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FAR NORTH QUEENSLAND PORTS CORPORATION

Cairns Port Long Term Management Plan

Dredging and Dredge Spoil Management

301001-00680 – 301001-00680-00-EN-REP-0001

12 May 2010

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FAR NORTH QUEENSLAND PORTS CORPORATION

Cairns Port - Long Term Management Plan – Dredging and Disposal

Item	Detail	Date	Approved
Version 1	FNQPC	15 October 2009	FNPQC
Version 2	To GBRMPA	4 November 2009	FNQPC
Version 3	To Cairns Port TACC	15 February 2010	FNQPC
Version 4	To GBRMPA for TACC Agency and GBRMPA review	22 March 2010	FNQPC
Version 5	From GBRMPA with TACC-GBRMPA comments	30 May 2010	
Version 6	To GBRMPA –for final review	05 May 2010	FNQPC

Final Version Agreed this 8th day of June 2010

This document is agreed between the below mentioned organisations for implementation by Far North Queensland Ports Corporation Ltd (FNQPC) for the term of the Marine Parks Permit and Sea Dumping Permit issued by Great Barrier Reef Marine Park Authority (GBRMPA) for dredging and disposal activity for the maintenance dredging of Port of Cairns.

This document is valid for the term of the permit, subject to agreement on variation, amendment or review, between the parties to this agreement.

Far North Queensland Ports Corporations Ltd	Chief Executive Officer	
Great Barrier Reef Marine Park Authority	Delegate *Dr Adam Smith Director EA & M PN 187*	8/6/10
Cairns Port Technical Advisory Consultative Committee (TACC)	Chairman	

SYNOPSIS

This Long Term Management Plan (LTMP) outlines the regulatory processes followed in obtaining approval for annual routine maintenance dredging, including management responsibilities. Existing background information relating to the identification of suitable disposal strategies has been revised. Roles and responsibilities of the Technical Advisory and Consultative Committee (TACC) are outlined and a process of involvement tabled. The LTMP also outlines the predicted volumes of maintenance dredging material and describes the processes by which dredging and disposal will be carried out. Existing environmental conditions, significant species, and habitats of concern are also described from a range of regional and specific studies undertaken by the Port over many years. Analysis of the potential risks associated with routine annual maintenance dredging and disposal has been completed, and a series of management strategies developed, via which these affects can be monitored and controlled.

Disclaimer

PROJECT 301001-00680 - CAIRNS PORT LONG TERM MANAGEMENT PLAN

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
5	Issued for use	J Kennedy	V Seto	T Koskela	12-05-10	A Fletcher	

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PARAMETERS OF SEA DUMPING PERMIT APPROVAL

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2. Approval to dispose of up to 6,600,000m^3 (4,200,000 dry load tonne) of maintenance dredging material that is compliant with the National Assessment Guidelines for Dredge Material (NAGD) at the Cairns Port approved offshore disposal over a ten year period (2010 – 2020). This is comprised of:
    a. Approval to dispose of up to 550,000m^3 (350,000 dry load tonne) at the off shore disposal site in any one annual maintenance dredging campaign in accordance with the LTMP.
    b. Approval to additionally dispose of up to 1,100,000m^3 (700,000 dry load tonne) at the off shore disposal site in two contingency dredging campaigns during the term of the ten year period (2010 – 2020) in the event of cyclonic/severe storm sedimentation. Utilisation of this contingency volume provision would require prior written approval from the Determining Authority.
3. Approval to undertake the dredging and sea dumping activities in accordance with the implementation of the Management Strategies and Actions (including monitoring) indentified in **Section 7** of the LTMP (or as amended and agreed by FNQPC and the Determining Authority).
4. Far North Queensland Ports Corporation (FNQPC) is to maintain a Technical Advisory Consultative Committee (TACC) which is to meet at least annually.
5. The FNQPC is to provide the Determining Authority with pre-dredge reports (sediment sampling and analysis plans, sediment characterisation reports, dredge environmental management plans), post-dredge reports (dredging volumes), and pre and post dump soundings.

FNQPC is to at least undertake a mid-term review of the LTMP and present any proposed amendments to the TACC and the Determining Authority for comment, consideration and agreement prior to adoption. Requests can be made at other times to modify or improve the current version of this 'living' document.

1. INTRODUCTION

This document describes the long-term environmental management arrangement for maintenance dredging and dredge spoil management by Far North Queensland Ports Corporation (FNQPC; formerly Cairns Ports Ltd and Cairns Port Authority), now trading as Ports North, within the Port of Cairns for the period 2010 – 2020. This Long Term Management Plan (LTMP) for Dredging and Dredge Spoil Management supports the application for a long-term Sea Dumping Permit/Marine Parks Permit for maintenance dredging under the *Environment Protection (Sea Dumping) Act (1981)* and the *Great Barrier Reef Marine Park Act 1975* for the same period. Henceforth the Sea Dumping Permit/Marine Parks Permit is referred to as the Marine Parks Permit in this document.

Within the Great Barrier Reef Marine Park, the Great Barrier Reef Marine Park Authority (GBRMPA) has been delegated authority under the *Environment Protection (Sea Dumping) Act 1981* for a range of activities within and outside the Marine Park, including the loading and disposal of dredged material.

The Sea Dumping Act implements Australia's obligations under the *1996 Protocol to the Convention on the Prevention of marine Pollution by Dumping Wastes and other Matter, 1972* (the London Protocol). Under the Sea Dumping Act, the *National Assessment Guidelines for Dredging* (NAGD; Commonwealth of Australia, 2009) sets out the framework for the environmental impact assessment and permitting of the ocean disposal of dredged material. The NAGD identifies that the Determining Authority will grant long-term permits for maintenance dredging on the following basis:

- An assessment of the applicant's ability to meet their obligations under the Sea Dumping Act and any permit granted;
- Establishment of a Technical Advisory and Consultative Committee (TACC) for long-term management; and
- Development and implementation by the applicant of a satisfactory long term Environmental Management Plan (EMP) for loading and dumping activities, which provides for better sampling and analysis to support future permit applications.

1.1 Cairns Port

Cairns Seaport is the most northern major port on Australia's eastern seaboard and is the closest port to the Great Barrier Reef. Cairns Port limits extend from Taylor Point to Green Island in the north, and south to Buddabadoo Creek (refer to **Figure 1-1**).

The seaport provides a range of marine facilities including bulk cargo facilities for petroleum products, sugar, fertiliser and liquid petroleum gas, a marina that accommodates 214 berths for yachts, fishing and tourism vessels, a cruise ship terminal and a Great Barrier Reef tourism terminal. A figure showing the layout of facilities at Cairns Port is provided in **Figure 1-1**.

Key areas that are dredged include:

- Outer Channel;
- Inner Port along the wharf faces;
- Marinas (Marlin Marina, Commercial fishing base 1 – CFB1, Commercial fishing base 2 – CFB2); and
- HMAS Cairns Navy Base (contract dredging).

Other areas that may be dredged irregularly include the following but specific detail is excluded from this LTMP and any dredging and spoil disposal would be managed under a separate SAP and EMP developed for Determining Authority approval:

- Locations in Smith's Creek, including adjacent to tenant facilities; and
- In the vicinity of the Maritime Safety Queensland wharf.

These locations are flagged as areas that have been maintained in the past, and for which a future maintenance requirement may be required.

Cairns Port is owned and operated by Far North Queensland Ports Corporation (FNQPC), a statutory Queensland Government Owned Corporation with two Shareholding Ministers. FNQPC also manages the ports of Cape Flattery, Mourilyan, Skardon River, Karumba, Burketown, Cooktown, Quintell Beach and Thursday Island.

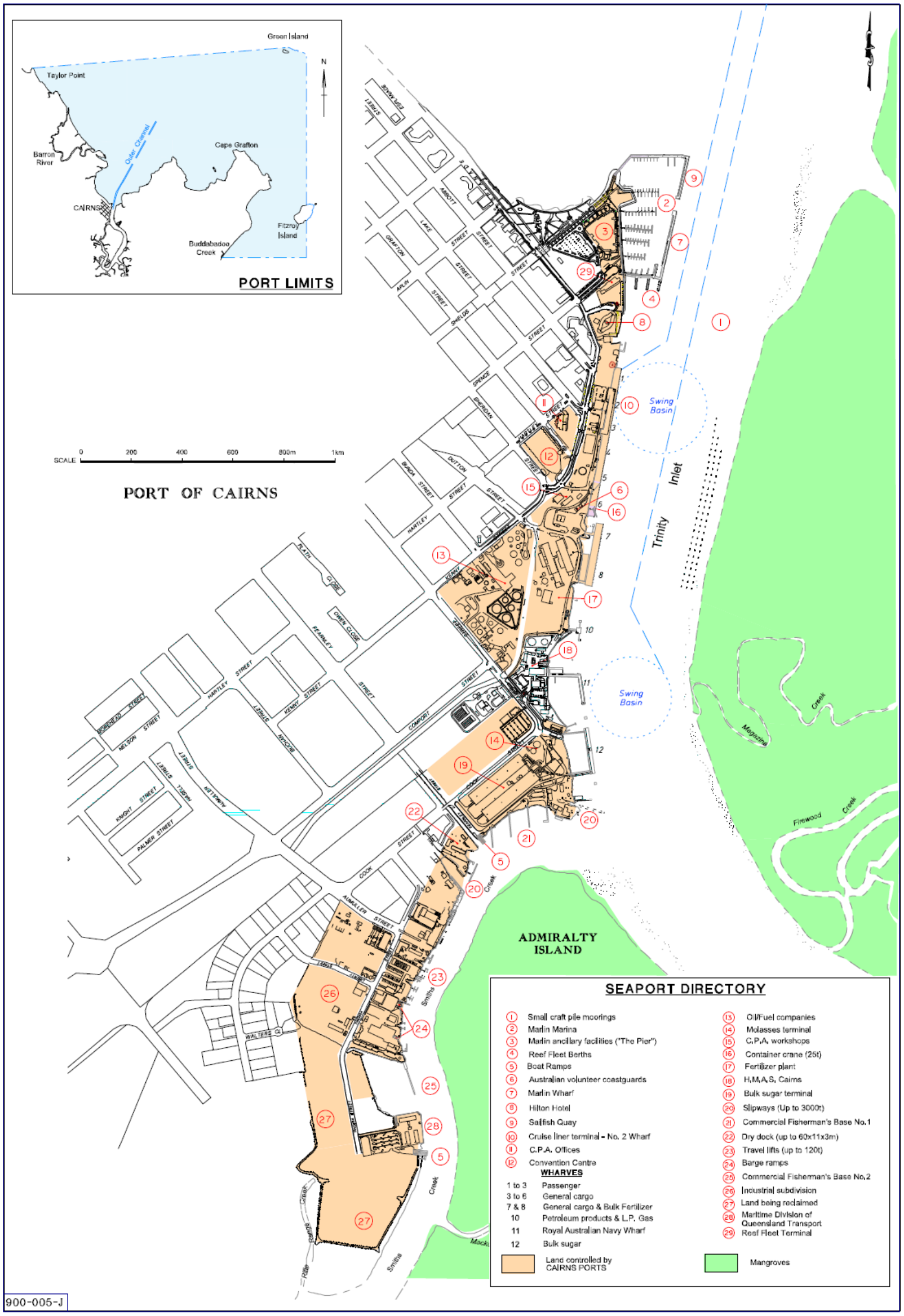


Figure 1-1 Cairns Port limits and seaport directory

The type and number of vessels visiting Cains Port between 2003 and 2008 are provided in **Table 1-1**.

Table 1-1 Cairns port vessel visitations 2003-2008

	2007/08	2006/07	2005/06	2004/05	2003/04
TRADING VESSELS					
Bulk Vessels					
Petroleum	47	40	45	38	39
LPG	25	26	28	21	34
Sugar	12	7	10	9	12
Fertiliser	8	7	7	10	8
Molasses	4	4	5	7	6
Other	2	1	1	2	
Total Bulk	98	84	96	86	101
OTHER TRADING VESSELS					
General Cargo	251	254	231	253	280
Barges	330	236	279	358	393
Total Other Trade Vessels	581	490	510	611	673
Sub Total Trade	669	574	606	697	774
CRUISE VESSELS					
International Cruise	38	35	33	21	13
Cairns Based Cruises	161	204	202	194	196
Sub Total Cruise	199	239	235	215	209
OTHER VESSELS					
Fishing	1,766	1,961	1,979	2,294	2,611
Navy	67	49	35	26	28
Sub Total Other	1,833	2,010	2,014	2,320	2,639

1.2 Long Term Management Plan

Disposal of dredged material within Australia follows concepts outlined within the Convention of the Prevention of Marine Pollution by Dumping Wastes and other Matter 1972 (London Convention) and the latter 1996 Protocol to the London Convention. These approaches are regulated within Australia via the Commonwealth *Environment Protection (Sea Dumping) Act 1981*, and recently revised *National Assessment Guidelines for Dredging* (NAGD; Commonwealth of Australia 2009). These guidelines replace the previous *National Ocean Disposal Guidelines for Disposal of Dredged Material* (NODGDM; Commonwealth of Australia 2002). While several technical edits and guideline values have been changed with respect to sampling and reporting, general processes remain similar for permitting, approval and management.

The NADG recognises the strong association between dredging and the economic viability of many of Australia's Port developments and on-going trade opportunities. The coordinated and timely approach to environmental investigations, permitting, management and approvals is considered important to maximising economic opportunity, whilst maintaining sustainability of our coastal resources. Although the NADG still provides for the continued case-by-case assessment of individual dredging proposals, it also considers the long term management of on-going dredge and disposal requirements as a jointly valuable outcome for Port operators and the environment.

1.2.1 Objectives of this Plan

FNQPC is developing this LTMP in support of an application for a ten-year maintenance dredging disposal permit, fulfilling the goals of strategic planning and operational certainty for the Port, while facilitating the ongoing protection of the marine environment, and recognising the interest of associated stakeholders.

This Plan outlines the regulatory processes followed in obtaining approval for maintenance dredging, including management responsibilities. Background information relating to the identification of suitable disposal strategies has been presented from historical studies. Roles and responsibilities of the TACC are outlined and a process of involvement tabled. The LTMP also outlines the predicted volumes of maintenance dredging material and describes the processes by which dredging and disposal will be carried out. Existing environmental conditions, significant species, and habitats of concern are also described from a range of specific studies undertaken for FNQPC over many years. Analysis of potential impacts associated with maintenance dredging and disposal has been completed, and a series of management strategies developed, from which potentially significant impacts to the marine environment can be monitored and managed. The relevant components of the LTMP and relevant document section(s) are indicated in **Table 1-2**.

It is important to note that the 2010-2020 LTMP takes a revised approach to monitoring, and as such presents a rationalized program based on the results from recent studies. The processes of continuous improvement, reporting and contingency management make provision for additional studies to be undertaken, as and where appropriate, to ensure effective management control of maintenance dredging and disposal activities.

Table 1-2 Coverage of the LTMP

Components of a LTMP	Section
Management framework and implementation of the LTMP, including regulatory framework, approvals requirements and role of the TACC.	2
History of dredging and disposal	3.1
Describe the maintenance dredging and disposal proposal for the term of the permit (locations, schedule, equipment etc.)	3.2
Review of disposal options, including minimising dredging and reducing contamination.	3.3
Define conditions of the material for disposal	4
Describe the existing environment, including physical processes, water quality, biota and management areas	5
Potential impacts of the dredge and disposal operation, defining both short and long-term impacts and uncertainties.	6
Management strategies and actions, responsibilities for the ongoing management of maintenance dredging	7
Program to monitor potential impacts and the effectiveness of the management strategies and actions.	7.10

2. MANAGEMENT FRAMEWORK

2.1 Approvals

Dredging and disposal activities conducted at Cairns Port are managed through a series of Commonwealth and State approvals, and depending on whom the proponent is (FNQPC or specific tenants), various approval and management instruments apply.

FNQPC maintains a Sea Dumping Permit issued by the Great Barrier Reef Marine Park Authority pursuant to the *Environment Protection (Sea Dumping) Act* 1981, the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC), the *Great Barrier Reef Marine Park Act* 1975 (Commonwealth) and the *Marine Parks Act* 2004 (Queensland) to load and dump spoil arising from maintenance dredging, at a designated spoil disposal site. This permit is a long term approval granted after development of a Long Term Management Plan for dredging and disposal, and formation of the Cairns Port Technical Advisory Consultative Committee (TACC) which includes various port users and Commonwealth and State agency representatives. Copy of permit provided in Appendix 1. The disposal site is located in a circular area of one nautical mile in diameter, centred on Latitude 16°47'24"S and Longitude 145°48'48"E. The area is located within Port Limits and also within the General Use zone of the GBRMP. Unconfined disposal is currently practised. The permit also allows contingency loading and dumping in response to a rapid loss of navigable depth resulting from a catastrophic event such as a cyclone or flood.

Previously, FNQPC has operated under the Queensland *Transport Infrastructure Act 1994*, which specifies that the port authority maintains a safe entrance channel and navigable port. Complementing this have been specific approvals for defined areas or projects, such as the ERA 19 for dredging issued under the Queensland *Environment Protection Act* 1994 for projects where FNQPC acts as a dredging contractor and receives payment (i.e. HMAS Cairns Navy Base dredging). With recent changes to the *Environment Protection Regulation 2008*, port authority's now must obtain an ERA 16 Extractive or Screening Activities, even where they were previously exempt from ERA 19 under the *Transport Infrastructure Act 1994*. The ERA 16 is relevant only to maintenance dredging activities at the port. Capital dredging activities require separate approval.

Approvals under the *Fisheries Act 1994* are held for disturbance to potential marine plants within the dredge areas, as ephemeral patches of sparse seagrass have been recorded in the channel dredge area, and in the vicinity of the spoil ground. Detail of the permit area is provided in Appendix 2.

Various components of the process require approval by regulatory agencies and certain documents require approval to meet conditions of the various permits or licences. **Table 2-1** outlines graphically the various dredging activities and management responsibilities.

Table 2-1 Management responsibilities matrix - Cairns Port Maintenance Dredging and Spoil Disposal Activities

		Ocean Disposal Site = Spoil Ground	Outer Channel	Inner Port	Marinas	Navy Base	Smiths Creek waterfront lots or Capital Projects
Applicable Legislation	*Environment Protection (Sea Dumping Act) 1981*	Sea Dumping Act Approval					Application to GBRMPA for approval to dispose to Spoil Ground required for each new/specific project
	Great Barrier Reef Marine Park Act 1975	Marine Park Permit 10 year Permit, 2010-2020.					
	Environmental Protection Act 1994	Development Approval and Registration Certificate required under SPAct for ERA 16 Extractive or Screening Activity for maintenance of approved Port Areas as per Plan appended to approval.					Development Approval under SP Act for specific projects if outside scope of ERA16 DA
	Fisheries Act 1994	Marine Plant disturbance- Development Approval (2006CA0478; ongoing) and Code MP02 (ongoing).					Development Approval under SP Act for specific projects if marine plants disturbed or Lot is adjacent to FHA
	Coastal Protection and Management Act 1995						Development Approval under SP Act for specific projects if other than maintenance
Management Documents	Environmental Management System (**EMS**)	**FNQPC Environmental Management System** – overarching system for operational control includes; Permits and Licences – organisations system for compliance Incidents and Near Miss Management System – respond, record, report system for environmental events Environmental Assurance Program – facility, asset, and lease inspection regime – Site Based Management Plans Development and Maintenance Projects – specific Construction or Maintenance EMP's, work methods, audits & inspections					
	Long Term Management Plan (**LTMP**)	For management of Dredging and Spoil Disposal at Port of Cairns Developed for acceptance by TACC and approval by GBRMPA - includes SAP and Marine Pest components					
	Sediment Sampling and Analysis Plan (**SAP**)	Sampling design and methodology Submitted to GBRMPA for approval prior to implementation of sampling & dredging					Project/Site Specific SAP to inform disposal options and subsequent approval requirements
	Environmental Management Plans (**EMP**)	Port of Cairns EMP (* proposed for development)					
				FNQPC dredging - ***"Willunga"* EMP**			Project specific EMP – submitted to support Development Approval application.
		Entrance Channel dredging by TSHD e.g. ***"Brisbane"* EMP** – by appointed contractor – reviewed/accepted by PN and provided to TACC					
	Hydrographic Survey Plans	Define dredging requirement/schedule and verify dredging extent within design footprint					
		Post disposal	3 monthly plus during dredging	3 monthly routine plus Pre and Post	3 monthly routine plus Pre and Post	Pre and Post Alternate between inner and outer	As required by project
Ecological Health Monitoring	Water			Trinity Inlet Water Quality Monitoring Program			EMP based program – if triggered by SAP results or location/ scale of works
	Sediment	Sediment Analysis Plan – each area prior to scheduled dredging					Project specific risk based assessment to identify need for SAP
	Marine Pests	Port Marine Pests Settlement Program SAP- Marine Pest survey per dredge area- pre dredge					Project specific risk based assessment to identify need for survey
	Seagrass	Long Term Cairns Harbour and Trinity Inlet Seagrass Monitoring Program					Site specific if in/adjacent to or if predicted to impact seagrass habitat
	Benthic Flora and Fauna	Ocean Disposal Site Benthic Survey – 2009, 2014 and 2019					If required following EIS phase of project approval
Recording and Reporting	Water Quality	FNQPC Environment section database					EMP component – if required
	Sediment	Sediment Analysis Plan Reports – and FNQPC Environment section database					Specific SAP Report to support Development Approval application
	Marine Pests	Post-dredging survey and included in ODS Flora and Fauna Survey 2009, 2014, 2019	Sediment Analysis Report –pre dredge per area (if required)				As part of project specific SAP Reporting
	Seagrass	Circulation of DPI&F and DEEDI's Publication Series					Project EIS report if required
	Flora and Fauna	Ocean Disposal Site benthic infauna study (2014 & 2019) provided to TACC and GBRMPA					Project EIS report if required
	Hydrographic Surveys	Hydrographic data – reported to Navy and GBRMPA	Pre-and post-dredging surveys – FNQPC Survey Plan Register				Pre-and post-dredging surveys – FNQPC Survey Plan Register

Agency interests:

DERM	GBRMPA	FNQPC	DEEDI - FQ	TACC (Technical Advisory Consultative Committee) includes GBRMPA, DEEDI, DERM, plus stakeholders)	Port Ecological Health Monitoring Program

2.2 Technical Advisory Consultative Committee

As required under the NAGD (Commonwealth of Australia, 2009), formation of a Technical Advisory Consultative Committee (TACC) is mandatory to meet an application for a long term maintenance dredging Sea Dumping Permit, and approval of a LTMP. The objectives of the TACC are to assist informing the Determining Authority (in this case GBRMPA) and the proponent (FNQPC) in protecting the environment, and maintaining user interests within the study area.

A TACC was initially established during the consultation phase on the channel widening campaign in 1990, and again in 2004 to review and inform the existing LTMP and existing Permit process. TACC meetings are held at least once annually, and prior to the major dredging component, which has typically occurred around August at the time of the main campaign in the Port by the *Brisbane* dredge.

Membership organisations include those presently involved in the existing TACC for the Port, namely GBRMPA, FNQPC, state and local government, industry associations, traditional owners and community interest groups. Invitee list for TACC meetings during the past permit period included:

- Far North Queensland Ports Corporation - Ports North;
- Cairns Port Advisory Group;
- Great Barrier Reef Marine Park Authority;
- Incitec Pivot;
- Cairns and Far North Environment Centre;
- Queensland Primary Industries & Fisheries;
- Dept. Environment and Resource Management;
- Cairns Regional Council;
- North Queensland Land Council;
- Tourism Tropical North Queensland;
- Maritime Safety Queensland;
- Fuel Companies;
- Mulgrave Mill;
- Sunfish NQ; and
- Department of Environment, Water, Heritage and the Arts.

Representation has been made by most groups on a regularly basis with the exception of DEWHA, CAFNEC, NQLC and fishing sector. Through development of this LTMP and the 2010 TACC meeting a need for inclusion of representation from the fishing sector was identified, and an invitation

extended by the TACC for a representative from the Cairns Local Marine Advisory Committee (LMAC) to attend future TACC meetings, as this local committee facilitated by GBRMPA includes a central contact point for commercial and recreational fishing groups as well as other users with interest in local marine issues.

As described within the NAGD (Commonwealth of Australia, 2009), the TACC is intended to:

- provide continuity of direction and effort in protecting the local environment;
- aid communication between stakeholders and provide a forum where points of view can be discussed and conflicts resolved;
- assist in the establishment, as appropriate, of longer term permitting arrangements, including reviewing the development and implementation of Sampling and Analysis Plans, Long Term Management Plans and research and monitoring programs;
- review ongoing management of dredging and dumping activities in accordance with these Guidelines and permitting arrangements, and
- make recommendations to the proponent and the Determining Authority as necessary or appropriate.

The Cairns TACC is facilitated by a chairperson nominated by FNQPC and the GBRMPA from within the committee. During 2006, the chairman of the Cairns Port Advisory Group was selected and holds this position until such time as a need for reselection arises. During the six TACC meetings convened since 2004 the issues of discussion have centred on outcomes of environmental monitoring programs, and planned dredging schedule with no issues identified that are of significant concern or have required detailed technical resolution by the TACC.

2.3 Existing Approvals and Conditions

Previously, annual maintenance dredging was undertaken under a 5 year Marine Parks Permit, following the approvals conditions outlined within Permit G05/13116.1 and with prior approval of annual sediment sampling and analysis plans and sediment characterisation reports.

The permit allowed for dredging and sea dumping up to 2,100,000 dry solid tonnes of dredge spoil, being:

- a maximum of 350,000 dry solid tonnes of spoil per annum arising from maintenance dredging of Cairns harbour and the Cairns harbour channel; and
- a maximum of 350,000 dry solid tonnes of spoil arising from the dredging of Cairns harbour and Cairns harbour channel as a result of one catastrophic event such as a flood or cyclone (contingency dumping).

Dredging was subject to terms and conditions specified in the permit.

3. DREDGING AND DISPOSAL

The NADG (Commonwealth of Australia, 2009) requires a proponent to define within their permit applications the estimated volumes of dredge material, as well as the proposed methods of dredging and disposal. Information regarding the location of dredging and disposal and timing/schedule of activities is also required. The following sections detail these requirements.

3.1 History of Dredging and Disposal Works

3.1.1 Capital Dredging

Following the ports declaration in 1876, the first capital dredging works were undertaken within the access channel and berths by *The Platypus* dredge in 1887. Unable to keep-up with the task of maintaining required depths, the *Trinity Bay* dredge took up operations from 1913, deepening the channel and increasing its width to 45m by 1929. By the early 1940s the channel had been widened progressively to 60m. During the 1970s a dredging contractor undertook a further widening of the channel (75m) and deepened the entrance to 8.2m. The *Sir Thomas Hiley* dredge replaced the *Trinity Bay* dredge during the early 1970s, and conducted the most recent capital dredging expansion during 1990, widening the channel to 90m and a design depth of 8.3m.

3.1.2 Maintenance Dredging

Maintenance dredging operations have been an ongoing annual requirement at Cairns port, since it was developed over a hundred years ago. FNQPC is required under the *Transport Infrastructure Act 1994* to maintain navigable depths within the port navigation areas. A trailer cutter suction dredge (TSHD Brisbane in recent years) and clam shell dredger, the *Willunga,* undertake annual maintenance dredging at Cairns Port. The Outer Channel is dredged using a trailing suction hopper dredge, and Inner Port (wharf areas) may also be dredged by this method if water depth is appropriate and the ship can be manoeuvred. Other areas where access is an issue are dredged by the *Willunga*.

FNQPC undertakes routine maintenance dredging operations generally within three separate campaigns that differ in dredging volumes, frequency and dredging plant. These separate campaigns are listed and described in more detail below.

- Outer and inner shipping channel and associated swing basins;
- Inner port (main wharves 1-12), Marlin Marina, CFB1 and CFB2; and
- HMAS Cairns Navy Base.

3.1.3 Outer and Inner Shipping Channel and Associated Swing Basins

The outer channel accessing Cairns Seaport is approximately 11.2 km in length, 90 m wide and has a maintained depth of 8.3 m at Lowest Astronomical Tide (LAT). The inner port shipping channel extends for approximately another 2.4 km in length, has a similar maintained depth to the outer channel and has variable width due to the presence of two swing basins.

The accumulated sediments in this channel range typically from fine silts to sands. Some areas within the outer channel (near the bend) are subject to scour and have stiff clay substrates that don't require dredging as the area is not subject to accretion of sediments.

Dredging of the outer and inner shipping channel and swing basins areas is undertaken annually by a trailing suction hopper dredge (TSHD *Brisbane* in recent years). Dredging by the TSHD in the inner shipping channel and swing basins are minimal apart from occasional dredging adjacent to the Main Wharf areas, from which material from the berth pockets can be dragged using a bar leveller. Approximately 220,000 m^3 – 460,000 m^3 is dredged annually by the TSHD. This dredging usually takes approximately three weeks to complete. Dredged material is placed at the approved spoil ground following approval by the Determining Authority.

3.1.4 Inner Port (Main Wharves 1-12), Marlin Marina, CFB1 and CFB2

Maintenance dredging of the inner port (including main wharves 1-12), Marlin Marina, Commercial Fishing Bases 1 and 2 takes place throughout the year. CFB1 has minimal dredging requirement past the -3.5 m (LAT) contour at the outer edged of the marina. CFB2 has no significant dredge requirement for the outer berths, with most dredging concentrated in the inner part.

Dredging operations are undertaken by FNQPCs' dredge '*Willunga*' and two hopper bottom barges. A conservative estimate of 13,500 m^3 of material is dredged from the main wharf area; 16,750 m^3 from Marlin Marina; 9,600 m^3 from CFB1; and 6,400 m^3 from CFB2.

Dredged material is placed at the approved spoil ground following approval by the relevant regulatory agencies.

Accumulated sediments in these areas are typically fine silty clay due to low energy conditions suitable for accretion of the fine fraction sediments under suspension within the inner port area.

3.1.5 HMAS Cairns Navy Base

HMAS Cairns Navy Base is dredged on a contractual basis alternating between inner and outer berth areas on an annual rotation. This area is dredged using the '*Willunga'* bucket grab dredge and two hopper bottom barges. A conservative estimate of 25,000 m^3 of material is dredged from the inner berth and 12,500 m^3 is dredged from the outer berth when rotational dredging operations are undertaken.

Dredged material is placed at the approved spoil ground following approval by the relevant regulatory agencies.

3.1.6 Historical Dredging Volumes

Table 3-1 outlines actual dredge volumes recorded for the period 1973-2008. Also noted is the estimated dry load weight and disposal location (note that three separate disposal locations have been used for material disposal at the Port of Cairns over this period).

Volumes of material dredged from the outer channel and inner port and dredge areas since 1989 are presented in **Figure 3-1** and demonstrate the vastly greater volumes dredged in the outer channel.

Table 3-1 Historical dredge quantities

Year	Dredge	Wet Load (m^3)	Dry Load (t)	Spoil Ground
1973	*SirThomas Hiley*	381,400	280,590	S16°49'24" E145°48'05"
1974	*SirThomas Hiley*	397,800	298,300	As above
1975	*SirThomas Hiley*	209,050	182,460	As above
1976	*SirThomas Hiley*	277,400	236,820	As above
1977	*SirThomas Hiley*	715,100	538,090	As above
1978	*SirThomas Hiley*	381,550	290,210	S16°48'12" E145°48'00"
1979	*SirThomas Hiley*	704,200	433,800	As above
1980	*SirThomas Hiley*	423,600	325,990	As above
1981	*SirThomas Hiley*	467,100	341,830	As above
1982	*SirThomas Hiley*	397,300	295,550	As above
1983	*SirThomas Hiley*	549,250	388,890	As above
1984	*SirThomas Hiley*	379,700	276,030	As above
1985	*SirThomas Hiley*	370,950	268,820	As above
1986	*SirThomas Hiley*	452,900	353,480	As above
1987	*SirThomas Hiley*	303,500	194,210	As above
1988	*SirThomas Hiley*	516,800	330,300	As above
1989	*SirThomas Hiley*	645,000	334,200	As above
1990	*SirThomas Hiley*	1,515,350	824,590	As above
1991	*SirThomas Hiley*	770,000	491,540	S16°47'24" E145°48'48"
1992	*SirThomas Hiley*	666,300	392,960	As above

Year	Dredge	Wet Load (m^3)	Dry Load (t)	Spoil Ground
1993	*SirThomas Hiley*	610,000	360,360	As above
1994	*SirThomas Hiley*	477,500	287,790	As above
1995	*SirThomas Hiley*	554,550	367,930	As above
1996	*SirThomas Hiley*	427,500	250,450	As above
1997	*SirThomas Hiley*	527,500	312,110	As above
1998	*SirThomas Hiley*	432,500	269,050	As above
1999	*SirThomas Hiley*	390,000	227,700	As above
2000	*SirThomas Hiley*	365,000	223,720	As above
2001	*Brisbane*	752,270	341,945	As above
2002	*Brisbane*	927,939	298,484	As above
2003	*Brisbane*	757,900	201,663	As above
2004	*Brisbane*	965,229	675,660	As above
	Willunga	57,285	40,100	
2005	*Brisbane*	655,045	458,532	As above
	Willunga	35,845	25,092	
2006	*Brisbane*	585,754	410,028	As above
	Willunga	34,840	24,388	
2007	*Brisbane*	466,098	326,269	As above
	Willunga	38525	26,968	
2008	Brisbane	438,182	306,727	As above
	Willunga	51590	36,113	
2009	Brisbane	*600,000	*420,000	As Above
	Willunga	*55,000	*38,500	

Notes:
#1 Figures from Connell Wagner (1992)
#2 Capital dredge works (extended channel width to 90m)
#3 Wet load (m^3) includes water from dredger. Dry weight (tons) calculated using a conversion factor of 0.700.
*estimate of quantity based on works completed, and initial survey understanding for 2009.

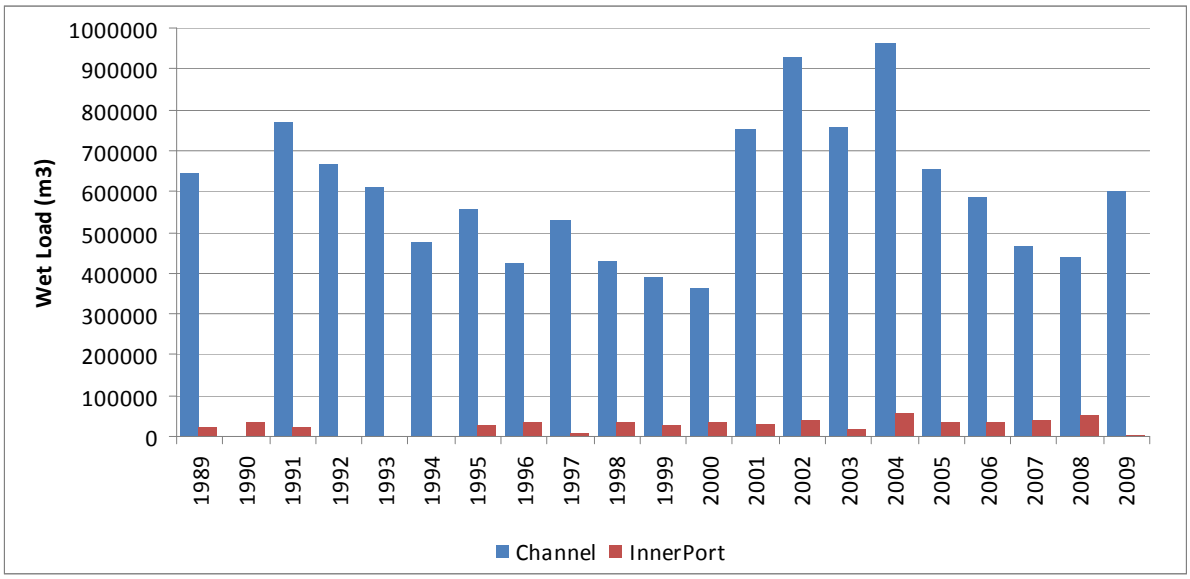


Figure 3-1 Volumes of material dredged from Outer Channel versus Inner Port dredge areas

3.2 Dredging Requirements 2010-2020

The required annual maintenance dredging requirements for Cairns Port during the 2010-2020 long term permit period are provided in **Table 3-3** and **Table 3-2**. The annual requirements for respective areas (refer **Figure 3-3**) are consistent with those of the 2005-2010 Sea Dumping / Marine Parks Permit. Whilst routine annual maintenance dredging is largely a function of prevailing sediment movement and hydrodynamics, periodic events such as cyclones and floods can significantly alter annual dredge estimates. For this reason a separate contingency volume provision has been outlined for dredging following cyclone and flood events in **Table 3-2**.

The required dredge volumes are considered to be relatively reliable estimates of requirements based on comparison of dredge volumes versus predicted volumes in the 2005-2010 long term dredging Sea Dumping / Marine Parks Permit and management plan (LTDSDMP) (refer **Figure 3-2**).

Table 3-2 Estimated spoil disposal quantities under 10 year LTMP (2010-2020)

Operational case	Dry Load (t)	Wet Load (m^3)
Average of maintenance dredging	350,000	550,000
Contingency dredging provision– allow additional annual maintenance dredging volume twice within 10 year LTMP period.	700,000	1,100,000
Total requirement for 10 year permit duration	**4,200,000**	**6,600,000**

Table 3-3 Typical annual routine maintenance dredging needs and characteristics for dredging areas within Cairns Port

Dredge Areas	Dry Solid Tonnes (t)	Wet Load Dredging Volume (m^3)	Dredge Name	Dredge Type	Design Depth of Dredge Area (m LAT)
Outer channel	157,500 – 332,500	225,000 – 475,000	TSHD	Trailing Arm Suction Hopper Dredge	8.3
Inner Port (main wharves, inner shipping channel and swing basins)	9,450	13,500	TSHD	Trailing Arm Suction Hopper Dredge	8.3
			Willunga	Bucket Grab Dredge	8.4 – 10.5
Marlin Marina (MM)	11,900	17,000	*Willunga*	Bucket Grab Dredge	2.5
HMAS Cairns Navy Base (NB)	17,500 8,750	25,000 inner berth 12,500 outer berth	*Willunga*	Bucket Grab Dredge	2.5 – 4.5
Commercial Fishing Base 1 (CFB1)	7,000	10,000	*Willunga*	Bucket Grab Dredge	3.5
Commercial Fishing Base 2 (CFB2)	7,000	10,000	*Willunga*	Bucket Grab Dredge	3.5
Approximate Total	**219,100 – 385,000**	**300,000 – 550,000**			

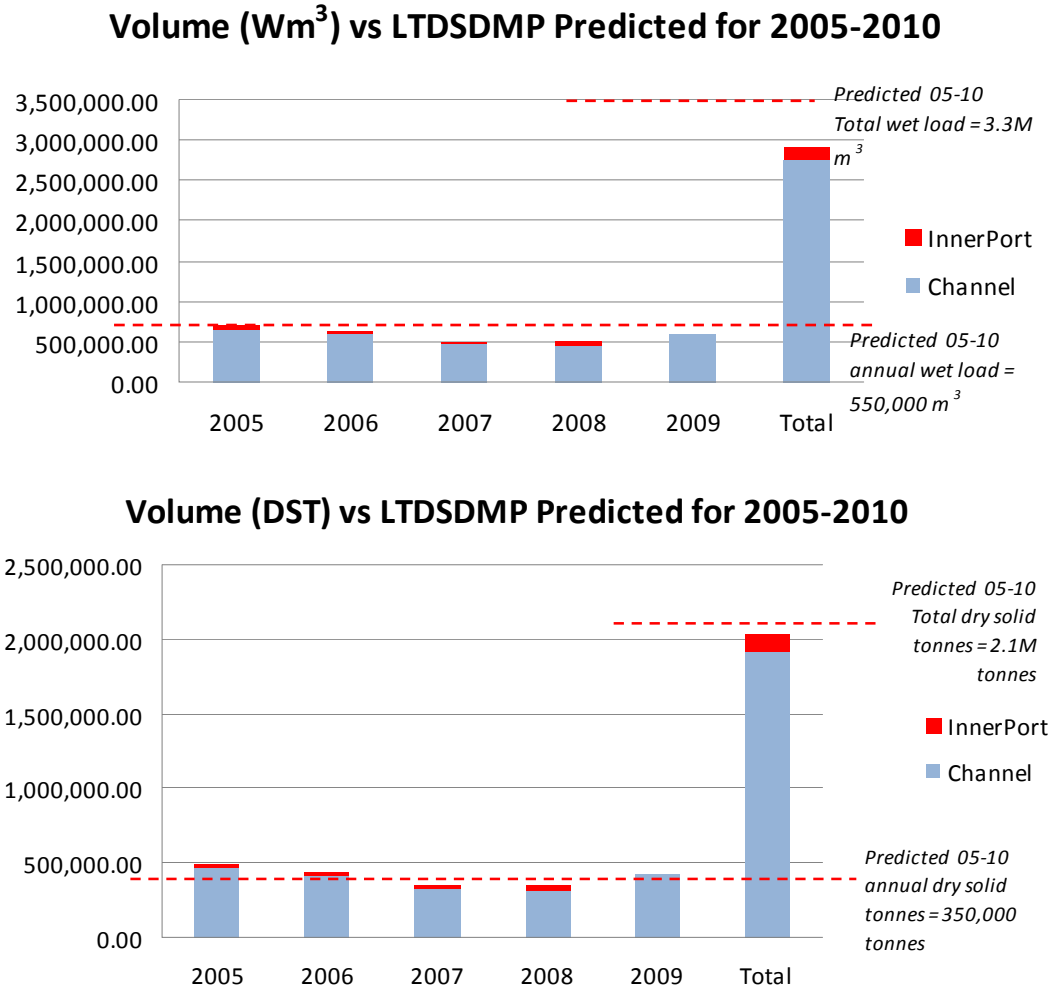
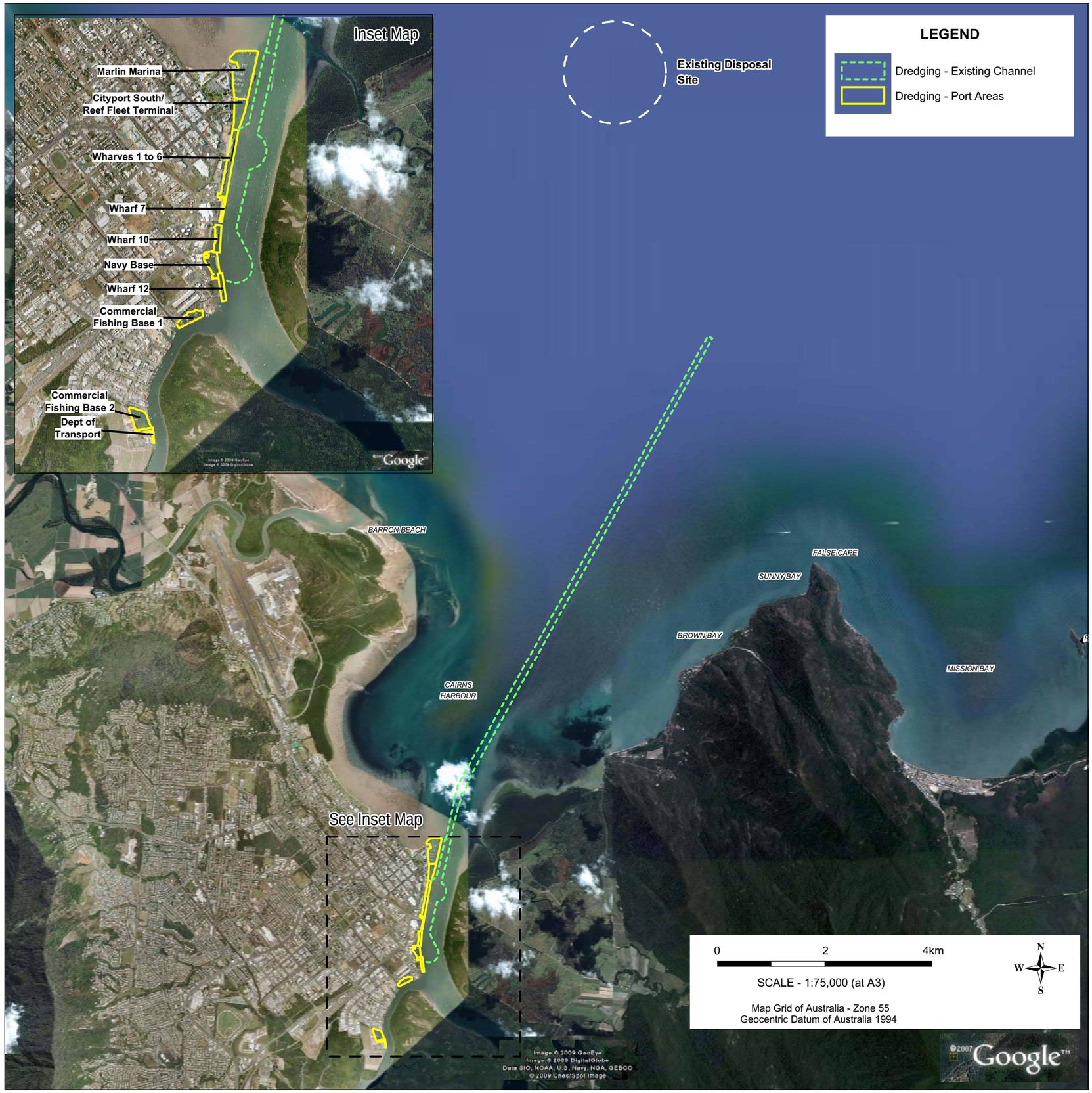


Figure 3-2 Annual and cumulative dredged volume (top; wet load m^3) and weight (bottom; calculated dry load solid tonne) versus those permitted in the Sea Dumpint Permit and LTDSDMP 2005-2010

Evaluation of the actual dredging activity and associated spoil disposal activity over the past five years indicates the estimates made in the preparation of the previous permit application were accurate, with average and subsequently the total of spoil disposed to the Cairns dump ground being within the volumes permitted under Marine Parks Permit G05/13116.1 between 2005 and 2010.

There have been no major weather events affecting the catchment sufficient in scale to give rise to a need for disposal of spoil as a contingency campaign during the 2005 to 2010 period.



Port facility layout based on data provided by CairnsPorts 13/10/2009
Google Earth imagery extracted 14/10/2009

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
B	15/10/2009	Issued for client review	KM	DH	JK	
A	14/10/2009	Issued for squad check	KM	WT		

WorleyParsons
resources & energy

Far North Queensland Ports Corporation Limited

FAR NORTH QUEENSLAND PORTS CORPORATION

PORT OF CAIRNS LONG TERM MANAGEMENT PLAN
Figure 3.3 Location of dredge and disposal areas within Cairns Port

Project No: 301001-00680	Figure: 00680-00-EN-DAL-0002	Rev: B

Compiled by BRISBANE INFRASTRUCTURE GIS SECTION

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3.2.1 Dredge Methods

TRAILING SUCTION HOPPER DREDGE

Based on the dredging methods of the TSHD *Brisbane*, the following methods are typical. It is recognised though that other TSHDs may be used for dredging, but the specifications and operations of the *Brisbane* dredge form a baseline for dredge specification and operational environmental management.

Material to be dredged is removed through two suction heads, which are lowered into position on either side of the vessel. As the vessel steams slowly at around 1 – 3 knots, large pumps draw water through the heads, which entrain the sediment and transport the water/sediment mixture aboard into a central collection hopper. Each extraction run takes approximately 1 hour to complete within about a 3 hour dredge cycle. Whilst the suction heads are fitted with high-pressure water jets, which can be used to agitate consolidated sediment, they are rarely required for maintenance dredging. They are, however, used when the head is being lifted, if turtles are in the area, to discourage them from the suction zone.

The sediment/water mix ratio of material delivered to the central hopper of the *Brisbane* dredge is typically quite low. Whilst it varies depending on the type of sediment being dredged, the sediment concentration is generally in the order of 10 – 30 % solids. To maximise dredge spoil capacity, these large volumes of water are managed using a central column weir, which is incorporated into the hopper. This arrangement allows excess water to decant from the sediment and overflow to discharge. Overflow only toward the very end of the dredging run as the hopper nears capacity (typically the last ten minutes of a one hour dredging run). The capacity of the hopper is dependent on the sediment type – with volumes (including both sediment and water) approximating 2,800 m^3 for fine silts and 1,700 m^3 for sands (of a maximum hopper capacity of 2,900 m^3). Considering that more water is held in the silt matrix than sands, the dry weight cubic metres of sand able to be practically collected in each load is therefore generally greater than that in silts.

Once the dredge has filled its hopper with dredged material from the channel, the vessel will then relocate the material to the designated spoil ground. Upon entering the designated area for dumping, the dredge would typically slow whilst material is being placed, however, a minimum steaming speed is required to maximise agitation within the hopper and clear dredged material, which would not otherwise be effected if the dredge were to remain stationary. Spoil is discharged below keel level to minimise turbidity generation.

Each spoil placement is logged using both satellite navigation and standard bridge equipment, and is electronically fixed using a differentially corrected global positioning system (GPS). The electronic track plot marks the start of the placement process (hopper open), and the end of the process (hopper closed). This track usually shows an arc, which the dredge follows to ensure that all dredged material is placed within the designated spoil ground boundary. The time taken to place material over the spoil ground is typically about 15 minutes out of the 3 hour dredge cycle.

During the dredging works, electronic logs of each spoil dump event will be maintained. At the completion of each dredge campaign, these logs will be reported to the relevant government agencies to demonstrate compliance with permit conditions.

TSHDs undertaking dredging works at the Port of Cairns will include the following minimum specifications to minimise environmental impact from dredging and disposal:

- Central weir discharge system;
- Below keel discharge point;
- Low wash hull design; and
- Electronic positioning system.

An Environmental Management Plan (EMP) is developed as a requirement of the dredging contract by the appointed contractor, reviewed by FNQPC to ensure consistency with the LTMP and Determining Authority's requirements prior to implementation for each of the main maintenance dredging campaigns. This EMP document is the administrative mechanism for implementation of operational controls and management action requirements set out within this LTMP (refer to **Section 7**). The dredge dumping procedures, any associated monitoring arrangements and corrective actions are incorporated into the EMP. Implementation of the EMP is audited by FNQPC environmental staff and may also be audited by the Determining Authority under permit conditions.

GRAB-BUCKET DREDGE (WILLUNGA)

Routine maintenance dredging of the main wharves (1-12), marina areas and HMAS Cairns Navy Base is undertaken using the grab-bucket dredge '*Willunga'* and two hopper bottom barges (GHT 22 and AD 501 and Punt number 1). The *Willunga* is a Priestman 625 Dredge on a 24.8m x 8.96m barge fitted with optional bucket grabs (2.2 m^3 silt bucket, or 1.9 m^3 mud bucket). The *Willunga* and barges are owned and operated by FNQPC and normally operate only during normal port daylight working hours. Typically, only two dredge cycles occur per day.

At the completion of grab-bucket dredging, bar levelling is typically undertaken to provide a more uniform bed profile. Bar levelling may also be undertaken within other port areas to maintain navigable depth or to move material within a dredge area to make it accessible by other dredging plant such as a THSD.

An EMP for dredging using the *Willunga* was developed by CPA in 1995 and has been revised to reflect present dredging operations and changes to the various legislative requirements. The most recent update of the EMP reflects the requirements of the changes to the *Environmental Protection Regulation 2008* and addresses conditions for the ERA 16 Extractive and Screening Activities approval. This EMP is to be revised to reflect the specifics of each of the maintenance dredging campaigns by FNQPC and distributed to the respective Determining Authorities for an initial review and then re-consideration as changes arise over the term of the LTMP. This EMP document is the

administrative mechanism for implementation of operational controls and management action requirements set out within this LTMP (**Section 7**).

Figure 3-4 Photograph of the grab bucket dredge *Willunga* loading a hopper bottom barge

3.2.2 Proposed Dredge Schedule

Routine Annual Maintenance dredging

The vast bulk of routine annual maintenance dredging (~90%) is completed within the entrance channel by a trailing suction hopper dredge during a 2 - 4 week period. The timing of routine maintenance dredging will depend on the schedule of the vessel and contract timing.

In recent years, the trailing suction hopper dredge used was the *Brisbane*, which services a number of ports around the Queensland coast. Dredging in Cairns Port is dependent on its dredging schedule but typically occurs around August.

Dredging works undertaken by the '*Willunga*' form part of standard port operations, with the dredge accessing areas on an 'as available' basis.

CONTINGENCY DREDGING

The passage of cyclones/severe storms and flooding events has the potential to reduce navigable depths within the Port over a very short period of time. As such, the FNQPC has no control over the extent or timing of such events and hence the timing or duration of necessary dredging to re-establish port operability and navigability.

An allowance for two contingency dredging events during the 10 year life of the LTMP has been included in the required dredging volume estimates (refer **Section 3.2**). However, it is possible that further contingency dredging may be required if the occurrence is more frequent than anticipated. In that situation, further application would be made to the Determining Authority for additional contingency dredging works.

Advice to the Determining Authority regarding the need for contingency dredging would be provided in writing. Utilisation of the additional amount would require prior written approval from the Determining Authority.

3.2.3 Future Dredge Requirements

Requirements for maintenance dredging are considered to remain constant as per the section above. Requirements for any future capital dredging are considered minimal; however some works may be required during the Cityport South works and as a result of consolidation of activities in Smiths Creek. Any such works are likely to require an approvals process and environment impact assessment which may give rise to additional specific applications for capital dredging and associated disposal.

NOTE: Discussion on future dredging requirements is provided for information only and does not form a component of the 2010-2020 LTMP for maintenance dredging or the long-term sea dumping.

3.3 Waste Prevention

The NAGD requires that a waste prevention audit be undertaken to identify opportunities for preventing or minimising pollution and any future sediment contamination. The audit should evaluate the following:

- The types, amounts and relative hazard of wastes generated;
- The waste sources; and
- The feasibility of waste reduction and prevention techniques.

The NAGD identifies that for dredged material, the audit should focus on identifying and managing controllable sources of contamination, such as port loading and unloading activities.

Bulk loading and unloading of three commodities occurs at the Port of Cairns – fuel, sugar and fertiliser. No mineral concentrates or other potential liquid or particulate contaminants are handled across the wharves. The Port operator is responsible for general environmental management of leases, tenants and common users on strategic port land within the scope of FNQPCs' legislative

responsibilities under the *Transport Infrastructure Act 1994* and the terms of respective lease, and use agreements. Conditions within each lease or agreement outline specific environmental clauses, including a requirement to hold and maintain all relevant environmental approvals from respective administering agencies.

Operators on port land may conduct activities that meet the criteria of Environmentally Relevant Activities (ERA) listed under Schedule 2 of the *Environmental Protection Regulation 2008*. Management of those activities is the responsibility of the Department of Environment and Resource Management (DERM), or for certain devolved activities, the local Cairns Regional Council. The most prevalent ERA's are for Boat Maintaining Repair Facilities, Abrasive Blasting, Surface Coating, Motor Repair Workshops and Fuel Storage. Bulk handling and Load-Unload ERA approvals are held by operators for the sugar, fuel and fertiliser activities. FNQPC does not conduct any of the loading/unloading activities, nor ERA activities likely to contribute contaminants or waste to the port environment.

A key component of the Environmental Management System maintained by FNQPC, to ensure actions by others on port land, not under direct operational control is suitably managed, is the Environmental Assurance Program (EAP). The EAP focuses on a series of regular inspections, reports and improvement plans to guide operators toward improved site based management. The main requirement on long term or established operators at leased sites is development and implementation of a site based operational environmental management plan, including a detailed stormwater management plan.

FNQPC therefore has a landlord role in managing the relationship between lessee, tenants and common users, and the administering authorities (DERM and CRC),which have specific legislative responsibilities for management of compliance of above mentioned lessees / users with the *Environmental Protection Act 1994* and *Environmental Protection Regulation 2008*. These other agencies hold responsibility for management of operator's compliance with licence and approval conditions, including those that cause or have potential to cause discharge of contaminants or waste to Trinity Inlet and ultimately to proposed dredge spoil.

Several tenants have Transitional Environmental Management Programs in place for capital expenditure on site improvements, remedial actions or implementation of environmental improvement initiatives.

Significant loads of contaminants and waste arise from urban storm water and sewage treatment plants in the Cairns area, distant to and outside the control of the FNQPC. These urban stormwater inputs are subject to the environmental controls in place by the Cairns Regional Council. Recent initiatives, which are predicted to improve the quality of waters and sediments within Trinity Inlet, include the completion of Clean Seas initiative upgrades from secondary to tertiary sewage treatment, and roll out of the Barron Trinity Inlet Water Quality Improvement Plan as part of the State "Reef Rescue Plan" initiatives.

As outlined above, FNQPC has minimal operational activities with potential to contribute to contaminant / waste concentrations in proposed dredge spoil, with contaminant loads originating

primarily from point source and diffuse discharges from numerous other stakeholders within the catchment. Consistent with the process outlined in **Section 7**, sediment contaminant concentrations are monitored by FNQPC and details are provided to the Determining Authority prior to approval being granted to FNQPC to undertake dredging and sea dumping.

3.4 Disposal Options Review

Connell Wagner completed detailed spoil disposal and dredge option studies between 1990 and 1992 (Connell Wagner 1990 and Connell Wagner 1992). A thorough review of these disposal options and predictions on the longevity of sea disposal at the present spoil ground was prepared by Environment North (2005) in the 2005 LTDSDMP. In summary, the Connell Wagner investigations provided an evaluation of spoil disposal options both on and off-shore. Spoil reuse was considered, but the quality of the material failed suitability tests for agricultural or other purposes. Of the 20 sites considered for disposal, only one terrestrial (T5) and three marine sites (M1-M3) were recommended for additional consideration. Marine disposal was recommended over terrestrial disposal, with the terrestrial site ultimately being lost to a Government supported acid sulphate soil rehabilitation project in 1994. Marine disposal has been undertaken within the M1/M2/M3 areas since 1991.

The Regional Coastal Management Plan for the study region specifically notes that due to strong urbanisation of the coastal areas around Cairns, suitable land for on-shore disposal is limited or not available. The Regional Coastal Management Plan further defines that the continued disposal of dredge material at sea is supported where full consideration of environmental factors has been undertaken (i.e. contamination assessments) and the placement is consistent with the requirements outlined within the NADG (Commonwealth of Australia, 2009).

GHD (2000) completed a specific spoil disposal assessment as part of a review of options for disposal of dredge material from HMAS Cairns Navy Base. The results of their investigation concluded that while land disposal options did exist, the most cost effective, efficient and long-term management solution, remained unconfined ocean disposal. Environment North (2005) recommended that further contemplation of dredge spoil for land disposal or reuse is not warranted.

The following key points are considered relevant in support of continued dredging and sea disposal at the Cairns Port and reflect to those considered previously (GHD 2000, Connell Wagner, 1990 and 1992):

- Cairns requires a Port for economic well-being and trade opportunities;
- The port and surrounds have no need for reclamation and the material is considered to be of poor quality as a fill material due to the high percentage of fine sediments;
- No practical alternative to the present Port exist, either regionally or locally;
- Natural water depth would rapidly preclude trading vessels from utilising the Port without regular maintenance dredging;
- Cairns Port is located in a naturally occurring zone of accretion;

- Dredge quantities cannot be reduced without reducing required channel and berthing dimensions. Such action would reduce serviceability of the Port;
- Competing needs for land from a developing coastal hub such as Cairns is likely to make land disposal increasingly impractical, and questionable as a secure long-term disposal solution;
- The existing disposal site meets nominated criteria of a disposal ground and is presently performing well;
- Onshore disposal to previously un-impacted sites would present significant potential ecological impacts to receiving areas and a probable greater net environmental harm than maintaining sediment resources within the coastal process;
- Offshore disposal remains a cost effective and efficient means of disposal; and
- The dredge material does not pose a contaminant risk to the environment or human health, principally because testing of sediments routinely identifies that contaminants are either below concentrations of environmental concern, or they are not bioavailable or likely to impact water quality during disposal.

Since completion of review of potential spoil disposal options in the LTDSDMP completed in 2004, constraints on local shore based disposal options have increased significantly, with all port authority reclamation works complete, the State Government declaring the East Trinity Reserve, closure of the Cairns Regional Council Portsmith Landfill, and amendments to the local government Cairns Plan. Constraints on further development (where spoil could possibly be used as fill) within low lying areas are now further enhanced due to the impending implementation of the Queensland Coastal Plan in 2010 which recognises the need for planning to account for coastal hazards and has greater recognition of coastal zone environmental values.

3.4.1 Offshore Spoil Disposal Location and Capacity

Disposal of material is all undertaken at the approved offshore disposal ground, located approximately 14km north of the Port Entrance (refer **Figure 3-3**). This location has been used for disposal since 1991 following a detailed spoil ground site selection study by Connell Wagner (1991).

Originally, the spoil ground was located outside the Great Barrier Reef Marine Park; however the Marine Park boundaries were expanded in 2001 by the Great Barrier Reef Marine Park Authority and now include the spoil ground which is located within a General Use Zone.

One of the key parameters in selecting the existing spoil ground over the historical spoil ground was that of increased depth and the reduction in wind derived subsurface currents (Connell Wagner, 1991). Monitoring surveys undertaken recently (WorleyParsons, 2009b) identify that the spoil ground is functioning well, with minimal apparent environmental impact.

The rate of accumulation of spoil between the five year period of 2004 and 2008 (inclusive) at the spoil ground was very consistent across the site. This is demonstrated in **Table 3-4,** which lists approximate accumulation rates for the period in each dump sector A-E (refer **Figure 3-5** and **Figure**

3-6) as well as minimum, maximum and average seabed depths from the 2008 Post Dredge Survey. The accumulation rate for the five years is approximately 0.5-0.6m, equating to an average annual maximum of 0.12m (12 cm). Such minor changes are evident in the consistency of hydrographic survey results between pre- and post-dredging surveys in 2007 and 2008 (refer **Figure 3-5** and **Figure 3-6**).

Use of the previous spoil ground (located immediately to the south west of the existing site), was ceased in 1990 when an overlying depth of 7m was reached. If similar management trigger is applied for the current dump ground, sufficient capacity is present for at least the 2010-2020 LTMP period if a similar regime of annual campaign sizes occurs.

The depth range across each sector (refer **Table 3-4, Figure 3-5** and **Figure 3-6**) demonstrates the sloping nature of the site. Future management options to maximise the life of the dump ground, particularly if the spoil ground is approaching capacity, could include dumping only in the deeper sectors such as A, C & D, or through selective placement of dredge spoil within each sector. However, this management would not be required within the 2010-2020 LTMP period.

Table 3-4 Accumulation rate corresponding seabed depths for sectors of the spoil ground

Sector	2004 – 2008 rate of accumulation	Minimum Seabed Depth (-RL LAT)	Average Seabed Depth (-RL LAT)	Maximum Seabed Depth (-RL LAT)	Depth Range Across Sector
A	+0.5 m	9.45 m	11.35 m	13.50 m	4.05 m
B	+0.6 m	8.80 m	9.85 m	11.35 m	2.55 m
C	+0.5 m	9.25 m	10.55 m	12.25 m	3.00 m
D	+0.5 m	10.35 m	11.50 m	13.30 m	2.95 m
E	+0.5 m	9.45 m	9.95 m	10.75 m	1.30 m

There are no other users of the spoil ground area that would be affected by ongoing use of the spoil ground. The nearest submarine cable in the area of the spoil ground is approximately 2.9 km to the north. There are no known historic shipwrecks in the vicinity of the spoil ground.

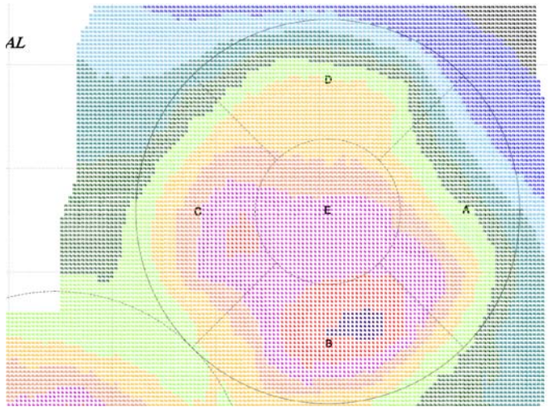
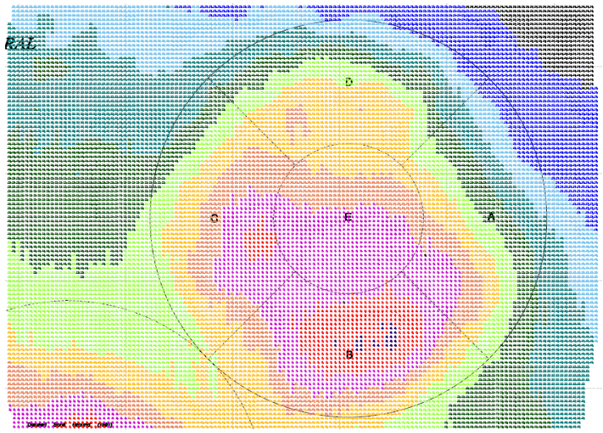
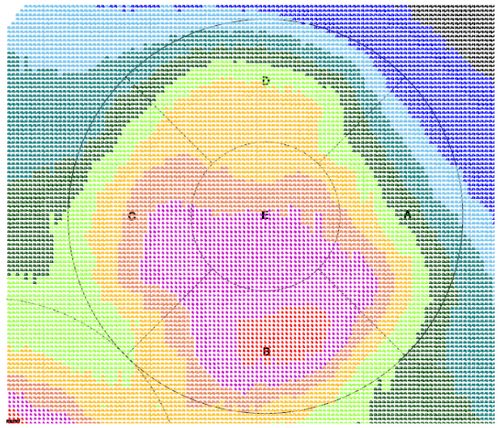
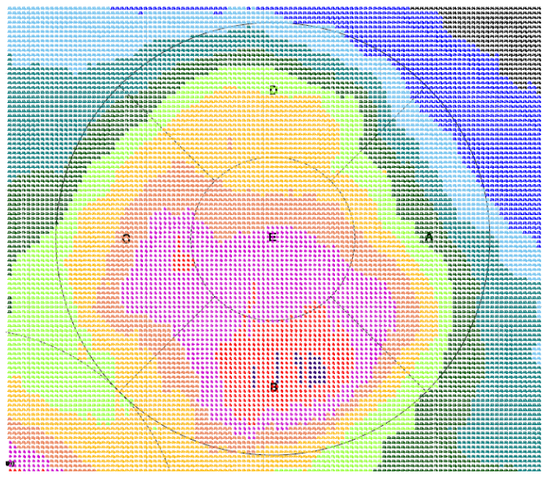
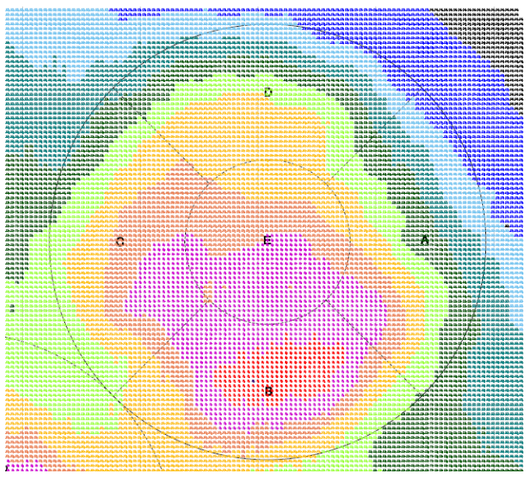
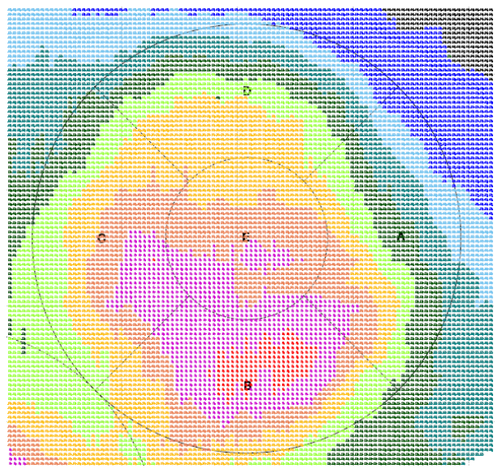
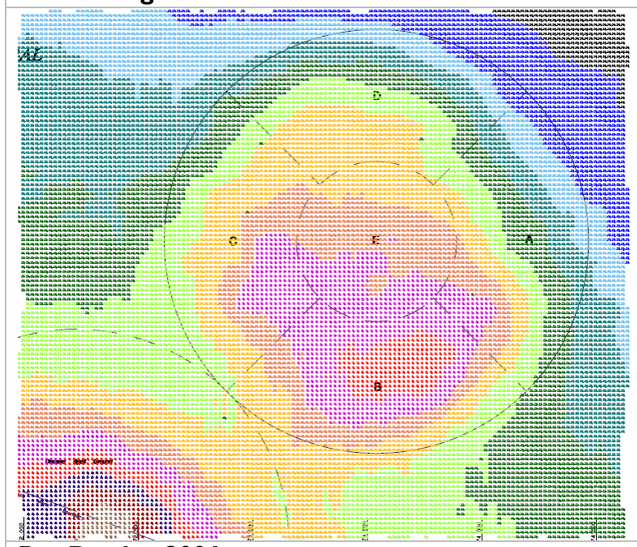
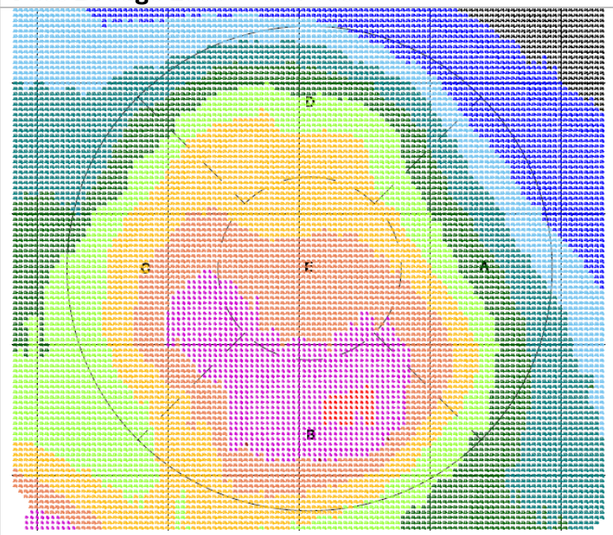
Post Dredge 2009 6-01-757	Post Dredge 2008 6-01-751	Post Dredge 2007 6-01-745
		
Pre Dredge 2009 6-01-754	**Pre Dredge 2008 6-01-748**	**Pre Dredge 2007 6-01-745**
		

Figure 3-5 Ocean disposal site pre- and post-dredge surveys 2007-2009

Post Dredge 2006 *6-01-739*



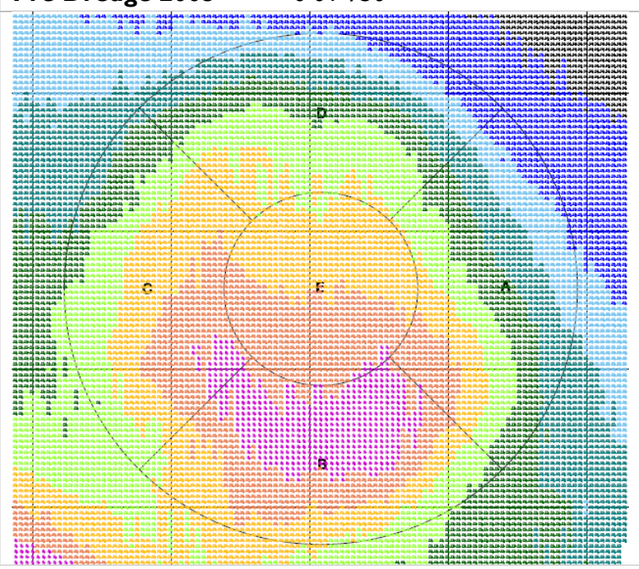
Post Dredge 2005 *6-01-733*



Pre Dredge 2006

Nil survey – due rough weather

Pre Dredge 2005 *6-01-730*



Legend

Depth Ranges				
	7.5 - 7.9	lt.brown	11.0 - 11.4	lt.green
	8.0 - 8.4	dk.brown	11.5 - 11.9	dk.green
	8.5 - 8.9	purple	12.0 - 12.4	teal
	9.0 - 9.4	red	12.5 - 12.9	lt.blue
	9.5 - 9.9	lavender	13.0 - 13.9	dk.blue
	10.0 - 10.4	orange	14.0 - 14.9	black
	10.5 - 10.9	gold		

Figure 3-6 Ocean disposal site pre- and post-dredge surveys 2005-2006

4. DREDGE SPOIL CHARACTERISTICS

Detailed sediment quality characterisation studies have been undertaken within Cairns Port since 1995. Since that time, there has been an increase in the number of sampling areas and sampling sites (within areas) included in the sediment studies. From 1995 to 1998, sampling sites were determined by reference to potential contaminant sources and distributed evenly along the entrance channel and inner port, with up to 22 sites surveyed annually. Following review of this initial program, a revised methodology was subsequently developed and implemented, with 33 sites randomly selected from 103 grid locations within the outer shipping channel, inner shipping channel and swing basins. During the development of the 2006 A-SAP, an increased sampling effort was implemented within each of the marina areas to be more consistent with the requirements of the *National Ocean Disposal Guideline for Dredged Material* (NODGDM; Commonwealth of Australia, 2002).

In 2008 the A-SAP approach was substantially modified to more closely reflect the NODGDM sampling design requirements. This design provided the basis for the 2009 A-SAP, and will remain the basis for sediment characterisation in the LTMP, which also recognises minor modifications relating to the recently released *National Assessment Guidelines for Dredging* (NAGD; Commonwealth of Australia, 2009).

4.1.1 Physical Characteristics

Based on 2008 particle size summary data, the last years that all dredge area were sampled; the following observations can be made (refer **Table 4-1** and **Figure 4-1**). These observations are consistent with observations from prior years and the dredge areas surveyed in 2009 (outer channel, inner port and navy base):

- Particle size distributions across dredge areas and the spoil ground are relatively similar on average;
- All dredge areas and the spoil ground are dominated by silt and clay fractions;
- Gravel is most abundant within Marlin Marina sediments;
- Sand is most abundant within inner port (wharf area) sediments; and
- Outer channel and inner port sediments can vary considerably in sand and gravel fractions between sampling locations. Sands and gravels are most prevalent at sites near the mouth of Trinity inlet, but still never represent a dominant fraction of the sediments to be dredged.

Table 4-1 PSD summary range for each dredge management area (Source: WorleyParsons, 2008 a,b,c).

Area	% Gravel (>2 mm)	% Sand (0.06-2 mm)	% Silt (0.002 – 0.06mm)	% Clay (<0.002mm)
Outer Channel	<1 – 12	1 – 71	24 – 91	3 - 28
Inner Port	<1 -4	1 - 62	21 - 51	13 - 61
Navy Base	0	1 – 7	27 – 46	53 – 69
Marlin Marina	0 - 12	2 - 25	29 - 50	36 - 58
CFB1	0	1 - 5	39 – 54	44 - 59
CFB2	0 – 1	2 – 20	29 - 86	0 – 61
Spoil ground	0 - 1	4 - 10	69 – 77	18 – 26

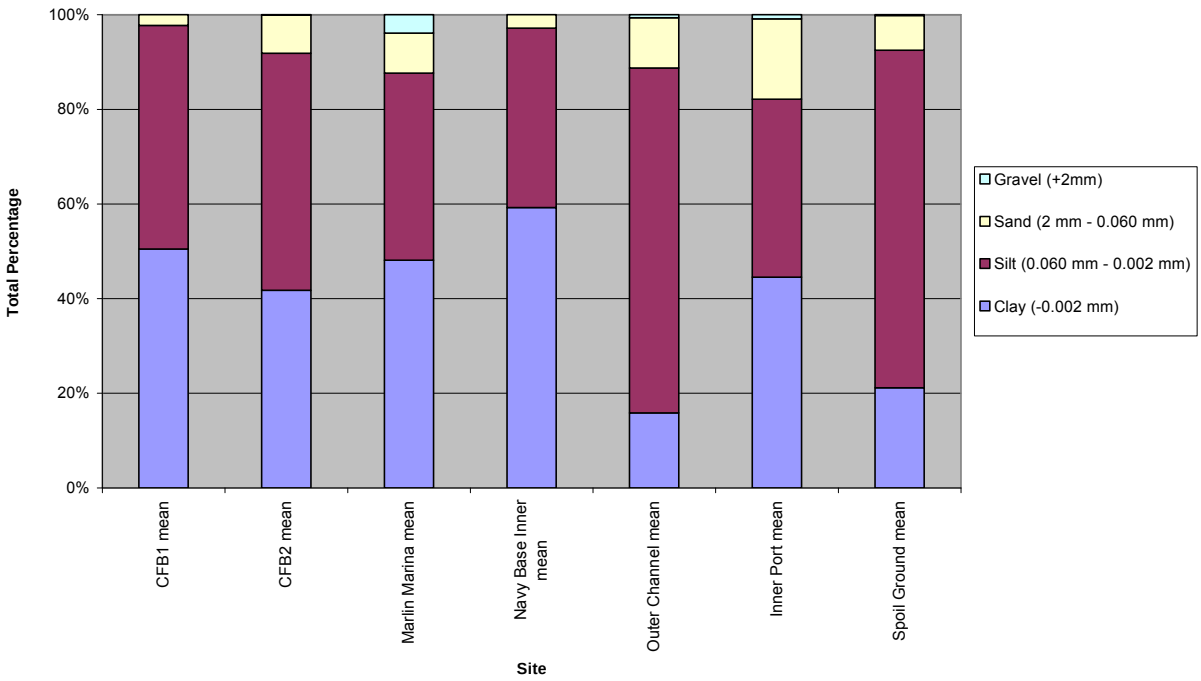


Figure 4-1 PSD mean for each dredge management area in 2008

(Source: Compiled from WorleyParsons 2008 a,b,c)

4.1.2 Chemical Contaminant Characteristics

A historical review summary of chemical contaminant characteristics in the various dredge areas is presented in **Table 4-2**. This review was originally compiled in 2005 as part of preparing the LTDSDMP (Environment North, 2005) and has been updated annually since. Contaminants are presented based on records for individual samples, in comparison with NODGDM / NAGD practical quantitation limits (PQL), screening guideline levels (SGL) and NODGDM maximum guideline levels (MGL) concentrations, as follows:

- Green shaded cells - below PQLs;
- Blue shaded area - above PQL but below SGL;
- Orange shaded cells - above SGL but MGL;
- Red shaded cells - have recorded levels above MGL.

A summary of means at the upper 95% confidence level (95%UCL) for contaminant substances within respective dredge areas between 2005 and 2009 is provided in **Table 4-3**. Also included in this table are results of further testing (elutriate, dilute acid extraction or porewater analysis) for substances that exceeded screening levels at the 95% UCL of the mean. No substances have been required to go beyond this level of further assessment to demonstrate the suitability of sediments for dredging and unconfined placement at sea according to the assessment framework of the NAGD.

Discussion of specific contaminant substances follows from the summary tables.

Table 4-2 Historical review summary of chemical substance records within dredge areas

a) Inorganic Substances

	Inner Port (including marinas)														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
As							#								
Cd															
Cr															
Cu															
Pb															
Hg													*		
Ni															
Zn															
Ag															
Mn															
Sn															
Al															
F															
Sb															
Radionuclides															
Total Cyanide															
Nutrients															
Ammonia															

	Navy Base														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
As															
Cd															
Cr															
Cu															
Pb															
Hg															
Ni															
Zn															
Ag															
Mn															
Sn															
Al															
F															
Sb															
Radionuclides															
Total Cyanide															
Nutrients															
Ammonia															

	Outer Port														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
As							#								
Cd															
Cr															
Cu															
Pb															
Hg															
Ni															
Zn															
Ag															
Mn															
Sn															
Al															
F															
Sb															
Radionuclides															
Total Cyanide															
Nutrients															
Ammonia															

	Spoil Ground														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
As															
Cd															
Cr															
Cu															
Pb															
Hg															
Ni															
Zn															
Ag															
Mn															
Sn															
Al															
F															
Sb															
Radionuclides															
Total Cyanide															
Nutrients															
Ammonia															

Legend: # No sampling conducted during 2001, but was completed at the end of December 2000 and start of January 2002

- < PQL
- > PQL but < SGL
- > SGL but < MGL
- > MGL

Table 5-2 Historical review summary of chemical substance records within dredge areas

b) Organic Contaminants

	Inner Port (including marinas)														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TPHs															
PAHs															
PCBs															
BTEX															
OPPs															
OCPs															
TBT															
Diuron															

	Navy Base														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TPHs															
PAHs															
PCBs															
BTEX															
OPPs															
OCPs															
TBT															
Diuron															

	Outer Channel														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TPHs															
PAHs															
PCBs															
BTEX															
OPPs															
OCPs															
TBT															
Diuron															

	Spoil Ground														
Contaminant	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TPHs															
PAHs															
PCBs															
BTEX															
OPPs															
OCPs															
TBT															
Diuron															

Legend: # No sampling conducted during 2001, but was completed at the end of December 2000 and start of January 2002

- < PQL
- > PQL but < SGL
- > SGL but < MGL
- > MGL

Table 4-3 Summary of 95%UCLs for dredge areas: 2005 – 2009

Contaminant (organics normalised to 1%TOC)	Unit	Guideline SGL	Guideline MGL	Guideline ANZECC	2009 Ocean Disposal Site	2009 Channel	2009 Inner Port	2009 Navy Base	2009 Marlin Marina	2009 CFB1	2009 CFB2	2008 Ocean Disposal Site	2008 Channel	2008 Inner Port	2008 Navy Base	2008 Marlin Marina	2008 CFB1	2008 CFB1 inc 3 additional sites	2008 CFB2	2008 CFB2 second round
As	mg/kg	20	70		18.3	19.4	20.2	21.9				18.2	20.6	24.2	25.0	19.7	20.3	20.7	28.5	
Cd	mg/kg	2	10		<0.1	<0.1	<0.1	<0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Cr	mg/kg	80	370		36.7	32.7	38.8	44.9				36.5	35.0	39.3	45.9	34.2	34.4	35.5	36.0	
Cu	mg/kg	65	270		11.9	12.6	29.3	29.8				21.1	14.0	47.7	30.2	23.9	35.8	34.6	49.7	
Pb	mg/kg	50	220		16.8	16.1	21.0	23.1				18.1	18.0	26.0	26.3	20.6	22.0	22.4	36.6	
Mn	mg/kg	-	-		693.8	691.2	700.9	757.8				614.0	759.0	866.0	908.0	647.0	689.0	689.0	498.0	
Ni	mg/kg	21	52		16.0	13.5	17.7	20.1				16.2	16.0	17.9	20.9	15.6	16.0	15.9	16.5	
Ag	mg/kg	1	3.7		<0.1	<0.1	<0.1	<0.1				0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.3	
Zn	mg/kg	200	410		44.2	42.3	68.4	80.3				57.0	52.0	79.8	88.0	69.7	85.0	85.4	147.0	
Hg	mg/kg	0.15	1		0.03	0.025	0.043	0.046				0.05	0.053	0.083	0.069	0.09	0.13	0.11	0.046	
Sb	mg/kg																			
Total N	mg/kg	-	-		679	807	2270	1428				890	1638	2760	1833	1410	2958	2374	2145	
Total P	mg/kg	-	-		527	292	771	506				551	325	839	680	507	917	737	660	
TPH(C10-14)	mg/kg	-	-		<3		<3	1.6				<3	2	2.7	3	<3	<3	1.9	<3	
TPH(C15-28)	mg/kg	-	-		<3		42.3	32.5				27	39	37	15	38	31	36	13.9	
TPH(C29-36)	mg/kg	-	-		<14		21.4	24.4				24	35	26	20	30	30	34	22.1	
Total PCB's	ug/kg	23	-									<5	<5	<5	<5	<5	<5	<5	<5	
Sum of PAH	ug/kg	4000	45000									84	70	495	114	69.8	178	154	106.2	
TBT	ug/kg	5 or 9	70		1.27	4.15	10.74	19,56				2.1	2.7	10.7	6.9	9.3	28.8	23.2	9.5	
BTEX	mg/kg																			
OCPs	mg/kg																			
OPPs	mg/kg																			
VOCs	mg/kg																			
Diuron	ug/kg	2*										-	<1	2.7	1.2	<1	2.9	1	3.2	
Further testing																				
Total As by ICPMS	mg/kg													23				22.7		30.4
Elutriate As	ug/L			2.3 & 4.5										4.2				18.7		54.8
Stage 1 DAE As	mg/kg	20	70										8.62	10.6	10.45		10.6		4.68	
DAE-As	mg/kg	20	70											3.5				2.13		2.7
PW-As	ug/L																			
Total TBT	ugSn/kg						14.6	21.47						20.7		12.4		14.5		7.2
Elutriate TBT	ngSn/L			6			<2	<2						<2		1		<2		<2
PW-TBT	ngSn/L			6			<2	<2						<7		<25		<33		na
Elutriate Cu	ug/L	1.4																		
DAE Cu	mg/kg	65	270																	
PW-Cu	ug/L																			
Total Diuron	ug/kg	2*												0.6				1.9		<1
Elutriate Diuron	ug/L			1*										<0.005				0.088		0.069
PW-Diuron	ug/L			1*										<0.005				<0.005		

Contaminant (organics normalised to 1%TOC)	Unit	2007 Ocean Disposal Site	2007 Channel	2007 Inner Port	2007 Navy Base	2007 Marlin Marina	2007 CFB1	2007 CFB2	2006 Ocean Disposal Site	2006 Channel	2006 Inner Port	2006 Navy Base	2006 Marlin Marina	2006 CFB1	2006 CFB2	2005 Ocean Disposal Site	2005 Channel	2005 Inner Port	2005 Navy Base	2005 Marlin Marina	2005 CFB1	2005 CFB2
As	mg/kg	13.2	21.4	17.4	15.8	18.2	31.8	19.1	18.1	15.5	20.2	19.8	16.5	16.9	19.5	14.8	12.5	13.6	13.4	13	14	15
Cd	mg/kg	1.7	1.3	1.9	1.6	1.7	0.9	1.77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cr	mg/kg			32.6	34.9			39.3			31.5	33.0	31.2	34.1	33.0							
Cu	mg/kg	8.7	10.8	20.7	24.1	25.4	61.8	87.6	7	10.1	25.8	22.6	20.9	54.1	40.5	10.9	9.4	22.5	24.7	26	43	22.5
Pb	mg/kg	25.0	17.8	29.2	29.4	30.1	25.0	33.9	15.3	10.3	18.5	14.4	16.8	17.3	25.1	14.3	12.6	16.9	16.3	20	28	16.9
Mn	mg/kg			843.9	613.7			634.6			754.9	682.5	655.5	628.8	448.6							
Ni	mg/kg		42.2	<0.5	10.6			15.48		8.7	11.2	10.2	10.3	10.8	10.5	12	10.1	8.9	10.9	9	9	10
Ag	mg/kg	0.6	0.4	0.5	0.6	0.6	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zn	mg/kg	37.6		108.1	69.8	97.1	126.1	159.6	31.9	38.1	76.2	72.5	60.4	95.2	91.3	46	40.8	74.1	70.5	60	180	82
Hg	mg/kg			<0.05	<0.05			<0.05			<0.05	<0.05	<0.05	<0.05	<0.05							
Sb	mg/kg		<0.5	<0.5	<0.5			<0.5		<5	<5	<5	<5	<5	<5	<3	<3	<3	<3	<3	<3	<3
Total N	mg/kg	1176	938.3	1300	3494			3040														
Total P	mg/kg	356	292.9	280				378.4														
TPH(C10-14)	mg/kg							nd			<2	4.7	nd	5.2	nd	<4		<4	<4	<4	<4	<4
TPH(C15-28)	mg/kg							180			35.8	48.4	30.1	83.5	66.4	14		31	25	31	43	84
TPH(C29-36)	mg/kg							180			83	95	60	120	137	46		58	78	62	100	140
Total PCB's	ug/kg			-				nd			nd	<0.02	nd	nd	nd	nd		nd	nd	nd	nd	nd
Sum of PAH	ug/kg			1.01				90			350	300	483	300	460	3		8	0.9	nd	8	nd
TBT	ug/kg	1.63	1.88	8.4	8.49	6.72	20.97	17.98	1.4	2.1	11.3	9.6	8.6	16.7	12	1.1	1.9	38.8	13.5	9.3	40.8	1
BTEX	mg/kg										nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
OCPs	mg/kg							nd			nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
OPPs	mg/kg							nd			nd	nd	nd	nd	nd	nd		nd	nd	nd	nd	nd
VOCs	mg/kg							nd			nd	nd	nd	nd	nd							
Diuron	ug/kg	<1	<0.1	<0.1	0.41	1.84		1			<0.05		<0.05	<0.05	<0.05							
Further testing																						
Total As by ICPMS	mg/kg																					
Elutriate As	ug/L							29.7														
Stage 1 DAE As	mg/kg			5.63	6.25	5.69	7.26															
DAE-As	mg/kg							8.48														
PW-As	ug/L																					
Total TBT	ugSn/kg					12.51																
Elutriate TBT	ngSn/L			0	<2	<2	<2	<5			<2	<4	<2	5	<2			<2	<2	<2	<2	
PW-TBT	ngSn/L			0		<6	<4											<2	<2	<2	<2	
Elutriate Cu	ug/L							<0.1														
DAE Cu	mg/kg				13	13	221	125														
PW-Cu	ug/L																					
Total Diuron	ug/kg																					
Elutriate Diuron	ug/L																					
PW-Diuron	ug/L																					

* Note that Diuron had agreed values of 2 ug/kg for sediments and 1ug/L for elutriate and porewaters in the absence of published guideline values.

95% UCL's
- >MGL
- >SGL but <MGL
- <SGL
- tested but not detected

95%ile
- > ANZECC 95% Ecosystem Protection Level
- < ANZECC 95% Ecosystem Protection Level

INORGANIC COMPOUNDS

Inorganic compounds include the following typical substances listed in Table 1 of the NAGD, for which testing may be required:

- Metals and metalloids;
- Cyanide; and
- Nutrients and ammonia.

These compound groups are addressed individually below.

METALS AND METALLOIDS

Metals and metalloids have been routinely been tested each year as part of the sediment monitoring program. These generally show the greatest degree of variation of all contaminants and are largely attributable to geology, catchment land use, industries and port operations (CPA, 2004 reported in CPA, 2007). Metal contaminants typically occur at or below NODGDM / NAGD screening levels. Based on the past five years data (2005 – 2009), metals and metalloids that have exceeded screening values for individual samples include:

- Arsenic, in the inner port (including marinas), navy base, outer channel and the spoil ground;
- Cadmium at the inner port and spoil ground; and
- Copper and zinc in the inner port only.

Arsenic has exceeded the screening level at the 95%UCL in most dredge areas except Marlin Marina within the past 5 years. Inspection of 95%UCLs over the previous 5 years indicates an apparent trend of increasing exceedance of the screening level; however this may be due to slightly different metal extraction techniques by different laboratories, with more aggressive extraction occurring in 2007, 2008 and 2009. Nevertheless, any exceedances have tended to be marginal over the 20 mg/kg screening level, with a maximum 95%UCL of 31.8 mg/kg. Additional analyses for arsenic have been undertaken in 2007 (SKM, 2007) and 2008 (WorleyParsons, 2008d) and included dilute acid extraction (DAE) and elutriate analysis to test for bioavailability within sediments and potential impacts to water quality during dredging and spoil disposal. DAE testing results have returned a maximum sample result of 12.9 mg/kg (Navy Base in 2008) and maximum ratio of total arsenic : DAE arsenic of 44% (CFB1 in 2007). DAE results indicate a low level of bioavailability of arsenic in sediments and are consistently found to be suitable for unconfined placement at sea as they are well below the 20 mg/kg screening level.

Arsenic elutriate analyses were undertaken in 2008 for inner port and commercial fishing base areas (CFB1 and CFB2). Elutriate analyses are undertaken on a 1:4 ratio of sediment to water and the supernatant is analysed for the contaminant of concern. The NAGD allows for further dilution at the disposal ground, typically by a factor of at least one-hundred. The 2008 elutriate results returned a

maximum concentration of 71.9 µg/L at CFB2, which is many times higher than the low-reliability water quality guidelines (ANZECC/ARMCANZ 2000) of 2.3 mg/L for As (III) and 4.5 mg/L for As(V). With allowable dilution at the disposal ground, however, arsenic concentrations were found to be acceptable and unconfined sea disposal was permitted.

It is generally recognised that arsenic is naturally elevated in the Cairns region due to the presence of natural mineralisation in metamorphic rocks of catchments discharging to Trinity Inlet. High background arsenic concentrations, known to be a feature of soils and sediments in the Cairns region, are recognised by Queensland EPA Contaminated Land Unit. Naturally elevated arsenic concentrations are also recognised more widely in eastern Australia. The NAGD (Commonwealth of Australia, 2009) recognises in the footnote to Table 2 Screening Levels that "*Sediments in eastern Australia commonly have high natural levels of As*". Other scientific references recognising this include Roach (2005), Preda & Cox (2002) and Munksgaard & Parry (2002).

A plot of arsenic total, elutriate and DAE concentrations from sediments collected from Cairns Port in 2008 is provided in **Figure 4-2**. This graph demonstrates that as total arsenic concentrations rise to a maximum of 39 mg/kg, the bioavailable concentration (as indicated by DAE) does not increase and remains below 4 mg/kg, which is well below the NAGD screening level of 20 mg/kg. Elutriate concentrations tend to increase as total concentrations increase, generally at a similar rate. Allowing for minimal dilution of at least 100 at the spoil ground post-disposal (as allowed for in the NAGD), even the outlier maximum of 71.9 µg/L (diluted to 0.719 µg/L) is at least a factor of three below the lower ANZECC/ARMCANZ (2000) water quality guideline level of 2.3 µg/L. Excluding this outlier, diluted elutriate concentrations are at least 10 times below the water quality guideline. Consequentially, it could be concluded that current arsenic levels do not pose a significant risk to water quality or benthic communities from the dredging and disposal activities and that a relaxation of the total arsenic concentration screening level could be justified.

Based on evaluation of existing current information an increase in the local screening level within the Cairns Port dredge management areas to 30 mg/kg for arsenic was agreed by the Determining Authority.

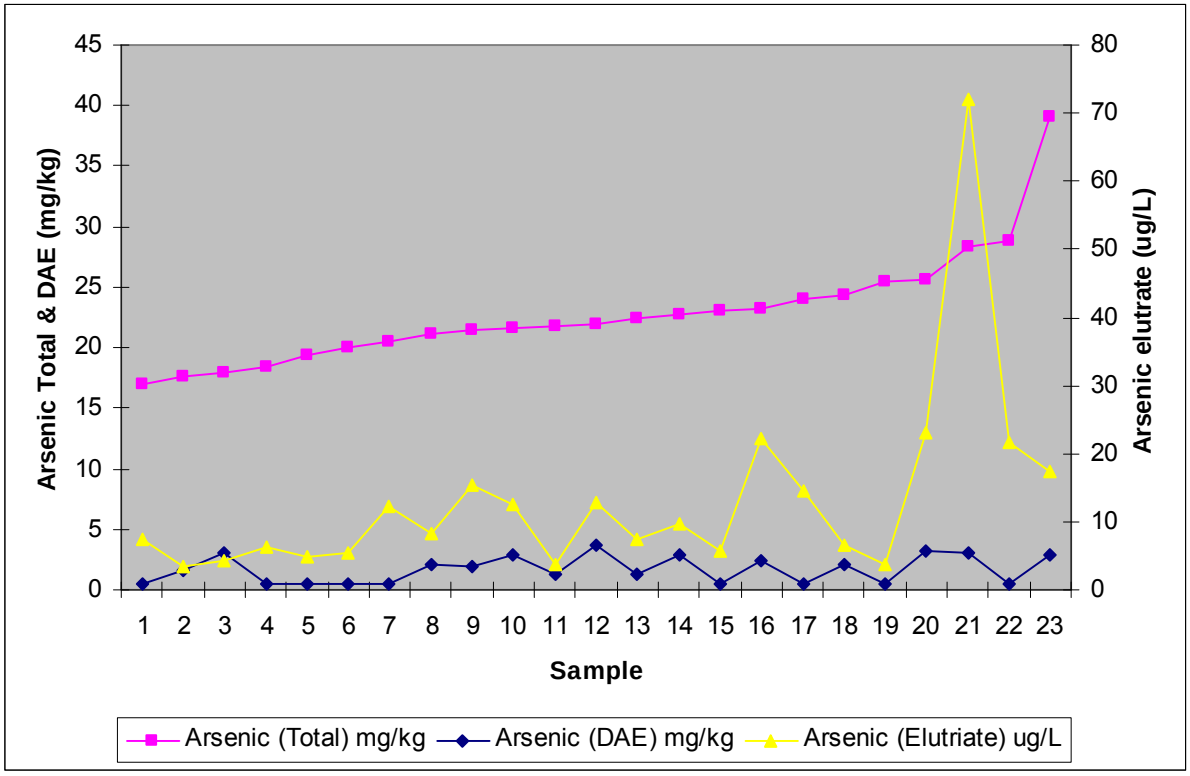


Figure 4-2 Plot of 2008 further arsenic testing of total, DAE and elutriate concentrations

Cadmium was slightly elevated above the screening level in one sample from the inner port in 2007, however the 95%UCL was below the screening level, so no further analyses were required under the NODGDM assessment framework. Cadmium is typically below detection within port sediments.

Copper was detected above the NODGDM maximum guideline level in CFB1 in 2007 and above the screening level in CFB2 in 2007. Elutriate testing on hold samples in CFB1 and CFB2 did not reach the required LOR for comparison against ANZECC/ARMCANZ (2000) water quality guidelines. Dilute acid extraction of CFB1 hold samples returned one particularly high concentration that resulted in the 95%UCL exceeding the screening level. CFB2 similarly exceeded the screening level at the 95%UCL for DAE analysis of copper. Similar levels were not experienced in the CFB1 and CFB2 dredge areas in 2008. Surveys of these areas were not undertaken in 2009 as dredging was not required.

Zinc was elevated above the screening level in one sample in CFB2 in 2007; however the 95%UCL was below screening so no further analysis was required.

RADIONUCLIDES

Radionuclides have not been tested as part of the routine annual sediment sampling and analysis program that began in 1995. While they were included in the NODGDM Table 3 as substances for which testing may be required, they are no longer listed in the equivalent table (Table 1) in the NAGD.

However, the NAGD suggests that inclusion (of substances not in Table 1) may be relevant if a particular source is identified near a dredging site. For example, if mineral sands are being handled in bulk in an area it may be relevant to analyse for radionuclides.

There are no known historical or currently known sources of radionuclides in the port vicinity or catchment, so testing is considered to be unwarranted.

Cyanide

Cyanide was tested for in the inner port and navy base dredge area in 2006 and 2007, but was not detected. The next previous testing for cyanide was in the Navy base was in 1998 and 1999 but again there were no detections.

Nutrients and Ammonia

Typically, Total Nitrogen (TN) and Total Kjeldahl Nitrogen (TKN) display an increasing concentration gradient from the Trinity Bay disposal site to the berth areas such as the Navy Base. Except for the disposal site, TN consists entirely of TKN, an organic form of nitrogen associated with protein compounds.

Phosphorus concentrations do not display an obvious gradient from the disposal site to Trinity Inlet.

Ammonia concentrations in sediments are greater within the inner port and berth / marina areas.

These trends are consistent over the three years (2007-2009) that the sediments have been tested for nutrient concentrations. There are no screening levels for nutrients in the NAGD, nor were there in the NODGDM.

Organic Compounds

Organic compounds include the following substances listed in Table 1 of the NAGD (previously Table 3 of the NODGDM), for which testing may be required:

- Petroleum hydrocarbons;
- Phenols;
- Volatile chlorinated hydrocarbons;
- Organochlorine pesticides (OCPs);
- Polychlorinated biphenyls (PBCs);
- Polynuclear aromatic hydrocarbons (PAHs);
- Chlorobenzenes;
- Benzene, toluene, ethylbenzene and xylene (BTEX);
- Organophosphate pesticides (non-organochlorine pesticides) (OPPs);

- Dioxins;
- Organotin compounds; and
- Miscellaneous organics.

Not all of these have been required to be tested by FNQPC (see **Table 4-2** for list of contaminant substances analysed during respective years), being limited primarily to those substances that have screening levels. One exception to this was the herbicide Diuron, which was requested by the Determining Authority to be sampled in 2007 – 2009.

Historical review of organic contaminants within dredge management areas of Cairns Seaport indicated the following:

- OCPs, PCBs, OPPs, Volatile Chlorinated Hydrocarbons, Phenols, PAHs and BTEX have been either undetected or below screening level throughout all areas of the port, including outer channel, Navy Base, inner port and marina areas.
- Dioxins have not previously been tested. The need to test for dioxins was evaluated during the development of the 2005 SAP and was determined not to be warranted.
- Organotin compounds (including tributyltin, TBT), which are derivatives of some antifouling paints, have routinely been detected in the marina areas, Navy Base, inner port and outer channel dredge area at or above screening guideline levels. Most dredge areas except the outer channel typically exceed the screening level for TBT at the 95%UCL and hence require further testing. Prior to 2008, further testing has typically involved only elutriate analyses but since then has also included porewater analysis. Analysis of pore water concentrations of a contaminant provides greater understanding of potential impacts to the marine environment than total sediment concentrations used during screening level assessments. Of the more than 70 elutriate samples analysed for TBT since 2005 on sediments that have exceeded screening levels, none have returned levels above 2 ngSn/L, which is below the 6 ngSn/L ANZECC/ARMCANZ toxicant trigger level. Prior to 2009, porewater analyses have commonly failed to achieve the low LORs required to compare against the trigger level but typically samples have not shown detections. In 2008 there were two detections (CFB1 and CFB2) which were above the 6 ngSn/L trigger level (400 ngSn/L and 17ng Sn/L). Where porewater analyses are unreliable due to inability to collect sufficient water for analysis and hence not achieve the necessary LOR, the NAGD permits reliance on undiluted elutriate results (i.e. raw laboratory results based on 1:4 dilution) as an indication of bioavailability. On that basis, elutriate concentrations were below detection (2 ngSn/L) and hence represent low risk of bioavailability. In 2009 (WorleyParsons, 2009), porewater analyses performed on a total of eight samples from the inner port and navy base achieved the required LOR and returned no detections of TBT even when total TBT concentrations were up to 92 μgSn/kg, more than ten-times the screening level. Consequentially, it could be concluded that current TBT levels do not pose a significant risk to water quality or benthic communities at the disposal ground from the dredging and disposal process. A relaxation of the total TBT concentration screening level was

requested but was not supported by the Determining Authority, largely due to there being insufficient data to suggest that porewater results for TBT are consistent given difficulties in previous years to achieve appropriate LORs; TBT being the primary contaminant of concern in most ports in Australia and being an artificial substance that has sub-lethal effects. Future review of the TBT dataset at some point in the future, with a view to increasing the local screening level, if consistent levels of resolution (and results) are achieved, remains.

- Diuron was found to be above an agreed literature derived screening level of 2 μg/kg in the Inner Port, CFB1 and CFB2 in 2008. Subsequent elutriate analysis testing for potential impacts on water quality demonstrated that Diuron was present at ultratrace levels but less than one-tenth the agreed literature derived guideline level of 1 μg/L, without any allowance for dilution afforded under the NAGD. Testing for Diuron in porewaters to assess for potential impacts to benthic organisms did not return any detections even at the ultra-trace detection level of 0.005 μg/L, which is two-hundred times lower than the agreed guideline of 1 μg/L (WorleyParsons, 2009c). In 2009, Diuron was not detected in sediments of any of the areas to be dredged (inner port, navy base) or the spoil ground. A review of Diuron was undertaken by the Determining Authority regarding the necessity of future Diuron analyses based on the very low levels present in elutriate and porewaters. A further two years of analyses will be undertaken to provide at least five years of good quality data upon which a more comprehensive review of data can be undertaken to support a recommendation to discontinue Diuron analyses.

SUMMARY OF CONTAMINANT STATUS OF SEDIMENTS

An extensive program of sediment contamination assessment has been implemented by the operators of Cairns Port since 1995 and is likely to be the most extensive of any port in Queensland.

Typically, the majority of contaminant substances do not exceed respective NAGD screening levels at the 95%UCL of the mean, with few exceptions. These exceptions frequently involve arsenic and tributyltin, however copper has exceeded the NAGD guideline at CFB1 and CFB2 in 2007, and Diuron exceeded the agreed guideline of 2 μg/kg in 2008.

Arsenic has exceeded the screening level at the 95%UCL in most dredge areas except Marlin Marina within the past five years. Any exceedances have tended to be marginal over the screening level and further testing using DAE and elutriate analysis has indicated that impacts to water quality and benthic communities are highly unlikely. Spoil ground total arsenic concentrations at the 95%UCL remain below the screening level. A revised local increase in the screening level of arsenic to 30 mg/kg is agreed.

Tributyltin has commonly exceeded the screening level at the 95%UCL of the mean in all dredge areas except the outer channel. In dredge areas where TBT has exceeded the guideline and further testing was undertaken, the levels present in elutriate and porewaters indicate that significant impacts to water quality during disposal or to benthic communities following placement are unlikely, even when sample total TBT concentrations are more than ten-times the screening level. A revision of TBT

screening level was not supported at this time by the Determining Authority but options for review in the future remain.

Diuron has been detected in port sediments and has exceeded the agreed screening level; however further testing has so far identified very low risk of impacts to water quality or benthic organisms. A further two years of analyses (2010, 2011) will be undertaken to provide at least five years of good quality data upon which a more comprehensive review of data can be undertaken.

5. EXISTING ENVIRONMENT

The following sections provide a description of key habitats, coastal processes, significant species, environmental management areas, and general background on water quality conditions within the marine systems surrounding the Cairns Port operations. This summary is based largely on the findings of previous investigations commissioned by FNQPC and recent database searches.

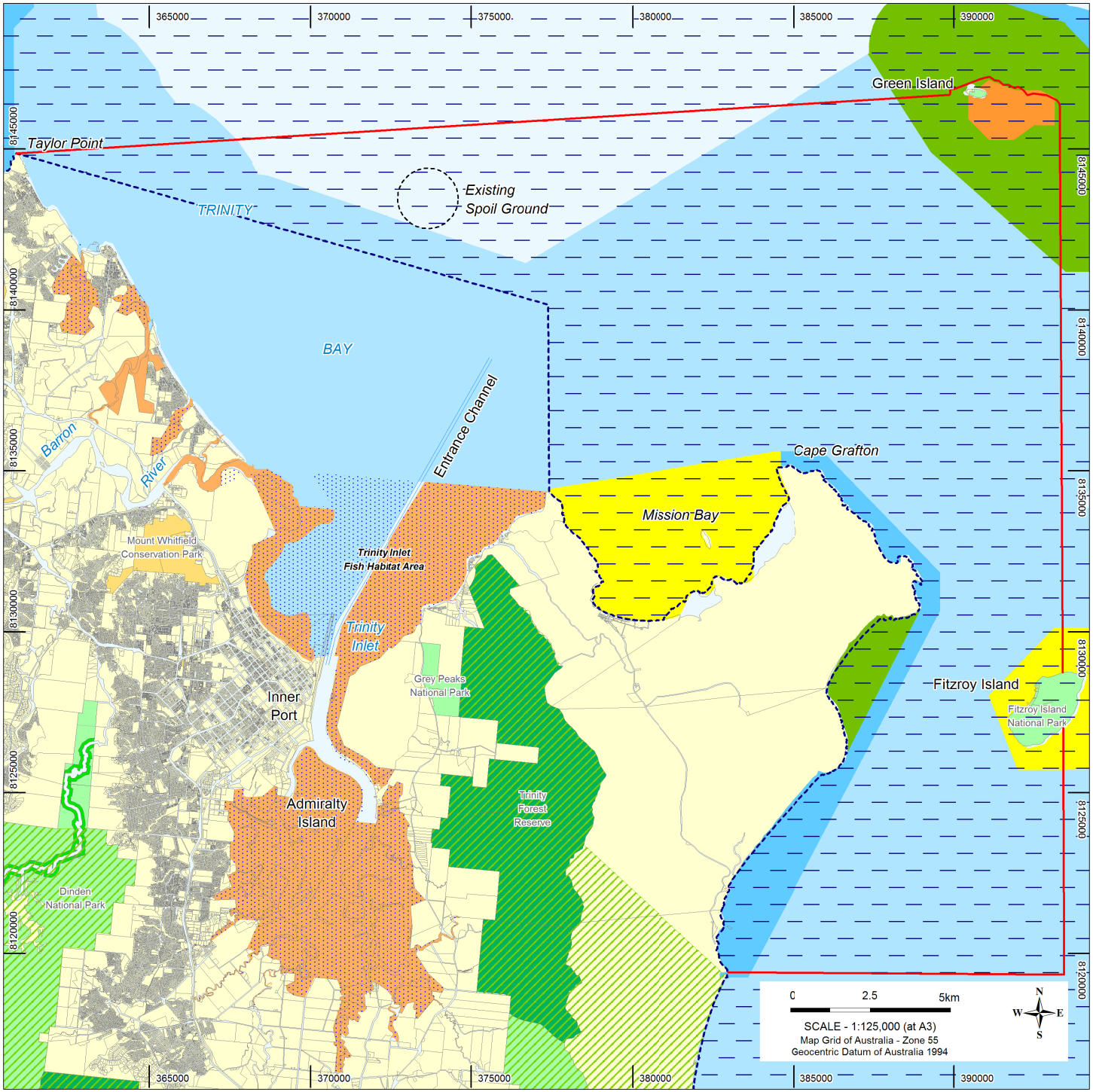
The key habitats described focus on those areas adjacent to port operations, dredging, and disposal activities, including seagrass, mangroves, sub tidal and intertidal soft sand and mud substrates. Other habitats within the Port Limits, but outside the likely influence of Port activities, such as fringing coral reef and rocky shore, have not been detailed. Carter *et al* (2002) conclude that the nearest substantial fringing reef systems of Green Island occurs approximately 35 km seawards of Cairns Port, and are not considered at risk from coastal sediment pollution and the activities of maintenance dredging and disposal.

5.1 Land Use and Management

With exception of its eastern boundary of broad mangroves, the catchments immediately adjacent to Trinity Inlet and the wider Trinity Bay area are largely developed. While mangroves within Trinity Inlet provide a substantial buffer between a mixed urban and agricultural land use spectrum to the south, the Port itself is bounded by mixed industrial, commercial and recreational land uses to the north and west. Chronic threats to the aquatic marine system and its associated flora and fauna are considered relatively high. Importantly, several protected areas have been established within the study area in an attempt to regulate and mitigate against impacts from industrial, commercial and recreational users.

5.1.1 Management Areas

The port area encompasses a range of recognised management areas, including the Great Barrier Reef World Heritage Area, Great Barrier Reef Coast Marine Park, Cairns Tidal Wetlands and Trinity Inlet Fish Habitat Area. **Figure 5-1** illustrates key management boundaries. While the Entrance Channel forms part of the World Heritage Area (not shown) and lies within the Great Barrier Reef Coast Marine Park, only the spoil ground is located within the Great Barrier Reef Marine Park. The inner harbour and entrance channel have been excluded from the Trinity Inlet Fish Habitat Area.



LEGEND

- Port limit
- Trinity Inlet fish habitat area
- Great Barrier Reef Marine Park boundary
- Wet Tropics of Queensland - World Heritage Area
- Cadastral parcels

Marine Park Zoning

- Buffer Zone
- Conservation Park Zone
- Estuarine Conservation Zone
- General Zone
- Habitat Protection Zone
- Marine National Park Zone
- Preservation Zone
- Scientific Research Zone

Protected Areas

- Conservation Park
- Forest Reserve
- National Park

Source Information

MSQ Port Limits
Maritime Safety Queensland 2009
Queensland Fish Habitat Areas
Department of Primary Industries and Fisheries 2009
Great Barrer Reef Marine Park Authority boundary
Great Barrier Reef Marine Park Authority 2009
Great Barrer Reef Coast Marine Park Zoning
Department of Environment and Resource Management 2010
Protected Areas (Queensland_estates)
Environmental Protection Agency 2009
World Heritage Areas (Australia)
Australian Government Department of the Environment and Water Resources 2009
Cadastre
Department of Natural Resources and Water, Queensland 2009

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
1	06/05/2010	Re-issued for use	KM	MZ	AF	
0A	04/05/2010	Re-issued for client review	KM	MZ	AF	
0	22/03/2010	Issued for client review	KM	NA	JAK	

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Ports North

PORTS NORTH

CAIRNS PORT LONG TERM MANAGEMENT PLAN

Figure 5-1 Management areas in the vicinity of Cairns Port

Project No: 301001-00975	Figure: 00975-00-GM-DAL-0002	Rev: 1

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5.2 Physical Environment

5.2.1 Coastal processes

Trinity Bay, and its natural harbour, Trinity Inlet, are low energy tropical embayments. Trinity Bay is identified as relatively shallow waters (<10m) between Double Island (north) to Cape Grafton (south). These northerly facing systems are protected from prevailing south-easterly trade winds by Cape Grafton, but remain open to fluctuating northerly winds during summer, and periodic cyclone activity.

Key physical processes leading to the transport and distribution of silt and sediment within the study area have been defined by Carter *et al.* (2002) as including:

- Tidal currents (southeast flood, north east ebb)
- Daily easterly breezes;
- South-easterly trade winds (winter)
- North easterly trade winds during summer; and
- Periodic affects of tropical cyclones.

A figure showing the physical environment and coastal processes in the vicinity of Cairns Port is provided in **Figure 5-2**.

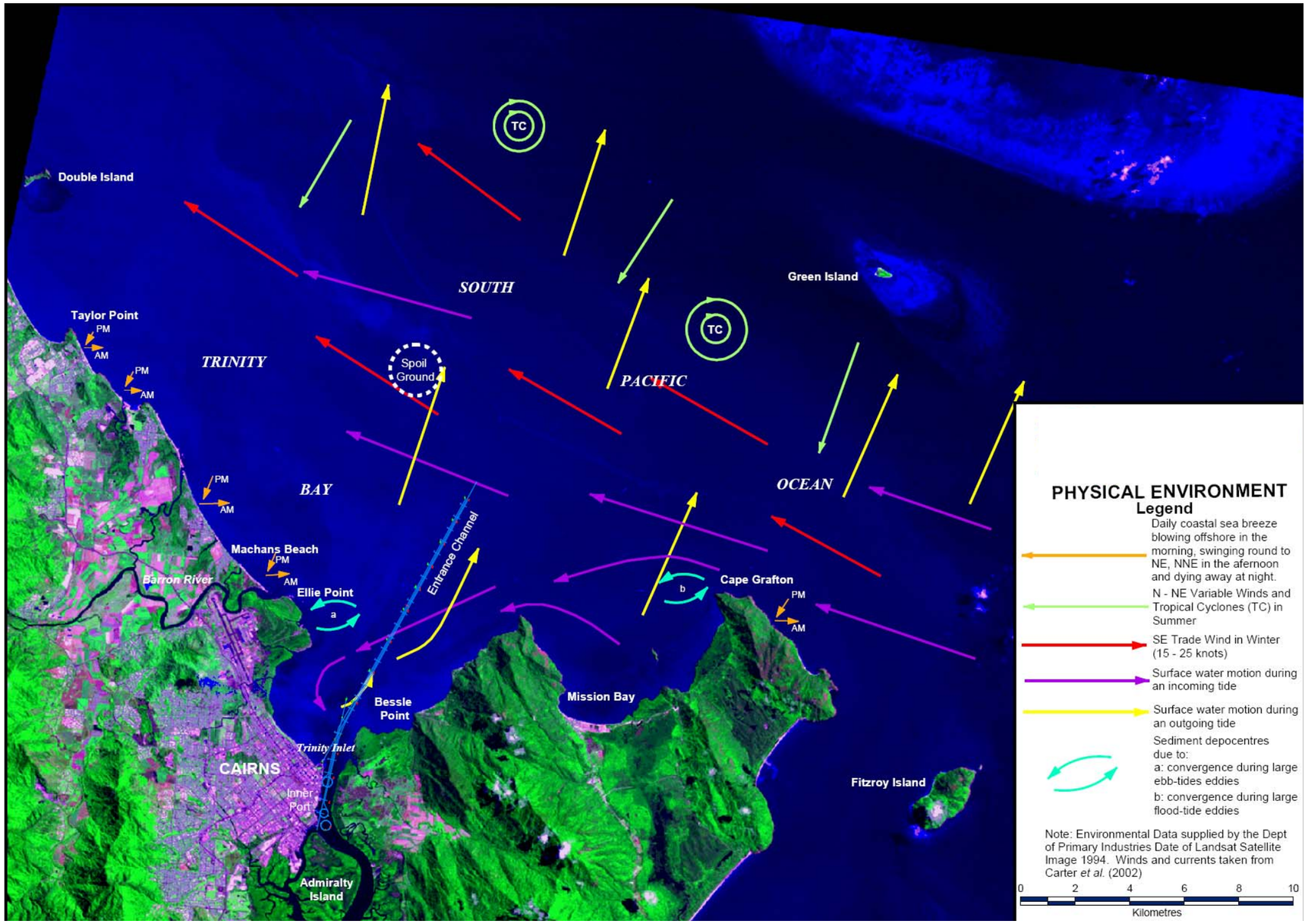


Figure 5-2 Physical environment (Source: Environment North, 2005)

5.2.2 Trinity Inlet and Trinity Bay

Prevailing hydrodynamic process create conditions within the south-eastern portion of Trinity Bay, which favour the deposition of sediments. These processes play a key role in defining the annual maintenance dredging load at Cairn Port. The offshore areas north east of the Cairns Esplanade have been described as a depocentre for the Bay (Carter *et al.*, 2002). These naturally shallow areas immediately adjacent and offshore from the Esplanade experience high elevations in turbidity, forced by prevailing winds, wave and current activity. Sediment movement within Trinity Bay is described as off-shore, following a general northerly drift, primarily dictated by prevailing south-easterly winds (Carter *et al*., 2002). However, weak southerly transport has been identified during the summer period as wind and wave action tends north to east (Carter *et al*. 2002).

During the spring ebbing tide, a large eddy forms on the western side of Trinity Inlet, directing suspended sediment mobilised by the ebbing tide over the sand and mud flats located adjacent to the Esplanade (Carter *et al*. 2002). This area represents the southern extent of one of the larger seagrass beds in Trinity Bay.

Spring tides within Trinity Inlet are described as being ebb tide dominant, with increased current velocities capable of mobilising mud and fine sands from the estuary system (Carter *et al*. 2002). This role is reversed during neap tidal states, with a net migration of fine sediments into Trinity Inlet. The role of currents is considered a significant diver leading to the need for annual maintenance dredging within the channel and berth pockets.

5.2.3 Spoil Ground

The existing spoil ground is well situated so as to negate impacts to significant regional habitats, being located approximately 26km from the nearest reef system (Green Island) and ~9 km from the shoreline at Yorkeys Knob. Benthic habitats immediately adjacent to the disposal ground have been described by Neil *et al* (2003) as flat soft sediments, supporting very limited epibenthic flora and fauna (i.e. featuring only isolated benthic macro algae and sea pens).

Survey of particle size within and adjacent to the spoil ground (WorleyParsons, 2009b) identified no significant difference between spoil ground and adjacent areas. The explanation for this is that the seabed across the area surveyed is homogenous and dominated by silt/clay with a low percentage of sandy material and the absence of gravel. The material placed at the spoil ground is also dominated by silt/clay with a low fraction of sand and only a very small percentage of gravel (WorleyParsons 2008 a-c, 2009a). The placement of dredged material with similar sediment particle size to the spoil ground itself has contributed to the homogeneity of sediment particle size between the spoil ground and the other surveyed locations.

Sediment sampling indicates no geochemical evidence as to the presence of contamination extending out from the disposal ground, as may be expected by longshore drift (Carter *et al*., 2002). Results of recent analysis (WorleyParsons 2008c, 2009a) outline very similar findings, with all samples remaining below adopted screening criteria within and adjacent to the spoil ground.

Prevailing currents and longshore sediment transport processes rework materials from the disposal ground in a predominantly northerly direction (Carter *et al*. 2002). Importantly, circulating currents within Trinity Bay actually prevent suspended sediments generated within these offshore waters from re entering the Bay (Connell Wagner, 1991) further limiting the interaction the disposal ground has with adjacent environments.

Typical of these shallow water environments, the generation of wind derived waves influences surface and subsurface currents, leading to increased resuspension and mobilisation of sediments. Carter *et al*. (2002) described that as south easterly winds approach 20 knots or more at the spoil ground, increased wave heights and bottom currents act to transport deposited sediments.

One of the key parameters in selecting the existing spoil ground over the historical spoil ground was that of increased depth and the reduction in wind derived subsurface currents (Connell Wagner, 1991). Despite these processes of mobilisation, results of hydrographic surveys (Environment North, 2005 and Carter *et al*., 2002) indicate that the spoil ground retains approximately 50% of the materials deposited during dredging, with the finer silts sand and clays distributed via wind, wave and current action to the north of the spoil ground.

5.2.4 Water Quality

Water quality within Trinity Inlet was summarised by Environment North (2005) as part of the previous LTDSDMP. Being located within a heavily urbanised catchment, the system is likely exposed to a broad range of nutrient and minor toxicant inputs associated with adjacent and upstream agricultural, residential, commercial and industrial land uses. The Trinity Inlet system is widely valued by the community with respect to waterway use and associated values have been placed on this waterway (EPA, 2007). Environmental values and water quality objectives established for Trinity Inlet under the Environment Protection (Water) Policy 1997 provide for sustainable utilisation by a wide range of users including:

- Education and scientific;
- Ecosystem health,
- Primary and secondary recreation;
- Visual amenity;
- Cultural and spiritual values;
- Aquaculture;
- Oystering; and
- Seagrass.

Water quality guideline criteria for the Trinity Inlet area have been established for open water, enclosed water and mid estuary systems (**Table 5-1**). The port operations area lies within the enclosed coastal / lower estuary water type, while the outer channel lies partially within the open

coastal water type. The spoil ground is outside the Trinity Inlet study area, but would be consistent with water quality requirements for open coastal waters.

Table 5-1 Guideline criteria for water quality within Trinity Inlet (EPA, 2007)

Parameter	Open coastal waters	Enclosed coastal waters	Mid estuary	Seagrass habitats
Clarity (secchi depth)	>1.2m (20th %ile)	>1.2m (20th %ile)	>1.2m (20th %ile)	Maintain background
TSS (mg/L) (background <15 mg/L)	<10mg/L increase (temporary)	<10mg/L increase (temporary)	<10mg/L increase (temporary)	Maintain background
TSS (mg/L) (background >15 mg/L)	<25mg/L (temporary)	<25mg/L (temporary)	<25mg/L (temporary)	
Chlorophyll-a	<0.6µg/L	<2µg/L	<3µg/L	
Total nitrogen	<140µg/L	<250µg/L	<250µg/L	
Oxidised N	<2µg/L	<20µg/L	<30µg/L	
Ammonia N	<2µg/L	<15µg/L	<15µg/L	
Organic N	<135µg/L	<200µg/L	<200µg/L	
Total Phosphorus (TP)	<20µg/L	<20µg/L	<20µg/L	
Filterable reactive phosphorous (FRP)	<3µg/L	<7µg/L	<7µg/L	
Dissolved oxygen	Not >10% below minimum	Not >10% below minimum	Not >10% below minimum	
pH	7.1-8.2	7.1-8.2	6.5-8.4	
Temperature	2 C	2 C	2 C	
Metals (µg/L) arsenic cadmium chromium copper iron lead mercury nickel	 36 9.3 2 3 1000 5 0.1 8			

Parameter	Open coastal waters	Enclosed coastal waters	Mid estuary	Seagrass habitats
selenium silver zinc ammonia (unionised) cyanide	70 0.1 50 n/d 1 Refer also AWQG section 3.4 - 'water quality guidelines for toxicants' (including Tables 3.4.1, 3.4.2, and Figure 3.4.1)			

Turbidity and total suspended solids

Carter *et al*. (2002) describe Trinity Inlet and Trinity Bay as being a high turbidity system, experiencing typical coastal water TSS concentrations of 20-200 mg/L. Physical hydrodynamic processes and the extent of shallow water, particularly adjacent to the esplanade, drive the regular mobilisation of fine sediments within the water column. Winds from the NE and NNE have been described as generating the greatest natural turbidity ranges within Trinity Inlet, reaching concentrations as high as 70 NTU (Connell Wagner, 1991). Winds from the E and SE also tend to increase turbidity but not to the same extent (30-40 NTU) due to reduced open water fetch (Connell Wagner, 1991).

Wet season time series turbidity and TSS data has been captured from four sites within the study area (Davis *et al*. 1998). Results indicate elevated turbidity concentrations immediately above the seabed, with results of a constant TSS 400 mg/L recorded from loggers situated adjacent to the first channel marker nearest the Port entrance. Data captured adjacent to the Marlin Jetty recorded a reduced mean concentration (30-50 mg/L), with data spiking during peak spring tidal currents to between 300-400 mg/L. Extremely elevated turbidity was recorded over the mud banks adjacent to the Esplanade, with consistent concentrations of 1000-2000 mg/L being recorded. TSS concentrations of approximately 400mg/L were recorded from the spoil ground, increasing during spring tidal phases to 420-430 mg/L. These bottom mounted loggers are likely to represent increased turbidity over surface measurements.

Turbidity data captured from the inner port area by CPA since 2001 has recorded a mean surface turbidity of 18 NTU, increasing with depth to approximately 30 NTU. Typical maximum turbidities recorded over this period are 200-300 NTU, with a peak of 700 NTU.

The GBRMPA (2001) describes the Trinity Inlet and Bay Region as having a relatively high frequency of riverine flood plumes within the Cairns Section of the GBR, and thus a naturally increased incidence of turbid plume events.

Light availability

From existing studies, the only available record of deployed light meters provided limited results from locations within the offshore disposal ground (Connell Wagner, 1991). Measurement of light, and in particular, photosynthetically active radiation (PAR), does not appear to have been undertaken over seagrass habitats.

However, limited ambient light levels over much of Cairns Harbour / Trinity Bay has been interpreted and summarised in findings of past seagrass surveys conducted. Surveys completed by DPI (*Lee Long et al 1993*) noted a mean depth of occurrence mostly between 0 m and 1 m below mean sea level because of the high turbidity's and increased attenuation of photosynthetically active light with depth. *Zostera capricorni* had the shallowest distribution (up to 0.01 m above MSL) and *Halodule pinifolia* the deepest (down to 3.09 m below MSL) and no seagrass was found at depths greater than 3.09 m below MSL within the area surveyed. The upper depth range is most likely controlled by exposure at low tides and high water turbidity's and light attenuation is the most likely cause for this limited depth distribution of seagrass within Cairns Harbour and Trinity Inlet. Only *H. pinifolia* was found at depths greater than 2.05 m below MSL but no beyond 3.09 m. Species such as *H.ovalis* and *H. decipens* occur at depths greater than 20m at offshore locations where light is less limiting (*Coles et al 1987* and *Lee Long et al 1993*). The depth distribution of seagrass species in the 1993 survey appeared shallower than that recorded in the 1988 survey (*Lee Long et al 1993*).

Samples of *Halodule* species have periodically been collected by FNQPC during grab sampling for collection of sediment, from within the batters and base of the main channel to a depth of approximately 8.5m indicating potential for conditions to be suitable for these species to have their minimum requirements met and conditions suitable to be a sporadic pioneering species.

There is an absence of regular data on the depth range ecology of deepwater seagrass within Trinity Bay and Inlet, primarily due to the sparse nature of such species and subsequent difficulty of routine efficient sampling. Consequently, DEEDI's surveys since 2001 under the Cairns Harbour Trinity Inlet Long Term Seagrass Monitoring Program have focused on the intertidal species where changes in condition are most efficiently observed as an indicator of the light and ecological conditions affecting seagrass. This dataset for the intertidal areas is the most comprehensive data set on depth distribution of seagrass within Trinity Bay and is a useful indicator of changes in seagrass response to conditions.

Table 5-2 summarises observed trends in depths of seagrass meadows monitored between 2001 and 2008. In the vicinity of the port area, the large intertidal seagrass meadow between the Esplanade and Ellie Point, to the west of the outer channel appear to be restricted in depth and hence assumed light availability. The sub-tidal Bessie Point seagrass bed on the eastern side of the outer channel have greater depth distribution is most likely because these meadows are more sheltered from the daily breezes that generate turbidity than are the Esplanade to Ellie Point seagrasses.

	Maximum Depth (depth below lowest astronomical tide level (m))							
Meadow location and ID number	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Esplanade to Ellie Point (34)	na	na	na	na	na	na	na	0
Bessie Point (11)	2	2	2.3	2.4	2.3	2.6	2.5	2.5
Trinity Inlet (19)	na	1.5	1.7	2.1	1.2	1.6	1.6	2.7
Redbank Creek (20)	-0.4	-0.6	-0.2	-0.1	-0.5	-0.6	0.3	-0.1
Redbank Creek (33)	na	1.7	1.5	1.5	1.2	0.7	1.3	0.1

Notes:
1. na = Insufficient depth measurements, or sites where surveyed using helicopter not boat).
2. Mean Sea Level (MSL) = Lowest Astronomical Tide (LAT) +1.7m
Source: McKenna *et al*., 2009

Table 5-2 Maximum depth of monitoring meadows at Cairns Port and Trinity Inlet (2001-2008)

Deeper seagrasses found closest to the channel which are not part of regular annual monitoring are known to be present, however data and therefore trends in the light availability to seagrass growing beyond the lower boundary of the intertidal meadows to greater depths of Trinity Bay in vicinity of channel dredging area is un-quantified.

Nutrients, dissolved oxygen and chlorophyll-a

Sampling undertaken by Cairns Port Authority (2001-2008) within the inner harbour denotes no significant variation in key nutrient parameters between sampling locations, and generally discounts the significance of port operations as a key point source for nutrient impact. It is understood that two Cairns Regional Council waste water treatment plants are located further upstream past Admiralty Island, and are likely contributors to nutrient regimes, in conjunction with surrounding urban and agricultural landuses. It is understood that the waste-water treatment plants will soon be upgraded to provide for tertiary treatment of sewage, which will reduce the ongoing nutrient loads entering Trinity Inlet waters.

While available data suggests a general compliance to adopted WQOs at Cairns Port for Total Nitrogen and chlorophyll-a over the term of monitoring, concentrations for ammonia and total phosphorus remain in excess of target WQOs.

Dissolved oxygen remains at the lower acceptable limits outlined within the guidelines for Trinity Inlet, and may indicate the system is struggling to processes available organic loads.

Monitoring undertaken from the entrance channel (1995-1997) recorded some elevations in nutrient parameters following rainfall, with positive correlations identified for ammonia, total nitrogen, total

phosphorous and chlorophyll-a. The wet season period was also shown to generate increases in suspended solids and chlorophyll-a.

It has been previously concluded that nutrient based impacts are unlikely to be associated with port activities, and more accurately represent a combination of urbanised and agricultural land uses (Environment North, 2005). It would also be associated with nutrient inputs from the upstream waste water treatment plants.

Toxicants

Sampling from within the inner harbour completed by FNQPC between 2001-2008 confirms an overall compliance to median zinc, chromium and cadmium guideline concentrations set out in ANZECC/ARMCANZ, 2000. However, elevations in copper, lead and TBT (including DBT and MBT) remain above guideline criteria. These findings are indicative of pollutants often associated with port operations and vessel repair facilities. It should be noted that TBT records a long term median of between 0.025 µg/L Sn, only marginally exceeding the adopted criteria of 0.02 µg/L Sn in water.

Water quality analysis for heavy metals and hydrocarbons was undertaken during 1999-2000 at the spoil disposal ground. Very low concentrations in metals during 1999 resulted in a reduced suite for analysis during 2000 (zinc and aluminium). Zinc recorded a concentration of 11µg/L during 2000, well below the adopted criteria for open waters for the Trinity Bay area (50 µg/L). Two minor detections for hydrocarbons were recorded during 2000 at 1-2 mg/L.

Background water quality analysis for toxicants has also been undertaken from within the entrance channel (1997-2001). Metals concentrations remained well below the adopted assessment criteria on all occasions.

Subsequent monitoring for toxicants has not been undertaken at the disposal ground or entrance channel. Metal and metalloid toxicant analysis remains part of the quarterly monitoring program conducted by FNQPC within the inner harbour.

5.3 Cultural Values

The cultural values of the Trinity Inlet area were described in the 2005-2010 LTDSDMP, and represent the current situation. These values were based on the ethnographic study compiled by David (1994) and were undertaken in close consultation with the Traditional Owners of lands surrounding the Inlet. Though the study was generally confined to a relatively small area in the north-eastern section and the coastal margins of the Trinity Inlet (David estimated that his survey probably included about 5% of the sites that could be recorded), much of the material in it is relevant to the wider Trinity Inlet catchment.

Northern Archaeology Consultancies (1999; reported in Environment North, 2005), reported that Aboriginal people have an occupation in North Queensland well in excess of 20,000 years, based on archaeological evidence, however little was known of the pre-contact history of the Trinity Inlet catchment area. Aspects of the post-contact Aboriginal history of the Trinity Inlet area have been documented in a number of sources.

Based on David (1994) and other work (especially Northern Archaeology Consultancies 1999) reported in Environment North (2005), it appears that Trinity Inlet remains a significant cultural and economic resource for Aboriginal people of the Cairns region, including traditional and historical owner groups (Yirrganydji, Gimuy Yidinji, Mandingalbai Yidindji, Yidindji, Gunggandji and Giangurra).

The sea country of local indigenous people and the history of the region has been recognised in management plans for dredging activity at the port, with no active Native Title claims over the Cairns foreshore or dredge areas in past permit period. Most recent activity was recognition of Native Title for the Mandingalbay Yidinji over land at East Trinity, Malbon-Thompson Range and sections of the eastern shore of Trinity Inlet including Mud Island.

5.3.1 Locations of Value

Environment North (2005) listed locations within the Trinity Inlet area are known to have significance for Aboriginal people. These include places used for hunting, fishing, shellfish gathering, mythological locales and rock art sites. The areas which were reportedly held most highly with meaningful regard by Aboriginal people are (the list is not exhaustive and in many cases it is not appropriate to disclose the location of cultural sites):

- the Cairns Esplanade - this area was extensively utilised as a traditional shellfish gathering place and was the location of an early Aboriginal camp;
- the Trinity Inlet wetlands – several Aboriginal groups have made and continue to make extensive use of the Inlet's biological resources, which are harvested according to traditional methods;
- Admiralty Island - this area has been noted as an important food gathering point, particularly for crab and shellfish;
- Bessie Point - this small beach community was occupied by Aboriginal families who were forcibly removed from the then Yarrabah Mission. It is an area of significance to Aboriginal people and the site of shell middens is now buried beneath sand deposits;
- Koombal Park - this beach, adjacent to Bessie Point, has several painting sites known to local Aboriginal people and there are believed to be nearby caves that may have been frequented for shelter in the past; and
- the False Cape area - the Cape is the focal point of a mythological narration relating to the creation of the headland and surrounding mountain range. There is also a rock painting, depicting a whale, which has been concealed by sand drifts.

Environment North (2005) summarised a report by Cribb and Lee Long (1995) that developed a predictive model of sites least and most likely to contain archaeological material. Least likely sites included: coastal mangroves; inland mangroves; salt pans; and urban/developed areas. Most likely sites included: sand ridges; and Melaleuca open forest.

Places of contemporary importance included not only hunting, fishing and gathering zones but also living spaces where people carried out their everyday activities. The traditional, historical and contemporary significance of raised sand ridges and cheniers[1] within mangrove systems is also emphasised from a number of sites which were identified on the western side of the Inlet, within the present International Airport (Bird and Hatte 1995 reported in Environment North 2005). These sites show occupation extending probably from pre-contact times through to the very recent past. These were primarily places from where the marine resources of the mangroves and the bay were exploited.

From a European point of view, the key cultural features of Trinity Inlet are:

- its connection with the early beche-de-mer fishery in north Queensland;
- its role as one of the most important 'gateways' for European settlement of north Queensland; and
- its role as a defence base during World War II.

These historical connections provide important links with the past and are worthy of recognition. Historical research is continuing to record and recommend protection of some important sites, including the gun emplacements at False Cape.

There are still relics of wartime occupation by United States and other Allied troops which may be of interest to visitors from that country. One such feature of considerable interest is the 'Catalina' memorial on the Esplanade near Upward Street. The memorial is located on the site of a debriefing hut which was used by aircrew of flying boats based in Cairns during the Second World War.

The Cairns Wharf complex is listed on the State Heritage Register. The complex is of importance in demonstrating the evolution of Queensland's history as it represents an important stage of development of Queensland and Australian wharf facilities dating from 1909 to 1942. The wharves are among the earliest Australian attempts to introduce the medium of reinforced concrete into wharf construction.

5.3.2 Marine Sites of Value

Environment North (2005) identified that the above references do not provide guidance on marine sites. They report that there has been no detailed work on indigenous archaeological underwater sites although some work has been done which suggests that such sites would most probably be associated with old reefs (i.e. limestone caves). They also consider that it is possible that there could be significant Aboriginal sites or Story places (again, often associated with reefs, also fishing areas).

A search of the National Shipwrecks Database (8 October 2009) using a 10 nautical mile search radius centred on Cairns Port identified seven historic shipwrecks as described in **Table 5-3**. Of

[1] Chenier is a geological term relating to a continuous ridge of beach material built upon swampy deposits, often supporting trees.

these, only three may have been wrecked near the port area (A.P.A.; Mary; and Mary). None of these would be subject to disturbance from continued routine maintenance dredging. The offshore spoil ground, which has been used for numerous years, is unlikely to be the site of marine incidents due to its distance from reefs or other hazards.

Table 5-3 Historic ship wrecks identified within 10 nautical miles of the Cairns Port

Ship Name	Ship Type	Date Wrecked	Where Wrecked
A.P.A.	Hulk	1/01/1961	Cairns
El Monte Star	Motor Vessel	3/10/1981	Off Fitzroy Island
Fitzroy	Steamship	1/12/1897	Beach near Cairns
James Merriman	Barque	4/01/1872	off Double I (Trinity Bay/Cairns)(GBR)
Mary	Cutter	3/08/1909	Cairns Harbour
Miro		29/07/1946	Cairns
Safari		7/07/1974	North of Cairns

5.4 Marine Habitats

Cairns Port Limits and the broader Trinity Bay comprise a wide range of tropical estuary and near shore habitats, including; mangroves, seagrass, intertidal mud/sand flats, saltpans/marsh, and subtidal soft sediment. Detailed seagrass habitat monitoring has been undertaken by Fisheries Queensland (DEEDI) over recent years. The distribution of key seagrass habitats and mangrove communities within the study area are well known.

5.4.1 Seagrass

A long-term monitoring program has been undertaken by Fisheries Queensland's Marine Ecology Group since 2002. This program follows prior surveys as follows:

- 1988 survey of Cairns Harbour (Coles *et al*., 1993);
- 1993 survey of Cairns Harbour and Trinity Inlet (Lee Long *et al*., 1996);
- 1996 survey of Ellie Point (Rasheed and Roelofs, 1996); and
- 2001 survey of Cairns Harbour and Trinity Inlet (Campbell *et al*., 2002), which formed the baseline survey for the subsequent long-term annual surveys.

The location of seagrass meadows in Trinity Inlet is shown in **Figure 5-3**. This figure includes the 2008 distribution of meadows monitored annually, supplemented by the distribution of meadows not routinely monitored but identified within the baseline survey in December 2001 (Campbell *et* al., 2002). Annual monitoring has been undertaken on five meadows until 2005 (meadows 34, 11, 19, 20

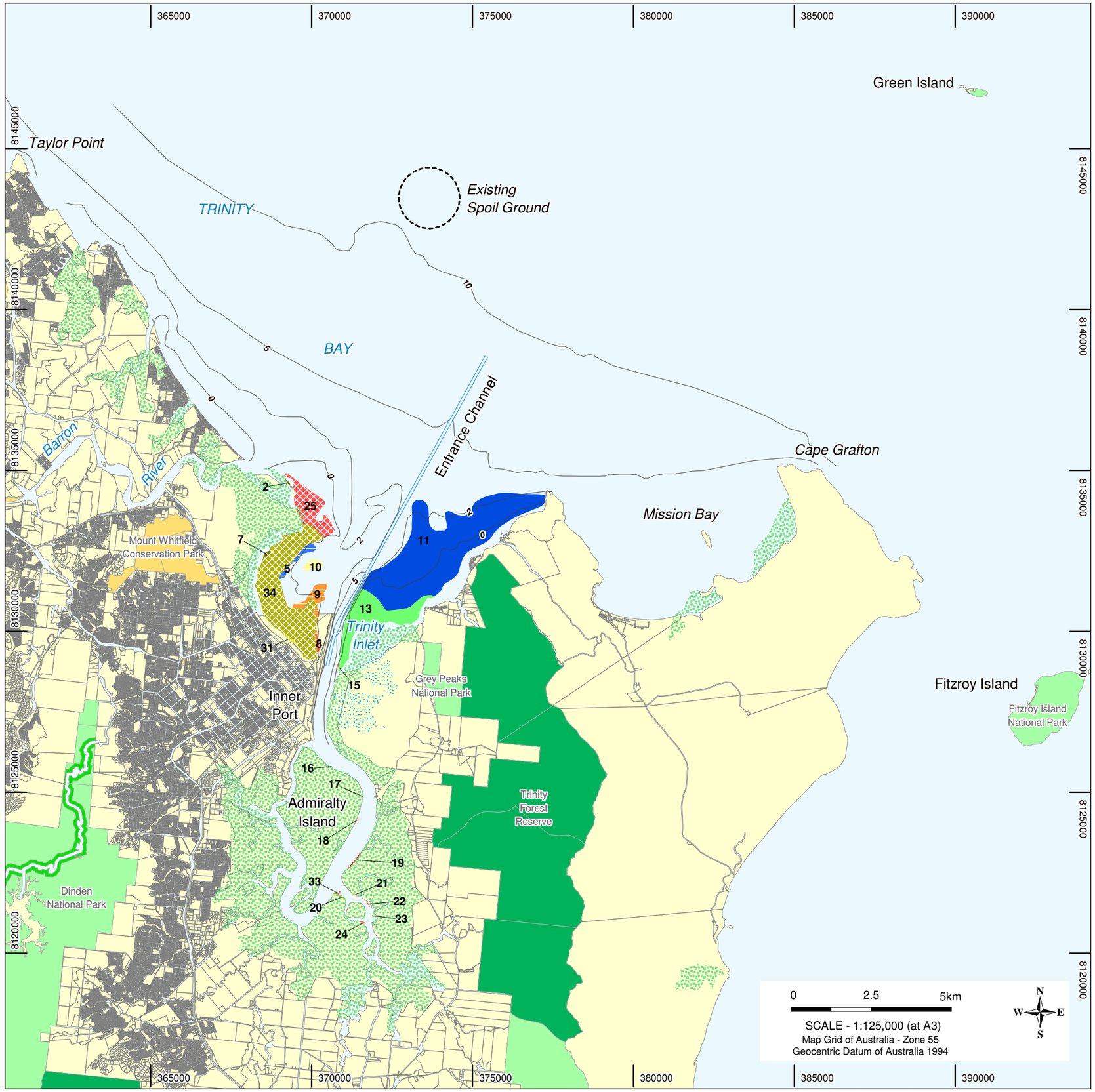
and 33) with a sixth meadow (13) added in 2006 following its initial establishment. Apart from these seagrasses, seagrass meadows can be found elsewhere such as on the upper slopes of the outer channel. These are typically ephemeral patches of pioneering species such as *Halodule uninervis*.

At the time of the 2001 baseline surveys (Campbell *et al*., 2002) there was an estimated 815 ha of seagrass in Cairns Harbour and Trinity Inlet, with 663 ha in the meadows now monitored. In the most recent monitoring survey in October and December 2008 (McKenna *et al*., 2009), a total area of 1383 ha was mapped. The smallest meadows were located in Trinity Inlet, accounting for only 2.5 ha of the overall mapped area (less than 2%). The largest meadows were located in Trinity Bay / Cairns Harbour and accounted for the remaining 1380 ha. It should be noted that only three of the monitored meadows are located in the vicinity of the port area. These are: Esplanade to Ellie Point (meadow 34); Bessie Point (meadow 11); and South Bessie Pt (meadow 13) and represent the Cairns Harbour / Trinity Bay meadows. The remaining monitoring meadows are located in Trinity Inlet (meadow 19) and Redbank Creek (meadows 20 and 33), well upstream of the port.

A graphical representation of biomass, area and species composition of the monitoring meadows is provided in **Figure 5-4** and is sourced from the 2008 monitoring report (McKenna *et al*., 2009).

Seagrass meadows in Cairns Harbour / Trinity Bay demonstrate moderate variability in biomass but have been generally increasing in area (refer **Figure 5-4**) since 2001. In the 2008 survey (McKenna *et al*., 2009), moderate above ground density for *Zostera capricorni* was reported from Cairns Esplanade to Ellie Point on the western side of Cairns Harbour (meadow 34) and dense above ground biomass, dominated by *Halodule uninervis (narrow)* was reported from Bessie Point to False Cape (meadow 11), on the eastern side of Cairns Harbour. The newly established meadow to the south of Bessie Point composition continued to change as it established and was characterised as light *Zostera capricorni* mixed species.

Trinity Inlet and Redbank Creek seagrass meadows demonstrate a high degree of variability in both biomass and area over time. In 2008, the Trinity Inlet meadow was characterised as light density *Halophila decipiens* with *Halophila ovalis*. Redbank Creek meadows were characterised as moderate density *Halophila ovalis* with mixed species and moderate density *Zostera capricorni* community types (McKenna *et al*., 2009).



LEGEND

Protected Areas

- Conservation Park
- Forest Reserve
- National Park
- Bathymetry
- Cadastral parcels
- Mangroves
- Saline coastal flats

Meadow biomass and type

- Moderate Halodule uninervis (narrow)
- Moderate Halodule uninervis (narrow) with Halophila ovalis
- Moderate Halodule uninervis (narrow) with Zostera capricorni/ Halophila ovalis
- Moderate Halodule uninervis (thin) with mixed species
- Dense Halodule uninervis (thin)
- Light Halophila decipiens
- Light Halophila decipiens with Halophila ovalis
- Moderate Halophila decipiens
- Moderate Halophila decipiens with Halophila ovalis/ Halodule uninervis (narrow)
- Light Halophila ovalis
- Moderate Halophila ovalis
- Moderate Halophila ovalis with mixed species
- Dense Halophila ovalis
- Light Zostera capricorni
- Light Zostera capricorni with Halodule uninervis (narrow)
- Light Zostera capricorni with mixed species
- Moderate Zostera capricorni
- Dense Zostera capricorni

Meadow cover

- Isolated patches
- Aggregated patches
- 1 Meadow ID
- Continuous
- Not determined

Source Information

Bathymetry
Digitised from Seafarer Chart AUS830
Seagrass meadow locations
2001 and 2008 survey data supplied by DEEDI 2010
Marine Plants - Mangroves and Saline coastal flats
Commonwealth of Australia (Geoscience Australia) 2009

Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
0	22/03/2010	Issued for client review	KM	NA	JAK	

WorleyParsons resources & energy

Ports North

PORTS NORTH

CAIRNS PORT LONG TERM MANAGEMENT PLAN

Figure 5-3 Marine resources in the vicinity of Cairns Port

Project No: 301001-00975 | Figure: 00975-00-GM-DAL-0003 | Rev: 0

Compiled by BRISBANE INFRASTRUCTURE GIS SECTION

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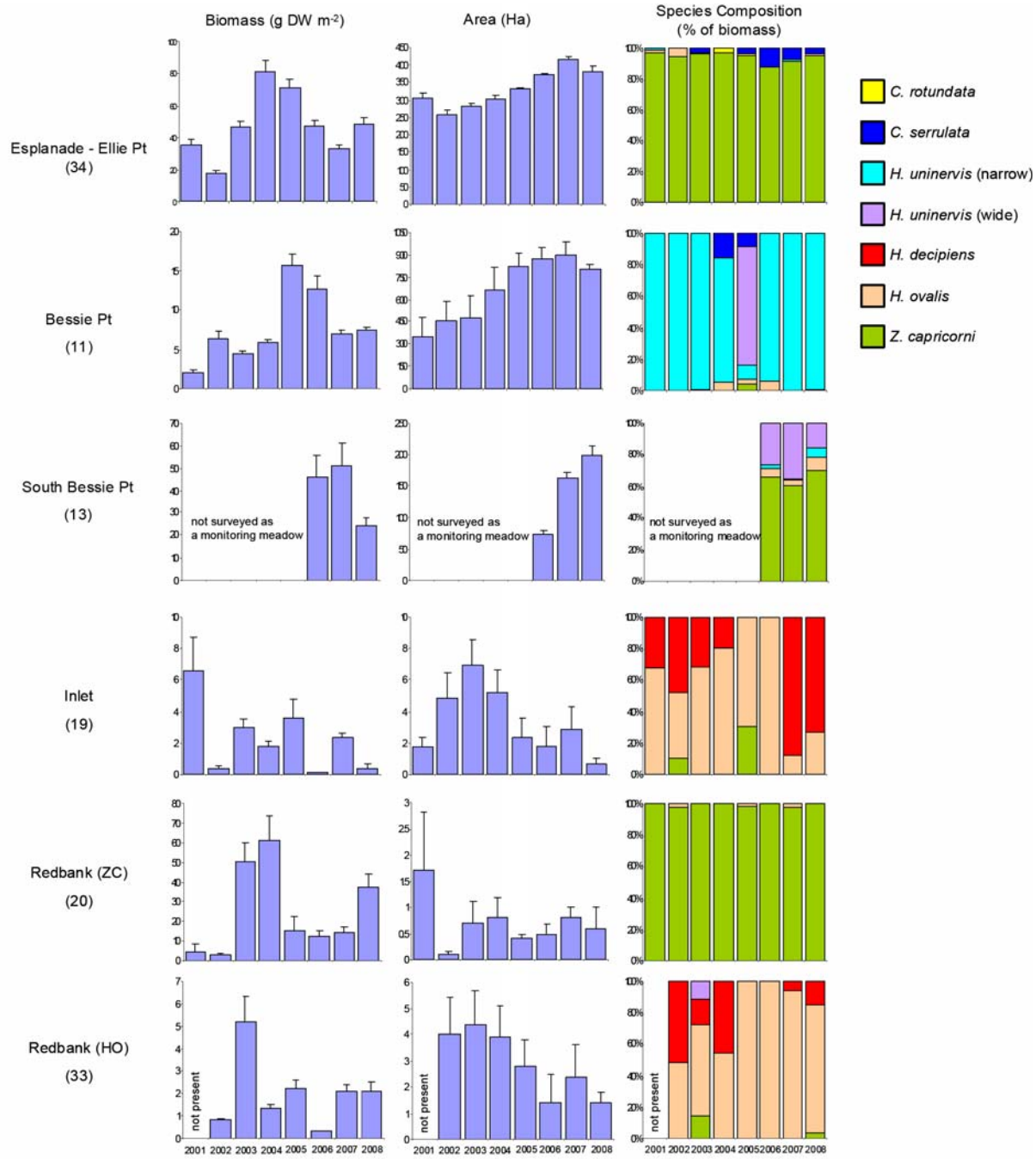

Source: McKenna *et al*, 2009

Figure 5-4 Mean monitoring biomass (g DW m^2) area ± R (ha) and species composition (%) of onitoring meadows at Cairns Harbour and Trinity Inlet from 2001-2008.

There was a varied description of seagrass health in the most recent (2008) survey, being described as both healthy and fair (McKenna *et al*, 2009). A healthy status was likely true of intertidal monitoring meadows (meadows 34, 13 and 20), the biomass of which had either remained stable or increased compared to the 2007 monitoring round, reversing three years of decline. Fair health status was likely reflects the small subtidal meadows within Trinity Inlet (meadows 19 and 33) where some significant declines in biomass and area were recorded in 2008. These particular meadows, which account for less than 2% of the monitoring meadows upon which health is assessed, had become fragmented and were considered to be highly vulnerable to impacts and stress. It should be noted that these Trinity Inlet and Redbank Creek seagrass meadows are at least 3km upstream of Cairns Port dredge areas and would not be subject to any dredging impacts, either directly or indirectly.

The seagrass habitats in Cairns Harbour and Trinity Inlet are considered regionally important according to the Trinity Inlet Management Plan Marine Wetlands Management System (Campbell *et al.* 2002). These seagrass habitats form critical nursing grounds for prawn and finfish fisheries and also create feeding habitats for ecologically significant species, including the Dugong (*Dugong dugong*), the Green sea turtle (*Chelonia mydas*), and populations of wading birds.

5.4.2 Mangroves

Mangrove habitats are a significant and ecologically important feature of the Trinity Inlet marine ecosystem. Within the Inlet, mangroves occupy approximately 3,500 ha of which some 3,000 ha are well developed mangrove communities. Areas of mangrove are shown on **Figure 5-3**.

Rhizophora spp. are the dominant fringing mangrove species, with *Bruguiera* and *Ceriops* species dominating as the system move further inland. A total of 21 species of mangrove have been recorded from the Cairns region.

Mangroves dominate the eastern shores of Trinity Inlet, the upper inlet reaches surrounding Admiralty Island and the shores north of the Esplanade to the Barron River. However, mangroves remain largely absent from a significant portion of the developed northern foreshore between the esplanade and the Public Boat Ramp at Tingira Street, encompassing the Port of Cairns, a distance of some 7.4km.

The Port and adjacent areas directly exposed to dredging are not associated with significant mangrove communities, with the shorelines consisting of primarily wharves and revetment structures. The proximity of Port operations to significant mangrove communities ranges between approximately 100-450m.

With the exception of Admiralty Island, the landward fringes of almost all the mangroves of the Trinity Inlet system are experiencing substantial encroachment due to adjacent land uses. A significant proportion of these pressures are attributable to agricultural uses (sugar cane), followed by residential, commercial and industrial uses.

5.4.3 Intertidal Soft Sediment

The intertidal habitats, particularly those adjacent to the Esplanade, provide habitat for a high diversity of birds and a significant location for use by migratory waders. These sand and mudflats provide important feeding and roosting habitat, and represent a readily accessible area frequented by scientists and the general public as an educational and recreational resource.

5.4.4 Subtidal Soft Sediment

Largely undescribed within the existing survey knowledge, subtidal soft sediments comprise the majority of benthic habitats within the Cairns Port Limits and wider Trinity Inlet area. High turbidity and low light regimes preclude the establishment of significant sub tidal seagrass beds, or 'reef' communities (coral, sponge, algal etc).

5.4.5 Spoil Ground Site Characteristics

Surveys undertaken by Neil *et. al*. (2003) and WorleyParsons (2009b) provide the most recent description of benthic flora and fauna of the spoil disposal ground.

The spoil ground has been characterised as a flat and bare soft sediment habitat, with occasional in fauna burrows and small sand waves (Neil *et al*.2003). Whilst a number of commonly encountered benthic infauna and epifauna species have been recorded, significant habitat forming coral, algae or seagrass species remain absent from the disposal ground. Seagrass has not been recorded from within the permitted spoil disposal ground (Neil *et al* 2003). The nearest isolated samples of seagrass (*Halodule uninervis and Halophila* decipiens) have been recorded approximately 2 km to the south of the present disposal ground boundary.

Benthic infauna survey undertaken within and adjacent to the spoil ground in 2009 (WorleyParsons, 2009b) identified that the benthic macro-invertebrate assemblage was dominated by three crustaceans – an unidentified tanaid, a corophid amphipod, and a phoxocephalid amphipod - which were abundant across most survey locations. Deposit feeders are generally the dominant feeding guild in muddy sediments (Long and Poiner, 1994), and the results of this study generally reflected this, however suspension feeders were dominant at some survey sites. Grazers were largely absent and this was to be expected due to the survey sites being largely devoid of marine plants. There was no evidence of changes to trophic structures of the benthic macro-invertebrate assemblage in response to dredge spoil deposition. Univariate measures of the benthic macro-invertebrate assemblage identified a homogenous assemblage principally dominated by the three aforementioned species. The results of the multivariate analysis on the structure of the benthic macro-invertebrate assemblage demonstrate only subtle differences between the spoil ground and the other locations sampled.

5.5 Species of Conservation Significance

The waters of Trinity Inlet provide potential habitat for a number of fauna species of conservation or economic importance as described below. This section reviews the likely presence of marine species of conservation significance in Trinity Inlet and discussion of those species that may be impacted by dredging or spoil disposal.

EPBC database protected matters search results are provided in Appendix 3 and summarised in **Table 5-4**. Species status under both the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and *Nature Conservation Act* (NC Act) are provided where applicable.

Table 5-4 Threatened, migratory and listed marine species identified as potentially occurring in the area from EPBC Protected Matters Search

Scientific Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Presence
Mammals				
Balaenoptera musculus Blue Whale	Endangered, Migratory, Cetacean	-	This species is predominantly an offshore pelagic species.	Unlikely
Megaptera novaeangliae Humpback Whale	Vulnerable, Migratory, Cetacean	Vulnerable	During spring, travels from Antarctic feeding grounds to breeding grounds in the Great Barrier Reef. The Trinity Bay area is not a known aggregation site for the species however it is within the migratory path of the species.	Likely
Balaenoptera edeni Bryde's Whale	Migratory, Cetacean	-	This species is predominantly an offshore species.	Unlikely
Dugong dugon Dugong	Migratory, Listed, Cetacean	Vulnerable	Predominantly shallow coastal waters in association with seagrass beds.	Likely

Scientific Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Presence
Orcaella heinsohni Australian Snubfin Dolphin	Migratory, Cetacean	Rare	Shallow coastal waters of less than 20m depth. Often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons.	Likely
Orcinus orca Killer Whale	Migratory, Cetacean		The species is predominantly associated with continental shelf and slope environments While it inhabits all oceans of the world, it is most abundant in temperate waters.	Unlikely
Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory, Cetacean	Rare	Shallow coastal waters of less than 20m depth. Often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons.	Likely
Reptiles				
Caretta caretta Loggerhead Turtle	Endangered, Migratory, Listed	Endangered	Waters with both hard and soft substrates including rocky and coral reefs, muddy bays, sandflats, estuaries and seagrass meadows.	Likely
Chelonia mydas Green Turtle	Vulnerable, Migratory, Listed	Vulnerable	Marine, tropical and warm subtropical seas of northern Australia. Shallow benthic foraging habitats containing seagrass and/or algae including inshore seagrass beds.	Likely

Scientific Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Presence
Dermochelys coriacea Leatherback Turtle	Endangered, Migratory, Listed	Endangered	The leatherback turtle are generally considered to be an oceanic species with little nesting occurring in Australia. The individuals that occurring in Australian waters are considered to be foraging migrants.	Unlikely
Eretmochelys imbricata Hawksbill Turtle	Vulnerable, Migratory, Listed	Vulnerable	Coastal marine waters with a foraging preference for rocky reef and coral reef habitats. Breeding predominantly on beaches in the Gulf of Carpentaria and the Great Barrier Reef Islands	Likely
Lepidochelys olivacea Olive Ridley Turtle	Endangered, Migratory, Listed	Endangered	Benthic and pelagic foraging habitats ranging from 1 – 100m depth. Scattered nesting records on beaches of inshore islands in Arnhem Land and the Gulf of Carpentaria.	Likely
Natator depressus Flatback Turtle	Vulnerable, Migratory, Listed	Vulnerable	Inshore coastal waters of northern Australia with a preference for shallow, soft-bottomed sea bed habitats away from reefs. Breeds exclusively on Australian beaches. On the east coast mainland major nesting sites occur from Bundaberg to Mackay.	Likely

Scientific Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Presence
Crocodylus porosus Salt-water Crocodile	Migratory, Listed	Vulnerable	Tidal reaches of rivers between Gladstone and Cape York. Also occur along beaches and offshore islands in the Great Barrier Reef and in freshwater lagoons, rivers and swamps.	Likely
Sharks				
Pristis zijsron Green Sawfish	Vulnerable	-	Marine/ Estuarine. Typically inhabit inshore coastal areas in muddy or sandy-mud soft bottom habitats. Most common in tropical and sub-tropical waters.	Unlikely
Rhincodon typus Whale Shark	Vulnerable, Migratory	-	The whale shark prefers pelagic environments near the continental shelf. Forms aggregations in areas of high seasonal food resources – particularly at Ningaloo Reef (Western Australia)	Unlikely

MARINE TURTLES

Marine turtles are long-lived and late maturing with maturity reached at between 30 and 50 years of age (Miller, 1996). The foraging habitats and preferred items of the various marine turtle species are described in **Table 5-5**. The Trinity Bay area provides potential foraging habitat for flatback turtles, olive Ridley turtles, loggerhead turtles and green turtles. Such habitats are widely distributed throughout the Great Barrier Reef.

The sub-tidal areas of Trinity Bay do not support extensive seagrass beds, principally due to the elevated turbidity levels. The seagrass beds are largely restricted to the intertidal and very shallow sub-tidal areas and it is these areas that provide the main foraging habitat for green turtles.

Marine turtles nest on beaches and the location of nesting beaches in Australia are described in **Figure 5-5** to **Figure 5-7**. Trinity Bay is not recognised as a major nesting area for any marine turtle species.

Table 5-5 Foraging habitats and preferred food items of the various marine turtle species

Turtle Species	Foraging Habitats	Preferred Food Items	Reference
Green turtle (*Chelonia mydas*)	Shallow coastal area, in particular seagrass beds	Seagrass and seaweeds although juveniles are also carnivorous	Brand-Gardner *et al.* (1999)
Hawksbill turtle (*Eretmochelys imbricata*)	Rocky reef and coral reef habitats	Algae, seagrass and sponges	Limpus (2009a)
Flatback turtle (*Natator depressus*)	Shallow coastal environments including rocky reef and sedimentary habitats	A wide variety of soft bodied animals including soft corals, sea pens, sea cucumbers, jellyfish and other large plankton.	Limpus (2007)
Loggerhead turtle (*Caretta caretta*)	A wide range of intertidal and subtidal habitats including coral and rocky reefs, seagrass meadows, and unvegetated sand or mud areas.	Although their diet is diverse, typical items include bivalve and gastropod molluscs and crabs.	Limpus (2008a)
Olive Ridley turtle (*Lepidochelys olivacea*)	Principally shallow unvegetated coastal environments	Principally feeds on gastropod molluscs and crabs	Limpus (2008b)
Leatherback turtle (*Dermochelys coriacea*)	Oceanic environments from the sea surface to the seabed	Principally feeds on colonial tunicates such as *Pyrosoma* spp., jellyfish such as *Catostylus* spp. and other soft-bodied invertebrates	Limpus (2009b)

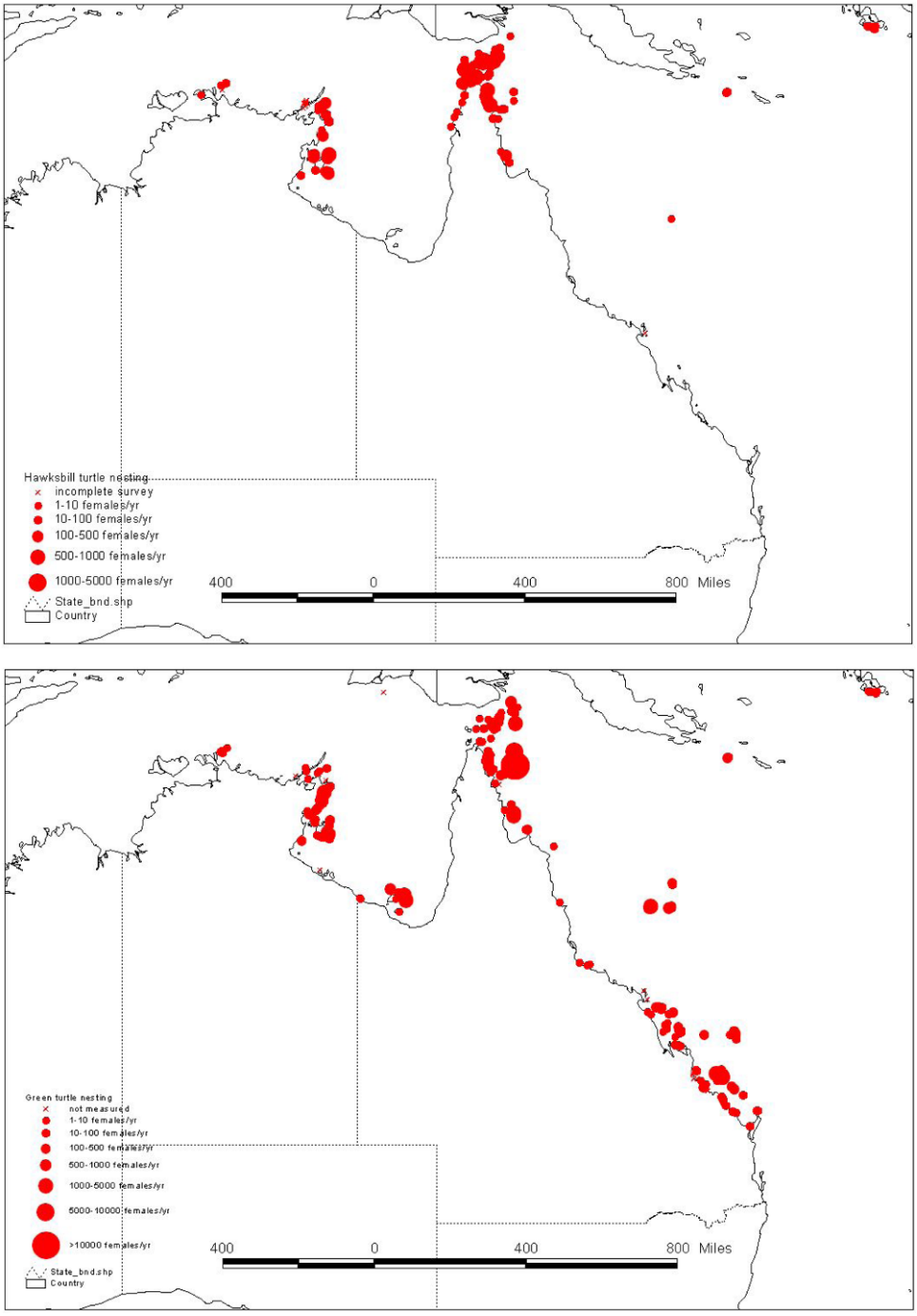

Figure 5-5 Nesting locations in northern and eastern Australia for hawksbill turtles (top) and green turtles (bottom) (from Limpus and Miller, 2008)

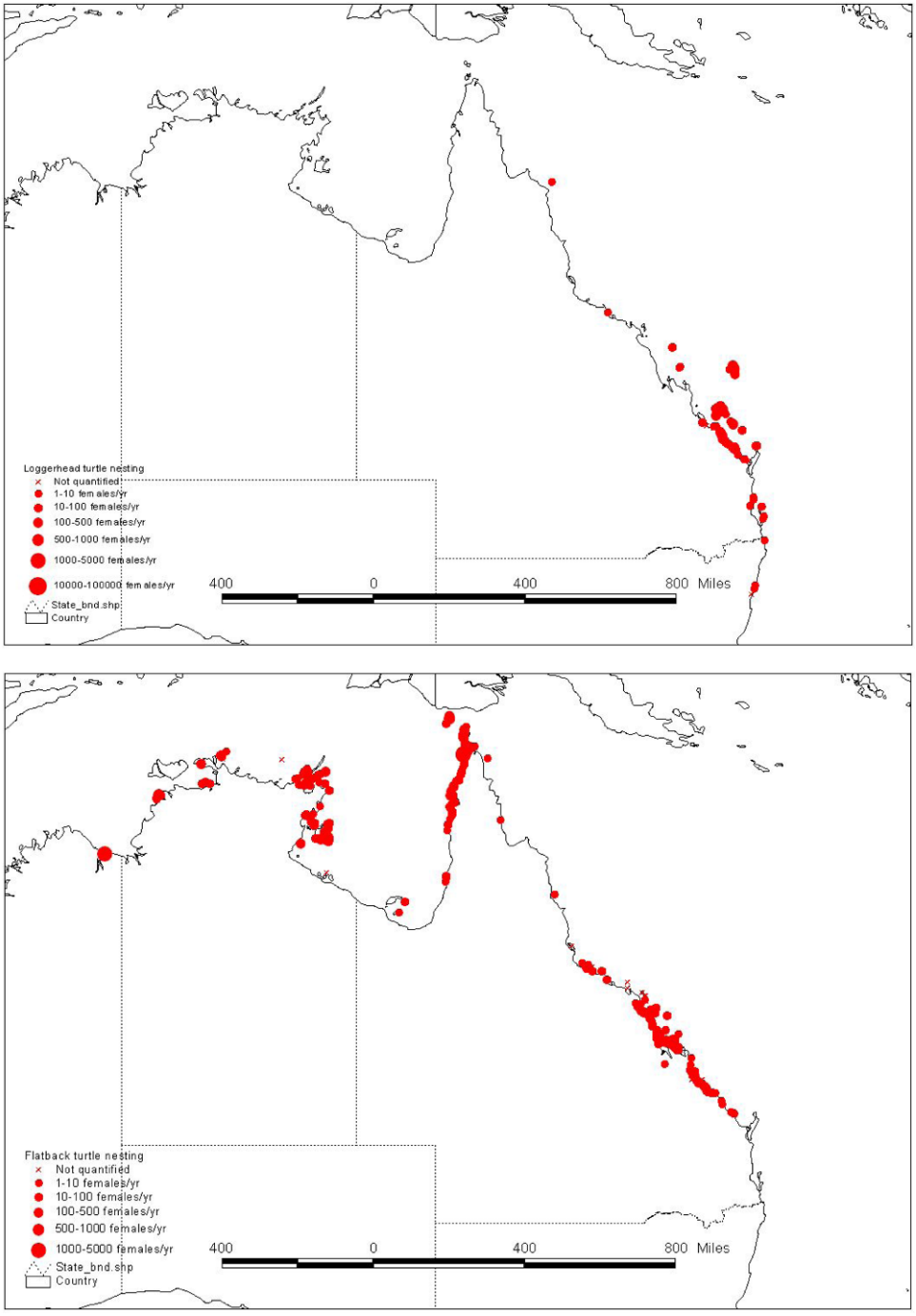

Figure 5-6 Nesting locations in northern and eastern Australia for loggerhead turtles (top) and flatback turtles (bottom) (from Limpus and Miller, 2008).

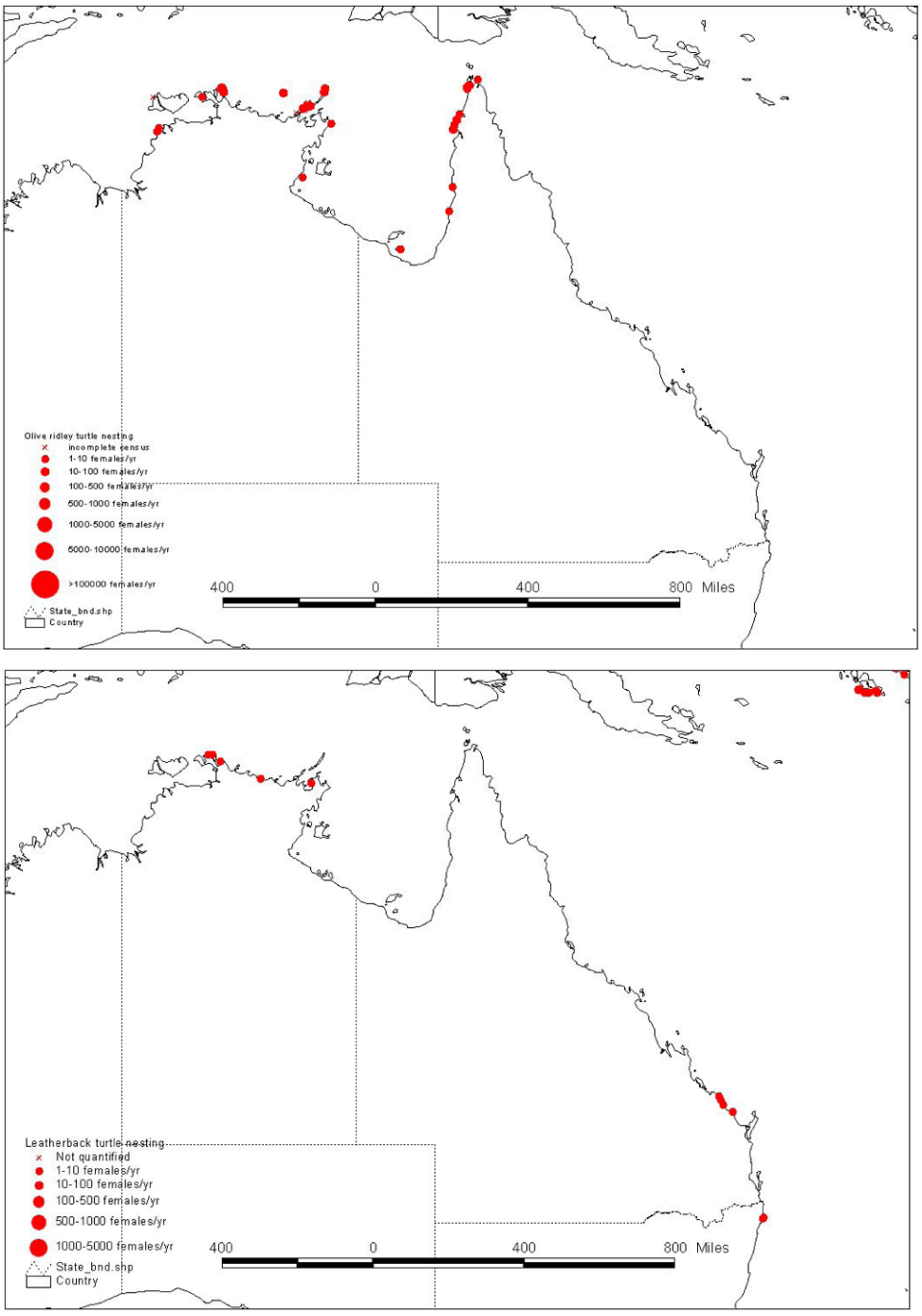

Figure 5-7 Nesting locations in northern and eastern Australia for olive Ridley turtles (top) and leatherback turtles (bottom) (from Limpus and Miller, 2008).

ESTUARINE CROCODILE

Estuarine crocodiles occur in the Trinity Bay region. The key areas for estuarine crocodile populations in Queensland is the north western Cape York Peninsula, particularly parts of the Wenlock River and the Lakefield National Park (Read *et al.*, 2004).

CETACEANS

The Indo-Pacific humpback dolphin (*Sousa chinensis*), the Australian snubfin dolphin (*Orcaella heinsohni*) and the bottlenose dolphin (*Tursiops aduncus* and *Tursiops truncatus*) – are known to or likely to occur in the Trinity Bay area. Both the Australian snubfin dolphin and the Indo-Pacific humpback dolphins usually inhabit shallow coastal waters of less than 20 m depth and are often associated with rivers and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.*, 1997, Hale *et al.*, 1998; Parra, 2006).

Elsewhere in Australia these dolphin species co-exist with coastal development including extensive port facilities (Hale *et al.*, 1998). For example, Indo-Pacific humpback dolphins and Australian snubfin dolphins are associated with port infrastructure at Cleveland Bay, Townsville (Parra, 2006) and the Indo-Pacific humpback dolphin also occurs in the Brisbane River (Hale *et al.*, 1998). Bottlenose dolphins also inhabit inshore areas where significant amounts of recreational vessel and commercial water-based activities occur including Moreton Bay (Chilvers *et al.*, 2005), Richmond and Clarence Rivers (NSW) (Fury and Harrison, 2008) and Port Stephens and Jervis Bay (NSW) (Möller *et al*., 2002).

The humpback whale migrates along the Australian east coast with the northern boundary of this migration being approximately Princess Charlotte Bay. Within Queensland the key resting areas for humpback whales are the Whitsundays, Hervey Bay, Moreton Bay, the Swains Reef complex and the Palm Island Group. Humpback whales are likely to migrate through the latitude of Trinity Bay in a northward direction in late July/early August and in a southward direction in late August/early September. While it is plausible that Humpback whales occur in Trinity Bay in the vicinity of the spoil ground, they are most likely to be found further offshore.

DUGONG

Dugong are known to occur in Trinity Bay and there is a considerable traditional harvest of the species by the residents of Yarrabah on the south eastern shore of Trinity Bay. Sixteen Dugong Protection Areas are declared under the Queensland *Nature Conservation Act 1992,* and as Special Management Areas under the *Great Barrier Reef Marine Park Regulations 1983* and the *Great Barrier Reef Marine Park Zoning Plan 2003*. The Great Barrier Reef Marine Park Authority's primary management intent for dugong conservation in the Great Barrier Reef Marine Park is to facilitate the recovery of dugong populations such that they fulfil their ecological role within the Great Barrier Reef ecosystem. DPA's are primarily a management tool to influence commercial fishing practices to protect dugong. Trinity Bay is not recognised as a Dugong Protection Area as the levels of inshore

fishing activity are low, however available seagrass habitat for the species in the area is substantial, but the concomitant abundance of dugong is less than many other areas along the Great Barrier Reef Coast.

OTHER SPECIES

Although not listed threatened or migratory species, a large number of seasnake and pipefish/seahorse (sygnathids) species that are listed marine species under section 248 of the *EPBC Act.* There are clear and significant knowledge gaps with respect to the distribution and abundance of sea snakes in Australia. However, the following sea snake species are considered to prefer inshore waters with sandy/muddy substrata and moderate turbidity such as those found in Trinity Bay: elegant seasnake (*Hydrophis elegans*), spine-bellied seasnake (*Lapemis hardwickii*), and the small headed seasnake (*Hydrophis mcdowelli*) (Heatwole and Cogger, 1993). There is insufficient information to determine which species of sygnathids are likely to be found in Trinity Bay.

5.6 Introduced Marine Pests

Three species considered to be of national pest significance, the Asian Green Mussel, Caribbean Tube Worm and most recently, the Asian Bag Mussel, have been detected on vessels in the Port of Cairns.

The history of introduced marine pest incursions was described by Sankey and Coles (2009). In July 2001, adult Asian Green Mussels (*Perna viridis*) were discovered on the hull of a foreign vessel (*Wing Sang 108*) within the Cairns Port. In response, a survey was conducted in Cairns Port in December 2001 by the Northern Fisheries Centre and the CRC Reef Research Centre to determine the prevalence of Asian Green Mussels. One mussel was found during dive surveys on each of the vessels (*Warunda* and *Shell Barge 56*) that had been moored in the vicinity of the *Wing Sang*. These vessels were slipped and a further three mussels were removed from the Warunda (26 January 2002) and five mussels from the *Shell Barge 56* (14 February 2002). Subsequent surveys by the Northern Fisheries Centre up until June 2002, located a further six Asian Green Mussels from vessels during diving and slipway inspections with the final mussel collected from an international trading vessel on a Cairns slipway in 2004. Even though at least one spawning and successful recruitment event took place in Trinity Inlet between 2001 and 2003 it was determined that the founder population was apparently too small to establish a permanent breeding population there. The Caribbean Tube Worm (*Hydroides sanctaecrucis*) was introduced into Cairns Port on the hulls of navy vessels slipped for routine maintenance in May 2001 and persists in low numbers.

Asian Green Mussels (*Perna viridis*) were detected again in Cairns Port on the naval vessel *HMAS Melville* on 4 December 2007 and a single, immature Asian Green Mussel was subsequently detected on the vessel *Aeolus III* on 16 January 2008. Samples from *HMAS Melville* also included adult Asian Bag Mussels (*Musculista senhousia*), a potential pest species. Both species of mussel are on the national list of introduced species (maintained by The Consultative Committee on Introduced Marine Pest Emergencies) that can trigger a national response.

Following the 2007 and 2008 identification of Asian Bag Mussels, Biosecurity Queensland (via Fisheries Queensland) enacted a quarantine process, which included a proof of freedom monitoring and surveillance program. This program was conducted between February and May 2009 and included a variety of surveillance techniques including:

- inspection of high risk vessels before they entered the port and inspections on slipways and moorings;
- visual survey of fixed structures that could potentially harbour Asian Green Mussels;
- monitoring for Asian Bag Mussels within the benthos; and
- collection of settlement plates and conducting plankton tows for mussel larvae on with to conduct DNA analysis.

This monitoring and surveillance program did not identify any Asian Green Mussel or Asian Bag Mussel DNA from plankton tow samples during the monitoring period. The survey identified that the Caribbean Tube Worm was wide spread in the port but did not appear to be causing major fouling problems at that time (Sankey & Coles, 2009).

Apart from the surveillance undertaken by Biosecurity Queensland, FNQPC has maintained rope mops and settlement plates at locations throughout the port since 2001 following detection of Black Stripped Mussels in Darwin. A plan of sampling sites for the Marine Pest Monitoring Program that is implemented by FNQPC is outlined in **Figure 5-8** and includes locations employed to complement the annual specific sampling of dredge areas for presence of marine pests. Sampling devices are checked on a quarterly basis by FNQPC staff, with any suspect material dispatched to Fisheries Queensland for further identification which may include referral to taxonomic expertise at James Cook University. Periodic replacement of surfaces and ropes is made once excessive fouling accumulates or if samplers are damaged. Outcomes of this sampling is compiled and reported to the Determining Authority in parallel with annual sediment characterisation studies, enabling consideration of both introduced marine pest status of the marine environment and the contaminant status of sediments when approving proposed annual dredging operations. To date (May 2010), there have been no detections of introduced marine pests on these rope mop or settlement plates.

As a condition of the Sea Dumping Permit approval, FNQPC has been required to complete an investigation into the presence/absence of introduced marine pests in proposed dredge sediments prior to annual dredging.

Figure 5-8 Marine pest sampler locations

The primary objectives of introduce marine pest investigations for sediments proposed for maintenance dredging have been to:

- Sample sediments for presence/absence of marine pest species previously detected within port limits, namely:
  - *Hydroides sanctaecrucis* (Caribbean Tubeworm);
  - *Perna viridis* (Asian Green Mussel); and
  - *Musculista senhousia* (Asian Bag Mussel)
- Survey sediments for presence of other potential marine pest species not previously identified within port limits; and
- Characterise sediments for suitability for colonisation of identified marine pest species.

Since the Port Baseline Survey in 2001-2002, surveys of proposed maintenance dredge material have been undertaken in 2003-2005 and 2007-2009. Surveys have been conducted using a combination of two methods: grab sampling and sled tows. Six replicate grab samples are taken from each contaminant assessment sampling location in respective port maintenance dredge areas. In addition, one-hundred metre long sled tows are undertaken at twelve pre-determined points along the outer channel and at several locations along the inner port adjacent to wharf areas. Grab samples are sieved using a 2mm mesh. The towed sled has a mesh size of approximately 3mm around the containment area through which material is washed. Material from sieved grab samples and sleds is typically sorted on board the vessel and any mussel shells (dead or alive), calcareous worm tube fragments or other evident introduced marine pest species are retained for identification by the relevant curator at the Queensland Museum or other taxonomic specialist.

Sampling has also been undertaken at the spoil ground using similar grab sampling and towed sled methods.

Dead mussel (mytillid) shell valves and fragments species are occasional found within sediments sampled using the towed sled and rarely when using the grab, clearly due the difference in volume of sediment sampled. None of the mussel specimens retained and identified at the Queensland Museum have been confirmed as any of the introduced marine pest species.

Very rarely are fragments of calcareous worm tubes (the type characteristic of the Caribbean Tube Worm) found in retained material. The calcareous tube fragments have been small and have not contained any living material and so are not suitable for formal identification.

Outcomes of all surveys of sediments to be dredged between 2003 and 2009 were similar in that no introduced marine pests were found and that the finer clayey silt material located throughout the dredge areas is unlikely to suit colonisation any of the species of concern (Neil *et al* 2003; Neil & Stafford 2004; and GHD, 2005; WorleyParsons, 2008 e,f,g; WorleyParsons, 2009a).

Previous identification of the Caribbean Tube Worm and Asian Green Mussel has been restricted to species colonisation and recruitment of hard substrates such as vessels and hard infrastructure, e.g.

pontoons. The only highlighted marine pest species that has the potential to colonise finer sediment material is the Asian Bag Mussel, which can inhabit both soft and hard substrates in coastal or brackish waters (Stafford and Willan, 2007).

6. IMPACTS OF DREDGING AND DISPOSAL

6.1 General

The environmental impacts of dredging at Cairns Port have been studied and documented during past dredging campaigns. As such, the following assessment of potential impacts is based on information drawn from studies undertaken during previous dredging campaigns and longer-term environmental monitoring undertaken in Cairns Harbour / Trinity Bay and Trinity Inlet.

Assessment of impacts of ongoing maintenance dredging must be undertaken in the context of historical dredging and spoil disposal activities and the ongoing requirements for maintenance dredging at Cairns Port.

In 2006, monitoring requirements for the 2005-2010 permit period were consolidated into the Cairns Harbour Dredging Long Term Dredge Spoil Disposal Management Plan Monitoring Plan (Years 2 to 5) (CPA, 2006). This plan was considered and approved by the TACC and Determining Authority. **Table 6-1** summarises the required monitoring programs, with commentary on the status of implementation and outcomes and demonstrates total compliance in implementing the monitoring program.

The following components of **Section 6** build on the findings of the past five years of monitoring, provide an update with contemporary understanding of dredging impacts in Cairns Port, make conclusions regarding predicted impacts for maintenance dredging at Port of Cairns in the 2010-2020 permit period, and provide supporting detail for monitoring required to meet the management strategies in subsequent **Section 7** of the LTMP.

The activities proposed during maintenance dredging have been detailed within **Section 3**, and characteristics of the material to be dredged and the prevailing environmental conditions detailed within **Sections 4** and **5** respectively. The impacts associated with the proposed dredging and disposal can be defined as either short or long-term effects. Short-term affects may include physical removal of benthic habitat, smothering and burial of benthic organisms at the spoil ground, impacts to water quality and receiving organisms and injury to significant megafauna. Long-term affects relate to changes in habitat conditions, such as significant sediment mobilisation to areas outside the spoil ground.

Table 6-1 Summary of actual versus planned monitoring under previous LTSDSMP – monitoring plan for years 2005-2009

✓= Proposed monitoring activity, **Y=** completed monitoring activity, **^=** item not required, **%=** monitoring required if prior study warrants it, **X=**monitoring not required, **(XXX)** =monitoring commitment not completed

2005 LTDSDMP IMPACT HYPOTHESIS	ACTIVITY	MONITORING ITEM	DETAILS	PLAN					COMMENTS	ACTUAL					Comments on Outcomes
				1	2	3	4	5		1	2	3	4	5	
				05	06	07	08	09		2005	2006	2007	2008	2009	
(1) Plumes associated with dredging and/or the deposited material will not reach any sensitive areas, through dispersal of the dredge plume, in amounts sufficient to be of concern.	Dredging – Inner Harbour (HMAS Cairns)	Water Quality Monitoring Program	Turbidity monitoring.	✓					Considered unwarranted for future years, pending SAP results.	**Y**	-	-	-	-	Program implemented at Navy Base (GHD) Nil issues identified – recommendation to cease implementation in subsequent years
			Dissolved metals	✓					Considered unwarranted for future years, pending SAP results.	**Y**	-	-	-	-	Program implemented at Navy Base (GHD) As above - Nil sediment issues identified that triggered an EMP Water Quality program
	Dredging – Outer Harbour/Entrance Channel	Water Quality Monitoring Program	Observe dredge plumes during dredging, and if excessive, alter weir overflow system.	✓	✓	✓			Via vessel operating procedures and the *Brisbane*'s EMP (Port of Brisbane Corporation).	**Y**	**Y**	**Y**	**Y**	**Y**	EMP for operations of the dredge *Brisbane* implemented for each campaign – no non-compliances recorded
			If seagrass declines are identified as, then undertake further investigations.	✓	✓	*			Long term seagrass monitoring work (recommended past December 2006).	**Y**	**Y**	**Y**	**Y**	**Y**	CPA support provided to implementation of DPI&F's program in each year- nil seagrass decline identified that could be attributed to plume induced impacts
	Dredging under ERA19(b) Licence or Capital projects	Water Quality Monitoring Program	Dissolved metals Turbidity		*	*			Specific water quality programs to be considered within the project EMP for capital dredging or ERA19(b) works. Monitoring to be considered for implementation on a project by project basis pending findings of Sediment Analysis Plan.						No potential sediment mobilised contaminant issues identified – no monitoring response required
(2) Disposal will not result in ecologically significant inputs of contaminants to the water column.	Disposal	Sediment Analysis Program – Contaminants of Concern	Step-wise approach for Action List (Groups 3 and 4).	✓	✓	✓			Implemented via the ASAP and SAP Report based on the stepwise approach framed in the 2006 SAP.	**Y** Ch IP MM NB(i) CFB1 CFB2	**Y** Ch IP MM NB(i) CFB1 CFB2	**Y** Ch IP MM NB(i) CFB1 CFB2	**Y** Ch IP MM NB(i) CFB1 CFB2	**Y** Ch IP NB(o)	SAP implemented for each year to meet dredging need. Greater intensity of sampling at Marlin Marina, CFB1 and CFB2 initiated from 2006 onwards
	Disposal	Sediment Analysis Program – Contaminants (Other)	Step-wise approach for Groups 1 and 2.		✓	✓			Implemented via the ASAP and SAP Report based on the stepwise approach framed in the 2006 SAP.	**Y**	**Y**	**Y**	**Y**	**Y**	SAP implemented for each year to meet dredging need. Nil issues with Group 1 or 2 elements detected
	Disposal	Sediment Analysis Plan – Contaminants (New)	Strategic assessment of "new" chemicals including pesticides, radionuclides, chlorinated hydrocarbons, dioxins, and trace metals.		✓	%			% If warranted, included in future SAP's.	-	**Y**	**Y**	**Y**	**Y**	Herbicide Diuron identified as a potential "new" CoC and included in 2006 SAP as an initial screen, then included in subsequent years, including assessment of elutriate and porewater which identified nil issues above guidelines when appropriate lab detection limit was achieved.

2005 LTDSDMP IMPACT HYPOTHESIS	ACTIVITY	MONITORING ITEM	DETAILS	PLAN					COMMENTS	ACTUAL					Comments on Outcomes
				1	2	3	4	5		1	2	3	4	5	
				05	06	07	08	09		2005	2006	2007	2008	2009	
(5) There will be no serious adverse impact from the dredging operation on seagrass beds adjacent to the dredged areas.	Dredging	Long Term Seagrass Monitoring Program	Continue Long Term Seagrass Monitoring. Compare results of monitoring with previous seagrass surveys and assess any changes in seagrass distribution and abundance in relation to natural events or anthropogenic port and catchment activities. If changes, undertake further investigations.	✓	✓	✓	✓	✓	* Committed (2005, 2006). DPI&F Cairns Harbour and Trinity Inlet Long Term Seagrass Monitoring Program - continuation supported.	**Y** CPA funded offset project	**Y** CPA funded offset project	**Y** CPA funded	**Y** Via TIW funds	**Y** Via TIW funds	CPA support provided to implementation of DPI&F's program in each year Seagrass Monitoring used to assess condition of seagrasses and resilience to impacts likely associated with dredging activities by TACC. - nil seagrass decline identified that could be attributed to port activities and no additional dredge mitigation was required Noted that seagrass resilience to dredging could be reduced by natural events in the future
(6) There will be loss of benthic assemblages at the disposal site once disposal commences, but this will not involve loss of any resources of high conservation or other value. The deposited material will not reach any sensitive receptors through re-suspension and dispersal by water movement in amounts sufficient to be of concern.	Disposal	Long Term Seagrass Monitoring Program	Compare results of monitoring with previous seagrass surveys (e.g. 2003 Disposal site Flora and Fauna survey) and assess any changes in seagrass distribution and abundance in relation to disposal activities.					*	Continue support for DPI&F Long Term Seagrass Monitoring within Trinity Bay as an indicator of wider port health.					**Y**	Ocean Disposal Site Survey completed in 2009 – included radial survey design to detect presence of marine flora and fauna (incl seagrass) at and adjacent to spoil ground – nil detection of seagrass. Nil broad scale DPI&F surveys conducted in the Bay during the period.
(7) There will be no significant/ deleterious disruption to the feeding, breeding and spawning behaviour of dugongs, turtles, fish and prawns.	Dredging	Port of Brisbane Corporation *Brisbane*'s EMP (8.2.4)	Observe fauna during dredging and disposal.	✓	✓	✓	✓	✓	Via vessel operating procedures by Port of Brisbane Staff. Reporting of any observations of large fauna to CPA.	**Y**	**Y**	**Y**	**Y**	**Y**	EMP for operations by *Brisbane* implemented for each campaign – no mega fauna sightings reported
		Long Term Seagrass Monitoring Program	Monitor seagrass meadows adjacent to the channel to assess the relative health of habitats for prawns, fish turtles and dugongs.	✓	✓	*	*	*	This is an indirect test to investigate loss of habitat or effect on feeding.	**Y**	**Y**	**Y**	**Y**	**Y**	CPA supported implementation of DPI&F's program – Seagrass meadow changes mostly related to regional climate condition and remained in healthy state
			If deleterious changes in flora and fauna adjacent to the dredge areas are identified by other agencies, support further investigations.		✓	*	*	*	Continue support for DPI&F Long Term Seagrass monitoring, and other agency programs within Trinity Bay as an indicator of wider port health.	**Y**	**Y**	**Y**	**Y**	**Y**	CPA support to implementation of DPI&F's program – nil decline issues identified. Dredge management and mitigation measures in place were effective - No specific investigations required.
(8) There will be no significant changes in sediment particle-size distribution at the disposal site as a result of spoil disposal.	Disposal	Sediment Analysis Program – Grain Size analysis	Compare pre dredge channel and inner port SAP results with historical dataset to observe trends in port sedimentology.	✓	✓	✓	✓	✓	Continue SAP grain size analysis to ensure no significant changes in composition of spoil being disposed occurs. Include this comparison in pre dredge SAP Report.	**Y**	**Y**	**Y**	**Y**	**Y**	Particle size evaluation completed each SAP, consistent sediment size trend

2005 LTDSDMP IMPACT HYPOTHESIS	ACTIVITY	MONITORING ITEM	DETAILS	PLAN					COMMENTS	ACTUAL					Comments on Outcomes
				1	2	3	4	5		1	2	3	4	5	
				05	06	07	08	09		2005	2006	2007	2008	2009	
(9) There will be no ecologically significant accumulation of contaminants at the disposal site as a result of spoil disposal.	Disposal	Sediment Analysis Program (Contaminants of Concern)	Annual sampling of Action List (Groups 4) elements at the Spoil Ground as per the SAP.	✓	✓	✓	✓	✓	Compare results with historical dataset to identify any increasing accumulation trends. Report findings in annual SAP Report.	Y	Y	Y	Y	Y	Annual SAP sampling replicated at the 6 sites at the ODS. No evidence of sediment contamination accumulation or increase identified.
		Sediment Analysis Program – enhancement	Review of the sedimentology work by Carter *et al.* (2002), the current Spoil Ground sampling, and new fieldwork to determine if warranted to establish background levels of pollutants of concern adjacent to the Spoil Ground.			✓	%	%	Desktop study in Year 3 to investigate the relative worth of doing background level investigation. % If warranted included in future SAPs as per Step 2, Section 3.10.2 of NODGDM (EA 2002).			X	X	X	Initial study completed and methodology proposed in 2007 but unresolved. Reverted to/accepted default NODGM and NADGD values. Derived local value for Arsenic on basis of monitoring dataset and outcome of Carter *et al* 2002.
(10) There will be no significant increase in turbidity at the disposal site associated with increased exposure to wave-generated currents.	Disposal	Hydrographic Survey Program	Complete surveys within four weeks pre and post each annual disposal episode.	✓	✓	✓	✓	✓	As per existing Hydrographic Survey Program.	Y	Y	Y	Y	Y	Hydro survey program implemented –
			Analysis of hydrographic survey findings (i.e. differences between pre- and post-disposal events) at end of 5 year program.					✓	Detailed analysis of residual bed level and reconciliation with dumping records and known hydrodynamic processes outlined in the LTDSDMP.					Y	Hydro survey results used to inform understanding on sediment accumulation per dredge area and refined sampling methods from 2007 onwards. Spoil ground hydro surveys evaluated at Year 5 (2009) to inform evaluation of capacity of spoil ground in next permit period.
(12) The lack of suitable habitat in both the dredged area and the Spoil Ground will prevent the development of significant populations of Asian Green Mussel or Caribbean Tube Worm at the Spoil Ground.	Dredging	Marine Pest Surveys	Pre-dredge survey for CTW and AGM in areas to be dredged (GHD 2005).	✓					Implemented for Year One (GHD, 2005). Considered unwarranted for future years.	Y Pre dredge and post dredge(spoil ground surveys completed (GHD)	Nil survey	Y Pre dredge survey completed at each dredge area (grabs)	Y Pre dredge survey completed per dredge area (grabs &sleds)	Y Pre dredge Survey completed per dredge area (grabs &sleds) also completed at Ocean Disposal Site	Sampling implemented, inclusion of methods to detect Asian Bag Mussels after BioSecurity QLD detection aboard vessel in early 2007 – nil CTW, AGM or ABM detected in spoil or at ODS in 5 year period.
		Marine Pest Monitoring Program	Ongoing larval settlement plate program for inner port area	✓	✓	✓	✓	✓	Program designed to detect presence of AGM and CTW within and adjacent to maintenance dredging areas.	Y	Y	Y	Y	Y	Ongoing implementation of program – increased intensity during 2008-2009 as a component of Biosecurity QLD's proof of freedom surveillance in response to Dec 2007 detection of AGM and ABM on vessel
		Marine Pest Monitoring Program	Contribute to and cooperate with agencies facilitating implementation of any new national marine pest monitoring plan within the port.		*	*	*	*	Contribute to the design of new marine pest surveys through national, industry and intergovernmental initiatives.			Y	Y	Y	Contributed to BioSecurity QLD's response to Asian Mussel detection. No repeat of port baseline survey .Continued involvement on marine pest issues via Ports Australia and Queensland Ports Association

2005 LTDSDMP IMPACT HYPOTHESIS	ACTIVITY	MONITORING ITEM	DETAILS	PLAN					COMMENTS	ACTUAL					Comments on Outcomes
				1	2	3	4	5		1	2	3	4	5	
				05	06	07	08	09		2005	2006	2007	2008	2009	
(13) There will be no significant outbreaks of exotic species at the current Spoil Ground.	Disposal	Marine Pests Survey – Future	Contribute to and cooperate with agencies facilitating implementation of any new national marine pest monitoring plan to survey the disposal site and wider port area.		*	*	*	*	Contribute to the design of new marine pest surveys through national, industry and intergovernmental initiatives. Implement as required.	^	^	^	^	Y	No repeat of port baseline survey, nor any new national or state protocols proposed by respective agencies. Completed 2009 ODS survey for marine pests- nil located
(14) There will be no significant loss of dugong, turtle, wading bird, fish or prawn feeding and shelter habitat resulting from sea disposal activity at the Spoil Ground.	Disposal	Long Term Seagrass Monitoring Program	Compare results of monitoring with previous seagrass surveys (e.g. 2003 Disposal site Flora and Fauna survey).	✓	✓	✓	✓	✓	Continuation of the DPI&F Cairns Harbour and Trinity Inlet Long Term Seagrass Monitoring Program. Assess any changes in seagrass distribution and abundance in relation to disposal activities to assess the relative health of habitats for prawns, fish turtles and dugongs.	Y	Y	Y	Y	Y Y	Continued support of DPI&F's Cairns Harbour and Trinity Inlet program – nil issues identified. Completed 2009 ODS survey, including check for presence of marine plants at and adjacent to site – nil detected.
			If deleterious changes in flora and fauna adjacent to the disposal site are identified by other agencies, support further investigations.		*	*	*	*	Continue support for DPI&F Long Term Seagrass Monitoring Program, and other agency programs within Trinity Bay as an indicator of wider port health.	Y	Y	Y	Y	Y	As noted above and at Item(5)
	Disposal	Dredging EMP	Visual observation of presence of large fauna while dumping.	✓	✓	✓	✓	✓	Via vessel operating procedures by Port of Brisbane Staff. Reporting of any observations of large fauna to CPA.	Y	Y	Y	Y	Y	EMP for the operations of the *Brisbane* implemented, nil sightings reported in 5 campaigns.

6.2 Water Quality

Impacts to water quality from dredging and disposal activities relate to increased turbidity and suspended solids concentrations, mobilisation of nutrient loads and toxicant substances. While water quality may be impacted during dredging processes, water is a vector of the disturbance to the 'true' receptors, including, adjacent benthic communities, nekton (fishes) and significant mega fauna such as turtles, dolphins and dugong. The alterations to water quality only are described below, with impacts to the true receptors discussed in other sections.

6.2.1 Turbidity and Suspended Solids

Of the two dredge types used for dredging at Cairns Port, the trailing suction hopper dredge, which operates primarily in the outer channel with limited operations in the inner port, generates most turbidity and suspended solids within the water column when operating in overflow mode as the hopper approaches capacity. Turbidity generated by the grab-bucket operations is minor in comparison and remains localised within the port operations area.

Monitoring undertaken by Connell Wagner (1991) during the widening of the Cairns entrance channel represents the most detailed early survey information available with respect to turbidity characteristics during dredging within the inner, mid and outer harbour. The channel widening project removed approximately 1 million tonnes of sediment to the offshore disposal ground. Monitoring results indicated a relatively small zone of impact surrounding the dredge (*Sir Thomas Hiley*), extending between 100-700 m from the point of disturbance in the channel before turbidity levels attained background concentrations. A very similar result was observed at the disposal ground, where disposal plumes were observed to travel no more than 1000 m before reaching prevailing background turbidity concentrations (Connell Wagner, 1991). These spatial extents would be reduced using more modern trailer suction hopper dredges, such as the *Brisbane*, which have subsurface discharges and moveable internal weirs to manage discharge turbidity and overflow duration. It should be noted that any turbidity generated in the entrance channel by overflow dredging would be limited to about 15 minutes during an approximate three hour dredge cycle (i.e. less than 10% of time), so the most intense turbidity plumes are limited both spatially and temporally. Further, potential for individual seagrass to be exposed to dredge generated turbid plumes would be limited to those times when dredging is occurring adjacent to it in the channel.

Environment North (2005) collated turbidity monitoring data from several dredging campaigns between 1998 and 2002. All studies reported increases in turbidity during dredging, yet remain largely within reported levels of background variation. SKM (2001) reported pre-dredge ambient surface water turbidity at ~5 ntu and dredge surface water turbidity at a maximum of 30 ntu, describing impacts of dredging within the port as being of small magnitude and highly localised. Background measurements were also obtained from the nearest seagrass meadow which reported ambient turbidity between 25-35 ntu.

Investigations undertaken by GHD (2002) in support of the City Port development surveyed background conditions utilising deployed nephelometer instruments available from James Cook University. These units also remained in position for the duration of dredging. Reactive monitoring teams adopted an impact monitoring threshold of 35 ntu when the plume intersected seagrass beds. In these instances a compliance value of ambient (outside the influence of the dredge plume) plus 100% was adopted as a management response limit for a periods greater than 6hrs. Despite the dredge plume intersecting the seagrass beds on several occasions during dredging, none of the monitoring sites experienced conditions above this management limit. The dredge plume was found to be highly mobile, and turbidity concentrations over the seagrass beds temporally variable. As recorded by the deployed turbidity loggers, the most significant elevations in turbidity were associated with natural tidal movement and not related to the dredge operations.

In comparison with wet season peak loads from the Barron River, and more frequent wind driven turbidity events, sometimes lasting several days to many weeks, the affects of episodic dredging and disposal within Trinity inlet, Trinity Bay and offshore disposal ground, is considered of minor consequence to this naturally turbid and highly variable system.

In conclusion, maintenance dredging of the outer channel, the dredging operation with most turbidity generation impact potential over seagrass habitat, typically lasts one to two weeks each year, with the mobile dredging operation undertaking overflow operation for a small portion of each dredge cycle. Turbid plume generation at the spoil ground would extend up to about one kilometre over muddy substrate, based on previous monitoring. While the previously recorded turbidity plumes reflect likely maximum extent, confirmation of this is proposed during a routine maintenance dredging campaign in the outer channel and following deposition at the spoil ground.

6.2.2 Nutrients

Nutrient concentrations from marine sediments reported from Trinity Inlet and Trinity Bay denote a potential for nutrients to be released to the water column during dredging and disposal (Carter *et al*. 2003, WorleyParsons, 2008a-c and 2009a). Routine water quality monitoring undertaken by CPA from the inner harbour demonstrate a general compliance to adopted WQOs for Total Nitrogen and Chlorophyll-a. However, concentrations for ammonia and total phosphorus remain in excess of WQOs. The similarity between offshore sediments and disposed sediments (Carter *et al*. 2003) suggests that deposited sediments are unlikely to drive a significant variation in nutrient release to that already occurring within the background sediments. Natural forces driving algal blooms, such as periods of warm calm weather following a turbulent period in the Bay would have a far wider impact than that of dredging and disposal. Previously mentioned risks of nutrients, epiphytic algal growth and seagrass health (Environment North, 2005) does not account for the temporal nature of dredge derived impacts (sustained nutrient elevations would be required to significantly influence epiphytic growth).

In conclusion, whilst the potential for nutrient release during dredging and disposal is perceivable, the existing background concentrations, and short duration of maintenance dredging activity lowers the

overall likelihood and consequence of problematic nutrient elevations. On that basis, analysis of dredge and disposal locations during disposal for nutrients in water is not considered warranted.

6.2.3 Toxicants

Prior to the disposal of dredge spoil, sediment sampling and analysis defines the overall suitability of the material for unconfined ocean disposal. Sediment quality at Cairns Port has been discussed in **Section 4**. Where analytes record 95%UCL values in excess of guideline criteria, elutriate testing is undertaken to predict impacts to water quality. The results of laboratory analyses, which essentially test the supernatant water from a settled 1:4 mixture of sediment and seawater, can be afforded a level of dilution which allows for at least 100 time dilution. For those substances that have required elutriate testing (i.e arsenic, tributyltin and Diuron), the diluted concentrations consistently fall well below the ANZECC/ARMCANZ (2000) water quality guideline toxicant guideline levels at the 95% species protection level. Field monitoring during dredging and disposal has recorded water quality concentrations for toxicants (metals/hydrocarbons) below the respective guideline criteria.

Risks to the marine environment from the mobilisation of toxicant substances into the water column during dredging or disposal are considered to be low. In accordance with NAGD requirements, potential impacts to water quality should be assed via elutriate analysis if the NAGD screening levels (or other agreed levels based on site specific data) are exceeded at the 95%UCL of the mean for total contaminant concentrations.

6.3 Sediment Quality at the Spoil Ground

Prior to the disposal of dredge spoil, sediment sampling and analysis defines the overall suitability of the material for unconfined ocean disposal. Where analytes record mean concentrations (upper 95% confidence interval) in excess of NAGD screening levels (or other agreed levels based on site specific data), the bioavailability of the contaminant substance is investigated via porewater concentration assessment or dilute acid extraction for metals (or acid volatile sulphide and simultaneously extracted metals). Where these tests have been undertaken, concentrations have been at levels that indicate that the contaminant substance is not likely to be bioavailable to benthic organisms.

While dredge material routinely is classified as suitable for placement at the spoil ground, monitoring of sediments at four sites within the spoil ground two sites and adjacent to the spoil ground is undertaken to gauge long term trends. Despite dredge area sediments occasionally exceeding Screening Levels, concentrations at the spoil ground routinely achieve Screening Levels at the 95%UCL of the mean. It is anticipated that spoil ground contaminant concentrations will remain stable or decrease as dredge area concentrations remain stable or decrease. Survey of the sediment to be dredged and monitoring of the spoil ground will continue during the term of this 2010-2020 LTMP under an approved sediment sampling and analysis program.

6.4 Benthic Flora and Fauna

6.4.1 Mangroves

Mangrove communities along the Trinity Inlet banks are not subject to potential impacts from routine maintenance dredging at Cairns Port as they are outside the dredging footprint and unlikely to be subject to turbidity plume impacts or sedimentation.

6.4.2 Benthic Flora – Seagrass

The only significant benthic flora in the vicinity of the maintenance dredging and disposal activities are seagrass meadows in Cairns Harbour / Trinity Bay adjacent to the outer channel.

Dredging operations can pose a significant risk to seagrasses, with risks arising directly from removal or burial or indirectly through turbid plumes generated during dredging, leading to a loss of light and seagrass declines. The actual impacts associated with a particular dredging program depend on the scale and extent of dredging, the individual physical environments within which they occur and the resilience of the seagrass community. Major capital dredging campaigns can physically remove large areas of seagrass and involve large volumes of material dredged over several months or longer. This extended large-scale dredging can result in significant periods of light deprivation and impacts to seagrasses and are often predicted in impact assessments. Erftemeijer and Lewis (2006) have summarised and tabulated large-scale losses of seagrass around the world from a range of scientific and impact assessment reports, which upon review relate principally to large-scale capital dredging or reclamation projects, with losses being principally from direct removal rather than from turbidity effects and light deprivation. Clearly, such large-scale projects can present a significant risk to seagrass communities.

Routine maintenance dredging, however, generally presents far lower risk to seagrass communities. Direct losses of seagrass are limited to low density isolated regrowth of pioneering species within the confines of the previously dredged area or within the designated spoil ground. Hence, potential impacts to seagrass from routine maintenance dredging activities relate principally to generation of suspended sediment turbid plumes potentially resulting in seagrass declines through loss of light for photosynthetic activity.

It is important to also recognise the physical and climatic environments within which the dredging operations are proposed to occur, since these can significantly influence the associated risks to seagrasses. Climatic and physical characteristics are increasingly being recognised as key drivers in seagrass dynamics and distribution and their influence can be quite site specific. Hence, where dredging operations are an ongoing concern, such as the case or routine maintenance dredging for ports, assessment of indirect impacts to seagrasses through turbidity and light deprivation should be based on results of prior monitoring where possible as historical dredging activities are reflected in the physical environment being considered.

A significant body of knowledge regarding the distribution and health of seagrasses within Cairns Harbour / Trinity Bay and Trinity Inlet has been developed over the last 10-15 years. Dedicated

programs undertaken by Fisheries Queensland and supported by FNQPC as part of the Trinity Inlet Monitoring Program have been established, providing annual monitoring of key seagrass communities since 2001.

While fluctuations in biomass per unit area are observed for monitored seagrass meadows in Cairns Harbour and Trinity Bay, the areal extent of the meadows has generally increased over time (refer **Section 5.4.1**) and the meadows retain a healthy status. No observed changes to seagrass biomass have been attributed to port operations or dredging operations to date. Seagrass communities appear to be resilient – in current environmental conditions - to the level of disturbance associated with the routine maintenance dredging campaigns. This is likely due to a combination of factors including the resilience of seagrasses to short term changes to light climate, the short duration of dredging campaigns and limited exposure to turbid plumes within those campaigns and regular tidal flushing with oceanic water.

The variations in biomass, area and health of the Cairns Harbour, Trinity Inlet and Redbank Creek seagrass meadows are reported to be largely driven by physical climatic factors such as wind, wave, cyclones, and flood (Rasheed *et al*, 2008; McKenna *et al*., 2009). Possible catchment based impacts have been speculated but not investigated. The identification of climatic factors being primary drivers of seagrass variability, rather than port operations or routine maintenance dredging, is a common conclusion of Fisheries Queensland seagrass monitoring for ports around Queensland. However, under adverse climatic conditions, seagrasses may become stressed and be vulnerable to dredging.

The changes observed in long-term seagrass monitoring meadows in Cairns have typically been reported (Rasheed *et al*, 2008; McKenna *et al*, 2009) as appearing consistent with the prevailing climatic conditions in the area and for other similar seagrass areas monitored in north Queensland.

Low light availability

Seagrasses in Cairns are likely to be limited by light availability, with relatively short windows of time where sufficient light is received for effective growth. Pollard and Greenway (1993) describe the seagrass adjacent to the Cairns Esplanade as being adapted to low light intensity and high turbidity. These communities receive approximately two hours of saturated light per day, and survive in conditions which return less than 1% surface irradiance (SI) for up to 80% of the daylight hours, and are potentially vulnerable to further reductions of light that decrease this photosynthetic window.

While intertidal seagrasses along the Esplanade to Ellie Point appear to survive in very dynamic and low light conditions, such seagrasses may be vulnerable to impact should the short time available during the day for photosynthetic activity be reduced through turbid plumes generated from dredging or through extended periods of natural turbidity from wind wave storm re-suspension and turbid mainland runoff, or a combination of both. The risk to the deeper meadows that occur even closer to the channels (not currently monitored) would be greater again. The design of the dredging program minimises the risk of this situation occurring by:

- Dredging turbid plume generation within the outer channel being limited to less than 10% of dredging cycle times;

- Maintenance dredging typically completed within a short one to two week period;
- Routine maintenance dredging is typically undertaken around August each year, which is not within the wet season, so cumulative impacts between flood-related and dredging turbidity plumes are unlikely to occur; and
- Some seagrass meadows potentially at risk are intertidal and may receive a respite from low light during periods of daytime low tide exposure (McKenna *et al*, 2009).

Despite these measures a combination of unfavourable climate events over extended periods (i.e. several years of drought) could lead to a situation where seagrasses become less resilient and vulnerable to further stresses such as those created during dredging. It is important therefore to have a good understanding on the condition of seagrasses prior to dredging to enable the implementation of additional mitigation strategies if required.

Spatial and temporal affects

The minor temporal and spatial scale of routine maintenance dredging operations at Cairns Port results in low risk of impact to seagrass communities. Channel dredging operations (works closest to the seagrass habitats) are undertaken over a one to two week period by the trailer suction hopper dredge, which operates in overflow mode for a small proportion of the dredging cycle (approximately 15 minutes out of three hours). Other dredge works undertaken within the inner port and marina areas using a clam-bucket dredge produces minor plumes that remain very localised within the port area and well removed from any seagrass beds.

For the major capital dredging campaign in 2001 to widen the entrance channel, Connell Wagner (1991) determined via field monitoring during dredging, that plumes extended up to ~700 m from the dredge before reaching background concentrations. Of the approximate 1380- 1450 ha of seagrass meadows within Cairns Harbour/Trinity Bay, less than 20% can be described as being nearer than 1000 m from dredge operations The communities within this likely zone of influence include isolated patches of light *Z. capricorni* near Marlin Marina / Cairns Esplanade and South Bessie Point, light density *Halophila decipiens* immediately west of the outer channel and moderate density *H. ovalis* over the Bessie Point meadows. The extent of turbid plume generated by the modern trailer suction hopper dredge during routine maintenance dredging would unlikely exceed that experienced during the 2001 capital dredging campaign.

Many naturally occurring events (wind, wave and cyclone) exceed both the duration and magnitude of turbidity and sediment generating processes such as that experienced during routine maintenance dredging. Similarly, the fluctuation of ambient turbidity during the change of tide, shift between neap and spring conditions and wind wave storm action drives a flux of increased turbidity over seagrass beds in the Cairns Harbour / Trinity Bay area on a daily to weekly basis.

While significant capital dredge programs or sustained land based reclamation programs may have the capacity to generate significant quantities of suspended and fine sediment deposits and limit light availability to seagrasses over extended periods, the routine dredging program at Cairns Port is not of sufficient spatial extent or duration to result in significant indirect impacts over the adjacent meadows

at Bessie Point or the Cairns Esplanade. Any turbidity generated is likely to be buffered by the regular flushing of Cairns Harbour / Trinity inlet, as identified by Lou Mason from James Cook University in relation to increased flooding and sedimentation associated with flooding (cited in McKenna *et al (2009).*

In summary and conclusion, long-term monitoring of seagrasses meadows in Cairns Harbour / Trinity Bay has demonstrated that seagrasses are healthy with changes to seagrass biomass and area likely associated with natural climate changes. The seagrass meadows monitored represent the majority of seagrass area within the Cairns Harbour / Trinity Inlet but deeper meadows close to the channel are not part of current routine monitoring. Concern has been raised over the observed changes within seagrass beds in Trinity Inlet and Redbank Creek; however these have not been attributed to port operations or routine maintenance dredging activities. These minor seagrass beds are well upstream of the port and not influenced by port or dredging activities.

Changes in seagrass meadows monitored within Cairns Harbour / Trinity Inlet have been described by Fisheries Queensland in recent monitoring reports as being driven largely by climatic factors and exposure (Rasheed *et* al, 2008; McKenna *et al*, 2009) and observed changes have generally been consistent with changes observed at other monitoring sites in North Queensland. There is evidence that large reductions in seagrass area and biomass have occurred in the past (e.g. during 2002-2003), along the Esplanade to Ellie Point as well as the Bessie Point meadow but seagrasses have been able to recover from these losses in recent years. These changes show that a combination of climate factors have the capacity to impact on seagrass health.

The nature of the maintenance dredging in Cairns is such that it mitigates much of the risk associated with dredging. Dredging occurs over a relatively short timeframe (approximately 2 weeks) and in the past; seagrasses have proven to be resilient to this level of impact. However, dredging still does pose some risk to seagrass meadows especially if changes to the cumulative levels of impact from other sources (i.e. climate, temperature stress, exposure) lead to seagrasses becoming less resilient to impacts associated with dredging".

The routine maintenance dredging to be undertaken within Cairns Port is consistent with that undertaken since 2001, so the low level of dredging risk will remain relatively constant. However it remains important to maintain a good understanding of seagrass health and condition for effective dredge mitigation planning as seagrasses are responding to a range of natural drivers that have the capacity to reduce their resilience to impacts associated with dredging activities.

6.4.3 Benthic Fauna

DREDGE AREA

The maintenance dredging area in the inner port, marina areas and entrance channel contain primarily open muddy substrates, with limited areas of open sandy/gravelly substrate. These habitats contain only benthic infauna and would be subject to disturbance or removal on an annual basis when dredging was undertaken. The recovery process between dredging events is anticipated to be rapid

for the more common, opportunistic invertebrate species. While some recovery of the benthic community may occur following dredging, it may be subject to removal again in the following year. It should be noted, however, that dredging within channels targets only those areas that are considered high spots, so there will be patchy areas of sediment removal only and recovery of infauna communities in the dredged area can be seeded by adjacent, undisturbed areas.

The area of substrate removal within the port and entrance channel is minor in relation to the extent of similar substrates within the remainder of Trinity Inlet, so impacts to benthic communities would be relatively minor. Any flow-on impacts to fish and mobile crustaceans from continued annual dredging are expected to be negligible since volumes of material to be extracted will be similar to previous years.

SPOIL GROUND

Monitoring undertaken recently at the offshore disposal ground (WorleyParsons, 2009b) benthic infauna assemblages with the express objective of identifying impacts within and adjacent to the spoil ground from spoil placement or sediment remobilisation. The survey design included five sites within the spoil ground, and five sites each of transects radiating out from the spoil ground boundary to identify any gradients of change that could be attributable to spoil disposal or remobilisation of sediments. A range of univariate and multivariate statistical analyses were performed on the dataset.

The survey outcomes clearly identified that in terms of the abundance and diversity of the benthic macro-invertebrate assemblage, there was little clear pattern between surveyed transects and the spoil ground. The spoil ground contained sampling sites with both the highest and lowest average abundances of benthic macro-invertebrates. There was also no clear pattern with respect to measures of taxa richness and taxa diversity or the evenness of the assemblage. This is not unusual for studies of dredge spoil deposition where the activity results in an increase in some taxa and a decrease in others which may balance out (Harvey *et al.*, 1998). Three species were generally common across all sites surveyed – corophid and phoxocephalid amphipod crustaceans and an unidentified tanaid crustacean. These three taxa were numerically dominant at nine of the fifteen survey sites including sites at the spoil ground, and both the northern and southern transects. There were a large number of taxa that were represented by only one or very few individuals (< 5) and this is generally common for benthic macro-invertebrate assemblages in tropical waters (Long and Poiner, 1994). Overall, univariate measures of the benthic macro-invertebrate assemblage identified a homogenous assemblage principally dominated by the three aforementioned species.

The results of the multivariate analysis on the structure of the benthic macro-invertebrate assemblage demonstrated only subtle differences between the spoil ground and the other locations sampled.

Changes to the trophic structure of benthic macro-invertebrate assemblages can result from deposition of dredge spoil (Harvey *et al.*, 1998). In the survey undertaken, taxa were categorised into feeding guilds as a surrogate to examine the function of the assemblage. Deposit feeders are generally the dominant feeding guild in muddy sediments (Long and Poiner, 1994), and the results of the survey generally reflected this, however suspension feeders were dominant at some survey sites.

Grazers were largely absent and this was to be expected due to the survey sites being largely devoid of marine plants. There was no evidence of changes to trophic structures of the benthic macro-invertebrate assemblage in response to dredge spoil deposition.

In summary, the monitoring of benthic infauna assemblage at the spoil ground identified minimal, if any, impact adjacent to the spoil ground that is directly attributable to spoil disposal. Any impact appears to be limited to within tens of metres of the spoil ground boundary. The apparent lack of impact to infauna communities in the vicinity of the spoil ground would be driven primarily by the similarity between the muddy sediments located in Trinity Inlet and the high fines content of the spoil being disposed.

6.5 Potential Translocation of Marine Pests

Although previously several specimens of the Asian Green Mussel, Asian Bag Mussel and Caribbean Tube Worm have been recorded from vessels within the Cairns Port area, all investigations from areas to be dredged, including pre-dredge SAP sampling, and the EPA and Bio-Security Queensland "Proof of Freedom" surveys, completed since 2002, have consistently recorded an absence of introduced marine pest species in proposed dredge material. These results, although not exhaustive, indicate the limited risk associated with the relocation of dredge sediments to the offshore disposal ground from Port facilities. In addition, the absence of suitable habitat for species other than the Asian Bag Mussel to establish reproductive populations of these target species at the disposal ground further minimises the risk associated with maintenance dredging activity.

Any TSHD dredger contracted to undertake dredging works will be required to comply with best hygiene practices, including AQIS and Bio-Security Queensland requirements in relation to ballast water and marine pest management.

While risks of translocation of potentially present marine pest species may be low, it is considered that given the history of detections within the port and difficulty and uncertainty of identifying resident populations, annual inspection for targeted marine pests in material to be dredged and placed within the Marine Park is required.

6.6 Significant Marine Megafauna

Impacts to marine megafauna are not anticipated to result from ongoing routine maintenance dredging at Cairns Port.

Direct physical impact from collision with the TSHD is unlikely as the vessel master routinely looks out for megafauna and takes aversive action if it is safe to do so. Direct impacts to megafauna through intake into the suction heads is unlikely as most fauna would temporarily move away from the dredging operation and the drag heads will continue to be fitted with turtle exclusion devices, as a requirement of the vessel specification. Ingestion incidents can happen, however the incidence is low due to dredge operation management actions inclusive of stopping suction before raising dredge heads as outlined in **Section 7**.

Dredging operations using the *Willunga* are unlikely to result in direct impact to marine megafauna, primarily because the risk of impact is low due to absence of preferred habitat of whales, turtle, dugong within inner port area; bucket dredging operations are stationary, with the barges slowly travelling to or from the spoil ground. Megafauna would likely temporarily move from the active dredge site and would be mobile enough to avoid collision with the moving barges.

Indirect impacts to megafauna dependent on seagrass as a food resource, such as dugong and some marine turtles, would only be relevant in the situation where these resources were impacted. As described in **Section 6.4**, risk of impact to seagrasses from routine maintenance dredging and port operations is low, with long-term monitoring not identifying any impacts attributable to maintenance dredging or routine port operations. Indirect effects to megafauna via their food sources could become an issue if resilience of seagrass became low due to other factors and those food resources became susceptible to impacts of dredging events. This is a potential risk but considered a low probability dredging impact.

7. MANAGEMENT STRATEGIES AND ACTIONS

FNQPC is currently minimising contaminant input sources and managing potential impacts from dredging and dredge spoil disposal as far as practicable. Key management strategies and actions to minimise the impact from dredging and disposal operations are introduced below.

7.1 Dredge Vessel Specifications

Mitigation of potential turbidity and suspended solids impacts from dredging and spoil disposal by the trailing suction hopper dredge operations is achieved through requirement for modern vessel specifications (including low wash hull-design, below keel discharge, central weir discharge system and electronic positioning systems). These specifications are considered the minimum standard of specification for trailing suction hopper dredges that will be selected to undertake dredging works in the outer channel and parts of the inner channel.

Technical specifications for a clam shell grab dredge shall include well maintained plant and ancillary equipment, a method of accurately achieving dredging location (e.g. GPS) and mooring system, well maintained dump barges including hopper doors and seals.

A contract deliverable item for activities by a TSHD is the development and implementation of a works specific Environmental Management Plan. Environment staff from the Port of Brisbane have continually improved the EMP for activities by the "*Brisbane"* over the past eight years to meet requirements of stakeholders, government departments and port authorities in each of the areas throughout Australia in which it has completed dredging activities. Therefore this document should be considered a benchmark for any other TSHD that may be employed to conduct channel maintenance works at Cairns.

The minor dredging works undertaken by the *Willunga* in the inner port, navy base and marina areas will continue to manage environmental impacts through implementation of its environmental management plan. A detailed EMP for the operation of the *Willunga* has been developed by FNQPC over several years and is implemented for each of the operations of the vessel.

Specific EMP's will be developed on an as needed basis in the event that capital operational works or if small scale tenant facility dredging needs arise during the future period of this plan.

STRATEGIES

TSHDs undertaking dredging works at the Port of Cairns will include strategies to minimise environmental impact from dredging and disposal, including:

- Central weir discharge system;
- Below keel discharge point;
- Low wash hull design;

- Electronic positioning system (GPS etc); and
- Use of turtle exclusion devices on TSHD intake heads.

Clam shell/bucket grab dredge shall include:

- an electronic position system for defining the location and depth of dredging activity;
- Apparatus maintained in good working order;
- Accurate positioning of the vessel and the dump ground;
- Not overloading hoppers;
- Spreading the material evenly over the site; and
- Washing the hoppers on dump barges while over the dredge/disposal site, not while in transit.

Works completed in accordance with this LTMP and the specific Environmental Management Plans (EMP's) for:

- a Trailing Suction Hopper Dredge (TSHD), e.g. the "Brisbane"; and
- a clam shell/ bucket grab dredge e.g. Willunga , bed leveller and dump barges.

7.2 Marine Mega Fauna

As summarised at **Section 6.6** above, there is a low probability of potential for impacts to marine mega fauna during operation of dredging plant and equipment, and the transit of such equipment between dredge site and spoil ground, and such interaction is not anticipated to occur regularly during routine maintenance dredging at Cairns Port. Direct physical impact from collision with the TSHD is unlikely as the vessel master routinely keeps watch for megafauna and direct impacts to megafauna through intake into the suction heads is unlikely as most fauna would temporarily move away from the dredging operation and the drag heads will continue to be fitted with turtle exclusion devices and management actions inclusive of stopping suction before raising dredge heads is implemented,

Dredging operations using the *Willunga* are unlikely to result in impacts to marine megafauna, primarily because the risk of impact is low due to absence of preferred habitat of whales, turtle, dugong within inner port area; bucket dredging operations are stationary, with the barges slowly travelling to or from the spoil ground. Megafauna would likely temporarily move from the active dredge site and would be mobile enough to avoid collision with the moving barges.

Indirect impacts to megafauna dependent on seagrass as a food resource, such as dugong and some marine turtles would only be relevant in the situation where these resources were impacted. As described in **Section 6.4**, risk of impact to seagrasses from routine maintenance dredging and port operations is low, with long-term monitoring not identifying any impacts attributable to maintenance dredging or routine port operations. Indirect effects to megafauna via their food sources could become an issue if resilience of seagrass became low due to other factors and those food resources

became susceptible to impacts of dredging events. This is a potential risk but considered a low probability dredging impact.

STRATEGIES

- Stop suction of dredge as dredge head is lifted from sea floor;
- TSHD's must be fitted with a turtle exclusion device;
- Vessel Master to maintain watch for whales/dugongs/turtles in high risk areas and take necessary action where risk of collision exists;
- Implementation of the EMP for TSHD and Clam shell/ Bucket grab ("*Willunga"*);
- Vessel master to maintain watch for whales/dugong/turtles during dredging, transit and disposal and take necessary action where a collision risk is identified:
  - Inner port area considered low risk due to less abundance of preferred habitat for large marina fauna and high vessel traffic;
  - Channel area considered medium risk for presence of turtles and dugong due to deeper water and adjacent seagrass meadows;
  - Spoil ground considered to have higher probability of presence of whales and turtles.
- Heed advice from TACC representatives on outcomes of ecological health monitoring programs, including marine flora surveys to determine status of marine resources, and condition of seagrass as an indicator of any emerging deleterious trends in potential food sources available to mega fauna.

7.3 Use of the Existing Spoil Ground

The continued use of the current spoil ground mitigates impacts from smothering through preventing the need to disposal of spoil in an area that has not been disturbed previously or may be closer to other resources. Recent monitoring identified that the spoil ground is functioning well and that any impacts adjacent to the spoil ground are locally minor and limited to benthic infauna in open muddy substrates of relatively minor environmental significance.

It is recognised that another spoil ground will ultimately need to be used when the current spoil ground has reached capacity but this is unlikely to be required for many years, and certainly longer than the ten-year term of this LTMP.

STRATEGIES

Maximise use of existing spoil ground through:

- Optimizing the type and volume of material going to sea;
- Implement regular hydrographic surveys of the site;

- Accurate positioning of the dredge/dumping vessel at the dump ground;
- Spreading the material evenly over the site;
- Routine assessment of hydrographic survey data to determine effective use of dumping sectors; and
- Regular assessment of dredge volumes disposed to sea, including reporting to Determining Authority to meet Sea Dumping Permit requirements.

7.4 Uniform Spoil Deposition

Impacts to the spoil ground and adjacent areas will be minimised through spreading of the dredge spoil in such a manner as to uniformly spread it over the spoil ground and minimise sediment mobilisation and turbidity plume extent beyond the spoil ground boundary. This is achieved through deposition patterns that vary with the prevailing current direction. When currents are minimal, deposition will occur relatively uniformly over the spoil ground area in arc patterns (refer **Figure 7-1 left**). When currents are present, deposition will occur in arcs in the up-current portion of the spoil ground to take into account drift of sediment as it settles (refer **Figure 7-1 right**).

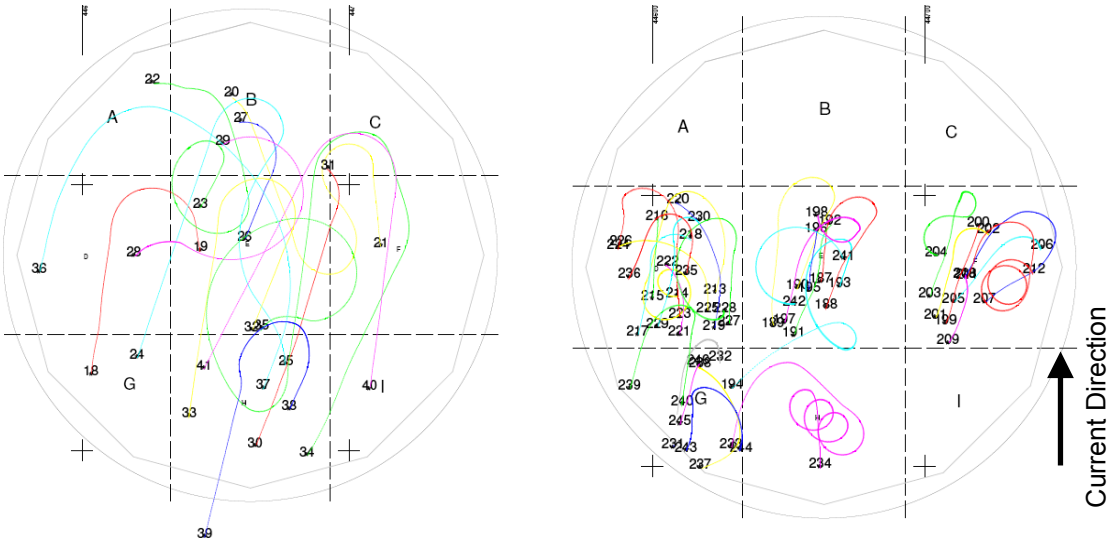

Figure 7-1 Dump plot example of deposition during periods of low current (left) and high current (right)

STRATEGIES

- Spreading of dredge spoil in a manner that sediment mobilisation and turbidity plume generation is minimised (e.g. bottom / keel discharge);
- Accurate positioning of the dredge/dumping vessel at the dump ground; and

- Spreading the material evenly over the site.

7.5 Timing of Dredging Campaigns

There are no timing restrictions on dredging operations at Cairns Port.

7.6 Reporting of Incidents and Contingency Arrangements

All FNCPQ Cairns staff, and any contractors involved have the responsibility to report any significant incidents and emergencies. There is an array of possible events that may cause potential or actual environmental nuisance or harm, as a result of near miss or incident events during dredging operations. These include fuel spills, mega-fauna interactions through to hopper door failure, vessel grounding or collision or non-compliance with permit conditions or LTMP or EMP requirements. The Environmental Management System maintained by FNQPC includes mechanisms for recording, reporting and investigating environmental near-miss and incident events.

Triggers for reporting of events to the Determining Authority include events classified as major non-conformance with permit or administrative requirements, and minor non-conformances resulting in potential or actual nuisance or harm to Marine Park. Arrangements to be implemented in respect of dredging and disposal include:

- In the first instance, reporting will be to the operational works supervisor, but generally, the Chief Executive Officer will have the responsibility to initiate corrective action for environmental incidents;
- All incidents will be reported to the project superintendent, as specified by FNQPC;
- In the case of an environmental emergency, after first notifying the Chief Executive Officer and DERM / GBRMPA, the operational works supervisor may make contact with FNQPCs' nominated consultants, who would help co-ordinate and manage a response;
- If an event is classified as major non-conformance the Chief Executive Officer will be required to notify the Determining Authority. It is the Chief Executive Officer's responsibility to ensure that the GBRMPA contact number and relevant officer's name are at hand prior to the commencement of the project;
- Significant environmental incidents must be logged in writing, with all relevant details recorded, after corrective action has been completed. The log book must be made available for inspection by the Operational Works Supervisor and Chief Executive Officer at all times;
- Any incident with marine megafauna (injury / mortality) during dredging activities will be reported by FNQPC to Queensland Parks and Wildlife Service (QPWS) and GBRMPA as soon as possible within 24 hours of the incident occurring. Details of any reports or sightings of sick, stranded, injured other fauna will be reported via respective hotline numbers to relevant agencies; and

- Implement responses applicable to dredging and disposal, if required under the Port Contingency Plan, First Strike and National Oil Spill Response Plans, Cyclone Contingency Plan.

FNQPC will report the following information to GBRMPA, if at any time during the course of, dredging or disposal activities any unanticipated environmental risk is identified:

- Nature of incident and type of risk associated with the incident, including (where possible) volume, nature and chemical composition of substances released;
- Measures taken to mitigate the risk;
- The success of the measures undertaken; and
- Proposed future monitoring.

7.7 Continuous Improvement

Monitoring to date suggests that impacts from dredging and disposal operations at Cairns Port are being well managed.

FNQPC has effective contemporary business management systems established for its present operations, including an Environmental Management System consistent with ISO14001, which includes numerous mechanisms for managing, monitoring and improving performance. Continuous improvement across the facets of environmental, operations, engineering and economics may occur over the life of this LTMP proactively identified or arise due to technical or management initiatives.

Opportunities for continual improvement may occur for dredging and disposal, including:

- Implementation of the Environmental Assurance Program (refer **Section 3.3**) at facilities under the operational control of FNQPC, and it's leased areas on Strategic Port Land to identify and improve management of land-based contaminant sources that may ultimately impact potential dredge spoil quality;
- Proactive engagement with other agencies with responsibilities for environmental management within the broader port catchment, inclusive of Cairns Regional Council, DERM, and catchment land use managers;
- Facilitate involvement of regulatory agencies where required and reasonable, to assist in contaminant source identification, identifying mechanisms to be implemented to identify sources, preventative strategies to be implemented as well as mitigation measures for and events requiring a contingency response;
- Administrative improvements to the EMS for recording, management, monitoring and reporting of dredging and disposal activity, and maintenance of this LTMP;
- Improvements to the effectiveness of this document and the sub-ordinate EMP's;
- Technical advancements in the methods for dredging and hydrographic surveys;

- Improvements to monitoring methods and program designs through technical advice of the TACC or others; and
- Implementation of strategies, or corrective actions listed in this LTMP for improved management and monitoring process if a need is identified by the Determining Authority or the TACC.

7.8 Record Keeping, Reporting and Auditing Requirements

FNQPC will:

keep records comprising either weekly plotting sheets or a certified extract of the ship's log which detail:

- The times and dates of when each dumping run is commenced and finished;
- The position of the vessel at the beginning and end of each dredging run;
- The position (by GPS) of the vessel at the beginning and end of each dumping run with the inclusion of the path of each disposal run; and
- The volume of dredge spoil (in cubic metres) dumped for the specific operational period.

These records will to be retained for audit purposes for the duration of the permit.

Undertake bathymetric surveys of the Disposal Site as follows:

- One prior to the commencement of any dumping activities; and
- One within one month of the completion of all dumping activities authorized under the permit.

FNQPC will provide a digital copy of the final bathymetric survey to the RAN Hydrographer,

FNQPC will provide an annual report on the bathymetry within two months of the final bathymetric survey being undertaken. The report must include a chart showing the change in sea floor bathymetry as a result of dumping and include written commentary on the volumes of dumped material that appear to have been retained within the spoil ground.

To facilitate annual reporting to the International Maritime Organisation, FNQPC will report to the Determining Authority by 31 December each year the following:

- Permit start date;
- Permit expiry date;
- Approved dumping site;
- Nature of material;
- Permit quantity;

- Quantity dumped per calendar year;
- Dumping method used;
- Summary of dredging and disposal monitoring activates undertaken during the year; and
- Incidents or near miss events.

The responsible parties for each of these reporting requirements will be the Chief Executive Officer of FNQPC.

Reporting on outcomes of routine monitoring will be provided via the TACC or through regular reports to the Determining Authority. These will include the SAP and the port initiated Marine Pest Reports.

7.9 Review of Management Plan

This Long Term Management Plan will be reviewed, and updated if necessary, according to the following timetable:

- Reviewed for currency of monitoring data and monitoring design mid-term (2015); and
- Where monitoring or management is proposed to be changed, any proposed modifications will be discussed with the TACC and GBRMPA; or
- Where unanticipated environmental risks are identified and are of a nature that warrants a review of the LTMP; and
- A review of the LTMP shall be undertaken at a frequency of not more than five years within the proposed ten year permit period. Components of the LTMP can be reviewed as required, upon request.

7.10 Monitoring Program

FNQPC will undertake monitoring of the marine environment where:

- dredging and offshore dredge spoil disposal for those elements that have the potential for significant impact to the marine environment. Such elements would include sediment contaminant status and introduced marine pest status;
- particular habitats can be impacted through the dredging or disposal activities such as seagrass beds in the vicinity of the outer channel or benthic assemblages within and adjacent to the spoil ground; or
- there are gaps in knowledge or some uncertainty regarding the extent of potential impact and confirmation of assumptions or previous monitoring is considered warranted, such as confirming turbidity plumes during dredging and disposal.

These monitoring programs are introduced below.

7.10.1 Sediment Quality Assessment

FNQPC has undertaken detailed surveys of dredge sediment quality in Cairns Port since 1995. Most contaminant substances tested have been below NAGD screening levels and hence been at acceptable levels for unconfined sea disposal. Primary substances that have exceeded screening levels, and hence required further assessment include Arsenic, Tributyltin and Diuron. Through further testing, it has been identified that these substances are unlikely to impact water quality during disposal or present a significant risk to benthic communities following disposal, and hence the sediments have been identified as suitable for unconfined ocean disposal and approval to place the material within the spoil ground located within the marine park has been approved. These outcomes are fairly consistent from year to year.

The NAGD provides the framework for assessment of potential contaminants and requires that data be 'current', which means that data is a maximum of five years old, where there is no reason to believe that the contamination status has changed significantly. The NAGD states that new data will be required where contamination of the site is likely to have increased or new pollution sources are present (such as a new industry or accidental spills).

Disposal of dredge material at the spoil ground, now located within a General Use Zone of the Great Barrier Reef Marine Park, has required approval from GBRMPA on an annual basis for each area to be dredged and has required extensive annual testing of sediments for a wide range of contaminants organic and inorganic contaminant substances. On the basis of the consistency of outcomes from prior testing, it is proposed to reduce the sediment contaminant status assessment design for the 2010-2020 LTMP and Sea Dumping Permit, but still remaining compliant with the requirements of the NAGD. Detail of the sediment characterisation approach is provided in Appendix 4, however key differences to the previous approach are introduced below.

Characterisation of sediments will still typically be undertaken on an annual basis, but for a restricted suite of parameters. A wider suite of parameters will be undertaken less frequently, every three years, to essentially monitor the level of other contaminant substances that have been demonstrated to have previously been detected within port sediments. This approach is a compromise between the minimum data currency requirements of the NAGD and recognition of higher level of monitoring expectation attached to placement of dredge material in the marine park. A reduced number of sampling sites is proposed in the Outer Channel dredge area based halving the number of sampling locations required under the NAGD Table 6, supported by the consistency of previous results and the outcome of statistical power analysis. The program also optimises the assessment and reporting process to allow movement from screening level (Phase 2) assessment and further (Phase 3) assessment on the basis of an agreed interim reporting approach.

7.10.2 Introduced Marine Pest Surveys

It was identified in **Section 6.4.3**, that all surveys of sediments to be dredged from Cairns Port as part of the routine maintenance dredging program have been surveyed essentially annually in the past permit period and have not returned any of the target marine pest species that have been detected on

hard-structures within the port, primarily on poorly maintained boats (i.e. Asian Green Mussel, Asian Bag Mussel and Caribbean Tube Worm). Further, the likelihood that they would occur within sediments to be dredged are low. Monitoring at the spoil ground has also not identified any specimens of target marine pest species.

However, further surveys of material to be dredged and placed in the marine park will occur annually for target marine pest species because of the history of detections within the port and difficulty and uncertainty of identifying perceived resident populations.

On that basis, monitoring for target marine pest species will continue largely in accordance with the same protocols used previously. The only difference is that instead of undertaking 100m sled tows AND grab sampling in the outer channel and inner port wharf areas, sled tows alone can be used because the relative bulk of sediment sampled using the grab is negligible compared to that of the sled. Generally, sled tows are the preferred method for all dredge areas where they can be used (i.e. outer channel and inner port wharf areas), leaving grab sampling to be undertaken in areas where manoeuvrability of the larger vessel is limited (i.e. marina areas and Navy base).

Grab samples are sieved on-board the vessel, while the sled effectively sieves the samples in the water. The retained material is sorted and any mytillid (mussel) or calcareous tube material is retained and sent to relevant taxonomic experts for formal identification.

Further details of the pre dredged introduced marine pest survey methodology is provided in Appendix 5.

Implementation of the marine pest settlement plate and rope mop monitoring program by FNQPC is to continue on a quarterly frequency as described at **Section 5.6**. It is anticipated that within the term of this LTMP, a port wide survey for presence of marine pests, similar to the “Port Baseline” completed by CRC Reef Research Centre in 2001-2002 will be required, and a routine State Bio-Security agency marine pest monitoring program may be established under the National System for the Prevention and Management of Marine Pest Incursions.

7.10.3 Spoil Ground Benthic Infauna Survey

Monitoring of spoil ground benthic assemblage will be undertaken in 2014 and 2019, reflecting the findings of recent monitoring (WorleyParsons, 2009b) that identified minimal impact, if any, within or adjacent to the spoil ground. While minimal impact was detected, monitoring at such frequency is considered appropriate given that these communities within the spoil ground are directly subject to repeated burial while outside the spoil ground they may reflect turbidity plume effects and sediment migration.

Benthic infauna assessment at the spoil ground will be undertaken similar to that which was undertaken 2009 (WorleyParsons, 2009b). This survey design and associated statistical analyses has proven rigorous in being able to identify differences between spoil ground and adjacent areas for particle size and benthic infauna assemblages, both in Cairns and other Queensland ports.

The rationale of the sampling design seeks to answering two questions:

- What is the impact at the spoil ground, in comparison to other non-spoil ground areas?
- How does the impact diminish with distance from the spoil ground?

This is achieved by taking three replicate samples for infauna and one sample for particle size at five sites within the spoil ground and five sites on axes extending from the boundary of the spoil ground in line with prevailing currents. Infauna samples are sorted, identified and counted, presented using a range of descriptive statistics and subjected to a range of univariate and multivariate statistical analyses.

Further detail of the proposed monitoring is provided in Appendix 4.

7.10.4 Seagrass Surveys

It has been identified in **Sections 5.4.1** and **6.4.2**, that the overall risk to seagrass from routine maintenance dredging and port operations at Cairns Port is low. However seagrasses are the key receiving environment at risk from dredging and their value to the local environment is high. Past monitoring has demonstrated that seagrasses in Cairns Harbour / Trinity Bay have proven resilient to the level of sedimentation and turbidity impacts associated with the short duration (approximately two weeks) dredging activity.

Fisheries Queensland, however, consider that while the risks to seagrasses from routine maintenance dredging at Cairns Port are low, seagrasses may become less resilient to impacts associated with dredging under cumulative levels of impact from other sources (i.e. climate, temperature stress, exposure).

The long term seagrass monitoring program provides an ability to assess the condition of key seagrass meadows and their resilience to cope with any impacts associated with dredging. The monitoring provides an assurance that the seagrasses remain in a robust condition to continue to cope with dredge related impacts, or if conditions change, an ability to assess the requirement for additional dredge mitigation measures to be implemented to continue to protect seagrasses during dredging.

Since the inception of the current monitoring program in 2001, there has not yet been a full review of the monitoring design taking into account the results of the program to date and review of current understanding of key drivers of seagrass dynamics, both natural and anthropogenic, within Cairns Harbour and Trinity Inlet as well as other Queensland coastal areas. FNQPC will continue to support implementation of a Cairns Harbour and Trinity Inlet Long Term Seagrass Monitoring Program over the duration of the LTMP that:

- Is subject to review prior to 2011 monitoring, and subsequent regular technical review, and is supported by the TACC;
- Is designed to ensure monitoring and assessment of seagrass meadow condition and health remains appropriate to the intent of this LTMP for dredging and disposal

- Informs management process and resultant mitigation actions as required at **Section 7** of this LTMP
- Addresses the need by the Port operator as one of the measures of general ecological health of the Port catchment;
- Includes mechanisms to ensure key at risk meadows are captured within the program and to identify and quantify those conditions that render seagrass vulnerable to temporal and spatial impacts from dredging; and;
- Quantifies the extent to which mitigation actions are required through continued involvement of DEEDI in the TACC process.

FNQPC will work in collaboration with other stakeholders which have a responsibility or interest in the condition of the Trinity Bay and Inlet seagrass resources to implement the above program.

7.10.5 Confirmation of TSHD Turbidity Plume Extent

Assessment of impacts to water turbidity from dredging has drawn largely from 1991 monitoring regarding the capital dredging project to widen the entrance channel, which was undertaken using the *Sir Thomas Hiley*. Because of the larger extent of dredging undertaken and lack of modern turbidity control devices (e.g. below keel discharge), it is likely that the turbidity plumes identified during dredging overstate that likely turbidity plume from maintenance dredging undertaken using modern TSHD's such as the *Brisbane*. Consequently, it is proposed to undertake monitoring for turbidity associated with dredging by the TSHD in the entrance channel and spoil ground during the 2010 dredge campaign to provide a more up to date understanding of dredging and disposal dredge plumes and confirm that background turbidity levels are reached within 700 m and 1000 m respectively from the point of disturbance.

A specific project turbidity monitoring protocol will be developed and resolved in consultation with the Determining Authority prior to the monitoring project being implemented. It is envisaged that this work will include use of a hand-held nephelometer while tracking a current drogue deployed adjacent to the TSHD vessel during overflow dredging within the channel or disposal at the spoil ground. The nephelometer will be deployed to take readings approximately every 100 m along the drogue trajectory until the turbidity stabilises near background level. The position of the drogue and location of turbidity monitoring will be tracked using GPS. Readings will be taken at 1m above the substrate as this lower water column layer of water is that which light dependent benthic organisms such as seagrasses are exposed to.

Monitoring will be undertaken at various tidal states during the dredging program, and will particularly target dredging in the vicinity of significant seagrass beds adjacent to the channel.

Similar monitoring will be undertaken at the spoil ground to identify turbidity plume distance is no greater than that previously identified by Connell Wagner (1991) (i.e. 1000 m). Measure will be taken at surface (-1 m), mid and bottom depths (approximately 10 m).

Outcomes of this investigation would also be considered in an evaluation of observed data versus the understanding of turbidity tolerances of seagrass species known to occur in and adjacent to the investigation area. Technical input from Fisheries Queensland's Marine Ecology Group would be sought on interpretation of data outcomes and historical understanding of the site. This data would further strengthen predictions about potential impacts of turbidity, and resultant alteration to light saturation of seagrass meadows in subsequent dredge campaigns and estimation of resilience.

A scientific report will be prepared and will include results in graphical format and contrast the outcomes against prior monitoring results and other available turbidity data for Trinity Inlet. The report will be forwarded to the Determining Authority for review and outcomes presented at the subsequent TACC meeting.

7.10.6 Summary of Proposed Monitoring

A tabulated summary of the monitoring program is provided in **Table 7-1**.

Table 7-1 Summary of LTMP Monitoring Program

Impact Hypothesis	Activity	Monitoring Item	Details	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Comments
Disposal of dredge spoil will not result in impact to the marine environment in the Marine Park	Disposal	Sediment quality assessment	Compare contaminant levels at 95%UCL of the mean to NAGD screening levels or local arsenic screening level	✓	✓	✓ *	✓	✓	✓ *	✓	✓	✓ *	✓	✓ Compare primary contaminants list annually. * Compare secondary contaminant list substances every 3 years.
No significant accumulation of primary contaminant substances at the spoil ground	Disposal	Sediment quality assessment	Compare contaminant levels against NAGD screening levels and historic levels	✓	✓	✓ *	✓	✓	✓ *	✓	✓	✓ *	✓	✓ Compare primary contaminants list annually. * Compare secondary contaminant list substances every 3 years.
There will be no significant impact on marine flora such as seagrass adjacent to the maintenance dredge area resulting from sediment mobilisation impacts (including turbidity and sedimentation)	Dredging	Seagrass Monitoring	Implement a the Cairns Harbour and Trinity Inlet Seagrass Monitoring Program	✓	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	✓*	* Assessment of seagrass meadow condition and health to inform dredge management and mitigation actions as described at Section 7.10.4
Lack of suitable habitat in both the dredged area and the spoil ground will prevent the development of significant populations of Asian Green Mussel, Asian Bag Mussel and Caribbean Tube Worm at the spoil ground.	Dredging	Marine Pest Surveys	Pre-dredge survey for AGM, ABM and CTW in sediments to be dredged and at spoil ground	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Apart from annual program, undertake spoil ground sled tows in 2014 and 2019 with infauna surveys. If IMPs found in port sediments, undertake spoil ground sled tows annually.
		Marine pest monitoring program	Ongoing larval plate and rope device monitoring program for inner port area	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Regular Report Summary compiled and reported to agencies
		Marine pest monitoring program	Cooperate with agencies implementing the National System for the Prevention and Management of Marine Pest Incursions											As required, contribute to design and review of any program relevant to Cairns Port.
There will be no significant impact on marine benthic infauna communities adjacent to the spoil ground resulting from sediment mobilisation	Disposal	Benthic infauna; Particle size distribution	Compare sites within spoil ground and identify gradient of impacts radiating from spoil round using univariate and multivariate statistical analyses.					✓					✓	Undertake at same time in year for temporal consistency. Use 2009 reference collection for taxonomic consistency.

Impact Hypothesis	Activity	Monitoring Item	Details	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Comments
Turbidity plume during dredging of outer channel does not extent further than that reported for the Sir Thomas Hiley by Connell Wagner (1991) (i.e. 700m from point of disturbance)	Dredging	Turbidity monitoring	Hand-held nephelometer every 100m along drogue track until background levels are reached (ie turbidity stabilises and is consistent with that outside the plume)	✓										Undertake at next possible TSHD dredging campaign. A detailed project design/plan to be submitted and approved by the Determining Authority and prior to work commencing.

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Appendix 1 Copy of 2010-2020 Marine Parks Permit

Appendix 2 Copy of Marine Plants Disturbance Permit

APPROVAL NOTICE

This notice is issued by the Department of Primary Industries and Fisheries pursuant to section 3.5.15 of the *Integrated Planning Act 1997*.

Development Application details:

Applicant's name:	Chief Executive Officer, Cairns Port Authority
Applicant's address:	Cnr Grafton and Hartley St, Cairns Qld 4870
Proposed development:	Operational works to remove, damage or destroy marine plants associated with Cairns Port maintenance
Description of the land:	Cairns Port Operations Area described as: Shoreline from the Pier Pt to 75 metres south of the Queensland Transport Operations Centre, Portsmith The Main shipping channel in Trinity Inlet and the Dredge spoil location site
DPI&F ID:	03NOCA1775
DPI&F file number:	NFC/140/000(811)

The Department of Primary Industries and Fisheries, acting as assessment manager under the *Integrated Planning Act 1997*, has issued your development permit as required under Section 241 of the *Fisheries Act 1994*.

Approval Number: 2006CA0478

1. Details of the approval:

The following type of approval has been issued:

Type of development	Development Permit	Preliminary Approval
• *Operational works to remove damage or destroy marine plants*	✓	

Delegate of the Chief Executive

Date: 7/9/06

2. Currency period

The standard currency period stated in section 3.5.21 of IPA apply to each respect of development in this approval.

3. Approved plans

The approved plans for this development approval are attached and listed in the following table.

Plan / Document Number	Plan / Document Name	Date
03NOCA8064MP1775	Marine Plant Permit Area – Inner Channel area and Outer Channel and spoil ground	11/07/03

4. IDAS referral agencies

There are no IDAS referral agencies applicable to this application.

5. Conditions

Conditions imposed by the Department of Primary Industries and Fisheries are the conditions listed in the 'Department of Primary Industries and Fisheries Conditions' attached.

Negotiation of Conditions

During your appeal period, you as the applicant may make written representations to the Assessment Manager about a matter stated in this decision notice. If the Assessment Manager agrees with the representations, a 'negotiated decision notice' will be given to you. Only one 'negotiated decision notice' may be given. If you require more time to make the written representations, you may suspend your appeal period, by making written notice to the Assessment Manager. You may only do this once. If the written representations are not made within twenty (20) business days after the suspension of your appeal period the balance of your appeal period restarts.

6. Additional Information to applicants:

Native Title

Future act notification was not undertaken as this is an existing approval and no new works are proposed.

Cultural Heritage

Under the *Aboriginal Cultural Heritage Act 2003* a person who carries out an activity must take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage (the "cultural heritage duty of care"). An assessment of your proposed activity against the duty of care guidelines will help you determine whether or to what extent Aboriginal cultural heritage may be harmed by your activity. If following an assessment of the duty of care guidelines you believe cultural heritage may be harmed by your proposed activity, you should contact the Cultural Heritage Coordination Unit for further advice on (07) 3238 3838. Further information on cultural heritage and a copy of the duty of care guidelines and cultural heritage search forms can be obtained from www.nrm.qld.gov.au.

Delegate of the Chief Executive

Date: 7/9/06

Acid Sulfate Soil

Any soil disturbance resulting from development works should be managed to prevent acid sulfate soil development as outlined in the current version of the Qld Acid Sulfate Soils Technical Manual Soil Management Guidelines. To obtain a copy of this document or for further information on acid sulfate soils, please contact Queensland Acid Sulfate Soils Investigation Team (QASSIT) on 3896 9819 or access the website www.nrm.qld.gov.au .

7. Appeal rights

Attached is an extract from the *Integrated Planning Act 1997* which details your appeal rights regarding this decision.

8. When the development approval takes effect

This development approval takes effect:

- from the time the decision notice is given, if there is no submitter and the applicant does not appeal the decision to the court

OR

- when the submitter's appeal period ends, if there is a submitter and the applicant does not appeal the decision to the court

OR

- subject to the decision of the court, when the appeal is finally decided, if an appeal is made to the court.

This approval will lapse unless substantially started within the above stated currency periods (refer to sections 3.5.19 and 3.5.20 of IPA for further details).

Delegate of the Chief Executive

Date: 7/9/06

DEPARTMENT OF PRIMARY INDUSTRIES AND FISHERIES CONDITIONS

Applicant(s)/Address:	Chief Executive Officer, Cairns Port Authority of cnr Grafton & Hartley Street, Cairns, QLD 4870
Purpose:	Habitat Disturbance (Marine Plants)
DPI&F Reference:	2006CA0478
File Number:	NFC/140/000 (811)

Department of Primary Industries and Fisheries has assessed the above development application against the purpose of the *Fisheries Act 1994.*

It has been determined that the approval should be a Development Permit to which the following conditions apply:

1 The nature and extent of disturbance are limited to: removal or pruning of mangroves and marine plants within Cairns Inner Port Operations area; dredging of the main shipping channel and disposal of dredge spoil at the designated ocean spoil disposal site as described in DPI Plan 03NOCA0864MP1775.

2 The Cairns office of the Queensland Boating and Fisheries Patrol (Ph. No.40 350 700, and the Manager (North) Fisheries and Aquaculture Development, Department of Primary Industries (Ph. No. 40 350 100), must be notified, in writing, of the date of commencement of works, other than dredging works, fifteen (15) days prior to the commencement of works.

3 Works, other than dredging works, are only authorised if the holder has notified the Queensland Boating and Fisheries Patrol and the Manager, Fisheries and Aquaculture Development Unit, Department of Primary Industries of the commencement of works PRIOR to the commencement of those works. Any works, other than dredging works, commenced without prior notification are deemed not to be authorised.

4 At least three (3) signs must be displayed around the work sites, other than dredging locations, in positions where they are clearly visible to the public, for fifteen (15) days prior to the commencement of the authorised activities and during all authorised works. Each sign must advise and describe the authorised activity, and state "Works authorised under DPI&F approval 2006CA0478".

Delegate of the Chief Executive

7/9/06

Basis for inclusion of conditions:

- The Department of Primary Industries and Fisheries must assess the development application against the purposes of the *Fisheries Act 1994*. This application can only comply with those purposes, including promoting ecological sustainable development, if compliance with the abovementioned conditions is achieved.

Delegate of the
Chief Executive

7/9/06

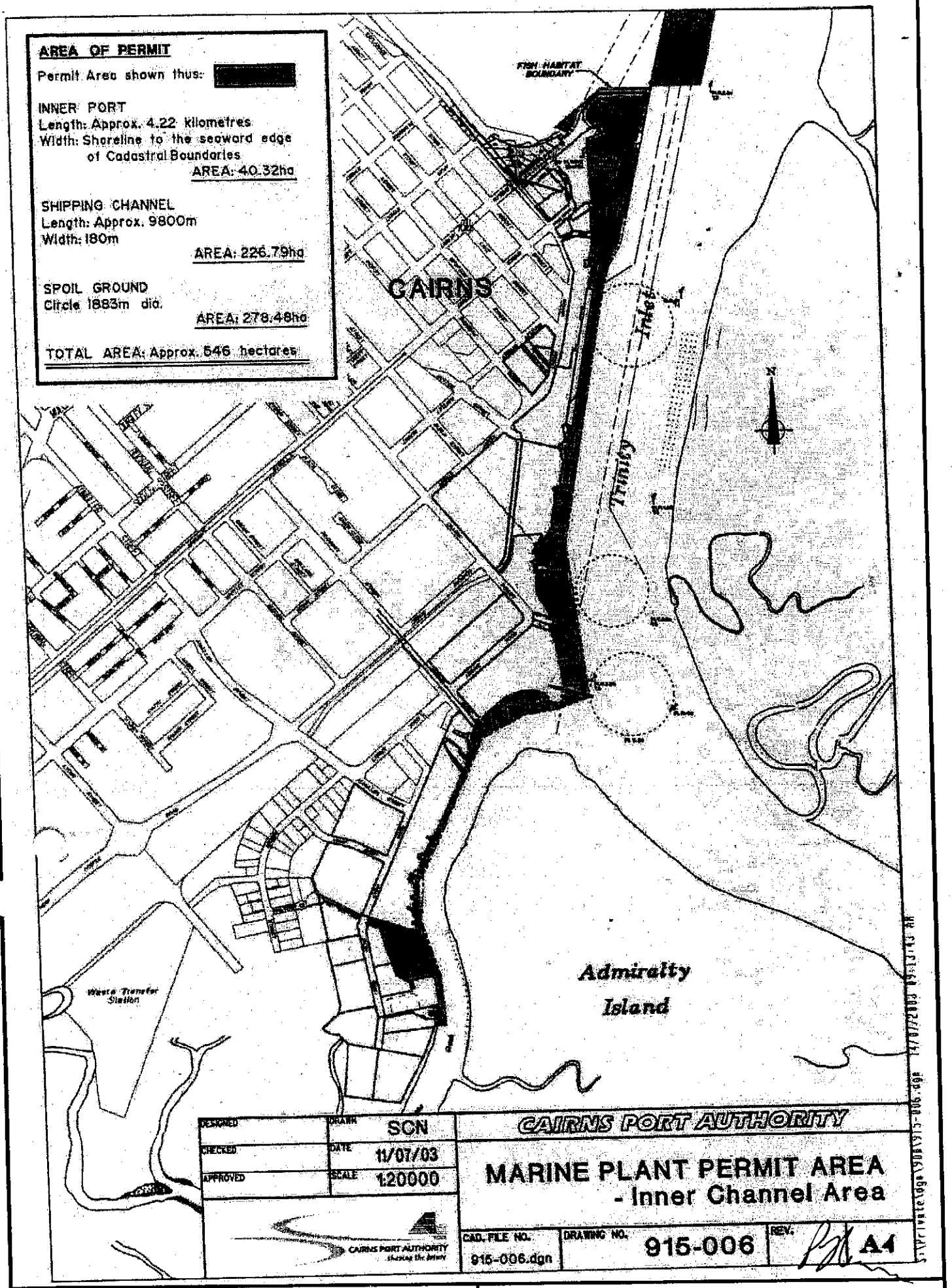


Figure 1. Permit area for port infrastructure and operations maintenance.

DPI PLAN NO.

03NOCA8064MP1775

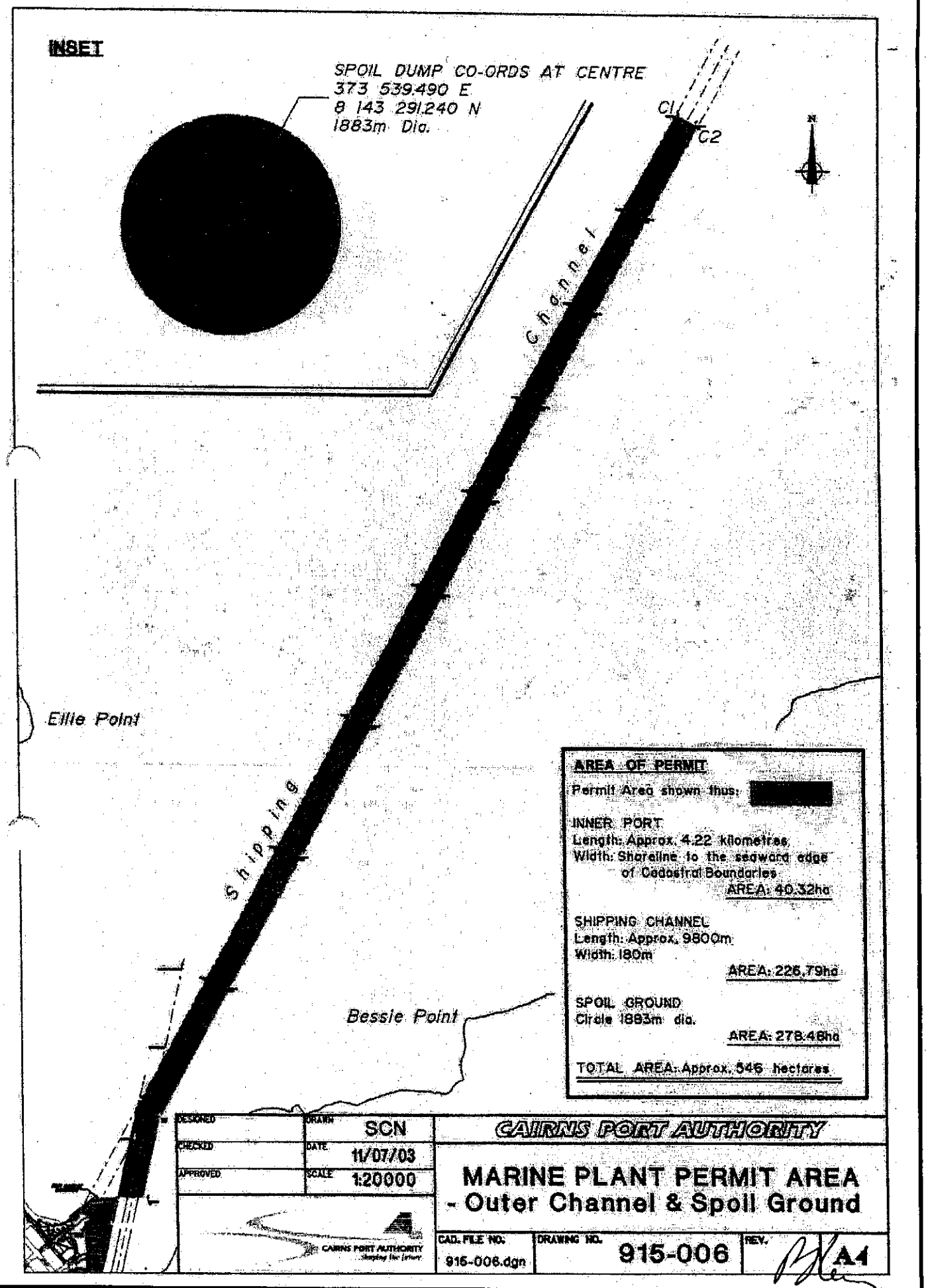


Figure 2. Permit area for main shipping channel and ocean spoil disposal site.

DPI PLAN NO.

03NOCA8064MP1775

Appendix 3 EPBC Protected Matters Database Search Result

Protected Matters Search Tool

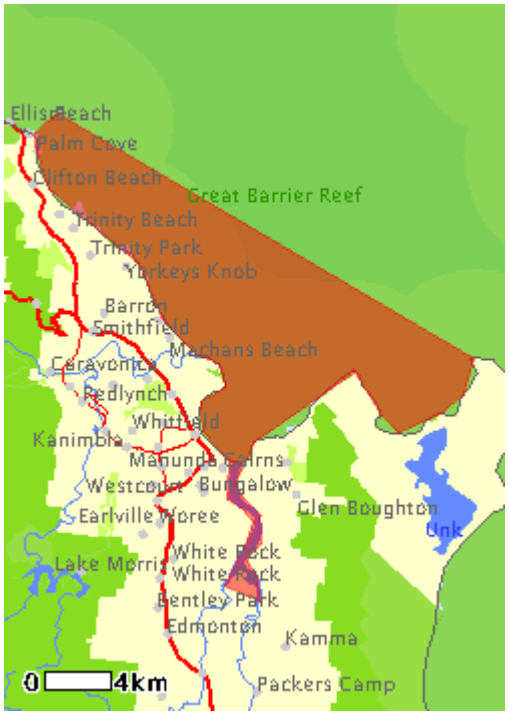
27 April 2009 15:48

EPBC Act Protected Matters Report

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

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

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



Search Type: Area

Buffer: 0.5 km

Coordinates: -16.72620,145.68248, -16.86447,145.91722, -16.88441,145.91143, -16.89470,145.89985, -16.90627,145.87477, -16.89598,145.86512, -16.87219,145.85033, -16.91142,145.79374, -16.92492,145.78795, -16.93457,145.78281, -16.94293,145.78731, -16.95258,145.79695, -16.96865,145.79760, -16.97766,145.78924, -16.98730,145.79503, -17.00145,145.79760, -16.99245,145.77702, -16.97123,145.78795, -16.95644,145.79310, -16.94872,145.78667, -16.94357,145.77830, -16.92171,145.77959, -16.90563,145.76480, -16.88891,145.76351, -16.88055,145.77766, -16.86704,145.77380, -16.86190,145.76030, -16.84261,145.74229, -16.81109,145.72879, -16.78858,145.70177, -16.76865,145.67798, -16.74614,145.67091, -16.73778,145.67026

Report Contents: Summary

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	2
National Heritage Places:	2
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	1
Threatened Species:	31
Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the

'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	16
Listed Marine Species:	87
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

State and Territory Reserves:	6
Other Commonwealth Reserves:	1
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]

Great Barrier Reef QLD

Wet Tropics of Queensland QLD

National Heritage Places [Dataset Information]

Great Barrier Reef QLD

Wet Tropics of Queensland QLD

Commonwealth Marine Areas [Dataset Information]

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

EEZ and Territorial Sea

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Casuarius casuarius johnsonii Southern Cassowary (Australian), Southern Cassowary	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Frogs		
Litoria nannotis Waterfall Frog, Torrent Tree Frog	Endangered	Species or species habitat may occur within area
Litoria nyakalensis Mountain Mistfrog	Critically Endangered	Species or species habitat likely to occur within area
Litoria rheocola Common Mistfrog	Endangered	Species or species habitat may occur within area
Nyctimystes dayi Lace-eyed Tree Frog, Australian Lacelid	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale	Endangered	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Dasyurus maculatus gracilis Spotted-tailed Quoll or Yarri (North Queensland subspecies)	Endangered	Species or species habitat likely to occur within area

Hipposideros semoni Semon's Leaf-nosed Bat, Greater Wart-nosed Horseshoe-bat	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Breeding known to occur within area
Pteropus conspicillatus Spectacled Flying-fox	Vulnerable	Species or species habitat may occur within area
Rhinolophus philippinensis (large form) Greater Large-eared Horseshoe Bat	Endangered	Species or species habitat may occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheathtail Bat	Critically Endangered	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leathery Turtle, Leatherback Turtle	Endangered	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Vulnerable	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Species or species habitat may occur within area
Sharks		
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Arenga australasica Australian Arenga Palm	Vulnerable	Species or species habitat likely to occur within area
Dendrobium superbiens	Vulnerable	Species or species habitat likely to occur within area
Durabaculum mirbelianum an orchid	Endangered	Species or species habitat likely to occur within area
Durabaculum nindii an orchid	Endangered	Species or species habitat likely to occur within area
Hodgkinsonia frutescens	Vulnerable	Species or species habitat

Atherton Turkey Bush		likely to occur within area
Huperzia phlegmarioides Layered Tassel-fern	Vulnerable	Species or species habitat likely to occur within area
Myrmecodia beccarii	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Migratory	Breeding likely to occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Migratory Wetland Species		
Birds		
Actitis hypoleucos Common Sandpiper	Migratory	Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Numenius minutus	Migratory	Species or species habitat may

Little Curlew, Little Whimbrel		occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Migratory	Species or species habitat likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Sterna albifrons Little Tern	Migratory	Species or species habitat may occur within area
Migratory Marine Species		
Mammals		
Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Migratory	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Migratory	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area

Dermochelys coriacea Leathery Turtle, Leatherback Turtle	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Migratory	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Migratory	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Migratory	Species or species habitat may occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper	Listed	Species or species habitat likely to occur within area
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus	Listed -	Species or species habitat may

White-throated Needletail	overfly marine area	occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Listed - overfly marine area	Breeding likely to occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Listed	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Sterna albifrons	Listed	Species or species habitat may

Little Tern		occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Ray-finned fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Bulbonaricus davaoensis Davao Pughead Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys sculptus Sculptured Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys flavofasciatus Yellow-banded Pipefish, Network Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys paxtoni Paxton's Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish	Listed	Species or species habitat may occur within area
Cosmocampus maxweberi Maxweber's Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus dactyliophorus Ringed Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus excisus Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area

Festucalex cinctus Girdled Pipefish	Listed	Species or species habitat may occur within area
Festucalex gibbsi Gibbs' Pipefish	Listed	Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus macrorhynchus Whiskered Pipefish, Ornate Pipefish	Listed	Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish	Listed	Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish	Listed	Species or species habitat may occur within area
Hippocampus bargibanti Pygmy Seahorse	Listed	Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse	Listed	Species or species habitat may occur within area
Hippocampus zebra Zebra Seahorse	Listed	Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish	Listed	Species or species habitat may occur within area
Micrognathus brevirostris Thorn-tailed Pipefish	Listed	Species or species habitat may occur within area

Microphis brachyurus Short-tailed Pipefish, Short-tailed River Pipefish	Listed	Species or species habitat may occur within area
Nannocampus pictus Painted Pipefish, Reef Pipefish	Listed	Species or species habitat may occur within area
Phoxocampus diacanthus Pale-blotched Pipefish, Spined Pipefish	Listed	Species or species habitat may occur within area
Siokunichthys breviceps Soft-coral Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
Solenostomus paradoxus Harlequin Ghost Pipefish, Ornate Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus longirostris Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle	Listed	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Listed	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water	Listed	Species or species habitat likely to occur within area

Crocodile		
Dermochelys coriacea Leathery Turtle, Leatherback Turtle	Listed	Species or species habitat may occur within area
Disteira kingii Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake	Listed	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Hydrophis mcdowelli	Listed	Species or species habitat may occur within area
Hydrophis ornatus a seasnake	Listed	Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
Laticauda colubrina a sea krait	Listed	Species or species habitat may occur within area
Laticauda laticaudata a sea krait	Listed	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Species or species habitat may occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin	Cetacean	Species or species habitat may occur within area
Grampus griseus	Cetacean	Species or species habitat may

Risso's Dolphin, Grampus		occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

Commonwealth Lands [Dataset Information]

Defence

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

Historic

Adelaide Steamship Company Building QLD

Barrier Reef Hotel QLD

Cairns City Council Building (former) QLD

Cairns Court House (former) QLD

Cairns Post Building QLD

Cairns War Memorial QLD

Customs House QLD

Government Offices (former) QLD

Hides Hotel QLD

Jack and Newell Store QLD

Natural

Cairns Tidal Wetlands QLD

Cairns Tidal Wetlands Redefined Area #2 QLD

Great Barrier Reef Region (Commonwealth) QLD

Great Barrier Reef Region QLD

Malbon / Thompson Range Area QLD

Malbon / Thompson Range Extension Area QLD

Extra Information

State and Territory Reserves [Dataset Information]
Barr Creek Fish Habitat Area, QLD
Cairns Marine Park, QLD
Half Moon Creek Fish Habitat Area, QLD
Trinity Inlet Fish Habitat Area, QLD
Trinity Inlet/Marlin Coast Marine Park, QLD
Yorkeys Creek Fish Habitat Area, QLD
Other Commonwealth Reserves [Dataset Information]
Great Barrier Reef Marine Park, COM

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose

distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgments

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium

- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated: Thursday, 20-Nov-2008 14:17:56 EST

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Appendix 4 Sediment Quality Assessment Survey Design

INTRODUCTION

This appendix provides the approach for undertaking sampling and analysis for sediment quality assessment for sediments to be dredged within the Cairns Port dredge areas between 2010-2020. It has been developed taking into consideration the results of detailed testing undertaken at Cairns Port since 1995.

PRIMARY CONTAMINANTS LIST

The NAGD includes a process for determining a *contaminants list* of substances that need to be investigated as part of sediment quality assessment studies. The NAGD states that the list of contaminants should include:

- Toxic substances known, from previous investigations, to occur in dredge area sediments at greater than one-tenth of the Screening Levels (in Table 2 of the NAGD); or
- Based on historical review, substances potentially present at such levels in the sediments to be dredged.

Based on a review of 2005 – 2009 data (refer **Table 4-3** in **Section 4.1.2**), the following contaminants should be included in the contaminants list for respective dredge areas, as results indicate that concentrations (at the 95%UCL) could be greater than one-tenth the screening level. These define the contaminants that should be assessed as part of each sediment characterisation study for determining suitability for unconfined ocean disposal at the Cairns Port spoil ground:

Inner Port, Navy Base, Marlin Marina, CFB1 and CFB2

- Metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn);
- Organotins; and
- Diuron (2010 and 2011);

Outer Channel

- Metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn);
- Organotins; and
- Diruon (2010 and 2011).

Spoil Ground

- Metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn); and
- Organotins; and
- Diuron (2010 and 2011).

Note that Diuron is included in the above primary contaminants list for 2010 and 2011 on the recommendation of the Determining Authority to provide a total of five years data (2007-2011) upon which to undertake a determination regarding the need for, or frequency, of further monitoring.

SECONDARY CONTAMINANTS LIST

While not strictly required under the NAGD, a secondary contaminants list is proposed to include contaminant substances that could be present in dredge areas, or sediments at levels of environmental concern although historical sampling indicates this is not likely. In essence, this list is proposed as a mechanism to monitor potential contaminants and so is proposed at a reduced frequency of analysis of each three years and at an intensity of 20% of sampling locations (with a minimum of three in any one dredge area) within inner port, Navy base and marina areas (including Marlin Marina, CFB1 and CFB2) as well as the spoil ground.

The following list is proposed:

- Total TPHs; and
- Total PAHs.

To allow for longer hold times of up to eight weeks during these surveys, an additional hold sample will be retained for each site and stored at -10°C within 12 hours of sampling. If initial results are detected at levels greater than one-tenth of the Screening Levels for Total TPH and Total PAH then the remaining hold samples for the specific dredge area will be tested.

The primary or secondary contaminants lists may be modified at the request of the Determining Authority or FNQPC if either party becomes aware of any potential new sources of contaminants that may impact sediments to be dredged to the extent that levels of environmental concern may be approached. Justification should be provided by the initiating party to provide context for the request to support discussion between both parties.

In the event of a contaminant release within the port (e.g. oil spill) that is deemed significant, the relevant contaminant parameter must be included in subsequent annual sediment monitoring for a suitable timeframe in all dredge areas assessed to have a reasonable likelihood of having been impacted, to confirm any impact to sediment quality and suitability for unconfined placement at sea. To facilitate this, FNQPC will provide a summary report of all spill/contaminant incidents each year within the introduction to the SAP and evaluate the need for specific contaminant testing prior to the next round of sediment sampling and analysis.

A summary of the sampling program is provided in **Table A5-1**.

SCREENING LEVELS AND GUIDELINE LEVELS FOR CONTAMINANT SUBSTANCES

Sediment contaminant screening levels will be those included within Table 2 in Appendix A of the NAGD, with the exception of arsenic and Diuron. Arsenic will have an agreed local screening level of 30 mg/kg for screening level purposes only. This revised arsenic screening level was agreed to by the

Determining Authority following consideration of total, elutriate and dilute acid extraction data from recent port sediment which identified that arsenic was likely naturally elevated in the regions sediments but that it was unlikely to be biologically available and would not impact water quality during sea dumping (refer **Section 4.1.2**). Diuron will continue to have the literature derived local screening level of 2 µg/kg.

For any further analyses, such as elutriate water or sediment porewater analysis, the relevant guideline levels in ANZECC ARMCANZ (2000) water quality guidelines for toxicants at the 95% species protection level are to be referred to, as indicated in the NAGD.

Where more specific local water quality management triggers exist for contaminants these will be applied at the 95% species protection level. For dilute acid extraction of metals, the values in Table 2 of Appendix A of the NAGD are to be used. The agreed local screening level for arsenic is not appropriate for DAE comparison as part of its justification was based on DAE results.

Table A5-1 Schedule of sediment sampling and analysis program for main dredge areas

	Outer Channel	Inner Port	Marlin Marina	Navy Base	CFB1	CFB2	Spoil Ground
2010							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Diuron	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2011							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Diuron	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2012							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs	x	x	x	x	x	x	x
Total PAHs	x	x	x	x	x	x	x
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2013							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2014							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2015							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs	x	x	x	x	x	x	x
Total PAHs	x	x	x	x	x	x	x
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2016							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2017							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2018							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs	x	x	x	x	x	x	x
Total PAHs	x	x	x	x	x	x	x
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x
2019							
Metals	x	x	x	x	x	x	x
Organotins	x	x	x	x	x	x	x
Total TPHs							
Total PAHs							
PSD	x	x	x	x	x	x	x
TOC	x	x	x	x	x	x	x

Notes: Not all dredge areas may require dredging each year.

SAMPLING DESIGN

Sampling Locations – Sediment Characterisation

Sampling locations are to be randomly selected from sampling grid cells developed by WorleyParsons as part of the 2008 and 2009 sediment sampling and analysis plans. These grids are largely compliant with minimum sample grid cell number requirements of the NAGD, with the exception of the Inner Port wharf areas where smaller grids would be impracticably small (less than 80 m x 80 m grid squares). The cells applicable for random selection are only those where more than half the cell is contained within a within the FNQPC bounds of dredging identified in respective areas on an annual basis.

Where sampling grids partially overlap, such as that of the navy base outer dredge area and inner port main wharf dredge area, then that portion may be included for sampling in only one of the two areas. It is important not to exclude either part as the navy base outer area is sampled only every other year.

The number of sampling locations within most dredging area is based upon at least those required under NAGD Table 6 for conservative estimates of dredge volume of potentially contaminated dredge material (refer **Table A5-2**). The exception to this is the Outer Channel area, which previously has required 27 sampling locations for the given dredge volume. Based on review of the many years data collected, it is proposed to take half the number of samples required under NAGD Table 6 (i.e. 14 sampling locations). The NAGD allows for halving the number of samples where the material is likely to be clean, based on good quality recent data. A significant reduction in sampling locations is also supported by power analysis of the existing outer channel metals and TBT dataset (i.e. primary contaminants list), which indicates that only three samples are required to achieve a power of 0.8, which an alpha of 0.05 (as recommended in ANZECC/ARMCANZ 2000).

Table A5-2 Sample site numbers for sediment characterisation

Dredge Area	Conservative Dredge Volume (m^3)	NAGD Table 6 Sample Site Number	Sample Numbers	Number of Sample Grids
Outer Channel	225,000 – 460,000	27	14	264
Inner Port (main wharves)	13,500	7	7	Number of cells within dredge area**
Inner Port (inner channel)	As required	As per NAGD	As per NAGD	Number of cells within dredge area**
Inner Port (swing basins	As required	As per NAGD	As per NAGD	Number of cells within dredge area**

Dredge Area	Conservative Dredge Volume (m^3)	NAGD Table 6 Sample Site Number	Sample Numbers	Number of Sample Grids
HMAS Cairns Navy Base (Inner)	25,000	9	9	45
HMAS Cairns Navy Base (Outer)	12,500	7	7	35
Marlin Marina	17,000	7-8	8	113
Commercial Fishing Base 1	<31,800*	10	10	60
Commercial Fishing Base 2	<10,000	6	6	94
Spoil Ground	Not applicable	Not applicable	6	6 predetermined
Tenants, MSQ, Smiths Creek	Various	TBA in separate SAP	TBA in separate SAP	TBA in separate SAP

Legend: * CFB1 volume of 31,800 m^3 volume is based on a pre-dredge bathymetric survey and design depth of -3.5 m LAT because no post-dredge survey was available. This is likely a significant overestimate of volume with CPA advising that a volume of <10,000 m^3 is typical.

** Number of sample grids does may comply with NAGD requirements particularly within main wharf areas. This is due to the inability to practicably use smaller grid sizes which are 80 m x 80 m.

Sample Collection Methods and Sampling Horizons

The selection of primary sampling methods within each dredge area is based on review of historic depths of dredging undertaken in those areas, consideration of practical sampling constraints and knowledge of sediment characteristics, as set out in **Table A5-3**. Demonstration of the typical depths of dredging is provided by differential survey plots for each of the dredge areas, provided at the end of this Appendix.

Table A5-3 Typical sediment dredge depth and collection method for dredge areas

Dredge Area	Typical Dredge Sediment Depth (m)	Sediment Grab	Piston Coring (Horizons)
Outer Channel	0 – 0.5	✓	Surface
Inner Port (main wharves, inner shipping channel and swing basins)	0 – 0.5	✓	Surface
Marlin Marina	0 – 1.5		✓ (0-0.5m; 0.5-1.2m)
Navy Base (Inner / Outer)	0.5 – 1.5		✓ (0-0.5m; 0.5-1.2m)
Commercial Fishing Base 1	0.5 – 1.5		✓ (0-0.5m; 0.5-1.2m)
Commercial Fishing Base 2	0.5 – 1.5		✓ (0-0.5m; 0.5-1.2m)
Tenants, MSQ, Smiths Creek	Various	TBA in separate SAP	TBA in separate SAP

Note that if requirements for dredging are greater than 1.2 m over the majority of the dredge area, coring should be to the required depth of dredging using an appropriate method and samples are to be taken at 0.5 m intervals.

The sampling will be led by a suitably qualified environmental professional with experience in the application of the NAGD Guidelines to sediment quality assessment.

The vessel to be used as the platform for the sampling will be provided by FNQPC. All working areas of the vessel will be thoroughly checked, cleaned and prepared for sediment sampling activities prior to each day's sampling.

Specific forms will be completed in the field (one for each sampling site) to document both collection details and sediment description for later compilation onto a standardised core description log. Photographs will be taken of samples obtained at each sampling location.

SAMPLE PROCESSING

Sample handling onboard the vessel will include sediment description logging, sample homogenisation and containerisation for dispatch to analytical laboratories under chain of custody documentation.

Samples will be placed/extruded into large stainless steel mixing bowls and homogenised using gloved hands (powderless latex gloves) or small stainless steel sample scoop. Samples will be stored in supplied by the analytical laboratory, which is to be NATA accredited for the analyses to be undertaken. Sample containers will be appropriately labelled (using indelible ink to write the sample site number and date on both the label and lid of the container) and will be stored either in refrigerators or in eskies with ice packs, without delay. Samples will remain in refrigerated condition until dispatched to the analytical testing laboratory, where they will be maintained at 4°C. If samples are to be frozen to extend hold times to minimise the need to recollect material for further analyses, sediments for organic contaminant or mercury assessment are to be stored at -10°C.

All sample material held at the analytical laboratory is to be retained for three months from the date of submission, to be available for repeat/verification testing as may be required.

DATA ANALYSIS

Data analysis is to be undertaken complaint with NAGD requirements.

QUALITY ASSURANCE AND QUALITY CONTROL

Field and laboratory quality assurance and quality control are to be undertaken in compliance with NAGD requirements. Primary and secondary laboratories to be used will be NATA accredited for the testing to be undertaken. If a laboratory has alternative quality control criteria, then these are to be reported. Alternative criteria are often employed on a sliding scale dependent on the magnitude of the results in comparison to the level of reporting and should be reported where applicable.

PROCESS FOR MOVING FROM SCREENING LEVEL ASSESSMENT TO ELUTRIATE AND BIOAVAILABILITY ASSESSMENT

Should screening level assessment identify contaminants above the NAGD screening level (or local screening level for arsenic) at the 95%UCL of the mean, then further testing is required according the NAGD framework for the assessment of potential contaminants. As the Determining Authority require that their approval is given to the proposed further sampling and analysis.

To facilitate this, a brief report is to be submitted via e-mail, detailing:

- the dredge area where the screening level exceedance occurred;
- a figure showing the sampling location of exceedances within the dredge area;

- a spreadsheet of sample values and sampling locations and horizon depths as well as statistical summary values (arithmetic mean/ geometric mean, standard deviation and 95%UCL of the mean);
- the number of samples and location of samples to be taken and analysed. These should be consistent with NAGD Table 7 requirements for dredge volumes and locations based on the sites with highest concentrations reported during screening level assessment; and
- proposed methods of laboratory and data analyses.

If exemption from further testing is requested, then a justification is to be provided.

The Determining Authority will then consider the results and proposed sampling and analysis plan and provide comment/approval, which is to be obtained prior to implementation.

REPORTING

A report is to be prepared consistent with the requirements of Appendix B of the NAGD. Depending on the staging of dredging, reporting of dredge areas may be undertaken separately.

The report(s) is to be submitted to the Determining Authority by FNQPC for review and comment or approval for sea dumping. Written approval is required from the Determining Authority for respective dredge areas prior to dredging and disposal activities commencing.

SUMMARY OF SAMPLE COLLECTION PROGRAM

A summary of the overall dredging requirements and sample collection program for respective dredge areas is provided in **Table A5-4**.

Table A5-4 Summary of overall sediment collection program for dredge areas

Area	Wet Load Dredge Volume (m^3)	Dredging Depth (m LAT)	Sediment Depth (m)	Dredging Frequency	Dredge Method	Sampling Sites / Sampling Grid Cells	Sampling Method	Horizons	Marine Pest Sampling Method	Survey Frequency
Outer Channel	225,000 – 460,000	8.5	0.5	Annual	TSHD	14 / 264	Grab sampler	1 (surface)	100m sled tows	Annual
Inner Port										
Swing basins	TBA, as required	8.5	0.5	Infrequent, as required	TSHD	TBA as required	Grab sampler	1 (surface)	100m sled tows	Infrequent, as required
Wharves	13,500	6-12	0.5	Annual	Willunga	7 / Cells within identified area	Grab sampler	1 (surface)	100m sled tows	Annual
Inner Channel	TBA, as required	8.5	0.5	Infrequent, as required	TSHD	TBA as required	Grab sampler	1 (surface)	100m sled tows	Infrequent, as required
Marlin Marina	17,000	2.5	0.5 – 1.5	Typically annual	Willunga	8 / 113	1.2 m piston corer	0 – 0.5 m; 0.5 – 1.2 m)**	6 grabs per sample site	Typically annual
CFB1	10,000	3.5	1 – 1.5	Semi-annual, as available	Willunga	10 / 60	1.2 m piston corer	0 – 0.5 m; 0.5 – 1.2 m)**	6 grabs per sample site	Typically annual
CFB2	10,000	3.5	1 – 1.5	Semi-annual, as available	Willunga	6 / 94	1.2m piston corer	0 – 0.5m; 0.5 – 1.2 m)**	6 grabs per sample site	Typically annual
Navy Base										
Inner	25,000	2.5 - 4.5	0.5 – 1.5	Every second year	Willunga	9 / 45	1.2 m piston corer	0 – 0.5m; 0.5 – 1.2m)**	6 grabs per sample site	Every second year
Outer	12,500	2.5 - 4.5	1 - 1.5	Every second year	Willunga	7 / 35	1.2 m piston corer	0 – 0.5 m; 0.5 – 1.2 m)**	6 grabs per sample site	Every second year
Spoil ground	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	6 / 6	Grab sampler	1 (surface)	6 grabs per sample site (5x100m sled tows)	Annual (2014, 2019)
Tenants	Various	Various	Various	Infrequent, as required	Willunga, excavator	TBA in separate SAP	TBA in separate SAP	TBA in separate SAP	6 grabs per sample site	Infrequent, as required

Footnote; ****** piston core interval to be 0.5 m intervals if >1.2 m as per NAGD guidance.

Appendix 5 Introduced Marine Pest Survey Design

INTRODUCTION

Sediments proposed for dredging within each specified dredge area will be assessed for the presence/ absence of introduced marine pest species. Previous marine pest monitoring of Cairns seaport has identified three species in areas other than sediments to be dredged and placed at sea. The survey will focus on the three species previously species: the Asian Green Mussel (*Perna viridis*), Caribbean Tube worm (*Hydroides sanctaecrucis*) and Asian Bag Mussel (*Musculista senhousia*).

The marine pest survey will be undertaken in conjunction with sediment contaminant status assessment within each of the proposed dredge areas. It will be undertaken annually until the Determining Authority agrees that there is low risk of presence of target marine species in sediments to be dredged and placed in the Marine Park and the monitoring can be reduced or stopped.

The design of the survey should be reviewed if incursions of other marine pest species occur. Any revised design is to be reviewed by the Determining Authority prior to implementation.

SAMPLING LOCATIONS AND METHODS

Outer Channel and Inner Port (Wharf Areas)

Sediments located within the Outer Channel dredge area will be sampled for marine pest species using a benthic sled. The benthic sled will sample sediments to 10cm depth below the seabed surface using a 600mm x 250 mm collection bag. At each of 12 previously determined sampling sites (D1-D12) the sled will be deployed from the rear of the sampling vessel and towed at a speed of <2 knots for approximately 100 m. **Table A6-1** provides the coordinates of proposed benthic sled sampling site locations in the outer channel and **Figure A6-1** provides a map of sampling locations.

Towed sled sampling will also be undertaken as far as practicable along the wharf faces of the inner port, provided vessels and other obstacles do not preclude reasonable access for the towing vessel and sufficient room to manoeuvre while towing the sled. Optimally, sled tows would be undertaken along the following wharf faces:

- Wharf 1 & 2;
- Wharf 4 & 5;
- Wharf 7 & 8;
- Wharf 10; and
- Wharf 12.

Where towed sledding is not possible, six replicate samples will be taken from the particular area and processed according to the methods for the marina areas and HMAS Cairns Navy Base (see below).

On completion of each transect the sled will be retrieved and the contents of the sample bag will be transferred to a sorting tray for field processing.

Table A6-1 GPS sampling site coordinates of proposed marine pest towed sled sampling site locations

Site ID	Easting	Northing
D-01	370516	8129160
D-02	370698	8129939
D-03	371145	8130764
D-04	371608	8131605
D-05	372072	8132446
D-06	372535	8133286
D-07	372998	8134127
D-08	373462	8134968
D-09	373925	8135808
D-10	374389	8136649
D-11	374775	8137350
D-12	375161	8138050

Datum: GDA94 (UTM Zone 55)

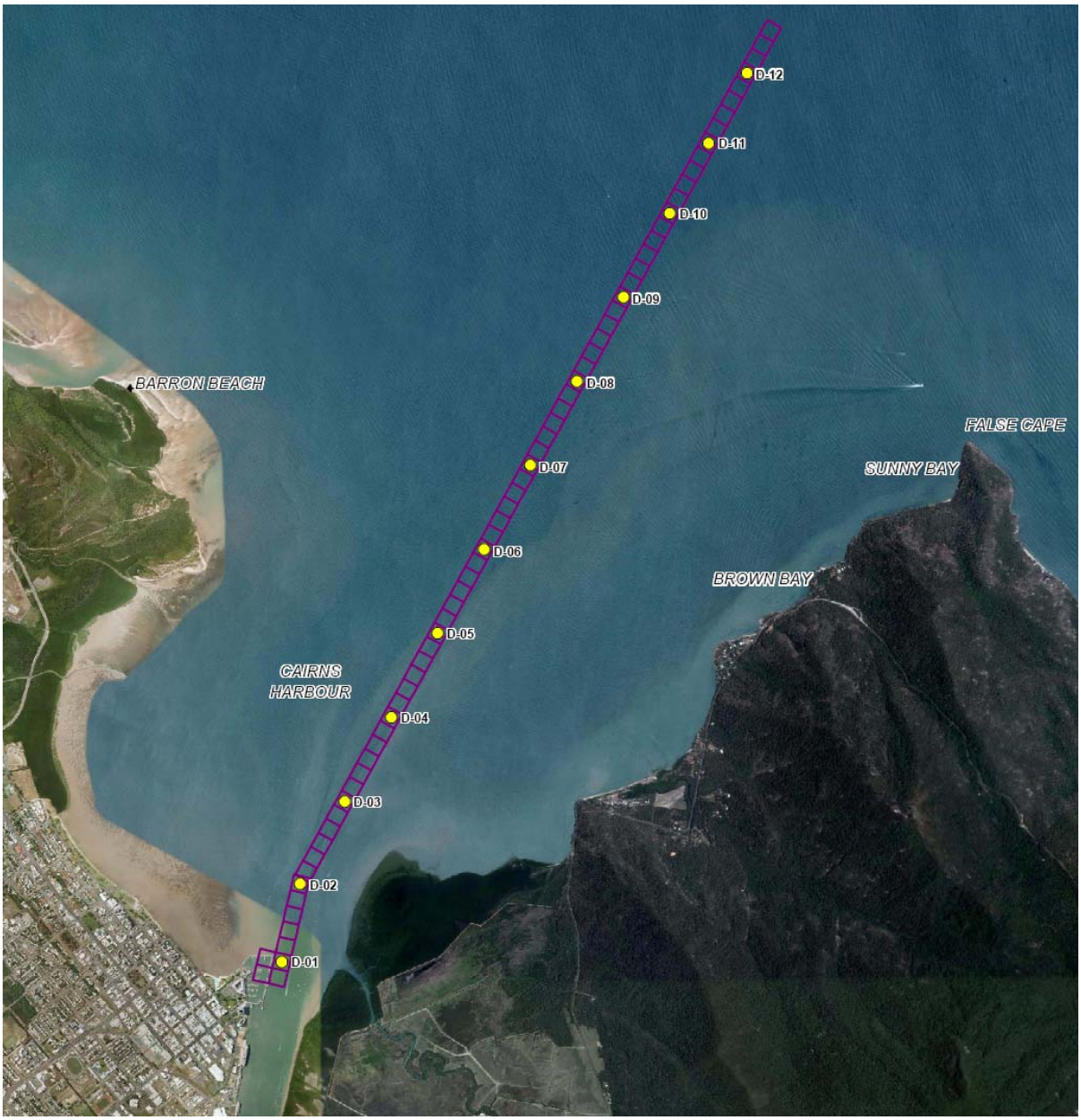


Figure A6-1 Outer Channel towed sled marine pest sampling site locations

Marina areas and HMAS Cairns Navy Base

Marina and Navy base areas will be sampled using a benthic grab instead of towed sled arrangement due to restricted space and manoeuvrability. Six grab samples are to be taken and composited from each location sampled for contaminant assessment. This sample will be sieved using a 2mm or smaller mesh and the remaining material transferred to a tray for field processing.

Spoil Ground

Introduced marine pest surveys of the spoil ground will be undertaken according to the following schedule and sampling methods:

- Annual sampling at the four sediment sampling locations within the spoil ground using single 100 m sled tows; and
- 2014 and 2019 as part of the benthic infauna monitoring surveys, using 100 m sled tows at the five benthic infauna sampling sites.

FIELD PROCESSING AND SAMPLE IDENTIFICATION

Upon transfer of retained material to the trays for sorting, each sample will be photographed for permanent record.

Initial screening of samples on-board the sampling vessel will be supervised by a qualified marine scientist with taxonomic skills sufficient to recognise mussel or calcareous tube worm specimens or fragments. Sample material will be sorted through and field notes recorded describing the biota contained within each sample and any suspect individuals or other relevant data.

Any suspect organisms or fragments are to be retained and preserved appropriately (10% formaldehyde in buffered seawater and later transferred to 70% alcohol). This material will be sent to a relevant taxonomic expert for formal identification.

REPORTING

A report will be prepared using a standard scientific reporting format and submitted to the Determining Authority for review prior to dredging being undertaken.

Appendix 6 Spoil Ground Infauna Monitoring Design

INTRODUCTION

The aim of the spoil ground benthic infauna survey is to answering two questions:

- What is the impact at the spoil ground, in comparison to other non-spoil ground areas?
- How does the impact diminish with distance from the spoil ground?

In order to investigate these questions, a survey design is necessary that can detect changes at the ocean disposal site itself, as well changes emanating from disposal at the site that manifest themselves outside the site.

The recent survey design implemented at Cairns Port spoil ground (WorleyParsons, 2009) has been demonstrated to be rigorous and able to detect subtle differences in benthic assemblages within and adjacent to the spoil ground. This design has been used successfully at the Port of Bundaberg on two occasions (2006 and 2008) and has been approved by DEWHA as a suitable design for surveying dredge spoil grounds.

SURVEY LOCATIONS

The rationale of the design is the detection of impacts both within the spoil ground, and along a gradient extending from the spoil ground in the direction of the prevailing currents. A second transect, which is not in a direction where prevailing current conditions are likely to transport material from the spoil ground to adjacent areas provides a reference.

For monitoring of impacts at the Ocean Disposal Site used by Cairns Port, the spatial pattern for sampling is as follows (refer to **Figure A7-1**):

- Five survey locations extending in a northerly direction from the edge of the spoil ground with one site per location and three replicate grab samples per site. The sites are positioned 50 m, 150 m, 500 m, 1 km and 2 km from edge of the spoil ground. These locations represent the zone of putative impact.
- Five survey locations extending in a southerly direction from the edge of the spoil ground with one site per location and three replicate grab samples per site. The sites are positioned 50 m, 150 m, 500 m, 1 km and 2 km from edge of the spoil ground. While inner locations may demonstrate minor gradient of impact, outer locations would represent reference locations.
- Five survey locations within the ocean disposal site – one in the centre and one each to the north, south, east and west of the site approximately two-thirds toward the boundary. Three replicates grab samples per location will be taken.

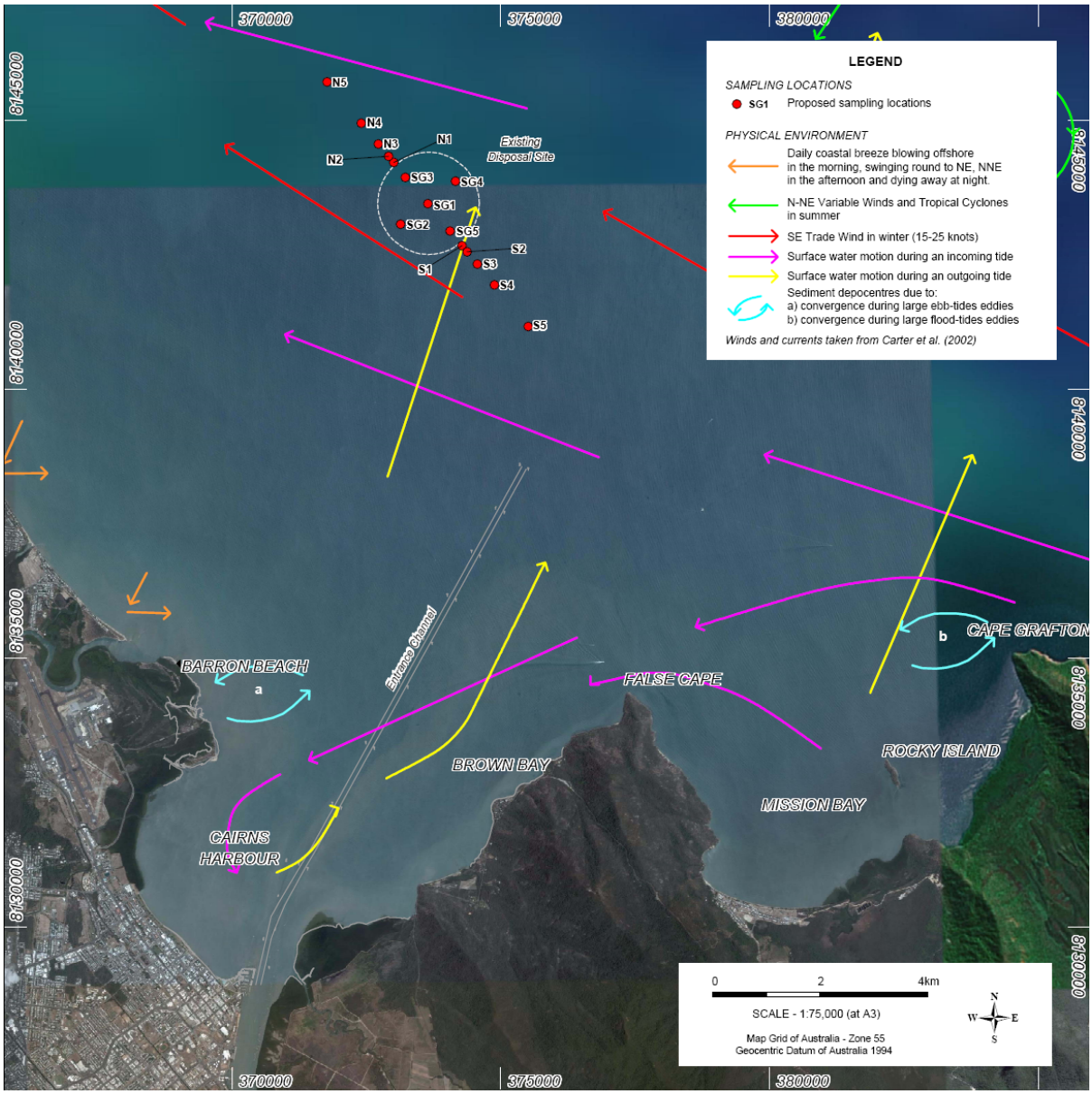


Figure A7-1 Benthic infauna survey locations

The chosen distances for survey locations are modified slightly from the 2009 survey, with the 150 m distance slightly closer to the spoil ground than the 200 m previously because no impact was detected at the greater distance. So a finer scale was recommended. The alignment of the axes is based on prevailing currents in the area. The sites selected span a limited depth variation across the area to be surveyed to reduce depth-related effects. The maximum distance of two kilometres from the edge of the spoil ground was chosen based on 1) consideration of hydrodynamics; 2) consideration of the scale of impacts found at other spoil grounds using TSHD dredging and spoil

disposal; and 3) extending it further which have pushed the southern survey sites into or beyond the existing shipping channel, thus introducing a potential confounding factor.

SAMPLE COLLECTION AND PROCESSING

Three replicate samples per survey site are to be taken for benthic infauna assessment and an additional sample per survey site collected for assessing particle size distribution of the sediment. Samples are to be collected using a hand operated van Veen grab of 0.15 m x 0.15 m gape.

Each sample collected for benthic infauna assessment is to be sieved in the field using a sieve of 0.5 mm mesh. The material remaining on the mesh should be preserved in 4% buffered formalin (containing Rose Bengal stain) in pre-labelled zip-lock bags for transfer to the laboratory for sorting and identification. Samples collected for particle size distribution are to be sealed in zip-lock bags without being sieved.

Laboratory Analyses

Laboratory analysis of the macrobenthic infauna will be conducted by a scientist suitably experienced in identifying benthic marine macroinvertebrate fauna to family level or below.

Upon arrival in the laboratory each sample will be processed by washing the samples in freshwater on a 0.5 mm mesh sieve to remove formaldehyde. The macrobenthic infauna should be removed from the sediment using a dissecting microscope, identified to the lowest practical taxonomic level, counted and stored in 70% ethanol. This level of taxonomic identification is consistent with what has been undertaken previously and consistent with a large number of peer reviewed studies that advocate groupings above species to assess environmental impacts. Using species or even genera for benthic invertebrates generally leads to introducing significant amounts of “noise” into the dataset which masks trends important for monitoring and assessment.

A representative collection of benthic invertebrates was prepared for the 2009 survey, and should form that basis for taxonomic identification of specimens to provide consistency between surveys. Any new taxa should be added to the representative collection.

Statistical Analyses

Statistical analyses involve both univariate and multivariate statistics and will allow for comparisons with the 2009 survey. Spatial variation of the following parameters is to be assessed: total abundance, species (taxa) richness, species (taxa) diversity and evenness.

Total Abundance

Density (or abundance) as a measure of the total number of individuals collected at each sampling location.

Species (Taxa) Richness

Richness is the measure of the number of species present at each sampling location. For the study, species are represented the lowest practical taxonomic units and as such it is convention to refer to it as taxonomic richness.

Species (Taxa) Diversity

Species (taxa) diversity shall be calculated using the Shannon Diversity Index which is a measure of the number of organisms in each taxa present at each sampling location.

Evenness

Evenness is another measure of community structure and is based on measuring the number of each taxa present at each sampling location. This index is a modification of the Shannon Diversity Index.

Functionally Analyses

The composition of functional groups (deposit feeders, filter feeders, scavengers) can be influenced by the fines fraction of the sediment. The different taxa identified in the study are to be categorised into their relevant functional groups and the ratio of the functional groups at the spoil ground and across the survey locations that extend from it investigated.

Univariate Analyses

Univariate analyses will be applied to test for significant differences in the structure of the benthic macro-invertebrate assemblage between the spoil ground site and the two survey axes that extend from the spoil ground. Parameters that will be tested will be total abundance, taxa richness, taxa diversity, evenness and functional groups. An appropriate mixed model Analysis of Variance (ANOVA) will be applied.

Multivariate Analyses

Multivariate methods use both the identity and the abundance of every taxa to describe each sampling location, and make comparisons between the structure of the macrobenthic infauna assemblage at different times and different locations. The software package Primer 6, designed specifically for marine ecological studies, will be used to undertake the following multivariate analyses: ordination using non-metric multidimensional scaling (nMDS), cluster analysis (if necessary pending the output of the nMDS), and analysis of similarities (ANOSIM). Multivariate statistics will provide greater insight into changes in the structure of the assemblage than either univariate (parametric or non-parametric) or descriptive statistics.

Ordination

Ordination methods such as nMDS force a multidimensional data set into a reduced number of dimensions. In lay terms, it allows for a visually representation of how survey locations differ taking into consideration the abundance of all taxa present. The closer the symbols in each plot are to one another, the more similar the overall macrobenthic infauna assemblage. Ordination results from the

2006 spoil ground survey show how a macrobenthic infauna assemblage at a spoil ground can differ from that of reference locations (**Figure A7-2**).

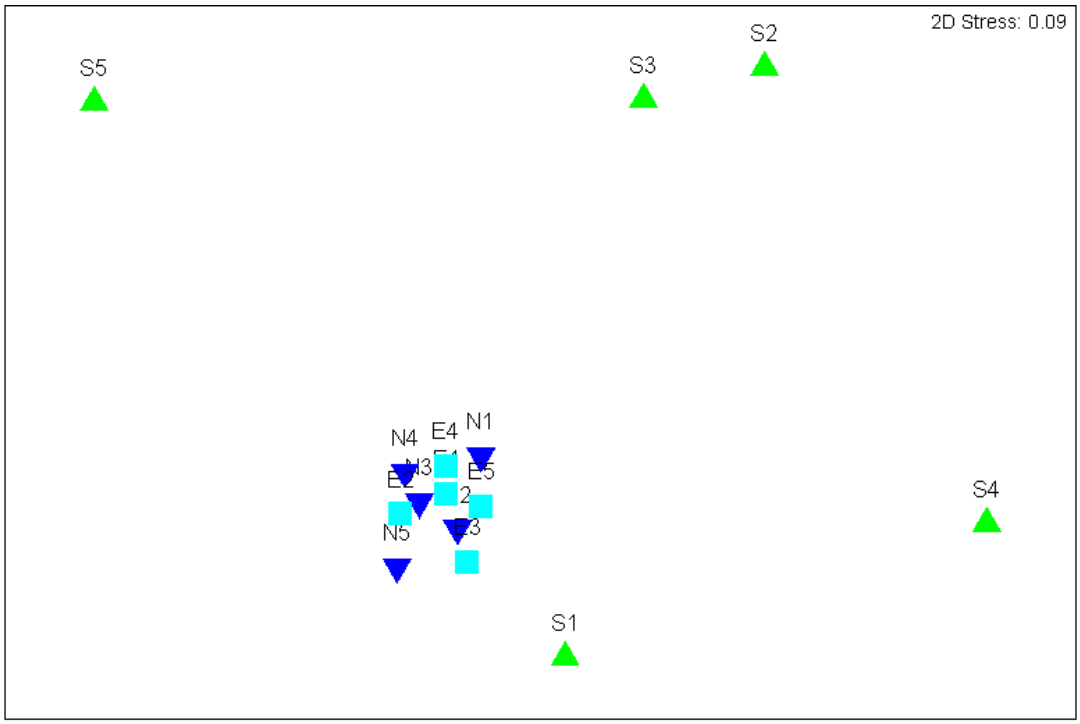
Data will be square-root transformed prior to generating a Bray-Curtis similarity index. The transformation is generally required to reduce the dominance of certain infauna taxa that might have otherwise overly influence the statistical assessment.

Stress is a measure of the success of the nMDS ordination method in reducing the high dimensional data to a lower dimensional plot (Clarke, 1993). **Table A7-2** provides a guideline for the goodness-of-fit for nMDS ordination for a range of stress levels.

Table A7-2 Guide to interpreting stress values from nMDS

Stress Value	Goodness of Fit
<0.05	Excellent representation with no prospect of misinterpretation.
<0.1	Good ordination with no real prospect of a misleading interpretation.
<0.2	Still gives a potentially useful 2-dimensional picture. Cross-check conclusions against alternative technique (e.g. cluster analysis).
<0.3	Ordination should be treated with a great deal of scepticism. Indicates points are close to being arbitrarily placed in the 2-dimensional ordination space.

Source: Modified from Clarke and Gorley (2001).



Note: Green triangles are sites within spoil ground. Dark blue triangles are sites along northern axis. Light blue squares are sites along eastern axis. The closer symbols are to each other, the more similar they are to each other.

Figure A7-2 2006 Example of nMDS output (from Port of Bundaberg spoil ground)

Cluster Analysis

Should the stress level of the nMDS be between 0.2 and 0.3, cluster analysis will be undertaken. The output from the cluster analysis is analogous to a "family tree" where the closer together the branches of the tree, the more similar the samples. Cluster analysis is based on the same dataset as the nMDS and it provides another method of visualising the similarities of the macrobenthic infaunal assemblage between survey times and locations. Cluster analysis would use a hierarchical cluster method based on the Bray Curtis similarity measure and square root transformation.

Analysis of Similarity (ANOSIM)

ANOSIM (ANalysis Of SIMilarities) will be used to test for significant differences in community structure between factors (e.g. sites) and is analogous to Analysis of Variance tests (ANOVA) for univariate analyses. ANOSIM is a non-parametric permutation procedure applied to the (rank) similarity matrix underlying the ordination or classification of samples (Clarke and Warwick, 2001). The resulting 'R' statistic is a comparative measure of the degree of separation of sites although main interest usually centres on whether it is significantly different from zero. The Global R statistic is based on the difference of mean ranks between sites and within sites and usually falls within 0 to 1. R equals 1 only if all replicates within sites (or sampling periods) are more similar to each other than any

replicates from different sites (or sampling periods). R is approximately zero if the similarities between and within sites (or sampling periods) are the same on average. The significance level provided in ANOSIM relates to the null hypothesis (H_o) that "*there is no difference between the factor being analysed*", with factors being sampling site or sampling date).

In addition to a Global R value, ANOSIM, also produces pair-wise R values, measuring how separate groups are, on a scale of 0 (indistinguishable) to 1 (all similarities within groups are less than any similarity between groups) gives an interpretable number for the difference between groups. R-values >0.75 are interpreted as well separated; R>0.5 as overlapping, but clearly different; and R<0.25 as barely separable at all, in accordance with the PRIMER-manual (Clarke & Gorley, 2001).

Discussion and Interpretation

All trends evident from the results will be appropriately discussed and interpreted, with particular focus on determining any impacts from the placement of spoil at the spoil ground.

Reporting

The benthic infauna monitoring report will be available three months after completion of the survey. It will be forwarded to GBRMPA and TACC members. Monitoring results will be discussed at the next TACC meeting.