grounds under consideration. Dredge along path assumed to be moving, whereas apron dredge assumed to be stationary.	Case is designed to test how much greater suspended sediment concentrations might be if two dredges were to operate simultaneously. The benefit would be a reduction in the length of the dredging campaign.
F3	Post Works	Rerunning of wave and hydrodynamic models to allow an assessment of whether changes to currents were likely	Designed to test whether changes are detectable and/or significant enough to potentially cause changes at the shoreline. With this case applying to the post dredging scenario, there is no relevance in modelling suspended sediment plumes.
NF	Non-overflow dredging	Dredging of the apron area and disposal at the western spoil site, with dredge operating in non-overflow mode.	Designed to test the variance in turbid plume resulting from operating with no overflow at the dredge site.

The bulk of modelled scenarios assumed the use of a single large dredge (capacity of 18,000 m³) operating in the vicinity of the apron. This scenario represents the base case, as the results of preliminary modelling suggest that dredging at the apron has a greater potential impact than dredging along the Departure Path. Other points of relevance when comparing dredging of the apron and Departure Path are:

- ▶ The Departure Path is effectively further away from Round Top Island.
- ▶ Sediments found in the Departure Path are generally coarser than sediments found within the apron area. Hence, sediments dredged from the apron area will tend to have a smaller settling velocity, and hence remain in the water column for longer.

For the case involving two dredges, the following scenario was modelled:

- ▶ A large capacity dredge (~ 25,000 m³) operating along the Departure Path; and,
- ▶ A smaller capacity dredge (~ 12,000 m³) operating within the apron.

The proposed spoil ground covers an area of approximately 18 km². The plumes generated from disposal at the spoil ground were represented in the model as point sources located along the northwest boundary. This locates the point sources closest to the environmentally sensitive areas, and hence provides a 'worst case' assessment of impact.

Dredging at the Apron (Scenario F1)

The model was run for a period of 50 days. The results of the modelling are presented in Figure 4-21 to Figure 4-25 followed by discussion.

The figures are summarised below:

- ▶ Figure 4-21: Suspended sediment concentration in vicinity of Round Top Island
- ▶ Figure 4-22: Suspended sediment concentration in vicinity of Victor Islet
- ▶ Figure 4-23: Worst condition for Round Top Island during spring tide (sediment plume)
- ▶ Figure 4-24: Worst condition for Victor Islet during spring tide (sediment plume)
- ▶ Figure 4-25: Reduced sediment plume (neap tide condition)

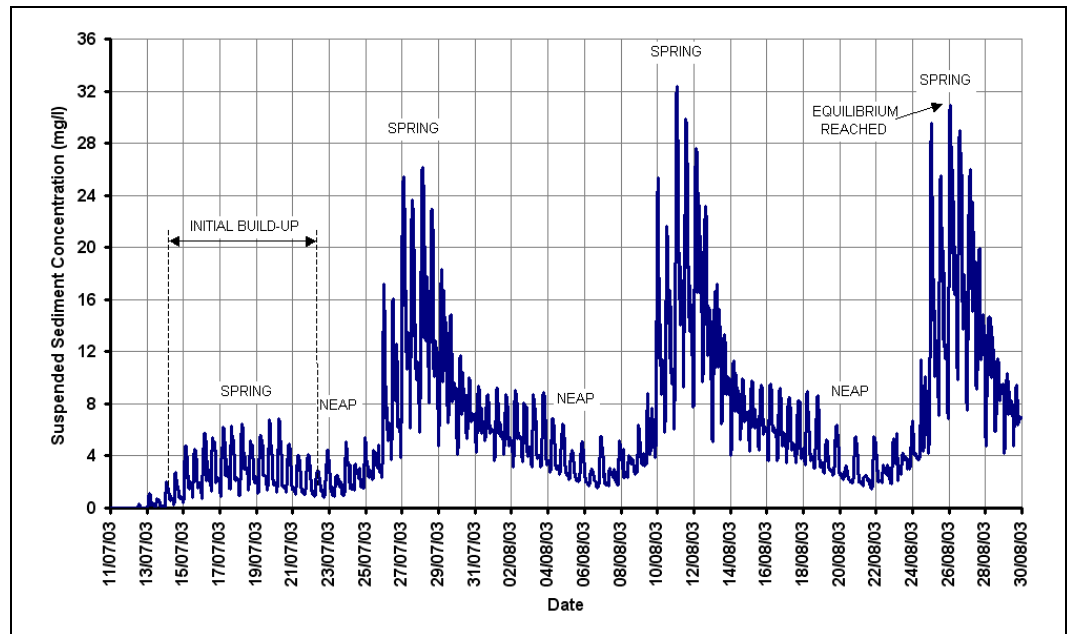


Figure 4-21 Suspended sediment concentration in vicinity of Round Top Island

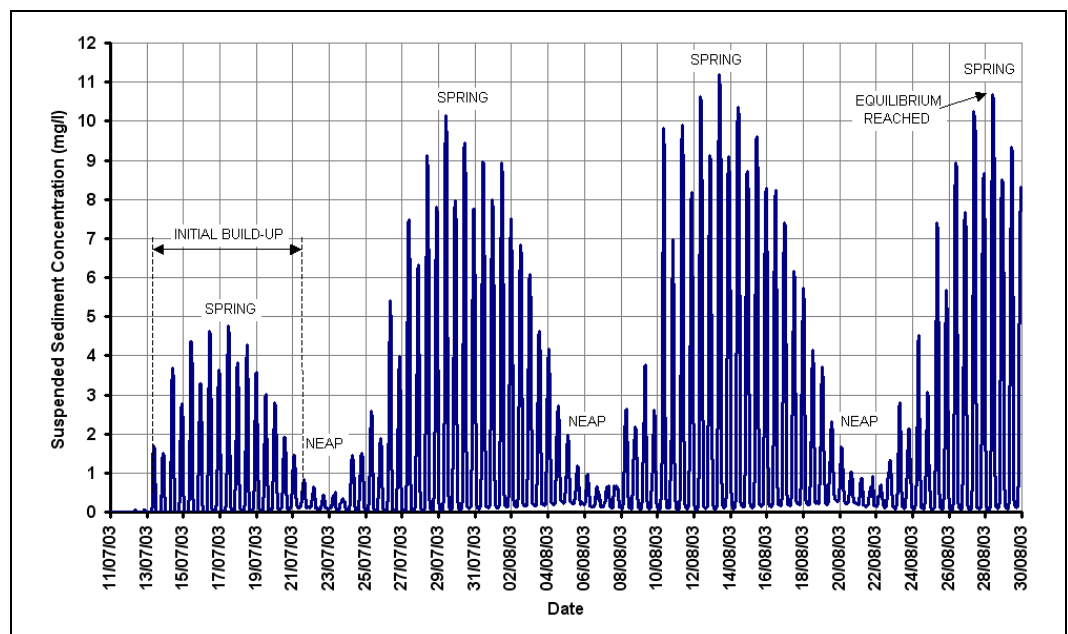


Figure 4-22 Suspended sediment concentration in vicinity of Victor Islet

Figure 4-21 and Figure 4-22 show an initial build-up of suspended sediment concentration for the initial period from commencement of dredging and spoil disposal. After the first few days, peak concentrations are reached with the trend repeated for subsequent spring and neap tide cycles. The peak concentrations around Round Top Island (approximately 32 mg/L) and Victor Islet (approximately 11 mg/L) are highest during spring tide when the plume extent is most significant. The suspended sediment concentration appears to reach equilibrium (i.e. consistent peak concentrations) after 45 days.

Figure 4-23 shows the plume covering a significant area of the coast after 31 days of dredging and spoil disposal (spring tide), representing a worst case scenario. However, the majority of the plume is at a concentration of less than 5 mg/L (approximately 16% of the adopted average concentration of 30 mg/L at the dredging site). Therefore, while the plume is likely to be highly visible because of the naturally high clarity of waters in the area, the concentrations of suspended sediment will be quite low and within those that are naturally experienced during elevated sea states and spring tidal currents.

The maximum concentration predicted at Round Top Island for the period of simulation would be of the order of 32 mg/l. The longest continuous time period for which the concentration remains above 20 mg/l is 4 hours during a spring tide phase. However, most of the time concentrations are less than 20 mg/l and would only exceed 20 mg/l for a period of less than 4 hours. Turbidity sampling conducted in April / May 2005 recorded a maximum turbidity of 146 NTU and 80th percentile of 8 NTU. The maximum predicted by the model is approximately 21% of that which occurs naturally during severe weather events. It is also evident that mild re-suspension is occurring in the tidal flats of Sandringham Bay where freshly deposited, non-consolidated material is being entrained from the bottom under the effect of strong currents.

A separation of the plume from the dredge is also evident from the figure. It should be noted that separation from the source is a normal state in plume behaviour and has been observed at Hay Point during previous dredging campaigns. The separation process can be explained as follows.

Figure 4-23 captures an instance (snapshot) of the tide, i.e., slack (high) water in this case. This is a markedly transient hydrodynamic condition during which the currents experience dynamic changes in magnitude and direction over the entire coastal area. In addition to these temporal changes and owing to its significant extent, the plume is also subjected to spatial changes where the plume signature and concentration adapt to the spatially varying current fields (i.e., within the area of plume extent).

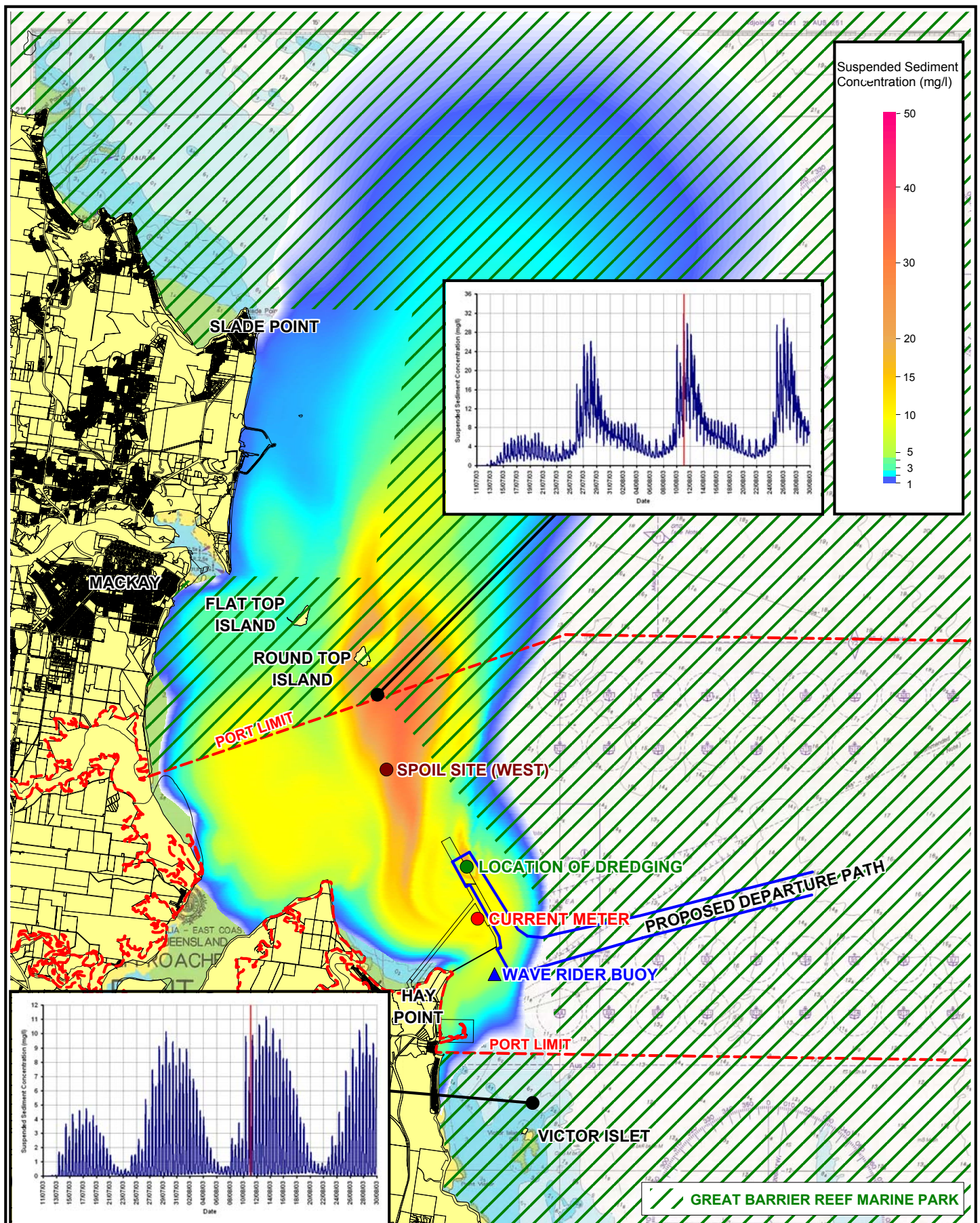
As a result of these disparities in the current fields, the plume experiences a rapid reversal in direction in the immediate vicinity of the dredge where currents are relatively strong while in Sandringham Bay, under the effect of weaker currents, the plume responds less dynamically (with less dispersion). In other words, the variability in the conditions characterising the receiving waters impacts the behaviour of the plume leading most naturally to short-lived separation from the source.

Animated sequences of snapshots showing the behaviour of the plume and the current field at different steps in time than the one represented on Figure 4-23 also indicate that disposal operations at the spoil ground contrive, with reduced dispersion, to maintain relatively higher plume concentrations. Irrespective of the build-up of concentration, peak plume concentrations remain below approximately 50% of the concentrations modelled in the immediate vicinity of the dredge.

Figure 4-24 (Victor Islet) demonstrates the plume at its most southerly reach during a spring tide. The maximum concentration predicted at Victor Islet was of the order of 11 mg/l. The longest continuous time period for which the concentration remains above 10 mg/l is 2 hours during spring tide. Most of the time, the concentrations are less than 10 mg/l or would only exceed 10 mg/l for a period of less than 2 hours. As with Round Top Island the maximum turbidity recorded during sampling was 65 NTU with an 80th percentile of 10 NTU. Again the maximum is significantly higher during naturally turbid conditions compared to the predicted maximum resulting from dredging.

Regarding plume separation, the same reasoning as for the previous figure applies.

Figure 4-25 (neap tide period) shows a similar plume extent as Figure 4-23 and Figure 4-24. However, the majority of the plume concentration is less than 5 mg/L, and appears to represent the residual plume generated during the spring cycle. The higher concentration bands (>10 mg/L) are restricted to a smaller area around the dredge and disposal site. Maximum concentrations reached in the waters surrounding Round Top Island and Victor Islet are generally less than 8 mg/L.



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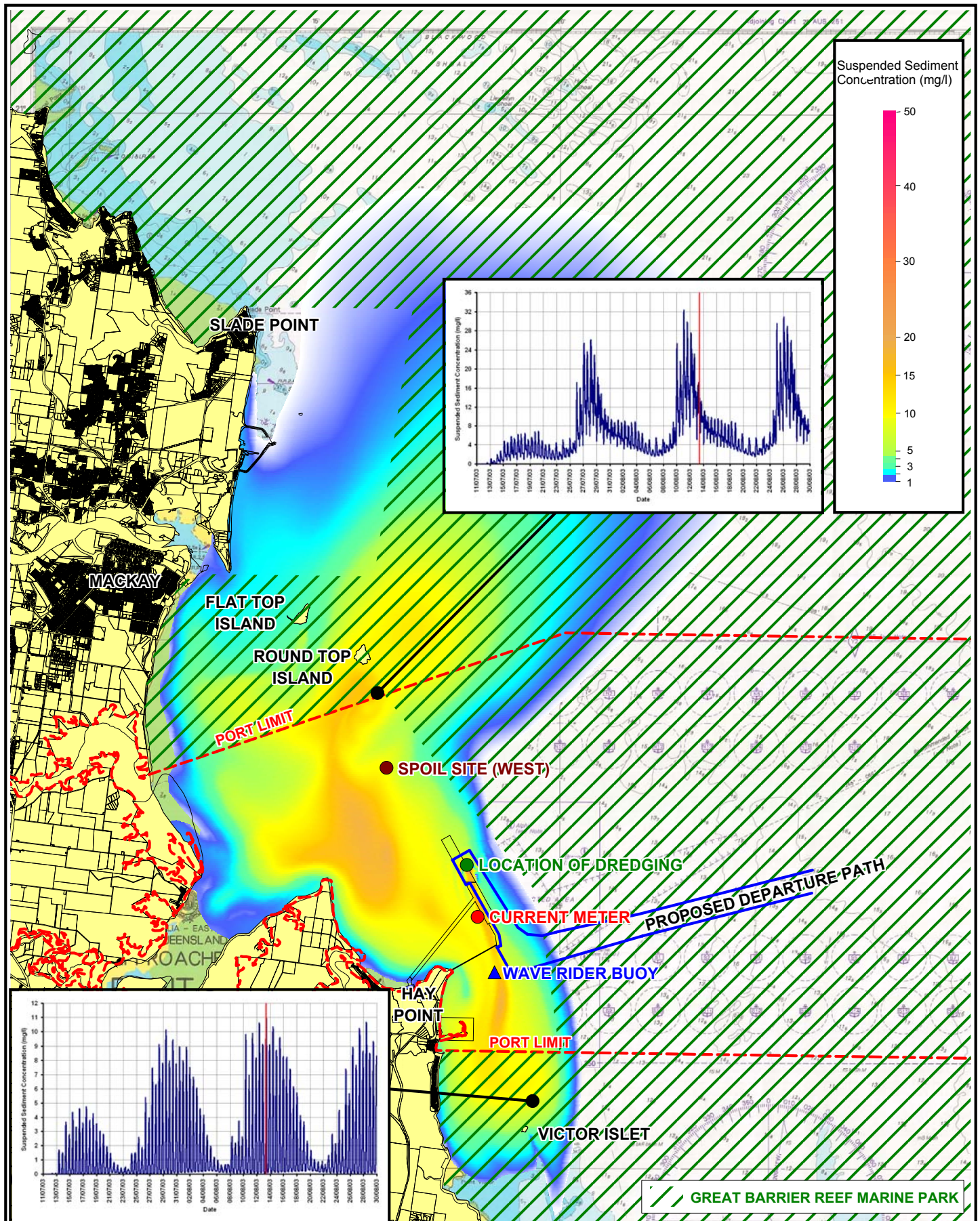
Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 31 Days of Dredging
Worst Condition for Round Top Island
Dredging at Apron & Dumping at
Spoil Site (West) During Spring Tide Cycle

Figure 4-23





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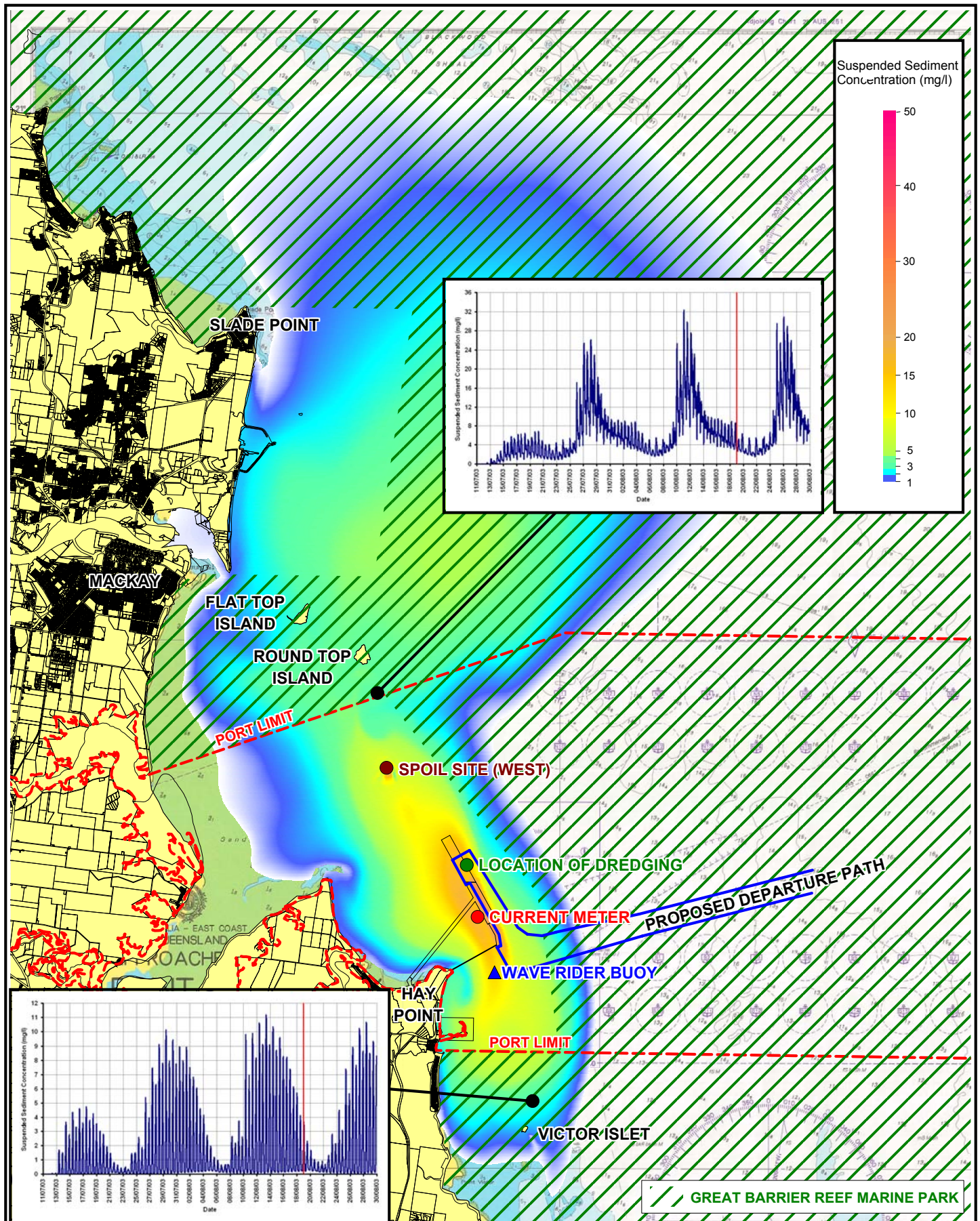
Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 33 Days of Dredging
Worst Condition for Victor Islet
Dredging at Apron & Dumping at
Spoil Site (West) During Spring Tide Cycle

Figure 4-24





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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 39 Days of Dredging
Dredging at Apron & Dumping at
Spoil Site (West) During Neap Tide Cycle

Figure 4-25



Simultaneous Dredging of Apron and Departure Path (Scenario F2)

The model was run with two dredges operating simultaneously for a period of 50 days. Two spoil disposal locations were introduced in the model. Material removed from the apron was disposed at the western corner of the spoil ground (Spoil Site West), while the material removed from the Departure Path was disposed further east of the spoil ground (Spoil Site East). The results of the modelling are presented in Figure 4-26 to Figure 4-30.

The figures are summarised below:

- ▶ Figure 4-26 Suspended sediment concentration in the vicinity of Round Top Island;
- ▶ Figure 4-27 Suspended sediment concentration in the vicinity of Victor Islet;
- ▶ Figure 4-28 Worst condition for Round Top Island during spring tide;
- ▶ Figure 4-29 Worst condition for Victor Islet during spring tide;
- ▶ Figure 4-30 Sediment plume after 39 days during neap tide.

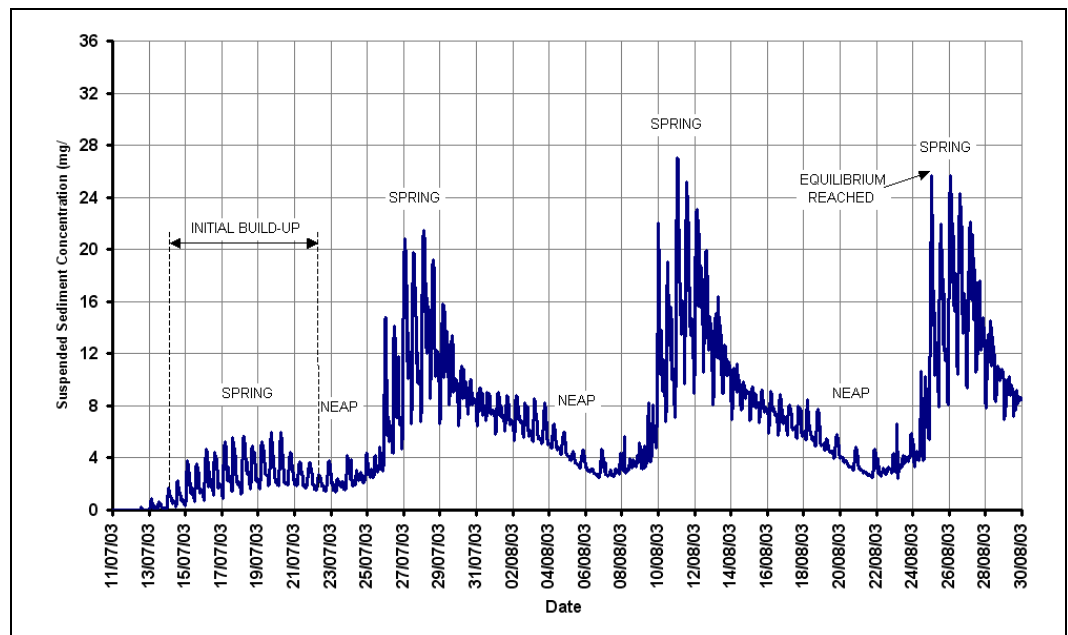


Figure 4-26 Suspended sediment concentration in vicinity of Round Top Island

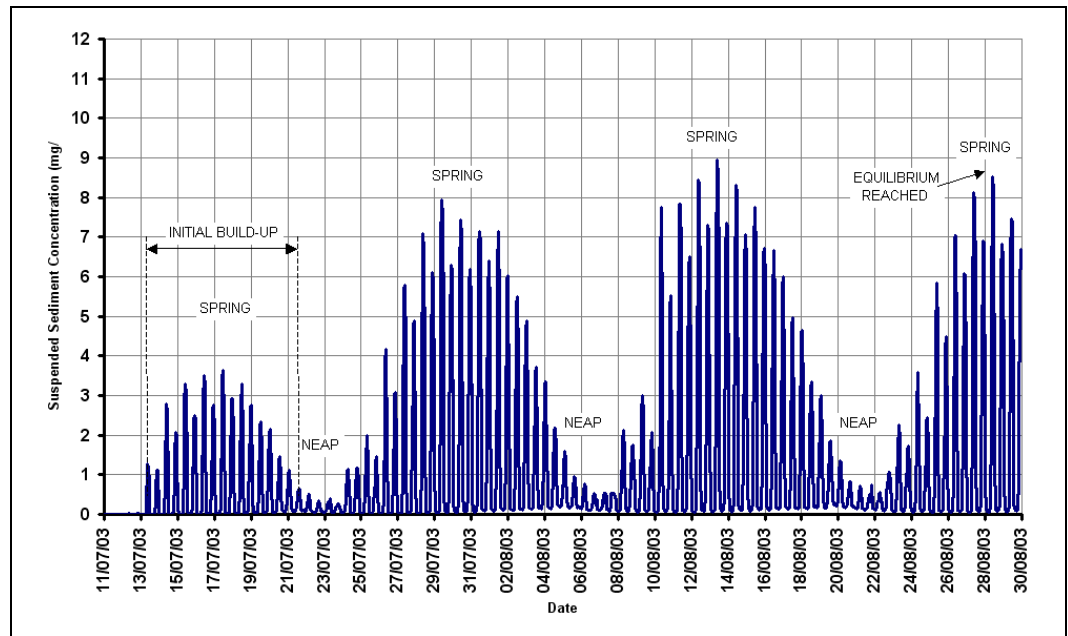


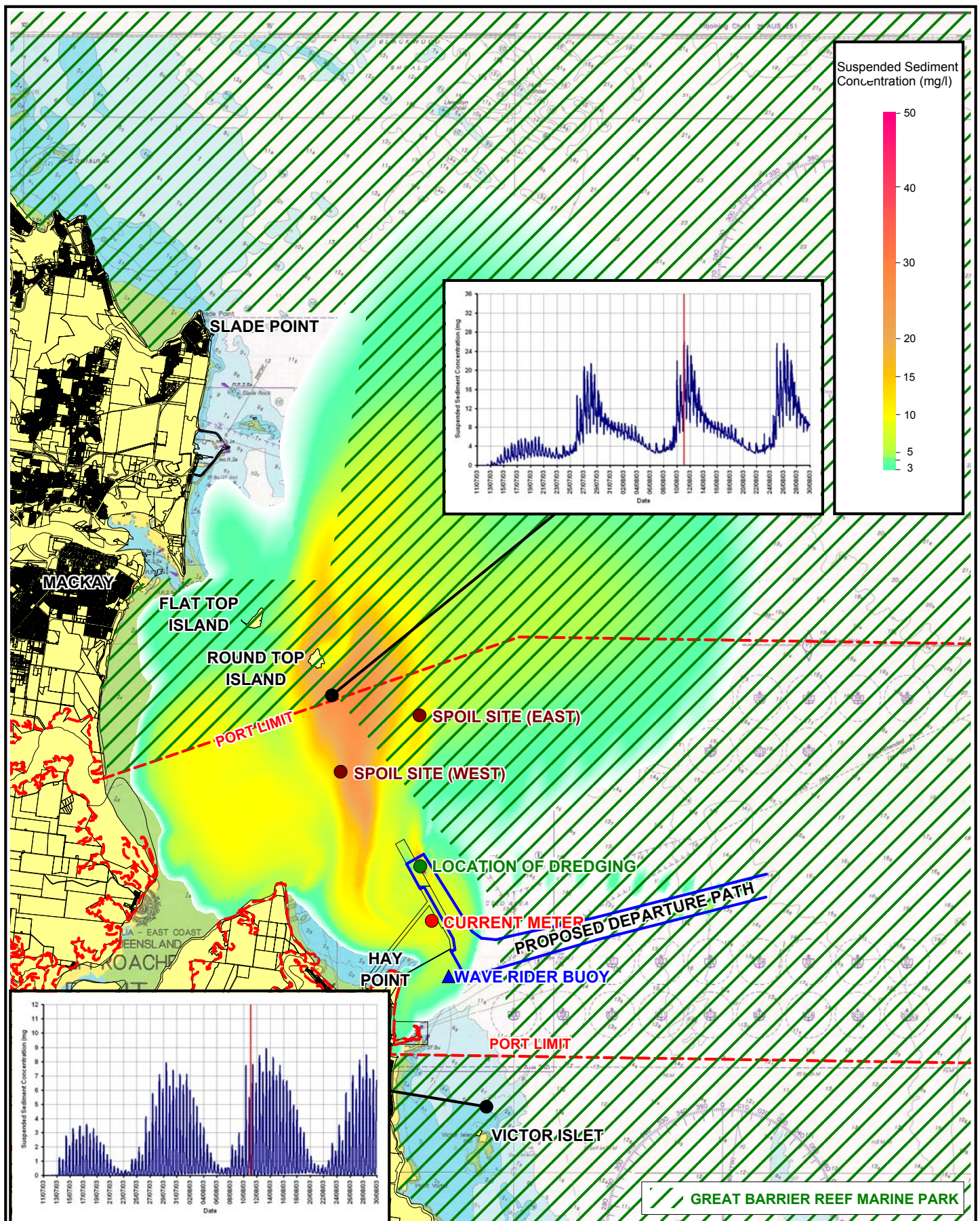
Figure 4-27 Suspended sediment concentration in vicinity of Victor Islet

The suspended sediment concentrations shown in Figure 4-26 and Figure 4-27 exhibit similar trends to the first case investigated (single dredge). However, in both cases peak concentrations are lower in comparison to the first case. The reduction in peak concentrations is the result of using a smaller dredge (12,000 m³ compared to 18,000 m³ adopted in the first case) at the apron. Furthermore, the reduction in peak concentration suggests that under low/negligible wind and wave conditions, the two plumes generated by dredging along the Departure Path and at the apron may not mix or superimpose. Hence, the source of the suspended sediments at a distance of 1 km from Round Top Island and Victor Islet is primarily from dredging at the apron.

The characteristics of the plume shown in Figure 4-28 to Figure 4-30 are similar to that of the first case, with the exception of the additional plume introduced by dredging along the Departure Path. The plume generated by dredging along the 9.5 km Departure Path is found to be of lower concentration (compared to plume generated from apron) as it is dispersed at a direction normal to the currents in Hay Point.

It was found that the plume generated from the eastern spoil site did not impact on Round Top Island. The plume moves in a northeast direction (away from Round Top Island) during ebb tide before settling to the seabed. Whereas the plume generated from the western spoil site does impact on Round Top Island at low concentrations.

Whilst these results suggest lower suspended sediment concentrations, this does not equate to a reduction of sediment in the water column. Rather, the two plumes have remained separate, and hence a larger area is affected. In the event of elevated wind or waves, the two plumes may mix, though typically it is expected that such events would act to further disperse the sediment plume, whilst background suspended sediment concentrations would also increase.



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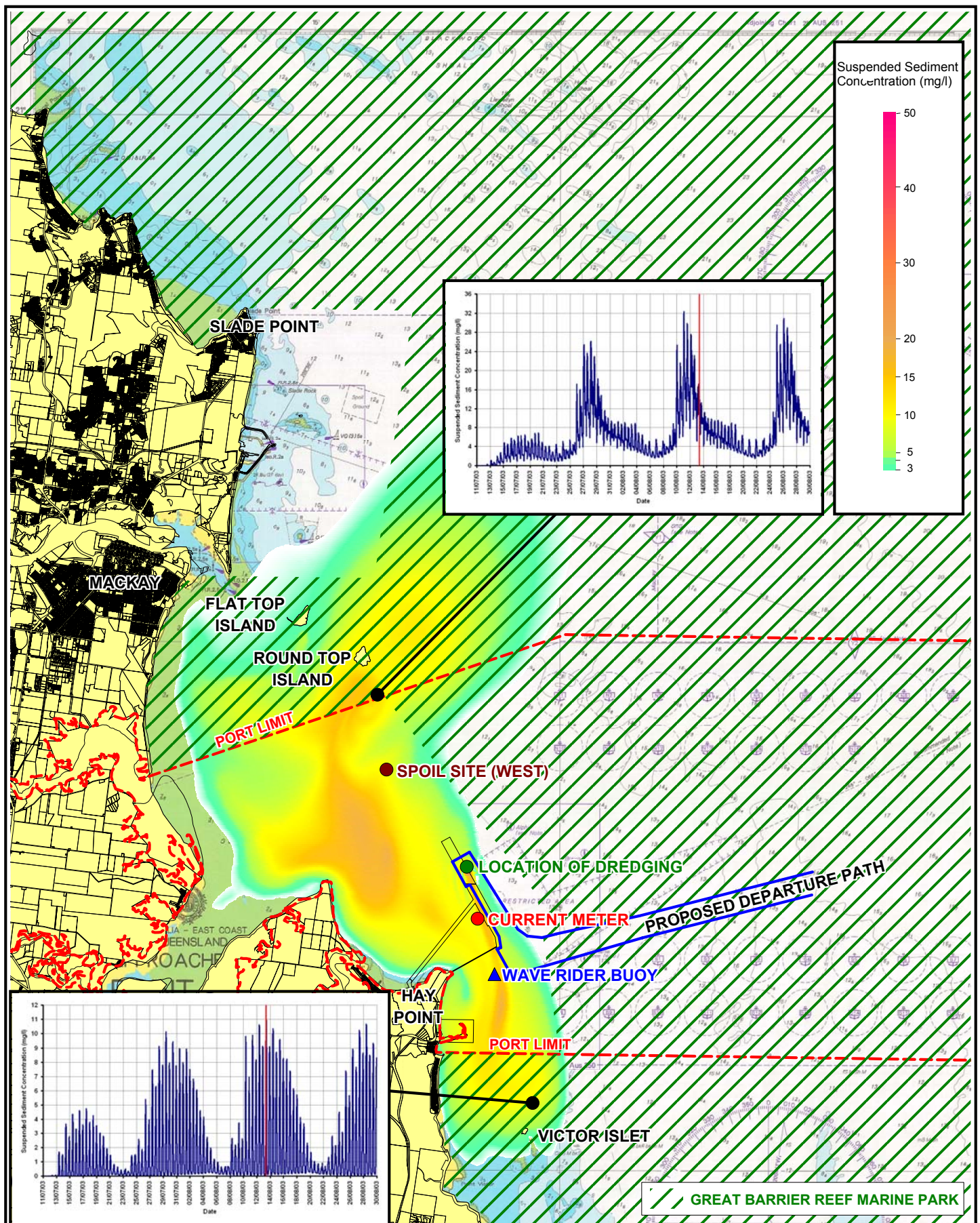
Port of Hay Point Capital Dredging

Sediment Plume After 31 Days of Dredging
Worst Condition for Round Top Island
Dredging at Apron & Dumping at Spoil Site
(East & West) During Spring Tide Cycle

Figure 4-28



Ports Corporation of Queensland



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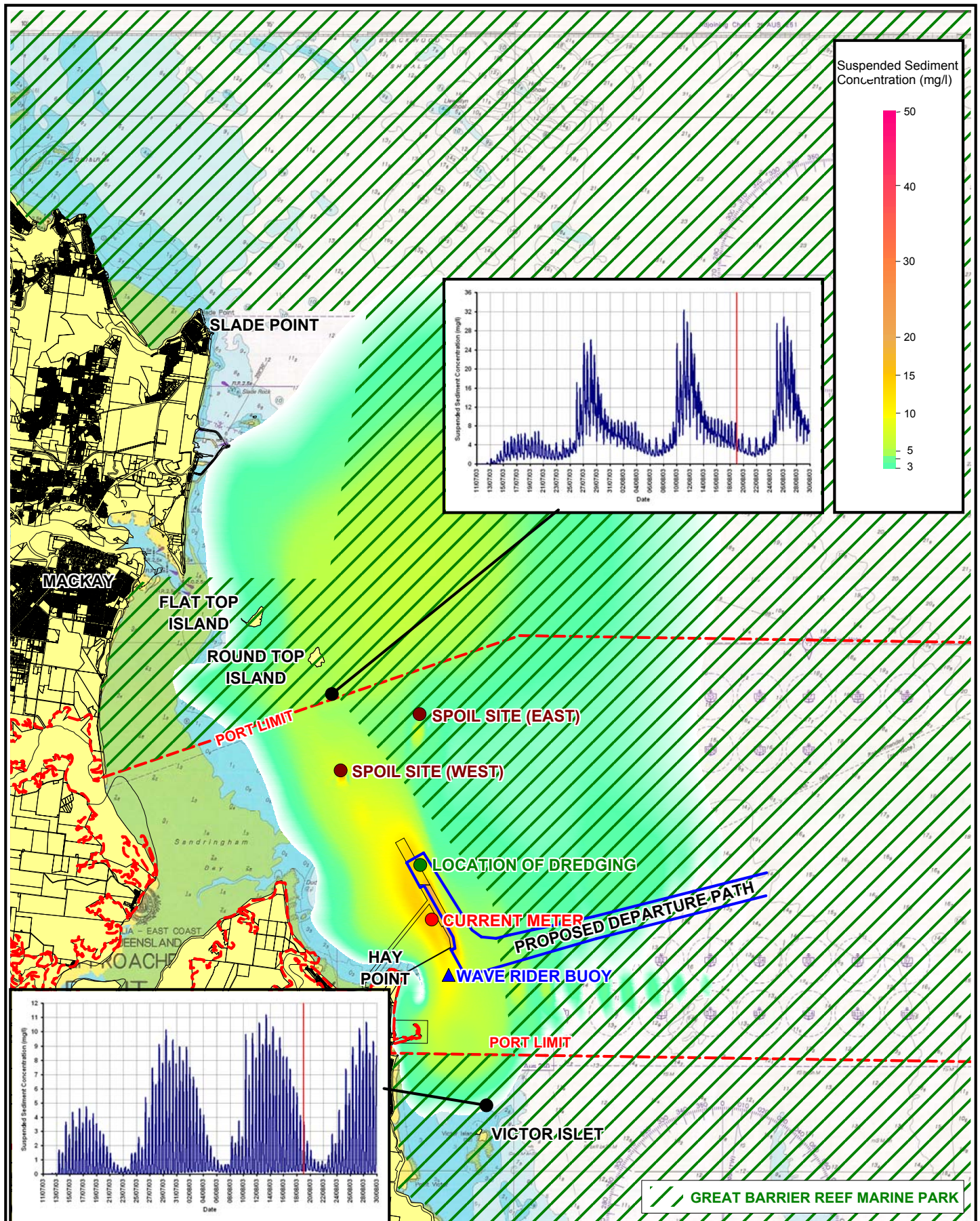
Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 33 Days of Dredging
Worst Condition for Victor Islet
Dredging at Apron & Dumping at
Spoil Site (West) During Spring Tide Cycle

Figure 4-29





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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 39 Days of Dredging
Dredging at Apron & Dumping at Spoil Site
(East & West) During Neap Tide Cycle

Figure 4-30



Non-overflow Dredging (Scenario NF)

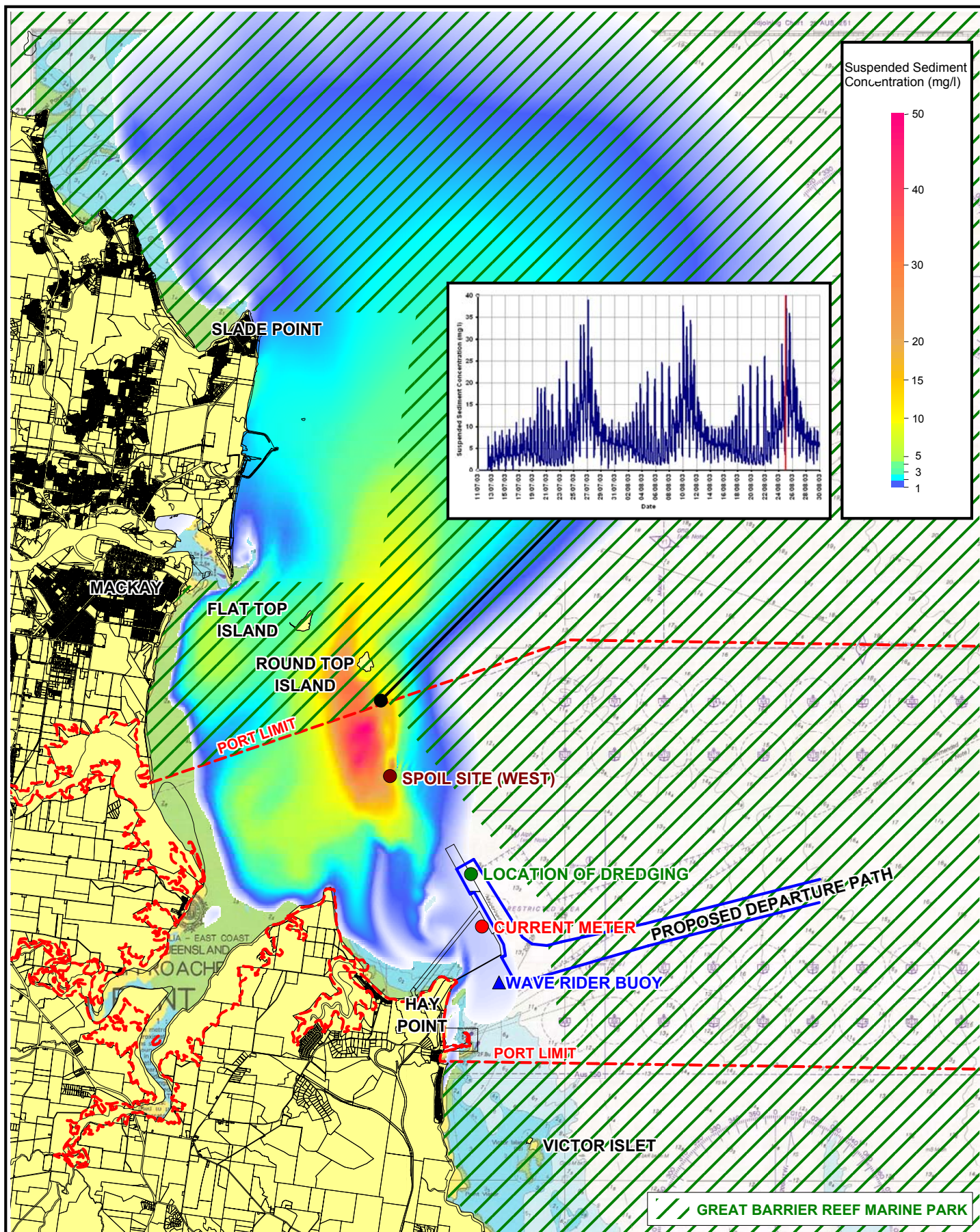
Non-overflow dredging is generally considered in situations where:

- ▶ environmentally sensitive habitats are located adjacent to the dredging site;
- ▶ dredge material contains significant levels of contaminants which may be released into the water column during dredging; or
- ▶ dredge material comprises fine silts only, as previously discussed.

The benefit of non-overflow dredging in the first two instances above, is that turbid waters are not released into the water column at the area immediately adjacent to the dredge. However, this turbid water is transported to the spoil ground area instead of being released at the dredging site.

This scenario represents a shorter dredge cycle which would be applicable to dredging in the non-overflow mode. Effectively a dredge cycle of 1 hr 45 mins would apply, therefore creating a significantly higher rate of dumping at the spoil ground. This scenario also results in a significantly higher quantity of turbid water being released into the water column. Regardless of whether the overflow or non-overflow method is used, the same amount of water is pumped through during to the hopper. With overflow dredging, this turbid water is released in situ at the dredging site, but with non-overflow dredging, it is released at the spoil ground from the hopper during dumping. For this Project, this would mean that turbid waters associated with non-overflow dredging would be relocated closer to where key biota exist, that is corals at Round Top and Flat Top Island.

The scenario was modelled for a period of 40 days. The results are presented in Figure 4-31. The peak concentrations around Round Top Island exceed those predicted during standard overflow dredging.

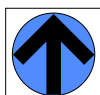


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Source Information: PCQ and Chart AUS 249, Australia East-Coast Approaches to Hay Point to Mackay.

Port of Hay Point Capital Dredging

Sediment Plume After 33 Days of Dredging
Worst Condition for Round Top Island
Dumping at Spoil Site (West) Only
During Spring Tide Cycle

Figure 4-31



Dredging Practices to Reduce Water Quality Impacts

In seeking expressions of interest from dredging companies wishing to undertake the proposed works a requirement of those registering an interest was to provide details of work undertaken in environmentally sensitive areas and to provide methodologies used to minimize potential impacts. This information was used as part of the selection criteria in establishing the panel to which the final tender documents will be provided.

Of the four companies chosen to receive documents each are all highly respected international companies with very good environmental credentials. All of these companies have reputations for being proactive in setting and meeting world best practice for dredging operations. In addition, the tender documents highlight that the proposed works is being undertaken in an area of environmental significance. Each tenderer is required to provide details of the measures to be employed during the works to minimise the dredging impacts and, in particular the reduction and minimisation of plume generation throughout the period of works.

An alternative to using a bottom dump dredge scenario for disposal within the spoil ground would be to lay a pipe from the dredge to the spoil ground to enable pump out from the dredge hopper. However this method presents several challenges and operational constraints.

- ▶ The pipeline would be either submerged below the surface or on the seabed which presents a potential navigational hazard for ships entering and exiting the berthing area which requires traversing of the proposed spoil ground. It is unlikely that the MSQ Regional Harbour Master would support such a method due to these safety hazards.
- ▶ In practice this method would require regular relocation of the pipe outlet during pump out phase to ensure appropriate distribution of material across the spoil ground. The equipment required to undertake this process is likely to comprise a vessel with a crane capable of lifting up to 50 t and winches to support slings to the pipe as well as a tug vessel. Such an operational is likely to be constrained by seastate conditions resulting in considerable down time. This presents a number of practical and operational constraints which could result in the period of works being extended.

Given the constraints associated with such an operation this scenario has not been considered further.

4.5.5 Mobilisation of Contaminants

Overview

Dredging and spoil disposal results in alterations to physicochemical conditions in sediments. This has the potential to mobilised contaminants contained in sediments into the water column. A detailed discussion of the potential impacts of mobilisation of contaminants into the water column during dredging and spoil disposal is provided in Section 4.6.

Toxicants

Section 4.6 concluded that as the upper 95% confidence limit concentrations of contaminants of concern in the sediment to be dredged is below the ISQG-low screening levels, the risk of mobilisation of contaminants into the water column during dredging and disposal is not a concern for this Project.

Nutrients

The total nitrogen and total phosphorus concentrations of sediments within the dredge area almost exclusively comprised organic nitrogen and organic phosphorus respectively, with concentrations of inorganic nitrogen (nitrate, nitrite and ammonia) and inorganic phosphorus (filterable reactive phosphate) being below the laboratory limits of reporting in the majority of samples. Given that organic forms of nitrogen and phosphorus are not biologically available for uptake by marine flora, the direct risk of eutrophication-related impacts associated with the mobilisation of sediment plumes during capital dredging at Hay Point are regarded to be low.

There are secondary biological processes that convert organic nutrients into inorganic forms, making them available to marine plants. Principal among these is the process of microbial mineralisation within the water column, with minor contributions made by zooplankton and benthic processes (Furnas *et al.* 1995). Resuspension of sediments due to natural or anthropogenic disturbance generally results in the release of nutrients into the water column (Lohrer & Wetz 2003, Alongi and McKinnon 2005). This is because the resuspension of sediments provides increased opportunity for biological mineralisation (Alongi & McKinnon 2005). The rate of this conversion is seasonally dependant, being much reduced during winter months. While the processes of sediment resuspension and organic nutrient mineralisation are important contributors to the available nutrient pool of the GBR, river and sewage-derived nutrients are believed to be important drivers in shallow coastal systems (Furnas *et al.* 1995).

Few studies have considered the release of nutrients during dredging (Lohrer & Wetz 2003). A study of nutrient releases into the water column during dredging in a tidal river in South Carolina found that while inorganic nutrient concentrations were increased in the dredge plume, they remained within the range of long-term water quality monitoring data for the area. Moreover, nutrient concentrations only remained elevated for approximately 15 minutes after the cessation of dredging (Lohrer and Wetz 2003). This rapid reduction in nutrient concentrations reflects the influence of sediment deposition processes.

The formation of a sediment plume during the proposed capital dredging works at the Port of Hay Point has some potential to provide nutrients to marine flora through the indirect process of biological mineralisation. However the relative risk of this contributing to excessive plant growth is considered to be low. This is because nutrient concentrations in the material to be dredged are relatively low and because much of the organic nutrients will be bound to sediment particles that are expected to fall out of suspension and deposit on the sea floor. This deposition will effectively render the majority of nutrients unavailable to marine flora, given that benthic processes of nutrient mineralisation only contribute slightly to nutrient availability (Furnas *et al.* 1995). The potential risk associated with dredging will also be reduced due to the scheduling of the bulk of the dredge works in the autumn and winter months, a period in which biological mineralisation rates are reduced.

4.5.6 Alterations to Physicochemical Parameters

Dissolved oxygen concentrations in oceanic waters are influenced by biological activity, which both consumes (respiration) and produces (photosynthesis) oxygen. The solubility of oxygen in water changes with temperature and salinity. Therefore, substantial changes in temperature, salinity or biological activity have the potential to result in changes in dissolved oxygen concentrations. Dredging and spoil disposal do not result in changes to temperature and salinity of ocean waters, and additional biological activity is not predicted as no elevations in nutrient concentrations within the water column are anticipated (see previous section). Consequently, substantial changes to dissolved oxygen concentrations as a result of dredging are not anticipated.

Oceanic waters are well buffered at the typical salinity and temperatures that are experienced at Hay Point (i.e. ~35 ppt and <30 °C). Alterations to the buffering capacity of the ocean generally only occur at elevated salinities and high temperatures. As dredging and spoil disposal do not result in changes to temperature or salinity, changes to pH are not expected as a result of the proposed capital dredging.

4.5.7 Summary

The following key points can be made in regard to sediment plumes generated by dredging and spoil disposal activities:

The maximum suspended sediment concentrations during the spring cycles in the vicinity of Round Top Island were determined to be of the order of 40 % of the peak plume concentrations near the dredge. In the vicinity of Victor Islet the maximum suspended concentrations were determined to be approximately 15% of the peak plume concentrations near the dredge. These values should be treated as indicative, as the influence of wind, waves, or other influences may lead to changed conditions.

Following the initial 10 days of dredging, a repeating trend of suspended sediment concentration (representing quasi-equilibrium) appears to be reached after 45 days.

The overall extent of the plume is similar for spring and neap tide. However, at very low concentrations, high concentration bands (>10 mg/l) are shown to be significantly

smaller during neap tide in comparison to spring. Therefore, the potential for adverse impacts on the identified environmentally sensitive areas during the neap cycles would be less than the potential for adverse impacts likely to be experienced during spring tides.

- ▶ Disposal at the western side of the spoil ground area produces a marginally worse condition for Round Top Island, as it brings the plume closer to the Island.
- ▶ The highest turbidity due to dredging on the Apron Area for Round Top Island (32 mg/L) occurs during the ebb phase of the spring tide cycle.
- ▶ The highest turbidity due to dredging on the Apron Area for Victor Islet (11 mg/L) occurs during the flood phase of the spring tide.
- ▶ The peak turbidity concentrations experienced at Round Top Island and Victor Islet are within the concentrations measured when no dredging is occurring (see Section 3.4);
- ▶ It is important to note that elevated suspended sediment concentrations oscillate with the tide, and hence marine flora and fauna communities are unlikely to be subjected to constant elevated turbidity levels.
- ▶ Mild re-suspension of sediments may occur around the tidal flats of Sandringham Bay during the ebb phase of the spring cycle.
- ▶ In the absence of significant wave or wind conditions, the two plumes generated by dredging along the Departure Path and by dredging at the Apron Area will not mix or superimpose.
- ▶ The plume generated by dredging along the 9.5 km Departure Path is found to be of lower concentration (compared to plume generated from Apron Area) as it is dispersed at a direction normal to the tidal currents in Hay Point; and
- ▶ It was found that the plume generated from disposal of dredged material at the eastern spoil site did not impact on Round Top Island. The plume moves in a northeast direction (away from Round Top Island) during ebb tide before settling to the seabed.
- ▶ The implications of the impacts of dredging and spoil disposal on water quality on marine flora and fauna are discussed in Section 4.3.

4.5.8 Mitigation Measures

As the extent of the plume predicted to be generated by dredging and spoil disposal will encompass Round Top and Flat Top Islands and Victor Islet, and the natural turbidity range exceed the ANZECC (2000) water quality guidelines, it is not considered appropriate to apply the same water quality criteria that have been applied in previous dredging campaigns at the Port.

Applying a trigger level for suspended solids in sensitive areas which requires dredging practices to be modified does not appear practical, because the suspended sediment may stay in the water column for an extended period of time, depending on tidal conditions. The most practical measure to minimise potential impacts is to minimise

the duration of dredging, ie: once dredging commences complete as quickly as possible to allow natural recovery mechanisms to commence and to minimise the period of stress.

The contractor employed to undertake the works will be required to demonstrate world's best practice methodologies for dredging in sensitive environments.

4.6 Sediment Quality

4.6.1 Introduction

The potential impacts of sediment quality on the marine environment have been assessment in accordance with the guide for suitability of sediment for ocean disposal as determined by the framework outlined in the NODGDM (EA 2002).

4.6.2 Impact Summary

Mobilisation of seabed sediments into the water column during spoil disposal may increase the bioavailability of toxicants to marine organism. The principle parameters that affect mobilisation of contaminants from sediment to water are clay type and content, organic matter content, cation exchange and capacity, reactive iron and manganese, oxidation reduction potential (redox), pH and salinity. Of these parameters clay type, organic matter, pH and redox conditions are considered the most important (Burt and Hayes 2005).

The process of dredging results in changes in physiochemical sediment conditions, favouring the mobilisation of contaminants into the environment. Upon disposal, potential contaminant pathways include its passage through the water column and benthic environments (Figure 4-32, USACE and US EPA 2004). Water column impacts are usually water quality (chemical) and toxicity (biological) while benthic impacts are measured from the perspective of toxicity and bioaccumulation. Primary contaminant groups that may impact the marine environment include heavy metals, hydrocarbons and persistent organic compounds (DEH 2002, Burt and Hayes 2005).

The material to be dredged in the current Project is considered to be suitable for unconfined ocean disposal according to the NODGDM (Section 3.5). Therefore the remobilisation of sediments into the water column and the placement of dredge spoil at the spoil ground will not result in the introduction of chemical contaminants to the receiving environment.

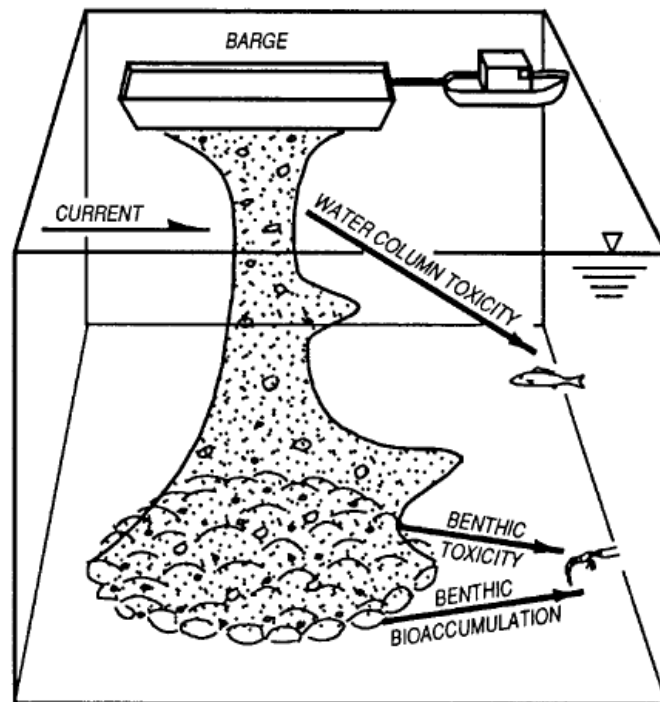


Figure 4-32 Primary contaminant pathways during the disposal of contaminated dredge spoil (from USACE and US EPA 2004)

4.6.3 Physical Characteristics

The material to be dredged is finer than the material at the spoil ground (Section 3.5). However, a proportion of the finer fraction will be deposited as cohesive clay lumps, reducing the differences between the non-cohesive fractions of the sediment to be dredged and the seafloor at the spoil ground. As summarised in Section 3.5.4, the comparison of particle sizes in the current spoil ground immediately pre and post-dredging in 2001 indicated that the particle size characteristics changed substantially. However a comparison a comparison of particle size characteristics between the pre-dredging and 2-years post-dredging surveys indicated that the longer term changes in spoil ground sediment composition were less than those recorded immediately post dredging, indicating a return to a particle size composition that was similar to the pre-dredging state.

The dredge that is contracted to do the work will be required to place the spoil as evenly as possible throughout the spoil ground. It is estimated that this will raise the seabed by ~82 cm over an area of approximately 18 km². This may have a localised influence on physical processes, however, predictive modelling has indicated that there are no expected changes to current velocity or direction at the spoil ground as a result of the proposed dredging and spoil disposal.

A key alteration to the seafloor of the proposed spoil ground sediment characteristics as a result of spoil disposal will be the introduction of clay lumps to the surface.

Previous experience suggests that it is likely that these lumps will remain relatively intact, with those at the surface potentially eroding slowly over time. Post-dredging, the spoil would be expected to settle into a structure with a relatively smooth surface, with finer material filling any gaps created by the larger clay lumps. Similar clay lumps have been introduced into the spoil ground in previous dredging campaigns and have not appeared to hinder recovery of benthic epifauna and macroinvertebrate communities.

4.6.4 Conclusions

Impacts of Dredging and Spoil Disposal

Mobilisation of seabed sediments into the water column during dredging and their subsequent deposition has the potential to result in toxicological effects via water column and benthic routes of exposure. However, as the contamination levels in the sediments to be dredged are below the ISQG low screening levels (Section 3.5), it is unlikely that dredging of these sediments would result in the release of contaminants into the water column or the introduction of contaminants to surrounding benthic habitats.

Alterations to the physical characteristics of seafloor sediments as a result of ocean disposal has the potential to alter the suitability of the habitat for benthic communities, leading to an altered post-dredging community. The physical differences between the sediment to be dredged and the sediments at the spoil ground are not considered to substantially alter the ability of the spoil ground to be recolonised by similar benthic communities to those that are currently present.

Mitigation Measures

As there are no predicted impacts of sediment toxicants on the receiving environment as a result of dredging or spoil disposal, no mitigation measures are proposed

4.7 Meteorological Environment and Climate

4.7.1 Introduction

This section of the EIS provides an assessment of the potential impacts of climatic factors the Project may have. The contribution of this Project to greenhouse gas emissions is also discussed.

4.7.2 Impact Summary

The conduct of the dredging will only result in minor and transient increases in emissions of greenhouse gases from the presence of the dredge and any other associated plant and equipment. The constant presence of numerous ships, tugs and other recreational and commercial fishing vessels means that the presence of the dredge will not add significantly to the existing greenhouse gas emissions generated by port activities.

Greenhouse calculations indicate that a six-month dredging campaign would result in 14,000 t of greenhouse gas emissions. If non-overflow dredging is undertaken, emissions will be approximately 43,000 t over an 18-month period.

4.7.3 Mitigation Measures

The main mitigation measure is to limit the duration of dredging. Undertaking non-overflow dredging will result in approximately 29,000 t of additional greenhouse gases emitted into the environment. The use of non-overflow dredging therefore, has the potential to cause additional environmental impacts rather than reduce them.

As there are no other predicted impacts of this Project on local meteorological and climate conditions, no mitigation measures are proposed.

4.8 Air Quality

4.8.1 Introduction

This section of the EIS provides an overview of possible air quality impacts. It is not expected that air quality impacts will result from the dredge and the Project as construction activities will occur well off-shore away from sensitive receiving environments.

4.8.2 Impact Summary

The current Project does not include the expansion of land or marine based infrastructure at the Port, therefore there will be no changes to the current air quality impacts associated with dust as a result of the dredging of the Departure Path and Apron Area. The Project is expected to allow an increase in Port throughput of 1.8 Mtpa however this is not a significant increase in the current 80 Mtpa Port throughput. This throughput is also being achieved without changes to the stockpile capacity on land, which is the main source of dust emission. Likely sources of air emissions during the capital works are limited to exhaust emissions from the dredge plant and equipment, which are considered minor emissions. Given the location of works off-shore from Hay Point and the relatively remote location of works, it is not expected that the regional air quality would be impacted.

The existing operational impacts of the Port on air quality, which are mitigated through various engineering design and management measures (e.g. dust suppression), will not alter as a result of the dredging of the Departure Path and Apron Area.

4.8.3 Mitigation Measures

Management measures consistent with the requirements of the EPP Air would be implemented to ensure that any potential air quality impacts are minimised. Plant and equipment utilised during dredging would be maintained to ensure that exhaust emissions comply with relevant guidelines.

4.9 Noise and Vibration

4.9.1 Introduction

The section of the EIS considers the following in relation to determining potential noise and vibration impacts of the Project on surrounding areas:

- ▶ noise and vibration as a result of dredging activities;
- ▶ the potential impact of noise from increased shipping; and
- ▶ the potential impacts of noise and vibration on marine mammals.

The Project does not include the requirement for blasting as part of the capital works. Therefore a detailed risk assessment of potential impacts of blasting on marine fauna and particularly marine mammals was not considered necessary.

4.9.2 Potential Impacts of Noise and Vibration on Marine Mammals

Overview

There is considerable national and international concern that the sounds introduced into the sea by humans could be having detrimental effects on marine mammals, by interfering with their ability to detect calls from individuals of the same species, echolocation pulses or other important natural sounds (Richardson *et al.* 1995). Potential effects of the elevated background noise levels caused by this introduced man-made noise include:

- ▶ limiting the detection by the mammals of natural sounds;
- ▶ disturbing their normal behaviour resulting in possible displacement from areas; and
- ▶ causing temporary or permanent reductions in hearing sensitivity.

These potential effects depend to a degree on the type of marine mammal involved. The potential area or zone of influence of a man-made sound is also influenced strongly by the levels and types of ambient noise (Richardson *et al.* 1995).

There is a large volume of literature concerned with the description of various impacts upon marine mammals (Richardson *et al.* 1995, McCauley 1994, Tasker & Weir 1998, Gisiner 1998, Davis *et al.* 1998, McCauley & Duncan 2001, and O'Brien 2002). Generally, these impacts are measured through observations of behavioural responses to noises. As such, these responses are used as a surrogate measure for sensitivity or susceptibility. The number of extensive reviews available has drawn on the same limited experimental and observational data, indicating that much more of this work is required. Consequently, when considering the possible impacts of underwater noise on marine mammals, in general McCauley & Duncan (2001) suggest that it is necessary to recognise that:

- ▶ each species in question has receptor systems for detecting the signal and that the noise frequency content must be such that it overlaps the hearing range of any species impacted;
- ▶ different types of noises may have different effects;

- ▶ different effects may be elicited from an approaching noise source as compared to a stationary or departing noise source; and
- ▶ the scale of the noise disturbance needs to be considered (i.e. is it frequent, infrequent or continual over short and long time scales?).

Based on a review of anatomical and audiometric data Ketten (1998) supports the notion that marine mammals are acoustically diverse, with wide variations in ear anatomy, frequency range and amplitude sensitivity. The general trend is that larger species tend to have lower frequency ranges than smaller species.

All marine mammals have sensitive ears that are simultaneously adapted to sustain moderately rapid and extreme pressure changes, and which appear capable of accommodating acoustic power relationships several magnitudes greater than in air. This is likely due to the fact that the aquatic environment propagates sound significantly more efficiently than air, and so aquatic auditory systems are adapted to these conditions. In addition, virtually all marine mammals are potentially impacted by sound sources with a frequency of 500 Hz or higher, but relatively few species are likely to be impacted by lower frequencies.

An animal's sensitivity to sounds varies with frequency, and its response to a sound is expected to depend strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Richardson *et al.* 1995).

Table 4-8 outlines the acoustic intensity and frequency of those sources of marine noise for which there is data, relative to the call and vocalisation ranges of marine mammals. While this information provides an indication of their known range of acoustic interactions, it does not necessarily relate to their acoustic or other physical tolerances to low frequency, high energy sound waves.

Table 4-8 Summary table of acoustic intensity and frequency of noise sources relative to those for marine mammals (approximated from the literature)

Source	Acoustic intensity (dB re 1µPa)	Frequency range (Hz)
Great whales	130 - 188	16 – 8,000
Toothed whales (vocal)	125 - 180	1,600 – 120,000
Toothed whales (echolocation)	180 - 228	6,000 – 130,000
Dugongs	unknown	1,000 – 8,000
Earthquakes (≤ 4)	35 - 199	10 - 50
Ships	177	5 - 100
Seismic	215 – 230	10 - 300
Extraction operations	182	unknown

Source	Acoustic intensity (dB re 1µPa)	Frequency range (Hz)
Cutter-suction dredge (working)	~180	100
Clamshell dredge (working)	150-162	250

Impacts and Sensitivities of Cetaceans

The types of effects underwater noise may produce on marine mammals range from severe to no effect (McCauley 1994). There has been no documented evidence of any lethal effects for most whale species resulting from exposure to noise. Several studies (Malme *et al.* 1983; 1984; 1986; 1988, *cited in* McCauley 1994) have shown that some whales begin to avoid sounds at exposure levels of 110 dB received acoustic intensity, and more than 80% of the whales investigated including humpbacks, showed avoidance to sounds of 130 dB received acoustic intensity. These sound events were continuous source (for example, ships) events. Therefore, it is likely that whales will avoid areas where the dredge is operating. However, as shipping occurs continuously within the port area, producing an acoustic intensity greater than 110 dB it is unlikely that dredging will result in a specific change to whale behaviour within the vicinity of the Port.

Recent experiments, by others, have been undertaken on bottlenose dolphins and white whales to test if any permanent changes in hearing thresholds occurred from exposure to intense signals (Schlundt *et al.* 2000). The tones in the range 40 – 7,500 Hz with levels up to 202 dB re 1 µPa (within the frequency and acoustic intensity ranges for seismic surveys and vocalisations of cetaceans, see Table 4-8) caused temporary threshold shifts in hearing, but returned to normal within a few days. This suggested that these whales had not suffered any sub-lethal effects from exposure.

In a long-term study over 25 years of whale responses to vessel approaches (Watkins 1986), the most vigorous response by whales came from the noise sources that changed suddenly, rapidly increased or were unexpected. Watkins (1986) also noted that whales that were preoccupied were less responsive than whales that were inactive. Other authors have found similar results where rapidly changing vessel noise often evokes a strong avoidance response, while a slow non-aggressive vessel approach results in little response from the whales (Richardson *et al.* 1995; McCauley *et al.* 1996). Vessel activity has also been implicated in long-term (Norris & Reeves 1978) and short-term (Jurasz & Palmer 1981; Baker & Herman 1989) changes in distribution of humpback whales.

Impacts and Sensitivities of Dugong

There are many anecdotal reports of dugongs avoiding areas with high boat traffic, though very little research has been undertaken to investigate the sensitivity of dugongs to noise. Initial research results into the auditory physiology and hearing sensitivity have highlighted some significant anatomical differences between manatees and dugongs, as well as between sirenians and other marine mammals (URS 2003,

cited in URS 2004). The sensitive parts of their auditory range appears to be restricted to the middle frequencies (1 – 18 kHz) (URS 2004). The sirenian inner ear has a mixture of marine and land mammal characteristics, and anatomically, they are relatively unspecialised. Their ears are closer to those of pinnipeds (seals and sea lions) than cetaceans, and there is no evidence that sirenians use echolocation (URS 2004).

The frequency of noise produced by dredgers (100 – 250 Hz) is outside the suspected high hearing sensitivity range of dugongs (1 – 18 kHz) and therefore it is of minimal risk to dugong.

4.9.3 Summary of Assessment of Risk from Noise in the Marine Environment

From the literature, the nature of dredging noise is that it occupies the mid- to low-frequency range, is tonal and continuous. While there is little specific information relating to the sensitivity of cetaceans and dugongs to dredging noise, there is a trend in the information that indicates that dredging is not considered to pose a significant risk. No impacts have been observed during previous dredging campaigns at the Port.

The nature of sound from dredgers is described in the literature as being perceived as a stationary low to moderate frequency plus tonal noise. While the noise from dredgers is within the hearing frequencies of larger cetaceans, it is considered to increase ambient noise levels, but not cause undue interference or stress. It is thought that dugongs may have limited perception of dredger noises at such low frequencies (URS 2004).

There is little information available in relation to noise impacts on turtles. Turtles do not appear to change behaviour due to noise.

The infrequent sighting of dugongs within the Port area indicates that dugongs may be infrequent visitors to the Port area, and as such, dugong populations would not be significantly affected by the Project.

In the recent revision documents for the DEH Cetacean Guidelines on the Application of the EPBC Act to Interactions between Off-shore Seismic Operations and Larger Cetaceans (URS 2004), a detailed risk assessment was undertaken for the impacts of various sources of noise on marine mammals occurring within Australian waters. The risk assessment was undertaken for those activities identified as having potentially significant impacts on marine mammals from an extensive literature review. No risk assessment was undertaken for dredging or similar sorts of activities, demonstrating that this activity is considered not to pose a significant threat to marine mammals.

Similarly, the authors of the DEH Guideline review did not consider it necessary to develop particular guidelines for management of impacts from dredging activities (URS 2004).

4.9.4 Mitigation Measures

No mitigation measures are considered necessary in relation to noise and vibration due to the minimal anticipated impacts.

4.10 Cultural Heritage

4.10.1 Introduction

This section of the EIS provides an assessment of any likely effects on sites, localities and resources of cultural heritage values and provides following recommended means of mitigating any negative impacts on cultural heritage values and enhancing any positive impacts.

4.10.2 Impact Summary

Both the Yuibera and Wiri#2 representatives stated that the study area was within the marine part of their country, and as such was of significance to them. Both groups were concerned about the impact of the Project on their traditional rights, especially those of fishing and hunting marine animals, as well as the general impact on the marine environment of their country.

4.10.3 Mitigation Measures

A CHMP has been developed in accordance with the requirements of the ACH Act and in consultation with the Traditional Owners. The CHMP addresses issues of concerns, provides recommendations and includes a range of monitoring and implementation strategies. The CHMP is included as Appendix H.

4.11 Land Use and Land Use Planning

4.11.1 Introduction

This section of the EIS described the potential impacts associated with land use and land use planning, including:

- ▶ compatibility of the Project with surrounding land uses;
- ▶ possible impacts on surrounding land uses and human activities;
- ▶ relationship to existing planning objectives and controls for study area; and
- ▶ consistency of the Project with GBRMPA zoning of the affected areas.

4.11.2 Impact Summary

Development of the Departure Path and Apron Area will not have a direct impact on any existing or future land use opportunities within the Port and surrounds. The works are confined to tidal waters within the current limits of the Port. Associated projects are currently being considered by port users (as described in Section 2.2.4) however these projects are complimented by the proposed works and the current Project is considered essential for the Port.

As described in Section 3.10.4 the proposal is consistent with the Land Use Strategy for the Port. The Project is also consistent in achieving the regional planning objectives for the area as described in the WHaM 2015 Regional Plan. The Project

area is contained within the General Use Zone of the GBRMPA Zoning Plan. Whilst the Project requires a permit application for approval to conduct works within the Zone it is not inconsistent with the intent of the area.

4.11.3 Mitigation Measures

No mitigation measures are considered necessary in relation to land use and land use planning as the Project is consistent with development of the Port.

4.12 Shipping

4.12.1 Introduction

The following section provides an assessment of increased shipping with consideration given to the following:

- ▶ ship's waste;
- ▶ ballast water;
- ▶ the introduction of exotic organisms attached to the hull of ships; and
- ▶ impact on ship queuing in port.

4.12.2 Impact Summary

Ship Waste

Ship waste is currently managed through the implementation of the Port Environmental Management Plan. PCQ is obliged to provide waste management facilities for all ships entering the Port. This is achieved through the quarantine waste facility operated at the port. Once berthed ships are able to offload waste for disposal at this facility. Disposal of general waste from ships anchored off-shore is recognised as an issue of concern. Whilst these issues are managed through the Australian Quarantine Inspection Service (AQIS) PCQ undertakes all practical measures to manage potential impact. Greater efficiency of ship loading and ships exiting the Port may reduce the number of ships anchored off-shore and queued to enter the Port and therefore reduce the amount of general waste being disposed from these vessels.

Ballast Water

Ship ballast water is discharged as ships enter the Port, while at anchor and during loading at the berths. AQIS is responsible for the management of ballast water discharges and places controls on all vessels entering Australian waters. The Port of Hay Point Ballast Water management Plan provides guidelines for the discharge and uptake of ballast water within the Port. This plan complements AQIS regulations. The plan encourages the discharge of ballast water in open waters in order to limit the amount of water discharges at anchorages or at berths.

Based on the measures currently in place to manage risks and potential impacts from ballast water discharge the proposed works are not expected to increase these risks. The number of ships entering the Port is not expected to increase significantly but

rather the proposed capital works will achieve increased exports through greater efficiency in operation.

Introduced Exotic Organisms

Regular surveys of the Port are conducted to identify exotic organisms which may have been introduced via ship movements within the Port. As discussed in Section 3.2.6 the most recent survey of the Port for exotic organisms found no evidence of any targeted marine pest species. Regular survey will continue to be conducted. However, the proposed works are not expected to have any influence on the future introduction of exotic organisms to the Port.

Ship Queuing

Current shipping queuing is a result of a number of factors, including access delays, ship loading times and the ability of laden vessels to exit the Port. The proposed development will enable fully laden ships to exit the Port at all tides and therefore limit delays associated with tidal influences. This in-turn also reduces the number of short-loaded vessels exiting the Port and provides greater efficiencies in throughput. The proposed capital dredging works along with additional works proposed by the terminal operators are expected to reduce the total number of vessels anchored off-shore, queued to enter the Port.

4.12.3 Mitigation Measures

No mitigation measures are considered necessary in relation to shipping as existing measures are in place within the Port's operational guidelines which manage these potential impacts.

4.13 Socio-Economic Environment

4.13.1 Introduction

This section of the EIS provides a summary of potential impacts associated with the socio-economic environment, including

- ▶ potential impacts on the community:
 - potential influx of workers and impacts on the local community;
 - activity by interested groups; and
 - implications (real and perceived) for public health, safety and amenity as a result of the development.
- ▶ potential impacts on the local and regional economy:
 - socio-economic impact of increased shipping efficiency;
 - impact on existing businesses and commercial activities both within the immediate study area and the wider community; and
 - an assessment of likely levels of employment and income (both direct and indirect) during construction and operation.

4.13.2 Impacts Summary

Community

The Project is expected to have limited impact on the local and regional community. Construction phase activities will result in minor opportunities such as provision of supplies for the dredge during works. This would be an incidental benefit and well within the existing commercial activities of local business. The most significant impact associated the socio-economic health of the region would be if the Project did not proceed and mining operations within the region were adversely impacted. The regional economy is dominated by the mining sector, and any negative impact to mining operations would have a parallel negative impact to the socio-economic health of the community.

Recreational fishing activities for the local community are expected to be enhanced following completion of the proposed works due to the redeclaration of restricted areas for recreational vessels.

Economy

The proposed development will deepen the economic base of the region while ensuring that the mining economic base of the region is maintained and enhanced. The proposed increase in operating capacity of the existing Port facilities will result in a more efficient and effective loading schedule allowing ships to be loaded to capacity while reducing the time in Port.

The proposed increase in the declared depth of the Departure Path will ensure that the existing transport infrastructure is capable of supporting activities identified as regionally significant.

Initially the proposed development will have limited if any implications for the growth of surrounding communities. However, the Project will increase the efficiency of the Port resulting in the potential generation of both direct and indirect employment assisting in the revitalisation of the local towns and communities.

4.13.3 Mitigation Measures

All recreational and commercial fishing vessels will be informed, via notice to mariners, to be coordinated through MSQ Regional Harbour Master, of the dredge works and informed of any limitations to vessel movements within Port limits. No other measures are considered necessary.

4.14 Waste Management

4.14.1 Introduction

A waste audit was conducted as part of the assessment of spoil disposal options (WBM 2004 see Appendix C). The audit was undertaken in accordance with the requirements of the NODGDM.

The waste prevention audit evaluated:

- ▶ waste sources;
- ▶ types, amounts and relative hazard of wastes generated; and
- ▶ feasibility of waste reduction and prevention techniques.

These requirements are considered in the following sections based on the spoil disposal options (WBM 2004 see Appendix C).

4.14.2 Waste Sources

The waste material (spoil) will consist primarily of previously undisturbed seafloor material from the Departure Path and Apron Area. Approximately 20% of material will be from the existing apron area in which maintenance dredging was undertaken in 2004.

4.14.3 Types, Amounts and Relative Hazard of Wastes

It is expected that up 9 million m³ of capital dredge spoil will be generated. The material to be dredged in the current Project is considered to be suitable for unconfined ocean disposal according to the NODGDM (Section 3.5). Therefore the material is not considered to represent a hazard.

4.14.4 Feasibility of Waste Reduction

The amount of spoil to be generated during the capital works is directly related to the extent of works. Therefore a reduction in volume could only be achieved through a reduction in the scope of works. This would in turn have a direct impact on the economic feasibility and overall benefit of the Project. The Departure Path design (see Section 2) is such to minimise the ongoing maintenance dredging requirements.

4.14.5 Summary

In summary the audit of possible dredge spoil material indicates:

- ▶ the material to be dredged is primarily previously und-disturbed seabed material;
- ▶ the physical and chemical characteristics of the spoil does not represent an environmental risk; and
- ▶ there are significant limitations to minimizing the amount of material of utilizing it for alternate purposes.

4.15 Hazard and Risk

4.15.1 Introduction

A hazard and risk assessment consistent with the *AS/NZS Risk Management Standard 4360:1999* has been carried out for the Project. The objective of a risk assessment is to filter the minor, acceptable risks from the major, non-acceptable risks. It involves consideration of the sources, consequences and probability of occurrence of each risk.

4.15.2 Methodology

Risk analysis may be undertaken to various degrees of refinement depending upon the risk information and data available. Analysis techniques include:

- ▶ qualitative assessment;
- ▶ semi-quantitative assessment; and
- ▶ quantitative assessment.

In practice, a qualitative analysis is often used to first obtain a general indication of the level of risk and then a more quantitative analysis is applied to refine the risk.

The risk assessment methodology for this EIS uses a semi-quantitative process for determining risk. The semi-quantitative process estimates the degree of the consequence and probability and assigns a score to each. The score allocated “does not have to bear an accurate relationship to the actual magnitude of consequences or likelihood” (as per Section 4.3.4 of Australian Standards 1999). The estimates used in this analysis were derived are based on past records and reports (where available), and specialist professional judgements.

The risk assessment methodology used to analyse and evaluate the risks is described in detail in the following section. The ratings of consequence, probability and resultant risk have been developed using the following risk analysis tables, based on the Standard.

4.15.3 Identify Impacts and Consequences

In order to conduct an initial risk assessment, impacts (actual and potential) have been identified for each aspect of the Project. In this qualitative level of analysis, the magnitude of potential consequences and likelihood of the consequences occurring are described in words.

It is not possible to directly compare the impacts from a diverse range of project aspects (for example, comparing air quality impacts to turbid plumes impacts). Therefore, relative consequences must be judged according to different criteria, as discussed below.

For example, in the case of turbid plume, the relative consequence should be assessed by evaluating such factors as:

- ▶ persistence;



- ▶ concentration;
- ▶ duration of the plume;
- ▶ proximity to sensitive environments;
- ▶ area of marine waters affected; and
- ▶ taking into account secondary consequences and existing mitigation measures.

The potential consequences must be judged using all available information.

For this risk assessment, five levels of consequences severity have been used – insignificant, minor, moderate, major and catastrophic. The definitions used to assess relative consequences have been adopted from HB 203:2000 *Environmental risk management – Principles and Process*, as shown in Table 4-9. The table provides a consistent method of assessment that can be applied by different personnel and at different times.

Table 4-9 Consequence ratings

Area impacted (a)	Insignificant consequences (Score = 1)	Minor consequences (Score = 2)	Moderate consequences (Score = 3)	Major consequences (Score = 4)	Catastrophic consequences (Score = 5)
Marine flora and fauna	Occasional short-term impact and/or disruption to marine flora and fauna.	Minor impact on marine ecosystem, including flora, fauna and habitat. No significant impact on marine resources.	Significant localised impacts but without longer-term impact on marine ecosystems, and/or short term impacts on marine resources.	Significant widespread impact on protected wildlife (eg migratory shorebirds, marine plants or marine ecosystems) of moderate duration.	Damage to an extensive portion of marine ecosystem resulting in severe impacts on marine populations and habitats and/or long-term impact on marine resources.
Atmosphere/ waste/ other	Temporary nuisance from noise, odour, dust, other air emissions, greenhouse gases, vibration, visual impact. Results in the generation of significant quantities of non-hazardous wastes.	Minor environmental impact due to contained release of pollutant (including odour, dust and noise), fire or explosion with no lasting detrimental effects. No outside assistance required. Significant use of water, fuels and energy and other natural resources.	Creation of noise, odour, dust, other controlled/ uncontrolled air emissions, greenhouse gases, vibration, and visual impact at significant nuisance levels. Results in the generation of significant quantities of hazardous wastes.	Major environmental impact due to uncontained release, fire or explosion with detrimental effects. Outside assistance required.	Catastrophic environmental impact due to uncontained release, fire or explosion with detrimental effects. Outside assistance required. Extensive chronic discharge of persistent hazardous pollutant. Results in the generation of significant quantities of intractable wastes.
Cultural heritage	Minor repairable damage to areas of little or no cultural significance.	Minor repairable damage to areas / items of cultural significance, or minor infringements of cultural values.	Moderate damage to areas / items of cultural significance, or significant infringement of cultural values/ sacred locations.	Major damage to areas / items of cultural significance, or major infringement of cultural values/ sacred locations.	Irreparable damage to highly valued areas / items of cultural significance or sacred value.

Area impacted (a)	Insignificant consequences (Score = 1)	Minor consequences (Score = 2)	Moderate consequences (Score = 3)	Major consequences (Score = 4)	Catastrophic consequences (Score = 5)
Community/ media reaction & reputation	Possibility of detrimental local media reports. Minor substantiated complaints from the community. Public concern restricted to local complaints.	Detrimental local media reports. Subject of local government action. Infrequent substantiated complaints from the community. Minor negative impacts on reputation.	Detrimental national or state media reports. Subject of parliamentary questions or ministerials. Systematic substantiated community / Non Government Organisations concerns and complaints.	Numerous detrimental national or state media reports. Subject of a number of parliamentary questions or ministerials. Organised community concern. Mobilisation of significant Non Government Organisations campaign.	Sustained detrimental international, national or state media reports. Subject of parliamentary committee hearing. Sustained community / Non Government Organisation outrage.
Total cost	Financial loss (compensation, fines, cost to repair) of less than \$5,000.	Financial loss (compensation, fines, cost to repair) of \$5,000 - \$50,000.	Financial loss (compensation, fines, cost to repair) of \$50,000 - \$500,000	Financial loss (compensation, fines, cost to repair) of \$500,000 - \$10M.	Severe financial penalties or legal liabilities. Financial loss (compensation, fines, cost to repair) of greater than \$10M.

Source: Standards Australia/ Standards New Zealand "HB 203:2000, Environmental risk management – Principles and process" 2001, Appendix F

4.15.4 Estimated Probability of Occurrence

Following identification of potential impacts and consequences, the probability of occurrence needs to be estimated. The table below provides likelihood ratings with descriptions for estimating the likelihood of each occurrence.

Table 4-10 Probability of occurrence

Descriptor	Likely Frequency	Probability
Frequent	Continuous or will happen frequently	5
Often	5 – 12 times per dredge campaign	4
Likely	1 – 5 times per dredge campaign	3
Possible	Once every dredge campaign	2
Rare	Less than once every dredge campaign	1

The probability of occurrence from any event, mode of occurrence or failure mechanism is considered.

In addition to evaluating the frequency for normal operating conditions, the following conditions could be considered:

- ▶ abnormal, startup and shutdown operation conditions;
- ▶ incidents, accidents and potential emergency situations; and
- ▶ current activities and planned future activities.

4.15.5 Risk Estimation

The level of risk is calculated by multiplying the Consequence Score and Probability of Occurrence together.

$$\text{Risk} = \text{Consequence Score} \times \text{Probability of Occurrence}$$

The final outcome is in relative point scores, rather than actual risks.

Note that risk estimations were carried out assuming a well-managed dredge campaign undertaken under normal conditions. Risk scores do not reflect the highest risks under adverse conditions/ worst case scenarios.

4.15.6 Risk Evaluation

Risk Scoring

The relative risk score estimated above enables definition between those risks that are significant, and those that are of a lesser nature. This allows a better understanding of the least probable events with high consequence against the highly probable low consequence events. Having established the comparative risk level applicable to individual impacts, it is possible to rank those risks. Four risk categories have been

used as described in Table 4-11. Once the impact has been ranked according to the relative risk level it poses, it is then possible to target the treatment of the risk exposure, beginning with the highest risks.

Table 4-11 Risk categories

Likelihood	Consequence				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Rare (1)	1	2	3	4	5
Unlikely (2)	2	4	6	8	10
Possible (3)	3	6	9	12	15
Likely (4)	4	8	12	16	20
Almost certain (5)	5	10	15	20	25

	Extreme risk	Requires immediate remedial action.
	High risk	Requires remedial planning and action via the Environmental Management Plan.
	Moderate risk	Address via new procedures and/or modification of existing practices and training.
	Low risk	No formal requirement for further action, unless escalation of risk is possible.

Limitations

As with any model, the relevance and applicability of the risk model revolves around a number of basic assumptions and limitations. The application of the risk model has been based on subjective ranges of consequences and probabilities.

The assessment has been limited to a selected number of primary risks and the assessment of cumulative risk to the environment from multiple pollution sources or sources of environmental degradation has not been addressed.

Although a semi-quantitative methodology was used to conduct the risk assessment, the resulting risk estimation is purely relative. The risk estimations do not imply an absolute scale of risk that can be applied to any other situation or assessment.

Table 4-12 provides a summary of the risks associated with the Project. Each risk is identified and given a preliminary score based on the consequences (C) and likelihood (L) of the risk. Mitigation measures are then applied to the risk and a second score calculated.

Table 4-12 Summary of risks associated with the project

Risk Aspect	Consequences	Preliminary Risk Assessment (C,L) Score	Mitigation Measures	Risk Rating with Mitigation Measures Adopted (C,L) Score
Capture of marine turtles	Potential impact on marine turtles through capture within the dredge.	(5, 4) 20	Minimised dredging in turtle nesting season and employ turtle deflecting devices on dredge arm. Survey dredging area daily during nesting season to help avoid contact. Use of overflow dredging to minimise duration.	(5, 1) 5
Loss of habitat	Potential impact on marine ecosystems including benthic communities from smothering during disposal of dredged material and sedimentation or increased turbidity. Potential impact on threatened marina fauna through loss of habitat.	(4, 5) 20	Minimisation of duration of dredging. Implement EMP measures for monitoring and corrective actions.	(2, 5) 10
Effect on water quality from increased turbidity	Potential impact on sensitive environments, including seagrass, algae and fringing reefs a result of increased turbidity.	(4, 5) 20	Use dredge overflow below water line. Monitoring of plumes and implementation of corrective practices should conditions result in significant turbidity.	(2, 5) 10
Noise and vibration from dredge	Low potential impact on marine mammals.	(1, 5) 5	Avoid marine mammals through relocation of dredge if proximate to area of works, if possible.	(1, 5) 5
Effect on water quality from hazardous spills.	Potential for moderate impact should a spill occur	(3, 1) 3	Management measures are in place to minimise likelihood of spill occurring and for expedient clean-up.	(2, 1) 1
Release of wastes to the environment.	Potential moderate impact on the natural environment should waste products be released.	(3, 1) 3	Management measures are in place to minimise likelihood of wastes being released.	(2, 1) 1
Air and noise pollutants.	Low potential for minor impact should emissions from the dredger exceed acceptable levels.	(3, 3) 9	Conduct routine maintenance of equipment in accordance with manufacturers requirements.	(3, 1) 3

Risk Aspect	Consequences	Preliminary Risk Assessment (C,L) Score	Mitigation Measures	Risk Rating with Mitigation Measures Adopted (C,L) Score
Conflict between dredge plant and other commercial and/or recreational vessels	Potential moderate to high impact should a collision occur between the dredge plant and other vessels.	(5, 3) 18	Provision of appropriate navigational aids and notice to mariners. Management of shipping activity in port by Regional Harbour Master.	(3, 1) 3
Disturbance of cultural heritage values through non-compliance with CHMP.	Impact associated with the disturbance of the cultural values beyond those acceptable impacts identified within the EIS or due to non-compliance with CHMP.	(3, 1) 3	Implementation of the EMP and CHMP.	(1, 1) 1
Community or public concerns relating to a visible plume.	Moderate impact relating to media publicity and potential for government agencies to seek investigations.	(3,4) 12	Community information about the extent of the plume and relative impacts associated with concentration levels. Monitoring of impact on seagrass and coral.	(2,2) 4
Delays following commencement of works.	Moderate to high potential impact to proposed environmental mitigation strategies which focus on mitigation completing the works within a schedule of sixth months. Significant economic impact.	(3,3) 9	Dredge contractor is required provide means suitable to undertake the works within the required sixth month timeframe.	(3,2) 6
Project approvals and licensing.	High financial impact relating to lost opportunity for the regional and national economy.	(5,3) 15	Working with approval agencies to facilitate a cooperative approach to developing the project. Appropriate management measures to minimise potential impacts	(5,2) 10

Note: C = Consequence
L = Likelihood

4.15.7 Summary

The principal risk concerns relate to well defined environmental risks which can be effectively managed through the proposed mitigation strategies outlined within Section 4 and further developed in Section 5. It is expected that short-term impacts will result from the project in relation to the loss of habitat, seagrass, algae and benthic communities. The loss of these habitat areas is considered an acceptable risk based on the knowledge that these communities will recolonise over the longer term.

Management of potential environmental impacts is highly reliant on the works being undertaken within the scheduled six month timeframe. There is a risk that works could be delayed due to weather or engineering breakdown. In order to minimise this risk the proponent is seeking international tenders for the works. During the tender process each tenderer has been required to demonstrate how they can achieve the proposed schedule. It is expected that this may be achieved through:

- ▶ the operation of a single very large dredge; or
- ▶ the simultaneous operation of two dredgers.

As a contingency to account for the potential longer duration of works, procedures for the use of a fauna spotter on the dredge has been included in the EMP, should works extend into the turtle nesting season.

4.16 Matters of National Environmental Significances

4.16.1 Controlling Provisions

The Project was determined to be a controlled action under the EPBC Act on 7 October 2004 (EPBC 2004/1775). The controlling provisions under the act are:

- ▶ Sections 12 and 15A World heritage;
- ▶ Sections 18 and 18A Listed threatened species and communities;
- ▶ Sections 20 and 20A Listed migratory species; and
- ▶ Sections 23 and 24A Marine environment.

4.16.2 World Heritage

Although operational areas of the port are excluded from the GBRMP, the World Heritage Areas is more extensive and extends to mean low water mark along the coast and covers the whole port area. The Project will consequently occur wholly within the GBRWHA. The following discussion focuses on the world heritage values of the GBRWHA which may be degraded or damaged by the proposal.

Sediment Quality

A detailed sediment testing program was undertaken in accordance with the NODGDM and a sediment sampling and analysis plan approved by the DEH. Section 3.5

provides a detailed summary of the outcomes of the sampling and analysis and the full results are included as Appendix G.

Section 4.6 concluded that as the upper 95% confidence limit concentrations of contaminants of concern in the sediment to be dredged is below the ISQG-low screening levels, the risk of mobilisation of contaminants into the water column during dredging and disposal is not a concern for this Project.

Based on the sediment results, the material to be dredged is clean sediment suitable for unconfined ocean disposal in accordance with the requirements of the NODGDM. It is concluded that the material to be dredged is of a standard suitable for disposal within the GBRWHA.

Benthic Communities

A detailed description of the benthic communities located within and adjacent to the Port is included in Section 3.2. An analysis of the potential impacts on these communities is included in Section 4.3. The analysis has been undertaken based principally on the outcomes of a detailed hydrodynamic and water quality monitoring study (see Appendix F). The following provides a brief summary of likely impacts (see Section 4.3 for further details):

- ▶ Seagrass and algae communities will be acutely impacted through direct removal during dredging and disposal but are also susceptible to mortality through smothering during the fallout of silts from the expected turbid plume and light attenuating effects of turbid plumes.
- ▶ Approximately 1,565 ha of seagrass will be physically disturbed, equating to approximately 28% of total seagrass cover recorded within the port limits. Of the area to be disturbed, approximately 70% is recorded as low density (<5%) cover. The species that will be disturbed are pioneering species and the area does not contain unique species that are not widely represented in surrounding areas.
- ▶ Approximately 2,365 ha of algae will be physically disturbed during the proposed works of which only 1% has a coverage of >5%. The algal communities that will be disturbed represent a small proportion of the total habitat within the study area and do not contain unique species that are not widely represented in surrounding areas.
- ▶ The distribution of coral is low to high percentage cover communities limited to Victor Islet and Round Top and Flat Top islands. The coral communities are not considered to be regionally significant within the GBRWHA when compared within similar in-shore reef communities occurring within the world heritage area. Physical removal of a limited number of isolated soft coral individuals will occur within the area to be dredged which is not considered significant. Plume modelling (Section 4.4) indicates that elevation in turbidity and minor sedimentation may be expected to occur at the fringing reefs of Victor Islet, Round Top and Flat Top islands. Analysis of the natural variability in turbidity regimes close to the reef communities confirms that these communities regularly experience natural pulses of elevated turbidity (>50 NTU) for short durations of times. The species of coral found in the

fringing reefs of Victor Islet and Round Top and Flat Top islands indicate a tolerance to natural sedimentation occurring within the area as a result of storm events. Strong currents and tidal movements occurring around the island act to remove sediment deposition naturally.

- The identification of low to medium density benthic communities within the existing spoil ground suggests a long-term ability for recolonisation of disturbed areas. It is expected that similar recolonisation will occur within the proposed spoil ground following spoil disposal. A longer-term program for managing disposal of maintenance dredged material is also being investigated. This program would implement a spoil ground mosaic that will allow a quicker recovery of benthic organisms.

Under the existing system of spoil disposal, benthic communities within the spoil ground undergo a recurrent cycle of disturbance and recovery. The extent of this disturbance varies between maintenance and capital dredging activities. Maintenance dredging would typically introduce finer sediments, while capital dredging requires the disposal of a mixture of materials, from unconsolidated sands and silts to consolidated clays. For example, where maintenance dredging is conducted every 2-3 years, a mosaic disposal regime consisting of 5 'cells', within an enlarged disposal ground, would limit the recurrent impacts from disposal. Under this regime of disposal, dredging impacts from each event could extend from ~3 years to over ~15 years. This approach provides a rotational regime, whereby 'cell 1' is utilised in the first maintenance campaign and then 'cell 2' the following campaign and so on. The benefits of this approach are that benthic communities smothered during the first campaign that may have commenced recovery will not be impacted again until the complete rotation has been achieved. Key advantages associated with the application of a disposal ground mosaic include the manipulation of both spatial and temporal scales of impact. A disposal mosaic approach would provide an opportunity to help mitigate the scale and frequency of future disposal impacts.

Hydrodynamic Processes

As a consequence of capital works dredging, there will be two major changes to the bathymetry in the vicinity of Hay Point:

- formation of the Departure Path and apron (invert -14.9 m LAT), and
- a raised spoil ground (+820 mm) at completion of the capital dredging campaign.

The potential effects of those changes on hydrodynamics (currents) were assessed through the creation of a difference map obtained by subtracting 'post-dredge' from 'pre-dredge' results. From this analysis it was concluded that:

- Maximum change in velocity does not exceed 0.06 m/s and maximum change in direction does typically does not exceed 6 degrees over the area of interest with one or two maximums reaching 30 degrees;
- The changes in current magnitude are confined to the vicinity of the Departure Path and spoil ground;

In summary, it is concluded that the change in bathymetry as a result of the dredging operations will not have any significant impact on current magnitudes and directions at the Port.

Introduced Marine Pests

No introduced marine pests have been identified in the port. As there are no predicted impacts from the translocation of introduced marine fauna during dredging and spoil disposal, no mitigation measures are proposed.

Proposed Monitoring and Management Measures

Details of proposed monitoring and management measures in response to the potential impacts on the GBRWHA are included in Section 5. Of principal relevance are the following programs:

- seagrass monitoring in accordance with DPI&F requirements;
- coral monitoring;
- hydrodynamic model validation; and
- turbidity, PAR and sedimentation monitoring.

4.16.3 Listed Threatened Species and Communities

The following provides a summary of the potential impacts associated with listed threatened species which may occur within the study area. Details of impacts and proposed mitigation and management measures are summarised from the detailed descriptions provided in earlier section of the EIS.

Turtles

Six species of turtle, the Flatback (*Natator depressus*), Green (*Chelonia mydas*), Loggerhead (*Caretta caretta*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*) and the Olive Ridley (*Lepidochelys olivacea*), have been recorded utilising the off-shore, inter-tidal, estuarine and shoreline habitats in the area. Further details of the nesting behaviour of these species are included in Section 3.2.8. All of these species of turtle are listed as either Endangered or Vulnerable under the *EPBC Act 1999* and the *NC Act*.

Given that there is little evidence of a large resident population of turtles in the Hay Point area, the relatively low numbers of nests recorded on local beaches, the knowledge that turtles have not been captured previously during dredging at the Port, the relatively low numbers of turtles captured by dredgers compared to other activities (traditional hunting, boat strikes) and the use of effective management and operational practices to reduce the potential for turtle capture, it is not considered that the proposed dredging and spoil disposal will have a significant impact on turtle populations in the study area. The removal of sparse seagrass that has recently been identified within the proposed spoil ground and area to be dredged is not considered to represent a significant impact on the ability of the region to support its current turtle population as the percentage cover is relatively low and the seagrass species

represent opportunistic colonisers (Rasheed *et al.* 2004). Despite the low risks to turtles, it is important to apply best practice dredging techniques.

The main measure to protect turtles is to ensure a turtle excluding device is fitted to the dredge draghead. This minimises the risk of a turtle being caught in the suction of the dredge while it is on the seabed. Other operating procedures to reduced turtle capture will be employed, such as reduce suction pump speed when the suction head is lifted off the seabed. As a secondary measure to minimise the risk of turtle capture during dredging is the avoidance of the turtle nesting season. Dredging will therefore be commenced as early as possible following the cyclone season (end of April) and a large dredge will be used to minimise the period of dredging. Current estimates indicate dredging will take approximately six months, which will complete the dredging around the end of October. This marginally extends the period of dredging into the turtle nesting season (October), but numbers of turtles present in the area are lower at the start of the nesting season. During this turtle nesting period, areas to be dredged will be surveyed each morning to check for turtles to allow avoidance of the area if required. Further details of mitigation and management measures to be employed are included in Section 5.12.4.

Cetaceans

Seven species of dolphins, five species of whales and dugong were identified as potentially occurring in the waters around Hay Point. The Spotted Bottlenose Dolphin is considered likely to occur within the study area and the Humpback Whale may transit the area off-shore from the port facilities.

The primary potential impact of dredging and spoil disposal on cetaceans is considered to be the generation of underwater noise and vibration. Underwater noise associated with dredging is not considered to represent a significant impact for cetaceans. These impacts are discussed further in Section 4.3.8.

Cetaceans are highly mobile and can generally avoid work areas for the duration of dredging activities. Considering the inshore location of the dredging activities, it is considered unlikely that dredging will impact on the migratory patterns of whales as they tend to migrate further off-shore (URS 2000) and will avoid contact with the dredge.

4.16.4 Listed Migratory Species

The turtle and cetacean species identified as threatened species within the study area are also migratory species. In addition to the discussion of potential impacts and mitigation measures relevant to listed threatened species the following provides a summary of potential impacts associated with dugong. Further details in relation to dugong are presented in Sections 3.2.10 and Section 4.3.9

Dugong

Sightings of dugong within the Port area are infrequent, indicating that the area is not a critical habitat for this species. However, seagrass beds within the Hay Point region

may provide a seasonal food source for any dugong which may pass through the area, (Rasheed *et al.* 2004).

The seagrass meadows recently identified within the port limits contain species which are a preferred food type for dugong and may provide a food source for dugong moving between the Dugong Protection Areas located to the north and south of the Port (Rasheed *et al.* 2004). However, as the seagrass beds in the affected areas are of an ephemeral nature and in quite deep water, they are not considered critical habitat or food source. Dugong are mobile and can generally avoid impacted areas for the duration of dredging activities. It is considered that there is little risk of injury from direct contact with the dredge head and no previous dredging campaigns at the Port have reported dugong strikes.

4.16.5 Commonwealth Marine Environment

The proposed action occurs within the Commonwealth marine area. Relevant to this the following provides a summary of the cultural heritage and economic considerations of the Project.

Cultural Heritage

Consultation has been undertaken with the native title claimants for the area. Both the Yuibera and Wiri#2 representatives stated that the study area was within the marine part of their country, and as such was of significance to them. Both groups were concerned about the impact of the Project on their traditional rights, especially those of fishing and hunting marine animals, as well as the general impact on the marine environment of their country.

In response to the concerns of both aboriginal parties a CHMP has been developed and agreed to by all parties.

Economic

The proposed development will provide significant benefit for the regional and National economy. As described in Section 1.7.2 the proposed 1.8 m increase in declared sailing draft will provide major benefits to port users in:

- ▶ Reduced short loading, resulting in an additional 1.7 million tonnes per annum (mtpa) of coal exports worth \$100 million per annum.
- ▶ Earlier sailing times, equivalent of up to \$60 million of infrastructure investment.
- ▶ Dead freight savings of \$55 million per annum. Dead freight is the term used to describe lost opportunity of transport product due to shortloading.

5. Environmental Management Plan

5.1 Introduction

The following Environmental Management Plan (EMP) details the measures to be adopted to address identified impacts during the dredging phase of the Project. The plan applies to the operational phase of the Project. The EMP details:

- ▶ Environmental element – the environmental aspect requiring management consideration.
- ▶ Potential impacts – potential impacts identified in the EIS.
- ▶ Performance objective – the target or strategy to be achieved through management.
- ▶ Management actions – the actions to be undertaken to achieve the performance objective, including any necessary approvals, applications, and consultation.
- ▶ Performance indicators – criteria against which the implementation of the actions and the level of achievement of the performance objectives will be measured.
- ▶ Monitoring – the intended monitoring program and the process of measuring actual performance.
- ▶ Responsibility – assign responsibility for carrying out each action to a relevant person/organisation.
- ▶ Reporting – the process and responsibility for reporting monitoring results.
- ▶ Corrective action – the action to be implemented in the case of non-compliance and the person/organisation responsible for action.

The EMP also addresses the requirements of Section 4.01 (d) of Schedule 4 of the EPBC Regulations, these being:

- ▶ an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing.

5.2 Overview

PCQ as the Port Authority for the Port of Hay Point are responsible for the proposed capital dredging of the Port of Hay Point as well as the environmental management of the Port. PCQ targets the achievement of high environmental standards and strives to ensure that activities within the Port are ecologically sustainable, providing minimal impact on water quality and sensitive marine flora and fauna communities. PCQ has an Environmental Management System in Place which is externally certified to AS/NZS ISO 14001-2004.

It will be necessary to implement management measures to control and minimise potential environmental impacts associated with the proposed capital dredging of the Apron Area, proposed Departure Path and associated disposal of dredge spoil in one of

the two proposed disposal grounds. The objective of these management measures will be to ensure that the dredging and disposal of dredged material can be carried out without significant adverse long-term impact on the environment in the vicinity of the proposed dredged area and spoil ground. Some short-term impacts such as elevated turbidity will occur but will be minimised through the proposed management measures.

The management measures and site monitoring required to ensure that potential impacts are identified and minimised are presented in this draft Environmental Management Plan (EMP). This plan is specific to the dredging and disposal methods proposed, and will be finalised following completion of the EIS. The EIS provides a critical prerequisite for the EMP, as it identifies the nature and magnitude of the potential impacts to be managed. This EMP is specific to the proposed capital dredging of the Port of Hay Point Apron Area, Departure Path and associated disposal of dredged material, as described in Section 2, and should not be applied to any other dredging campaigns without a review of its suitability.

The dredge contractor will be required to submit an EMP to PCQ for review and approval prior to commencement of works.

5.3 Objectives of the Environmental Management Plan

This EMP has been prepared as supporting documentation to accompany the EIS. The EMP is to provide:

- ▶ PCQ with a practical framework for establishing best practice environmental management standards and guidelines to mitigate potential environmental harm for each activity undertaken;
- ▶ a mechanism to assist managers, supervisors and dredging crews to comply with current legislation;
- ▶ a means of identifying environmental issues and to provide general procedures which must be considered when undertaking dredging activities;
- ▶ a mechanism to reduce the potential impacts of the dredging and spoil disposal undertaken; and
- ▶ a preliminary basis for establishing environmental due diligence during dredging and disposal phases.

In essence, the EMP is to provide PCQ and dredging contractors with a practical guide to ensure compliance by all parties with the environmental requirements. The EMP achieves this by providing a framework for comprehensive monitoring and control of dredging and disposal. The aim is to minimise the potential for negative environmental impact on the environment.

The EMP identifies corrective actions if monitoring indicates that the performance requirements have not been met.

5.4 Structure of the Environmental Management Plan

Each EMP component is comprised of a number of elements, each with an overall associated management policy, mechanisms of policy implementation, proposed monitoring programs and potential corrective actions as described in Table 5-1.

Table 5-1 Structure of environmental management plan

EMP Element Component	Description of Content
Element	The environmental aspect of construction or operation requiring management consideration.
Policy	The guiding operational policy that applies to the element.
Policy Implementation	The mechanisms and actions through which the policy will be achieved.
Performance Requirements	The criteria by which the success of the implementation of the policy will be determined.
Monitoring and Reporting	The process of measuring actual performance, or how well the policy has been achieved, including the format, timing and responsibility for reporting and auditing of the monitoring results.
Corrective Action	The action to be implemented and by whom in the case where a performance requirement is not met.

5.5 Environmental Training

PCQ will ensure that all employees and subcontractors involved with the Project receive environmental instruction in relation to the EMP.

Each person will be made aware of and have an understanding of their obligations and duties detailed in this EMP.

5.6 Monitoring Responsibility

The primary responsibility for monitoring the potential impacts of the dredging will be with PCQ. However, PCQ may contract a third party (e.g. a consultant) to undertake any independent sampling and analysis required.

5.7 Auditing

The EMP and its inherent procedures and controls should be audited in the early and mid stages of dredging and spoil disposal and on completion of dredging and spoil disposal.

A suitably qualified auditor will carry out auditing of the EMP. Appropriate action shall be taken to ameliorate any deficiency in implementation of the EMP and any elements that prove to be unworkable.

5.8 Contingency Plans

Adverse weather conditions, including tropical cyclones and storms, that result in elevated sea states can cause significant interruptions and delays to dredging activities. Prior to the commencement of the dredging activities, the contractor shall prepare a contingency plan for the occurrence of adverse weather conditions. It should be noted that dredging is scheduled to occur principally over the Autumn / Winter and early Spring months, which is the time of year when wind and sea state conditions are generally calmer.

5.9 Coordination of Communication, Documentation and Record Keeping

All environmental communications including reports, audits, complaints, minutes of meetings, records of non-conformances, corrective actions and site inspections will be kept at PCQ's head office such that they are readily retrievable.

5.10 Overall Environmental Policy

PCQ is an environmentally responsible organisation, which is committed to providing cost-effective and competitive facilities and services required by existing and potential Port users, with minimum adverse impact on the natural and social environment.

PCQ's environmental policy is to:

- ▶ *'Comply with all relevant environmental legislation and government policies and aim for best industry practice in all aspects of our operations.'*
- ▶ *Monitor the impact on the natural and social environment surrounding our ports.*
- ▶ *Minimise the environmental impacts of our port operations and developments and seek continual improvement in the environmental performance of all of our ports.*
- ▶ *Use resources efficiently and minimise wastes.*
- ▶ *Strive for usage and development of Corporation ports to be consistent with the concept of ecologically sustainable development.*
- ▶ *Aim to enhance our reputation as a business and port authority through our high environmental standards and performance.*
- ▶ *Develop and maintain effective Environmental Management Plans and Emergency Plans to protect the environment under our control.*
- ▶ *Communicate openly and honestly on the environmental performance of our ports to key stakeholders, government and the general community.*
- ▶ *Work cooperatively with other organisations, or provide appropriate support, where it will help achieve the environmental objectives of the Corporation. Share any outcomes from the Corporation's own research work.*
- ▶ *Hold all employees accountable for environmental performance in their area so that they carry out their duties in accordance with legislation and company requirements.*

- ▶ *Require contractors engaged by the Corporation to meet the Corporation's environmental standards and requirements and to comply with relevant legislation.*
- ▶ *Encourage port tenants/lessees to meet the Corporation's environmental standards and requirements.*

PCQ will manage the dredging Project to ensure the adherence to this policy and ensure compliance with regulatory conditions which may be imposed. ”

5.11 Management Responsibility

Responsibility for the implementation and monitoring of the EMP is with the Project Superintendent. The Project Superintendent is to ensure that all the contractors are familiar with the elements of the EMP and that the dredging contractor is aware of and has knowledge of the methods required to ensure environmentally sound practices are implemented at the dredging and spoil disposal sites and during all activities.

Specific management responsibilities are summarise in Table 5-2.

Table 5-2 Management responsibilities

Role	Responsibilities
Project Superintendent	▶ Ensure all supervisory and management staff are aware of and understand their responsibilities under this EMP. ▶ Ensure periodic reviews of environmental performance are conducted. ▶ Ensure the development and implementation of best practice environmental management procedures. ▶ Report to PCQ on environmental performance and any major environmental incidents that may have a significant impact on the surrounding marine environment. ▶ Ensure that appropriate and adequate resources are allocated to allow for the effective implementation and maintenance of the EMP. ▶ Ensure the contents of the EMP is understood and implemented by all personnel working at sites and carrying out activities. ▶ Where necessary, personally coordinate the response to environmental incidents. ▶ Ensure adequate training in the elements of the EMP is provided to all personnel, including contractors, involved in dredging work.



Role	Responsibilities
Dredging Contractor	- Ensure that all equipment used is properly serviced and that all precautions are in place to prevent the likelihood of an environmental incident occurring. - Report all environmental incidents to the PCQ Project Superintendent. - Make sure that all environmental safeguards and precautions are in place and adhered to at all times at the site and activity. - Regularly inspect and monitor all activities for adherence to proper environmental safeguards. - Be aware of and understand the contents of and the reason for implementing the elements of the EMP. - Ensure that dredging personnel adhere to the strategies outlined in the EMP. - Carry out all work in accordance with the elements of the EMP appropriate for the site or activity. - Must be aware of and understand their environmental responsibilities and the elements of the EMP.

5.12 Operational Management

5.12.1 Element 1: Water Quality

Potential Impacts

The potential impacts of dredging and spoil disposal on water quality are:

- the generation and migration of turbid plumes; and
- the introduction of contaminants into the water column.

Performance Objective

To minimise the migration of turbid plumes and the introduction of contaminants in the marine environment (e.g. oils and fuel) during dredging and spoil disposal operations.

Management Actions

- Refer to Element 2: Sediment Mobilisation from Dredge Head and Element 3: Sediment Mobilisation from Spoil Disposal.
- Precautions should be taken by the dredger to minimise the risk of spillage of pollutants, such as fuels, oils, greases and other chemicals associated with the dredging and spoil disposal operations, into the water.
- Contain all wastes and spillages and implement appropriate storage and disposal practices to ensure no wastes enter Port waters.
- Provide a spill clean-up kit to deal with spills on the dredger.

- ▶ Have contact details for the RHM to report any oil spills to water to allow a rapid emergency response.

Performance Indicators

- ▶ Reference with Element 2: Sediment Mobilisation from Dredge Head, and Element 3: Sediment Mobilisation during Spoil Disposal.
- ▶ Minimal impact on water quality around the dredge and spoil disposal sites.
- ▶ No visible water contamination

Monitoring

- ▶ The Plume Validation Monitoring Program will be implemented. This program includes the following elements:
 - A pilot investigation will be implemented within 3 weeks of the commencement of dredging works. Assessment of the turbidity plume generated during dredging and disposal will be undertaken as a vessel based program and by aerial surveillance. Survey locations at increasing distances from the dredging and disposal activities will be assessed to aid in the validation of the plume model. Replicate measurements will be obtained from each location over several survey events.
 - This program is to be repeated midway through the capital dredging program.
 - Routine water quality monitoring will include regular assessment of the results of remote sensors deployed at Victor Islet and Round Top Island. These results shall be considered in conjunction with the above reviews.
 - Monitoring locations will correspond with seagrass monitoring sites as required and specified by DPI&F.
- ▶ Monitoring of the potential impacts of dredging on seagrass communities will be undertaken. The monitoring program is to be developed by DPI&F.
- ▶ The Dredging Contractor should monitor the operation on a continual basis and will report any incidents that are likely to cause environmental harm to the project location and surrounding areas.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring the Plume Validation Monitoring Program and seagrass monitoring programs required by DPI&F are implemented. The Project Superintendent may subcontract a specialist sub-consultant to undertake the monitoring program.
- ▶ The Dredging Contractor is responsible for monitoring the dredging operation.

Reporting

- ▶ Reports following the model validation studies are to be sent to DE, GBRMPA and EPA.
- ▶ Monthly analysis of turbidity monitoring results will be provided to the above agencies.

Corrective Action

- ▶ The dredging strategy will be reviewed with appropriate agencies if any adverse impacts, other than those identified within the EIS are observed.
- ▶ In the event of an environmental incident (e.g. fuel spillage), implement appropriate contingency and emergency response measures.

5.12.2 Element 2: Sediment Mobilisation from Dredge Head

Potential Impacts

Sediment mobilisation from the dredge head will produce sediment plumes that are likely to migrate over sensitive habitats.

Performance Objective

- ▶ To minimise the duration of elevated turbidity at sensitive.

Management Actions

- ▶ Reference with Element 1: Water Quality.
- ▶ Engage a large dredger to undertake the works in order to minimise the duration of works. Consider using two dredgers to achieve this objective.

Performance Indicators

- ▶ Visible turbid plumes should not exceed the limits of the predicted in modelling.

Monitoring

- ▶ Reference with Element 1: Water Quality. Monitor suspended sediment concentrations, PAR and sediment deposition via Coral Condition and Plume Validation Monitoring Program.
- ▶ Seagrass and algal communities will be monitored as required by DPI&F.
- ▶ The Dredging Contractor should monitor the operation on a continual basis and will report any incidents that are likely to cause environmental harm to the project location and surrounding areas.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring the Plume Validation Monitoring Program and DPI&F seagrass monitoring programs are implemented. The Project Superintendent may subcontract a specialist sub-consultant to undertake the monitoring program.
- ▶ The Dredging Contractor, in liaison with the Project Superintendent, is responsible for the operational parameters of the dredge.

Reporting

- ▶ Monthly compliance reports comparing results of water quality monitoring to adopted thresholds will be provided to the Project Superintendent.

Corrective Action

- ▶ Review of dredging strategy with relevant agencies if plumes are considered to impact upon key sensitive habitats.
- ▶ Implementation of a reactive monitoring program to assess the impacts of dredging and spoil disposal on sensitive habitats.

5.12.3 Element 3: Sediment Mobilisation from Spoil Disposal**Potential Impacts**

Sediment plumes created by the disposal of dredge spoil are likely to migrate over sensitive habitats.

Performance Objective

- ▶ To minimise the migration of turbid plumes from the proposed spoil ground.

Management Actions

- ▶ Reference with Element 1: Water Quality and Element 2: Sediment Mobilisation from Dredge Head.
- ▶ Ensure that spoil disposal is conducted in a way that minimises the generation of sediment plumes at the spoil disposal site.
- ▶ Monitor suspended sediment concentrations, PAR and sediment deposition via Plume Validation Monitoring Program and turbidity monitoring program.

Performance Indicators

- ▶ The concentration of turbid plumes should not significantly exceed predicted values from modelling.

Monitoring

- ▶ Reference with Element 1: Water Quality and Element 2: Sediment Mobilisation from the Dredge Head. Monitor suspended sediment concentrations, PAR and sediment deposition via Plume Validation Monitoring Program.
- ▶ A seagrass monitoring program will be implemented.
- ▶ The Dredging Contractor should monitor the operation on a continual basis and will report any incidents that are likely to cause environmental harm to the project location and surrounding areas.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring the Plume Validation Monitoring Program and DPI&F seagrass monitoring programs are implemented. The Project Superintendent may subcontract a specialist sub-consultant to undertake the monitoring program.
- ▶ The Dredging Contractor, in liaison with the Project Superintendent, is responsible for the operational parameters of the dredge.

Reporting

- ▶ Monthly compliance reports comparing results of water quality monitoring to predicted modelling values will be provided to the Project Superintendent.

Corrective Action

- ▶ Adjust disposal times to occur during least tidal flow.
- ▶ Revision of dredging strategy, including potential relocation of the dredge and alterations to operational mode if plumes are considered to impact upon key sensitive habitats.
- ▶ Implementation of a reactive monitoring program to assess the impacts of dredging and spoil disposal on sensitive habitats.

5.12.4 Element 4: Marine Flora and Fauna

Potential Impacts

Potential impacts of dredging on marine flora and fauna include:

- ▶ Dredging of the sediments removes benthic habitats and the associated species;
- ▶ Suspended sediments and sediment deposition can smother benthic organisms, in particular seagrass and coral communities and benthic infauna;
- ▶ Dredging can result in disturbance of marine fauna; and
- ▶ Marine fauna can suffer direct physical injury through contact with the dredge head.

Performance Objective

To ensure marine fauna and flora is not adversely impacted by the dredging operation.

Management Actions

- ▶ Turtle excluding devices are to be fitted to the drag heads of the dredger.
- ▶ During times the drag head is not in contact with the seabed, and pumps are in operation, pump speed must be reduced and drag head water jets (if available) must be activated to minimise the risk of turtle capture.
- ▶ Dredging should be undertaken as quickly as possible to minimise the duration of stress to marine flora and fauna.
- ▶ Dredging should commence in April / May to allow completion as early as possible to minimise the overlap with turtle nesting and coral spawning periods.
- ▶ A spotter will be used to identify any marine fauna that may be in the dredge path should works extend into the turtle nesting season.
- ▶ Where cetaceans are identified within proximity to the dredging operations will be moved wherever possible to avoid contact.

Performance Indicators

- ▶ No fauna mortalities occur during the dredging campaign.
- ▶ Impacts to the coral and seagrass communities are minimised.

Monitoring

- ▶ Implementation of the Plume Validation Monitoring Program.
- ▶ Implementation of a coral monitoring program.
- ▶ Implementation of a seagrass monitoring program.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring the Plume Validation Monitoring Program and DPI&F seagrass monitoring programs are implemented. The Project Superintendent may subcontract a specialist sub-consultant to undertake the monitoring program.
- ▶ The Project Superintendent is responsible for ensuring that a spotter / spotting vessel is used if dredging extends in October / November.

Reporting

- ▶ Ensure any fauna injury or mortality is reported to the Project Superintendent and PCQ Representative immediately:
- ▶ The PCQ Representative will ensure that the relevant regulatory agencies (eg: Queensland Parks and Wildlife Service and GBRMPA) are informed of the incident within 24 hours:
 - Queensland Parks and Wildlife Service Marine Stranding and Injury Hotline: 1300 360 898
- ▶ Coral condition reports will be provided to the Project Superintendent in accordance with the program described in Section 5.13.

Corrective Action

- ▶ If marine fauna are spotted during dredging activities, the dredge should avoid moving towards that area if possible if capture or strike is likely.
- ▶ Implementation of a reactive monitoring program to assess the impacts of dredging and spoil disposal on sensitive habitats.

5.12.5 Element 5: Storage and Handling of Hazardous Substances

Potential Impacts

Incorrect storage and handling of hazardous substances may result in environmental harm.

Performance Objective

To minimise the potential for environmental harm from the release of hydrocarbons from the dredge to the surrounding marine environment.

Management Actions

- ▶ Hazardous substances handling is to be carried out by suitably trained personnel only.



- ▶ Only essential maintenance to be undertaken while on-site.
- ▶ Contain all wastes and hydrocarbon spillages and implement appropriate storage and disposal practices.
- ▶ Ensure training is provided for handling and storage of hazardous substances to all personnel working on the dredge.
- ▶ All hazardous waste (eg: waste oil and maintenance waste such as oily rags and oil filters) shall be retained in secure containers on the dredge and removed to an appropriate location for disposal to a licensed facility.
- ▶ The Dredging Contractor is to provide on-site spill clean up kits. All personnel on the dredge will be familiar with the use of the clean up kit and dispose of waste in the prescribed manner.

Performance Indicators

- ▶ No contamination of Port waters from the dredge.

Monitoring

- ▶ The Dredging Operator shall regularly visually monitor the area around the dredging and spoil disposal sites for hydrocarbon spillages.

Responsibility

- ▶ The Dredging Contractor is responsible for monitoring the spoil disposal and dredging areas for hydrocarbon spillages.

Reporting

- ▶ In the event of an environmental incident, the Dredging Contractor is to notify the Project Superintendent and appropriate authorities immediately.

Corrective Action

- ▶ Maintain the hazardous goods storage area in a clean, safe and environmentally acceptable manner.
- ▶ Spilt hazardous substances should be contained on the dredge by implementing appropriate corrective action procedures and not hosed or washed away.
- ▶ Prevent any on-site spillages from entering the marine environment where possible.
- ▶ All spills should be reported immediately to the Project Superintendent and cleaned up with the contaminated materials removed and disposed of on-shore to an approved site.
- ▶ In the event of a spill the Dredging Contractor is to complete an Environmental Incident Report and Corrective Action Report and forward on to the Project Superintendent.

5.12.6 Element 6: Waste Management

Potential Impacts

Incorrect handling and storage of waste materials may result in the introduction of wastes into the marine environment.

Performance Objective

To ensure best practice management for the handling and storage of all waste materials on board the dredge.

No waste, other than treated sewage, is to be released into the Port waters.

Management Actions

- ▶ Ensure that all rubbish is contained in bins or other appropriate containers.
- ▶ Ensure the removal of all rubbish and other waste from the dredge to an appropriate location at the cessation of dredging and spoil disposal.

Performance Indicators

- ▶ All waste materials are handled and stored in a safe and appropriate manner.
- ▶ There is no environmental impact on, and disturbance to, the surrounding marine area from waste.
- ▶ The dredge is maintained in a clean and tidy manner.

Monitoring

- ▶ The Dredging Contractor will monitor the storage of waste materials the disposal of waste from on board the dredge.
- ▶ The Dredging Contractor shall report any incident of waste spillage into the marine environment to the Project Superintendent and implement appropriate spill clean up procedures.

Responsibility

- ▶ The Dredging Contractor is responsible for ensuring the appropriate waste handling and storage procedures are implemented on the dredge.

Reporting

- ▶ In the event of the release of wastes into the marine environment, the Dredging Contractor is to complete an Environmental Incident Report and Corrective Action Report and forward on to the Project Superintendent.

Corrective Action

- ▶ Implement appropriate management and preventative measures to reduce the potential for an environmental incident.

5.12.7 Element 7: Noise and Hours of Operation

Potential Impacts

The dredge will operate 24 hours per day seven days per week.

The operation of the dredge may result in increased noise levels at surrounding facilities.

Performance Objective

To reduce or minimise the impact of noise associated with the dredging on surrounding facilities, users and visitors.

Management Actions

- ▶ Ensure that all equipment is properly maintained and silencers are operational and put in place action plan if requirements are not met.
- ▶ Maintain and operate all equipment on board the dredge in a safe and efficient manner.
- ▶ Carry out non-essential maintenance during day-light hours.

Performance Indicators

- ▶ Absence of complaints from people directly affected by dredge noise.

Monitoring

- ▶ Maintain a record of any noise complaints in a log book, including the date and time of complaint, name of complainant, nature of complaint, action taken and follow up.

Responsibility

- ▶ The Project Superintendent is responsible for logging and responding to all noise complaints.

Reporting

- ▶ All complaints are to be reported to the Project Superintendent.
- ▶ Maintenance of a record of any noise complaints in a log book.

Corrective Action

- ▶ All complaints are to be responded to within 24 hours of receiving the complaint.
- ▶ Maintain all equipment so that noise levels do not exceed specified guidelines.

5.12.8 Element 8: Air Quality

Potential Impacts

Air emissions, including greenhouse gases, will be produced by the dredge.

Performance Objective

To minimise the air emissions produced during dredging operations and thereby minimise potential effects on the natural airshed.



Management Actions

- Ensure that engines on board are maintained in good working order and that emission controls are in place and working.
- Use overflow dredging where practicable to minimise the duration of dredging and production of greenhouse gases.

Performance Indicators

- No visible emissions from the dredge.

Monitoring

- The Dredging Contractor will visually monitor air emissions.

Responsibility

- The Dredging Contractor is responsible for visual monitoring of emissions from the dredge.

Reporting

- The Dredging Contractor is to report any visible emissions from the dredge to the Project Superintendent.

Corrective Action

- Repair or replace emission control devices.

5.12.9 Element 9: Environmental Emergency Procedures

Potential Impacts

Environmental incidents that have the potential to result in environmental harm may occur during the dredging campaign.

Performance Objective

To identify and reduce the potential for an environmental incident before it occurs so as to prevent damage to the surrounding marine environment and the public.

To respond quickly and effectively in the event of an emergency or environmental incident.

Management Actions

- Prevent and reduce the potential for an environmental incident by ensuring the implementation of Best Practice Management throughout the dredging operation and by implementing the EMP.
- The Dredging Contractor is to document the procedure for dealing with an environmental emergency situation with details including contact organisation, names and telephone numbers.
- The Dredging Operator is to take immediate action to contain and rectify the cause of the incident, if safe to do so.

- ▶ Suspend, relocate or amend dredging operations immediately if an environmental incident occurs that may be aggravated by continued dredging operations.
- ▶ The Dredging Contractor is to notify the Project Superintendent and relevant emergency response agencies immediately in the event of an environmental incident.
- ▶ Initiate response and corrective action procedures pending the Project Superintendent and PCQ's directive.
- ▶ The procedures detailed in the MSQ Oil Spill Contingency Plan for the Port of Hay Point are to be followed in the event of a spill to the marine environment.
- ▶ Identify any near miss incidents and put in places corrective actions to prevent reoccurrence.

Performance Indicators

- ▶ Maintain public and navigational safety.
- ▶ The ecological integrity of the surrounding marine environment is maintained.
- ▶ Minimise the potential for an environmental incident.
- ▶ Facilitate the timely and effective implementation of the appropriate emergency response procedures in the event of an environmental incident.

Monitoring

- ▶ Monitor and record all unusual and inappropriate procedures and events.

Responsibility

- ▶ The Dredging Contractor is responsible for monitoring for and immediate response to all environmental incidents under the direction of the Project Superintendent.

Reporting

- ▶ The Dredging Contractor will report environmental incidents to the Project Superintendent and relevant government agencies immediately.
- ▶ In the event of an environmental incident, the Dredging Contractor is to complete an Environmental Incident Report and Corrective Action Report and forward on to the Project Superintendent.

Corrective Action

- ▶ The Project Superintendent will determine the appropriate emergency response and corrective actions to be implemented depending on the type and magnitude of the event.
- ▶ Establish twenty four (24) hour contact details for the Project Superintendent (eg: mobile phone and pager).

5.12.10 Element 10: Site Access

Potential Impacts

Minor interruptions to commercial and recreational fishing activity are possible during dredging and spoil disposal operations.

Potential risks to safety if unauthorised vessels are too close to the dredge or disposal areas.

Performance Objective

To prevent the access of unauthorised vessels too close to the dredge and the spoil disposal area.

Ensure that dredging operations do not unduly interfere with vessel movements in the Port or at the ocean disposal site.

Management Actions

- ▶ MSQ to provide a notice to mariners advising the commencement of dredging and expected duration of operations.
- ▶ The Project Superintendent is to place a public notice prior to works commencing.
- ▶ Dredge operator to liaise with the Regional Harbour Master regarding vessel movements.

Performance Indicators

- ▶ All vessels remain well clear of the dredging and disposal sites.
- ▶ No complaints received about shipping access to and from the Port during dredging and ocean disposal.

Monitoring

- ▶ Visual inspections of the spoil disposal area to ensure no vessels are within the area.

Responsibility

- ▶ MSQ and the Project Superintendent are responsible for ensuring that notice of the dredging works is provided to all users and visitors to the Port.
- ▶ The Dredging Contractor is responsible for liaising with the Regional Harbour Master regarding vessel movements.

Reporting

- ▶ MSQ are to advise the Project Superintendent of any complaints or incidents.

Corrective Action

- ▶ Increase the number of signs/buoys and/or relocate them to ensure they are effective.
- ▶ Contact boat owners who approach too close and explain the hazards.

5.12.11 Element 11: Management and Staff Responsibilities

Potential Impacts

Ineffective or inadequate communication will restrict the management of environmental incidents and Port access during the dredging program.

Performance Objective

To ensure that there is an identifiable chain of command and available procedures in place for communication and reporting of environmental issues.

To ensure that adequate information is available to Port users as to the duration and nature of the operation and any restrictions placed on harbour users.

Management Actions

- ▶ A written chain of command indicating authority and responsibilities should be available for both the Project Superintendent, the Dredging Contractor and Regional Harbour Master. This is to be established with the Dredging Contractor prior to the commencement of works.
- ▶ The Project Superintendent is to be responsible for ensuring that all relevant staff and the Dredging Contractor are familiar with reporting procedures and comply with the EMP and all approval and permit conditions.
- ▶ The Dredging Contractor is to inform the Project Superintendent of any environmental incident or a potential environmental incident, which has the potential to cause environmental harm as soon as possible.
- ▶ On-site personnel are responsible for reporting an incident or potential incident if he/she is the first to notice or cause an incident.
- ▶ Report forms are to be available on-site at all times.
- ▶ Report forms are to include:
 - a complaints register;
 - an environmental incident and corrective action report; and
 - a site inspection/progress report.

Performance Indicators

- ▶ The Project Superintendent, the Dredging Contractor and Regional Harbour Master know the procedures for communication of information between all relevant parties.
- ▶ The establishment and implementation of a practical framework for the reporting and amelioration of potential environmental incidents is in place.
- ▶ All regular operators in and out of the harbour are aware of the nature and duration of the operation and any restrictions that may apply during the operation (refer also to Element 10: Site Access).

Monitoring

- ▶ The Project Superintendent is responsible for ensuring that reporting procedures are being followed.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring that reporting procedures are being followed.

Reporting

- ▶ The Project Superintendent is responsible for ensuring that reporting procedures are being followed.

Corrective Action

- ▶ The Project Superintendent should ensure that the Dredge Operator is familiar with reporting procedures.
- ▶ Modify reporting procedures as required.

5.12.12 Element 12: Staff Environmental Training**Potential Impacts**

Environmental impacts are not appropriately mitigated due to lack of staff and Dredging Contractor awareness and training.

Performance Objective

To ensure that relevant Project Superintendent staff and Dredging Contractor personnel are adequately trained in environmental awareness with regard to the marine environment.

Management Objectives

- ▶ Appropriate environmental training appropriate to the Project should be given to all personnel involved in dredging and associated operations.
- ▶ The Project Superintendent is to ensure that environmental training needs are identified.

Performance Indicators

- ▶ All relevant Project Superintendent staff and Dredging Contractor personnel understand the environmental issues associated with the proposed work.

Monitoring

- ▶ The Project Superintendent should ensure that the Dredging Contractor personnel have been given adequate training in the areas outlined above and are familiar with the EMP and their environmental responsibilities.

Responsibility

- ▶ The Project Superintendent is responsible for ensuring that the Dredging Contractor personnel have been given adequate training in the areas outlined above.

Reporting

- ▶ The Project Superintendent should maintain records of staff and contractors who have undergone training in relation to the EMP and general environmental responsibilities.

Corrective Action

- ▶ The Project Superintendent and Dredging Contractor should ensure that anyone who appears to lack an understanding in the above areas undergoes adequate retraining.

5.13 Coral Condition Monitoring

5.13.1 Introduction

Fringing coral reef communities have been identified as the primary sensitive receiving habitat potentially effected by the turbidity plume generated during dredging at the Port of Hay Point. The process of managing and mitigating the effects of dredging and spoil disposal on the coral communities of Round Top and Flat Top Island and Victor Islet is supported by a targeted monitoring regime. The proposed monitoring program incorporates baseline and routine coral condition surveys in combination with remotely accessed 24-hr telemetry based monitoring to provide improved temporal coverage of key physical parameters.

5.13.2 Monitoring Schedule

The monitoring schedule outlines key components of the coral monitoring program. These components include the **baseline survey**, and a **routine coral monitoring** program encompassing initial **fortnightly surveys** and subsequent routine **monthly monitoring**. The analysis and reporting of turbidity, deposition and PAR parameters captured using **telemetry** will be undertaken daily. **Post dredge** coral survey will also undertaken to assess possible long-term changes in community composition. While this schedule is based on the proposed dredging program of 6-months, the actual intensity of monitoring may vary according to findings from the routine monitoring program.

5.13.3 Baseline Survey

The baseline program will be conducted approximately four weeks prior to the commencement of dredge operations at the Port of Hay Point. The purpose of the baseline survey is to collate information regarding key coral condition indicators, providing an assessment of pre-dredge coral condition. The baseline surveys will include diversity and abundance indices for epibenthos and fish communities as reported within the coral investigations completed as part of the Port of Hay Point EIS (GHD 2005). Additional parameters will also be captured during the baseline program and applied as part of the routine coral condition monitoring program. These additional indicators provide a method of rapid assessment for monitoring sublethal impacts

associated with dredge operations. Rapid assessment indicators of coral condition will include:

- ▶ percent coral bleaching; and
- ▶ sediment deposition.

These indicators will be supported by electronic logging for turbidity, photosynthetically active radiation (PAR) and sediment deposition. It is proposed to install telemetry based electronic logging systems during the Baseline survey. Impacts of suspended sediment and deposition are considered a key threat to coral communities.

Locations

Baseline surveys will be undertaken at Victor Islet and Round Top Island. Multiple sites will be selected at each location following the review of fringing reef field investigations completed by GHD (2005). Sufficient sites will be established so as to provide a robust data set for statistical analysis. Power analysis will be used over existing community data to select the appropriate level of site replication. As an example, six survey sites with four replicate transects at each site were undertaken at each Island/Islet during the 2005 survey completed by GHD. It is expected that a similar program utilising fixed transects would be applied during the baseline survey program.

Survey Methods

Survey methods will include SCUBA based survey of fixed transects and the application of electronic data logging for turbidity, PAR and sediment deposition.

Fixed Transects

Fixed survey transects will be established at Round Top Island and Victor Islet. Survey of these transects will be undertaken for diversity and percentage cover/abundance, sediment deposition, and percentage bleaching/mortality.

Line Intercept Survey

Epi-benthic communities are surveyed using percentage cover video line intercept transects. At each sampling site divers measure out four 20 m long line transects along the seabed using a measuring tape. Divers then swim along the length of the tape recording the intercept distance in cm of all benthic organisms beneath the tape. Previous surveys completed by GHD (2005) considered a range of hard coral genera, soft corals, macroalgae, sponges, turfing algae and hydroids.

Distance totals for each group of organisms are then calculated and converted to percentage cover estimates. Divers also record transects using digital video for confirmation of identification purposes and provision of a permanent record. The video line intercepts method is considered a non-destructive, nil-disturbance method.

Fish counts can also be undertaken in a similar fashion to that proposed for the epi-benthic survey. SCUBA divers swim along the tape recording large fish in a five metre wide strip. When this count is completed, the divers return along the tape recording small fish in a one metre wide strip. Digital video photography of each transect is also taken to allow for more detailed post-survey assessment. Assessment of epibenthic

and fish community diversity and abundance will form part of the longer term monitoring program as an indicator of community change.

Bleaching

Assessment of coral bleaching will also be made using the line intercept method. This data will be recorded as a separate percentage cover to other organisms and represents a key rapid assessment indicator for application during routine coral monitoring.

Sediment Deposition

Each transect will also be surveyed for sediment deposition at 10 randomly located sites along each 20 m fixed survey transect. Five replicate measures will be taken from each of the 10 locations along the transect, providing 50 discrete sediment depth measurements. The random nature of site selection along each transect helps to account for natural variability of sediment deposition over reef environments due to the effects of tides, waves and hydrodynamic effects of coral structure on the settling of fine particles.

The number of survey transects will replicate those included within the line intercept program described above. Sediment deposition transects will also be incorporated as a rapid response measure undertaken during routine monitoring program.

Electronic Loggers (Turbidity, PAR and Deposition)

Electronic loggers are considered an essential component to the reactive management of dredge derived impacts over coral habitats. Nephelometer turbidity loggers, PAR sensors and deposition sensors record data at regular intervals during extended deployment periods. These *in situ* loggers are deployed from a survey vessel often using divers and are anchored to the seabed. Regular measurements are automatically recorded by the logger and stored electronically. General practice is to retrieve the loggers prior to downloading of the data. For this project it is proposed to include telemetry based remote reporting equipment to facilitate remote download and regular monitoring of benthic conditions. The installation, testing and commissioning of these telemetry based data loggers will be completed during the baseline program.

Duration

The baseline survey and installation of logging equipments will be completed over a two week period.

Reporting

A baseline report will be prepared describing the environmental conditions immediately prior to dredge operations. The results of this report will be considered during the comparison of data from routine monitoring programs and upon finalisation of the post dredge survey. The baseline report will outline the purpose of the works, describe the project methodology, present results and provide a discussion as to the condition of the community. Results will incorporate key measures of diversity and abundance, and provide a clear description of community structure.

5.13.4 Routine Coral Monitoring

Routine coral monitoring has been portioned between a series of fortnightly and monthly surveys. The purpose of the initial fortnightly coral monitoring study is to observe actual coral community condition and response during the dredge impact process. This program is proposed to extend over four events before reverting to a monthly monitoring regime. The routine monitoring program will focus on the rapid assessment methods of bleaching and sediment deposition conducted during the baseline survey. The monthly coral monitoring surveys will follow the same methodology and extend over three events.

Locations

The routine survey program will consider coral habitats at Round Top Island and Victor Islet. Coral habitat survey sites will replicate those undertaken during the baseline surveys.

Survey Method

Rapid assessment protocols will be applied during routine monitoring. These include:

- Coral bleaching (fixed transects);
- Sediment deposition (fixed transects); and
- Electronic loggers for turbidity, PAR and sediment deposition.

These surveys will follow the methods previously described within for the Baseline program.

Reporting

Summary reports considering the findings of baseline compared with subsequent fortnightly and monthly surveys will be completed within one week of each survey event. Reports will succinctly describe the findings and overall trends in coral condition. Finalised reports will be provided immediately to management for consideration.

5.13.5 Telemetry – Daily turbidity, deposition, PAR reporting

The monitoring consultant will complete download of telemetry units, data analysis, comparison to trigger values and compliance reporting. The telemetry data will be compared to threshold levels developed within the EIS and finalised during the baseline program. Downloading of the data will be undertaken daily and reporting of the results included in the fortnightly and monthly coral condition reports.

5.13.6 Post dredge Coral Condition Survey

The post dredge coral condition survey will include a complete coral survey as conducted during the baseline program. Results will be compared with baseline conditions and the likely long-term consequences associated with the dredging campaign elucidated.

5.14 Marine Plant and Fisheries Monitoring

Marine plants (seagrass and algae) will be monitored in accordance with the monitoring program developed by DPI&F to measure the variability of deepwater seagrass and algae dynamics and invertebrate and fish communities in the Port of Hay Point and to monitor impacts of the capital dredging. This program was developed by DPI&F in accordance with DPI&F's Fish Habitat Management Operational Policies (FHMOP 001-005) in particular, "Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss" (FHMOP 005). The following has been extracted from DPI&F's monitoring program. To ensure independence of monitoring, PCQ will fund the monitoring to be carried out by DPI&F.

5.14.1 Objective

This proposed research project aims to fill knowledge gaps on how the deepwater seagrass and algae communities in the Port of Hay Point change naturally through time, their roles in fisheries productivity and their resilience and capacity for recovery from disturbance associated with dredging. It will also provide direct information on the impact of the dredging works on seagrass and algae and their recovery.

5.14.2 Sampling Approach

There will be two alternate sampling approaches based on the status of seagrasses found in the port in the first pre-dredge seagrass sampling event.

Assessing the impacts of dredging on deepwater marine plants and their recovery

DPI&F will implement a *Before/After/Control/Impact* (BACI) design to assess the various impacts associated with dredging on marine plants and their recovery if substantial seagrass areas are found in the impact zones prior to dredging.

Dynamics of deepwater marine plant communities

If the area of seagrass has declined substantially from that recorded in the July 2004 baseline survey, the focus of the program would be to investigate the dynamics of deepwater seagrass at Hay Point. This would require a different sampling design set up to detect recruitment and changes in seagrass abundance.

Sampling Design

Changes associated with dredging impacts will be compared to two reference (control) sites. The first impact site will be to the north of the apron dredging zone and be in the area continually affected by the high turbidity section of the dredge plume. The second impact site will be in the proposed dredge spoil ground and examine the impact of burial by spoil. Two reference sites within the port that will be largely unaffected by dredging will act as controls to compare with changes at the impact sites and measure natural seasonality and variability.

At each of the four sites replicate video transects will be sampled using the standard methodology developed by DPI&F for analysis of deepwater seagrass and benthic

communities. Transects will be surveyed using a CCTV camera system, with real-time monitor towed from a research vessel.

At each transect the real-time underwater camera system will be towed for 200 m at drift speed. Footage will be observed on a TV monitor and recorded to digital tape. The camera is mounted on a sled that incorporates a sled net 600 mm width and 250 mm deep with a net of 10 mm-mesh aperture. Surface benthos including seagrass and macrophytic algae is captured in the net and used to confirm algal and seagrass habitat characteristics observed on the monitor.

Data recorded at each site will include:

1. **Seagrass species composition** - Seagrass identifications in the field and from video according. Species composition measured from the sled net sample and from the video screen when species are distinct.
2. **Seagrass biomass** - Estimates of seagrass biomass from video images. A visual estimate of above ground biomass will be made by an observer viewing the screen. All observers are calibrated to a standard set of video images that have been harvested and measured.
3. **Algae** - Algae type and percent cover (measured from the video grab). Algae collected in the sled net and grab will provide a taxa list.
4. **Coordination with Turbidity Monitoring Program** – Turbidity monitoring will occur at the four seagrass impact and control sites. This would enable actual turbidity values to be directly linked to any changes to seagrasses observed in the program.

Sampling Frequency

Two sampling events prior to dredging in December 2005 and March 2006 (based on a May 2006 dredging start) will establish a predredge baseline for comparisons as well as sample in the ideal time to detect the presence of seasonal species (December).

Monthly sampling will be conducted during the six month dredging campaign in order to measure any changes associated with the dredge plume and determine the length of time required by this type of impact for loss of seagrass to occur. Monthly sampling will continue for two months after the cessation of dredging to pick up any rapid recolonisation.

After this, sampling will be conducted every three months to track the progress of recovery through to November 2007. This will allow 13 months of post impact recovery to be assessed.

Sampling frequency and the use of the two control (reference) sites will also allow a determination of the extent of natural variability for these habitats over the 2 year period for future considerations of likely impacts from developments.

Should initial sampling in December 2005 show that there was insufficient seagrass within the proposed impact and control zones for an effective BACI designed monitoring program, a different sampling design will be implemented. Sites will be spread throughout the port area rather than focus on the impact zones, and measure recruitment and changes in seagrass and algae abundance through time. This design

will provide information on the natural variability of these types of marine plant habitat and will also examine if there are any differences to recruitment between impacted and un-impacted areas of the port.

While location of sites will vary from the BACI design program, the methodology for collecting information would remain the same. If this approach is utilized, sampling would be conducted every two months from December 2005 to December 2007 rather than the staggered frequency that was designed to pick up the loss of seagrasses in the dredge plume zone for the BACI design.

Monitoring of Invertebrate and Fish Communities

To determine the utilisation of these seagrass habitats by invertebrate and fish communities and the impact of dredging on invertebrate and fish communities, beam trawling on seagrass meadows will be conducted in conjunction with the seagrass sampling. In a similar manner to the seagrass sampling, fish and invertebrate sampling will be conducted using a BACI design with beam trawling conducted at both impact sites and a control site within the port. Sampling will be conducted at three monthly intervals to pick up any seasonal recruitment of invertebrates and fish. Sampling will occur prior to, during and after dredging (BACI) to determine any impact of the plume or spoil burial on invertebrates and fish and recovery when compared with the control site. Three monthly monitoring at the control site will also answer the broader question of the value of these types of seagrass meadows as a nursery ground for fisheries species.

Sampling will be conducted at the time of high water at night. A beam trawl will be towed along a 100 m transect. Four replicate trawls will be conducted at each site.

All Penaeidae (prawns) will be identified to species and carapace length measured. All fish will be identified as far as possible and standard length measured. Numbers of Brachyura (crabs), squid, sepiolids (cuttlefish) and miscellaneous crustaceans (shrimps, isopods, amphipods, and stomatopods) will be recorded for each trawl. Biomass (g dry weight) of fish, penaeids (all species pooled), crustaceans and miscellaneous from each trawl will also be determined by drying (60C, 48 hrs) and weighing samples.

5.15 Model Verification Program

Verification of the model developed for the EIS will be undertaken during the first 3-4 weeks of works. Electronic multi-parameter water quality meters with logging capability will be used to measure physicochemical parameters in the water column (salinity, conductivity, temperature, pH dissolved oxygen and turbidity). YeoKal 611 Water Quality Analysers are commonly applied for this purpose. Measurements are recorded *in situ* by lowering the logger by a cable down through the water column to pre-determined depths where measurements are recorded from the surface using the logger feature. These and similar instruments may also be used by temporarily leaving the instruments within the water column, fixed to appropriately marked temporary buoyage or stands fixed to the seabed. In all instances, the environment is not disturbed by deployment and no residual material remains at the conclusion of monitoring.



Assessment of the turbidity plume generated during dredging and disposal will be via a vessel based program. Establishment of survey sites will depend on tidal conditions, sea state and safety requirements pertaining to required distances from operating equipment.

Survey locations at increasing distances from the dredging and disposal activities will be assessed to aid in the validation of the plume model. Replicate measurements will be obtained from each location over several survey events.

The data gathered during this initial survey will then be compared with predicted sediment concentrations as reported in the EIS and an assessment made in relation to the accuracy of the predictions. The result of the model verification study will be reported to



6. Environmental Record

Section 6 of Schedule 4 of the EPBC Regulations requires the following information relating to the environmental record of the proponent, PCQ:

- ▶ PCQ has had no non-compliances with any Commonwealth, State or Territory approvals, permits or legislation and thus no proceedings exist against the Corporation.
- ▶ PCQ's environmental policy is detailed in Section 5 and the planning framework relevant to this Project is in accordance with the Port of Hay Point Environmental Management Plan.

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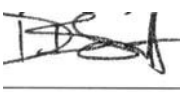
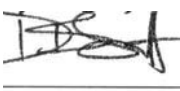
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