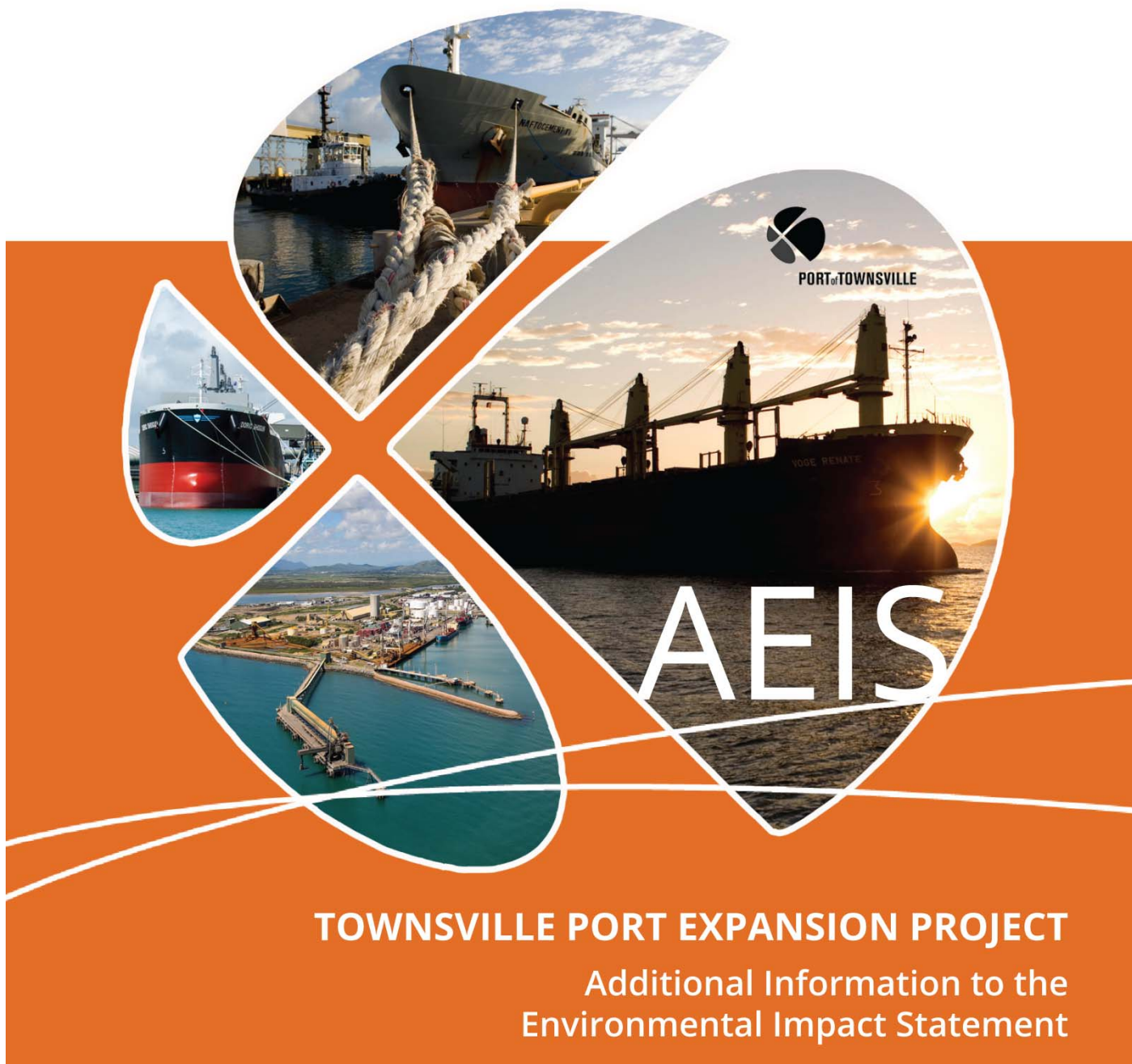




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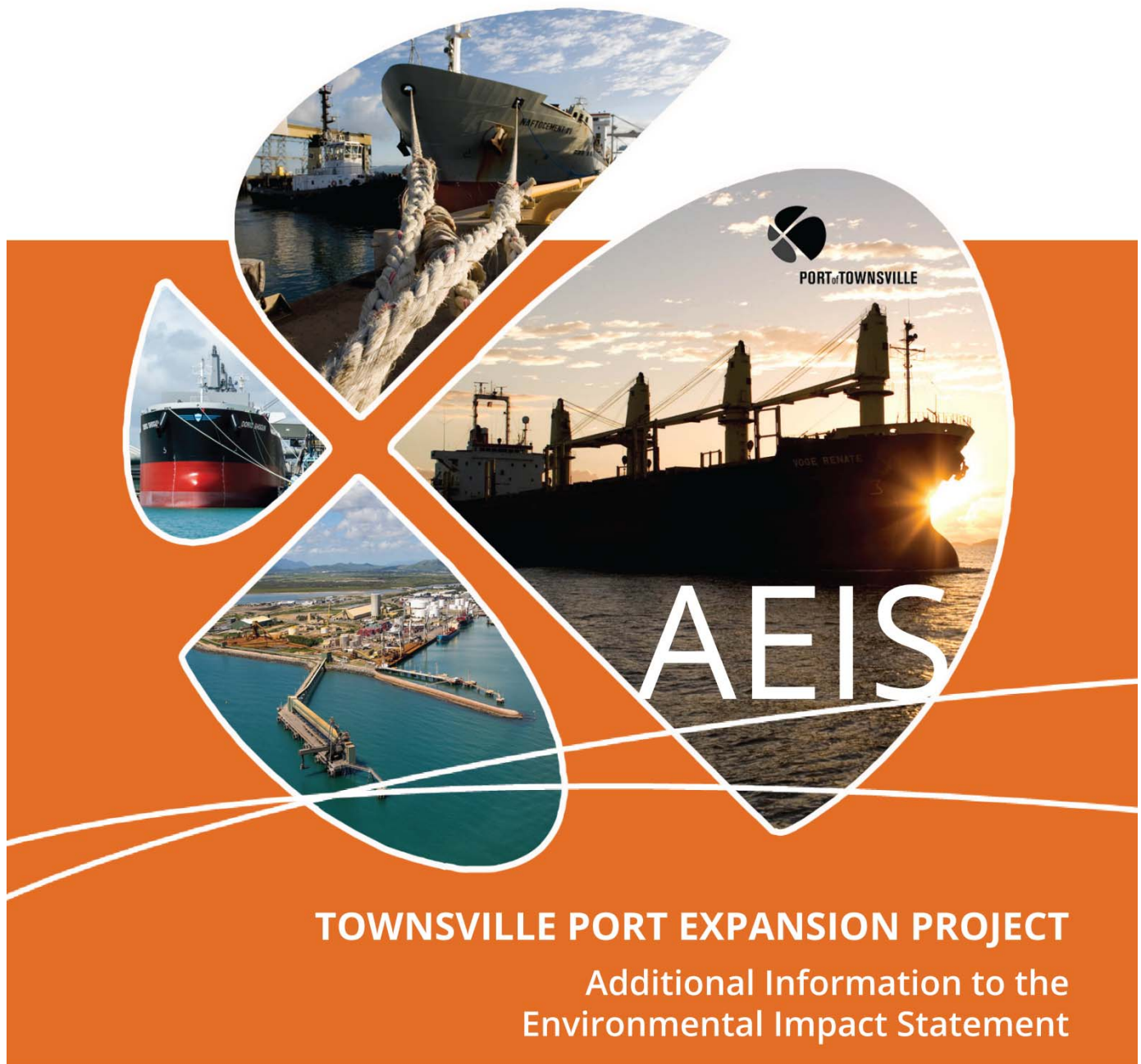


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Appendix A: Supporting Studies

Appendix A1 Additional Field Studies for Townsville Port Expansion Project AEIS

Appendix A2 Townsville Port Expansion AEIS Hydrodynamic and Advection – Dispersion Modelling Technical Report

Appendix A3 Consideration of the PEP Design Refinement on Wave Climate at the Port of Townsville; Wave Analysis

Appendix A4 Air Quality Impact Assessment Supporting Information

Appendix A5 Cumulative Impacts Assessment Supporting Information

Appendix A6 Noise and Vibration Supporting Information

Appendix A7 Terrestrial Ecology Likelihood Supporting Information

Appendix B: Management Plans

Appendix B1 Dredge Management Plan

Appendix B2 Construction Environmental Management Plan

Appendix B3 Operational Environmental Management Plan

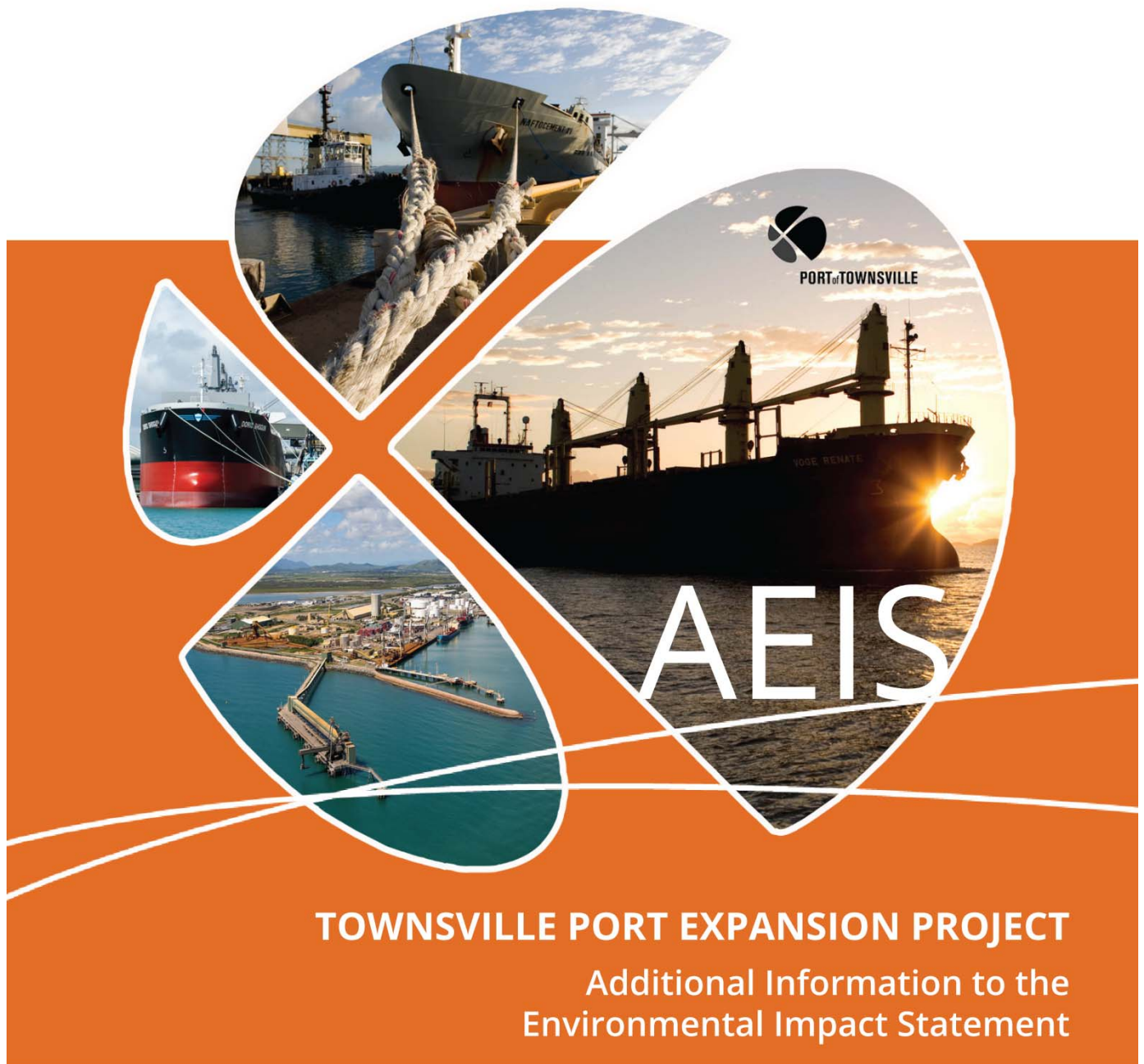
Appendix C: AEIS Supporting Documentation

Appendix C1 Submissions

Appendix C2 Changes to Legislation

Appendix C3 Errata List

Appendix C4 References



Glossary

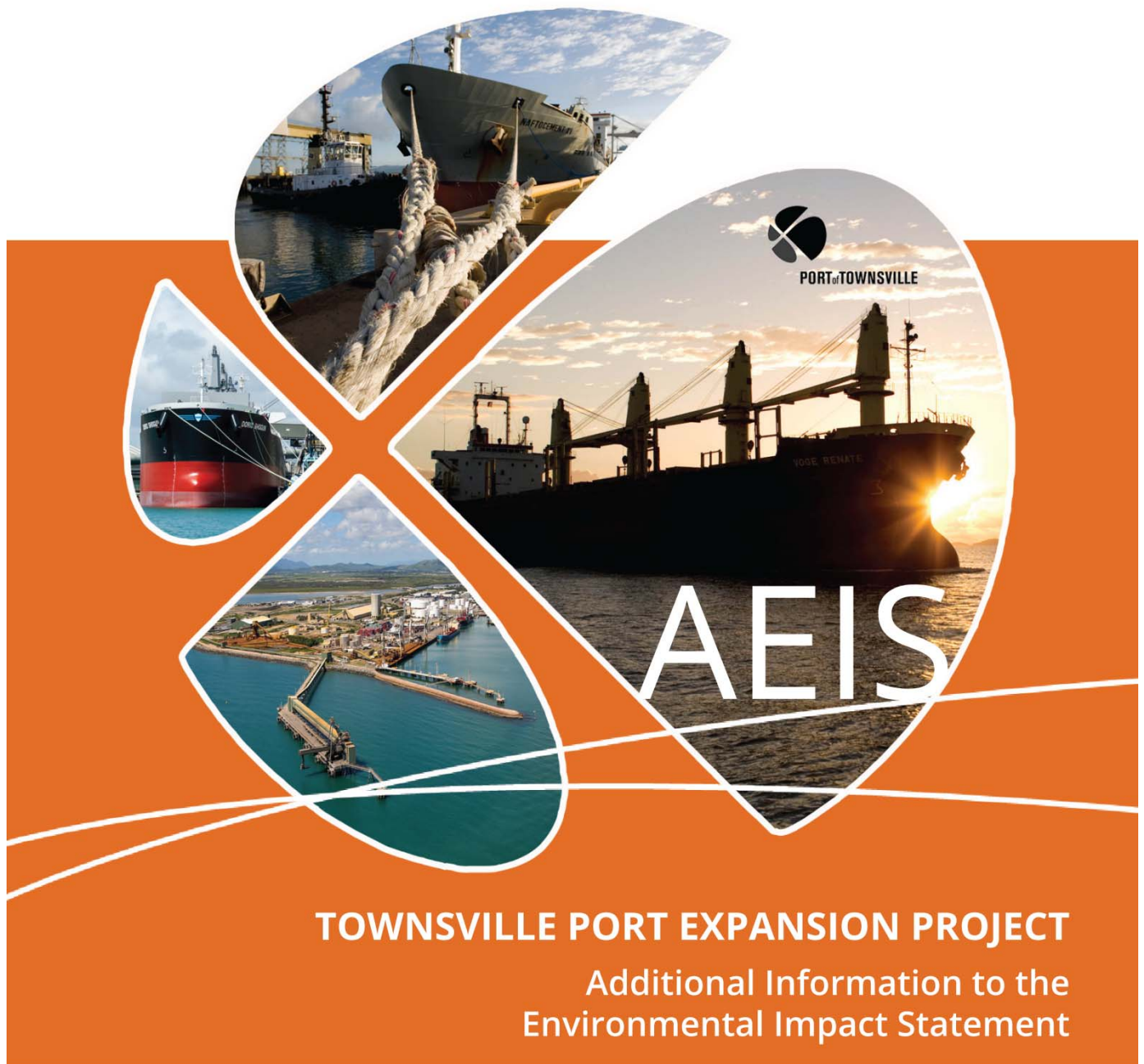


Glossary

Term	Definition
AAD	average annual damages
ABB	aerobic bacteriochlorophyll containing bacteria
ABS	Australian Bureau of Statistics
AEIS	Additional Environmental Impact Statement
AEP	Annual Exceedance Probability
AIMS	Australian Institute of Marine Science
ALCAM	Australian Level Crossing Assessment Model
AMSA	Australian Maritime Safety Authority
AQIA	Air Quality Impact Assessment
ASS	Acid Sulfate Soils
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CBD	Central Business District
CEMP	Construction Environmental Management Plan
CG	Coordinator-General
CH ₄	methane
CIA	Cumulative Impact Assessment
CE	Choice experiment
CH ₄	Methane
CO	Carbon monoxide
CO ₂	carbon dioxide
CoTS	Crown of Thorns starfish
CVM	Contingent valuation method
DAF	Department of Agriculture and Fisheries
DATSIMA	Department of Aboriginal and Torres Strait Islander and Multicultural Affairs
dB	decibels
DEHP	Department of Environment and Heritage Protection
DMP	Dredge Management Plan
DMPA	Dredge Material Placement Area
DNPRSR	Department of National Parks, Recreation, Sport and Racing
DO	Dissolved oxygen
DoE	Department of the Environment
DSDIP	Department of State Development, Infrastructure and Planning
DSITI	Department of Science, Information Technology and Innovation
DTMR	Department of Transport and Main Roads
EC	Electrical Conductivity
EIS	Environmental Impact Statement

Term	Definition
EMP	Environmental Management Plan
EMS	Environmental Management System
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPP	<i>Environmental Protection Policy</i>
ERA	Environmentally Relevant Activity
EVs	Environmental Values
FS	Form Letter Submission
FTE	Full Time Equivalent
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
H ₂	Hydrogen
HEV	High Ecological Value
HFO	Heavy Fuel Oil
Hg	Mercury
IDAS	Integrated Development Assessment System
IPCC	Intergovernmental Panel on Climate Change
IPL	Incitec Pivot Limited
JCU	James Cook University
KPI	Key Performance Indicators
LAT	Lowest Astronomical Tide
LOA	Overall length
LPG	liquefied petroleum gas
MICDA	Magnetic Island Community Development Association
MINCA	Magnetic Island Nature Care Association
MLWS	mean low water spring
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
MSQ	Maritime Safety Queensland
N ₂ O	nitrous oxide
NAGD	National Assessment Guidelines for Dredging
NC Act	Nature Conservation Act 1992
NEPM	National Environment Protection Measure
NTU	Nephelometric Turbidity
OESR	Office of Economic and Statistical Research
OUV	Outstanding Universal Value
PAR	Photosynthetically active radiation

Term	Definition
PASS	Potential Acid Sulfate Soils
PEES	Preliminary Engineering and Environment Study
PEP	Port Expansion Project
POTL	Port of Townsville Limited
PDA	Priority Development Area
PPDA	Priority Port Development Area
QRSIS	Queensland Regional Statistic Information System
QSL	Queensland Sugar Limited
RAP	Reconciliation Action Plan
RHM	Regional Harbour Master
RMP	Reactive Monitoring Program
SARA	State Assessment and Referral Agency
SDAP	State Development Assessment Provisions
SDPWO Act	State Development and Public Works Organisation Act 1971
SDSs	safety data sheets
SERs	sensitive ecological receptors
SO ₂	Sulfur dioxide
SP Regulation	<i>Sustainable Planning Regulation 2009</i>
SPA	<i>Sustainable Planning Act 2009</i>
SPP	State Planning Policy
TAC	Technical Advisory Committee
TCC	Townsville City Council
TN	Total nitrogen
ToR	Terms of Reference
TP	total phosphorous
TSDA	Townsville State Development Area
TSHD	Trailer Suction Hopper Dredge
UKC	under keep clearance
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHA	World Heritage Area
WHO	World Health Organisation
WQO	Water Quality Objectives



SECTION 1 Introduction



1.0 Introduction

Port of Townsville Limited (POTL) proposes an expansion of the Port of Townsville to accommodate future trade growth over the planning horizon to 2040. The Port Expansion Project (PEP, the Project) proposes channel deepening, widening, and development of a new outer harbour, wharves, reclamation, and associated infrastructure to support new berths.

The Additional Information to the Environmental Impact Statement (AEIS) has been prepared in response to submissions and the Commonwealth government and Coordinator-General's request to provide further clarification on specific matters raised following the public notification of the Environmental Impact Statement (EIS).

The Project is being assessed under separate Commonwealth and State approval processes. The EIS was prepared in accordance with regulatory requirements below.

- *Terms of Reference for an Environmental Impact Statement (ToR)* issued by the Coordinator-General under the *State Development and Public Works Organisation Act 1971* (CG, 2012) (refer Appendix A1 of the EIS).
- *Guidelines for an Environmental Impact Statement for the Port of Townsville Limited Port Expansion Project, Queensland* (EIS Guidelines) (DSEWPC, 2012) (refer Appendix A2 of the EIS) issued by:
 - Department of the Environment (DoE) (formerly Department of Sustainability, Environment, Water, Populations and Communities) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
 - Great Barrier Reef Marine Park Authority under the *Great Barrier Reef Marine Park Act 1975*.

The AEIS for the PEP fulfils the requirements of both the ToR and the EIS Guidelines, and forms the basis for the two separate assessments under the *State Development and Public Works Organisation Act 1971* and the EPBC Act.

An invitation for public comment was issued on the 23 March 2013. A combined total of 435 submissions on the EIS were received by the Commonwealth and State governments under their respective processes. This AEIS responds to those submissions and Commonwealth government and Coordinator-General's request to provide further clarification on specific matters raised.

1.1 Purpose of the AEIS

The purpose of this report is to provide:

- a summary of submissions
- the proponent's response to the submissions
- an outline of amendments to the submitted EIS assessment and design in response to the submissions
- address changes to legislative instruments made since the release of the EIS.

The AEIS forms part of the overall environmental impact assessment process for the Project (refer Section 1.2 of the EIS).

The AEIS does not seek to duplicate the EIS but rather to complement the existing assessment by providing additional clarification on specific matters raised during the public consultation period, including project design refinements.

1.2 The EIS Process

An Initial Advice Statement for the PEP was lodged with the Coordinator-General on 13 April 2011 and on 23 May 2011, the Coordinator-General declared the Project a 'significant project' for which an EIS is required, under Section 26(1)(a) of the *State Development and Public Works Organisation Act 1971*. The Coordinator-General's final ToR was prepared in February 2012 following public consultation of the draft between 29 October 2011 and 25 November 2011.

On 26 May 2011, the Project was referred to the Commonwealth, Minister for Sustainability, Environment, Water, Population and Communities (now DoE) seeking a decision as to whether the Project will constitute a 'controlled action' under the EPBC Act.

The Project was deemed to be a controlled action (EPBC 2011/5979) by the Commonwealth on 1 July 2011. The controlling provisions under the EPBC Act are:

- World Heritage properties (Sections 12 and 15A)
- National Heritage places (Sections 15B and 15C)
- wetlands of international importance (Sections 16 and 17B)
- listed threatened species and communities (Sections 18 and 18A)
- listed migratory species (Sections 20 and 20A)

- Commonwealth marine areas (Sections 23 and 24A)
- Great Barrier Reef Marine Park (Sections 24B and 24C).

For the purposes of assessment against the EPBC Act, the Commonwealth decision (dated 21 July 2011) required a separate assessment process, being the preparation of an EIS under the EPBC Act. The Commonwealth EIS Guidelines under the EPBC Act was finalised in April 2012. This included assessment requirements for specified matters of national environmental significance and the provisions of the *Great Barrier Reef Marine Park Regulations 1983*.

The EIS formed the basis for the two separate assessments by the Coordinator-General, under the *State Development and Public Works Organisation Act 1971*, and both the Minister of Department of Environment and the Great Barrier Reef Marine Park Authority, under the EPBC Act and *Great Barrier Reef Marine Park Act 1975*.

The EIS public notification period for State submissions closed on 13 May 2013 and a total of 256 submissions were received. The EIS public notification period for Commonwealth submissions closed on 27 May 2013 and a total of 179 submissions were received. Submissions under both processes were received from government agencies, businesses, community groups, non-government organisations and private individuals.

The EIS processes are illustrated in Part A, Figure A.2.1 of the EIS. The AEIS responds to the stage marked *Preparation of Supplementary EIS* and provides a response to the submissions made, to facilitate the assessment of the EIS by the State and Commonwealth governments. This AEIS is the equivalent of a Supplementary EIS or a Supplementary Report to the EIS, as referred to in the EIS. This AEIS addresses the Coordinator-Generals request of 30 July 2013 to provide supplementary information to address specific matters raised during the public notification period, pursuant to Section 35(2) of the *State Development and Public Works Organisation Act 1971* as well as addressing the Commonwealth Environment Ministers requirements in finalising the EIS assessment under the Commonwealth EIS Guidelines.

Further details about the assessment of the Project after the EIS public notification stage and rights to appeal are detailed in Chapters A.2.1.4 and A.2.1.5 of the EIS.

1.3 Public Consultation Process

The consultation process for the EIS is described in Chapter A.2.1.3 of the EIS. The public notification period was undertaken in accordance with Section 33(1) of the *State Development and Public Works Organisation Act 1971* and Section 103(3) of the EPBC Act.

An invitation for public comment was issued on the 23 March 2013 and closed on the 13 May 2013 (State government) and 27 May 2013 (Commonwealth government). During this period, a range of consultation activities were undertaken by POTL. These included:

- advertisements in local, state and national newspapers describing the EIS and submission process and detailing where copies of the EIS could be obtained or viewed
- soft copies of the EIS were made available on the Queensland Government Department of State Development (formerly Department of State Development, Infrastructure and Planning (DSDIP)); Great Barrier Reef Marine Park Authority; Department of the Environment; and POTL websites
- staffed public information displays were located on Magnetic Island and in South Townsville in addition to advertisements in local media to promote information displays
- static displays at Townsville City Council local libraries and the Magnetic Island Country Club
- maintenance of the Project webpage on the POTL website and the Project hotline
- emailed updates to all registered stakeholders (including elected representatives, primary stakeholders, special interest groups and the community) and undertook a range of stakeholder and agency briefings.

In addition to public comment, a workshop with agency representatives was held on the 7 August 2013 to discuss key matters arising from the submission period. Since the receipt of submissions, one-on-one meetings have been undertaken with various regulatory and advisory government agencies during the development of responses to submissions on the EIS.

1.4 EIS Submissions

1.4.1 Summary of submissions

A total of 435 submissions were received by the Coordinator-General and Commonwealth Environment Minister. Each submitter is identified by a unique code and all submissions on the EIS are considered in this report.

Of the total submissions, 40 were duplicates submitted to both the State and Commonwealth government agencies by the same respondent. Submissions were sorted into four categories:

- government agency comprising local, State and Commonwealth government departments
- non-government comprising non-government organisations and private companies
- private individuals
- private individuals (form), to include separate categories for the purposes of analysis.

The breakdown by submitter type is provided in Table 1.1.

Table 1.1 Breakdown of EIS Submissions by Submitter Type

Category	Subcategory	Number of Submissions
Government agency		23
Non-government		39
Non-Government Organisation	27	
Private company	12	
Private individual		373
Private Individual	157	
Private individual (form)	216	
Total*		435

*Total number includes 40 submissions which were submitted both to the State and Commonwealth government.

A total of 23 submissions were received from government agencies, 39 submissions from non-government organisations, including private companies, 157 submissions from private submitters, and the majority 216 were online-facilitated submissions either fully or partially based on a form letter. These online-facilitated submissions generally raised the same matters and are therefore a common response that has been considered in this AEIS.

A full list of submissions is provided in Appendix C1, however, for privacy reasons individual submitters are denoted by "private submitter".

1.4.2 Government submitters

A total of 23 submissions were received from different government agencies. An alphabetical listing of the government agencies is provided in Table 1.2. The table also highlights whether the submission was submitted to the Commonwealth or State government.

Table 1.2 Breakdown of Government Submissions

Government Agency	Submitted To:
Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA)	State
Department of Agriculture and Fisheries	State
Department of Community Safety	State
Department of Education, Training and Employment	State
Department of Energy and Water Supply	State
Department of Environment and Heritage Protection	State
Department of Housing and Public Works	State
Department of Justice and Attorney-General - Hazardous Industries and Chemicals Branch, Work Health and Safety, QLD	State
Department of National Parks, Recreation, Sport and Racing	State
Department of Natural Resources and Mines	State
Department of Tourism, Major Events, Small Business and the Commonwealth Games	State
Department of Transport and Main Roads	State
Economic Development Queensland, DSDIP	State
Great Barrier Reef Marine Park Authority	Commonwealth
Major Projects Office and Government Land Asset Management (Department of State Development)	State
NQ Dry Tropics	State
Powerlink	State
Queensland Health	State
Queensland Police	State
Regional Services, DSDIP	State

Government Agency	Submitted To:
Skills Queensland	State
Strategy and Governance, DSDIP	State
Townsville City Council	State
Total	22 (State) 1 (Commonwealth)

1.4.3 Non-government submitters

A total of 39 submissions were received from different non-government agencies and private companies. An alphabetical listing of the non-government submitters is provided in Table 1.3. The table also highlights whether the submission was submitted to the Commonwealth or State government.

Table 1.3 Breakdown of Non-Government Submissions

Non-Government Submitters	Submitted To
Non-Government Organisations	
Alliance to Save Hinchinbrook Inc.	State
Australian Coral Reef Society	State
Australian Coral Reef Society	Commonwealth
BirdLife Townsville	State
BirdLife Townsville	Commonwealth
Greenpeace Australia	Commonwealth
Mackay Conservation Group	State
Magnetic Island Community Development Association	Commonwealth
Magnetic Island Community Development Association Heritage Infrastructure and Planning Group (MICDA)	State
Magnetic Island Nature Care Association Inc.	State
Magnetic Island Nature Care Association Inc.	Commonwealth
Mount Isa to Townsville Economic Development Zone Inc.	State
North Queensland Conservation Council	State
North Queensland Conservation Council	Commonwealth
North Queensland Wildlife Care	State
North Queensland Wildlife Care	Commonwealth
Picnic Bay Surf Life Saving Club	Commonwealth
Queensland Conservation Council	State
Queensland Conservation Council	Commonwealth
Queensland Tourism Industry Council	State
Townsville Local Marine Advisory Committee	Commonwealth
Townsville Local Marine Advisory Committee	State
Wildlife Preservation Society of Queensland	State
Wildlife Preservation Society of Queensland	Commonwealth
Wildlife Preservation Society of Queensland - NQ Branch	State
Wildlife Preservation Society of Queensland - Townsville Branch	Commonwealth
WWF Australia	State
Subtotal	15 (State) 12 (Commonwealth)
Private Company	
Aquascene Tours and Charters	Commonwealth
Blackwood Corporation Limited	Commonwealth
Butterfly House Graphic Design	Commonwealth
Environmental Defenders Office	Commonwealth
Foodworks	Commonwealth
Foodworks	State
IRC Pty Ltd	State
Legal Centre	State
Legal Centre	Commonwealth

Non-Government Submitters		Submitted To
Non-Government Organisations		
Townsville Chamber of Commerce		State
Townsville Chamber of Commerce		Commonwealth
Townsville Enterprise Limited		State
	Subtotal	5 (State) 7 (Commonwealth)
	TOTAL	20 (State) 19 (Commonwealth)

1.4.4 Response to submissions

All submissions received during the public comment period have been acknowledged and reviewed. The following process was adopted to effectively address the submissions received.

- All submissions received from the Coordinator-General and DoE were registered, categorised from where it was received (e.g. Commonwealth or State) and a unique identification code applied to every submitter.
- The matters raised within the submission were then identified and a sub-number (matter number) applied to the submission identification number.
- Each matter number was assigned to topics based on the chapters of the EIS (e.g. Marine Ecology, Terrestrial Ecology, Land, etc.).
- The key matters raised in the submissions under each chapter were identified and are summarised at the beginning of each section.
- Responses to submissions were documented in sections that relate to the topic area (chapter). The summarised response was cross-referenced with the AEIS sub-section and reported in the register.

Technical responses to specific matters raised in the submissions are provided in Sections 3.0 to 28.0 of the AEIS. Within each section, specific matters are categorised into broader, key matters to enable a coordinated approach to their response. Where relevant, the responses refer directly to information presented in the EIS to avoid repetition.

Submissions that provided general commentary on the Project or the EIS process / methodology or represented information provided for the proponents benefit but were not matters that required a response, were noted in the submissions database.

Submissions relating to typographical errors, incorrect cross-referencing and/or suggested amendments to the language used in the EIS are addressed in the errata list provided in Appendix C3 of this AEIS. This is provided in lieu of direct amendments to the EIS publicly exhibited.

1.4.5 Identification of key matters

The key matters identified across these submissions included:

- Project need
- Project options and alternatives including the dredger methodology and dredged material disposal options
- environmental and socio-economic impacts from the Project including:
 - impact to local ecosystems and resilience of marine habitats impacts to the Great Barrier Reef World Heritage Area including cumulative impacts to the Great Barrier Reef
 - impacts to amenity of Townsville and Magnetic Island and associated tourism activities
 - the adequacy of environmental offsets proposed.

1.5 Changes to Legislation and Policy

A significant number of changes to Commonwealth, State and local legislative and policy frameworks have occurred since the preparation of the EIS.

There have also been significant Commonwealth and State reforms affecting the future development of ports in Queensland. Amongst the more significant changes was the development of the joint Commonwealth and Queensland governments' *Great Barrier Reef Region Strategic Assessment Report* (Strategic Assessment) (DSDIP, 2013) in response to World Heritage Committee concerns regarding the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area. The role of ports and associated dredging requirements has featured in this assessment, which has resulted in the preparation of a *Program Report* and *Reef 2050 Long-term Sustainability Plan* (Long Term Sustainability Plan) (DSEWPC, 2014).

The Strategic Assessment and the Long Term Sustainability Plan respectively further clarify matters of national environmental significance and OUV relevant to the Great Barrier Reef; recognising the States commitment towards better management of the reef and development that is likely to have an impact. The implementation of much of the Strategic Assessment outcomes is to be facilitated through State legislation and policy frameworks.

The *Sustainable Ports Development Act 2015* commenced on 20 November 2015. The purpose of the Act is to provide protection of the Great Barrier Reef World Heritage Area through managing port related development. The Act recognises the Port of Townsville as one of four Priority Ports along the Queensland Coast. The Act prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park, unless:

- a) it is for a priority port and in accordance with that port's Master Plan
- b) if the development is the subject of an EIS process started before the Act came into effect.

The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

The PEP is identified in the Commonwealth Government *White Paper on Developing Northern Australia* as projected infrastructure to accommodate forecast growth in trade and to address current capacity constraints. The White Paper acknowledges that the prohibition of sea based disposal of capital dredge material from the proposed port expansion means that significant additional funding will be required to allow the expansion to progress. Key features of the Project listed include: new deep-water outer harbour, six additional berths in new harbour and deepening and widening of existing approach channels.

The *2016 Australian Defence White Paper* identifies investment in national defence infrastructure – including the Army, Navy and Air Force bases in northern Australia, including Townsville as a focus of the White Paper. The White Paper acknowledges the Defence fuel installations as critical enablers for the generation of Defence capability. The government will continue to improve Defence's fuel resilience and capacity to transport bulk fuel to support of bases and operations. This will include upgrades to existing Defence fuel infrastructure as well as improvements to Defence ability to utilise commercial fuel supplies. The Port of Townsville provides a fuel link (and other cargo) to Defence assets in Townsville, which include Lavarack Barracks, RAAF Base Townsville and the Townsville High Range Training Area.

The majority of the State reforms strengthen the focus on economic development potential for Queensland. This includes facilitation of greater opportunities through better planning for infrastructure. The rationalisation of approval and other administrative processes through legislation and policy changes is also intended to clarify the vision and outcomes sought by the State government for Queensland.

The approach that POTL has undertaken in developing the PEP in the design, staging and demand planning is consistent with the *Sustainable Ports Development Act 2015* and other key Commonwealth and State legislation and policy. The changed legislation and policy is summarised in Table 1.4. A full listing is provided in Appendix C2.

Table 1.4 Summary of legislation and policy changes relevant to PEP since 2012

Legislation/Policy
Commonwealth
2015 White Paper on Developing Northern Australia
2016 Australian Defence White Paper
<i>Clean Energy Act 2011 (Repealed)</i>
CS FP 001-1995 Fire emergency response
Great Barrier Reef Marine Park Regulation 1983
Handbook 203:3006 Environmental risk management – principles and processes (HB203:2012)
<i>Maritime Transport and Offshore Facilities Security Act 2003</i>
National Counter-Terrorism Plan (NCTC, 2005), Revised Edition
<i>National Greenhouse and Energy Reporting Act 2007</i>
National Ports Strategy
Joint Commonwealth/Queensland Government
Commonwealth Government Great Barrier Reef Region Strategic Assessment Report
Great Barrier Reef Region Strategic Assessment Program Report
Reef 2050 Long-Term Sustainability Plan
State of Queensland
Coastal Management Plan 2014
<i>Coastal Protection and Management Act 1995</i>
<i>Economic Development Act 2012</i>
<i>Environmental Offsets Act 2014</i>

Legislation/Policy
<i>Environmental Protection Regulation 2000</i>
<i>Forestry Act 1959</i>
Great Barrier Reef Coastal Zone Strategic Assessment
<i>Nature Conservation Act 1992</i>
Planning and Development Bill 2014
Queensland Counter-Terrorism Strategy 2013
Queensland Ports Strategy
<i>Road Traffic Noise Management Code of Practice 2008</i>
<i>State Development and Public Works Organisation Act 1971</i>
State Development Assessment Provisions
State Disaster Management Plan 2013-2014, prepared in accordance with Disaster Management Act 2003
State Planning Policy
State Planning Regulatory Provisions
<i>Sustainable Planning Act 2009</i>
<i>Sustainable Planning Regulation 2009</i>
<i>Sustainable Ports Development Act 2015</i>
Townsville State Development Area Development Opportunities Strategy
Local
Townsville City Economic Development Plan 2013-2017
Townsville City Plan 2014
Townsville City Waterfront Priority Development Area Development Scheme 2015

1.6 Design Response

The Project has undergone a design refinement process in direct response to submissions received during the consultation period and the changes that have occurred in government policy and legislation since the EIS was completed. This design refinement process is detailed in Section 2.0 of this AEIS.

1.7 Structure of the AEIS

The structure of the AEIS aligns with the topics and EIS chapter headings, where possible. This approach has been adopted to facilitate cross-referencing between the two documents and evaluation of the revised Project. Table 1.5 below provides a cross reference from sections of the EIS to the AEIS.

Table 1.5 Structure of the AEIS in comparison to EIS structure

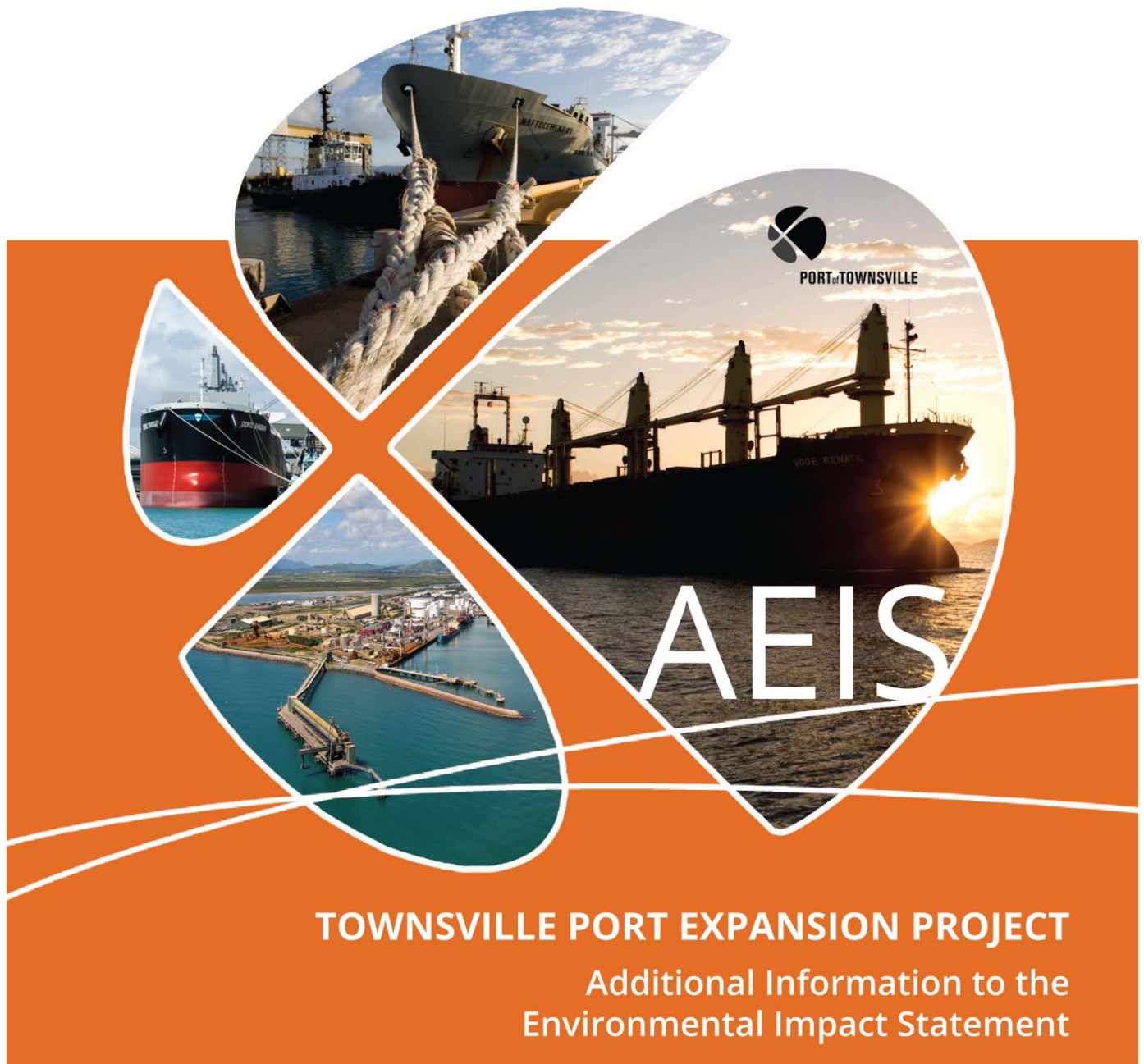
EIS	AEIS
Part A (Introduction, EIS Process and Project Description)	Section 1.0 – 2.0
Part B (Technical Sections)	3.0 – 28.0
Part C (Management Plans)	Appendix B

The structure of each section in the AEIS has been formulated to provide the reader with a response to submissions and where relevant updates the impact assessment based on the refined design. Typically sections include the following:

- Introduction
- Response to submissions
- Consideration of relevant legislation and policy changes, and the design refinement
- Revised environmental impacts assessment, if required
- Summary, including updated mitigation measures, if required
- Conclusion.

Section 29.0 provides a summary of the AEIS. Supporting information to the AEIS, including updated Environmental Management Plans are included as Appendices.

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SECTION 2

Project Description



2.0 Project Description

2.1 Introduction

Throughout the Port's history a number of upgrades to the channel and harbour have been required to cater for larger vessels visiting the Port as the global shipping fleet and trading partners changed. A capital dredge campaign in 1993 was the most recent example of a significant increase in channel capacity and at the time was considered industry leading, in terms of stakeholder cooperation and environmental management. The Port Expansion Project (PEP) has built on this benchmark, also incorporating current industry standards and available technology, to develop a design that balances engineering, environmental and economic drivers.

In order for the Port to continue to service its customers effectively, the Port must remain internationally competitive and able to accommodate expected medium to long term changes in vessel sizes and shipping requirements. The global shipping fleet is incrementally increasing, as some of the world's significant limiting infrastructure, such as the Panama Canal, is upgraded. To accommodate larger vessels, there is a requirement to upgrade the existing channel.

The need for the PEP was originally identified through a master planning process, which was completed in 2007. As a result of this process it was determined that a steady increase in trade over future decades will exceed existing port capacity and require increased port infrastructure. Following this process, the Project has undergone a preliminary engineering design process that has considered environmental, social and economic factors culminating in the PEP "EIS design".

The PEP Environmental Impact Statement (EIS) was informed by the technical studies undertaken in accordance with the Queensland State Government Terms of Reference and the Australian Commonwealth Government Guidelines, as well as the Port's extensive experience, particularly in dredging.

This section of the AEIS has been structured to provide additional information on the following:

- development of the PEP, including assessment of alternatives that informed the PEP EIS design
- the design refinement process to address legislative changes since the EIS and in response to submissions
- description of the refined design which forms the basis of the PEP and the subject of this Additional Information to the Environmental Impact Statement (AEIS).

2.2 Development of the PEP and Assessment of Alternatives

Recognising there is limited availability for growth in the existing harbour, coupled with long lead times typically associated with port development, POTL has undertaken continual and evolving investigations and assessments to inform master planning since the original PEP concept in 2007.

The development of the EIS design commenced with the development of a Master Plan (2007) which was optimised through a series of studies, being the Preliminary Engineering and Environment Studies (PEES), and finally assessed through the EIS process. These steps are summarised below.

2.2.1 Port Master Plan

The Master Plan was completed in 2007 by the Townsville Port Authority (now POTL) to guide future development of the Port. The objective of the Master Plan was to provide the context for staged future development, as a competitive and efficient trading port co-existing alongside the city of Townsville and sensitive environments. The master planning process investigated future trade demand under low, medium and high growth scenarios, and developed associated trade forecasts. Existing port characteristics, capacity and constraints were analysed, and options for future port capacity were developed and assessed. The resulting Master Plan recommended a number of upgrades within the existing harbour to maximise the available capacity from existing port assets, and the development of a new harbour to the north of the existing harbour with six new berths to augment the existing Berth 11 and proposed Berth 12 in that location. This proposed new harbour became the PEP.

The Master Plan included an assessment of alternative port sites including an option for a new port development at Cape Cleveland. This option had previously been investigated by the port as a part of the considerations around the development of Berth 11 (SKM, 1994), and concluded on both environmental and economic grounds, a new port adjacent to Cape Cleveland was an inferior solution to the incremental development of the existing port to the north of the existing northern breakwater. The Master Plan review concluded that there was no new evidence or information to suggest the outcomes of the original study will be any different if updated as similar trades and development scenarios to the use expected in the PEP. Planning work therefore concentrated on redevelopment of the existing inner harbour and the incremental expansion of the Port seaward of the existing breakwater.

The Master Plan proposed the assessment of two preferred layouts for port operations within the new harbour based on the following scenarios.

- Scenario A, which entails an incremental expansion seaward of the eastern breakwater with minimum disruption to existing users and lessees. It will be driven by growth in general cargo and potential new cargoes such as magnetite. It was identified as a less than optimal future layout with a mix of general cargo and bulk cargoes in both the inner and expanded harbour areas with some existing inefficiencies prolonged.
- Scenario B, supports a staged program of redevelopment and relocation of existing bulk operations, resulting in all general cargo operations (plus sugar) located in the inner harbour and all bulk liquid and dry bulk (except sugar) located in the expansion seaward of the existing breakwater.

Common to both scenarios was the eventual port expansion seaward of the existing breakwater and creation of new berths, dredged basin and land areas protected by a new breakwater. The options also contained the potential for a new breakwater west of the existing channel adjacent to the new harbour. The need for this western breakwater will be confirmed during the detailed design phase of the Project.

2.2.2 Preliminary Engineering and Environment Study

The Preliminary Engineering Environmental Study (PEES) was undertaken to continue to progress the planning for the PEP following the finalisation of the Master Plan. The study identified the requirement for demand responsive expansions of the existing port to meet North Queensland's predicted growth and expected changes to the global shipping fleet. Port of Townsville's long-term development requires additional capacity and infrastructure to meet future demand. This requires an extension of the port and its infrastructure into Cleveland Bay to cater for changes and increases in demand for trade and port capacity, including a greater emphasis on bulk materials handling.

The PEES included a number of technical engineering and environmental studies that collectively informed the development of the PEP. It also outlined the scope for environmental investigations and engineering design to be undertaken as part of the subsequent environmental impact assessment and detailed engineering design stage of the PEP.

The preferred dredging and reclamation strategy was developed based on the following guiding principles.

- (a) Beneficial reuse of material is preferable and should be maximised.
- (b) The extent of reclamation for the port expansion should be sufficient to allow for the future operational needs of the port but maintain a reasonable size.
- (c) Selection of the material to be reused as reclamation fill or to be disposed offshore should consider the opportunities and constraints of *in situ* material location, dredging processes and material properties.

The Offshore Disposal Study in the PEES looked at the existing disposal site, its capacity and detailed the historical use and the former ecological state of the area. Three other potential alternative offshore disposal locations were also considered, including a site seaward of the existing offshore disposal site, a site to the north of Magnetic Island, and site at a distant offshore location.

The design elements and the concept design developed as a part of the PEES are outlined in Part A, Chapter A.1.3.2 of the EIS.

2.2.3 Port Expansion Project Environmental Impact Statement

Part A, Chapter A.1.6 of the EIS summarises the options and alternatives to the PEP and builds upon the master plan process that identifies the new outer harbour on the seaward side of the existing inner harbour as the most appropriate location from both an environmental and an operational perspective.

Existing berths in the port are fully committed to other uses, either through long-term lease arrangements with specific exporters/importers, or through the requirement to provide intermittent berth allocation for general cargo. It is not possible to handle the changing and long-term increased trade on a large-scale across the existing berths and many of the berths are not suitable for export of dry bulk trades in Panamax sized vessels on a regular basis. This will require dredging the existing harbour and channel, for which the existing berth structures are not designed.

Both previously identified and new alternatives were further considered in the EIS, including:

- new harbour to the west of the existing harbour (Option A)
- new harbour to the east of the existing harbour (Option B)
- additional berthing outside existing harbour using exposed port berths (Option C)
- new protected harbour without reclamation – remote land cargo storage (Option D)
- new port harbour at Cape Cleveland (Option E).

The locations of Options A to E from the EIS are illustrated as Figure 2.1 below.

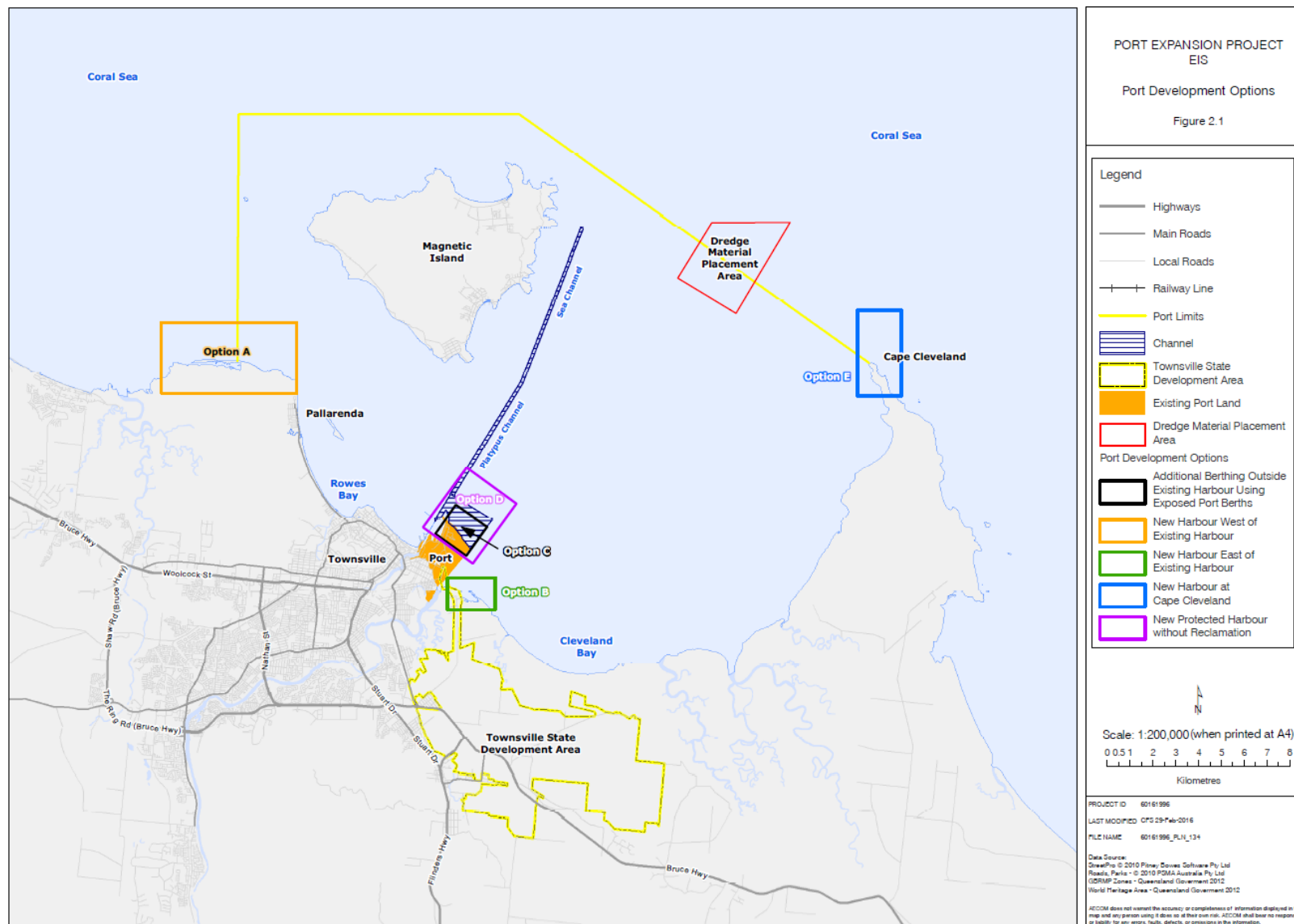


Figure 2.1 Port Development Options Considered During the PEP

The preferred EIS option is in the same general location as Option D above, but with the inclusion of land reclamation. This option provides additional berthing outside the existing inner harbour with protected berths and reclamation to provide land for cargo storage and transfer and transport infrastructure (e.g. road and rail).

The other design options assessed tended to fragment and duplicate port facilities. They are disconnected from existing land and sea access infrastructure, and require a major new approach channel to be dredged, in addition to the existing port channel. Also, these options do not provide opportunities for beneficial re-use of the dredged material produced from the harbour basin and berths. The preferred Option D was found to provide the best balance of environmental impacts, economic efficiency and safety.

2.3 Design Refinement

During the public consultation phase for the PEP EIS, undertaken in May 2013, matters raised by 84 submitters primarily related to dredging, sea placement of dredged material, and related perceived impacts to Magnetic Island and the broader Great Barrier Reef Marine Park. A number of significant changes also emerged in terms of environmental regulation and government policy as a result of national and international events. These factors are broadly summarised below.

- UNESCO's concerns triggered by the LNG projects on Curtis Island and the potential 'in danger' listing of the Great Barrier Reef World Heritage Area.
- A visit to Australia by a UNESCO committee and preparation of a report expressing concern about the health of the Great Barrier Reef World Heritage Area.
- Concern about dredging at other major ports along the Queensland coast.
- A review of environmental factors affecting the Great Barrier Reef World Heritage Area and preparation of a Strategic Assessment by the Commonwealth and Queensland governments (DSDIP, 2013).
- Release of the Great Barrier Reef Outlook Report 2014 (GBRMPA, 2014).
- Indications from both the Commonwealth government and Queensland government that capital dredge material should be beneficially re-used in preference to at sea disposal.
- Release of the Abbot Point dredging and sea disposal decision, subsequent legal challenges and decision by the Queensland government to investigate land based placement of the dredged material as an alternative.
- Wider and longer vessels seeking to visit Australian ports sooner than originally anticipated.
- Release of the Queensland Ports Strategy (DSDIP, 2014a) by the Queensland government as a blueprint for managing and improving the efficiency and environmental management of the State's port network over the next 10 years. The strategy includes a commitment to concentrate port development to selected long-established major port areas (including the Port of Townsville) within or adjoining the Great Barrier Reef World Heritage Area.
- The Commonwealth Minister for the Environment ordered the creation of regulations for the Great Barrier Reef Marine Park Authority to put an end to the sea disposal of capital dredge material in the Great Barrier Reef Marine Park (The Hon. Greg Hunt MP, 2015).
- Release of complementary Queensland legislation in late 2015 with the *Sustainable Ports Development Act 2015*.
- The Act prohibits the sea-based disposal of capital dredge material into the Great Barrier Reef World Heritage Area and mandates the beneficial reuse of port-related capital dredge material such as for land reclamation, or disposal on land where it is environmentally safe to do so.
- The Act also prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the Act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

The Project has undergone a design refinement process in direct response to submissions received during the consultation period and the changes that have occurred in government policy and legislation since the EIS was completed. This design process resulted in following key design outcomes.

- Avoiding sea disposal by relocating all capital dredge material within the reclamation for beneficial re-use which has resulted in an expanded outer harbour reclamation footprint.
- Avoiding direct impact on the Great Barrier Reef Marine Park General Use Zone by widening the channel design and only partially deepening the channel.

- Modifying the dredging methodology to reduce the bulking¹ of dredged material in order to reduce the size of the reclamation area during dewatering and consolidation. This has also resulted in improved water quality impacts during capital dredging.

The design refinement process has incorporated Berth 12 as it forms a critical component of the outer harbour swing basin. Previously, the EIS had assumed that the approved Berth 12 project will be constructed ahead of the PEP, however the introduction of the *Sustainable Ports Development Act 2015* has affected the Berth 12 approval leading to its inclusion in the revised design.

The design refinement process also included examination of in situ volumes of dredged material for each stage of the works considering different dredging and reclamation methodologies. Other critical elements included optimising the ultimate location of the rail loop within the PEP AEIS footprint, and locating any temporary breakwaters or revetments as footings to minimise the cost of installing this infrastructure when it is required.

A summary of the updates to the PEP EIS design as a result of the design refinement process is provided in Table 2.1 below. The AEIS design addresses key matters raised by respondents and is consistent with Commonwealth and State government policy and legislation changes since the EIS. Specific consideration and response to EIS submissions are provided in the relevant sections of this AEIS.

Table 2.1 Key outcomes of the AEIS design refinement process

Project Aspect	EIS Design	AEIS Design Refinement	Outcome
Reclamation size	100 ha	152 ha	Increased by 52 ha to accommodate all capital dredge material onshore
Capital dredge material placement at sea	5.6 million m ³	No placement of capital dredge material at sea	Reduced sea placement by 5.6 million m ³
Dredge Material Placement Area	Area 1,140 ha	No placement of capital dredge material at sea	No impact from placement of capital dredged material in the Dredge Material Placement Area
GBRMP*	Dredging in Stage D extending into the GBRMP* General Use Zone (extension of channel)	No dredging required within the GBRMP* General Use Zone	No direct impacts to benthic environments in the GBRMP* General Use Zone
Beneficial reuse volume (reclamation)	4.3 million m ³	11.4 million m ³	Increased by 7.1 million m ³ to accommodate all capital dredge material onshore
Dredging duration	Approximately 4 years	Approximately 10.5 years	Increased by 6.5 years due to change in dredging methodology to minimise the size of the reclamation footprint
Channel length	16.6 km	14.9 km	Channel length reduced by approximately 1.7 km
Channel width	92 m (including some minor strategic widening)	Platypus Channel – tapers from 180 to 135 m Sea Channel - tapers from 135 to 120 m	Increased channel width to accommodate longer and beamier vessels and improve vessel navigational safety
Channel navigation design depth	-13.7 m LAT	-12.8 m LAT	Reduced channel navigation design depth by 0.9 m to minimise impact in the GBRMP* General Use Zone and minimise the reclamation footprint
Number of berths for PEP	6	6	No change in number, locations have been refined
Harbour basin area	56.1 ha	51.4 ha	Reduced by approximately 4.7 ha to minimise the reclamation footprint size
Revetment wall (excluding	3.5 km	4.0 km	Increased by approximately

¹ *Bulking* - when material is disturbed from insitu giving a larger volume for the same weigh of material, usually through the realignment of particles. The level of bulking is dependent upon several variables including the type of dredging plant used and the soil characteristics

Project Aspect	EIS Design	AEIS Design Refinement	Outcome
breakwaters)			0.5 km to accommodate the reclamation increase
Project impacts	- Expanded reclamation footprint at an increased project cost. - Reduction of total number of berths in the proposed outer harbour to seven. - Shallower channel. - Berth infrastructure program delayed. - Modified dredge methodology and increased dredge duration. - Further investigations required and undertaken as part of the AEIS.		

*Great Barrier Reef Marine Park

2.4 Port Expansion Project Revised Design

2.4.1 Project Staging

As discussed in Chapter A.3.3 of the EIS, the PEP is proposed to be developed progressively to match the demand for additional port facilities. The Project staging has been revised based on the outcomes of the design refinement process. The staging comprises 3 primary stages of development as follows:

- Stage 1 – Initial outer harbour reclamation, channel widening and Berth 12
- Stage 2 – Ultimate outer harbour reclamation, Berths 14, 15 and 16
- Stage 3 – Channel deepening, Berths 17 and 18.

The details of these stages, including approximate dredge volumes are discussed in the following sections. The AEIS Revised Design – Project Overview is illustrated in Figure 2.2.

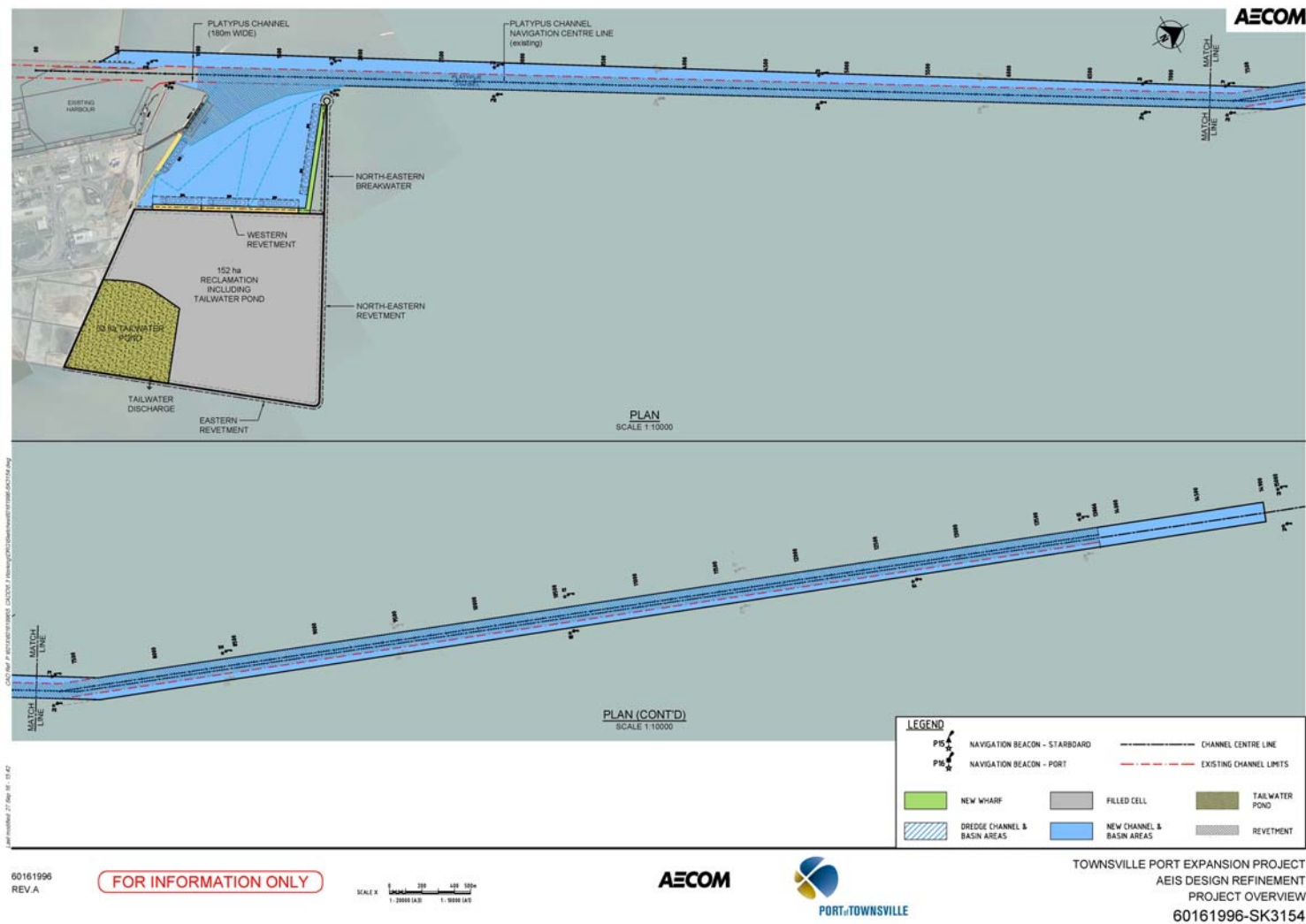


Figure 2.2 AEIS Design Refinement – Project Overview

2.4.2 Stage 1

The Stage 1 (refer Figure 2.3) development involves:

- construction of perimeter revetment structures for the initial reclamation area
- widening of the Platypus and Sea Channels
- development of Berth 12 (including dredging of basin area) and associated landside infrastructure.

Construction of revetment structures

The construction of perimeter revetment structures will create a confined area for the placement of material dredged during the channel widening and creation of the outer harbour basin. The construction of the revetment structures will involve the following activities.

- Removal of approximately 0.3 million m³ of soft marine sediments from the area of the proposed revetment structures to form a suitable foundation and the placement of the core, filter material, secondary armour and primary armour rock. This material will be removed by a mechanical dredger and relocated to temporary bund areas within the new outer harbour reclamation area.
- Construction of revetments will consist of rock-fill bunds and rock armour layers. The material will be sourced predominantly from POTL's Granitevale quarry or other approved quarry and trucked to the site, where the rock material will be placed where previously dredged. Rock armour material from the existing north eastern revetment will also be re-used where possible. A geotextile material will be placed on the inside of the revetment structure to retain the fine sediment particles of the dredged material within the reclamation.
- The construction of the revetments may occur along one or two work faces concurrently, which will impact the duration of the activity. It is anticipated that this will occur in parallel with the removal of soft marine sediments from under the footprint of the structures, and completed over a 12 month period.

The reclamation area will include an area that will be used as a tailwater pond.

Widening of the Platypus and Sea Channels

The widened channel alignment has been determined by POTL based on simulation of likely future vessels, working in conjunction with pilots and the Regional Harbour Master. The channel widening involves the following.

- Platypus Channel
 - The widening will be on the west side of the channel and extend to just inside the inner harbour, rejoining the inner harbour channel alignment. The eastern edge will remain unchanged. The width between toelines will be 180 m at the outer harbour and reducing to 135 m at the junction with the Sea Channel. The AEIS shows the maximum width, noting the interaction with the western breakwater as a result of channel widening, will be further considered as part of detailed design.
 - A provisional allowance has been made for a small area of localised dredging on the eastern side of the channel, between Berth 11 basin and marker P16 to allow for channel batter if required.
- Sea Channel
 - The widening will be on the east side of the channel (opposite side from Magnetic Island) with the western edge remaining. The width between toelines will be 135 m at the junction with the Platypus Channel reducing to 120 m at the sea end.

Dredging will be undertaken using a Trailer Suction Hopper Dredge (TSHD) and a mechanical dredger (backhoe and/or grab dredgers). All dredged material from the channel widening will be placed in the reclamation area.

The material dredged using the TSHD will be approximately 1.5 million m³ and typically comprise soft marine sediments and the clayey sands as these are suitable to be pumped to shore. A small TSHD (hopper capacity of approximately 3,000 m³) is proposed due to the depth limitations during the early stages of dredging, especially in the Platypus Channel. Material will be transferred to the reclamation area by pumping in a slurry form through floating and fixed pipelines. The resultant tailwater will be managed in a tailwater pond prior to releasing it to the sea at a location on the eastern revetment. The tailwater pond is particularly important for the treatment of tailwater from the dredging undertaken by the TSHD for part of the channel widening and deepening works. The TSHD will transfer the dredged material ashore by pumping it in a slurry mix which will introduce significant volumes of water to be treated prior to release. The duration of the TSHD dredging work will be approximately 4 months.

The mechanical dredger will be used to relocate approximately 2.4 million m³. A large backhoe dredger is proposed to excavate and place material in hopper barges. The hopper barges will transport the material to the outer harbour where they will be mechanically unloaded into the reclamation using conventional earthmoving plant. Relatively small quantities of tailwater will be generated by mechanical dredging when compared to the dredging work undertaken by a TSHD. The tailwater will be managed in a tailwater pond prior to releasing at a location on the eastern revetment. The duration of the mechanical dredging operation is estimated to be approximately 2.3 years.

Construction of Berth 12

Berth 12 will be for ship operations which do not require breakwater protection from waves, such as export of bulk cargoes, i.e. similar to the current Berth 11. The development of Berth 12 will involve the following.

- Deepening of the existing outer harbour basin area and dredging of the basin area and berth pocket associated with Berth 12 (approximately 1.4 million m³). This will be undertaken using a large mechanical dredger, with the dredged material placed in hopper barges. The barges will travel to a transfer location adjacent to the constructed revetments where the material will be unloaded and placed into the reclamation area using conventional earthmoving plant. It is anticipated dredging will be done over a period of approximately 15 months.
- If required, additional fill material will be placed on top of the dredged material so that trucks and equipment can work on the reclamation area. This fill material will be trucked in from an approved land source or sourced from within the Port.
- The wharf will be similar to the current Berth 11 as it will initially not be protected by a breakwater. The wharf structure will most likely be designed and constructed as a conventional reinforced concrete deck that is supported on steel piles. The deck level will be designed high enough to allow waves to pass under the deck.

Berth 12 terminal operations may be performed on existing port land or in the new outer harbour reclamation area. Should there be a requirement for land to be developed in the outer harbour to support Berth 12, ground improvement works may be required at this stage. It is assumed that development of the land for port operations, including the installation of services, will be undertaken in a similar manner to that described in the EIS (refer to Chapter A.3.5). The timing will be dependent on the rate at which the ground improvement is achieved.

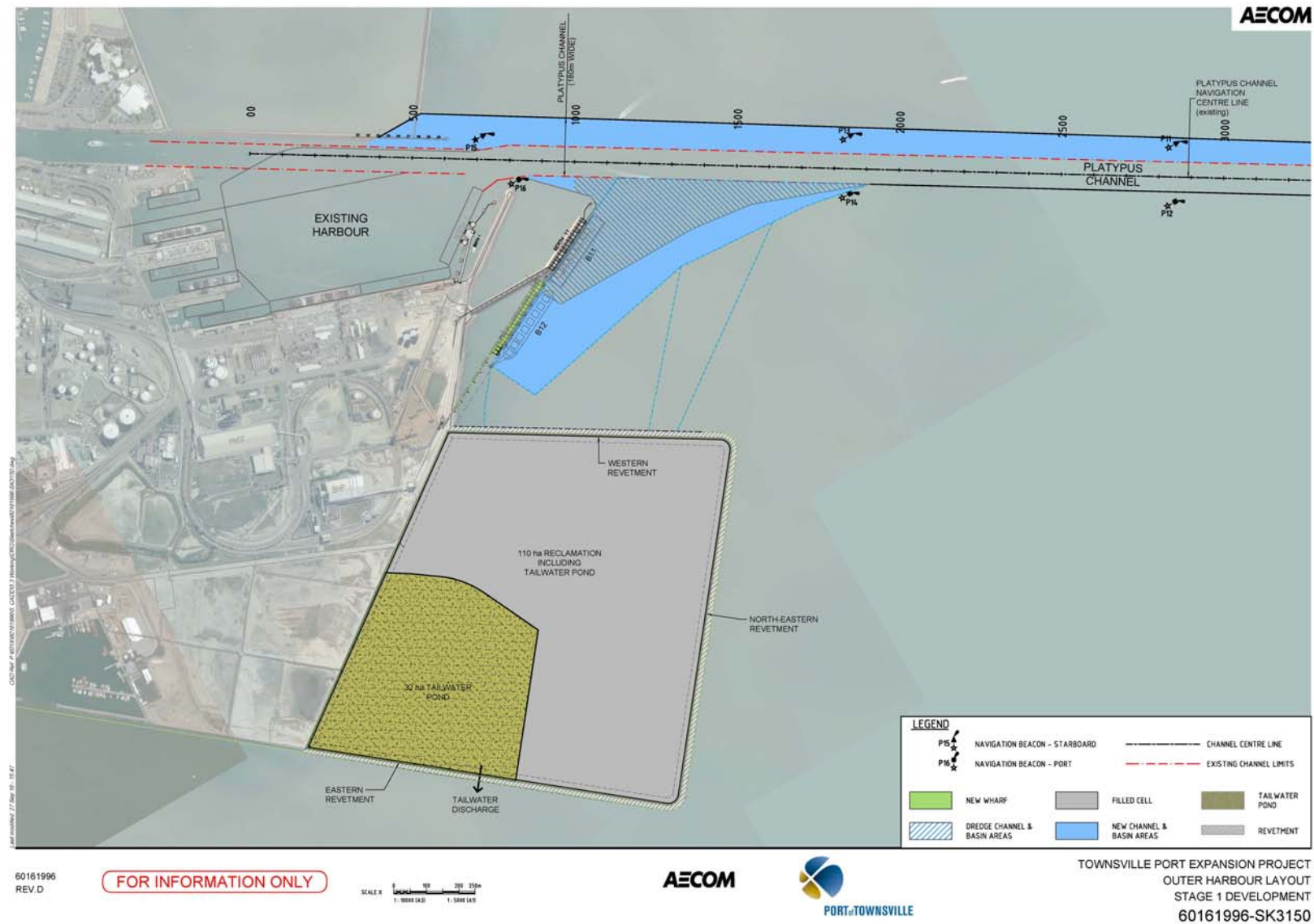


Figure 2.3 PEP AEIS Stage 1 Development

2.4.3 Stage 2

The Stage 2 (refer to Figure 2.4) development involves:

- construction of the remainder of the perimeter revetments for the ultimate outer harbour reclamation area as well as construction of the North Eastern Breakwater
- development of Berths 14, 15 and 16 in the outer harbour, including dredging of basin areas and associated landside infrastructure.

Revetment and breakwater structures

The main construction activities will be similar to the development of the revetment structures described in Section 2.4.2 for Stage 1 and comprise the following activities.

- Removal of approximately 0.2 million m³ of soft marine sediments from the area of the proposed revetment and breakwater structures. This material will be removed by a mechanical dredger, placed directly into hopper barges and transported to be placed in the PEP Stage 1 reclamation area. It is anticipated that this will occur over a period of approximately 12 months.
- Construction of revetments will consist of rock-fill bunds and rock armour layers. The material will be sourced predominantly from POTL's Granitevale quarry or other approved quarry and trucked to the site, where the rock material will be placed. A geotextile will be placed on the inside of the structure to retain the fine particles of the dredged material.
- The construction of the revetments may occur along one or two work faces, which will impact the duration of the activity. It is anticipated that this will occur in parallel with the removal of soft marine sediments from under the footprint of the structures, and completed over a 12 month period.

Construction of a new western breakwater to protect the outer harbour, which may or may not be required depending on the results of further hydrodynamic and engineering studies to be undertaken as part of the detailed design is still relevant, as described in the EIS (Part A). If required it is envisaged that it would be constructed during Stage 2.

Berths 14, 15 and 16

Dredging for the new basin areas and berth pockets will be done after the revetment structures and North East Breakwater have been constructed. Mechanical dredging equipment will be used to relocate approximately 3.6 million m³ of material. A large backhoe dredger is proposed to excavate the material and place in hopper barges. The hopper barges will transport the material to be mechanically placed in the reclamation area using conventional earthmoving plant. It is expected that the dredging operation for the basin areas will be undertaken as a continuous process of nearly 3.5 years. However it is also possible to dredge the requirements for each berth as separate dredging campaigns.

Development of Berths 14, 15 and 16 could be undertaken in one or more stages according to demand for facilities or to achieve efficiency of a continuous construction program. The berths will be located in a basin with breakwater protection from waves which will enable them to be developed to suit all cargo types. Development of the land for port operations, including the installation of services, will be undertaken in a similar manner to that described in the EIS (refer to Chapter A.3.5).

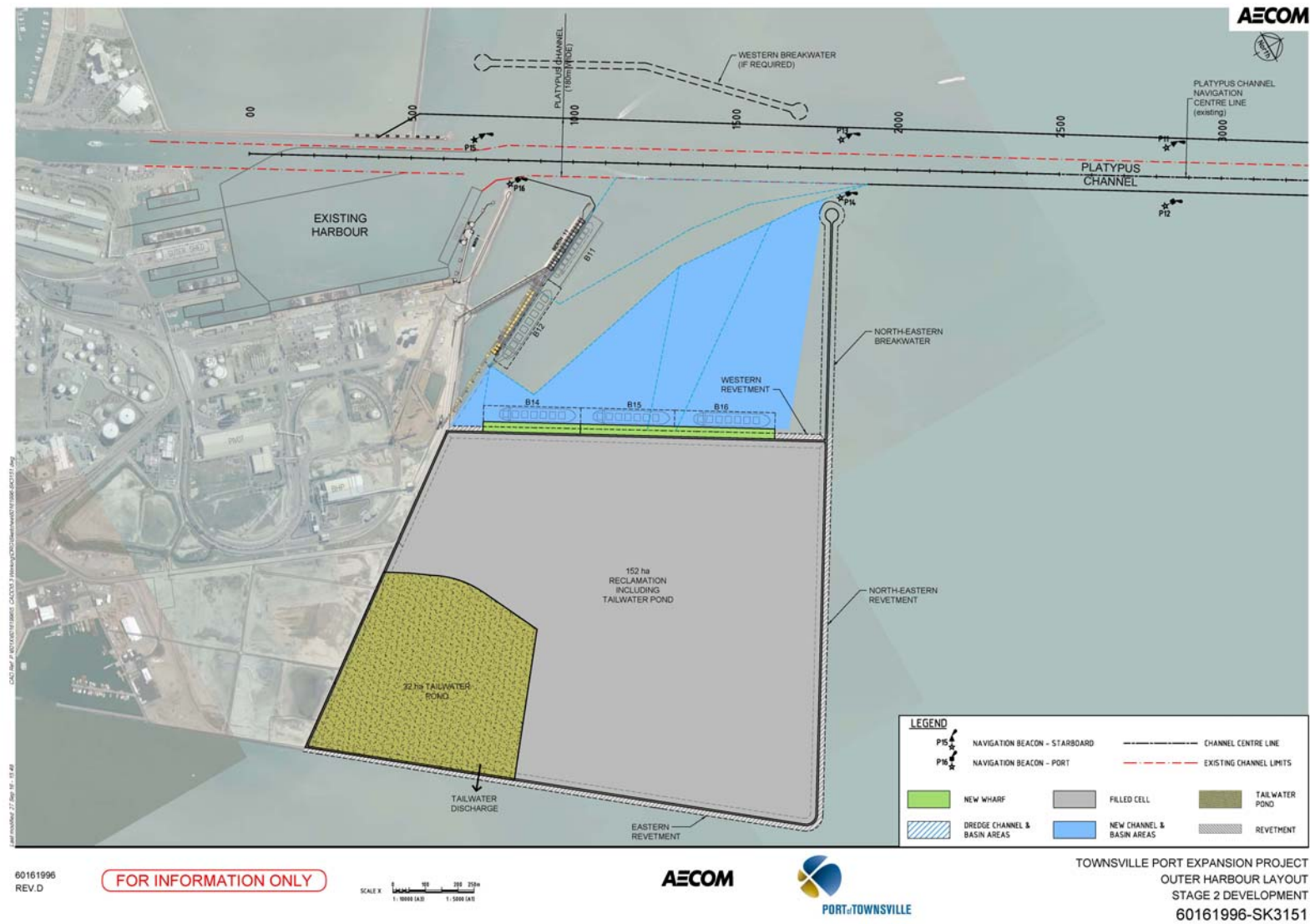


Figure 2.4 PEP AEIS Stage 2 Development

2.4.4 Stage 3

By the time that Stage 3 commences, the outer harbour perimeter revetments and North Eastern Breakwater will be established. Stage 3 development (refer to Figure 2.5) involves:

- deepening of the Platypus and Sea Channels
- development of Berth 17 and Berth 18 (including dredging of berth pockets) and associated landside infrastructure.

Stage 3 development is not constrained as the perimeter revetments and the North Eastern Breakwater will be in place and the entire outer harbour basin will have been dredged during Stage 2.

The Platypus and Sea Channels will be deepened to a navigation design depth of -12.8 m LAT using a TSHD and a mechanical dredger (backhoe and/or grab dredgers). All dredged material from the channel deepening will be placed in the reclamation area. The channel deepening will result in the Sea Channel being lengthened approximately 1 km seaward, rather than the 2.7 km lengthening proposed in the EIS.

The TSHD will be targeted to material types that are suitable to be pumped ashore. The material dredged using the TSHD will be approximately 0.7 million m³ and typically comprise soft marine sediments and the clayey sands. A small TSHD (hopper capacity of approximately 3,000 m³) is proposed to appropriately manage the turbidity from dredging operations. Material will be transferred to the reclamation area by pumping in a slurry form through floating and fixed pipelines. The resultant tailwater will be treated in a tailwater pond prior to releasing it to the sea at a location on the eastern revetment. The duration of this work will be approximately 8 weeks.

The mechanical dredger will be used to relocate approximately 1.3 million m³. A large backhoe dredger is proposed to excavate and place material in hopper barges. The hopper barges will transport the material to the outer harbour where they will be mechanically unloaded into the reclamation using conventional earthmoving plant. The duration of the mechanical dredging operation is estimated to be approximately 2.2 years.

Development of Berth 17 and Berth 18 could be undertaken in one or two stages according to demand for facilities or to achieve efficiency of a continuous construction program. Dredging of the berth pockets will involve mechanical dredging of approximately 0.08 Million m³ of material which will be relocated to the reclamation area. The berths will be located in a harbour basin with breakwater protection from waves which will enable them to be developed to suit operations that do not require land immediately behind the berths. Development of the land for port operations, including the installation of services, will be undertaken in a similar manner to that described in the EIS (refer to Chapter A.3.5).

2.4.5 Dredge Volume Overview

The following provides a summary of the above dredging volumes by stage and dredge type. These volumes are approximate based on current design and presented as million m³.

- Stage 1
 - Revetment structures dredging with mechanical dredger – 0.3.
 - Widening of Platypus and Sea Channels with TSHD – 1.5.
 - Widening of Platypus and Sea Channels with mechanical dredger – 2.4.
 - Berth 12 basin and pocket dredging with mechanical dredger – 1.4.
- Stage 2
 - Revetment and breakwater structures dredging with mechanical dredger – 0.2.
 - Berth 14, 15 and 16 basin and pocket dredging with mechanical dredger – 3.6.
- Stage 3
 - Deepening of Platypus and Sea Channels with TSHD – 0.7.
 - Deepening of Platypus and Sea Channels with mechanical dredger – 1.3.
 - Berth 17 and 18 pocket dredging with mechanical dredger – 0.08.

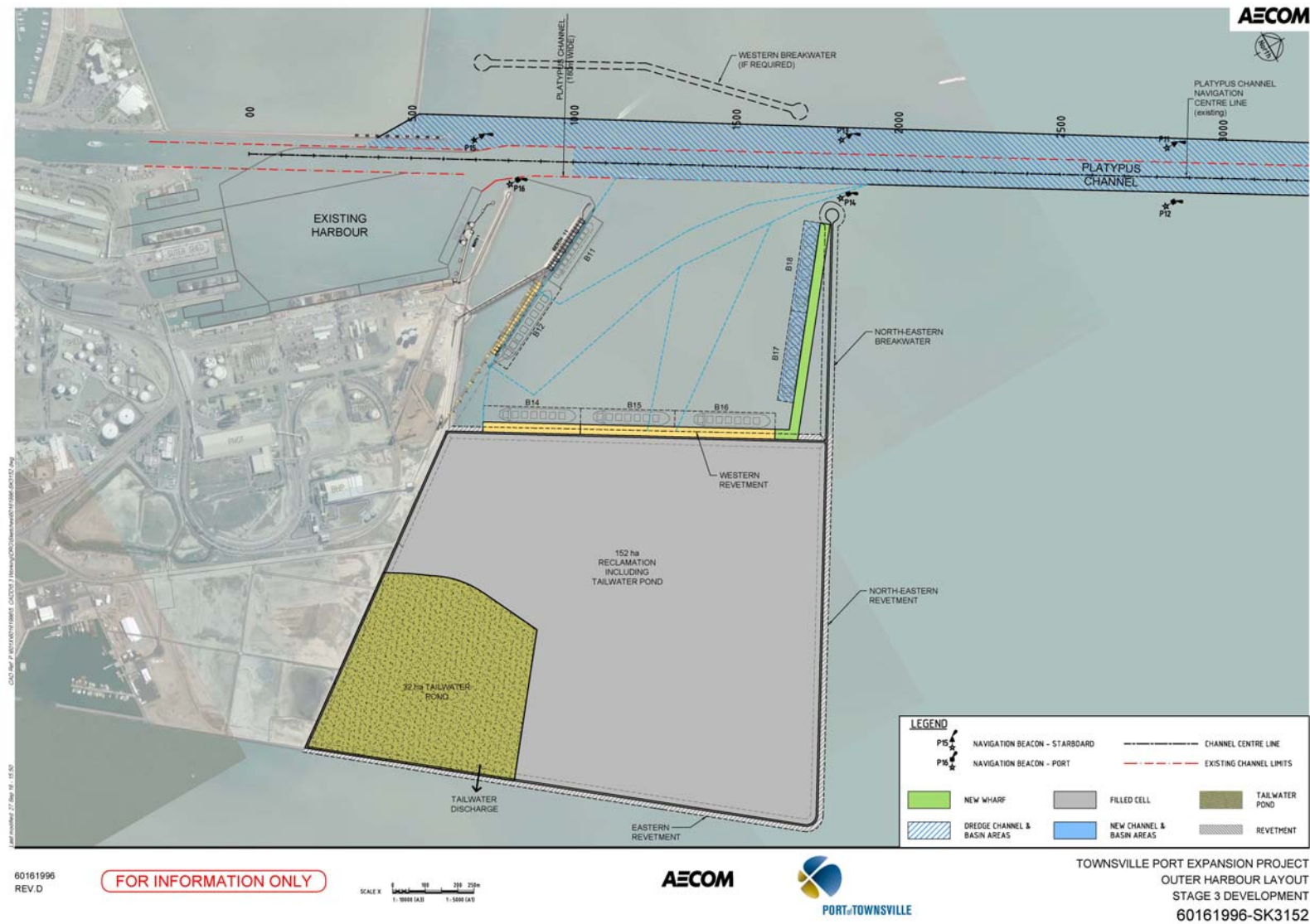


Figure 2.5 PEP AEIS Stage 3 Development

2.4.6 Project Program

The AEIS construction program recognises that the timing of the new berths and associated infrastructure is dependent on trade growth and available port capacity. Other considerations including the long lead time in obtaining approvals, procuring contractors, construction timing and duration require that the proposed sequence and timing of development will be regularly reviewed and adjusted to reflect the actual demand for cargo handling capacity and shipping requirements.

The construction timing for the revised design is provided in Table 2.2. This indicative program forms the basis of assessment in the AEIS and is dependent upon assessment and approval timeframes.

Table 2.2 Indicative PEP staging program

Stage	Start construction*	Total duration*	Indicative duration of main construction activities***
Stage 1	2017	4.5 years	
Reclamation perimeter structures (Initial)	2017 (Q1)**	12 months	Construction of temporary revetment structure to capture soft material from under perimeter revetment bunds over approximately 12 months (Q1 2017 to Q4 2017). Construction of bunds over 12 months (Q1 2017 to Q4 2017).
Channel widening	2018 (Q1)	2.3 years	Dredging to widen Sea and Platypus Channels over 2.3 years (Q1 2018 to Q1 2020).
Berth 12	2020 (Q2)	15 months	Deepening of the existing outer harbour basin and dredging of basin area and pocket for Berth 12 over 15 months Q2 2020 to Q2 2021. Concurrent construction of wharf over 12 months. Construction of landside infrastructure over 9 to 12 months.
Stage 2	2023	4.5 years	
Reclamation perimeter structures (ultimate) & North Eastern Breakwater	2023 (Q1)	12 months	Dredging of material under perimeter revetment bunds and North Eastern Breakwater over 12 months (Q1 2023 to Q4 2023). Construction of bunds over 12 months (Q1 2023 to Q4 2023) overlapping with dredging activity.
Berth 14	2024 (Q1)	17 months	Dredging of basin area for Berth 14 over 14 months Q1 2024 to Q1 2025, including 3 weeks to dredge the Berth 14 pocket.. Construction of wharf over 12 months. Construction of landside infrastructure over 9 to 12 months.
Berth 15	2025 (Q2)	13 months	Dredging of basin area for Berth 15 over 10 months Q2 2025 to Q4 2025 including 3 weeks to dredge the Berth 15 pocket. Construction of wharf over 12 months. Construction of landside infrastructure over 9 to 12 months.
Berth 16	2026 (Q1)	20 months	Dredging of basin area for Berth 16 over approximately 17 months Q1 2026 to Q2 2027 including 3 weeks to dredge the Berth 16 pocket. Construction of wharf over 12 months. Construction of landside infrastructure over 9 to 12 months.
Stage 3	2030	2.5 years	
Berth 17 & Berth 18	2030	19 months	Dredging of berth pockets for Berth 17 and Berth 18 over 5 weeks. Construction of wharves over 18 months. Construction of landside infrastructure over 16 to 19 months.
Channel deepening	2030	2.2 years	Dredging to deepen Sea and Platypus Channels.

* This program is indicative based on preliminary PEP design and subject to all relevant assessments being undertaken and approvals being obtained. Some overlap exists between the construction components.

** Q1 – Quarter 1, Q2 – Quarter 2

*** Refer to Figures 2.2 to 2.5 for a visual representation of dredge areas for each stage

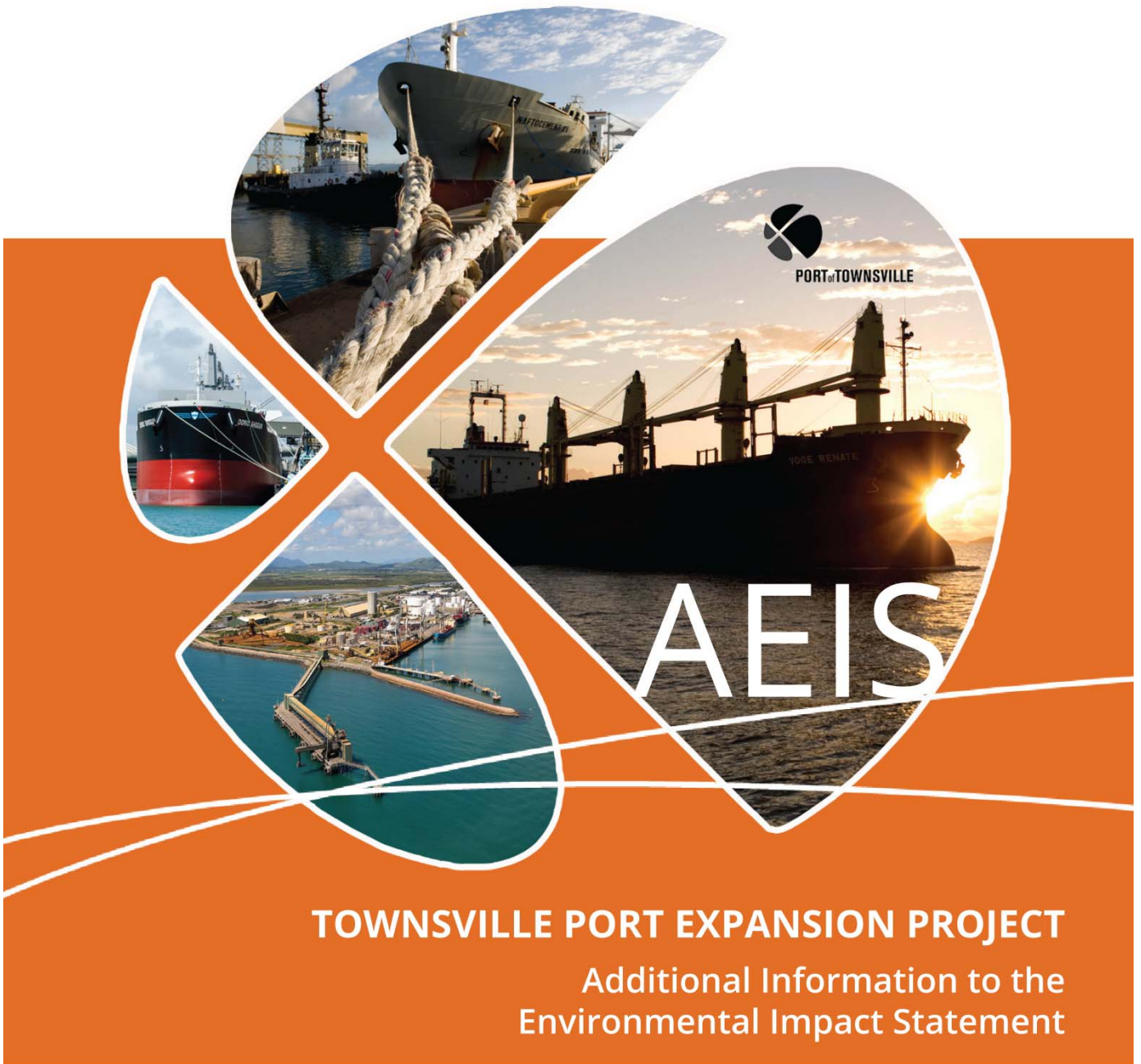
2.4.7 Project Design Summary

Table 2.3 summarises the design refinement outcomes and represents the updated PEP Design parameters which are the subject of this AEIS. The dredge depths are presented as Average Dredge Depth at Lowest Astronomical Tide (LAT).

Table 2.3 Design Elements and Average Dredge Depth

Design Element	Stage 1	Stage 2	Stage 3
Channel Characteristics			
Channel widening	Platypus Channel: 180 m at harbour, tapering to 135 m at sea channel. Sea Channel: tapering from 135 m to 120 m at outer end.	-	-
Channel deepening	-	-	Both channels to an average dredge depth of -13.6 m LAT
Enclosed reclamation area	110 ha	152 ha	Placed in Stage 2 area
Berth staging	12	14, 15 and 16	17 and 18
Average Dredge Depth*			
Berth 12	-15.5 m LAT		
Berth 14		-15.5 m LAT	
Berth 15		-15.5 m LAT	
Berth 16		-15.5 m LAT	
Berth 17			-15.5 m LAT
Berth 18			-15.5 m LAT
Outer harbour	-13.1 m LAT	-13.1 m LAT	-13.1 m LAT
Channel			-13.6 m LAT

* A Navigation Design Depth has been used to describe the channel depth during the design process in the EIS and AEIS. The Navigation Design Depth includes allowances for underkeel clearance, and other tolerances which are applied for safe vessel navigation. Navigational Design Depth of -12.8 m LAT in the channel translates to an Average Design Depth of -13.6 m LAT.



SECTION 3

Land



3.0 Land

3.1 Introduction

Land values of the Project area and surrounds are discussed in Chapter B.1 (Land) of the Environmental Impact Statement (EIS) for the Port of Townsville Limited (POTL) Port Expansion Project (PEP). The PEP is expected to support and facilitate the expansion of existing port land uses and provide opportunity for further growth of Townsville's trading capabilities. It is not expected to significantly impact upon the values of surrounding land.

Soils beneath the Project area are sub-tidal marine sediments and are broadly characterised as a soil profile composed of two strata being, Holocene sediments of approximately 1 m to 1.5 m on the seabed in the outer harbour and reclamation areas and in the order of 0.5 m to 1.0 m in the Platypus Channel and Sea Channel (sediments were typically soft/loose) and Pleistocene deposits comprised of harder sandy clays and sands.

Limited testing of the sediments confirmed the presence of potential acidity in the Holocene sediments from the dredge and reclamation areas. These sediments display characteristics typical of potential acid sulfate soils (PASS) (i.e. generally dark grey, saturated clays and silts). These sediments also generally contained calcareous materials which provide suitable neutralising capacity in excess of acid generating potential. Pleistocene deposits were considered to have a low potential to be PASS.

This section provides information to address submissions received in response to the EIS relevant to land values. More specifically, key matters raised from the submission process include:

- consideration of the State government planning reforms
- adequate consultation with Department of Justice and Attorney-General
- consideration of the Townsville State Development Area (TSDA) Opportunity Strategy
- sources of quarry materials and permit requirements
- adequacy of data to assess the extent of PASS
- release of acidity from offshore PASS disposal and re-suspension
- management of PASS in the reclamation area
- emissions from anoxic sediments.

3.2 Response to Submissions

3.2.1 Consideration of State government planning reforms

The Department of Infrastructure, Local Government and Planning advised the need to consider State Planning Policy (SPP), State Assessment and Referral Agency (SARA) and changes to the State Planning Regulatory Provisions concerning coastal management.

The Department of Environment and Heritage Protection also suggested that clarification be sought on which SPP applies to the EIS. Since the EIS, several changes to the development assessment process in Queensland have occurred. Changes include the formation of SARA, a single State referral agency for assessable development matters (through the State Development Assessment Provisions) under the *Sustainable Planning Act 2009*; and the adoption of the SPP which outlines provisions for the assessment of development in regards to matters of State interest. Both of these tools provide provisions include those pertaining to coastal management.

State government planning reforms and relevance to the PEP are further discussed in Section 1.0 of the AEIS. Changes to the SPP and coastal management provisions do not affect the PEP at this stage; however, they will need to be considered as part of any assessable development triggered under the *Sustainable Planning Act 2009*.

3.2.2 Consultation with the Department of Justice and Attorney-General

The Department of Justice and Attorney-General raised the need to consult with the department where there is likely to be workplace, health or safety requirements for handling Schedule 15 chemicals under the *Work Health and Safety Regulation 2011*.

Detailed requirements for the design or operation of the PEP will be completed in the detailed design and approval stages for the Project. The Project is to be designed in accordance with the relevant standards and industry practice procedures applicable at the time. Specific hazardous chemical installations are unlikely to be relevant to the PEP and are expected to be dealt with under specific-development approvals for future activities, separate to the PEP.

Workplace practices involving hazardous materials are administered by the Department of Justice and Attorney-General and will be the responsibility of the construction contractors in accordance with any legislative requirements that may apply at the time.

3.2.3 Consideration of Townsville State Development Area Opportunities Strategy

Three submissions raised the need to consider the TSDA Opportunities Strategy and draft proposed amendments to the Development Scheme for the TSDA.

POTL acknowledges the strategic role that the TSDA plays in the ability of the Port of Townsville to meet increased trade demands and recognises the need to consider the TSDA Opportunities Strategy in any expansion of operations. The PEP is consistent with the strategic direction of the revised TSDA Development Scheme. It is anticipated that the future industry within the TSDA will be closely aligned with the Port as potential customers / users of port facilities.

3.2.4 Sources of quarry materials and permit requirements

The Department of Agriculture and Fisheries highlighted the potential need for a Sales Permit to be obtained for quarry material on land reserved to the State government. A number of options are available to the Project for sourcing rock material, including the purpose planned Granitevale Quarry. POTL will ensure that all relevant permits and approvals are obtained prior to commencing construction activities.

The Department of Natural Resources and Mines requested assessment of the impact of potential depletion of extractive resources in the local area. POTL is in the final stages of obtaining development approval for the Granitevale Quarry to supply armour rock and material for the Project. POTL will supplement with material from other quarries where required, but is not anticipating to have a significant impact upon the availability of quarry materials in the region.

3.2.5 Adequacy of data to assess the extent of PASS

Six submissions raised the adequacy of available data to assess the extent of PASS. It is acknowledged that the Golders (2012) Desktop Report was a review of limited available PASS analysis and the need for further PASS investigation prior to dredging was recommended. Whilst the amount of PASS analysis on samples was limited, the available geotechnical information was substantial and suitable to provide a high level of confidence of the interface between younger Holocene sediments and older, stiffer Pleistocene deposits. The approximate in-situ volumes of Holocene and Pleistocene materials to be dredged and used for reclamation, based on the revised design, are summarised in Table 3.1 to Table 3.4.

The limited PASS analysis conducted to date for this Project and historical results from other PASS investigations in and around the port, provide clear evidence that the Holocene sediments are PASS, regardless of available neutralising capacity. Therefore, the need for PASS mitigation and/or management measures will apply to these materials. Pleistocene deposits are expected to have a low potential to be PASS and limited testing on these soils conducted to date has confirmed these expectations. Additional detailed testing of Holocene and Pleistocene deposits will be included in the sediment Sampling and Analysis Plan.

The assessment below is based on the anticipated typical Holocene layer thicknesses described above. It is possible that a larger volume of Holocene sediments are encountered when dredging commences. A broad review of geotechnical data indicates that this could be about 26% of the total dredged volume, in the order of 2.96 million m³. The reclamation area has been sized on this basis to allow for potentially larger volume to be managed if required.

Table 3.1 Stage 1 – Channel Widening and B12 Basin and Pocket

	Insitu Volume of Material by Type (m ³)		TOTAL
	Holocene	Pleistocene	
Removal of soft sediments under reclamation perimeter structures	260,000	0	260,000
Channel Widening	600,000	3,300,000	3,900,000
B12 Basin & Pocket	200,000	1,200,000	1,400,000
TOTAL	1,060,000	4,500,000	5,560,000

Table 3.2 Stage 2 – Outer Harbour B14 Basin, B15 Basin and B16 Basin

	Insitu Volume of Material by Type (m ³)		TOTAL
	Holocene	Pleistocene	
Removal of soft sediments under reclamation perimeter structures	180,000	0	180,000
B14 Basin	190,000	1,000,000	1,190,000
B15 Basin	140,000	700,000	840,000
B16 Basin	240,000	1,300,000	1,540,000
TOTAL	750,000	3,000,000	3,750,000

Table 3.3 Stage 3 – Channel Deepening and Berth Pockets B17 and B18

	Insitu Volume of Material by Type (m³)		TOTAL
	Holocene	Pleistocene	
Channel Deepening	190,000	1,800,000	1,990,000
B17 & B18 Berth Pockets	40,000	40,000	80,000
TOTAL	230,000	1,840,000	2,070,000

Table 3.4 Total All Stages (1,2 & 3)

	Insitu Volume of Material by Type (m³)		TOTAL
	Holocene	Pleistocene	
Stage1	1,060,000	4,500,000	5,560,000
Stage 2	750,000	3,000,000	3,750,000
Stage 3	230,000	1,840,000	2,070,000
TOTAL	2,040,000	9,340,000	11,380,000

3.2.6 Release of acidity from offshore disposal and/or re-suspension of PASS

Six submissions raised the generation and release of acidity arising from offshore disposal and/or re-suspension of PASS. Four submissions specifically referred to soil contact with “100% oxygenated water” and the resulting formation of low pH conditions. Offshore disposal of any material is no longer proposed. All dredged materials including PASS material will be placed within a contained reclamation area at the Port. The comments below address the matter in the context of the proposed reclamation area.

Once left undisturbed and submerged in an anoxic environment, pyrite (in acid sulfate soil) is chemically inert. Pyrite oxidizes in the presence of oxygen and hydrogen to form sulfuric acid. There are a number of variables affecting the oxidation of pyrite, and the reactions are complex, although the rate at which pyrite is oxidised tends to be closely linked with pH, with oxidation increasing as pH decreases, and is usually only limited by the rate of supply of oxygen.

When PASS is excavated and allowed to dry, an almost infinite supply of atmospheric oxygen at relatively high concentrations (21 %) is available. The oxygen is delivered to the soil via advection and diffusion. Under this scenario there is a high potential to generate acid.

When PASS is saturated, the available supply of oxygen is significantly lower (typically 9 ppm). In still water, the oxygen is delivered to the soil surface via diffusion at a very slow rate and the risk of acid generation is low. In dynamic, open water bodies (such as Cleveland Bay), the oxygen is principally delivered via advection to suspended soil particles (either through natural processes or dredging activities) and oxygen delivery via diffusion to bottom sediments is negligible. The risk of acid generation is variable and dependent upon the rate and duration of suspension.

Seawater contains the major buffering constituents - bicarbonate and carbonate in solution. When acid is generated the neutralising reaction occurs instantaneously. In an open marine environment, the available buffering capacity is immense and surrounds the suspended soil particles. Therefore, any acid generated by this process is immediately neutralised and does not pose a risk to the surrounding environment.

In open marine environments (dredge areas), the alkaline and relatively stable pH of seawater results in a slow rate of pyrite oxidation and the greatest risk of acid generation is associated with suspended or resuspended sediments. At the reclamation area, the majority of the dredged spoil will settle to the floor of the reclamation area and return to an anoxic, reducing state. The risk of pyrite oxidation during dredging and transportation to the reclamation area will be mitigated by maintaining the spoil in a saturated state and limiting the time period between dredging and placement at the reclamation area.

As further evidence of the above processes and potential impact on the floor of Cleveland Bay is covered with Holocene PASS soils, this will be similar to those dredged by PEP. Cleveland Bay is naturally turbid with wind driven re-suspension of fine seabed sediment over a significant broad scale area. There is no evidence from historical water quality measurements that indicate acidification has resulted from these natural re-suspension processes.

3.2.7 Management of PASS in the reclamation area

Four submissions raised the management of PASS in the reclamation area. Response details are provided below. Further clarification was requested from one submission regarding the removal and placement of soft Holocene material within the reclamation area. The soft Holocene sediments are to be removed from under revetment footprints only and not the entire reclamation area footprint. The soft sediments need to be removed in these areas to provide a firm and stable foundation for the bunds to contain reclamation material. The revetments will provide lateral containment for the placement of dredged Holocene and Pleistocene materials and prevent release into the surrounding area. As discussed in Section B.1.4.1 and B.1.5.1 of the EIS, a detailed Acid Sulfate Soils Management

Plan will be developed during the pre-construction planning of the Project and will be implemented during construction of the PEP.

Submissions also raised the potential for PASS materials to be placed above LAT in the reclamation area and the need for treatment of such materials. One of these submissions also raised the process of discharging and settling spoil into the reclamation area could redistribute fine and coarse materials and create acid generating hotspots not reflective of the current net acidity results. In response, the proposed volume of dredged Holocene (PASS) sediments to be placed in the reclamation area at various stages under the revised design is approximately 2 million m³ (insitu). This is equivalent to a thickness of about 0.7 m across the reclamation area and can easily be accommodated below LAT within this area volumetrically. This is the preferred method of managing PASS as it requires minimum treatment effort.

Dredging placement of these materials can be managed and topographically surveyed to confirm the placement below LAT. Where placement below LAT is confirmed then there is a low risk of future acid generation and additional management/monitoring is not required. If confirmed that the placement of Holocene sediments below LAT cannot be accommodated, then such materials will be characterised at a sampling frequency of not greater than 1 per 1000 m³ to confirm the potential PASS risk. Dependent upon the level of indicated risk, management measures will be implemented which may range from groundwater monitoring to re-excavation and lime treatment of these materials to ensure that hotspots are avoided. Whilst this method of treatment is also effective in managing PASS, due to high labour and cost associated with this approach, it is not preferred. POTL has managed and treated PASS during a number of dredge campaigns and has a high degree of experience in management of this issue. Should PASS be identified in Pleistocene deposits during future testing conducted as part of the detailed sediment Sampling and Analysis Plan, then additional treatment and management measures will be developed.

The potential for PASS materials within the reclamation area to generate and discharge acid and metals to surface waters was also raised in submissions. In response, keeping dredged PASS saturated and placement below LAT in the reclamation area should result in a low potential for acid generation and subsequent metals mobilisation. As part of management measures, the pH and dissolved oxygen of waters within the reclamation areas and tailwaters will be monitored. Where a decline in these parameters is observed, water treatment measures will be implemented.

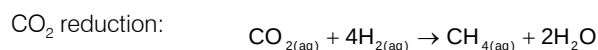
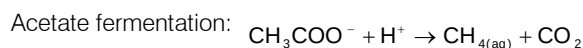
An Acid Sulfate Soils Management Plan will be developed 3 months prior to construction. This will be undertaken in consultation with the Department of Environment and Heritage Protection to quantify the PASS risks and provide clear management and outcomes.

3.2.8 Emissions from anoxic sediments

NQ Dry Tropics commented that consideration should be given to emissions (such as methane release) that may arise as a result of disruption of anoxic organic sediments.

Methane (CH₄) is a significant “greenhouse” gas and it has long been documented that atmospheric concentrations have been increasing steadily over time (e.g. Blake and Rowland, 1988). Methane releases from paddy soils or thawing permafrost are considered to be a significant terrestrial sources to the atmosphere (e.g. Shakhova *et al.*, 2010); whereas contributions from oceanic sediments are comparably insignificant to the atmospheric methane budget (Cicerone and Oremland; 1988). This is mainly due to minimal methane production in shallow marine sediments and/or subsequent oxidation in the overlying water column (Whiticar, 1999). Nonetheless, methane production is predominant in deeper marine sediments and it is possible that this greenhouse gas could be emitted from dredge spoils from Cleveland Bay.

Methane production, aka methanogenesis, occurs through fermentation of organic substrates or reduction of carbon dioxide (CO₂), both of which are biologically mediated by bacteria. The stoichiometry of these two reactions is as follows:



In organic-rich marine sediments, methanogenesis is severely inhibited by the presence of sulfate. Sulfate is the third most abundant ion in seawater and the labile organic carbon in marine sediments is typically consumed by sulfate reduction as opposed to acetate fermentation. As such, the dominant methanogenic pathway in marine sediments is CO₂ reduction by hydrogen (H₂). However, this reaction cannot occur in the presence of sulfate as the sulfate reducing bacteria (SRB) out-compete the CO₂ reducing bacteria (methanogens) for the H₂. For this reason, methane is rarely observed in shallow portions of the marine sediment column (Whiticar, 1999).

The presence or absence of methane in dredge spoils from Cleveland Bay will depend on whether methanogenesis is occurring within the dredging horizon. As discussed above, this will depend on the balance between the rates of sulfate supply vs. sulfate reduction in the pore waters of Cleveland Bay sediments. If found to be emitted from stockpiled dredge spoils, the quantity will be very minor in scale relative to greenhouse gas emissions from the combustion engines used to power the dredging equipment.

3.3 Revised Environmental Impact Assessment

3.3.1 Legislation and policy

3.3.1.1 Contaminated land

Provisions for contaminated land assessment development have been revised under the *Sustainable Planning Act 2009*. Under the *Sustainable Planning Act 2009*, a compliance assessment is required for any material change where all or part of the premises are listed on the State Contaminated Land Register or Environmental Management Register. This requirement may affect future tenants and their operations if development is proposed on land identified on these registers.

Under the *Sustainable Planning Act 2009*, the Department of Infrastructure, Local Government and Planning is now the concurrence referral agency for any contaminated land referrals with new relevant assessment criteria contained in the SPP, State Development Assessment Provisions (SDAP) and *Queensland auditor handbook for contaminated land module 5; Contaminated Land investigation documents, auditor certification and compliance assessment; Part D*. Changes to contaminated land assessment processes are largely administrative and are not expected to significantly impact upon the PEP. Future development of the extended reclamation area is expected to be affected by the changes and will be addressed in separate approvals to be submitted by the relevant proponent at the time.

Amendments to the Commonwealth National Environment Protection (Assessment of Site Contamination) Measure (NEPM) were registered by the Ministerial Standing Council on Environment and Water on 15 May 2013 with the existing NEPM being repealed on 17 May 2013. The changes related to new content and greater detail in the technical guidelines regarding site assessments. The types of assessment that are likely to apply to the PEP under the NEPM largely remain the same and will not change the effects on the PEP.

There are no other Commonwealth or State legislative or policy changes, which are likely to significantly affect the PEP contaminated land assessments or approvals.

3.3.1.2 Acid sulfate soils

There are no legislation or policy changes since submission of the EIS relevant to the assessment of PASS. It is noted that the *Queensland Acid Sulfate Soils Technical Manual – Soil Management Guidelines V4.0* has been released since submission of the EIS. Mitigation measures proposed in the Construction and Operational Environmental Management Plans have considered these guidelines.

3.3.1.3 Land Use and Tenure

The legislative and policy implications affecting strategic and statutory land use directions of the two governments are summarised in the following discussion.

Great Barrier Reef Region Strategic Assessment

The Commonwealth government *Great Barrier Reef (GBR) Region Strategic Assessment Report 2014* has provided a framework for the revised assessment of the values and protective needs of the Great Barrier Reef. This included a complementary assessment by the State of Queensland for State coastal waters. This assessment identified the need to protect the Great Barrier Reef while allowing sustainable port development to proceed in clearly defined priority areas. The Queensland Ports Strategy identifies the Port of Townsville as one of the Priority Port Development Areas for further port development. The PEP is consistent with this policy approach of the Queensland government.

Other outcomes from the strategic assessment of the GBR to date, do not significantly impact upon the EIS requirements of the PEP.

Detailed Development Assessment Provisions

There is a range of detailed land use and environmental based assessment provisions that have been introduced since the writing of the PEP EIS. Most notably is the integration of various SPPs into a single SPP, which clearly identifies specific matters of State interest and further detailed code assessment provisions for assessable development and referral requirements through Queensland's SDAP.

The SDAP assessment criteria are contained in separate Modules, which are grouped according to state interest categories contained within the SPP. Specific Modules that are likely to be applicable to subsequent approval stages for the PEP under the current legislative framework are summarised in Table 3.5.

Table 3.5 Summary of State Development Assessment Provisions Likely to be Applicable to PEP Development

SDAP Module	Likely Applicability to Revised PEP
Module 4: Environmentally relevant activities	Applicable. The PEP will constitute an environmentally relevant activity (ERA) for dredging and potential screening of dredged material as well as other potential ERAs and a development application for these activities will apply.
Module 5: Fisheries resources	Unlikely Applicable. Marine plant impacts form a key component of the fisheries resources assessment criteria. A permit will apply for the removal of any marine plants if present at the time of construction.
Module 10: Coastal protection	Applicable. Tidal work development associated with the PEP is a referral matter under this Module.
Module 13: Major hazard facilities	Possible. The Port of Townsville is not classed as a major hazard facility, however if any major hazard activities are proposed on Port land, this Module and a referral to SARA is required.
Module 14: Maritime safety	Applicable. Tidal works associated with the PEP are assessable development and are required to be referred to SARA. The PEP will form part of the Townsville Port overall operations and will be designed in accordance with all relevant maritime safety standards and practices in mind.
Module 18: State transport infrastructure protection	Applicable. The primary road and rail corridors to be used are specifically intended to service the Port therefore the PEP is consistent with the intent of the State transport infrastructure.
Module 19: State transport network functionality	Applicable. The PEP is consistent with the intended function of the State transport network consisting of road and rail infrastructure that services the Port.

The PEP is generally consistent with the purpose and the outcomes of the applicable codes. The proposed development will be the subject of more detailed assessment during the detailed design stage. This may include assessable development under State legislation.

Local Land Use Planning Changes

Recent significant local changes have included the adoption of the Townsville City Council's (TCC) new planning scheme – *Townsville City Plan 2014* (City Plan) (TCC, 2014). The City Plan recognises and complements the Port's presence and its intended expansion. While development on Strategic Port Land is not directly affected by the City Plan, the PEP (which is identified in the Port of Townsville Land Use Plan (Port of Townsville Limited, 2013), however, yet to be included as Strategic Port Land) is consistent with the strategic intent of the City Plan.

3.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. The revised design is not anticipated to change the impacts on social values described in the Section B.1 (Land) of the EIS.

3.3.3 Supporting studies

No additional studies were undertaken relevant to land values.

3.3.4 Revised assessment

3.3.4.1 Impact assessment

Land Uses

Impacts on land values associated with the revised design are expected to be similar to those identified in Section B.1 (Land) of the EIS with the exception of the channel length reduction. The reduction of the proposed extension to the Sea Channel will reduce potential land use impacts previously associated with encroachment into zoned Marine Park areas.

Policy and legislative reforms that have come into place since the preparation of the EIS have strengthened the Port's position as an important strategic land use asset and as a preferred location for port expansion works.

This is not only reflected in the policy changes in terms of anticipated fewer potential adverse environmental effects but also in terms of a recognition of the port's current and anticipated future role in helping to facilitate other land uses in the region to support economic development, in particular those proposed within the TSDA, supporting a staged demand driven approach encompassed in the PEP

Potential Acid Sulfate Soils

Impacts on land values associated with PASS are similar to those identified in Section B.1 (Land) of the EIS. Additional planning will be required to ensure that these potential impacts are appropriately managed through an Acid Sulfate Soils Management Plan.

The potential impacts associated with the generation and release of acidity from offshore disposal and/or re-suspension of PASS are no longer relevant, as offshore disposal of dredge spoil material is no longer proposed. All dredged materials including PASS material will be placed with a contained reclamation area at the Port.

3.3.4.2 Mitigation measures

Mitigation measures to manage the impact of the Project on land values are outlined in Section B.1.5 of the EIS. No additional measures are considered necessary as a result of the revised design; however minor updates have been made in recognition of submissions and statutory changes.

3.3.5 Summary

The following table provides a summary of the mitigation measures proposed to reduce impacts of the Project on land values.

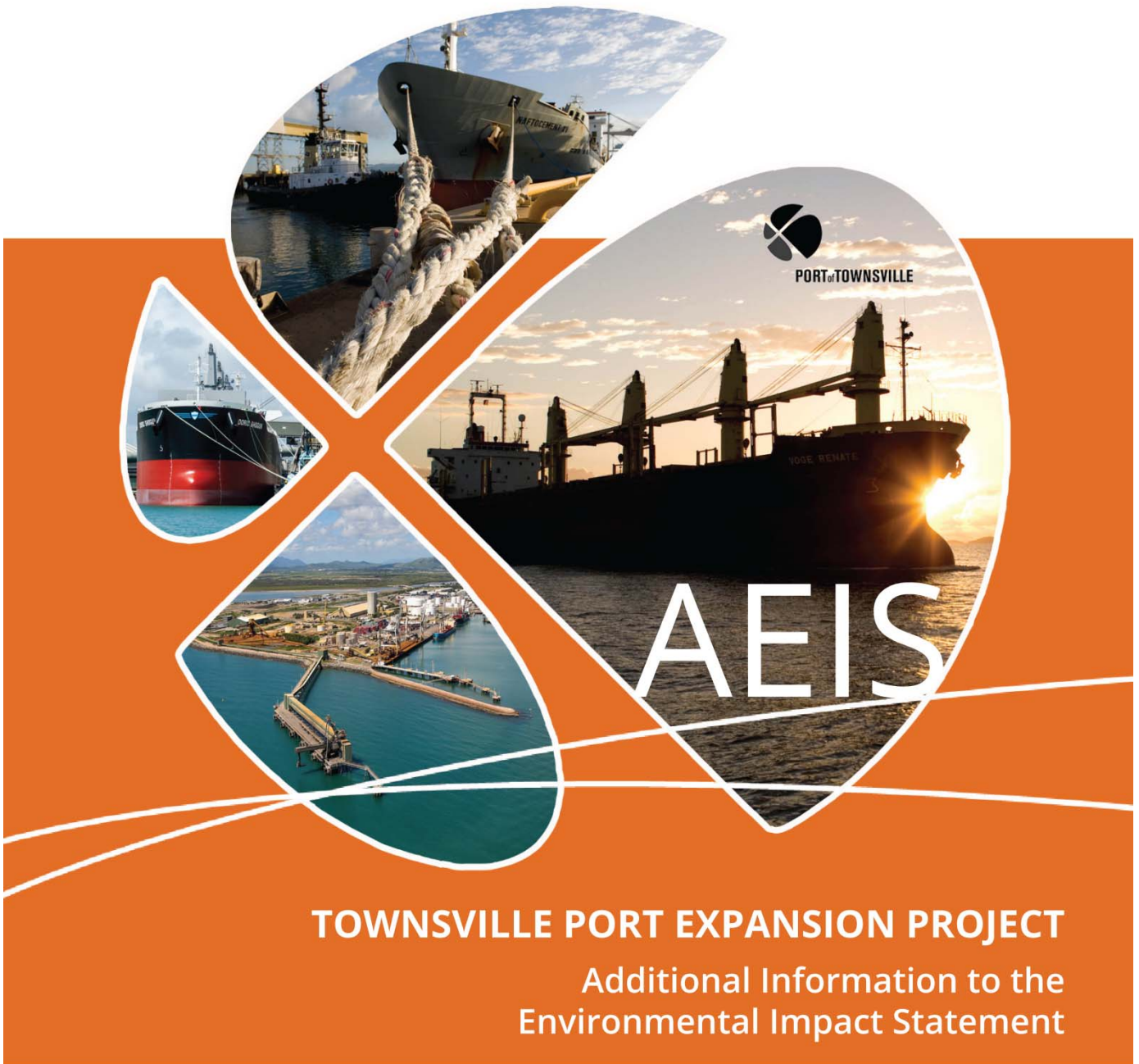
Table 3.6 Summary of Impact of the PEP on land values

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Restrictions to recreational fishing in Cleveland Bay	Construction / Operation	Minor	Possible	Low	Provide ongoing awareness of current entry restrictions and POTL plans for maritime activity well in advance of undertaking any works, through POTL's website, newspaper advertisements and temporary signage at boat ramps in Ross Creek and Ross River as may be required.	Negligible
Restriction to boating navigation to and from Ross Creek and Ross River	Construction / Operation	Minor	Possible	Low	Provide ongoing awareness to boating community regarding stages for the PEP and potential effects on recreational and other boating into Cleveland Bay from Ross River and Ross Creek. Inform Townsville boating organisations, including the Townsville Motor Boat and Yacht Club and the Coast Guard, of PEP activity through regular information correspondence. Liaise with Maritime Safety Queensland for any construction activities that may require a Notice to Mariners.	Negligible
Inadequate planning for infrastructure and integration with other providers (e.g. Ergon Energy)	Operation	High	Unlikely	Medium	Review of the Port's strategic trunk infrastructure needs and liaison with TCC to identify water and sewer needs, required capacity, integration requirements, cost, staging and potential funding. Continued engagement with Council (i.e. through informal discussions and negotiations as well as formal submissions during any stakeholder consultation stages) in relation to the finalisation of the Priority Infrastructure Plan as part of the preparation of the new planning scheme and any subsequent amendments to ensure that the Port's needs are reflected accurately and accounted for. Undertake early consultation with Ergon to ensure that adequate electricity planning and augmentation can occur in advance of PEP being ready to 'come online'.	Low
Loss of amenity and increased safety risk to residences and other uses main access routes and identified haulage route due to increase transport and traffic	Construction / Operation	Moderate	Likely	Medium	Impact assessments (Road Impact Assessment, Traffic Operations Assessment) six months prior to construction. Road Safety Audit six months prior to construction. Update the Port Community Forum as required for any transport and safety issues.	Medium
Incompatibility with future land uses along Boundary Street due to inappropriate location of conflicting land uses	Operation	Minor	Possible	Low	Continue engagement with TCC to ensure compatible land uses are established and maintained along Boundary Street.	Low
Loss of amenity at residences and other land uses along the existing rail corridor to the Port in South Townsville and incompatibility with future land use along the alignment of the existing rail yards	Operation	Moderate	Possible	Medium	Work closely with Queensland Rail to identify appropriate trigger points and plan for the development of rail along the Eastern Access Corridor if it is not already developed prior to the PEP. This will provide sufficient capacity for the PEP rail requirements and will provide an opportunity to address existing port rail efficiency, capacity and amenity matters.	Low

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Acid sulfate soil oxidation and release associated with transport and placement of dredge material in reclamation	Construction	Moderate	Possible	Medium	Keep dredged materials wet and saturated during transport to reclamation area. Holding times outlined in the Queensland Acid Sulfate Soils Technical Manual will be complied with noting that material will be wet. Sampling of Pleistocene soils in dredge areas to confirm PASS status/management requirements. Placement of PASS dredge spoil in reclamation are below LAT. Survey to confirm top of placed PASS. Where PASS is placed above LAT, sample at 1 per 1000m³ to confirmed the need for further management measures. Develop an Acid Sulfate Soils Management Plan in consultation with DEHP for management and monitoring of the reclamation area. Include appropriate triggers and protocols eg monitor water quality (pH and DO, minimum) of standing water within the reclamation area and tailwaters prior to discharge. Treat waters, if required.	Low

3.4 Conclusion

The revised PEP is not expected to significantly impact upon land values and surrounding land use. Policy and legislative reforms that have come into place since the preparation of the EIS have strengthened the Port's position as an important strategic land use asset and as a preferred location for port expansion works. POTL has managed and treated PASS during a number of dredge campaigns and has a high degree of experience in management of PASS to minimise potential environmental impacts. The implementation of mitigation measures described above and in the construction and operational EMPs, show the overall impact to land, including PASS, is considered to remain low.



SECTION 4

Water Resources



4.0 Water Resources

4.1 Introduction

Existing surface water and groundwater values and the impacts of the Port Expansion Project (PEP) on these values are described in Chapter B.2 (Water Resources) of the Environmental Impact Statement (EIS). The Project area lies in marine waters offshore from the existing reclamation area in the vicinity of the mouth of Ross River and Ross Creek. Existing groundwater monitoring on the constructed eastern reclamation area adjacent to the Project area, indicates water levels are tidal influenced and the quality is saline. Groundwater quality is also slightly acidic, which is likely attributed to localised oxidisation around individual wells during diurnal tide surges.

This section provides information to address submissions received in response to the EIS relevant to water resources and the implications of the proposed revised design on these values. Key matters pertaining to water resources include:

- consideration of potential flood impacts on the future Townsville State Development Area as a result of the PEP
- consideration of revised water and sediment quality guidelines
- degradation of groundwater from potential acid sulfate soils (PASS).

The potential for PASS and subsequent potential for degradation of groundwater associated with the PEP is addressed in Section 6.2.5 of the Additional Information to the Environmental Impact Statement (AEIS).

4.2 Response to Submissions

4.2.1 Consideration of potential flood impacts on the future Townsville State Development Area as a result of the Project

The Department of Environment and Heritage Protection (DEHP) recommended the inclusion of a comprehensive flood study. A further submission from Department of Transport and Main Roads recommended that the Townsville State Development Area (TSDA) Development Scheme and associated flood study, be included in the assessment of flood impacts from the PEP. The Project area is located in marine waters adjacent to the existing reclamation area which lies on the northern side of the mouth of the Ross River, whilst the TSDA lies to the south of the Ross River.

The PEP flood impact study presented in Appendix G of the EIS considered the original Townsville Flood Hazard Study model. Flood modelling has since been revised to consider a straightening of the eastern revetment of the proposed reclamation to test the sensitivity of the PEP to the future development of the TSDA. This revised revetment was simulated to be continuous with the existing reclamation edge as illustrated in Figure 4.1. In lieu of the Department of Transport and Main Roads model, which was not available at the time of this revision, the inflow of the updated PEP modelling was doubled to account for future development of the TSDA. This was considered to be a conservative approach in assessing how significant flows from future developments via the Ross River could affect upstream flooding, given the limited detail currently available about future developments within the TSDA.

As a result the revised modelling demonstrated no change in impact to flood level, flow or inundation as a result of the revised design and future development of the TSDA. Mitigation measures provided in Section B.2.5 of the EIS and reiterated in Section 4.3.4.2 of the AEIS are considered adequate to effectively manage impacts on water resources.

4.2.2 Consideration of revised water and sediment quality guidelines

A submission from DEHP requested the following references be taken into consideration when assessing the impact of the Project on water resources:

- a review of nitrate toxicity to freshwater aquatic species (Hickey, Martin, & NIWA, 2009)
- revision of the ANZECC/ARMCANZ Sediment Quality Guidelines (Simpson, Batley, & Chariton, 2010)
- development of guidelines for ammonia in estuarine and marine water systems (Batley & Simpson, 2009).

The Project is located seaward and offshore from the existing reclamation area and will drain to the marine environment seaward of the mouth for both Ross Creek and Ross River. Water discharges, such as tailwater during construction and stormwater during operation, are predominantly limited to the marine environment.

Nitrate and ammonia trigger values used in the EIS assessment of impacts to freshwater environments are derived from the draft *Ross River Basin Environmental Values and Water Quality Objectives* (DEHP, 2012) and are considered more relevant and applicable to the PEP than the aforementioned guidelines. Impacts to freshwater systems, in the context of this guideline, are provided in Chapter B.2 (Water Resources) of the EIS. Impacts on freshwater water quality as a result of the PEP are expected to be minimal, due to the implementation of mitigation measures outlined in Section B.2.5 of the EIS.

Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines (Simpson, Batley, & Chariton, 2010) and Development of guidelines for ammonia in estuarine and marine water systems (Batley & Simpson, 2009) were considered in the EIS, specifically these were used for development of Chapters B.4 (Marine Water Quality) and B.5 (Marine Sediment Quality) of the EIS. These references were omitted in the EIS and have been individually noted in the Errata List (Appendix C3) and Reference List (Appendix C4) of the AEIS.

4.3 Revised Environmental Impact Assessment

4.3.1 Legislation and policy

There are no legislation or policy changes applicable to the assessment of water resources values as they apply to the PEP, or the management of these values.

4.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. The design refinement process has resulted in an increased reclamation footprint to enable greater volumes of dredge material to be placed on land. The revised design has been considered in the flood modelling by extending the eastern revetment to run continuous to the existing reclamation revetment to identify any change in the extent, duration or frequency of flood events with the construction of the PEP.

4.3.3 Supporting studies

Flood modelling was reassessed to consider the revised PEP design and future development within the TSDA. Results of this remodelling are illustrated in Figure 4.1 to Figure 4.7.

4.3.4 Revised assessment

4.3.4.1 Impact assessment

Flood modelling was undertaken using a revised Developed Case Model to consider an extended eastern revetment design and future development of the TSDA, illustrated in Figure 4.1.

The revised modelling showed the impact of the PEP on the extent and intensity of storm surges is consistent with Appendix G of the EIS (refer Figure 4.2). There is no measurable change in the impact of the PEP on the extent or duration of a 50 year or 100 year flood event in the Townsville region as a result of the revised design (refer Figure 4.3 and Figure 4.4). The revised design does not change the expected impact of the PEP on the 100 year surge event (refer Figure 4.7). This would be expected given the distance seaward of the PEP from the mouth of both Ross Creek and Ross River.

Impacts of the Project on water resource values are consistent with Section B.2.5 of the EIS.

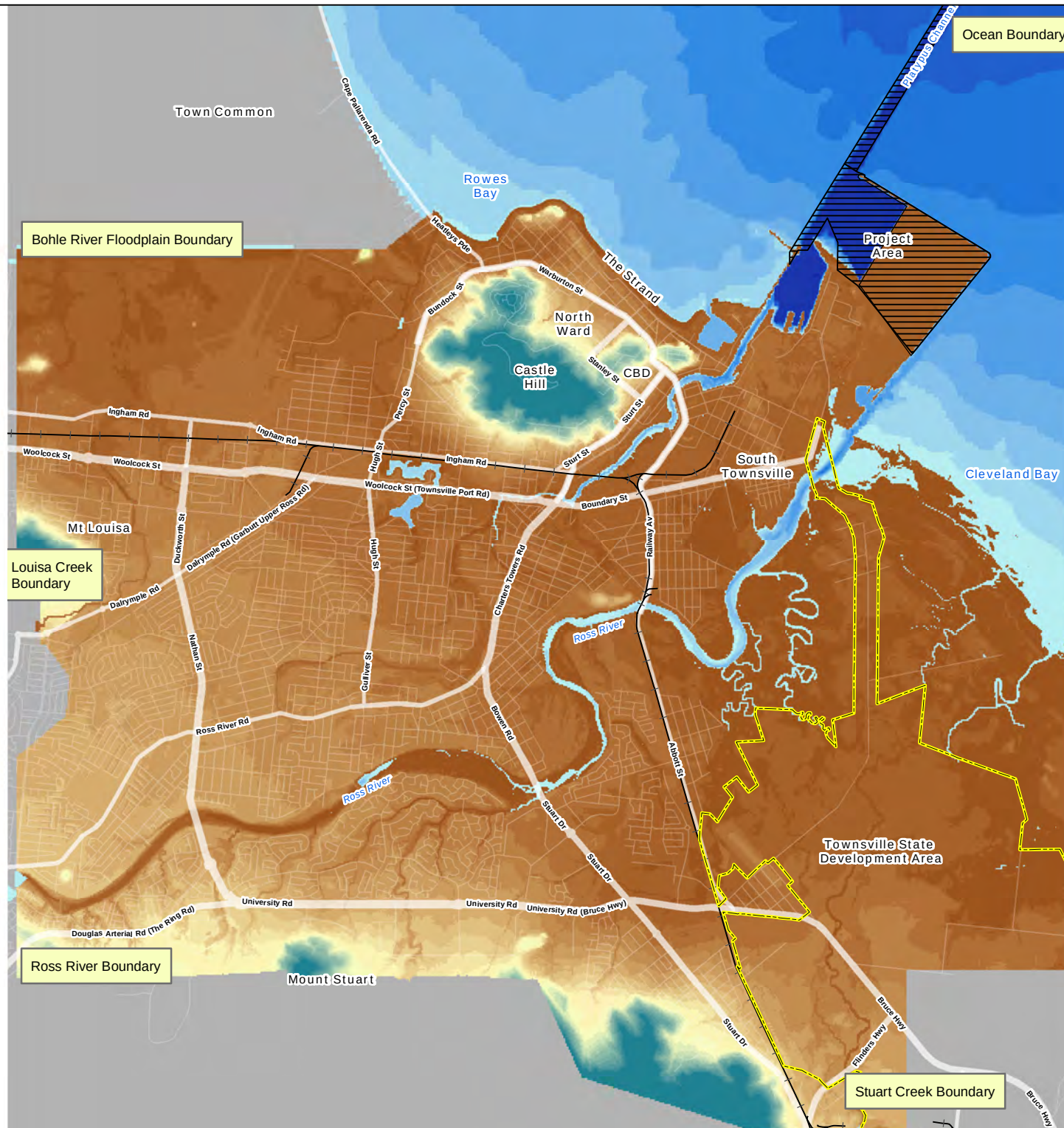
PORT EXPANSION PROJECT AEIS

Developed Case Model DEM

Figure 4.1

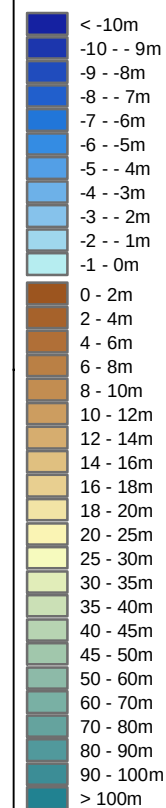
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Legend

Elevation (AHD m)



Scale: 1:70,000 (when printed at A4)



Kilometers

PROJECT ID 60161996

LAST MODIFIED CFS 19-02-2016

FILE NAME 60161996_PLN_162

Data Source:

Noise Data - AECOM 2015

StreetPro © 2010 Pitney Bowes Software Pty Ltd

Roads, Parks - © 2010 PSMA Australia Pty Ltd

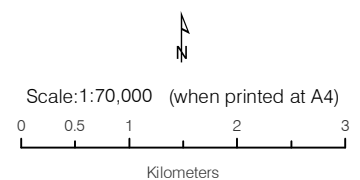
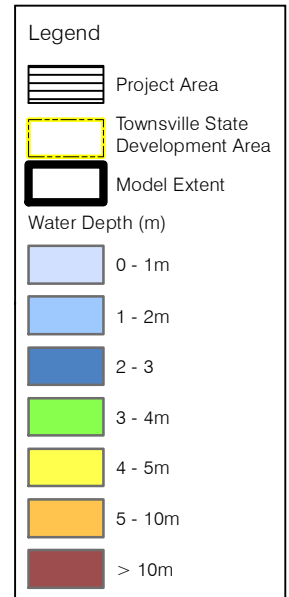
Base Image - ESRI 2012

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PORT EXPANSION PROJECT AEIS

100 Year ARI Flood Extents with
100 Year ARI Surge Tailwater

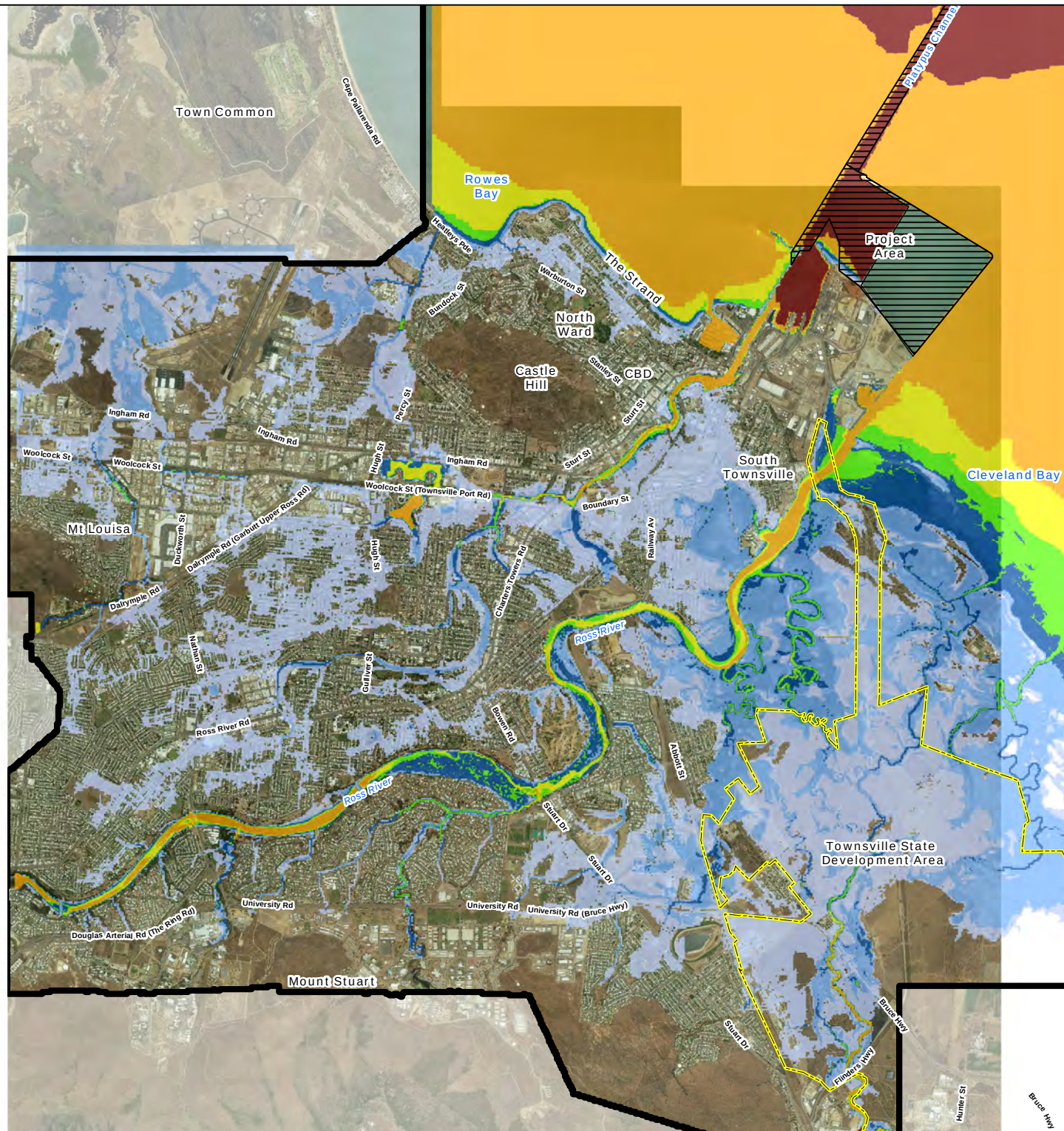
Figure 4.2



PROJECT ID 60161996
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 Data Source:
 Noise Data - AECOM 2015
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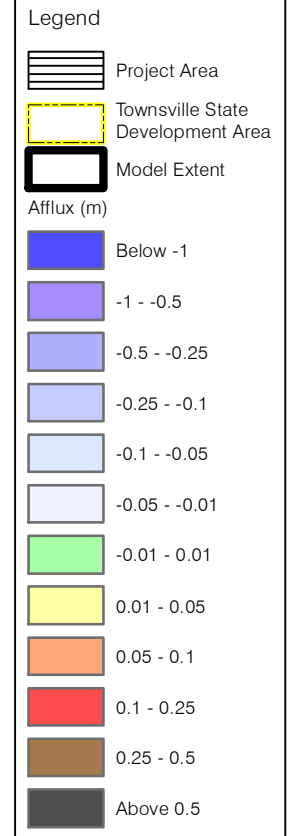
PORT EXPANSION PROJECT AEIS

Afflux Map for the 50 Year ARI
Rainfall Event with MHWS
Tailwater Condition

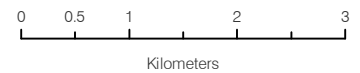
Figure 4.3

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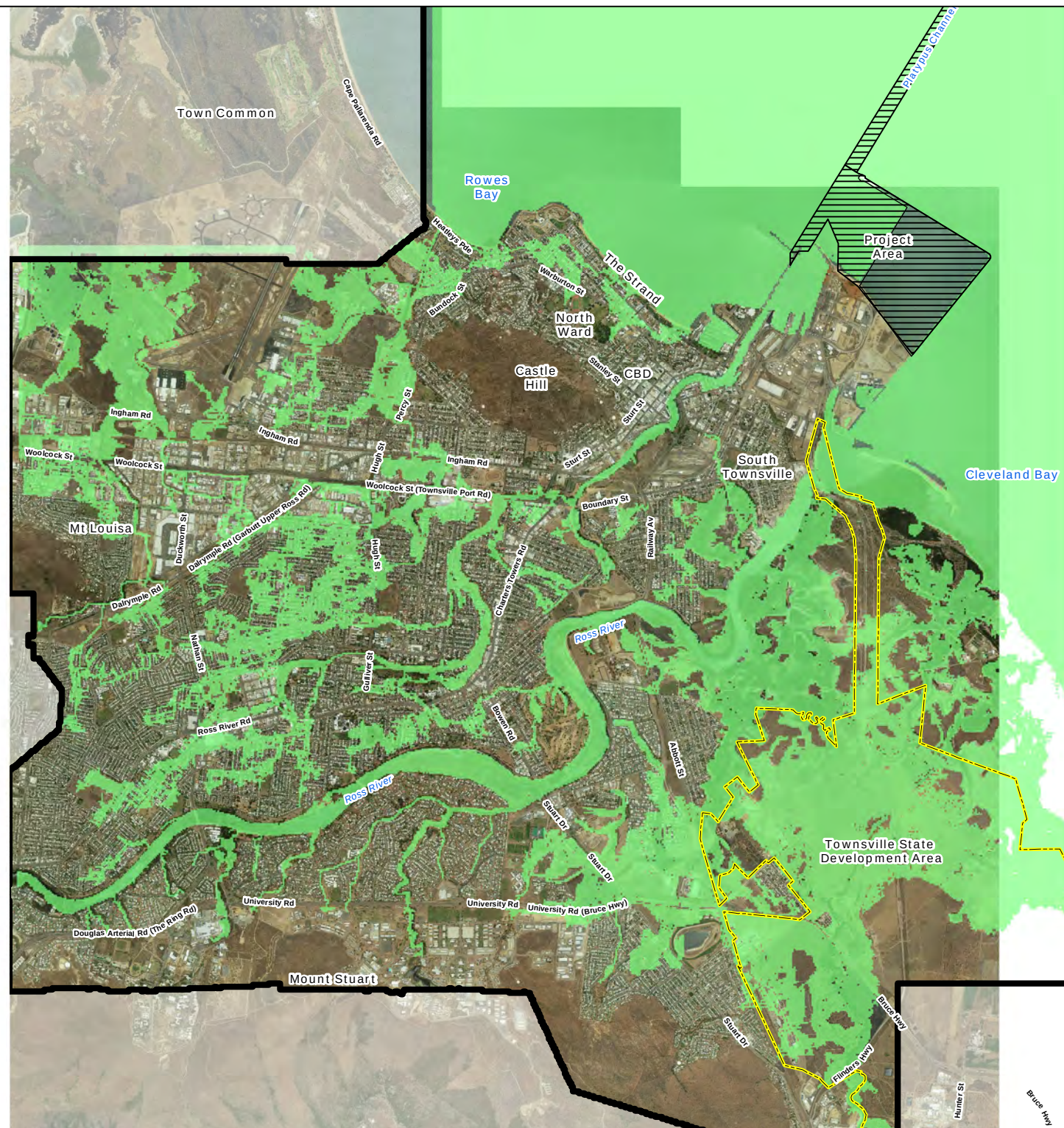
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PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with MHWS
Tailwater Condition

Figure 4.4

EXTENT OF MODEL



EXTENT OF MODEL

Legend

-  Project Area
-  Townsville State Development Area
-  Model Extent
- Afflux (m)
-  Below -1
-  -1 - -0.5
-  -0.5 - -0.25
-  -0.25 - -0.1
-  -0.1 - -0.05
-  -0.05 - -0.01
-  -0.01 - 0.01
-  0.01 - 0.05
-  0.05 - 0.1
-  0.1 - 0.25
-  0.25 - 0.5
-  Above 0.5



Scale: 1:70,000 (when printed at A4)



Kilometers

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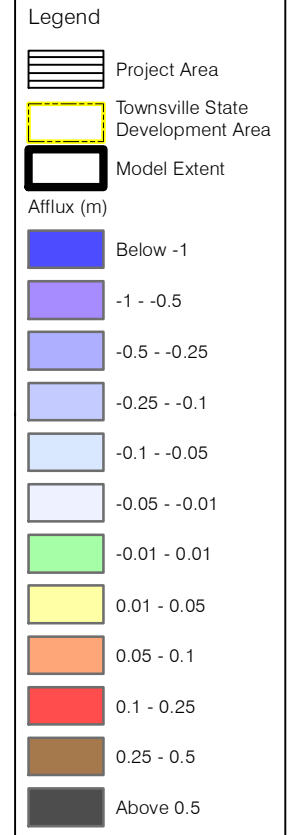
PORT EXPANSION PROJECT AEIS

Afflux Map for the 50 Year ARI
Rainfall Event with MHWS
Tailwater Condition
Double TSDA Area Runoff Hydrograph

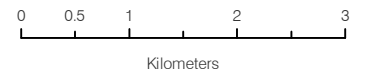
Figure 4.5

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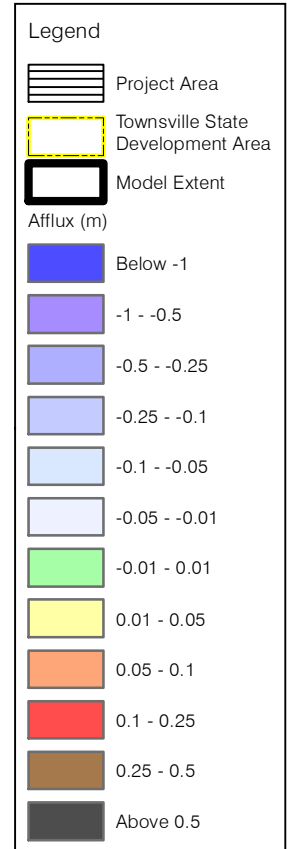


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PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with MHWS
Tailwater Condition
Double TSDA Area Runoff Hydrograph

Figure 4.6

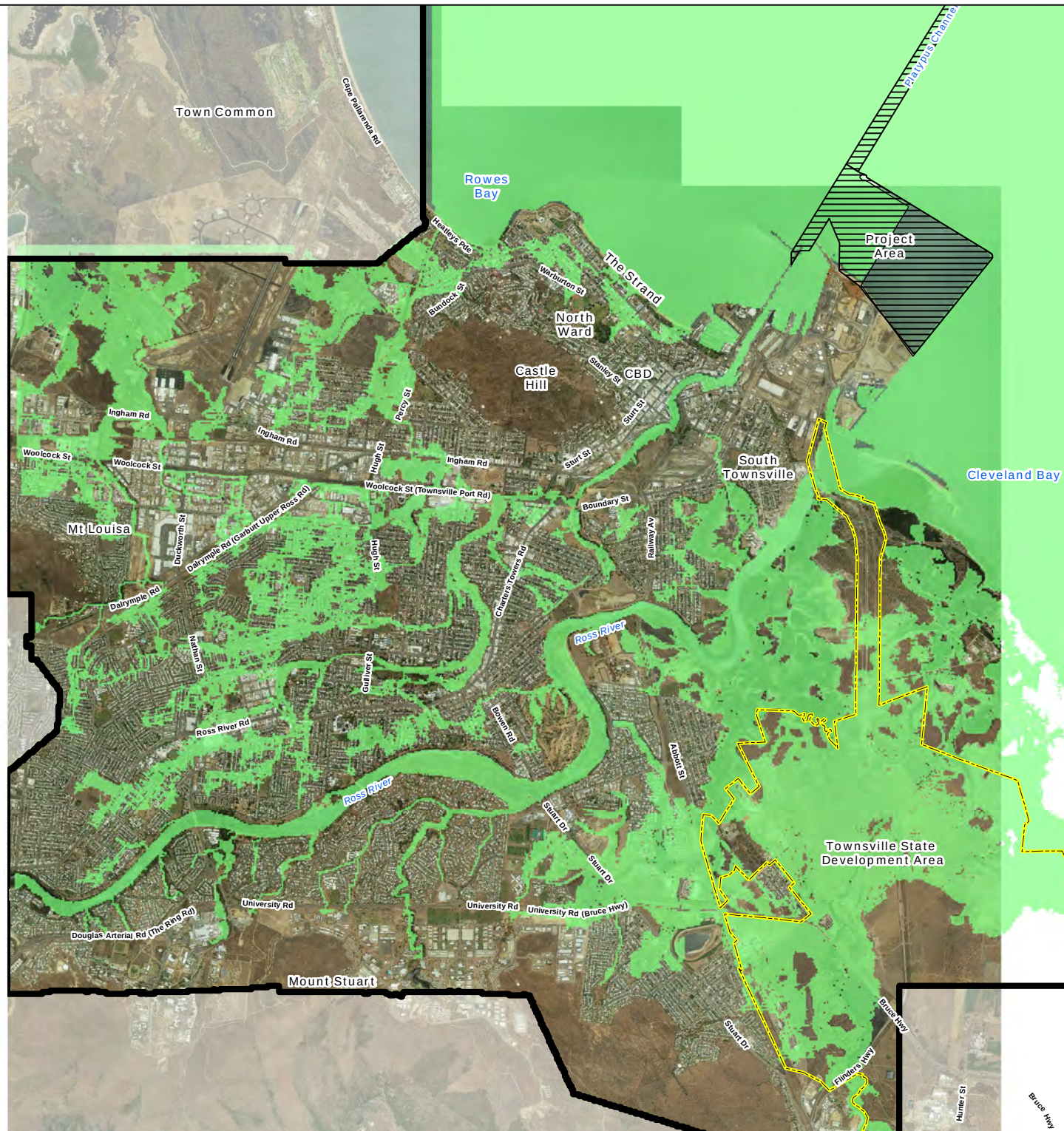


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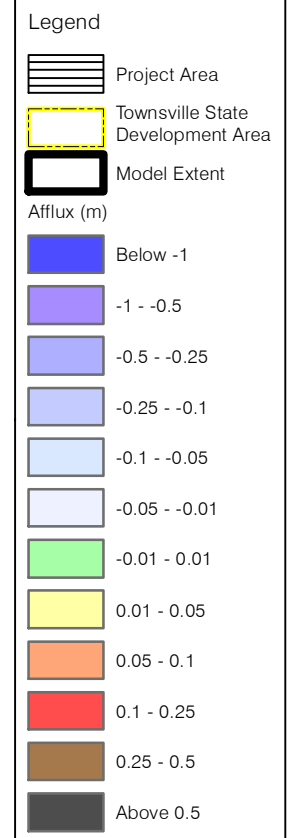


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PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with 100 Year ARI
Surge Tailwater Condition

Figure 4.7



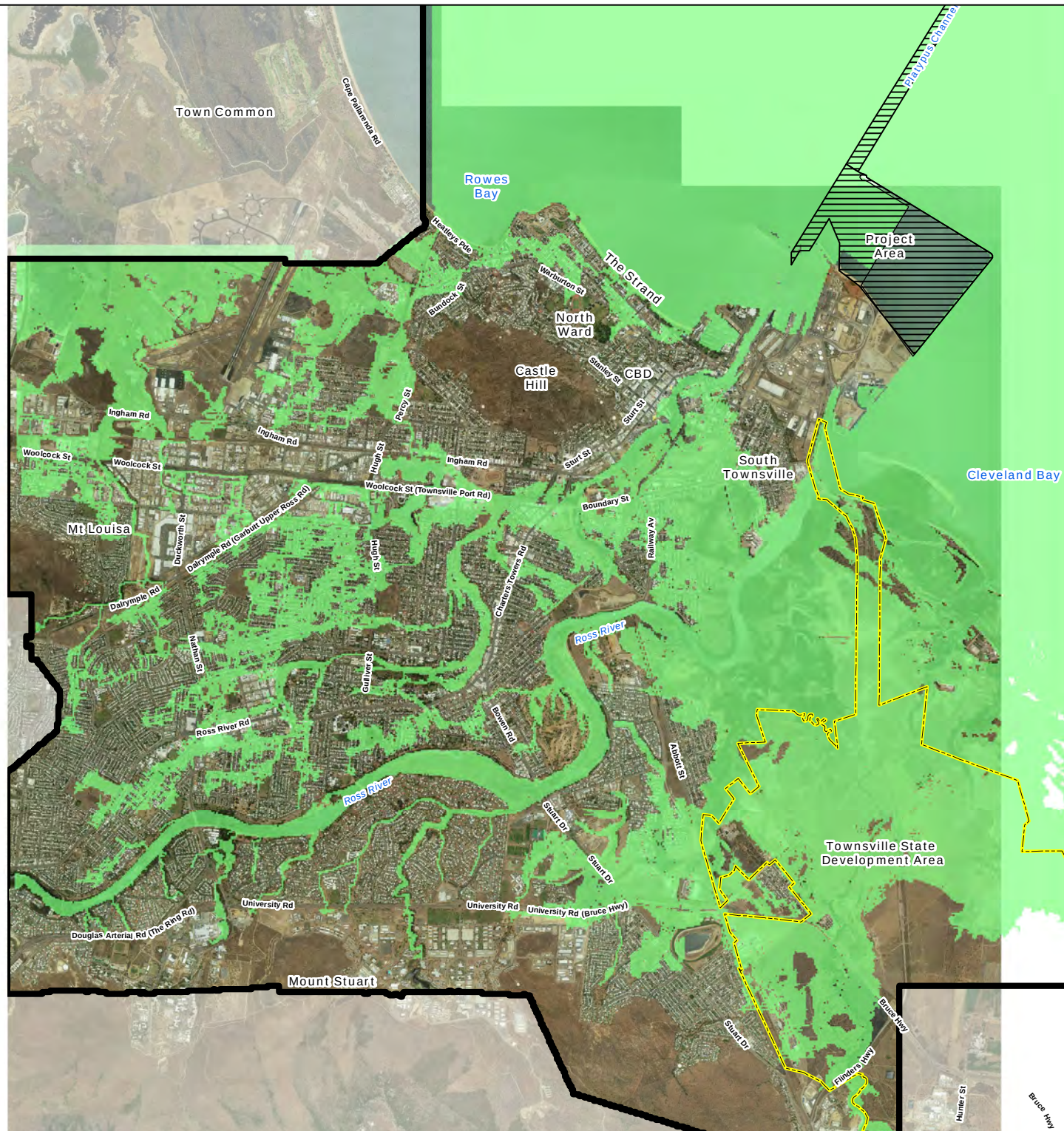
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4.3.4.2 Mitigation measures

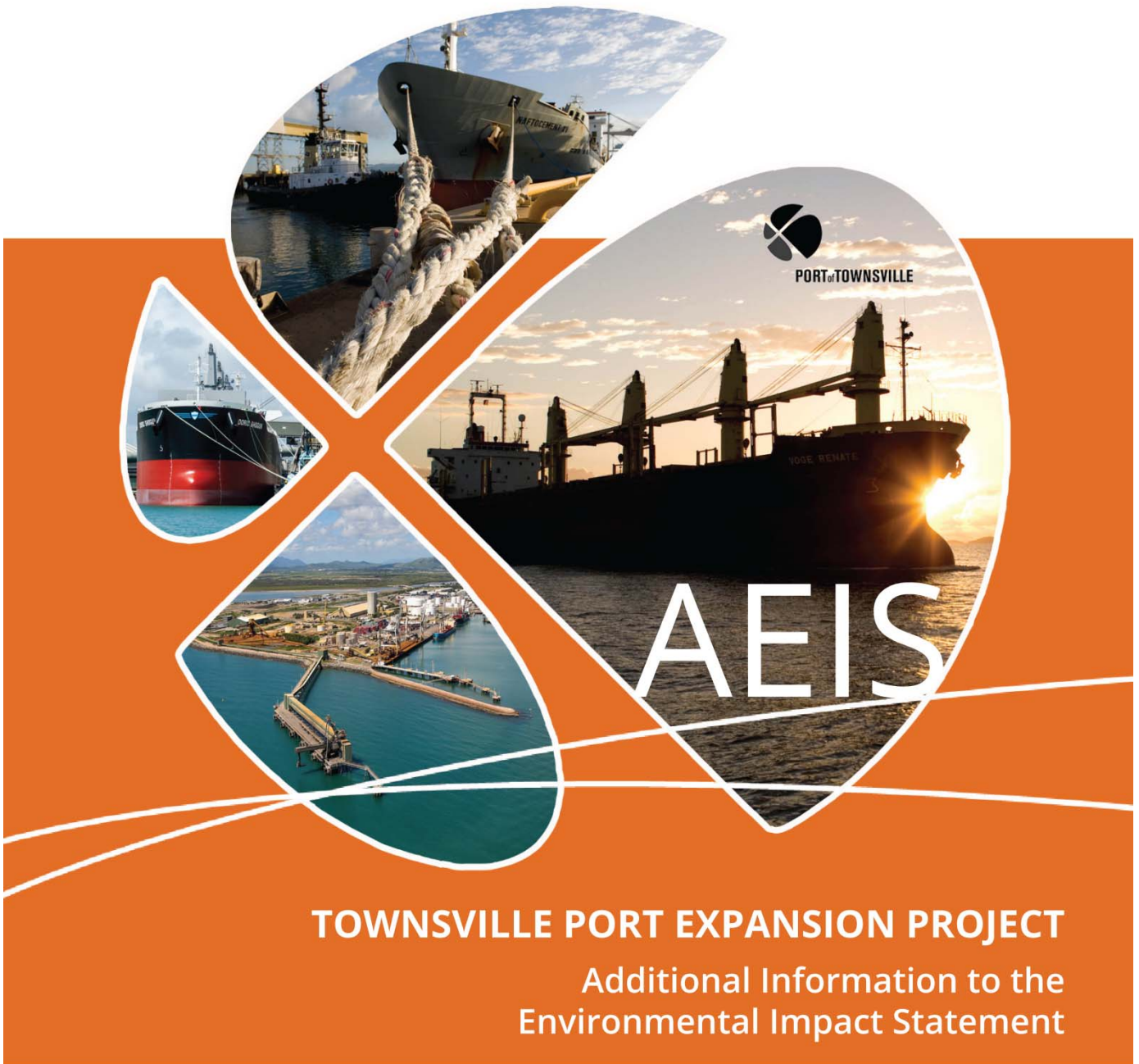
Mitigation measures to reduce the impact on the Project water resources values are provided in Section B.2.5 of the EIS and outlined in the Construction Environmental Management Plan (Appendix B2) and the Operational Environmental Management Plan (Appendix B3).

4.3.5 Summary

Impacts of the Project on water resource values are consistent with Section B.2.5 of the EIS. Mitigation measures provided in Section B.2.5 of the EIS remain current for the revised design.

4.4 Conclusion

The PEP is expected to have a low impact on water resources on site or within the surrounding area during construction and operation. Whilst the Project reclamation footprint has been revised through the design refinement process, this has not altered the outcome of the assessment presented in the EIS. The mitigation measures identified in the EIS remain relevant given the scale and duration of the PEP construction.



SECTION 4

Water Resources



4.0 Water Resources

4.1 Introduction

Existing surface water and groundwater values and the impacts of the Port Expansion Project (PEP) on these values are described in Chapter B.2 (Water Resources) of the Environmental Impact Statement (EIS). The Project area lies in marine waters offshore from the existing reclamation area in the vicinity of the mouth of Ross River and Ross Creek. Existing groundwater monitoring on the constructed eastern reclamation area adjacent to the Project area, indicates water levels are tidal influenced and the quality is saline. Groundwater quality is also slightly acidic, which is likely attributed to localised oxidisation around individual wells during diurnal tide surges.

This section provides information to address submissions received in response to the EIS relevant to water resources and the implications of the proposed revised design on these values. Key matters pertaining to water resources include:

- consideration of potential flood impacts on the future Townsville State Development Area as a result of the PEP
- consideration of revised water and sediment quality guidelines
- degradation of groundwater from potential acid sulfate soils (PASS).

The potential for PASS and subsequent potential for degradation of groundwater associated with the PEP is addressed in Section 6.2.5 of the Additional Information to the Environmental Impact Statement (AEIS).

4.2 Response to Submissions

4.2.1 Consideration of potential flood impacts on the future Townsville State Development Area as a result of the Project

The Department of Environment and Heritage Protection (DEHP) recommended the inclusion of a comprehensive flood study. A further submission from Department of Transport and Main Roads recommended that the Townsville State Development Area (TSDA) Development Scheme and associated flood study, be included in the assessment of flood impacts from the PEP. The Project area is located in marine waters adjacent to the existing reclamation area which lies on the northern side of the mouth of the Ross River, whilst the TSDA lies to the south of the Ross River.

The PEP flood impact study presented in Appendix G of the EIS considered the original Townsville Flood Hazard Study model. Flood modelling has since been revised to consider a straightening of the eastern revetment of the proposed reclamation to test the sensitivity of the PEP to the future development of the TSDA. This revised revetment was simulated to be continuous with the existing reclamation edge as illustrated in Figure 4.1. In lieu of the Department of Transport and Main Roads model, which was not available at the time of this revision, the inflow of the updated PEP modelling was doubled to account for future development of the TSDA. This was considered to be a conservative approach in assessing how significant flows from future developments via the Ross River could affect upstream flooding, given the limited detail currently available about future developments within the TSDA.

As a result the revised modelling demonstrated no change in impact to flood level, flow or inundation as a result of the revised design and future development of the TSDA. Mitigation measures provided in Section B.2.5 of the EIS and reiterated in Section 4.3.4.2 of the AEIS are considered adequate to effectively manage impacts on water resources.

4.2.2 Consideration of revised water and sediment quality guidelines

A submission from DEHP requested the following references be taken into consideration when assessing the impact of the Project on water resources:

- a review of nitrate toxicity to freshwater aquatic species (Hickey, Martin, & NIWA, 2009)
- revision of the ANZECC/ARMCANZ Sediment Quality Guidelines (Simpson, Batley, & Chariton, 2010)
- development of guidelines for ammonia in estuarine and marine water systems (Batley & Simpson, 2009).

The Project is located seaward and offshore from the existing reclamation area and will drain to the marine environment seaward of the mouth for both Ross Creek and Ross River. Water discharges, such as tailwater during construction and stormwater during operation, are predominantly limited to the marine environment.

Nitrate and ammonia trigger values used in the EIS assessment of impacts to freshwater environments are derived from the draft *Ross River Basin Environmental Values and Water Quality Objectives* (DEHP, 2012) and are considered more relevant and applicable to the PEP than the aforementioned guidelines. Impacts to freshwater systems, in the context of this guideline, are provided in Chapter B.2 (Water Resources) of the EIS. Impacts on freshwater water quality as a result of the PEP are expected to be minimal, due to the implementation of mitigation measures outlined in Section B.2.5 of the EIS.

Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines (Simpson, Batley, & Chariton, 2010) and Development of guidelines for ammonia in estuarine and marine water systems (Batley & Simpson, 2009) were considered in the EIS, specifically these were used for development of Chapters B.4 (Marine Water Quality) and B.5 (Marine Sediment Quality) of the EIS. These references were omitted in the EIS and have been individually noted in the Errata List (Appendix C3) and Reference List (Appendix C4) of the AEIS.

4.3 Revised Environmental Impact Assessment

4.3.1 Legislation and policy

There are no legislation or policy changes applicable to the assessment of water resources values as they apply to the PEP, or the management of these values.

4.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. The design refinement process has resulted in an increased reclamation footprint to enable greater volumes of dredge material to be placed on land. The revised design has been considered in the flood modelling by extending the eastern revetment to run continuous to the existing reclamation revetment to identify any change in the extent, duration or frequency of flood events with the construction of the PEP.

4.3.3 Supporting studies

Flood modelling was reassessed to consider the revised PEP design and future development within the TSDA. Results of this remodelling are illustrated in Figure 4.1 to Figure 4.7.

4.3.4 Revised assessment

4.3.4.1 Impact assessment

Flood modelling was undertaken using a revised Developed Case Model to consider an extended eastern revetment design and future development of the TSDA, illustrated in Figure 4.1.

The revised modelling showed the impact of the PEP on the extent and intensity of storm surges is consistent with Appendix G of the EIS (refer Figure 4.2). There is no measurable change in the impact of the PEP on the extent or duration of a 50 year or 100 year flood event in the Townsville region as a result of the revised design (refer Figure 4.3 and Figure 4.4). The revised design does not change the expected impact of the PEP on the 100 year surge event (refer Figure 4.7). This would be expected given the distance seaward of the PEP from the mouth of both Ross Creek and Ross River.

Impacts of the Project on water resource values are consistent with Section B.2.5 of the EIS.

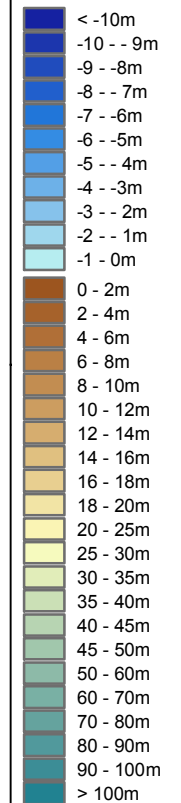
PORT EXPANSION PROJECT AEIS

Developed Case Model DEM

Figure 4.1

Legend

Elevation (AHD m)



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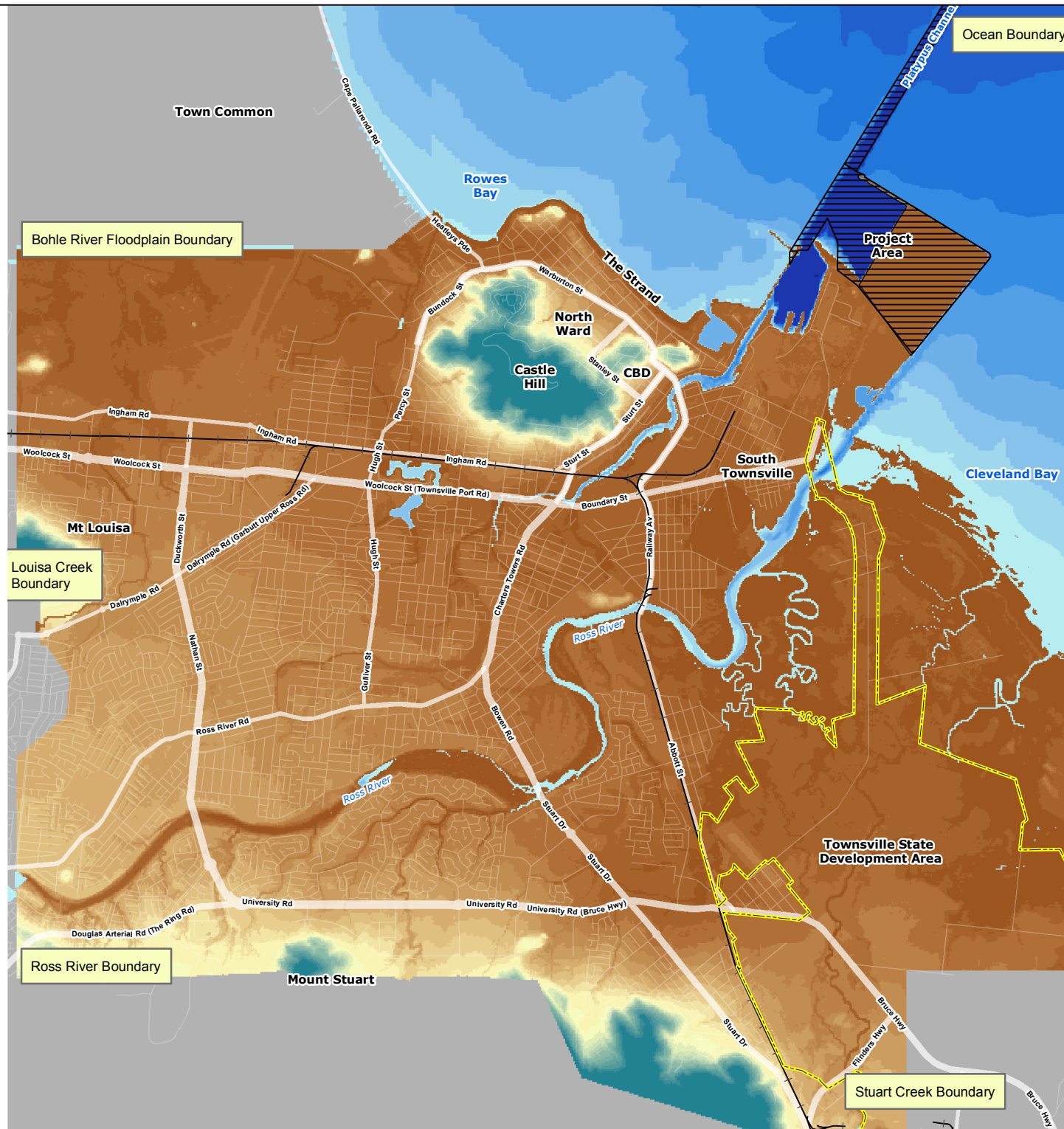
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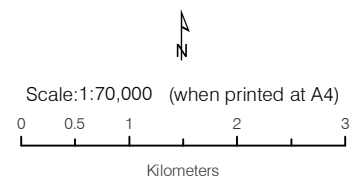
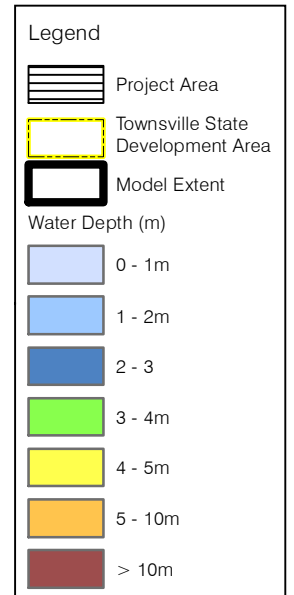
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PORT EXPANSION PROJECT AEIS

100 Year ARI Flood Extents with
100 Year ARI Surge Tailwater

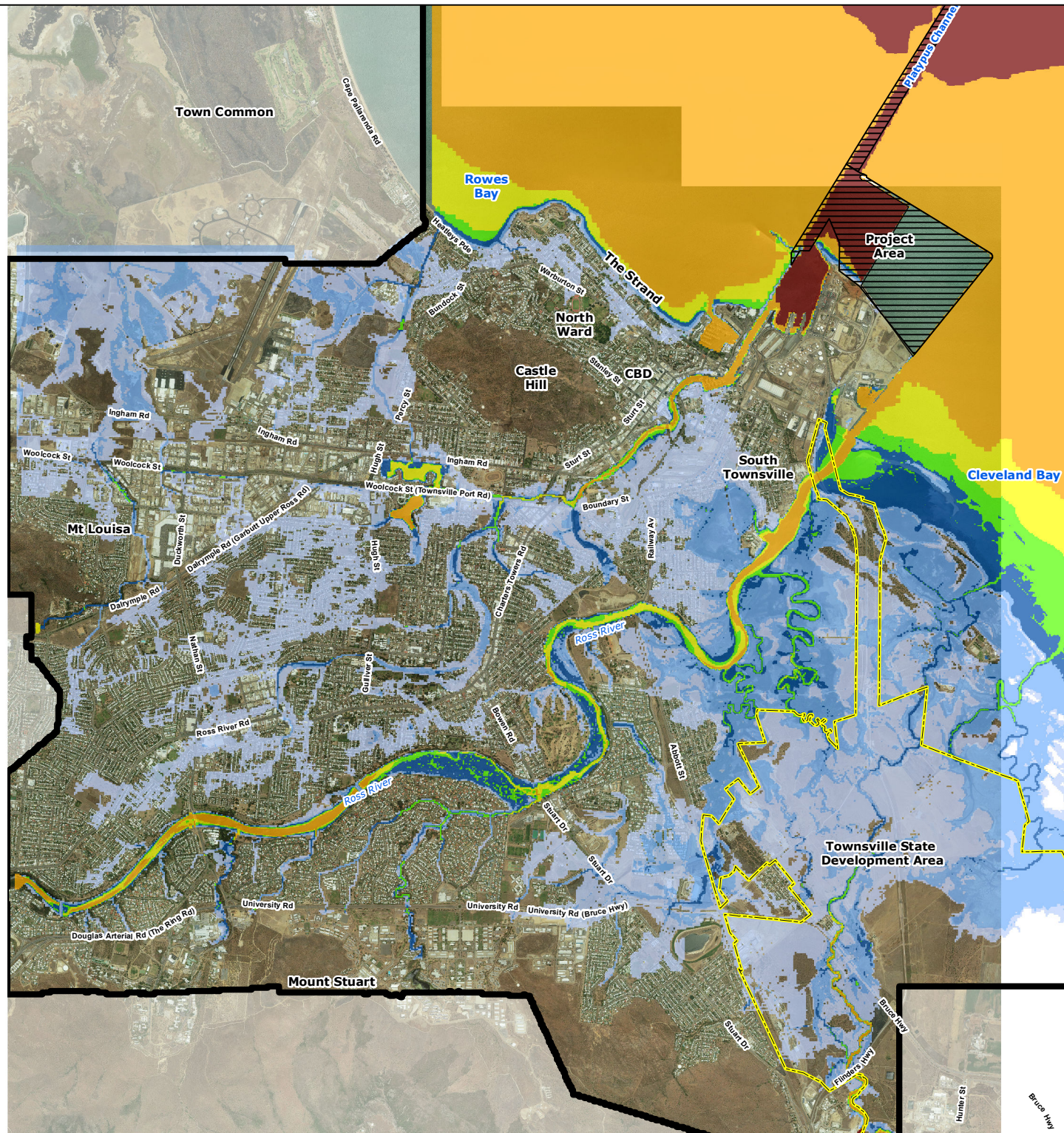
Figure 4.2



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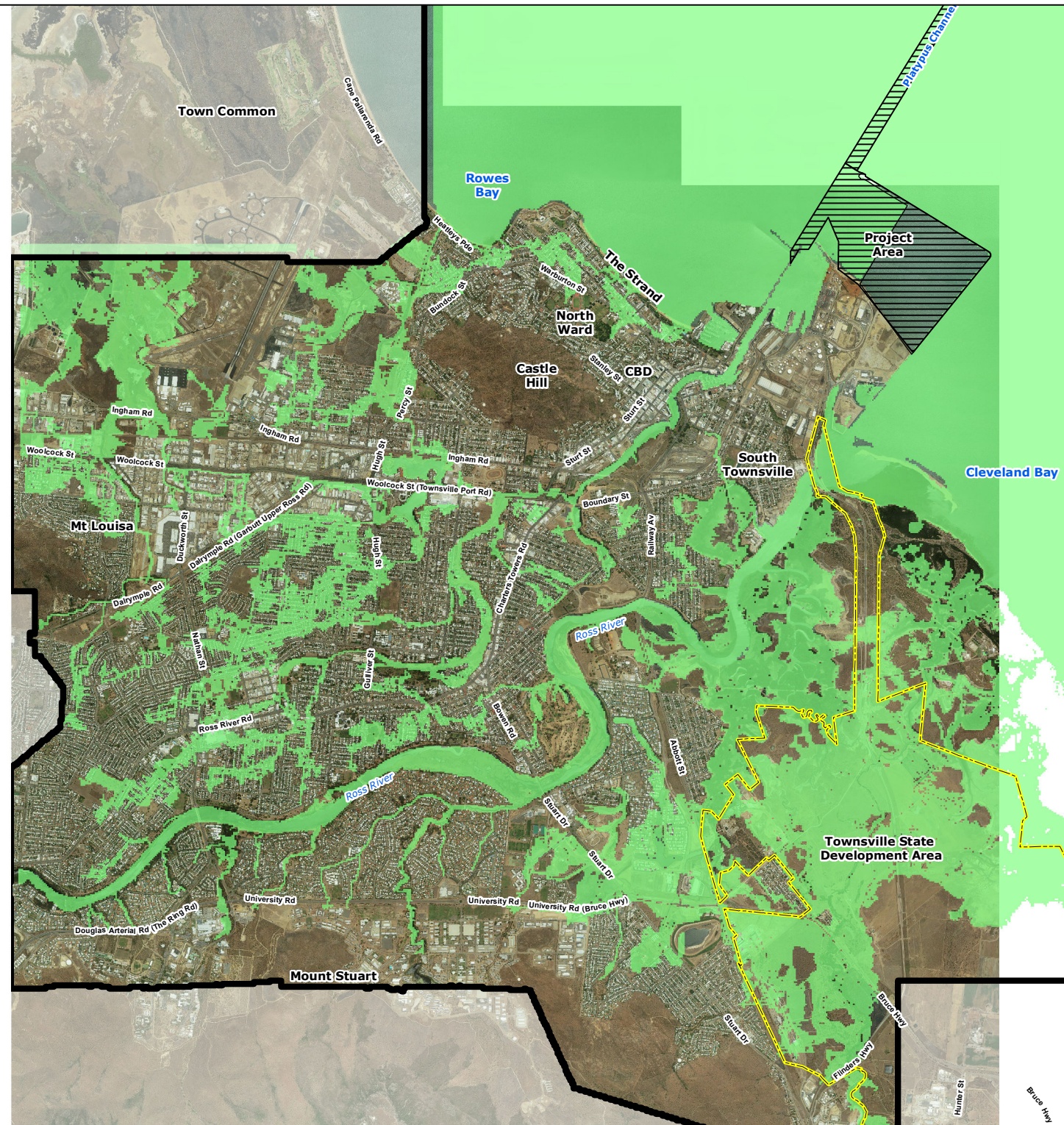
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PORT EXPANSION PROJECT AEIS

Afflux Map for the 50 Year ARI
Rainfall Event with MHWS
Tailwater Condition

Figure 4.3



Legend

-  Project Area
-  Townsville State Development Area
-  Model Extent
- Afflux (m)
-  Below -1
-  -1 - -0.5
-  -0.5 - -0.25
-  -0.25 - -0.1
-  -0.1 - -0.05
-  -0.05 - -0.01
-  -0.01 - 0.01
-  0.01 - 0.05
-  0.05 - 0.1
-  0.1 - 0.25
-  0.25 - 0.5
-  Above 0.5



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Kilometers

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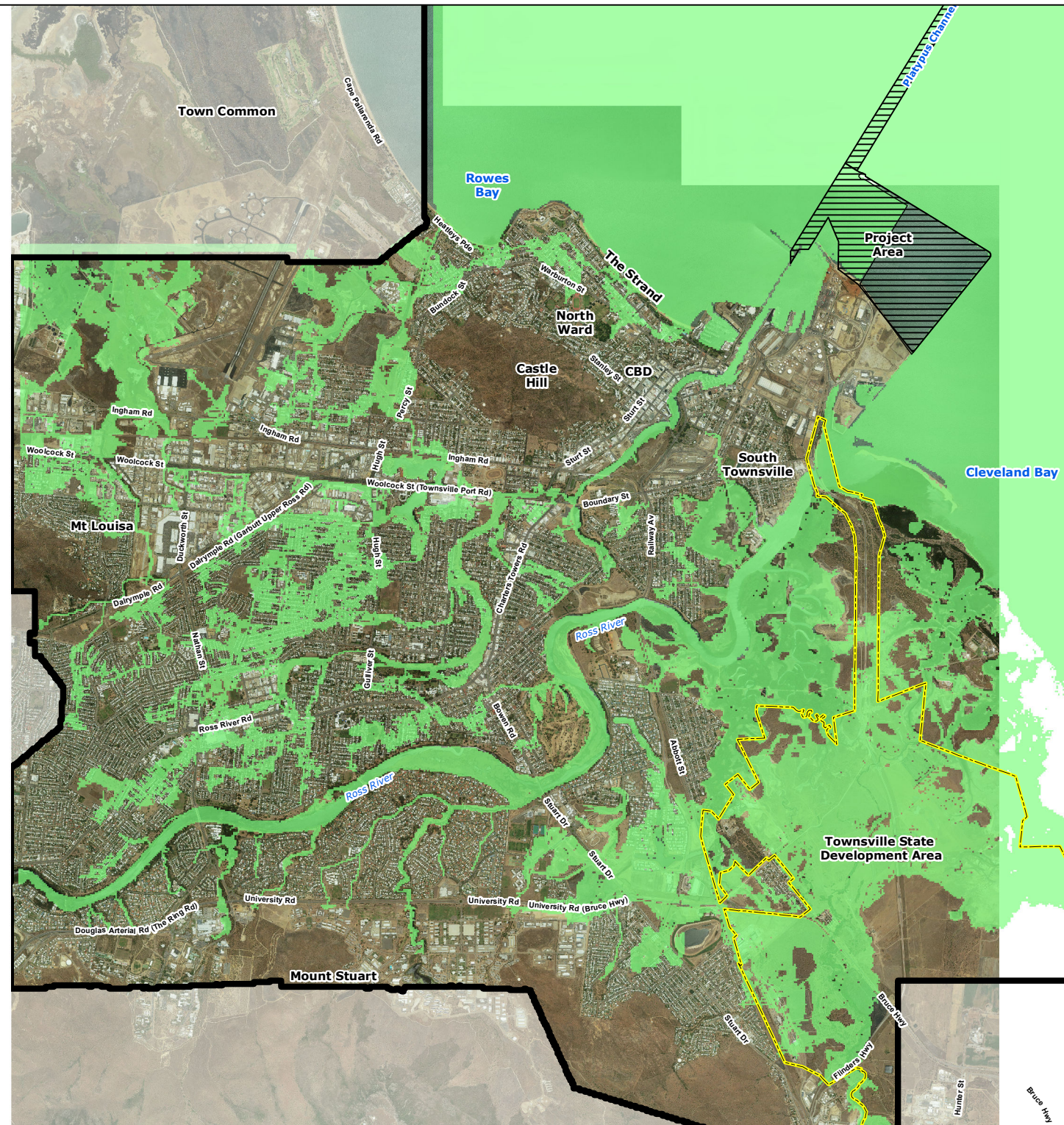
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PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with MHWS
Tailwater Condition

Figure 4.4



Legend

-  Project Area
-  Townsville State Development Area
-  Model Extent
- Afflux (m)
-  Below -1
-  -1 - -0.5
-  -0.5 - -0.25
-  -0.25 - -0.1
-  -0.1 - -0.05
-  -0.05 - -0.01
-  -0.01 - 0.01
-  0.01 - 0.05
-  0.05 - 0.1
-  0.1 - 0.25
-  0.25 - 0.5
-  Above 0.5



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Kilometers

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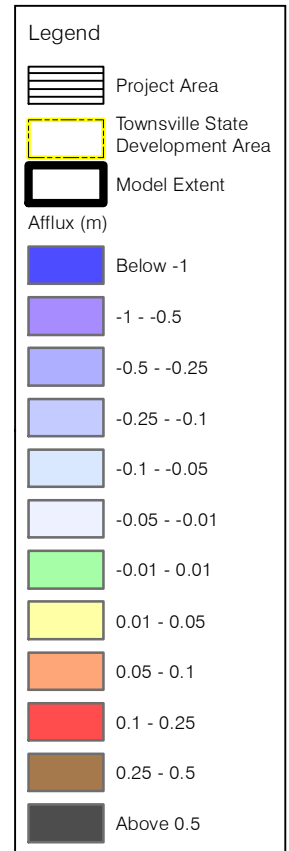
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PORT EXPANSION PROJECT AEIS

Afflux Map for the 50 Year ARI
Rainfall Event with MHWS
Tailwater Condition
Double TSDA Area Runoff Hydrograph

Figure 4.5



Scale: 1:70,000 (when printed at A4)

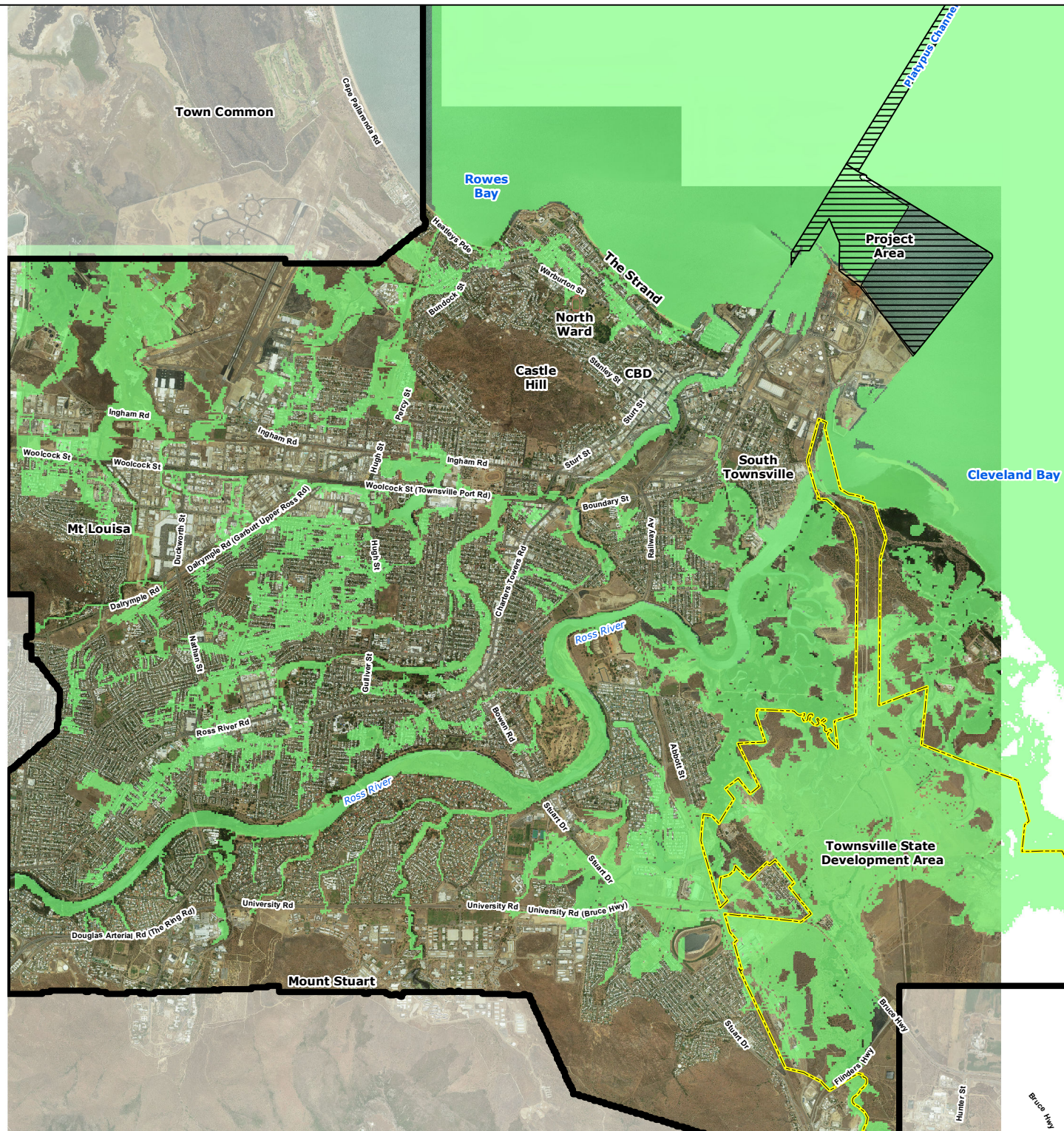


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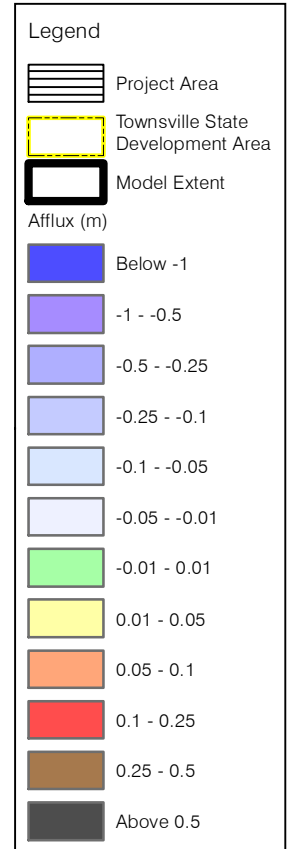
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PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with MHWS
Tailwater Condition
Double TSDA Area Runoff Hydrograph

Figure 4.6



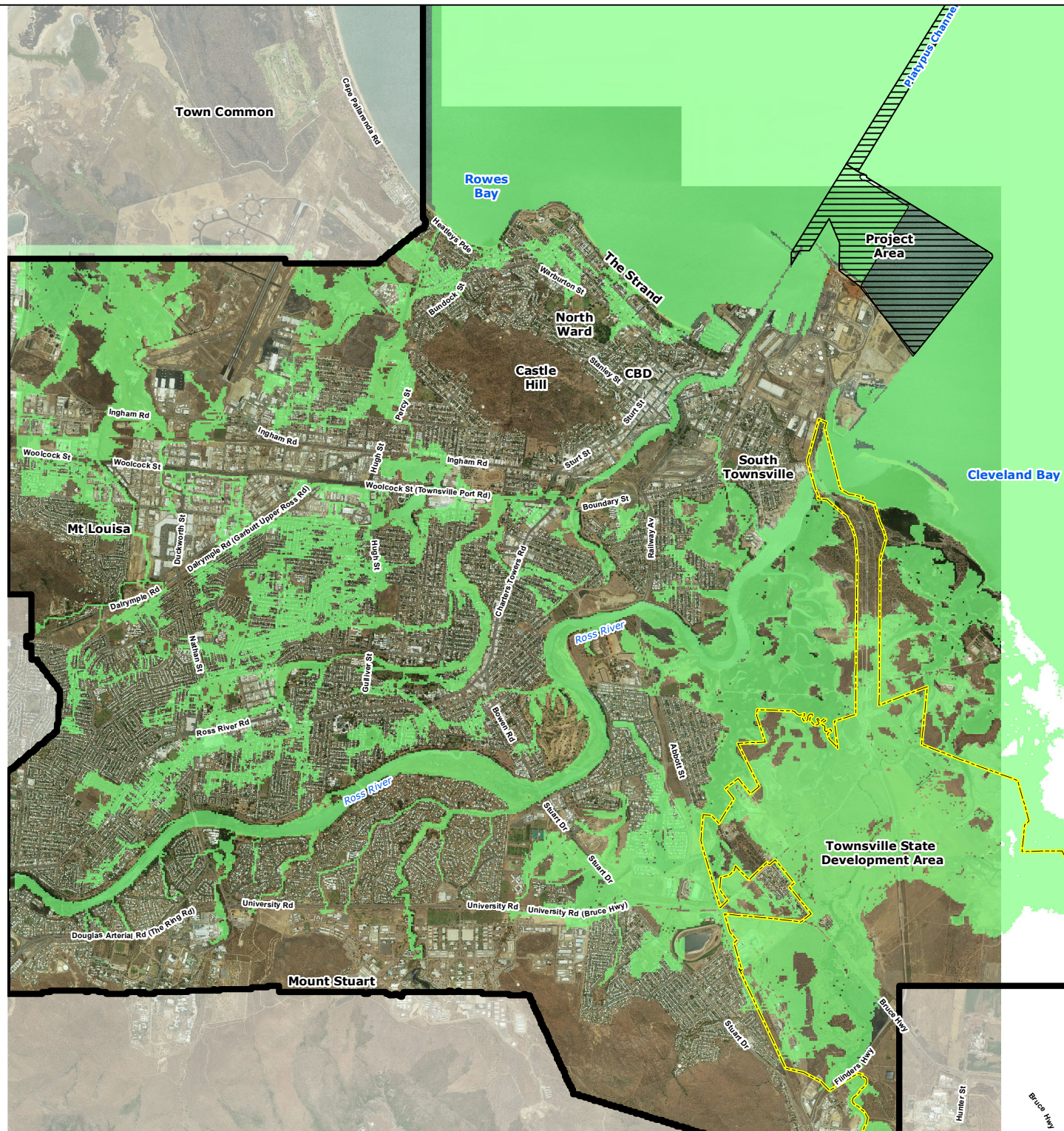
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Kilometers

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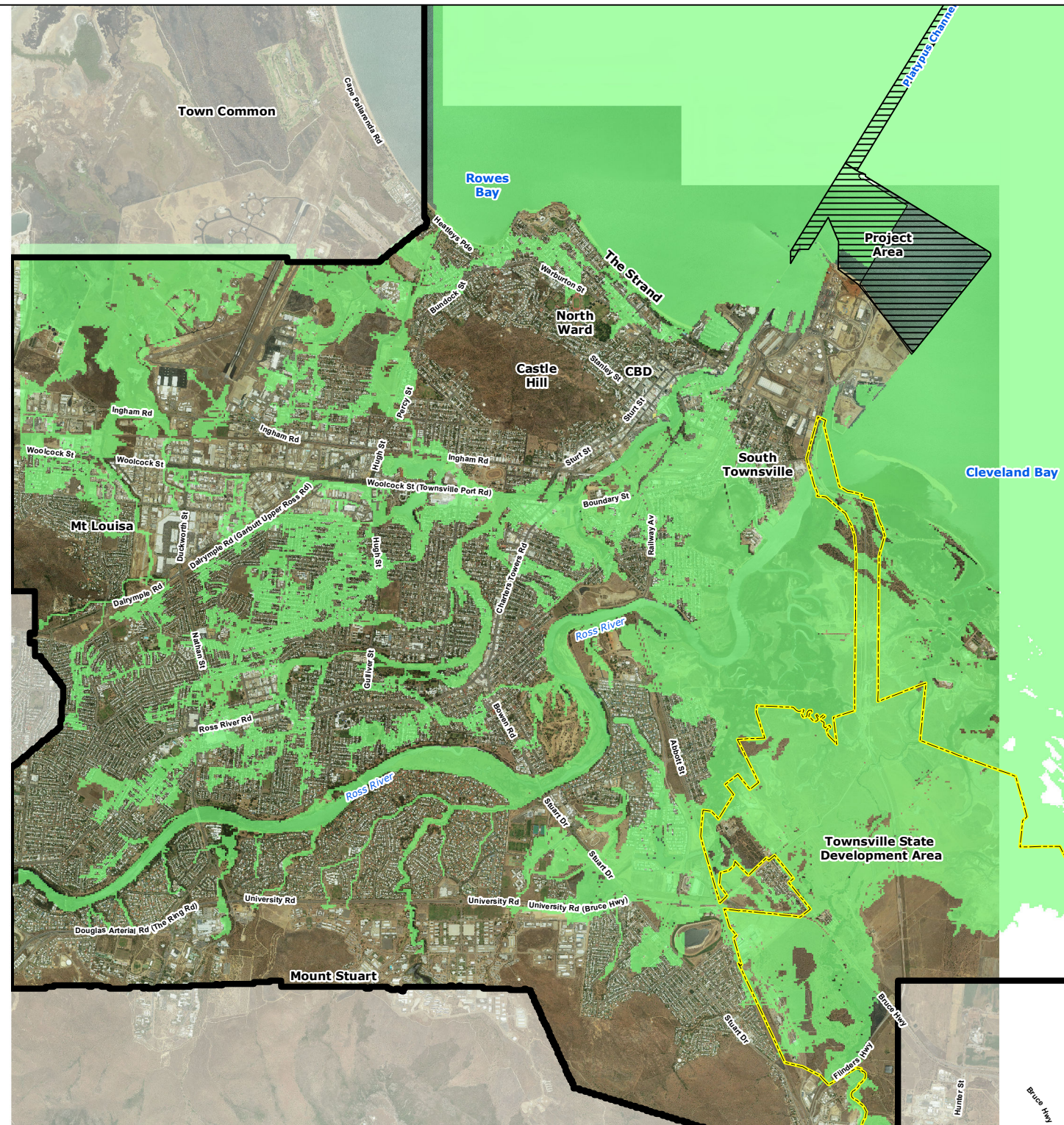
PORT EXPANSION PROJECT AEIS

Afflux Map for the 100 Year ARI
Rainfall Event with 100 Year ARI
Surge Tailwater Condition

Figure 4.7

EXTENT OF MODEL

EXTENT OF MODEL



Legend

-  Project Area
-  Townsville State Development Area
-  Model Extent
- Afflux (m)
-  Below -1
-  -1 - -0.5
-  -0.5 - -0.25
-  -0.25 - -0.1
-  -0.1 - -0.05
-  -0.05 - -0.01
-  -0.01 - 0.01
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4.3.4.2 Mitigation measures

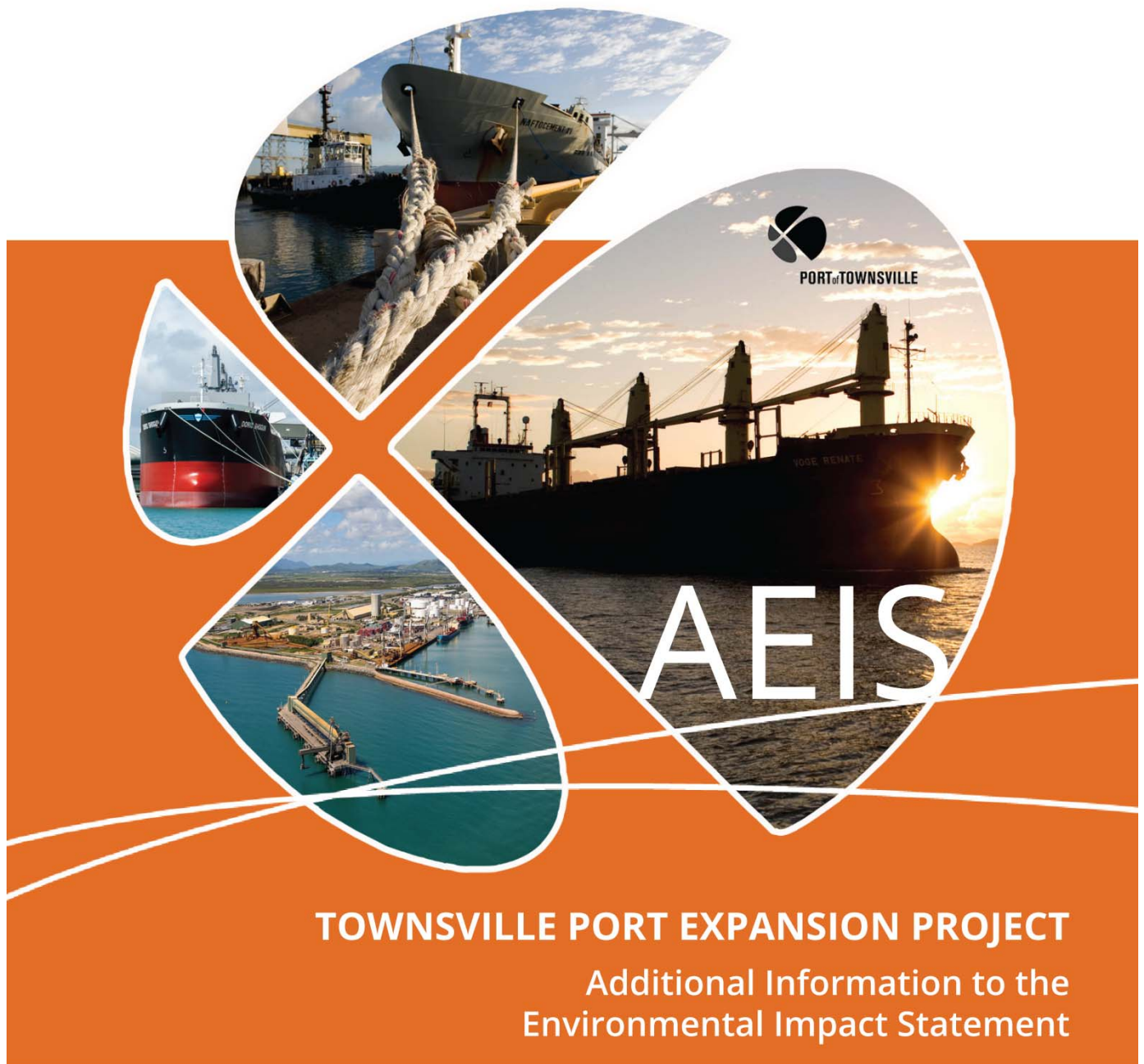
Mitigation measures to reduce the impact on the Project water resources values are provided in Section B.2.5 of the EIS and outlined in the Construction Environmental Management Plan (Appendix B2) and the Operational Environmental Management Plan (Appendix B3).

4.3.5 Summary

Impacts of the Project on water resource values are consistent with Section B.2.5 of the EIS. Mitigation measures provided in Section B.2.5 of the EIS remain current for the revised design.

4.4 Conclusion

The PEP is expected to have a low impact on water resources on site or within the surrounding area during construction and operation. Whilst the Project reclamation footprint has been revised through the design refinement process, this has not altered the outcome of the assessment presented in the EIS. The mitigation measures identified in the EIS remain relevant given the scale and duration of the PEP construction.



SECTION 5

Coastal Processes and Hydrodynamics



5.0 Coastal Processes and Hydrodynamics

5.1 Introduction

The physical processes occurring within the Cleveland Bay study area that are relevant to the Port Expansion Project (PEP) impact assessment include:

- hydrodynamics
 - water levels relating to tides and storm surges
 - wave climate, which comprises:
 - ocean swell
 - Great Barrier Reef lagoon wind waves
 - Cleveland Bay wind waves
 - currents within Cleveland Bay, generated predominantly by tidal and wind forcing
 - freshwater inflows from the Burdekin River, Ross River and Ross Creek
 - tidal exchanges with Ross River and Ross Creek
 - key influencing factors of cyclones and other severe weather events
- marine sedimentation processes
 - fluvial sediment supply to Cleveland Bay, including from the Burdekin River
 - seabed sediment re-suspension, transport and deposition
 - sedimentation of Port areas requiring maintenance dredging
- shoreline sedimentation processes
 - alongshore sand transport at the beach shorelines, driven by wave breaking
 - erosion and accretion along the adjacent beach system.

Through the Environmental Impact Statement (EIS) and Additional Information to the Environmental Impact Statement (AEIS) process, measurement campaigns and numerical modelling have been undertaken to define baseline hydrodynamic and geomorphological conditions within the study area and to assess the PEP impacts on these processes.

This section considers the coastal process and hydrodynamic impact assessment findings in the context of the following:

- comments raised by stakeholders on the EIS submissions
- findings of additional numerical modelling impact assessments carried out subsequent to the release of the EIS
- refinements to the project design.

The key issues raised in the submission process include:

- adequacy of hydrodynamic modelling methodology
- adequacy of dredge plume modelling methodology
- dredge plume loads relative to Burdekin River loads
- resuspension of dredge material from the Dredge Material Placement Area (DMPA)
- dredge plume impacts on Magnetic Island
- safety concerns due to altered hydrodynamics
- assessment of wave refraction and reflection in Cleveland Bay
- assessment of beach erosion due to the reclamation
- impacts of Project on maintenance dredging volumes
- risk of contaminants in maintenance dredging material
- adequacy of storm surge assessment

- assessment of marine placement options
- adequacy of peer review process.

5.2 Response to Submissions

5.2.1 Hydrodynamic modelling

The Great Barrier Reef Marine Park Authority (GBRMPA) raised the matter that the hydrodynamic model did not include forcing terms for oceanic currents which may be significant within the Great Barrier Reef lagoon. The TUFLOW-FV hydrodynamic model has since been upgraded to include these forcing terms, and the revised impact assessment presented in the AEIS does incorporate the effects of these currents.

5.2.2 Dredge plume modelling

234 submissions (includes form letter submissions) queried the validity of the modelling in the EIS since it was not in full accordance with the GBRMPA guidelines "The Use of Hydrodynamic Numerical Modelling for Dredging Projects in the Great Barrier Reef Marine Park" (GBRMPA, 2012). The modelling in the AEIS has been carried out in full accordance with these guidelines, including the use of additional baseline data for model. The numerical modelling in the AEIS goes beyond the requirements of the guidelines by including ambient sediment dynamics, allowing much more accurate simulation of the mixing of dredged and ambient sediment.

5.2.3 Dredge plume loads and DMPA resuspension

25 submissions raised the matter that the modelling of resuspension of dredged material from the DMPA was not undertaken for a long enough following after placement. The AEIS dredging methodology has been changed so that there is no longer any placement of capital dredge material at the DMPA. Therefore this matter has been resolved and is closed out.

Two of these submissions also referred to the high relative impact of disposal of dredging spoil compared to the fluvial sediment loads delivered to the Great Barrier Reef lagoon by the Burdekin River. They noted that the 5.6 million cubic metres of dredged material proposed for sea disposal in the EIS was larger than the 4 million tonnes of sediment delivered to the coastal environment each year by the Burdekin River (Kroon *et al.* 2012). This calculation is discussed in detail in Section 25.0 of the AEIS, and summarised below.

The revised design considered in the AEIS has removed the need for placement of capital dredging material at sea. Therefore this matter is no longer applicable.

5.2.4 Magnetic Island impacts

217 submissions (includes form letter submissions) expressed the view that perceived increases in turbidity along the coast of Magnetic Island is associated with port dredging activities. Three submissions expressed the view that sediment from dredging will settle out onto beaches and cause an increase in muddiness.

Pringle (1989) undertook an extensive review of the history of dredging in Cleveland Bay. In that study, analysis of aerial photography and beach profile measurements showed no clear trend of expansion or contraction of the beaches along the south-east coast of Magnetic Island. It was concluded that it was unlikely that dredge material was being redistributed onto those beaches. Some coral damage was noted in the early 1970s, however this was attributed to the effects of major cyclones Althea and Bronwyn (December 1971 and January 1972). The study did identify likely impacts on seagrass beds in Cleveland Bay from the combined effects of dredging and cyclones (with associated freshwater runoff) in the early 1970s (noting that a different shallow water DMPA south-east of Magnetic Island was in use at that time).

Analysis of aerial photography undertaken as part of the AEIS has revealed that there continues to be no clear trend of expansion or contraction of the beaches on Magnetic Island. The numerical modelling results indicate that accumulation of dredged sediment is unlikely to occur on Magnetic Island beaches due to the tendency for currents and wind waves to generate sufficiently high bed shear stresses to keep fine sediment in suspension.

5.2.5 Hydrodynamic impacts

Three submitters expressed a view that changes in hydrodynamic conditions in Cleveland Bay will cause safety issues for swimmers at patrolled beaches. The AEIS modelling study identified that direct changes to hydrodynamic conditions are restricted to the area immediately adjacent to the proposed reclamation area and therefore there will be no direct effects on swimmer safety due to changes in currents or water levels. Any indirect effects such as increases in turbidity will be minor in the vicinity of patrolled beaches (refer to Section 6.0 of the AEIS).

5.2.6 Wave impacts

Two submitters raised the matter that wave transmission and reflection influenced by the proposed reclamation structure was not analysed for any areas in Cleveland Bay apart from The Strand. The reason for this is that because of the geometry of the reclamation layout and the nature of the wave climate in Cleveland Bay, impacts are only likely in the vicinity of The Strand (though potential impacts to Rowes Bay are also discussed). Long wave swell energy

enters Cleveland Bay from the east or north east, so it is only the blockage of short 'sea' waves from the north or north-west that could cause impacts to the east of the Port. Because of the relatively infrequent occurrence of these waves and the relatively minor potential for sheltering due to the proposed reclamation geometry, the potential for wave-related impacts to the east of the Port is considered to be minor. Additional discussion of this issue is provided in Section 5.3.4.5.

5.2.7 Beach erosion impacts

215 submissions (includes form letter submissions) expressed a view that the construction of the proposed reclamation area will result in beach erosion. Chapter B.3 (Coastal Processes) of the EIS and this section have considered the potential for changes to hydrodynamics and wave conditions in detail and have concluded that any changes to beaches caused by the reclamation will be very minor. Ongoing monitoring of The Strand is proposed as part of the AEIS. It is worth noting that the slight reduction in wave energy reaching The Strand due to the protection afforded by the reclamation will reduce the likelihood and severity of major storm erosion.

5.2.8 Maintenance dredging impacts

One submission raised the matter that the Project will lead to increased maintenance dredging requirements. The AEIS modelling assessment concludes that maintenance dredging requirements will increase by a relatively small percentage (~14%) upon completion of the full port expansion. Details of this assessment can be found in Section 5.3.4.4 below. It should be noted that due to the expansion in port capacity (an additional six berths); the dredging volume per berth will actually be reduced by approximately 36%.

Five submissions expressed a view that an increased proportion of fine sediment in the material depositing in the outer harbour will result in increased concentrations of contaminants. Although the fine sediment may be a higher proportion of the total, the actual quantity of fine sediment accumulating in the outer harbour after construction of the PEP will be reduced. There is no identified mechanism for any increase in contaminant concentrations as a result.

5.2.9 Storm surge assessment

Two submissions raised the matter that a storm surge level of only 0.4 m was assessed in the EIS. Chapter B.3 (Coastal Processes) of the EIS does in fact discuss the occurrence of much larger storm surge events and the EIS also considers the effects of climate change on the Project. The design of the Project included full consideration of these issues.

5.2.10 DMPA options assessment

243 submissions (includes form letter submissions) suggested that further assessment needs to be undertaken on alternative marine disposal locations, including those further offshore in deeper water. As part of the revised AEIS methodology, no capital dredging material is to be placed at sea. Therefore this matter has been resolved and is closed out.

5.2.11 Independent peer review

Four submissions asserted that the numerical modelling was not peer reviewed, or that the peer review was not completed. The numerical modelling work undertaken as part of the EIS was peer reviewed by an independent third party and the peer review report was included in Appendix H2 of the EIS. These peer reviews concluded that the modelling was carried out to a high standard and was well suited to the task of assessing the environmental impacts of the Project. In addition, as part of its assessment process, GBRMPA commissioned Australian Institute of Marine Science (AIMS) to undertake a peer review of the EIS modelling methodology, which *"did not raise significant concerns around the suitability of the predictive model, its forcing and its ability to predict longshore transportation and sediment movement within Cleveland Bay"*.

5.3 Revised Environmental Impact Assessment

5.3.1 Legislation and policy

Since the initial release of the EIS, there have been important legislative changes at both the State and Commonwealth level. A new regulation under the Great Barrier Reef Marine Park Regulations 1983 (Cth) was introduced on 2 June 2015, which prevents the placement of capital dredge material in the Marine Park. Specifically, the regulation prevents GBRMPA from granting permission for placement of capital dredge material in the Marine Park.

The Sustainable Ports Development Act also prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

5.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. The design of the Port Expansion Project has been revised in response to submissions and in order to reduce the overall environmental impact and to eliminate the disposal of capital material at sea.

The proposed reclamation is now larger, extending further to the east in the vicinity of the Ross River channel. The hydrodynamic impact assessment has been revised to include consideration of the effects of this refinement (refer to Section 5.3.4.1).

The expanded reclamation area will allow all capital dredging material to be taken onshore rather than placed at sea. Only maintenance dredging material will continue to be placed at sea as part of the current proposal. As a result, the total amount of dredged sediment available for long term resuspension has been substantially reduced.

The revised design includes widening the Platypus Channel on its western side and widening the Sea Channel on its eastern side. It also includes a reduction in the proposed deepening of the channels (to -12.8 m LAT rather than -13.7 m LAT in the EIS). By reducing the depth of the channel in the Ultimate Case design, the need to extend the channel into the Great Barrier Reef Marine Park General Use Zone has been avoided. The impacts associated with widening the channels have been fully assessed as part of the AEIS.

The proposed development will take place gradually in stages, reducing the intensity of the development and its associated environmental impacts. A smaller dredging plant is now proposed, which further reduces the potential impact due to suspended sediment plumes and dredged sediment deposition.

As a result of the design refinements detailed above, the following coastal process impacting processes have been reassessed as part of the AEIS:

- hydrodynamic impacts
- wave impacts due to channel widening
- shoreline impacts due to reclamation expansion
- sediment transport and siltation impacts
- dredge plume impacts.

5.3.3 Supporting studies

The AEIS includes the Hydrodynamic and Advection-Dispersion Modelling Technical Report which is attached as Appendix A2. This report provides details of the upgraded model boundary conditions, model calibration and modelling methodology for the revised design.

5.3.4 Revised impact assessment

5.3.4.1 Hydrodynamic Impacts

Various bathymetric configurations and reclamation phases were considered in the hydrodynamic modelling scenarios based on the proposed staging of the development. The three scenarios assessed included a Base Case (representative of conditions at the time of development of the port expansion), an Interim Case (at the conclusion of Stage 1 development), and an Ultimate Case, as described below.

1. Base Case. This included existing Port geometry plus widening of the Platypus Channel near the harbour entrance.
2. Interim Case. This included the widened channel following Stage 1 dredging, the dredging of Berth 12, and the interim reclamation area proposed as part of Stage 1.
3. Ultimate Case. This included full dredging of the constructed harbour, the final reclamation configuration and deepening of the approach channel to -12.8 m LAT.

Model layouts for these scenarios are shown in Figure 5.1 to Figure 5.3.

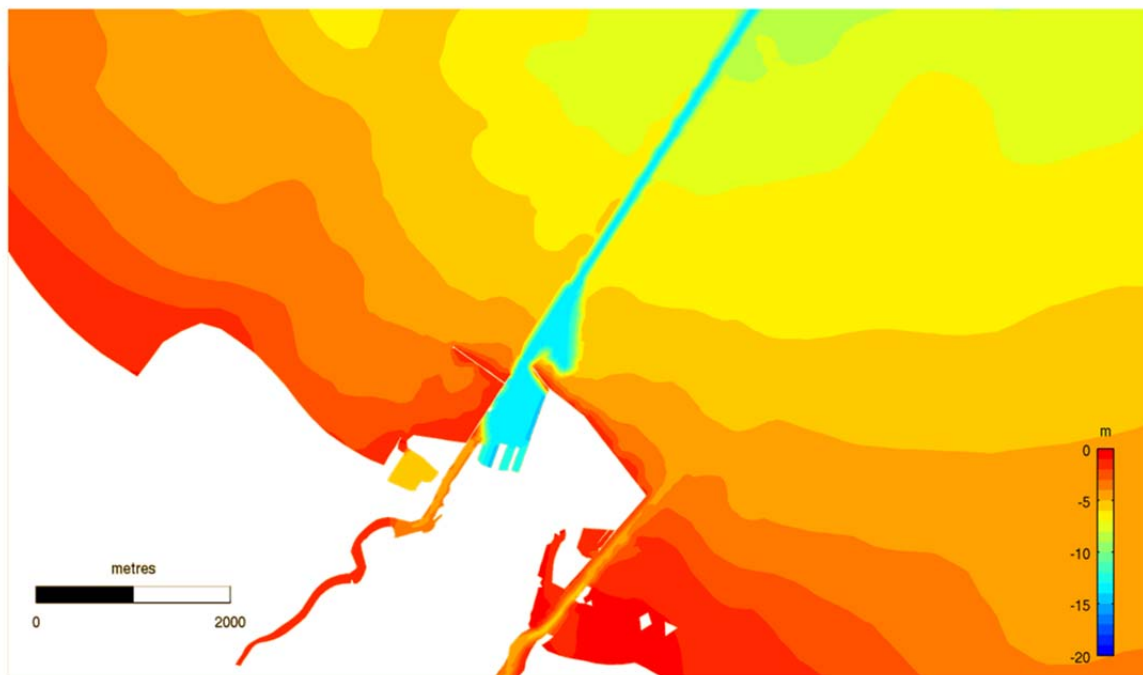


Figure 5.1 Base Case Model Bathymetry

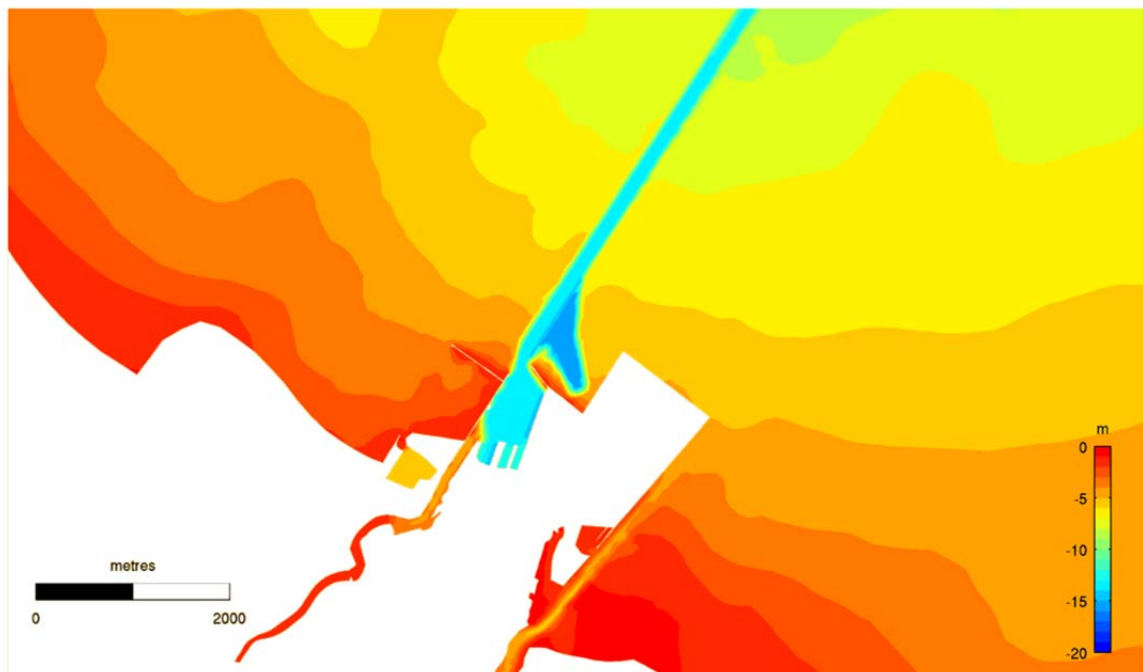


Figure 5.2 Interim Case Model Bathymetry

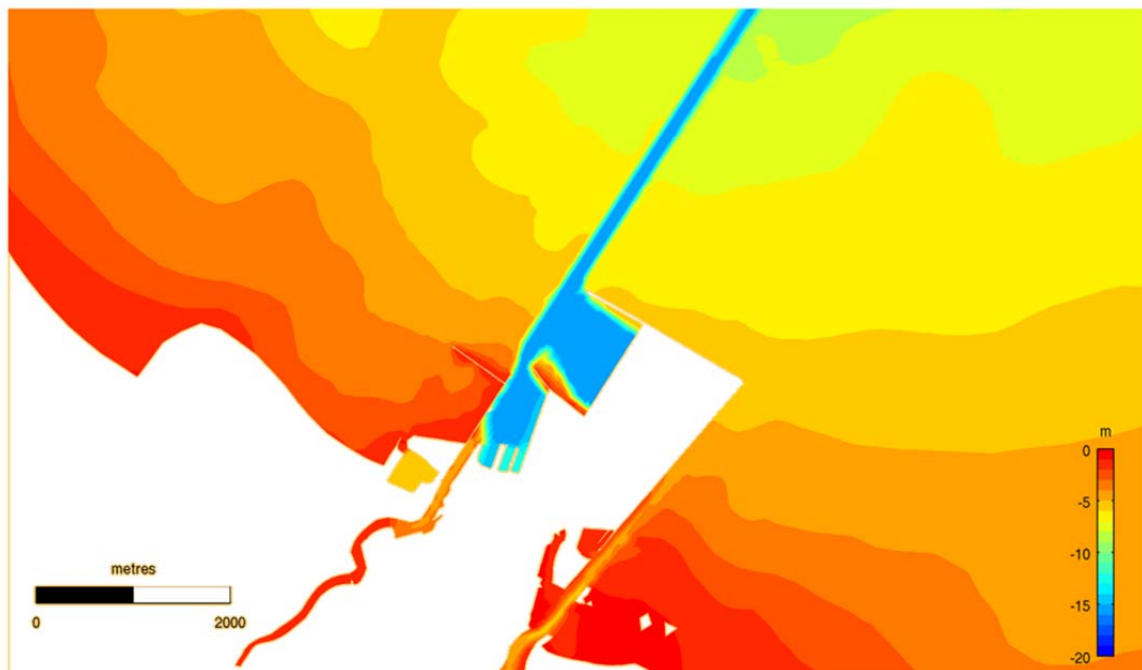


Figure 5.3 Ultimate Case Model Bathymetry

For hydrodynamic impact assessment purposes the model was run from 1/01/2013 to 1/02/2013, a period which included predominantly easterly winds and a period of significantly large spring tides. Hydrodynamic impacts were assessed by comparing the Interim Case and Ultimate Case with the Base Case.

Results are presented below in terms of hydrodynamic impact at specific times between the Base Case and Interim configuration, and the Base Case and Ultimate configuration. Figure 5.4 illustrates the tide level near the port for the simulation and the times at which the typical current patterns and impacts have been extracted. These tidal conditions correspond to peak ebb and flood flows during a period with a large spring tidal range.

Spatial plots of the changes in depth-averaged velocity magnitudes between the Base Case and Interim Case are shown in Figure 5.5 and Figure 5.6, and between the Base Case and Ultimate Case in Figure 5.7 and Figure 5.8. Further context is provided by the base case and developed case current figures in Appendix A2.

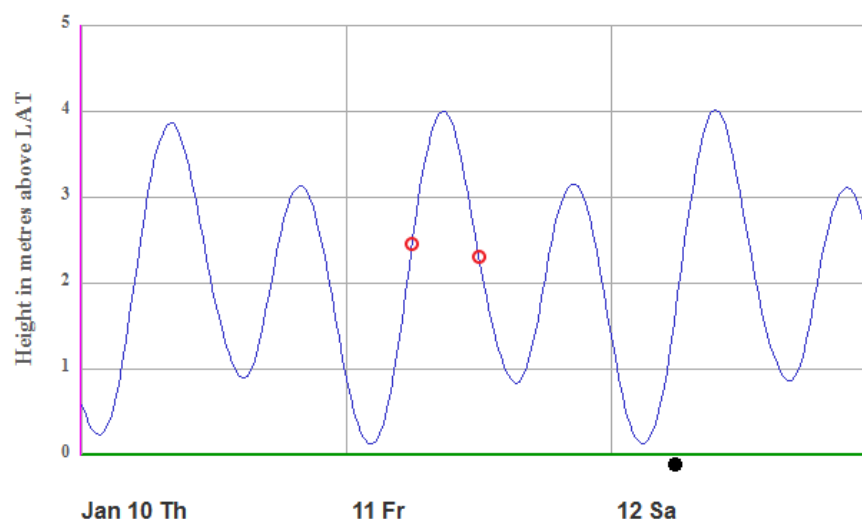


Figure 5.4 Hydrodynamic Impact Assessment Tide Levels Flood: 06:00 11/01/2013 Ebb: 12:00 11/01/2013

Figure 5.5 illustrates the difference in velocity in the Interim Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north, west and south of the interim reclamation area are reduced by up to 0.15 m/s. There are increases in velocity of up to 0.2 m/s relative to the Base Case to the east of the interim reclamation area due to the diversion of tidal flows around the reclamation area. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Townsville Marine Precinct.

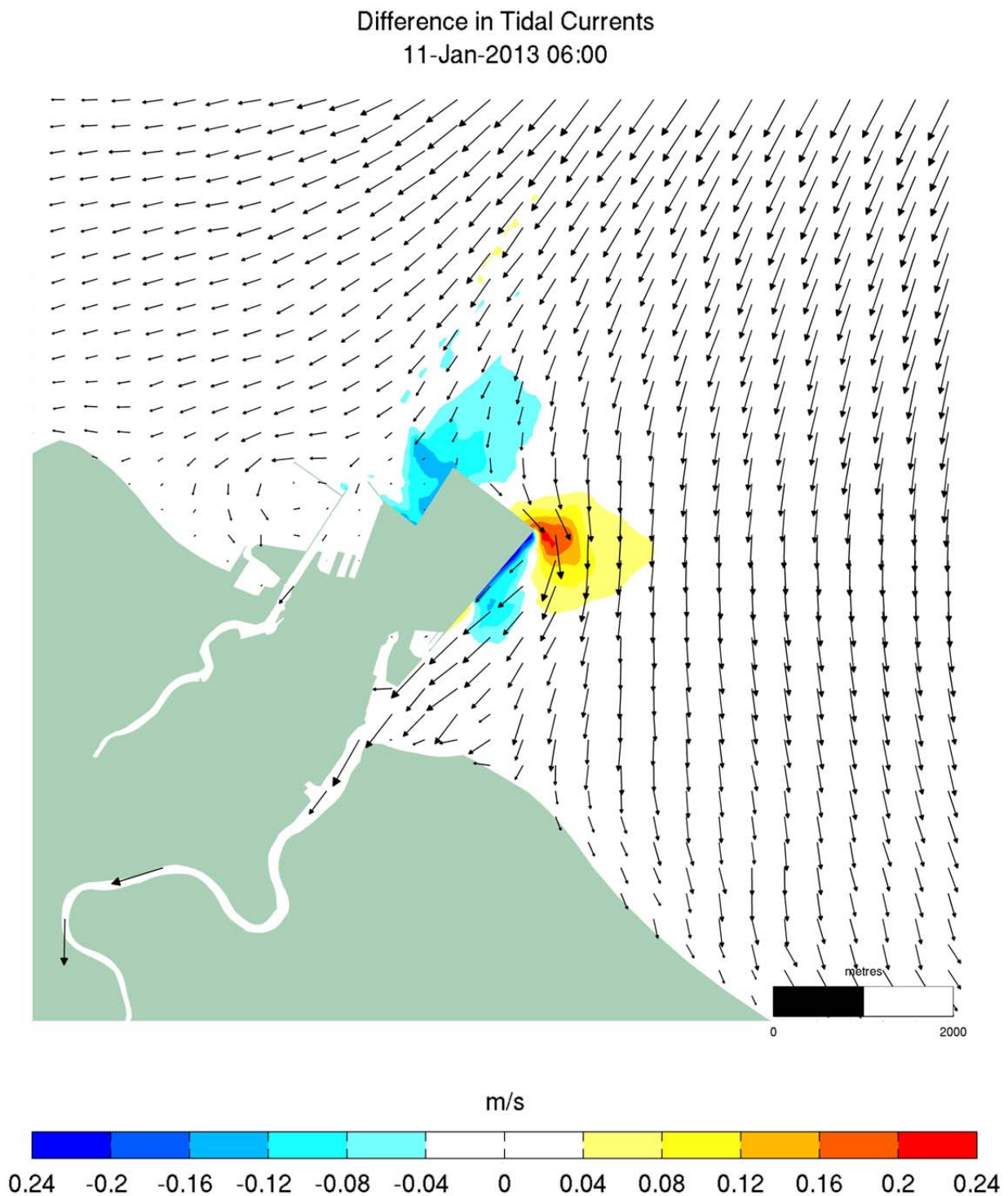


Figure 5.5 Difference Between Interim Case and Base Case during Flooding Tide

Figure 5.6 illustrates the difference in velocity in the Interim Case compared to the Base Case during an ebb tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the west of the interim reclamation are up to 0.07 m/s lower in the Interim Case than in the Base Case. There are increases in velocity of up to 0.03 m/s relative to the Base Case to the east of the proposed interim reclamation due to the diversion of tidal flows around the reclamation area.

Figure 5.7 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-eastern revetment are reduced by up to 0.15 m/s. Velocities within the new port expansion harbour

area are up to 0.2 m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.25 m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area. The Ross River approach channel will continue to experience flood tide cross-currents at the tip of the reclamation, which will be shifted further offshore under the Ultimate Case but will remain of a similar magnitude to the Base Case. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Marine Precinct.

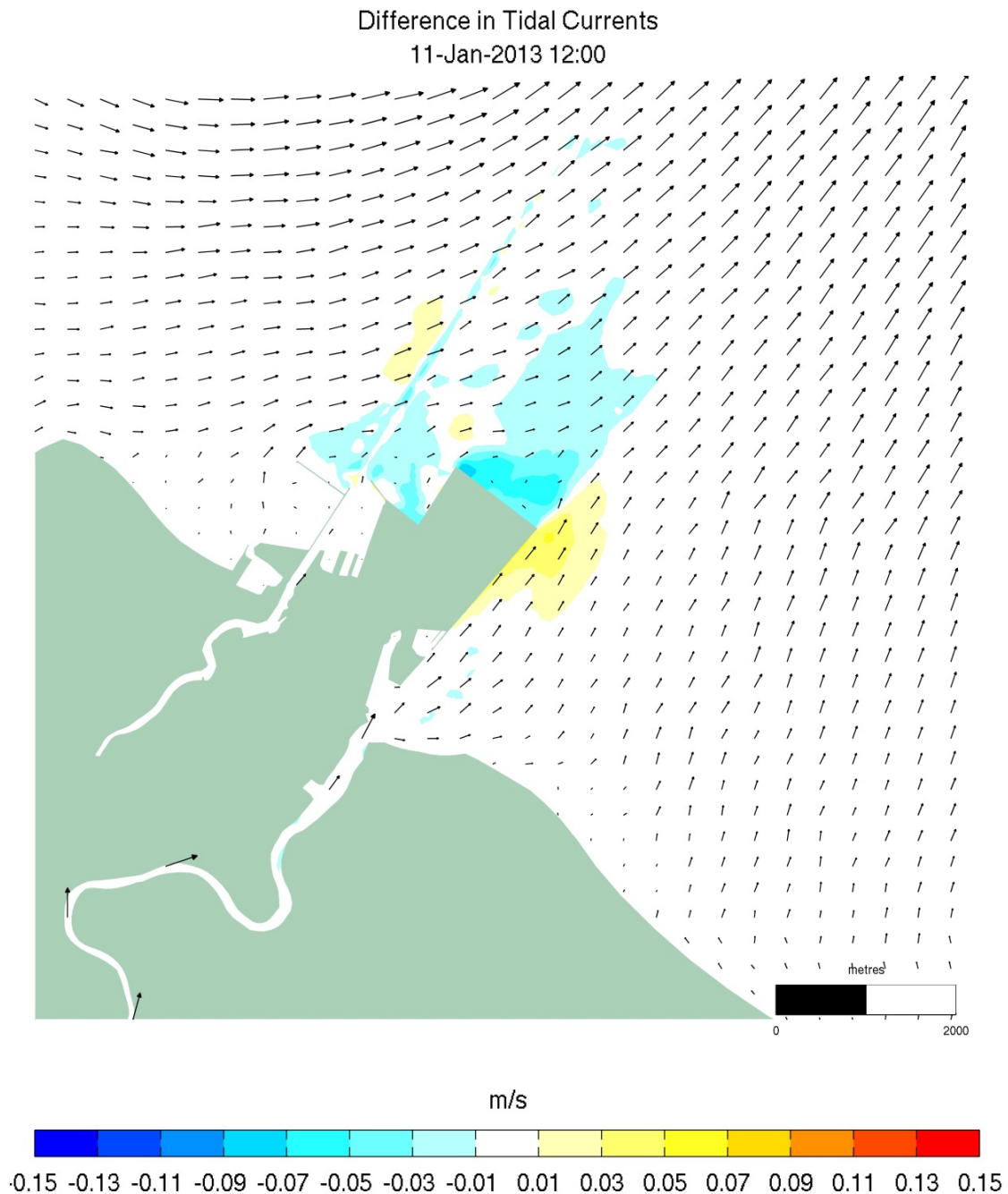


Figure 5.6 Difference Between Interim Case and Base Case during Ebb Tide

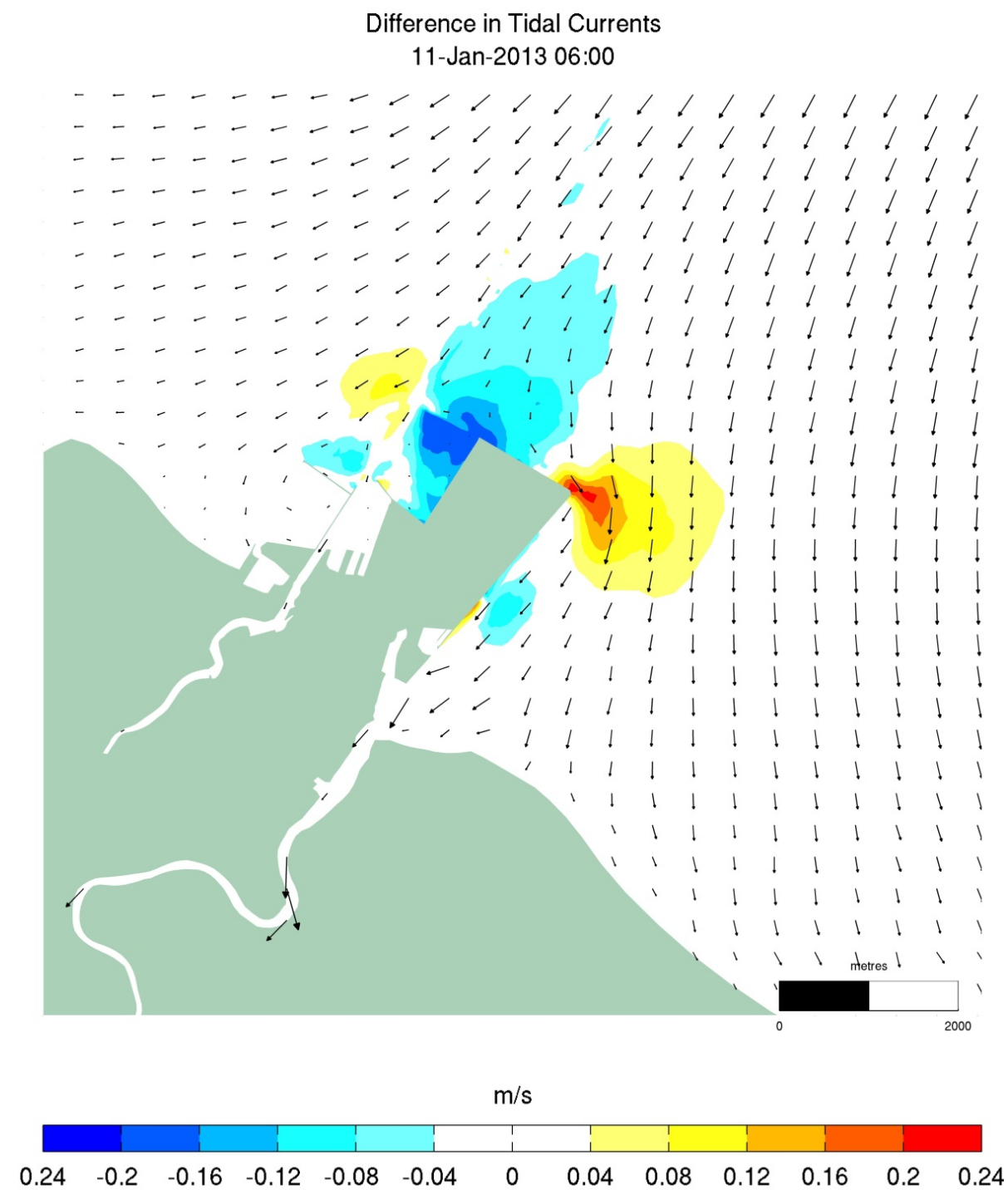


Figure 5.7 Difference Between Ultimate Case and Base Case during Flooding Tide

Figure 5.8 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during an ebb tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-east breakwater are up to 0.07 m/s lower in the Ultimate Case than in the Base Case. Velocities within the new port expansion harbour area are up to 0.1 m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.05 m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area.

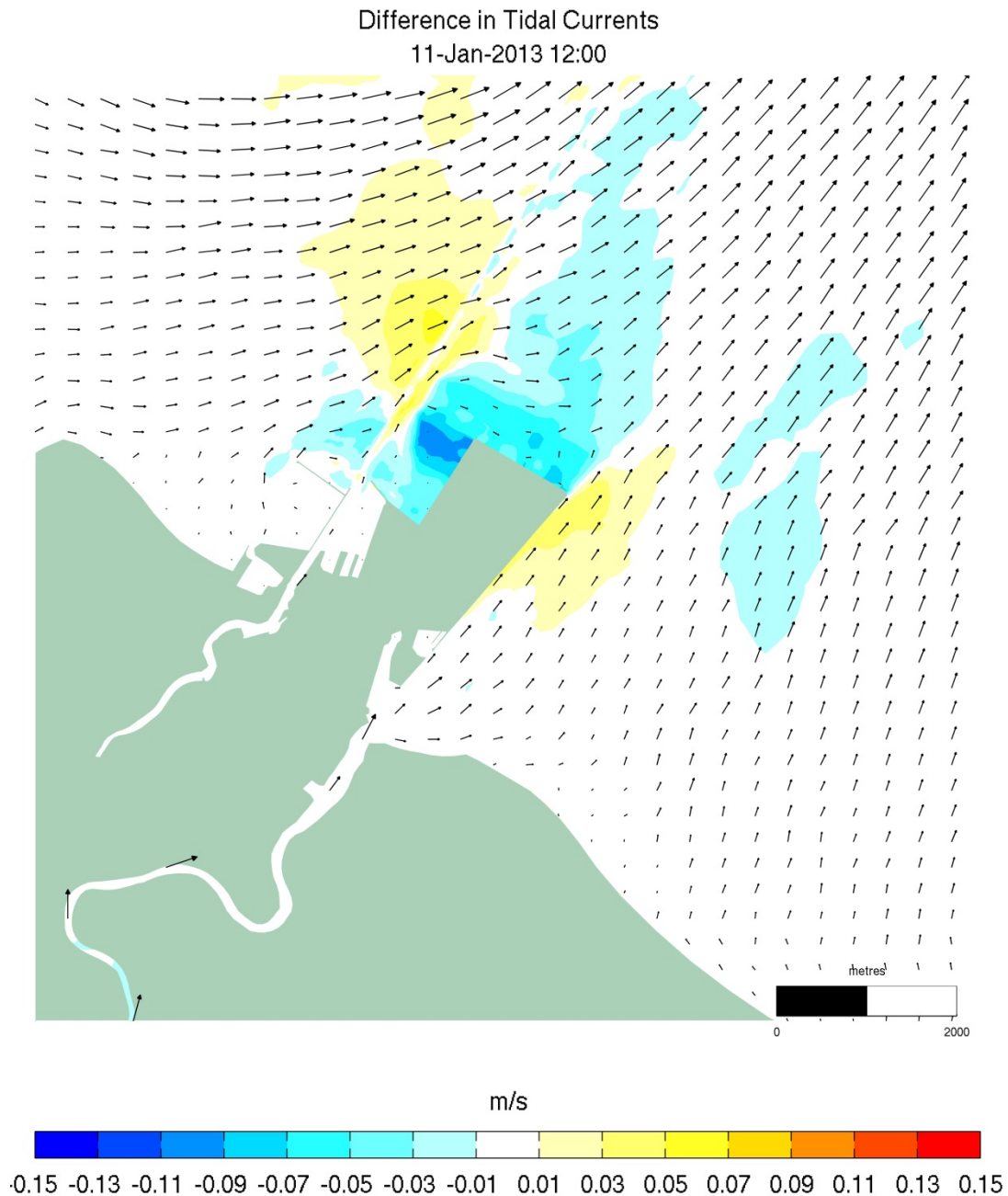


Figure 5.8 Difference Between Ultimate Case and Base Case during Ebb Tide

Water level percentiles derived from the model at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case are shown in Figure 5.9, which shows that no significant change in water levels is predicted for the ultimate port expansion development case relative to the Base Case. The model results indicate that no water level impacts will occur at any location due to the port expansion development.

The velocity magnitude time series near the reclamation footprint for the Ultimate Case is compared to the Base Case in Figure 5.10. The two locations that are compared are shown as Point 1 and Point 2 in the top panel of Figure 5.10. This provides a direct comparison between the expected currents adjacent to the existing and future breakwaters. It is noted that a significant increase in spring tide velocities is expected in the Ultimate Case compared to velocities adjacent to the existing breakwater. In general the current velocity changes are unlikely to create any additional problems for ship navigation.

The hydrodynamic impacts of the proposed port expansion are not large in magnitude or extent, being confined to changes in velocity magnitude in the immediate vicinity of the proposed breakwaters and reclamation area. Water levels at all locations in the vicinity of the proposed works will not change as a result of the Project.

Velocity magnitudes decrease by up to 0.2 m/s adjacent to the new breakwater structures and within the port expansion harbour area on both the flood and ebb tides in the Ultimate Case. There are increases in velocities of up to 0.25 m/s in the Ultimate Case in some areas as shown in Figure 5.7. No significant change in tidal current velocities is predicted in the existing Inner Harbour in the Ultimate Case port expansion scenarios considered in these assessments.

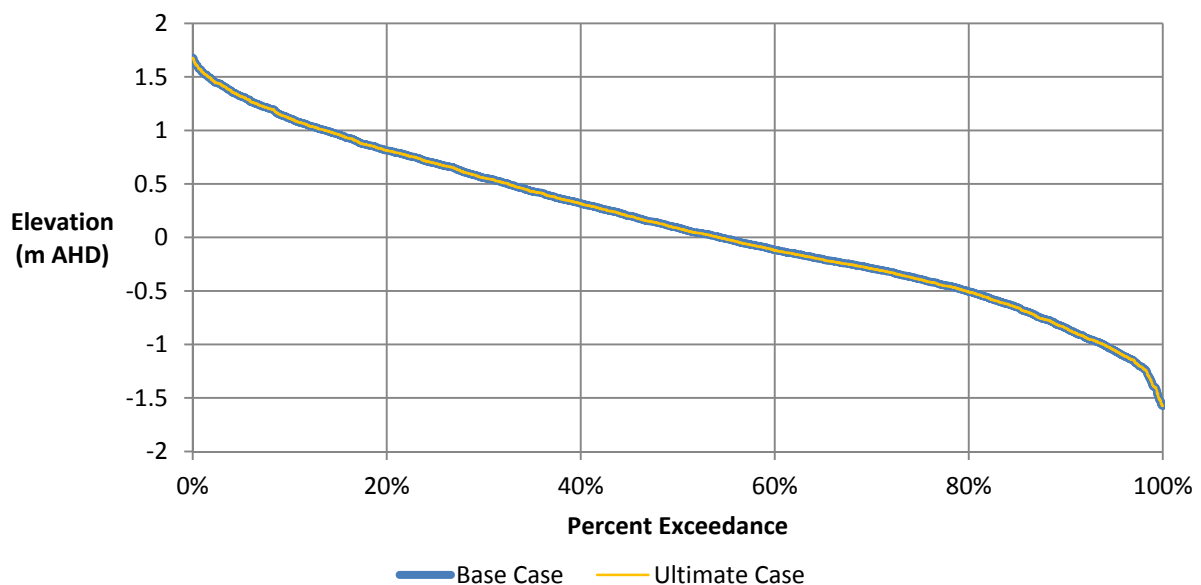


Figure 5.9 Water Level Exceedance Plot at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case

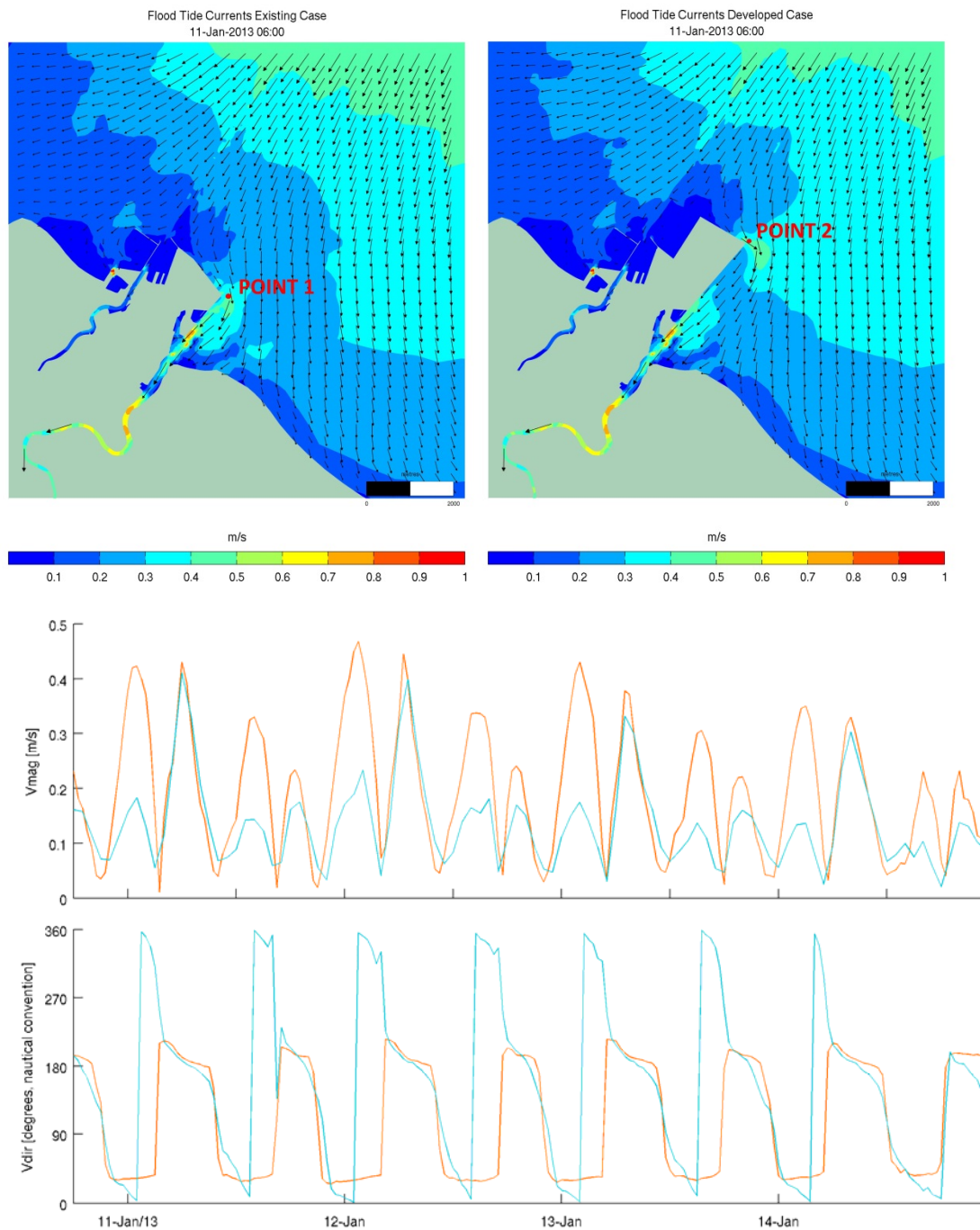


Figure 5.10 Velocity Magnitude Time Series at Point 1 in the Base Case and Point 2 in the Ultimate Case (Base Case in Red, Ultimate Case in Blue)

5.3.4.2 Wave Impacts

The effects of the PEP on the wave climate in Cleveland Bay were investigated in detail in the EIS. The design refinement introduced as part of the AEIS includes widening of the channel, so a new assessment was undertaken to determine if additional changes to the wave climate could be expected as a result of the widened channel. It was determined that the widening of the Platypus and Sea Channels will not affect the transmission or reflection of waves in Cleveland Bay (AECOM 2014), and therefore the conclusions of the EIS remain valid and appropriate for the AEIS. Refer to Appendix A2 Hydrodynamic and Advection-Dispersion Modelling Technical Report for the detailed wave impact assessment.

5.3.4.3 Sediment Transport Impacts

The proposed PEP will alter the bathymetry and hydrodynamics in the vicinity of the Port such that the local sedimentation processes will be altered to a significant extent. Impacts on sedimentation processes and the marine seabed morphology relate predominantly to the following:

- effects that the reclamation and breakwater structures will have on both waves and currents and associated sediment re-suspension, transport and deposition
- effects that deepening and widening the channels will have on sediment deposition in those dredged areas of the marine seabed
- effects that alterations of the harbour basin configuration and depths have on hydrodynamics and deposition there.

This section considers impacts of the revised PEP on siltation processes associated with the harbour and channels and at adjoining nearshore seabed areas (e.g. adjacent to The Strand).

In the context of determining impacts on sedimentation processes, including siltation rates in the harbour and shipping channels, the TUFLOW FV model was used to simulate the re-suspension of fine material due to the action of waves and currents for the Base Case and Ultimate Case to determine the potential impact of the Project on bed morphology and siltation rates. The model was run for the period 01/01/2013 to 01/06/2013 for the purposes of the impact assessment.

Residual sediment transport rates were calculated by averaging results over the simulation period, ensuring that the start and end points both coincided with similar high tide levels. It is acknowledged that the long-term residual may differ from the values derived over this limited time period, however the selected period was adopted based on being reasonably representative of prevailing climatic conditions and should not therefore be grossly different from the longer term residual.

The Base Case residual suspended sediment transport patterns are shown in Figure 5.11, which indicates a net transport in the north-west direction with highest transport rates in the shallower inshore parts of Cleveland Bay. A concentrated region of higher transport is shown immediately offshore of the existing port and the partial interception of the suspended sediment flux by the dredged approach channel can be inferred by the evident reduction in transport from updrift to downdrift of this feature.

The Ultimate Case residual sediment transport and corresponding impact (difference from Base Case) are shown in Figure 5.12 and Figure 5.13 respectively. It can be seen that outer harbour extension will redirect the residual suspended sediment drift around the reclamation. A small net reduction in fine sediment drift from east to west of the port may occur due to the combined interception effect of the outer harbour extension and the wider and deeper Platypus channel.

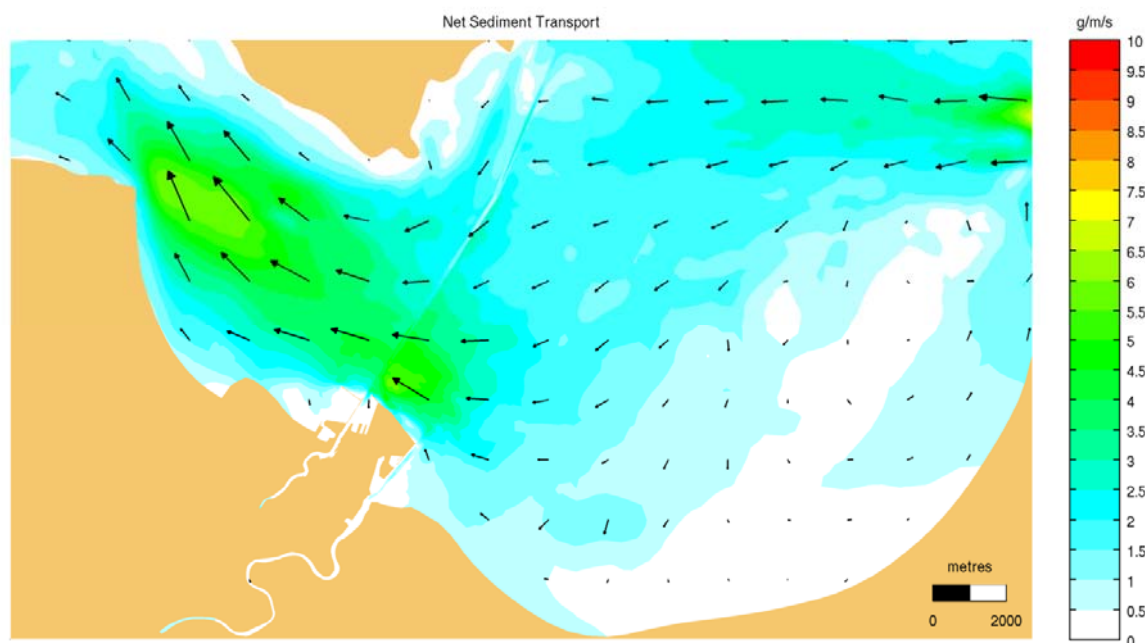


Figure 5.11 Modelled Base Case Residual Suspended Sediment Transport

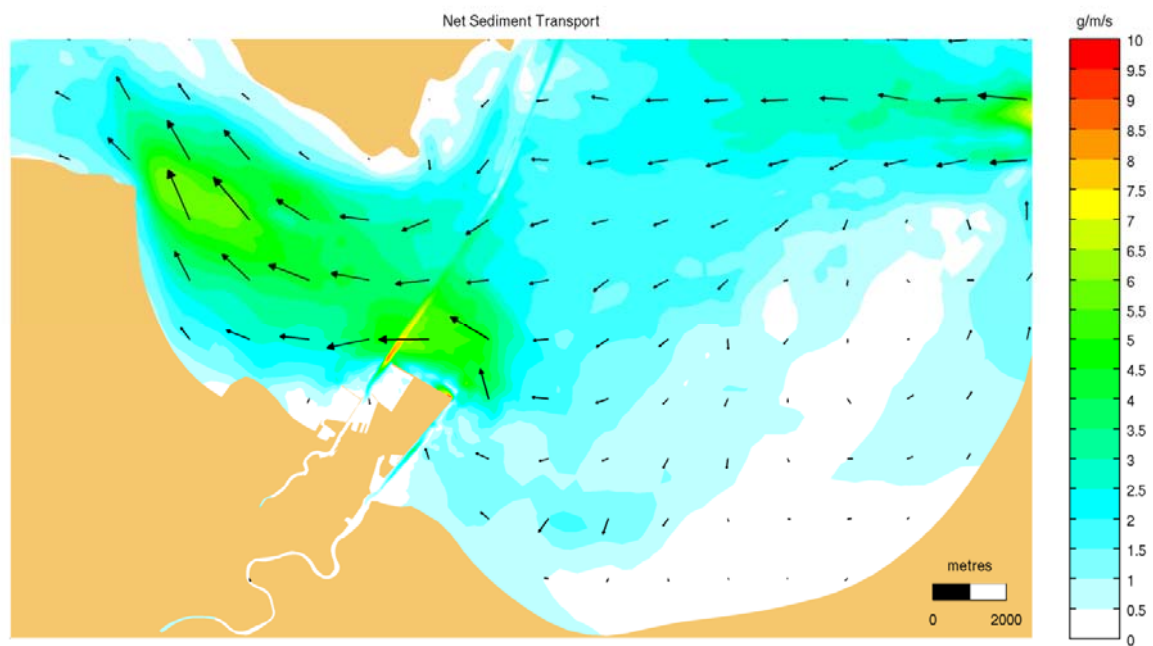


Figure 5.12 Modelled Ultimate Case Residual Suspended Sediment Transport

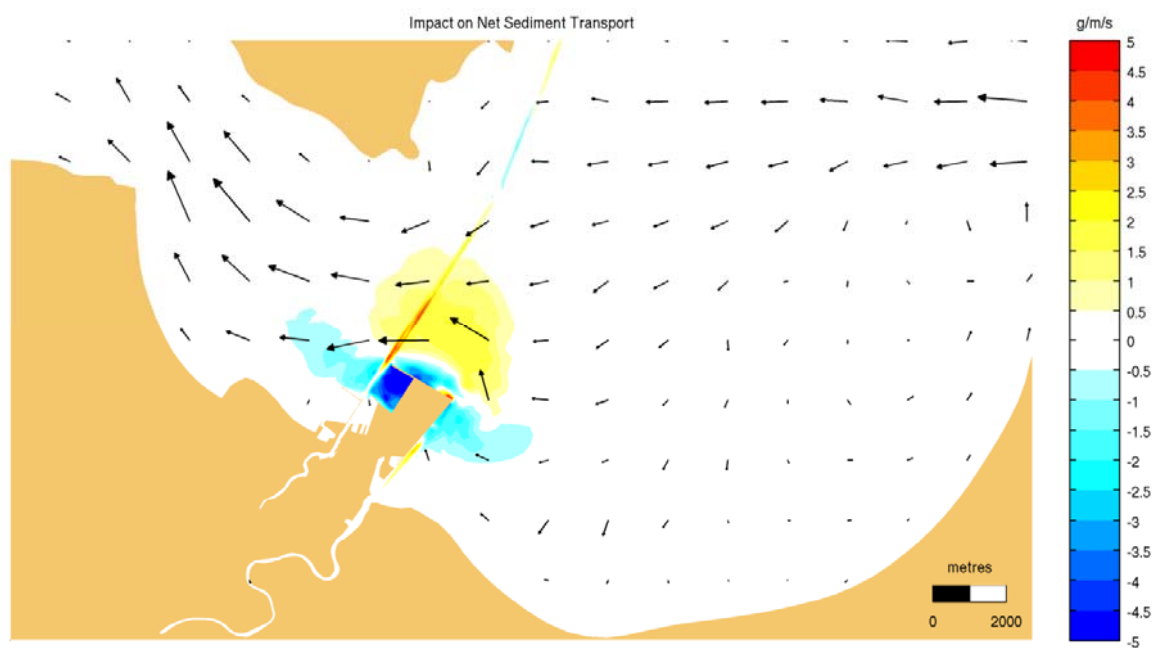


Figure 5.13 Modelled Ultimate Case Residual Suspended Sediment Transport Impacts

5.3.4.4 Siltation Impacts

The modelled Base Case siltation rate in terms of bed level change in metres per year is shown in Figure 5.14 and the modelled annual siltation volumes are summarised in Table 5.1. The modelled base case sedimentation rates were found to be in reasonable agreement with annual average historic dredging volumes for the existing dredged areas (POTL, 2013).



Figure 5.14 Modelled Base Case Siltation Rate (m/year)

5.3.4.4.1 Interim Case (Post Stage 1)

The distribution of modelled Interim Case siltation rate is shown in Figure 5.15 and the modelled annual siltation volumes for the Interim Case are summarised in Table 5.1. The changes to siltation rates due to the interim port expansion are shown in Figure 5.16. The model indicates a reduction in siltation rates within the inner harbour, and an increase in newly dredged areas. The model indicates an increase in siltation in most of the Platypus and Sea Channels.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 36%. The Interim Case reclamation acts to partly reduce the magnitude of suspended sediment transport into the inner harbour dredged areas.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 20%, and by 13% in the Sea Channel. This is mainly due to the increased channel width. Sedimentation volumes within the outer harbour are predicted to increase by around 20% relative to the Base Case, primarily due to the Berth 12 dredging.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined may be increased by around 70,000 m³ per year (about 17% relative to the present situation). This is primarily due to the widening of the Platypus and Sea Channels.

Table 5.1 Modelled Annual Sedimentation Volumes – Interim Case (m³)

Dredge Area	Base Case	Interim Case	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	18,000	- 36%
Platypus Channel	163,000	195,000	+ 20%
Sea Channel	40,000	45,000	+ 13%
Outer Harbour	128,000	153,000	+ 20%
Ross River	33,000	50,000	+ 52%
Total (modelled)	396,000	465,000	+ 17%

**Figure 5.15** Modelled Interim Case Siltation Rate (m/year)

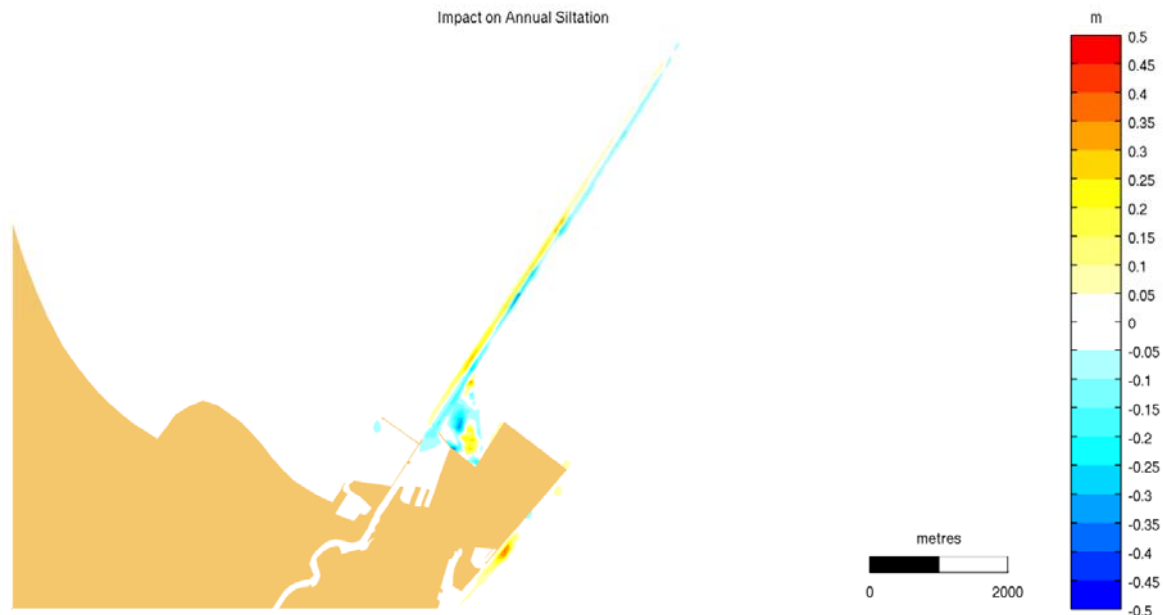


Figure 5.16 Difference in Siltation Rate between the Interim Case and Base Case (m/year)

5.3.4.4.2 Ultimate Case (Post Stage 3)

The distribution of modelled Ultimate Case siltation depths is shown in Figure 5.17 and the modelled annual siltation volumes for the Ultimate Case are summarised in Table 5.2. The change in siltation rates due to the port expansion are shown in Figure 5.18. The model results indicate a reduction in siltation rates within the new enclosed outer harbour area, and an increase in siltation in the Platypus Channel and Sea Channel.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 21% and sedimentation volumes within the outer harbour are predicted to decrease by around 15% relative to the Base Case. The Ultimate Case reclamation and breakwaters act to significantly reduce the efficiency of suspended sediment transport into the outer and inner harbour dredged areas. It should be noted that the Ultimate Case assessments have been undertaken without a western breakwater in place. A modest decrease in predicted sedimentation will most likely occur with the addition of a western breakwater.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 26%, and within the Sea Channel it is predicted to increase by around 65%. This is due to the increased channel width and depth as part of the ultimate development.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined will increase by around 14% relative to the present situation. Although there will be a reduced suspended sediment net transport flux around the expanded port, this is more than offset by increased siltation in the widened and deepened channel. The material depositing in the new enclosed outer harbour area will be entirely very fine silts without the minor component of coarser silt/sand that deposits in the existing dredged basin and berth areas exposed at the present time.

Table 5.2 Modelled Annual Sedimentation Volumes – Ultimate Case (m³)

Dredge Area	Base Case	Ultimate Case	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	22,000	- 21%
Platypus Channel	163,000	205,000	+ 26%
Sea Channel	40,000	66,000	+ 65%
Outer Harbour	128,000	109,000	- 15%
Ross River	33,000	46,000	+ 39%
Total (modelled)	396,000	452,000	+ 14%

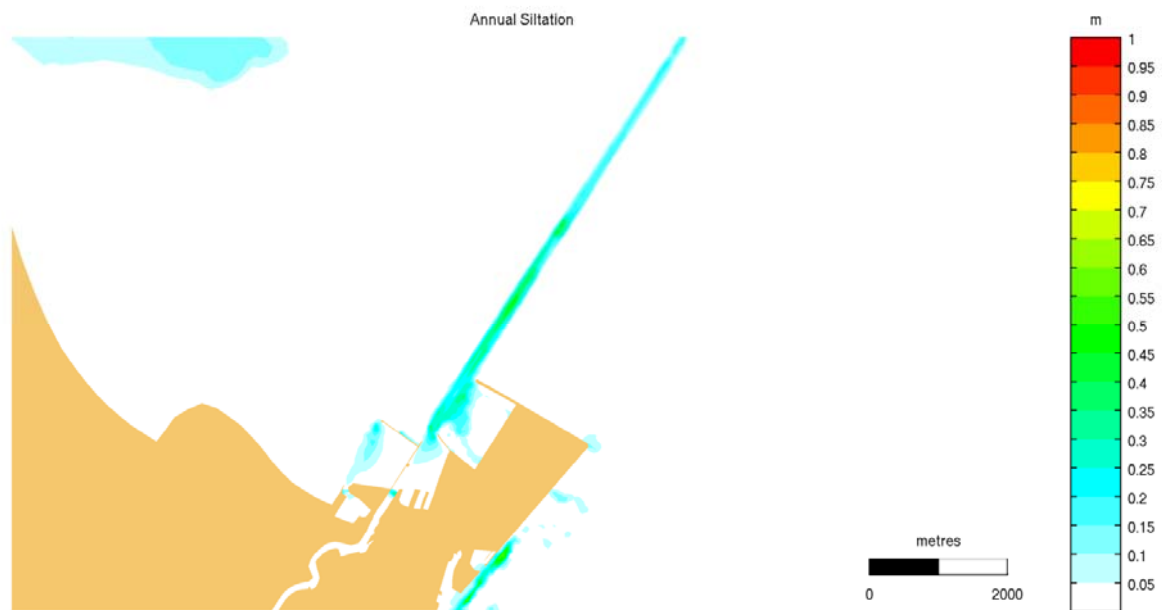


Figure 5.17 Modelled Ultimate Case Siltation Rate (m/year)

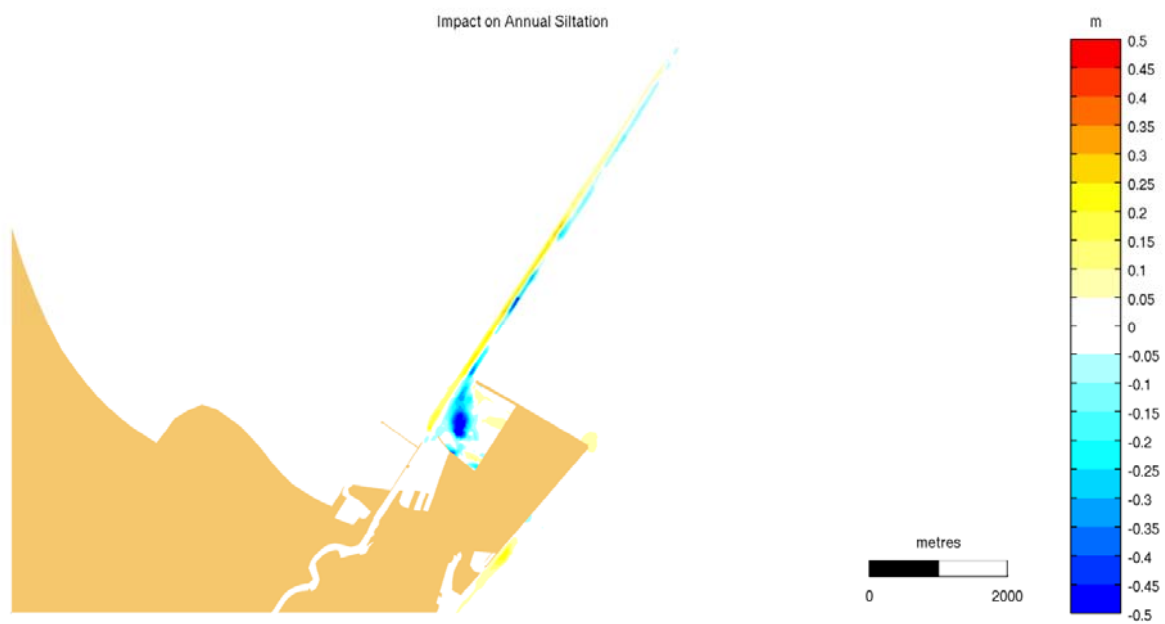


Figure 5.18 Difference in Siltation Rate between the Ultimate Case and Base Case (m/year)

5.3.4.5 Shoreline Impacts

The revised design shoreline impacts to the west of the Port are unchanged from those described in the EIS. Chapter B.3 (Coastal Processes) of the EIS provides a detailed shoreline impact assessment for the Strand and Rowes Bay.

The revised reclamation area extends further to the east than the design proposed in the original PEP EIS. Therefore, there is potential for additional modification to the wave climate to the east of the Port and potential changes to the shoreline coastal processes and morphology of that part of Cleveland Bay.

The shoreline to the east is considerably sheltered from wave action by Cape Cleveland, being exposed only to relatively small locally generated wind waves from the north and highly attenuated waves entering Cleveland Bay from offshore. The minor sand ridges have developed by shoreward movement of coarser sediments during infrequent larger wave events, with only minor longshore distribution of these sediments. The Ross River mouth area is exposed to somewhat higher energy wave action which, together with sand supply from the river, has led to development of more prominent sand ridges (Figure 5.19).

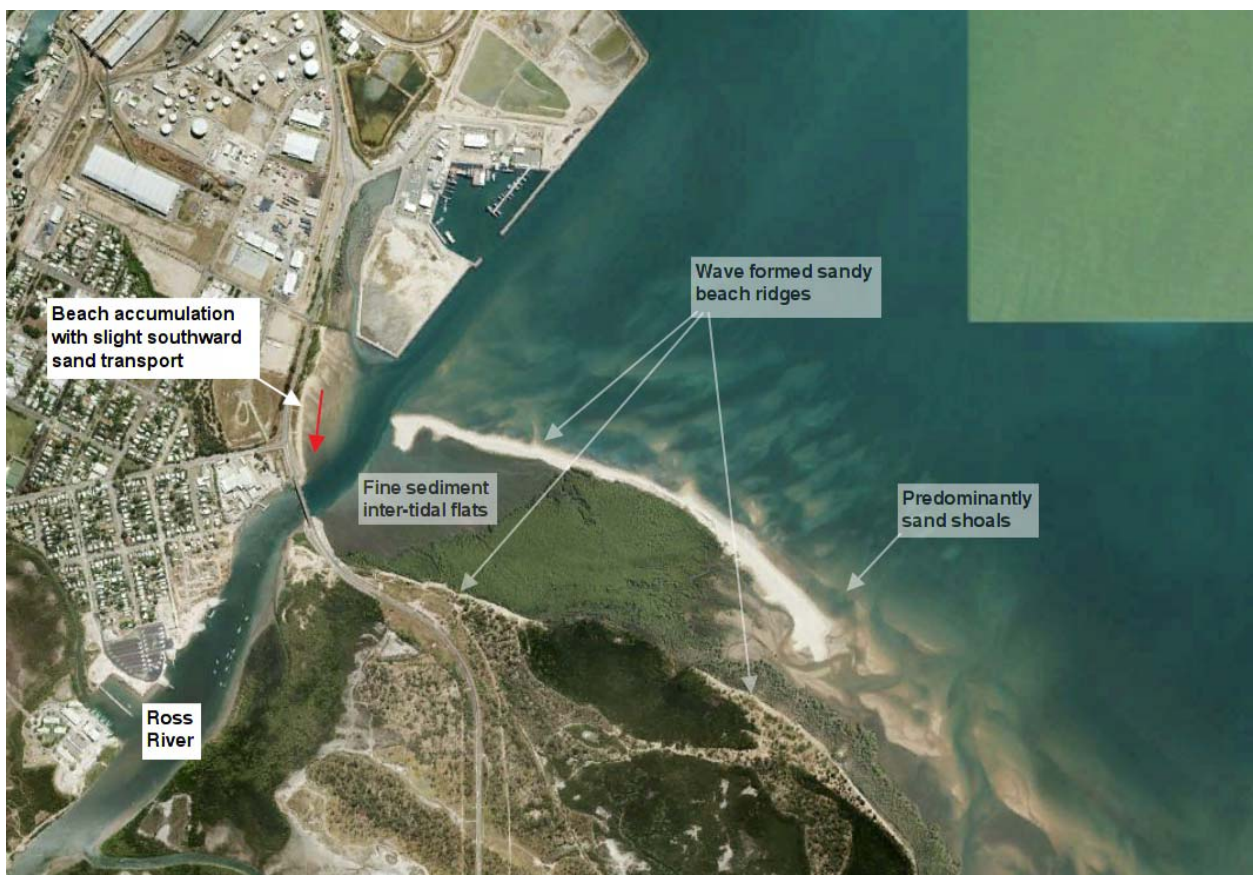


Figure 5.19 Morphology of Ross River Mouth Area

The wave modelling results show that, apart from the local area at the mouth of Ross River, wave propagation to the shoreline east of the Ross River is not affected significantly by the existing Port works. At the Ross River mouth, the eastward extension of the reclamation blocks and modifies waves from the north to north-northeast, particularly along the western side of the river channel. There, fine sediments appear to be accumulating gradually and a small beach has developed (Figure 5.19). Waves propagating to the Ross River mouth from the modal north-easterly direction are not significantly affected by the existing reclamation.

An illustration of the potential modification of wave propagation from the north-west to the Ross River mouth as a result of the PEP development is shown in Figure 5.21. It is apparent that the 'shielding' effect of the Port reclamation from north-westerly waves will be increased as a result of the proposed PEP development. The likely morphological response in the vicinity of the Ross River entrance and the coastline to the east will involve a slight increase in the rate of net sediment accumulation in the area. The propagation of waves from the dominant easterly direction will continue to be unaffected after construction of the new reclamation (as shown in Figure 5.21). Since fine sediments were accumulating in that area already due to the existing Port reclamation and given that the prevailing easterly wave direction is not significantly modified, construction of the new reclamation is not likely to result in any substantive change in the long term morphological condition.

The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case. The increased extent and shielding of the new reclamation may have the effect of slightly accelerating the rate of progradation. Sediment transport modelling results (refer 5.3.4.3-5.3.4.4) indicate that the scale of morphological impacts to the east of the port will be imperceptible within the context of underlying trends and natural variability.

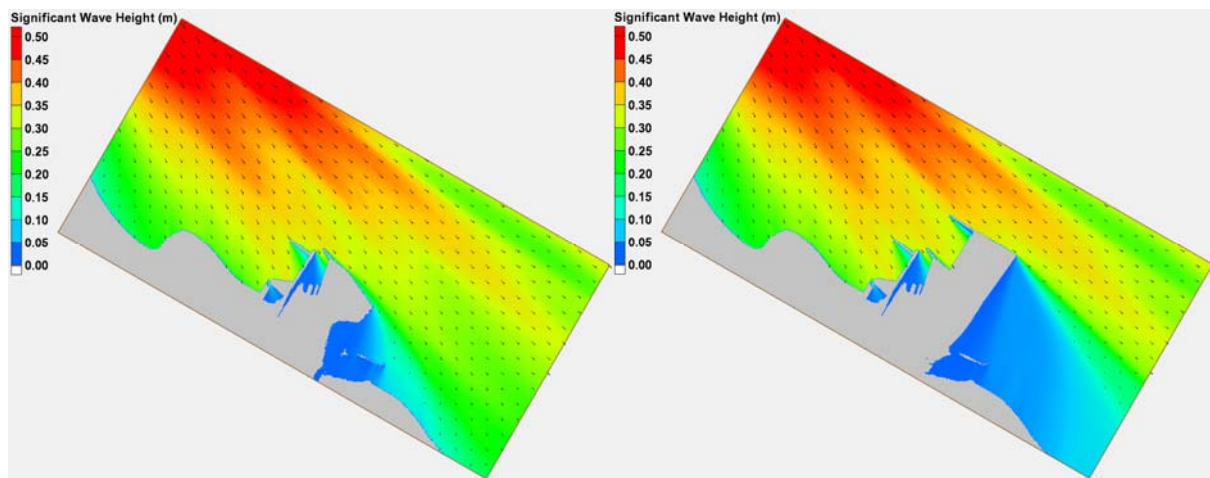


Figure 5.20 Wave Propagation from the North West in the Base Case (Left) and Ultimate Case (Right)

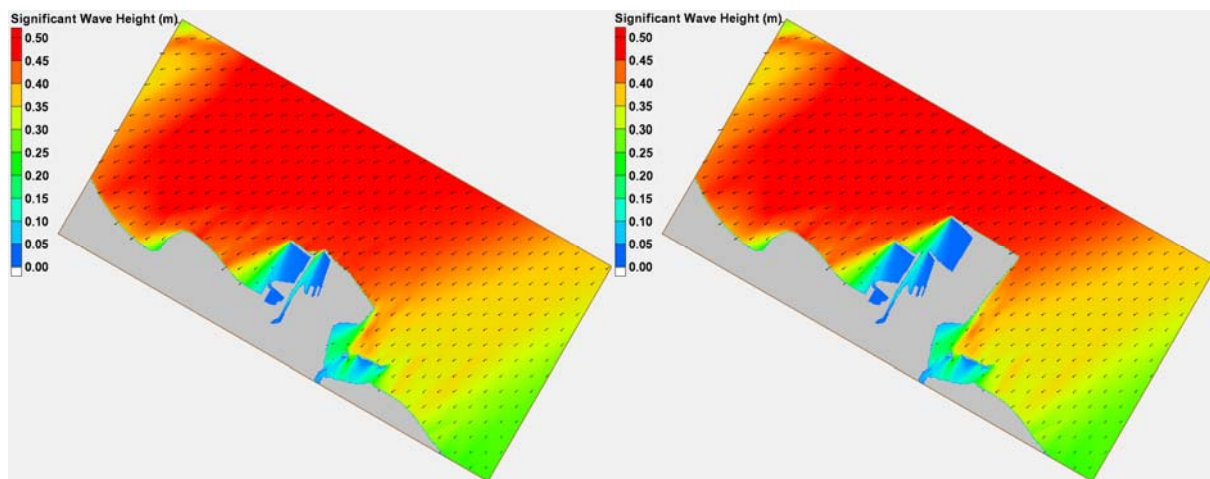


Figure 5.21 Wave Propagation from the North East in the Base Case (Left) and Ultimate Case (Right)

5.3.4.6 Dredge Plume Impact Assessment Methodology

A number of changes have been made to the numerical modelling methodology in the AEIS. Some of the changes are in order to satisfy requirements of the GBRMPA Guidelines (GBRMPA, 2012), while others have been implemented in response to feedback from EIS submissions. The most significant changes include the following.

- Ocean current forcing is now included on the open boundaries.
- All dredge plume modelling was undertaken with both dredged and ambient sediment explicitly included. This allows for mixing of ambient and dredged sediment in the model and improves the accuracy of resuspension dynamics.
- The assessment methodology for predicting dredging plume impacts is substantially different, and includes analysis of turbidity and deposition rate percentiles over a number of 30-day simulation periods. The ensemble approach has allowed for both 'expected' and 'Worst Case' impacts to be derived.
- The collection of 12 months of ambient turbidity data has allowed impact thresholds to be derived (refer to Sections 6.0 and 8.0).
- The model has been recalibrated for ambient sediment resuspension using the full 12 month set of water quality measurements.
- Maintenance dredging is now explicitly included in the modelling assessment and the cumulative impacts of capital and maintenance dredging are assessed.

The effects of dredging were assessed based on modelled increases in suspended sediment concentration and sedimentation above natural or ambient levels. Both ambient and dredge related signals have been resolved in the predictive model, which allows for an understanding of how significant the dredge contribution is in relation to ambient conditions.

Each dredging activity was simulated over a 30 day period. Spatial representations of the dredging impacts were based on percentile exceedance analysis of the model results. The 30 day window period is somewhat arbitrary but in a physical hydrodynamic context represents the approximate duration of two (2) consecutive spring-neap tidal cycles, while in an ecological context it is a meaningful timescale for assessing impacts to some key sensitive receptors in the area (e.g. dominant seagrass *Halophila ovalis*).

The percentile impact plots correspond to the predicted increase in turbidity/sedimentation statistics over ambient conditions that are attributable to the dredging. It is important to note that the presented turbidity percentile plots do not represent the plume extent at any one particular instant in time. Percentile values considered in this report are 95th and 50th, which correspond to exceedance durations of 36hrs (5%) and 15 days (50%) respectively for the 30 day window. The highest percentiles correspond to relatively acute and short-lived increases in turbidity/sedimentation while the lower percentiles correspond to more chronic longer-term increases.

The spatial percentile exceedance dredging impact plots are presented in tandem with the equivalent modelled ambient percentile statistics, calculated as the average over all 30 day modelling periods. This allows the increases in turbidity/sedimentation due to dredging to be seen relative to the modelled ambient conditions.

For the most significant dredging activities, the simulation was carried out for an ensemble of five different 30 day periods during different seasons and the results were aggregated to determine the likely range of potential impacts. The 'Expected Case' impacts were determined on the basis of the ensemble average turbidity and deposition percentiles. The 'Worst Case' impacts were determined on the basis of the ensemble maximum turbidity and deposition percentiles.

Key features of the dredging impact analysis include the following:

- Consideration of a range of impact durations from acute to chronic
- Can account for the influence of a variety of meteorological conditions
- A similar analysis applied to the baseline data can quantify the ambient conditions including natural variability across different periods. This can be used to derive meaningful thresholds for the impacts.

Twelve months of baseline turbidity monitoring was undertaken as part of the Project which has allowed for the derivation of contour limits for the presentation of the percentile impact plots that are meaningful at specific sites. It should be noted that different thresholds (and therefore different contour limits) are appropriate for the different percentiles.

For a full discussion of all assumptions and inputs used in this dredging impact assessment please refer to the Hydrodynamic and Advection-Dispersion Modelling Technical Report (Appendix A2). The modelling results provide a detailed and site specific assessment of possible dredge plume dispersion which was used as the basis for water quality and ecological impact assessments. The implications of the modelled turbidity and deposition rate impacts are discussed in Section 6.3.4 and 8.3.4 of the AEIS.

5.3.5 Summary

Table 5.3 Impact Assessment Summary – Coastal Processes

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Changes in longshore sand transport regime at The Strand	Construction of breakwaters and reclamation	Minor	Almost Certain	Medium	Monitoring of the beach in potentially vulnerable locations. Minor local dune strengthening as needed.	Low
Reduced storm erosion exposure at southern end of The Strand beach	Construction of breakwaters and reclamation	Beneficial	Almost Certain	Positive Benefit	Nil	Positive Benefit
Changes in longshore sand transport regime at Rowes Bay	Construction of breakwaters and reclamation	Negligible	Possible	Low	Nil	Low
Increased rate of sediment accumulation at the Ross River Mouth	Construction of breakwaters and reclamation	Minor	Almost Certain	Medium	Nil	Medium
Changes in velocity magnitudes in the immediate vicinity of the Port	Construction of breakwaters and reclamation	Negligible	Almost Certain	Medium	Nil	Medium
Changes in Cleveland Bay morphology in the immediate vicinity of the Port	Construction of breakwaters and reclamation	Negligible	Almost Certain	Medium	Nil	Medium
Siltation in the harbour and channel	Capital dredging, placement and reclamation	Negligible	Almost Certain	Medium	The ultimate design enclosure of the outer harbour reduces siltation to the extent that Project siltation volumes are increased by 14% over the base case (despite widened channel infrastructure).	Medium
Siltation at The Strand due to Ross River sediment discharge	Construction of breakwaters and reclamation	Beneficial	Possible	Positive Benefit	Nil	Positive Benefit
Sediment resuspension from the DMPA	Capital dredging, placement and reclamation	None	None	None	There is no offshore placement of capital material under the revised AEIS design.	None
Widening and deepening of channel affecting wave propagation	Channel widening and deepening	Negligible	Unlikely	Negligible	Nil	Negligible

5.4 Conclusion

The revised design has accommodated the legislative requirement preventing offshore placement of capital dredge material through development of an expanded reclamation footprint. The revised assessment presented in this AEIS addresses the issues raised in EIS submissions as well as assessing any changes associated with the design refinement.

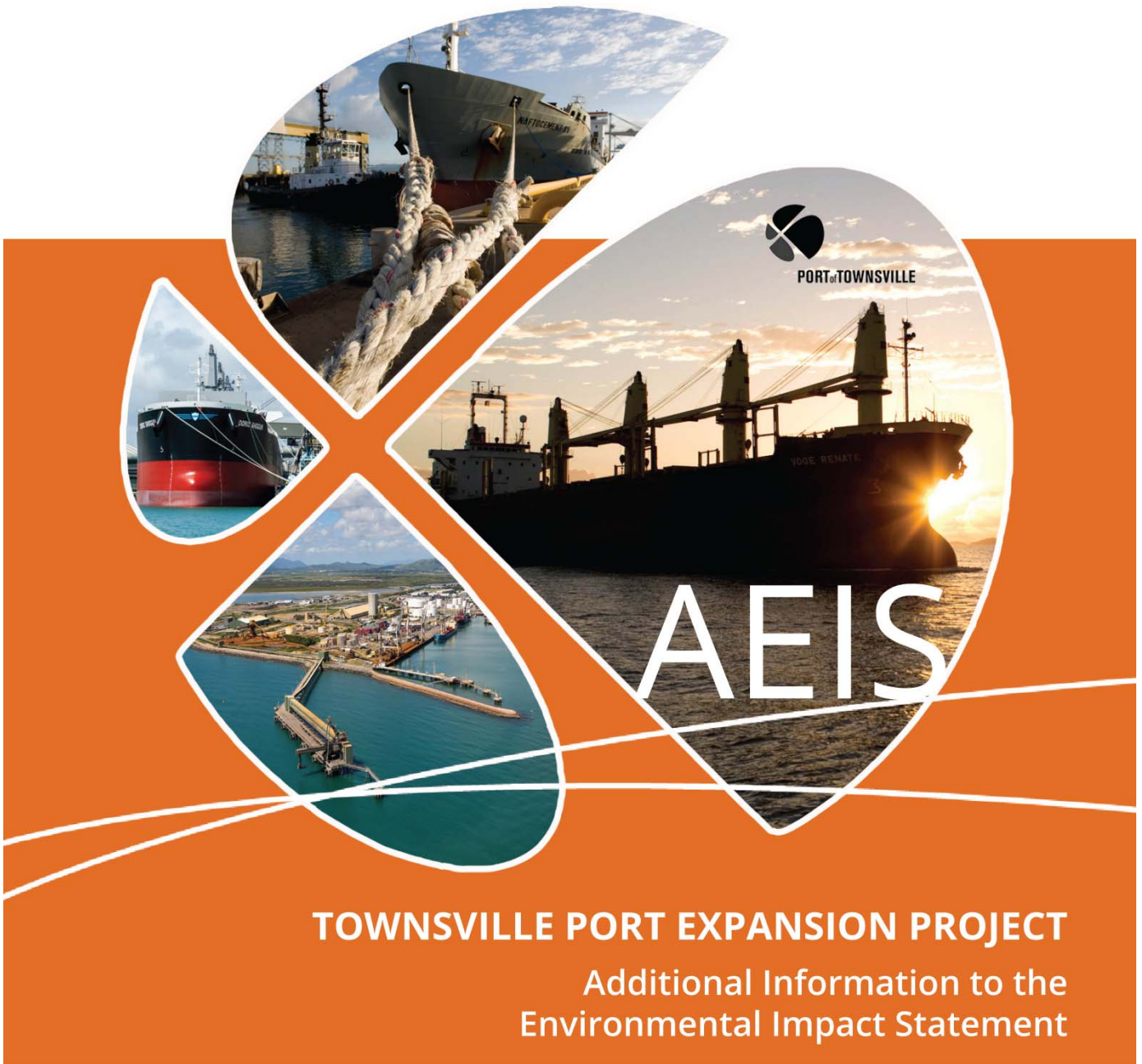
The expanded footprint of the reclamation area will not cause significant additional impacts beyond those identified in the EIS. The changes to hydrodynamics and sediment transport caused by the construction of the reclamation and breakwaters are minor and there may be slight benefits at The Strand due to a potential reduction in siltation.

The proposed widening of the channel is not expected to cause additional coastal processes impacts because it will not have a significant impact on wave transmission or reflection. The reduction in the proposed depth of the final channel design has reduced the length of the required channel and therefore reduced impacts at the northern end of the Sea Channel. Due to the widened channel, maintenance dredging volumes are predicted to increase by 17% over the existing case for the Interim development stage and by 14% over the existing case for the Ultimate development.

The likely changes in the longshore sand transport regime at The Strand are not changed in the revised PEP. There will be increased sheltering of the Ross River mouth from northerly waves due to the expanded reclamation, however exposure to prevailing north easterly waves will not be significantly changed. The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case.

The revised assessment presented in this AEIS addresses the matters raised in EIS submissions and finds that the design refinement does not represent a significant increase in impacts to coastal processes and hydrodynamics compared with the EIS.

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SECTION 6

Marine Water Quality



6.0 Marine Water Quality

6.1 Introduction

Marine water quality values of the Project area and surrounds are discussed in Chapter B.4 (Marine Water) of the Port Expansion Project (PEP) Environmental Impact Statement (EIS). The Port of Townsville is located in Cleveland Bay, which is bordered by Magnetic Island and the Coral Sea to the north, Cape Pallarenda to the west and Cape Cleveland to the east. Ross River discharges into Cleveland Bay at the Port, with other major river systems feeding in to the north of Cleveland Bay (Bohle River) and the south (Burdekin River). During wet season storm events, these and other smaller river systems deliver sediments and nutrients into Cleveland Bay and other nearshore waters of the Great Barrier Reef lagoon.

Marine water quality is an important environmental asset in the Study Area and surrounds due to the presence of a number of ecological receptors that are sensitive to altered water quality conditions. These sensitive receptors include seagrass meadows, which are located throughout Cleveland Bay, as well as reef communities (including coral) at Middle Reef and Magnetic Island. The Great Barrier Reef Marine Park is adjacent to the Port of Townsville exclusion zone, and supports areas with high ecological values.

Resuspension of existing (predominantly mud) sediments, the majority of which were deposited during the Holocene period, where wave action created high suspended sediment concentrations within shallow nearshore environments of Cleveland Bay (Larcombe *et al.* 1995). Offshore areas of Cleveland Bay, including the waters surrounding Magnetic Island, typically have lower suspended sediment concentrations than nearshore environments, resulting in relatively clear water conditions for most of the time (refer to Section 6.2.8).

A number of submissions were received in response to the EIS that are relevant to marine water quality. Key matters raised from the submission process include:

- adequacy of baseline water quality data and trigger levels
- consideration of ambient turbidity in impact assessment
- adequacy of water quality impact assessment method
- assessment of impacts from maintenance dredging
- oxidisation of potential acid sulfate soils (PASS) in the water column
- perception of 'green valve' used in dredging
- water quality and public swimming safety concerns
- natural turbidity of Cleveland Bay.

Responses to these key matters raised in submissions are provided in the following sections.

6.2 Response to Submissions

6.2.1 Adequacy of baseline water quality data and trigger levels

Two submissions questioned the adequacy of the baseline water quality data used to characterise baseline water quality and to set trigger levels for impact assessment. Specifically, the submissions raised the following matters.

- Perception that the baseline data was unrepresentative as a result of periods of maintenance dredging and large rainfall events being included in the analysis of baseline data.
- That the baseline data did not allow seasonality to be considered in determining the impact assessment trigger levels.

In response to the first matter, periods of dredging and an unusually large rainfall event were quarantined from the data prior to analysis. All data was subjected to a quality control process whereby periods of data were quarantined to ensure the data represented baseline conditions. This resulted in a 'cleaned' data set with small periods of data quarantined, but still encompassing a 12 month period.

Periods of data were quarantined if the following occurred during the monitoring period:

- obvious signs of sensor bio-fouling
- equipment failure
- periods of dredging
- any unusually large rainfall events (i.e. larger than 1 in 5 year recurrence interval).

This same quality control process was undertaken for the additional 12 months of data collected as discussed below.

In response to the second matter, the EIS acknowledged insufficient existing data to describe seasonal patterns in water quality (due to monitoring data collected over a period of 3-4 months). For this reason, the EIS committed to a 12 month water quality monitoring program in an attempt to characterise seasonality better. This program consisted of continuous water quality data collection over a 12 month period (July 2012 to July 2013) at five sites generally representing sensitive ecological receptor locations that could potentially be indirectly affected by the PEP. The locations of these sites are shown in Figure 6.1 (which also shows the sites where monitoring data was collected in 2008/2009) and include:

- Geoffrey Bay
- Picnic Bay
- Florence Bay
- Virago Shoal
- The Strand.

While the focus of the monitoring was on turbidity and Photosynthetically Active Radiation (PAR), other parameters such as water temperature, electrical conductivity and pH were also recorded. Further information in regard to the 12 month baseline water quality monitoring program is provided in Appendix A1 (Additional Field Studies Report).

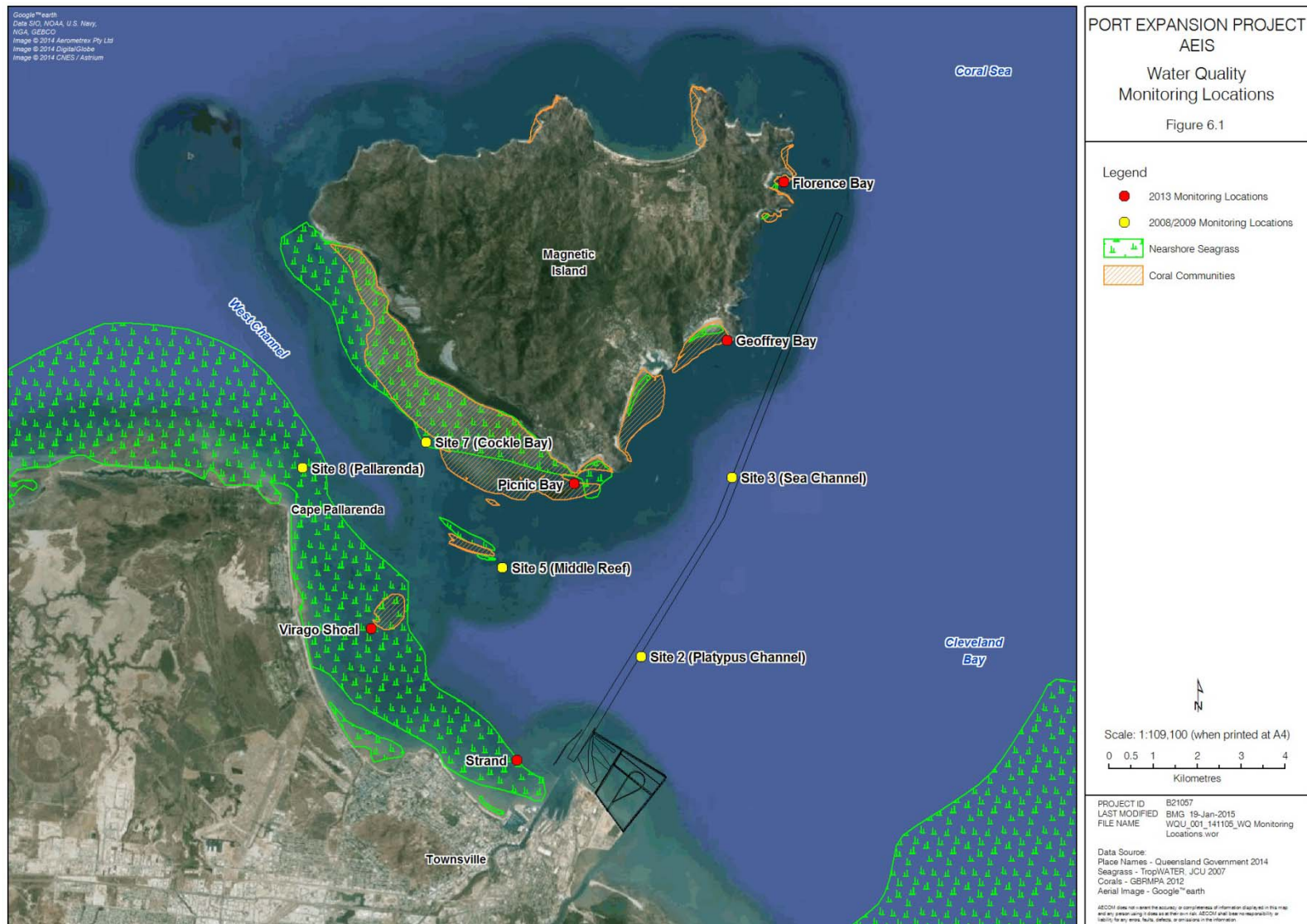


Figure 6.1 Water Quality Monitoring Locations

Using the 12 months of additional baseline data, along with the existing baseline data used in the EIS (i.e. 2008/2009 data), trigger values for assessing potential impacts of the PEP have been revised as part of this AEIS.

To determine if the ambient turbidity baseline data displayed distinct seasonal patterns, the dataset was analysed and it was found that variability is driven primarily by the wind regime (speed and direction), and there were no distinct differences in turbidity between wet and dry seasons. For this reason, the 12 month data set was analysed using 10 day moving windows to account for varying wind conditions. Therefore, seasonality is built into the methodology used to determine the revised trigger levels, which take into consideration the natural variability of water quality throughout the 12 month monitoring period. The methodology and revised trigger levels are discussed in Section 6.3.4.1.

6.2.2 Consideration of ambient turbidity in impact assessment

Three submissions related to the failure to address ambient turbidity in the impact assessment. Specifically, the submissions highlighted that the modelling impact plots are presented as 'above ambient', potentially ignoring the already disturbed nature of the receiving environment.

At the time of the EIS preparation, modelling of ambient conditions was not undertaken due to inadequate data and limitations of the model. However, recent improvements in the model and the availability of the 12 month data set (used to calibrate the model) have enabled ambient conditions to be modelled. As a result, the revised impact assessment in Section 6.3.4.1 takes into consideration ambient turbidity by showing ambient turbidity plots (without dredging) along with dredging impact plots which represent the predicted change in ambient turbidity due to dredging. Further details on how modelled ambient turbidity has now been incorporated into the model are included in Appendix A2 (Modelling Report).

6.2.3 Adequacy of water quality impact assessment method

Seven submissions were related to the water quality impact assessment method used in the EIS. The impact assessment method used in the EIS was based on McArthur *et al.* (2002). The submissions stated that the McArthur *et al.* (2002) method focussed on the 95th percentile of baseline data, thereby only considering acute impacts instead of chronic impacts.

While the McArthur *et al.* (2002) method has been used in a number of major port EIS projects in Queensland and elsewhere in Australia, the EIS noted that the methodology has significant limitations. To (partially) address these limitations, the EIS used the McArthur *et al.* (2002) method to assess acute impacts and 50th percentile (median) plots to assess chronic impacts.

A revised impact assessment methodology has been developed to account for both highly elevated 'acute' sediment concentrations, and chronic, low level changes to suspended sediment concentrations. In the present study, 20th, 50th and 80th percentile values¹ were calculated from baseline data, which were used to develop a set of 'impact threshold values'.

The revised impact assessment used in this AEIS involves the use of 'zones of impact', which are recommended in the GBRMPA Modelling Guidelines and are generally based on environmental assessment guidelines for dredging produced by the WA EPA (2011). The revised impact assessment methodology, including the zones of impact, is discussed further in Section 6.3.4.1.

It is important to note that the 'impact threshold values' were specifically developed to generate 'zones of impact', based on the degree to which dredge plumes (predicted by modelling) deviated from natural variability. These 'impact threshold values' were specifically developed for impact prediction purposes, and have not been developed for setting 'response action levels' for dredge plume monitoring programs. It is the intention that a technical advisory committee will develop action levels for any future dredge plume monitoring program, as outlined in the DMP.

6.2.4 Assessment of impacts from maintenance dredging

240 submissions (includes form letter submissions) related to the maintenance dredging required after the capital dredging has been completed, and that the EIS needs to undertake further assessment of impacts from maintenance dredging. Specifically, submissions were focussed around the following.

- Whether there will be increased maintenance dredging due to the increased length and depth of the shipping channel (coastal processes issue).
- Whether annual maintenance dredging will have a significant impact on sensitive ecological receptors, especially along the Magnetic Island coastline.

¹ These percentile values have been adopted in the Queensland Water Quality Guidelines for determining whether water quality meets water quality objectives in High Ecological Value (HEV) waters

As discussed further in Section 5.0 (Coastal Processes), the ultimate development of the PEP is predicted to increase the volume of maintenance dredging by approximately 14% with the design refinement, mostly due to the increased channel width. Nevertheless, maintenance dredging impacts are not predicted to differ significantly from current maintenance dredging activities. This is discussed further in Section 6.3.4, which presents the findings of additional modelling of maintenance dredging using the increased volume of material.

While the predicted impacts from maintenance dredging are discussed in Section 6.3.4, further assessment of maintenance dredging was undertaken in 2013 (BMT WBM 2013) and in 2014 (BMT WBM 2014) assuming a slightly shorter dredging program (i.e. as per existing maintenance dredging programs). These assessments involved modelling of typical and worst case maintenance dredging campaigns. The findings from the BMT WBM (2013 and 2014) assessments are summarised as follows.

- Impacts from annual maintenance dredging under different periods were predicted to be negligible, with zones of impact restricted to areas within and immediately adjacent to dredging and placement areas only. The change in turbidity due to dredging at sensitive receptor locations was predicted to remain well within the range of variability in ambient water quality of Cleveland Bay.
- Sensitive ecological receptors in Cleveland Bay, such as seagrass and coral reef habitats along Magnetic Island, were within the predicted 'zone of influence' (detectable plumes but negligible impacts predicted) of maintenance dredging (and associated marine placement at the approved Dredge Material Placement Area), however they were not predicted to be within any zones of low, moderate or high impact (varying levels of potential impacts to sensitive receptors, if present).
- Given the short duration (typically up to five weeks) of maintenance dredging campaigns, the short term nature of dredge plumes and the tolerance of biota to short term increases in turbidity, it was not expected that impact thresholds will be exceeded during maintenance dredging at areas containing sensitive ecological receptors.
- Cumulative impacts from maintenance dredging and placement impacts were assessed and indications were that the relative contribution of dredge sediment to overall sedimentation processes operating in Cleveland Bay are minimal and cumulative impacts on water quality (between years) and marine habitats that are currently in poor (recovering) condition were not expected. Furthermore, maintenance dredging during increased turbidity from flood plumes is not expected to noticeably contribute to impacts on ecosystems due to the flood plumes.
- In terms of resilience, it was acknowledged that there was little information on the tolerances of seagrass during periods of recovery, and it was possible that if seagrass condition was poor in the period leading up to future maintenance dredging campaigns, measurable changes to condition (e.g. reduced growth, loss of carbohydrate) of the more sensitive seagrass species could occur. However, taking into consideration the negligible impacts predicted, the current condition and extent of seagrasses and corals, and the temporary nature of turbid plumes, it was considered that water quality effects resulting from the annual maintenance dredging will not affect longer term recovery of seagrass or corals.
- In regard to regional impacts from resuspension of material from the DMPA, 12 month resuspension modelling indicated that the modelled change in the 95th percentile turbidity (i.e. the turbidity value exceeded 5% of the time, or 18 days in the year) was less than 2 NTU, while the modelled change in the 50th percentile turbidity (representing median or typical turbidity) was less than 0.05 NTU throughout the model domain. This very small change to ambient turbidity is highly unlikely to cause measurable changes to biota or ecosystems.
- In terms of sediment deposition, the change in the 95th percentile deposition rate and the 50th percentile deposition rate will be less than 1 mg/cm²/day and less than 0.01 mg/cm²/day respectively throughout the entire model domain. At sensitive receptor sites within Cleveland Bay, changes in deposition rates will be virtually undetectable. These small changes to sedimentation rates are very small compared to background variability (e.g. 2.9-7.4 mg/cm²/day recorded at Middle Reef) and are highly unlikely to cause adverse effects to sensitive receptors.

These conclusions are supported by previous reactive monitoring undertaken during the 1993 capital dredging campaign (11 week campaign). This dredging campaign was longer than a typical 5 week maintenance dredging campaign, so provides a conservative comparison. The results of the 1993 monitoring program indicated that 'no extreme suspended sediment concentration occurred at any of the Magnetic Island bay sites as a direct result of dredging' and 'given available data, dredge related effects appear to lie within normal variation at seagrass sites in SE Cleveland Bay and the coral systems at Middle Reef' (Larcombe and Ridd 1994).

6.2.5 Oxidisation of potential acid sulfate soils (PASS) in the water column

Five submissions were related to the potential for oxidisation of sediments that contain potential acid sulfate soil (PASS) when placed at sea below the lowest astronomical tides water level. These submissions suggested that placement of this material below lowest astronomical tides could well be within the wave re-suspension zone, bringing the material into contact with 100% oxygenated water and potentially forming low pH conditions.

In response to this, it is generally accepted that dredged material which remains waterlogged in the marine environment will not oxidise (*sensu* Dear *et al.* 2014). Dear *et al.* 2014 does acknowledge that dissolved oxygen can

sometimes be high enough to cause oxidation of submerged sulfidic fines, however this is more relevant to enclosed freshwater bodies such as lakes. In the marine environment, seawater is a natural buffer against the formation of sulphuric acid, and any acidity will be neutralised relatively quickly.

Nevertheless, the revised design now involves placement of all dredged material in reclamation. This will allow appropriate treatment of any acid sulfate soils in a confined area. Furthermore, the reactive monitoring program (in the Dredge Management Plan) will include monitoring of pH during dredging and placement in the reclamation.

6.2.6 Perception of 'green valve' used in dredging

12 submissions were related to the use of a 'green valve' by the Trailer Suction Hopper Dredge (TSHD), and whether this will actually reduce the potential impacts from dredging. Specifically, the submissions stated that the green valve will not change the amount of sediment released, only that the sediment will be released beneath the water surface thereby only reducing visual impacts.

An environmental valve, or 'green valve', is used in the dredging industry to reduce the environmental impact from dredging. While it is correct that the green valve does not reduce the amount of sediment released from a dredge, it does reduce the extent of turbid dredge plumes in the water column and limits the mobility of dredged material.

The overflow from the TSHD consists of water, sediments and air. Without a green valve, the air in the overflow carries the sediment fines to the surface. As a consequence, the sediment fines are dispersed over a much larger area increasing turbidity in the water column. With a green valve (Figure 6.2), the overflow is choked such that a constant fluid level is maintained in the hopper and, as a result, no air is taken down with the overflow water. This results in more sediment taken to the seabed and less sediment suspended in the water column as turbid plumes. The material on the seabed is less likely to become mobilised into areas of sensitive ecological receptors compared to material suspended in the water column.

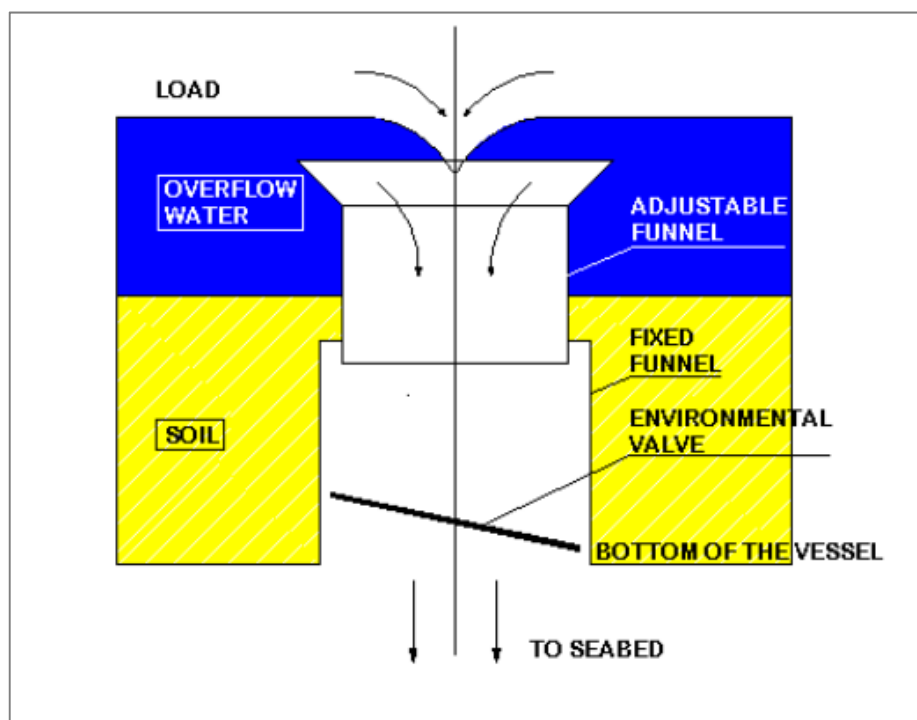


Figure 6.2 Diagram of an Environmental Valve or 'Green Valve'

6.2.7 Water quality and public swimming safety concerns

Picnic Bay Surf Life Saving Club raised the potential change in water quality which could lead to public swimming safety concerns. Specifically, the submission stated that changes to water quality could potentially result in the following:

- increased frequency of toxic algal blooms
- increased jellyfish abundance as a result of higher nutrient level
- changes to shark and crocodile population and behaviour in the area resulting from increased turbidity
- decreased ability to identify dangerous predatory animals and underwater hazards due to increased turbidity.

The predicted changes to water quality as a result of dredging are not expected to be at a level of magnitude which will lead to the above issues. The levels of nutrients and other contaminants in the dredged sediment have been shown to be in low concentrations such that a perceptible increase in these constituents in the water column will be unlikely as a result of dredging (Section B4.4.3.2 and B4.4.3.3 of the EIS). With placement of all dredged material now in reclamation as a result of the design refinement, the risk to changes in water quality are further reduced.

Further to this, while there is predicted to be a short-term increase in turbidity near to the dredging area, the level of increased turbidity will be unlikely to be noticeable at public swimming areas (i.e. increased turbidity may be able to be measured by instrumentation, but not likely to be visually perceptible).

Therefore, the low levels of predicted short-term changes to water quality are expected to have a negligible effect on the safety matters raised in the submission.

6.2.8 Natural turbidity of Cleveland Bay

Six submissions were related to a statement made in the baseline section of the EIS that Cleveland Bay is 'naturally turbid'. The submissions raised that Cleveland Bay (including Magnetic Island and the Strand) have been contaminated by dredge spoil for about 100 years, and the water is turbid with sediment that contains high concentrations of anthropogenic metals and organic contaminants. The submissions also raised that many bays to the north and south of Cleveland Bay are relatively clear water bays (except during cyclonic flooding), indicating that it is more likely that the turbidity of Cleveland Bay is due to historic dredging activities.

While it is accepted that there is some level of anthropogenic sources of turbidity in Cleveland Bay (dredging, port activities and other urban development), the general consensus is that the sediment in Cleveland Bay is predominantly derived from sediments deposited during the Holocene period (e.g. Larcombe and Ridd 1994, and Orpin 1999).

In response to the matter of Cleveland Bay being contaminated with dredged material, water quality monitoring data indicates that while some areas of Cleveland Bay are typically turbid due to resuspension from wind and waves (in particular the nearshore shallow areas), other areas of Cleveland Bay (especially around Magnetic Island and in offshore waters) are typically low turbidity environments for most of the year as a result of regular tidal exchange with less turbid offshore waters.

To illustrate the natural turbidity in Cleveland Bay from resuspension of bed sediments during high wind events, aerial photos are shown in Figure 6.3. These photos were taken on a day when high winds were occurring and had been sustained for a number of days previously. As can be seen, the waters within Cleveland Bay can become naturally turbid during high wind events.

In contrast, Figure 6.4 shows photos of the typical low turbidity experienced year round along the Coast of Magnetic Island. While the turbidity generally increases for short periods of time during high wind events such as that in Figure 6.3, the waters surrounding Magnetic Island are less susceptible to increased turbidity from wind and waves.

This difference in turbidity at various areas within Cleveland Bay is demonstrated in the different water quality threshold values presented in Section 6.3.4, with very low turbidity threshold values for waters surrounding Magnetic Island due to the low turbidity measured in these areas.



Figure 6.3 Natural turbidity in Cleveland Bay from resuspension during high winds – looking toward the Port (top) and looking toward Cape Cleveland (bottom)



Figure 6.4 Typical Low Turbidity Environment at Geoffrey Bay

6.3 Revised Environmental Impact Assessment

6.3.1 Legislation and policy

Since the initial release of the EIS, there have been important legislative changes at both the State and Commonwealth level. A new regulation under the *Great Barrier Reef Marine Park Regulations 1983* (Cth) was introduced on 2 June 2015 which sets out to prevent the placement of capital dredge material in the Marine Park. Specifically, the regulation prevents GBRMPA from granting permission for placement of capital dredge material in the Marine Park.

In addition, the *Sustainable Ports Development Act 2015* (Qld) prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

At the time of preparing the EIS, draft environmental values (EVs) and water quality objectives (WQOs) for the Townsville region had been recently released for public comment. These EVs and WQOs have now been finalised and are included in Schedule 1 of the *Environmental Protection (Water) Policy 2009* in the Ross River Basin and Magnetic Island Plan (Basin No. 118), which was released in late 2013.

Implications from this document include zones of high ecological value around Magnetic Island and the eastern region of Cleveland Bay, resulting in more stringent turbidity and WQOs around Magnetic Island, with WQOs expressed as 20th, 50th and 80th percentiles.

As the PEP impact assessment described below does not rely on assessment against WQOs, this change in WQOs for the study area does not affect the outcomes of the impact assessment in the EIS or in this AEIS.

6.3.2 Design refinement

The design of the Port Expansion Project has been refined in response to submissions and in order to reduce the overall environmental impact and to eliminate the placement of capital dredge material at sea.

The proposed reclamation is now larger (increased from approximately 100 ha to approximately 150 ha), extending further to the north-east in the vicinity of the Ross River channel. The larger reclamation will allow all capital dredging material to be placed onshore rather than at a marine DMPA. Only maintenance dredging material will continue to be placed at the existing marine DMPA as part of the current proposal.

The design refinement also includes widening the Platypus and Sea Channels and a reduction in the proposed deepening of the channels (-12.8m LAT rather than -13.7m LAT). The impacts associated with widening the channels have been fully assessed as part of this AEIS.

The proposed development will take place gradually in stages, reducing the intensity of the development and its associated environmental impacts. Smaller dredging plant are now proposed, which further reduces the potential impact due to suspended sediment plumes and dredged sediment deposition.

The impacts on marine water quality from the design refinement are assessed in Section 6.3.4.1. Due to the change in dredging campaign (equipment and timing) and dredge material placement resulting from the design refinement, the following impacting processes have been reassessed:

- turbid plume impacts to water quality from dredging
- turbid plume impacts from tailwater discharges from the reclamation
- sediment deposition due to settling of suspended sediments in turbid dredge plumes.

6.3.3 Supporting studies

Supporting studies relevant to this section of the AEIS include Appendix A1 (Additional Field Studies Report) and Appendix A2 (Modelling Report).

6.3.4 Revised assessment

6.3.4.1 Impact assessment

Impact assessment methodology – water quality

Conceptual approach

To assess potential impacts to marine water quality and ecologically sensitive areas from the dredging works as part of the revised design, 'zones of impact' were developed using site-specific threshold values. The zones of impact, which are recommended in the GBRMPA Modelling Guidelines and are generally based on environmental assessment guidelines for dredging produced by the WA EPA (2011), include the following.

- Zone of Influence - extent of detectable plume², but *no predicted ecological impacts*.
- Zone of Low Impact - water quality *may* be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors with a nominal recovery time of approximately 6 months.
- Zone of Moderate Impact - water quality *likely* to be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors and/or mortality with a nominal recovery time up to 24 months.
- Zone of High Impact - water quality will *most likely* be pushed beyond natural variation (excluding extreme weather events) potentially resulting in mortality of ecological receptors with recovery greater than 24 months.

It is very important to note that the recovery times outlined for the various zones should be considered as indicative only, noting that recovery timeframes are dependent on a range of factors that are far too complex to accurately predict. The zones and 'recovery timeframes' represent a means for comparing the likelihood that significant, detectable impact to sensitive receptors could occur, and are based on the assumption that recovery timeframes are dependent on the magnitude of impact.

The Zone of Low Impact indicates that sub-lethal effects to sensitive ecological receptors are expected to be minor (e.g. stress, but mortality unlikely), and on this basis recovery times are expected to be relatively rapid. The Zone of Moderate Impact indicates possible greater sub-lethal effects or impacts at the colony scale (e.g. seagrass leaf loss, partial colony loss), with longer recovery timeframes therefore expected. Zone of High Impact indicates that a large proportion of seagrass or coral could be lost from the affected area, and on this basis, long timeframes (measured in years) will be expected for full recovery to occur.

Threshold development methodology

To determine the zones of impact, site-specific threshold values were developed using a combination of water quality (turbidity) and biological tolerances methods. This entailed using baseline water quality monitoring data to set initial threshold values. These values were then compared to biological tolerances from literature values as a 'reality check' to confirm that the threshold values are biologically meaningful.

To determine initial impact assessment threshold values, the 12 month baseline water quality monitoring data set (Section 6.2.1) was amalgamated with previous monitoring data (Chapter B.4 (Marine Water Quality) of the EIS). As mentioned in Section 6.2.1, the baseline monitoring data set underwent a quality control process whereby periods of data were quarantined (to remove periods of dredging, bio-fouling and unusually large weather events) to ensure the data represented baseline conditions. The amalgamated baseline data were analysed and percentile curves were produced. These percentile curves provide an indication of magnitude of turbidity and combined duration/frequency metrics for a range of conditions.

The baseline data were analysed over 30 day periods to give a range of percentile values over different time periods. This method provides a general indication of natural variability around each percentile value and provides context for modelling outputs which show turbidity in a 30 day window (refer to Appendix A2, Modelling Report). In selecting a 30 day period, it is acknowledged that different species vary greatly in terms of their tolerances to the duration/frequency of exposure to water quality stressors (including turbidity). Based on a review of ecological tolerance data for relevant sensitive receptors (i.e. seagrass and corals), measurable responses to water quality stress by sensitive species typically occur over periods measured in days to weeks (e.g. the seagrass *Halophila ovalis*). The adopted percentile values (20th, 50th, 80th percentile) measured over a 30 day time period are meaningful for assessing changes to sensitive receptors at sub-monthly time-scales. For context, a percentile curve was also calculated based on data collected over the entire monitoring period.

As an example, Figure 6.5 shows the percentile curves for data collected at Virago Shoal. This shows the natural variability measured around the median (50th percentile) and other percentile values. The x-axis in Figure 6.5 represents the different percentile values extracted from the rolling 30 day window analysis moving from frequently exceeded on the left to rarely exceeded on the right. The different curves are statistics representing the variability of the percentile analysis results across the different 30 day periods (making up the entire baseline monitoring period). The lower curve represents the least turbid conditions experienced across the monitoring period while the upper curve is conversely the most turbid conditions. The solid green line is the mean of the different 30 day window conditions.

² 'Detectable' plume in terms of detectable by instrumentation deployed in the water column

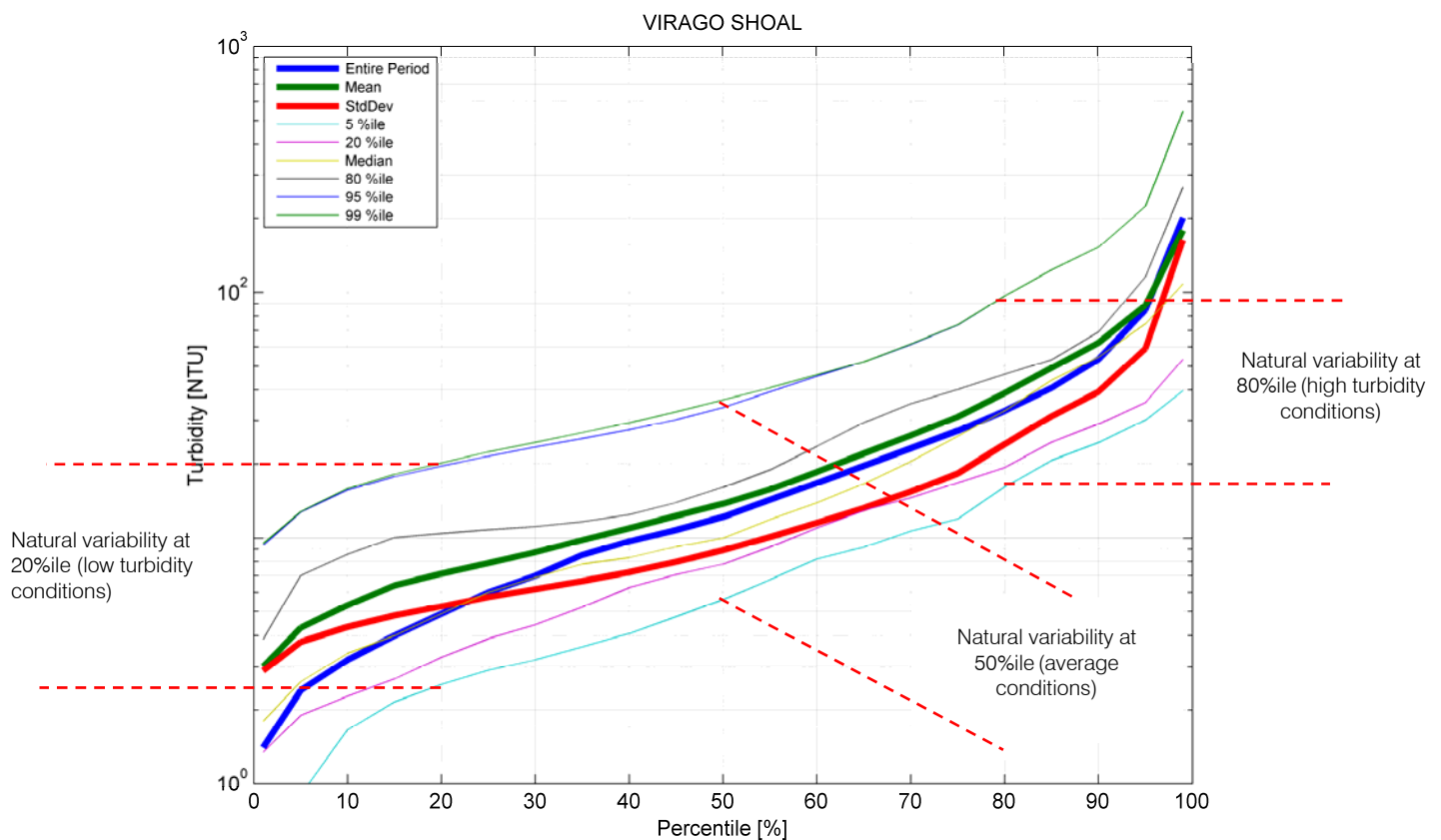


Figure 6.5 Example Summary Analysis of Baseline Data for Virago Shoal

Threshold values were derived from these percentile curves based on the natural variability around the 50th percentile (average conditions), 20th percentile (low turbidity conditions – typically low wind and waves) and the 80th percentile (high turbidity conditions – typically moderate to high wind and waves). The higher percentiles (e.g. 80th percentile) represent less frequent occurrences of higher turbidity which can lead to acute impacts, while the lower percentiles (e.g. 20th and 50th percentiles) represent more frequent occurrences of lower turbidity which can lead to chronic impacts. Therefore, this method considers both acute and chronic impacts.

A description of the threshold values for the zones of impact and how they relate to the natural variability is provided in Table 6.1. The approach used to determine the threshold levels involved using the standard deviation from the natural background mean at each percentile (i.e. 20th, 50th and 80th percentiles). This is conceptually similar to the approach developed by Orpin *et al.* (2004) to assess impacts from construction-related turbidity increases in Nelly Bay in Townsville.

The threshold values for each zone of impact are based on a number of standard deviations from the mean, increasing from the zone of low impact (1-2 standard deviations) up to the zone of high impact (3-5 standard deviations). Initially, the number of standard deviations used for each zone of impact was consistent across all sites. However, after testing against biological thresholds (discussed below) and comparing to other thresholds for corals in low turbidity waters (DHI in Chevron 2010), it was considered more appropriate for the less turbid offshore waters around Magnetic Island to use a different number of standard deviations than the more turbid nearshore waters.

The 'zone of influence' was defined as the extent of detectable plumes due to the proposed dredging. Turbid plumes were assumed to become detectable once they were approximately 20-30% above background conditions (background conditions conservatively assumed to be waters around Magnetic Island). To determine the extent of this zone, the following criteria were used:

- greater than 0.5 NTU above 50th percentile conditions (i.e. 50% of the time)
- greater than 2 NTU above 80th percentile conditions (i.e. 20% of the time)
- greater than 5 NTU above 95th percentile conditions (i.e. 5% of the time).

Benchmarking to biological thresholds

As the key sensitive ecological receptors in Cleveland Bay are hard corals and seagrass, these have been considered in the current assessment.

Numerous laboratory studies have examined the tolerances of hard corals to sediments, however there are several uncertainties regarding the applicability of these data for developing locally-specific thresholds. Potential stress thresholds for some coastal corals were quantified by Cooper *et al.* (2008) using an 18-month data set of water turbidity at Horseshoe Bay on the northern side of Magnetic Island. Based on the analysis of coral bio-indicators for water quality, Cooper *et al.* (2008) concluded that long-term (ca. 2 years as interpreted by McDonald *et al.* 2013) turbidity greater than 3 NTU leads to sub-lethal coral stress while turbidity greater than 5 NTU may represent a threshold for severe stress on corals in shallow areas.

There is a large body of work on the tolerances of some seagrass species to benthic light levels. Relevant tolerance values for seagrass were provided by James Cook University (JCU) and are presented in Table 6.1. The purpose of these biological tolerances is to test the impact zone predictions (discussed further in section below) developed using water quality (turbidity) thresholds, and are not intended to be used for light based thresholds.

Descriptions of water quality threshold values along with biological tolerance values (from the literature) for each zone of impact are presented in Table 6.1.

Table 6.1 Description of Impact Assessment Threshold Values

Zone of Impact	Water Quality (Turbidity)	Biological Tolerances (Seagrass)
Zone of High Impact	- Excess turbidity most likely to cause total turbidity to go beyond natural variation. - Threshold value = excess turbidity greater than three standard deviations from the natural background mean for nearshore areas, and five standard deviations for offshore areas. - Durations of excess turbidity based on 20%, 50% and 80% of dredge period (Table 6.2 and Table 6.3).	- LR[#] for <i>Zostera</i> (4.5-12 mol/m²/day rolling 2 week average) is not met for more than 6 weeks during the growing season (July-Dec). - LR for <i>Halophila ovalis</i> (2.8-4.4 mol/m²/day)^{##} is not met for more than 21 days during the growing season (July-Dec). - Resulting in total loss of seagrass and no recovery within 12 months (reliant on new recruitment).
Zone of Moderate Impact	- Excess turbidity likely to push total turbidity beyond natural variation. - Threshold value = excess turbidity greater than two standard deviations from the natural background mean for nearshore areas, and three standard deviations for offshore areas. - Durations of excess turbidity based on 20%, 50% and 80% of dredge period (Table 6.2 and Table 6.3).	- LR for <i>Zostera</i> (4.5-12 mol/m²/day rolling 2 week average) is not met for 3-6 weeks during the growing season (July-Dec). - LR for <i>Halophila ovalis</i> (2.8-4.4 mol/m²/day) is not met for 15-21 days during the growing season (July-Dec). - Resulting in declines in seagrass but some recovery within one month.
Zone of Low Impact	- Excess turbidity may push total turbidity beyond natural variation. - Threshold value = excess turbidity greater than one standard deviation from the natural background mean for nearshore areas, and two standard deviations for offshore areas. - Durations of excess turbidity based on 20%, 50% and 80% of dredge period (Table 6.2 and Table 6.3).	- LR for <i>Zostera</i> (4.5-12 mol/m²/day rolling 2 week average) is not met for 7-21 consecutive days during the growing season (July-Dec). - LR for <i>Halophila ovalis</i> (2.8-4.4 mol/m²/day) is not met for 7-14 consecutive days during the growing season (July-Dec). - Management action can avoid declines in seagrass cover.
Zone of Influence	- Extent of detectable plumes. - Dredging related turbidity exceeds 0.5 NTU for 50% of the time, 2 NTU for 20% of the time, and/or 5 NTU for 5% of the time (Table 6.2 and Table 6.3).	- LR for <i>Zostera</i> (4.5-12 mol/m²/day rolling 2 week average) is not met for <7 consecutive days during the growing season (July-Dec). - LR for <i>Halophila ovalis</i> (2.8-4.4 mol/m²/day) is not met for <7 consecutive days during the growing season (July-Dec).

Notes:

LR = Light Requirement

Collier *et al* 2009 lab experiments found significant loss of *Halophila ovalis* after 14 days below LR and based on lab experiments determined a light requirement of 4.4 mol/m²/day. JCU work in Gladstone also noted declines of *Halophila ovalis* in shaded treatments within 2 weeks

The output from the analysis of data was turbidity (NTU) impact assessment threshold values for each impact zone at each monitoring site. These values represent turbidity above background levels, and are included in Table 6.2 for offshore waters and Table 6.3 for nearshore waters. Importantly to note is that the threshold values presented in Table 6.2 and Table 6.3 have been used for impact assessment purposes only, and are not proposed as trigger values during dredging. Turbidity trigger values during dredging will be developed following further monitoring prior to commencement of the dredging campaign, as per Appendix B1 (Dredge Management Plan).

Benchmarking to other studies

As mentioned, threshold values for offshore waters around Magnetic Island are based on a higher number of standard deviations than the more turbid nearshore waters due to the much lower natural turbidity in the offshore

areas. These offshore threshold values are comparable to thresholds developed by DHI in Chevron (2010) for corals in low turbidity waters, as follows:

- Zone of total mortality (high impact) = 80th percentile turbidity threshold of 13 NTU (converted from TSS of 25 mg/L).
- Zone of partial mortality (low to moderate impact) = 50th percentile value of 2.5 NTU, and 80th percentile value of 5 NTU.

Development of impact zones

To delineate the zones of impact, the site-specific impact threshold values were interpolated spatially across the study area using GIS mapping software to produce 3-dimensional threshold grids. These threshold grids were then analysed against the 3-dimensional model output grids. This produced impact zone maps which indicate areas where modelled turbidity is higher than the relevant impact threshold value.

Table 6.2 Turbidity Threshold Values (Above Background) for Impact Assessment Purposes – Magnetic Island and Offshore Waters

Impact Zone	Description	Method	Percentile	Percentile Descriptor (Duration of excess turbidity per month of dredging)	Picnic Bay	Geoffrey Bay	Florence Bay	Cockle Bay	Sea Channel
					Turbidity Threshold Values (NTU) – <i>above background</i>				
Zone of High Impact	Excess turbidity <i>most likely</i> pushes total turbidity beyond natural variation	5 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	3	3	3	6	3
		5 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	5	5	5	9	8
		5 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	12	10	18	13	25
Zone of Moderate Impact	Excess turbidity <i>likely</i> to push total turbidity beyond natural variation	3 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	2	2	2	3	2
		3 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	3	3	3	5	5
		3 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	7	6	11	8	15
Zone of Low Impact	Excess turbidity <i>may</i> push total turbidity beyond natural variation	2 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	1	1	1	2	1
		2 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	2	2	2	4	3
		2 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	5	4	7	5	10
Zone of Influence	Full extent of detectable plumes (including resuspension)	Dredging related turbidity exceeds 0.5 NTU	50%ile	Exceeded 50% of the time (15 days per month of dredging)	0.5				
		Dredging related turbidity exceeds 2 NTU	80%ile	Exceeded 20% of the time (6 days per month of dredging)	2				
		Dredging related turbidity exceeds 5 NTU	95%ile	Exceeded 5% of the time (1.5 days per month of dredging)	5				

Table 6.3 Turbidity Threshold Values (Above Background) for Impact Assessment Purposes – Nearshore Waters

Impact Zone	Description	Method	Percentile	Percentile Descriptor (Duration of excess turbidity per month of dredging)	Strand	Virago Shoal	Platypus Channel	Middle Reef	Cape Pallarenda
					Turbidity Threshold Values (NTU) – above background				
Zone of High Impact	Excess turbidity <i>most likely</i> pushes total turbidity beyond natural variation	3 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	12	16	19	5	3
		3 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	17	27	43	9	11
		3 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	50	72	91	21	49
Zone of Moderate Impact	Excess turbidity <i>likely</i> to push total turbidity beyond natural variation	2 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	8	11	12	3	2
		2 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	12	18	29	6	8
		2 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	33	48	60	14	33
Zone of Low Impact	Excess turbidity <i>may</i> push total turbidity beyond natural variation	1 x standard deviation from 20%ile mean	20%ile	Exceeded 80% of the time (24 days per month of dredging)	4	5	6	2	1
		1 x standard deviation from 50%ile mean	50%ile	Exceeded 50% of the time (15 days per month of dredging)	6	9	14	3	4
		1 x standard deviation from 80%ile mean	80%ile	Exceeded 20% of the time (6 days per month of dredging)	17	24	30	7	16
Zone of Influence	Full extent of detectable plumes (including resuspension)	Dredging related turbidity exceeds 0.5 NTU	50%ile	Exceeded 50% of the time (15 days per month of dredging)	0.5				
		Dredging related turbidity exceeds 2 NTU	80%ile	Exceeded 20% of the time (6 days per month of dredging)	2				
		Dredging related turbidity exceeds 5 NTU	95%ile	Exceeded 5% of the time (1.5 days per month of dredging)	5				

Testing of impact zones

In consultation with researchers from James Cook University, a method was developed to test whether the zones of impact developed using water quality (turbidity) thresholds in Table 6.2 and Table 6.3 are biologically meaningful. This method involved applying the turbidity thresholds to periods where actual benthic PAR monitoring data and surface PAR monitoring data coincided for three monitoring sites known to previously contain seagrass. The locations of these monitoring sites are shown in Figure 6.1 and include the following:

- Geoffrey Bay – offshore waters around Magnetic Island
- Virago Shoal – nearshore waters
- The Strand – nearshore waters.

The aim of undertaking this analysis was to assess the benthic PAR available to these seagrass areas if additional turbidity as per the turbidity impact thresholds was added to the measured PAR data. To achieve this, the time series benthic PAR was converted to time series turbidity using a light attenuation/turbidity correlation developed for each monitoring site. Once the additional turbidity was added onto this time series it was converted back to benthic PAR using the same light attenuation/turbidity correlations.

The aim was to simulate a hypothetical scenario whereby a dredge will be operating with turbid plumes being created at these threshold values. An outcome of this analysis, for example, should be that benthic PAR available to seagrass after adding the low impact or moderate impact turbidity threshold should only result in predicted low to moderate impacts and not high impacts (i.e. seagrass mortality).

The 50th percentile threshold values for Geoffrey Bay, Virago Shoal and The Strand were used as this allowed a relatively simple addition of excess turbidity to the time series PAR data.

Two week rolling averages of the derived benthic PAR data for each of the three monitoring sites are presented in Figure 6.6, which also shows baseline monitoring data (actual recorded data). Note that the monitoring periods at each site are different depending on the availability of data at each site.

The results were compared to the biological tolerances for *Halophila ovalis* in Table 6.1 noting (i) this is one of the most sensitive species to light reductions; and (ii) this is one of the most abundant species found at the monitoring locations (average water depth of 2-4m). The results indicate that:

- Using the high impact zone threshold values, there will be extended periods under ambient conditions at Virago Shoal and the Strand when benthic PAR will fall below the *Halophila ovalis* light requirement for longer than 3 weeks. On this basis, it will be predicted that turbidity in this zone will result in the total loss of seagrass (as expected of this zone). At Geoffrey Bay, benthic PAR will be below the light requirement for up to 2 weeks, resulting in more moderate impacts. This indicates the offshore threshold values are on the conservative side.
- Using the moderate impact zone threshold values, there will be short periods (1-2 weeks) when benthic PAR will be below the *Halophila ovalis* light requirement at all three sites, but PAR will remain mostly within the light requirement range.
- Using the low impact zone threshold values, benthic PAR will remain mostly within the light requirement range, with only a few very brief periods (up to one week) when benthic PAR will be below the *Halophila ovalis* light requirement.
- The zone of influence (no predicted impacts) will be in the range between the baseline and the low impact zone threshold. As indicated in Figure 6.6, benthic PAR in this range will remain above the light requirement for most of the simulated period.

Therefore, based on this analysis, the zones of impact derived using the turbidity threshold values in Table 6.2 and Table 6.3 are considered to be suitable for impact assessment purposes.

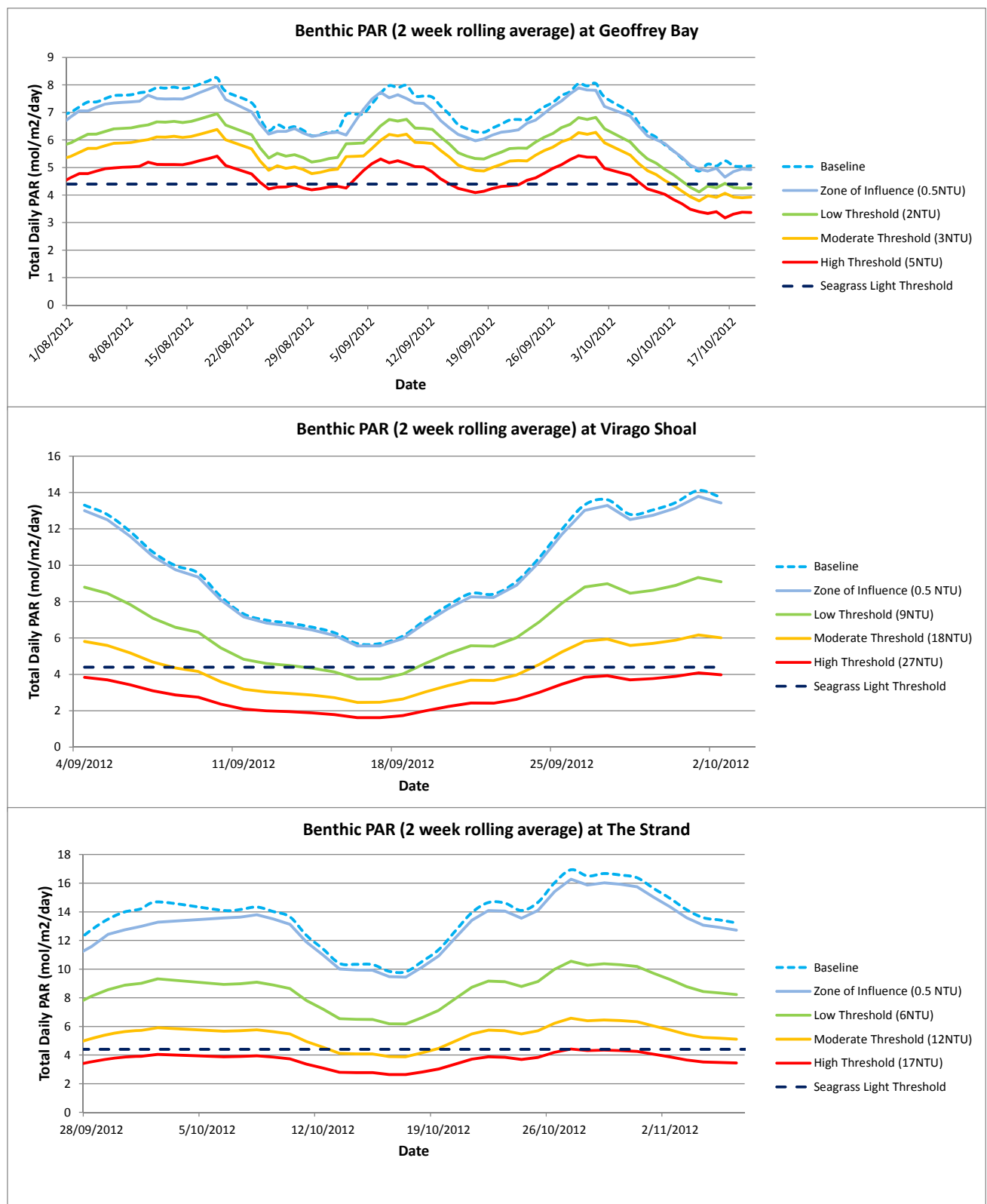


Figure 6.6 Total Daily PAR (mol/m²/day as 2 week rolling average) at Seagrass Monitoring Sites (Geoffrey Bay, Virago Shoal and the Strand) showing Baseline (actual monitoring data) and Addition of Impact Zone Threshold Values (note that scales differ between each figure)

Impact assessment methodology – sediment deposition

Sediment deposition impact thresholds should ideally:

- take into account ambient background conditions at the site
- be based on the tolerance limits of resident biota, and incorporate different levels of ecosystem stress
- use consistent methods, and have similar underlying assumptions as modelling with regard to deposition and erosion processes.

Tolerance limits

Tolerance limits vary greatly among species, as outlined in reviews by Erftemeijer *et al.* (2012) for corals, and Erftemeijer *et al.* (2006) for seagrass. In general terms many corals tend to be more sensitive to sediment deposition than seagrasses (Erftemeijer *et al.* 2006; 2012). On this basis, adopting thresholds that protect corals should protect most seagrass species, particularly those found in turbid depositional environments as occur in Cleveland Bay.

GBRMPA (2010) recommends sedimentation trigger values of 3 mg/cm²/day (mean annual) and 15 mg/cm²/day (daily maximum). GBRMPA (2010) indicates that the trigger value has low confidence, but has been developed to mitigate “excessive coral recruit mortality and includes an uncertainty factor for higher organic content or small grain sizes”.

GBRMPA (2010) suggests that this trigger value may not necessarily apply to all environments, and that “experimental evidence suggests that 10 mg/cm²/day sedimentation is valid in areas with coarse calcareous sediments, but trigger levels need to be lower where sediments are largely of terrigenous origin, of small grain size or of high organic content (De’ath and Fabricius 2008).” This is further considered below with regard to ambient environmental conditions in Cleveland Bay.

Gilmour *et al.* (2006) calculated preliminary estimates of different loads and durations likely to cause increasing levels of impacts to corals. Gilmour *et al.* (2006) cautions that the estimates are based on very limited data from their investigation area (the Pilbara) and other regions, and that levels will need to be refined and corrected through further research. The curves shown in Figure 6.7 apply to relatively tolerant coral taxa in nearshore reef systems in the Pilbara, which can have high background sedimentation rates as occurs in Cleveland Bay. These curves were assessed in the benchmarking exercise of the indicative thresholds developed for the purposes of this impact assessment.

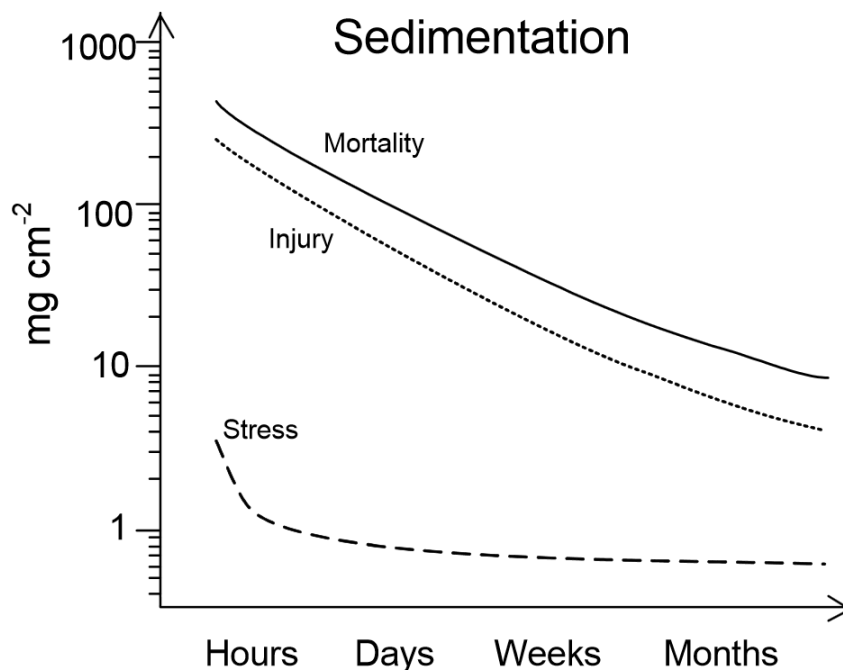


Figure 6.7 Preliminary estimates of loads and durations of sediment likely to cause impacts to corals in north-west Australia (Source: Gilmour *et al* 2006)

Ambient deposition measurements

As discussed in the EIS, sediment deposition rates vary great over time and spatially in response to wind and wave re-suspension of the seabed and environmental conditions at the receptor site. The measurement method is also important. Baseline sediment trap data collected from Middle Reef recorded sedimentation rate of 270 g/m²/day or 27 mg/cm²/day (Larcombe *et al.* 1994), whereas sedimentation rates recorded at fringing reefs of Magnetic Island varied between 26 to 3640 g/m²/day (2.6 – 364 mg/cm²/day) (Mapstone *et al.* 1992 in Larcombe and Ridd 1994). These studies were made using sediment tubes that alter hydrodynamics and significantly impede sediment resuspension. Browne *et al.* (2012) measured seasonal variations in sedimentation at Middle Reef and Paluma Shoals (located in Halifax Bay), and used a sampling device that allowed for natural resuspension of sediments. At Middle Reef, mean sedimentation rates varied among sites from 30 to 74 g/m²/day (3-7.4 mg/cm²/day), which were far lower than measured by Larcombe *et al.* 1994 using sedimentation tubes.

The lowest seasonal average sediment deposition value measured by Browne *et al.* (2012) at Middle Reef (3 mg/cm²/day) was equivalent to the annual average guideline value of GBRMPA (2010) but less than the daily maximum guideline value of 15 mg/cm²/day. It is important to note that the methods to measure sedimentation rates by Browne *et al.* (2012) and those used to calculate guideline values are unlikely to provide consistent results, and caution is therefore required when comparing values.

Adopted thresholds

Indicative impact thresholds were developed to assess potential risks of sediment deposition impacts to corals and seagrass. Similar to the water quality thresholds discussed previously, sediment deposition thresholds were scaled to take into account impact duration and intensity (i.e. 95th percentile equivalent to 1.5 days per month, 50th percentile equivalent to 15 days per month), and benchmarked to:

- GBRMPA (2010) guidelines
- Gilmour *et al.* (2006) sedimentation loads, as shown in Figure 6.7
- impact thresholds adopted by DHI (in Chevron 2010) for a dredging project in north west Australia, as shown in Table 6.5.

It is important to note that GBRMPA (2010) guidelines and Gilmour *et al.* (2006) are based on total sediment deposition levels, whereas impact thresholds adopted by DHI (in Chevron 2010) are for 'excess' sediment resulting from dredging (i.e. above background sedimentation levels) and reportedly take into account the tolerance limits of corals and seagrass found in their investigation area (North West Australia). As the modelling in the present study also reports 'excess' sediment resulting from dredging, a level of conservatism was adopted for the indicative impact thresholds.

The indicative impact thresholds were developed for impact assessment reporting purposes, i.e. prediction of potential impacts of one to two month dredging campaign. These threshold values are presented in Table 6.4. As mentioned previously, it is important to note that methods to measure sedimentation rates are varied and can produce different results. It is unknown what types of sedimentation sampling devices were used to develop the guideline values in Table 6.4. It is therefore recommended that any future monitoring program should establish trigger values based on locally specific field measurement data, and should not rely on the indicative impact thresholds adopted in the present study.

Note that while particle size of dredged sediments has been taken into account by the model, there is insufficient existing data to develop different impact thresholds for different sediment types.

Table 6.4 Impact thresholds for sediment deposition (above background)

Impact Zone	50 th ile i.e. 15 days per month (mg/cm ² /day)	95 th ile i.e. 1.5 days per month (mg/cm ² /day)	Notes
Zone of High Impact	>20.0	>200	▪ Similar to DHIs most conservative Zone of Mortality threshold of >20 mg/cm²/day averaged over 14 days ▪ More conservative (50th percentile) or similar to (95th percentile) 'mortality' thresholds in Gilmour <i>et al.</i> (2006): ▪ days (>200 mg/cm²) ▪ weeks (>70-80 mg/cm²)
Zone of Moderate Impact	10.0-20.0	100-200	▪ 50thile (medium term impact) > or = GBRMPA (2010) daily max values (15 mg/cm²/day) ▪ Similar to DHIs most conservative Zone of Partial Mortality thresholds for corals = 5-20 mg/cm²/day averaged over 14 days ▪ Upper bounds approximates 'injury' thresholds in Gilmour <i>et al.</i> (2006): ▪ days (~> 100 mg/cm²) ▪ weeks (~>20 mg/cm²)

Impact Zone	50%ile i.e. 15 days per month (mg/cm ² /day)	95%ile i.e. 1.5 days per month (mg/cm ² /day)	Notes
Zone of Low Impact	1.5-10	15-100	- Upper bound of 95%ile value (short term acute impact) > daily max value of GBRMPA (2010), i.e. 15 mg/cm²/day 50%ile (medium term impact) within range of GBRMPA (2010) mean annual and daily max values (3-15 mg/cm²/day)
Zone of Influence	0.5-1.5	5.0-15	- Upper bound of 95%ile value (short term acute impact) = daily max value of GBRMPA (2010), i.e. 15 mg/cm²/day 50%ile (medium term impact) below GBRMPA (2010) mean annual and daily max values (3-15 mg/cm²/day) - Similar to DHIs most conservative ZOI thresholds for corals = 1-5 mg/cm²/day averaged over 14 days

Table 6.5 DHI (in Chevron 2010) Impact Zone Thresholds (Above Background)

a) Coral – transitional periods

Zones	Definitions
Zone of Total Mortality	• Sedimentation > 0.2 kg/m ² /day (> 7.0 mm/14day*)
Zone of Partial Mortality	• Sedimentation 0.05 – 0.2 kg/m ² /day (1.7 – 7.0 mm/14day*)
Zone of Influence	• Sedimentation 0.01 – 0.05 kg/m ² /day (0.3 – 1.7 mm/14day*)
No Impact	• Sedimentation < 0.01 kg/m ² /day (< 0.3 mm/14day*)

* conversion from kg/m²/day to mm/14 days assumes an initial deposition dry density of 400kg/m³

b) Coral summer-winter

Zones	Definitions
Zone of Total Mortality	• Sedimentation > 0.5 kg/m ² /day (> 17.5 mm/14day*)
Zone of Partial Mortality	• Sedimentation 0.1 – 0.5 kg/m ² /day (3.5 – 17.5 mm/14day*)
Zone of Influence	• Sedimentation 0.025 – 0.1 kg/m ² /day (0.9 – 3.5 mm/14day*)
No Impact	• Sedimentation < 0.025 kg/m ² /day (< 0.9 mm/14day*)

* conversion from kg/m²/day to mm/14 days assumes an initial deposition dry density of 400kg/m³

c) Seagrass – transitional periods

Zones	Definitions
Zone of Total Mortality	• Sedimentation > 0.7 kg/m ² /day (> 25 mm/14day*)
Zone of Partial Mortality	• Sedimentation 0.2 – 0.7 kg/m ² /day (7 – 25 mm/14day*)
Zone of Influence	• Sedimentation 0.03 – 0.2 kg/m ² /day (1 – 7 mm/14day*)
No Impact	• Sedimentation < 0.03 kg/m ² /day (< 1 mm/14day*)

* conversion from kg/m²/day to mm/14 days assumes an initial deposition dry density of 400 kg/m³

d) Seagrass – summer-winter

Zones	Definitions
Zone of Total Mortality	• Sedimentation > 1 kg/m ² /day (> 35 mm/14day*)
Zone of Partial Mortality	• Sedimentation 0.3 – 1 kg/m ² /day (10 – 35 mm/14day*)
Zone of Influence	• Sedimentation 0.04 – 0.3 kg/m ² /day (1.5 – 10 mm/14day*)
No Impact	• Sedimentation < 0.04 kg/m ² /day (< 1.5 mm/14day*)

* conversion from kg/m²/day to mm/14 days assumes an initial deposition dry density of 400 kg/m³

Note that the units for sedimentation can be expressed as either kg/m²/day or mg/cm²/day, as shown in the above tables. The difference between the units is two orders of magnitude – e.g. 0.2 kg/m²/day is equal to 20 mg/cm²/day.

Revised impact assessment

The following impact assessment assumes that no mitigation measures, such as constraints on overflow, are implemented (i.e. unmitigated case).

The assessment considers both the 'Expected Case' and likely 'Worst Case' as per GBRMPA modelling guidelines. Modelling was undertaken to simulate dredging during five different 30 day periods during different seasons and the results were aggregated to determine likely impacts. The 'Expected Case' impacts were determined on the basis of the average turbidity and deposition percentiles at each location over the five different modelling periods. The 'Worst

Case' impacts were determined on the basis of the maximum turbidity and deposition percentiles at each location from all of the five modelling periods. Further description of this is included in Appendix A2 (Modelling Report).

Stage 1 dredging

Stage 1 will be undertaken over a 4.5 year period and consists of the following.

- Construction of temporary perimeter revetment structures to capture any soft sediments and subsequent construction of revetment structures including removal of soft sediments (0.3 million m³) under retaining wall structures along the perimeter of the proposed interim reclamation area. This will be carried out by a mechanical dredger and relocated to temporary bund areas within the existing reclamation area.
- Widening the Platypus Channel on its western side (a new width of 180 m at the outer harbour, tapering to 135 m at its northern end), and widening the Sea Channel on its eastern side (for 135 m at the southern end to 120 m at its northern end). The soft marine sediments and dense clayey sands will be dredged by TSHD (dredge volume of 1.5 million m³). The stiff, very stiff and hard clays will be dredged by a mechanical dredger (dredge volume of 2.4 million m³).
- The dredging of Berth 12 by mechanical dredger (dredge volume of 1.4 million m³).
- Total dredge volume of approximately 5.6 million m³.
- All dredge material to be placed in the reclamation.
- Duration of dredging for Stage 1 estimated as follows:
 - construction of temporary revetment structures including placement of soft material – 12 months
 - channel widening by TSHD – 4 months
 - channel widening by mechanical dredger – 2.3 years
 - Berth 12 – 15 months
 - total duration of Stage 1 ~ 4.5 years.

For the purposes of the AEIS, it was assumed that a small TSHD (hopper capacity of approximately ~ 3,000 m³) would complete the TSHD dredging. Previously in the EIS, it was assumed a medium sized TSHD would be used.

The following percentile contour plots, sourced from Appendix A2 (Modelling Report), show depth averaged dredging-related turbidity above background levels for the TSHD dredging for the Expected Case (Figure 6.8) and the Worst Case (Figure 6.9). The mechanical dredging plots, which show very minimal dredge plumes, are presented in Appendix A2 (Modelling Report).

Note that the scales used on the plots differ between the 50th and 95th percentiles to reflect ambient turbidity during these varying conditions. Plots shown are based on the following percentile values:

- 50th percentile plot - typical (median) turbidity levels, which occur 50% of the time
- 95th percentile plot - infrequent periods (occurring 5% of the time) of high turbidity.

For context, percentile contour plots showing modelled ambient turbidity (without dredging) during 50th and 95th percentile conditions are provided in the Appendix A2 (Modelling Report).

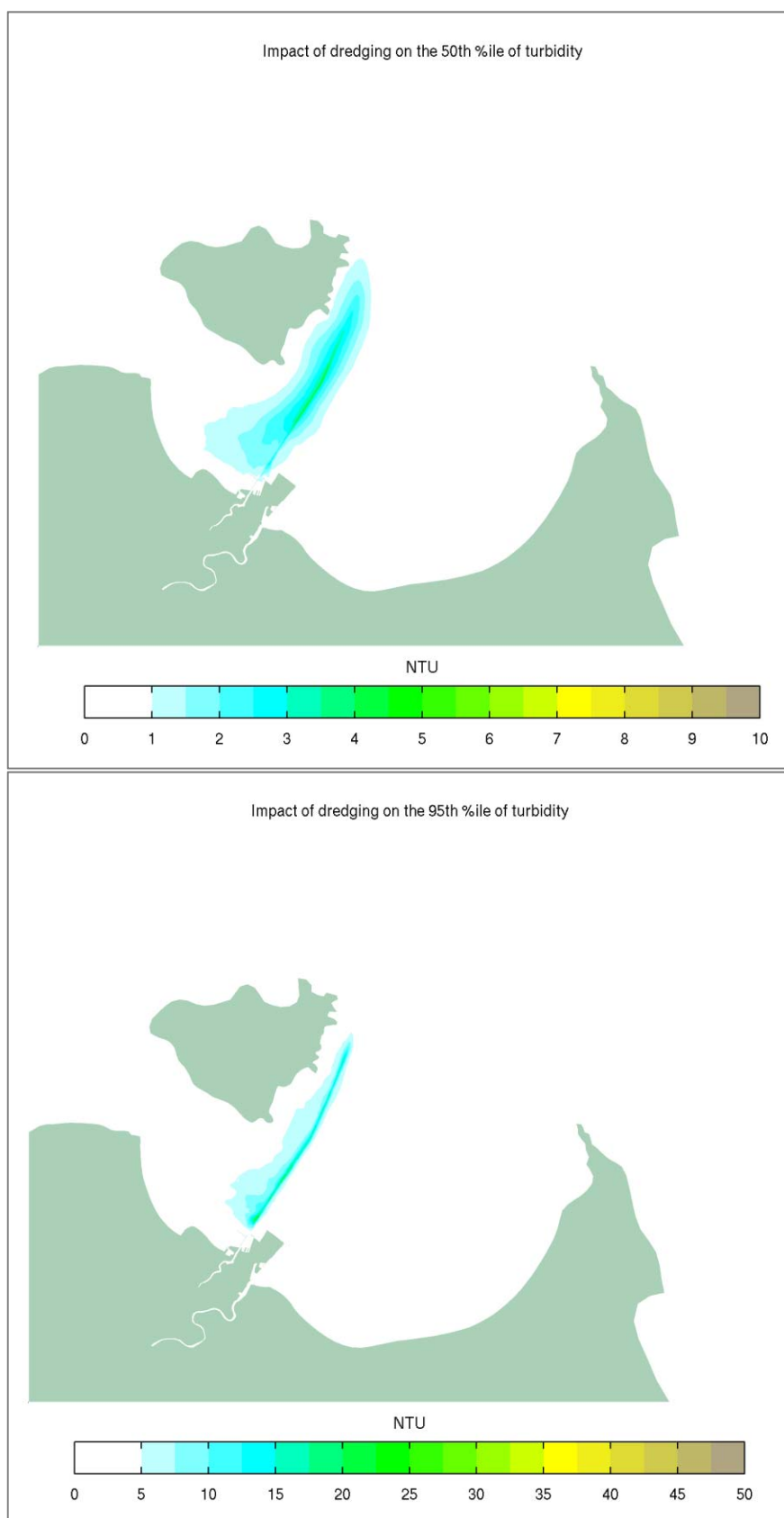


Figure 6.8 Impact of Dredging on the 50th Percentile (top) and the 95th Percentile (bottom) – Stage 1 (Widening) by TSHD – Expected Case (note that scales differ between the two figures)

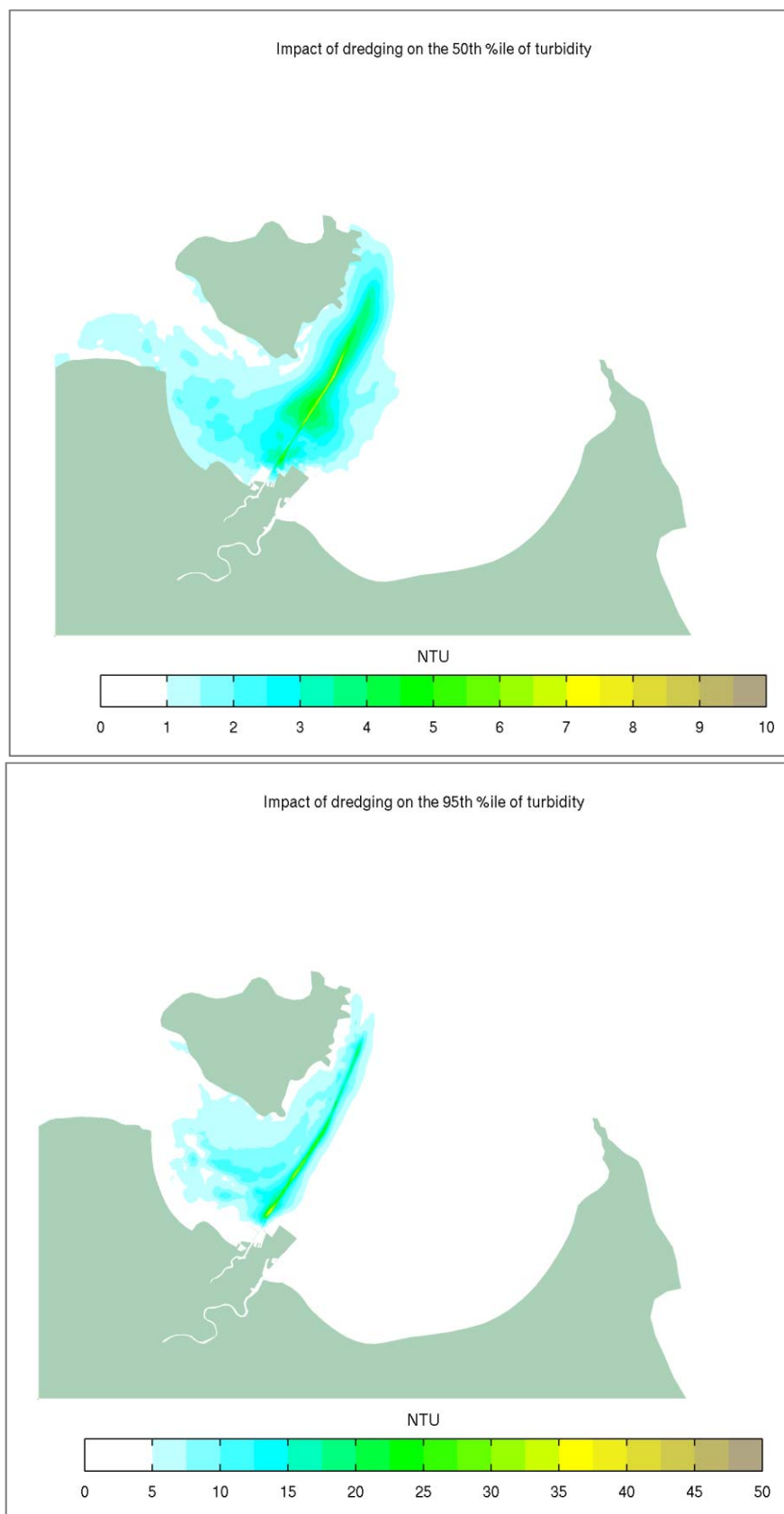


Figure 6.9 Impact of Dredging on the 50th Percentile (top) and the 95th Percentile (bottom) – Stage 1 (Widening) by TSHD – Worst Case (note that scales differ between the two figures)

The impact significance of these results is interpreted using zones of impact as described previously. Note that model outputs from both the TSHD dredging and the mechanical dredging were combined (as both types of dredging will likely be undertaken concurrently) for the purposes of the zone of impact assessment.

The impact zone maps for Stage 1 dredging for the Expected Case and the Worst Case are shown in Figure 6.10 and Figure 6.11 respectively, and indicate the following.

- For the Expected Case, the zone of influence (detectable plumes but negligible impacts predicted) extends to the eastern Magnetic Island Coastline and through West Channel past Middle Reef. There is a zone of low impact (potential low level sub-lethal impacts to sensitive receptors, if present) extending out from the dredge channel by approximately 1 km each side of the channel. However, this zone does not extend to areas of sensitive ecological receptors.
- For the Worst Case, the zone of influence extends further west along the mainland coastline and around the north-eastern corner of Magnetic Island. The zone of low impact extends to the eastern Magnetic Island coastline between Geoffrey Bay and Florence Bay/Gowrie Bay on the north-eastern coast. These areas are known to contain corals and seagrass. There is also a relatively small zone of moderate impact (moderate sub-lethal impacts/small scale mortality of sensitive receptors, if present) located near the channel bend where the junction of the Platypus Channel and the Sea Channel. This zone is limited to the channel and areas directly adjacent.
- The impact zones are concentrated around the outer section of the Platypus Channel and the inner section of the Sea Channel. This is likely due to the volume of material and material type being dredged in these areas, and the lower impact thresholds in the offshore waters. While dredge plumes are predicted to occur in nearshore areas (including inner Platypus Channel), they are not predicted to cause impacts due to the naturally elevated turbidity (and hence impact threshold values) in these nearshore areas.

Based on areas of low impact predicted to occur along the coastline of Magnetic Island during the Worst Case scenario, *minor* impacts are predicted from Stage 1 dredging.

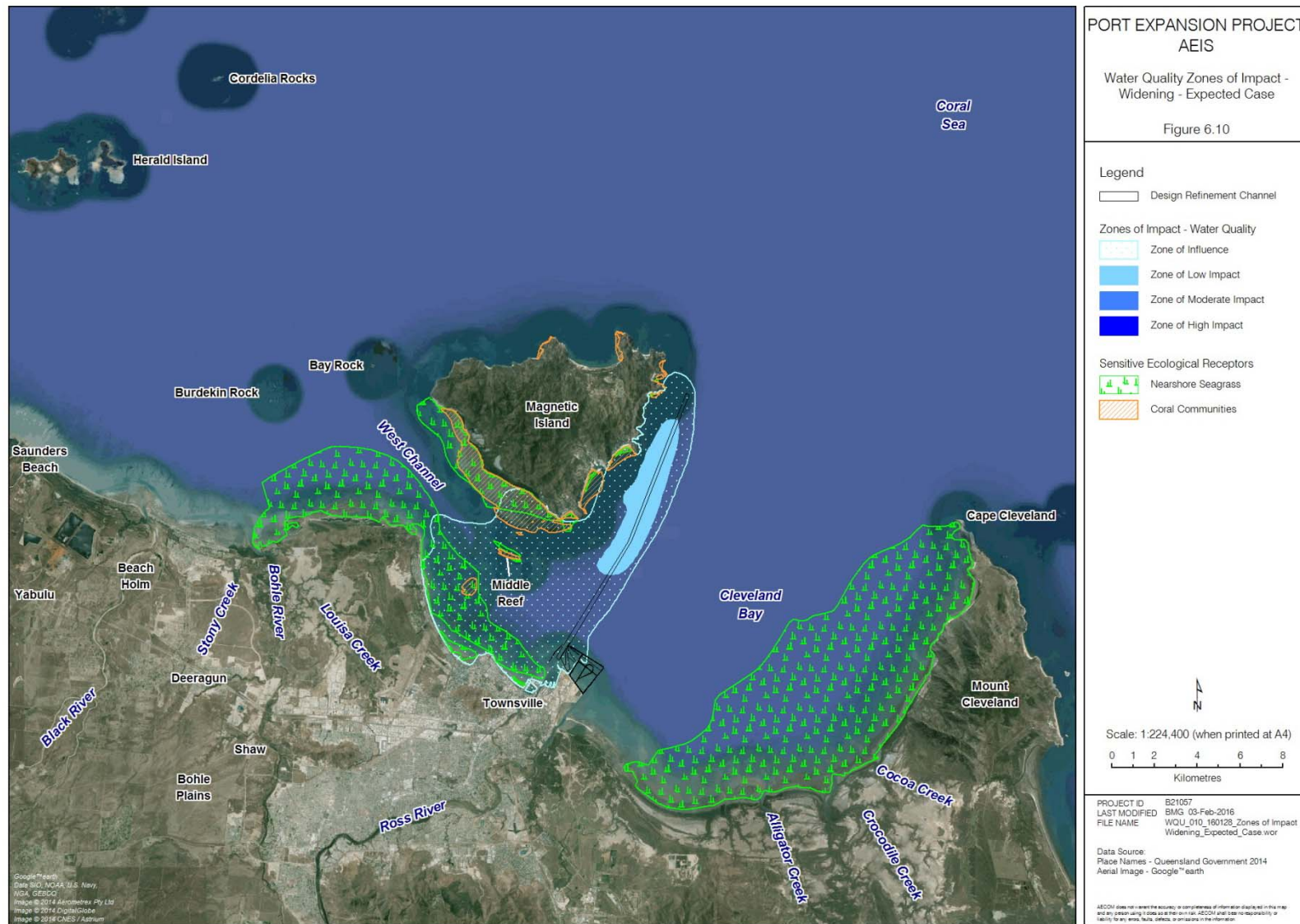


Figure 6.10 Water Quality Zones of Impact – Stage 1 (Widening) - Expected Case

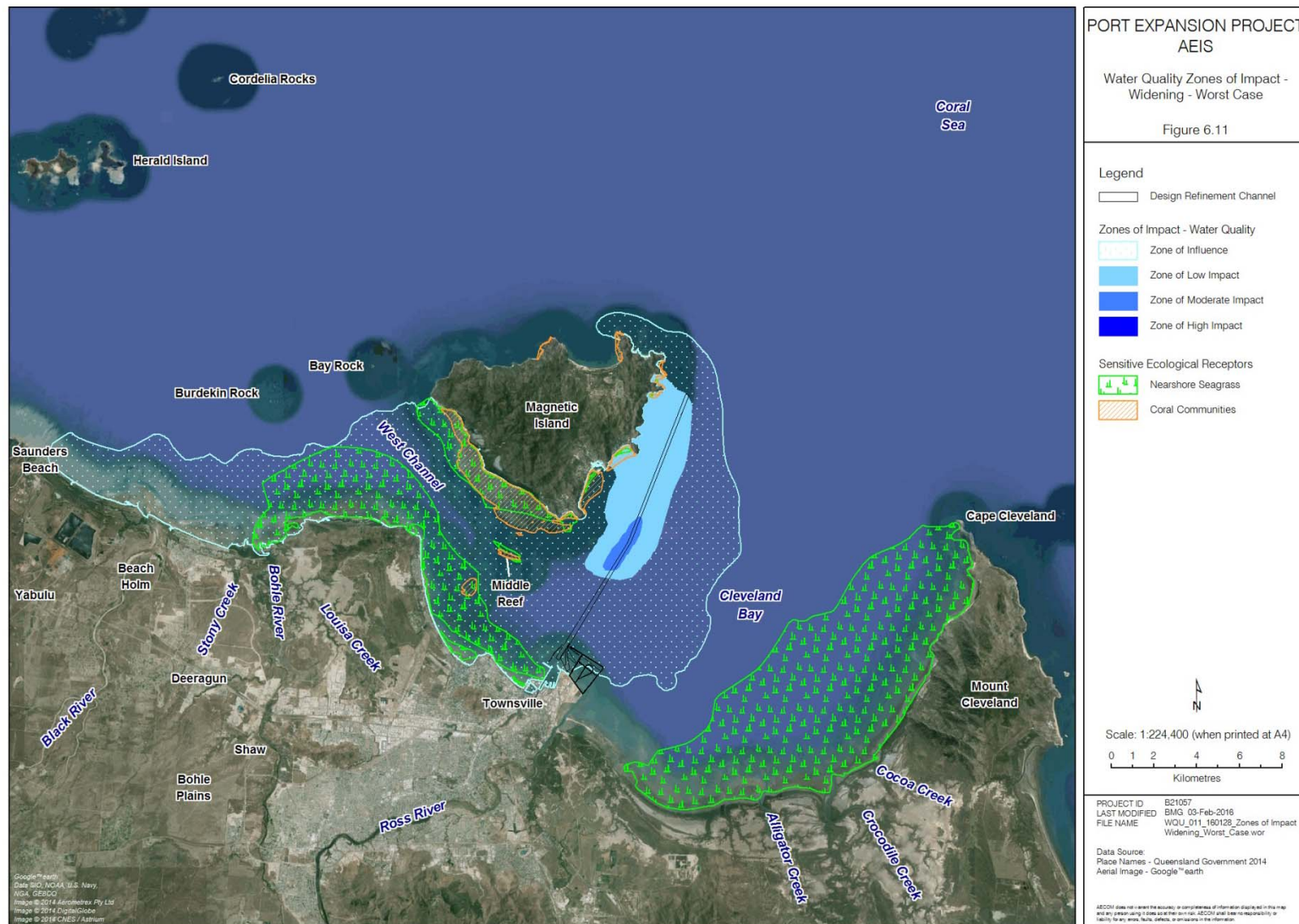


Figure 6.11 Water Quality Zones of Impact – Stage 1 (Widening) - Worst Case

Stage 2 dredging

Stage 2 involves dredging berths 14, 15 and 16 in the outer harbour (3.6 million m³), as well as soft sediments under the footprint of the final reclamation bunds and breakwater (0.2 million m³). The total dredge volume is expected to be 3.8 million m³ and be undertaken over a duration of 4.5 years by a mechanical dredger as follows:

- reclamation works – 12 months
- Berths 14, 15 and 16 ~ 3.5 years
- total ~ 4.5 years.

Modelling plots in Appendix A2 (Modelling Report) indicate that turbid dredge plumes from dredging during Stage 2 are limited to the outer harbour area, and do not disperse over a wide area (i.e. do not disperse near any sensitive ecological receptors). Therefore, *negligible* impacts are predicted from Stage 2 dredging.

Stage 3 dredging

Stage 3 dredging will be undertaken over a 2.5 year period and consists of the following:

- Deepening of the Platypus Channel and the Sea Channel to a Navigation Design Depth of -12.8m LAT. The total dredge volume is expected to be 2 million m³, with the soft marine sediments and dense clayey sands will be dredged by TSHD (dredge volume of 0.7 million m³), and the stiff, very stiff and hard clays will be dredged by a mechanical dredger (dredge volume of 1.3 million m³).
- The dredging of the berth pockets for Berths 17 and 18 by a mechanical dredger (0.08 million m³).
- Duration of dredging is:
 - channel deepening by TSHD – 8 weeks
 - channel deepening by mechanical Dredger – 2.2 years
 - Berths 17 and 18 – 5 weeks
 - total ~ 2.5 years.

The following percentile contour plots show depth averaged dredging-related turbidity above background levels for the TSHD dredging for the Expected Case (Figure 6.12) and the Worst Case (Figure 6.13) during Stage 3 dredging. The mechanical dredging plots, which show very minimal dredge plumes, are presented in Appendix A2 (Modelling Report).

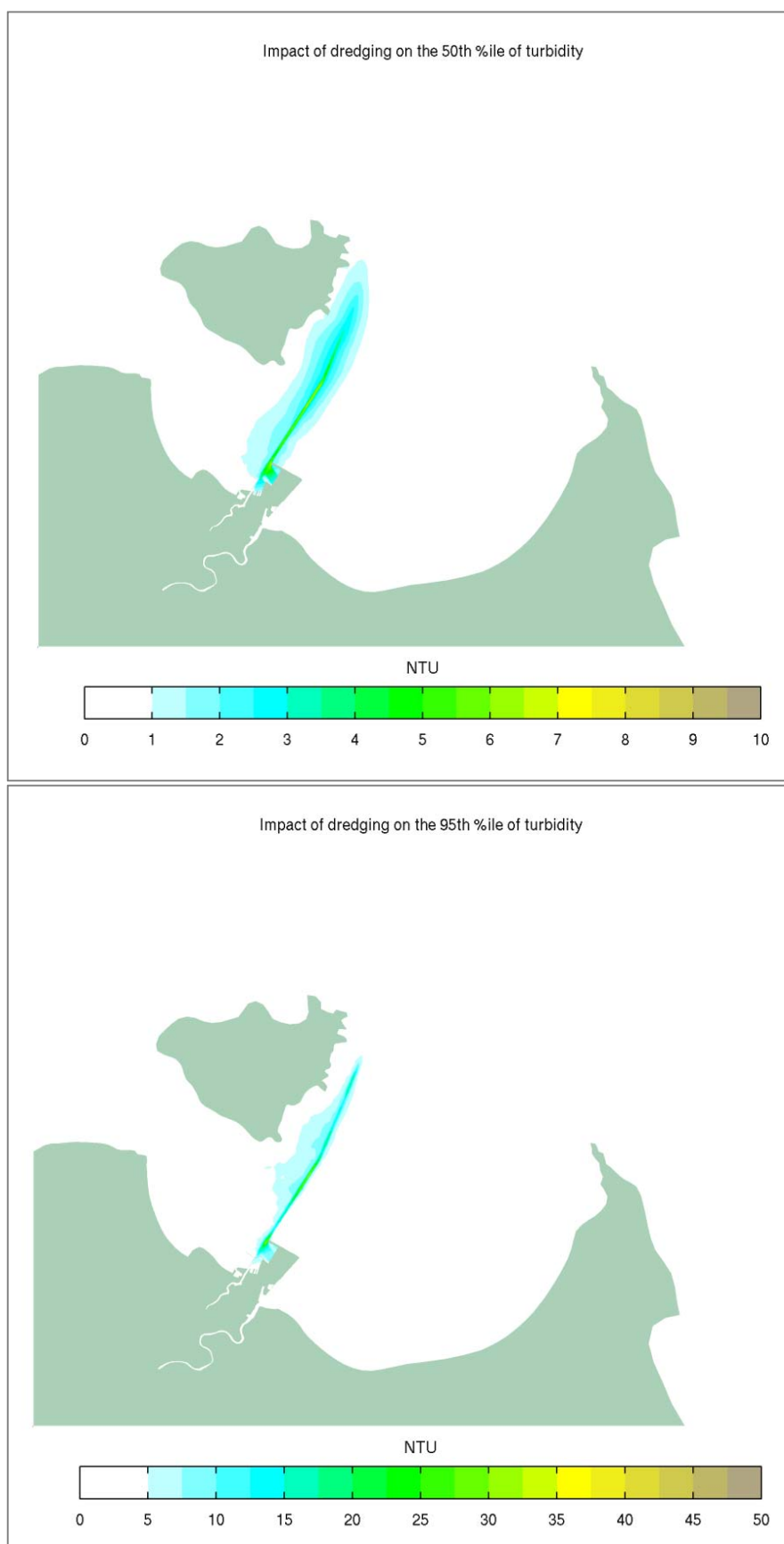


Figure 6.12 Impact of Dredging on the 50th Percentile (top) and the 95th Percentile (bottom) – Stage 3 (Deepening) by TSHD – Expected Case (note that scales differ between the two figures)

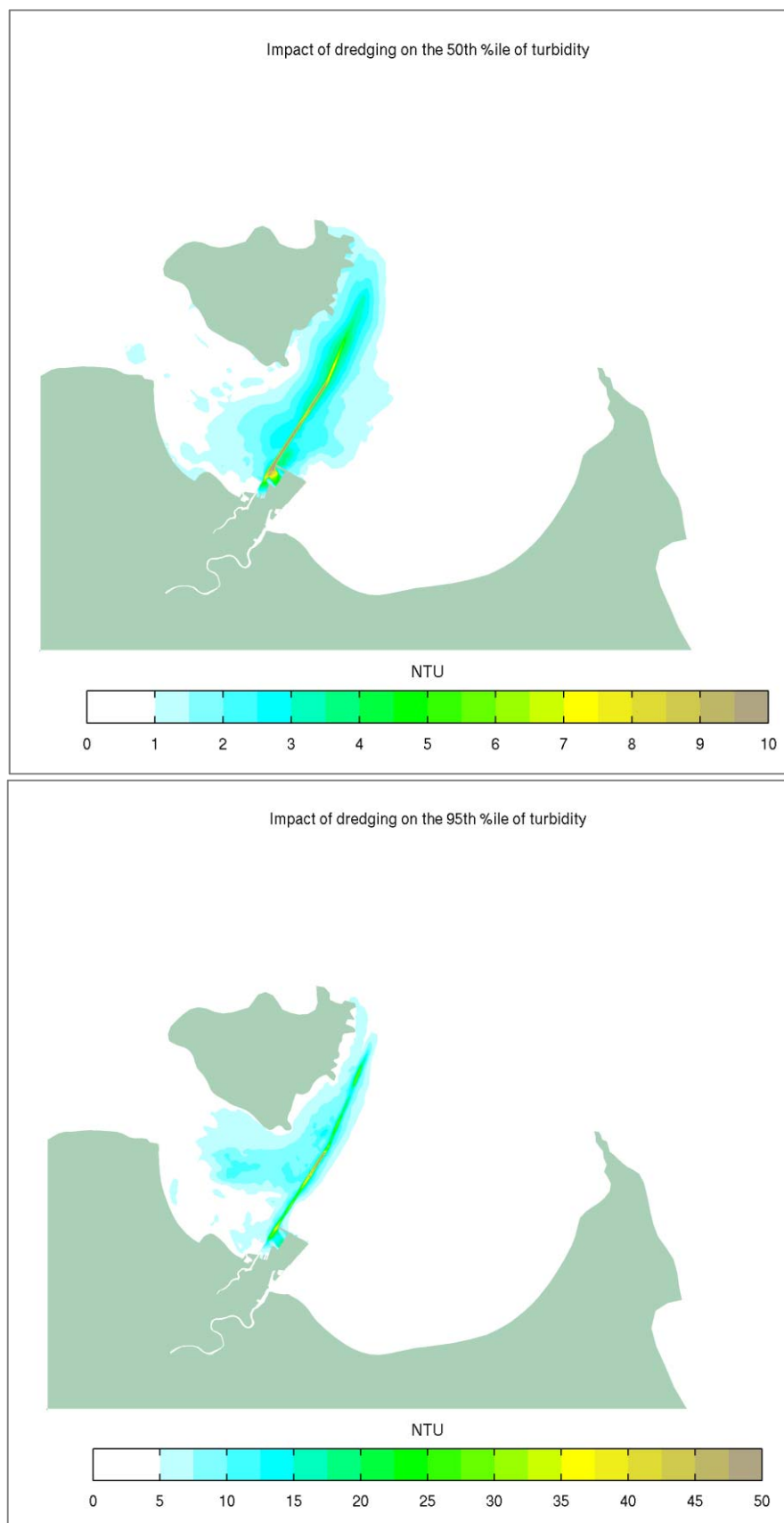


Figure 6.13 Impact of Dredging on the 50th Percentile (top) and the 95th Percentile (bottom) – Stage 3 (Deepening) by TSHD – Worst Case (note that scales differ between the two figures)

The significance of these results is interpreted using zones of impact as described previously. Note that the model outputs from both the TSHD dredging and the mechanical dredging were combined (as both types of dredging will likely be undertaken concurrently) for the purposes of the zone of impact assessment.

The impact zone maps for Stage 3 dredging for the Expected Case and the Worst Case are shown in Figure 6.14 and Figure 6.15 respectively. These figures indicate that the zones of impact for Stage 3 (deepening) are very similar to Stage 1 (widening), with a zone of low impact extending to the north-eastern coast of Magnetic Island under the Worst Case scenario. This similarity is due to the use of similar dredging campaigns (equipment and dredge material type) for both stages.

Based on areas of low impact predicted to occur along the coastline of Magnetic Island during the Worst Case scenario, *minor* impacts are predicted from Stage 3 dredging.

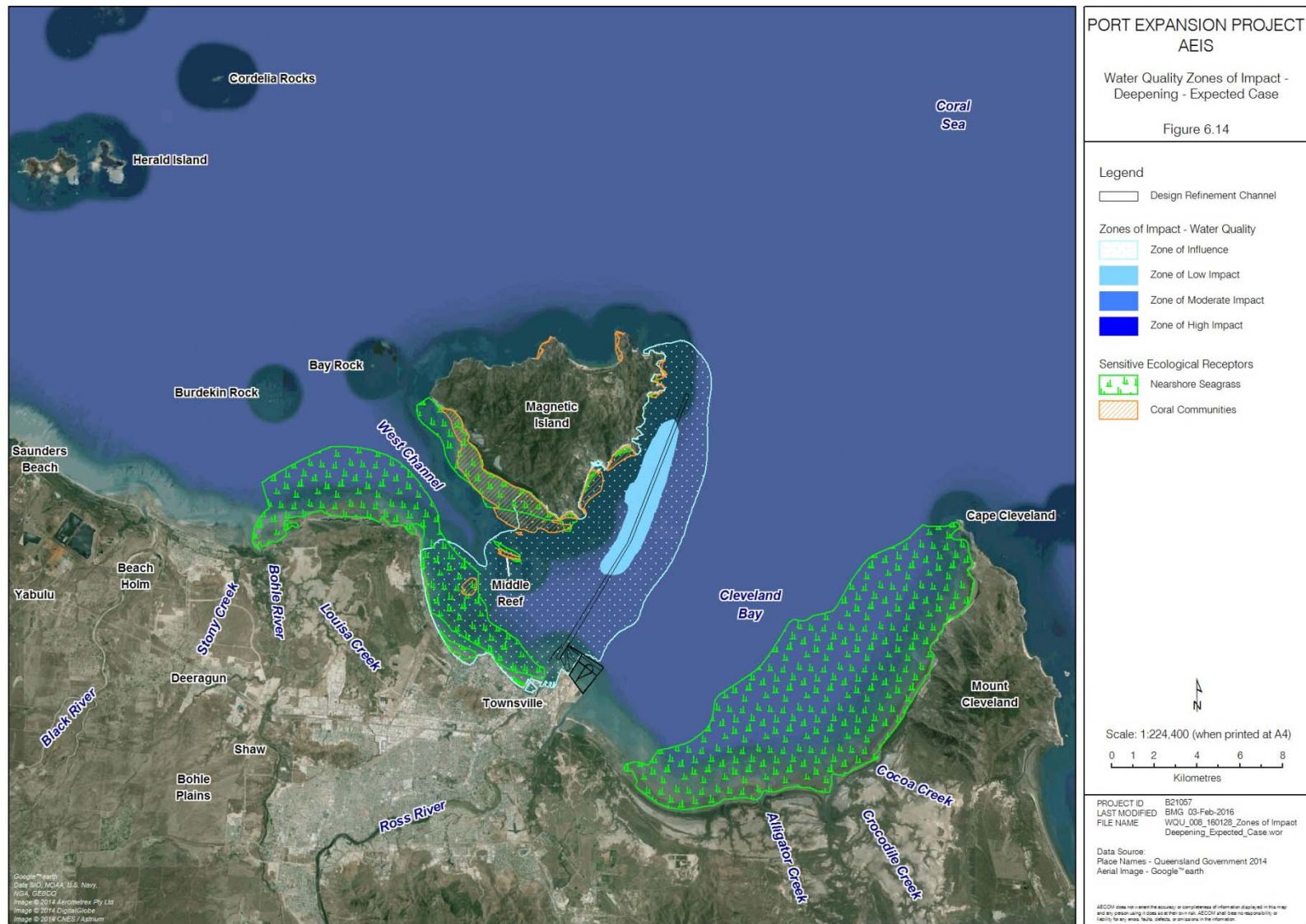


Figure 6.14 Water Quality Zones of Impact – Stage 3 (Deepening) – Expected Case

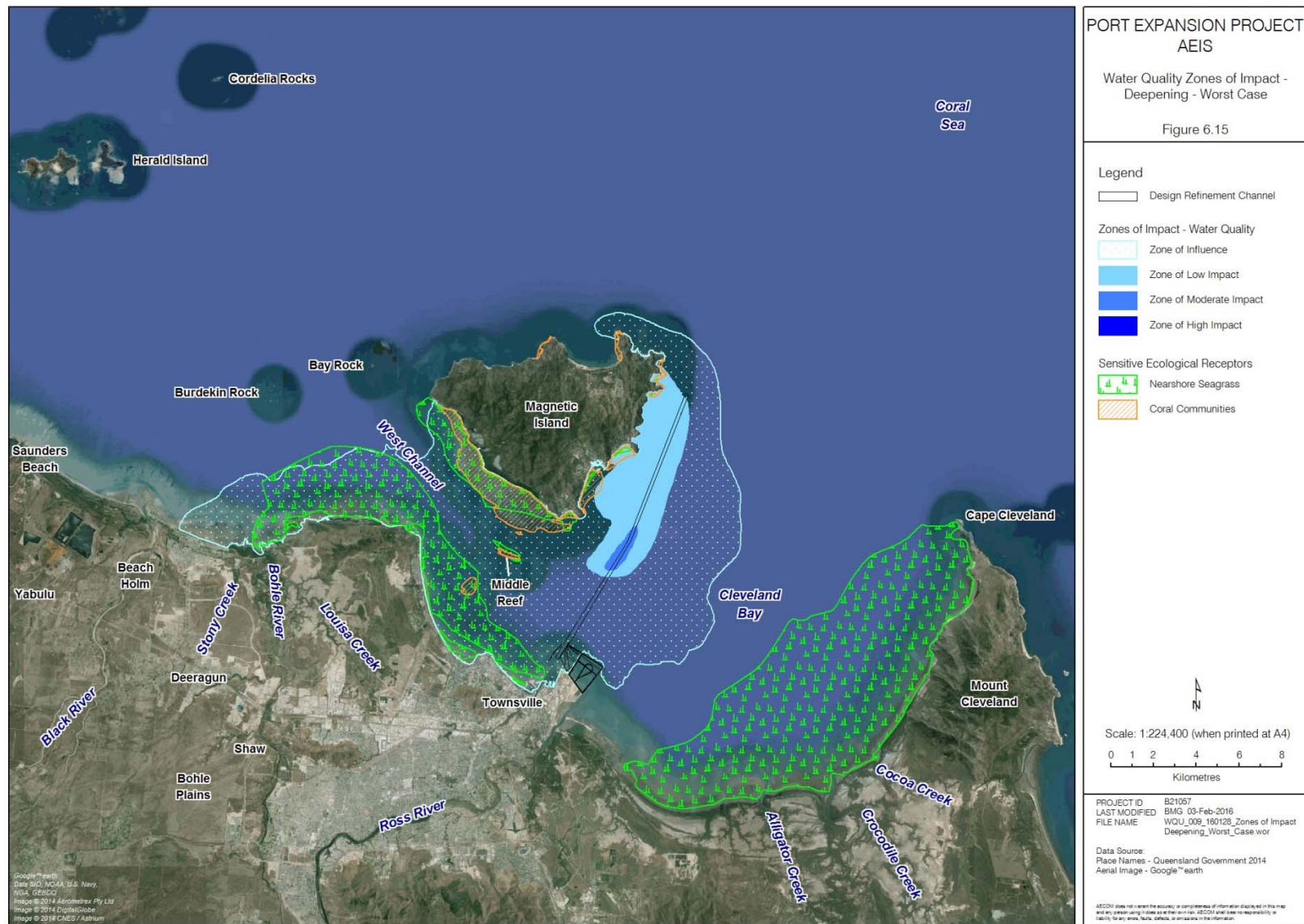


Figure 6.15 Water Quality Zones of Impact – Stage 3 (Deepening) – Worst Case

Sediment deposition

While the previous section assessed impacts to water quality from suspended sediments in the water column as a result of turbid dredge plumes, this section assesses the potential impacts in terms of sediment deposition from the settlement of these suspended sediments.

Resuspension of sediments was also simulated during the modelling period, i.e. the sediment deposition results indicate the final location of settled sediment particles at the end of the modelling period, and each particle may have been re-deposited a number of times over the modelling period due to resuspension.

Sediment deposition percentile contour plots are presented in Appendix A2 (Modelling Report). The impact significance of the sediment deposition results is interpreted using similar zones of impact to water quality. These sediment deposition zones of impact are described in the impact assessment methodology section.

The impact zone maps for sediment deposition for the Expected Case and the Worst Case are shown in Figure 6.16 to Figure 6.19, and indicate the following.

- There is a zone of high impact (i.e. 50th percentile deposition rates of >20 mg/cm²/day, and/or 95th percentile deposition rates of >200 mg/cm²/day) predicted to occur during the Worst Case scenario for Stage 3 (deepening) only. However, this zone of high impact is limited to the area of dredging in the outer harbour (Figure 6.19).
- During the Worst Case scenarios for both stages, there are zones of moderate impact (i.e. 50th percentile deposition rates of 10-20 mg/cm²/day, and/or 95th percentile deposition rates of 100-200 mg/cm²/day) predicted to occur along the Platypus Channel and areas directly adjacent to the channel. The zone of moderate impact is predicted to be slightly larger during Stage 3 (deepening), however does not extend to areas of sensitive ecological receptors.
- Sediment deposition during Stage 1 (widening) and Stage 3 (deepening) will be predicted to result in similar zones of low impact (i.e. 50th percentile deposition rates of 1.5-10 mg/cm²/day, and/or 95th percentile deposition rates of 15-100 mg/cm²/day) in the channel and adjacent areas. These zones extend close to the Magnetic Island coastline during the Worst Case Scenario, but do not extend into areas of sensitive ecological receptors.

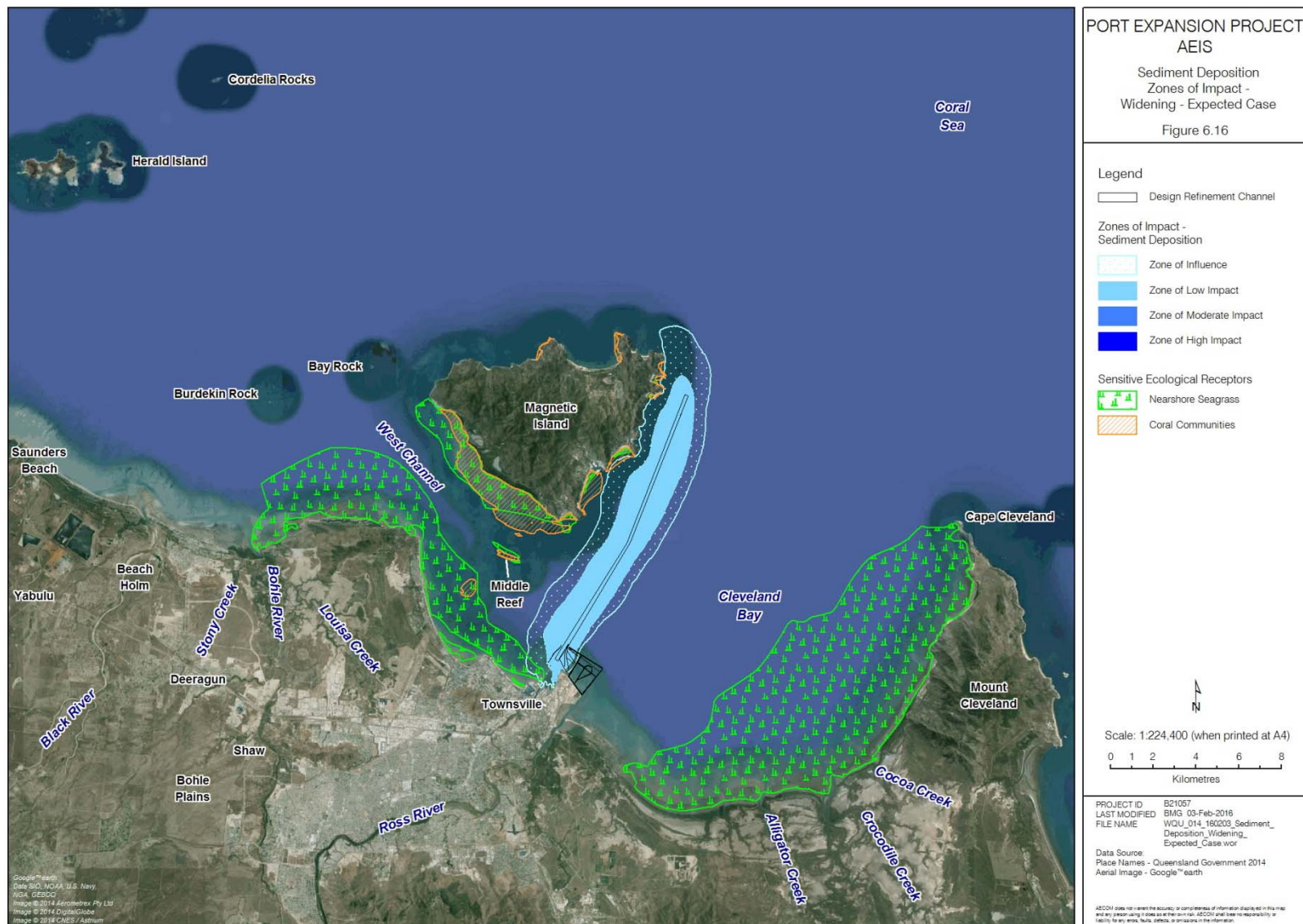


Figure 6.16 Sediment Deposition Zones of Impact – Stage 1 (Widening) – Expected Case

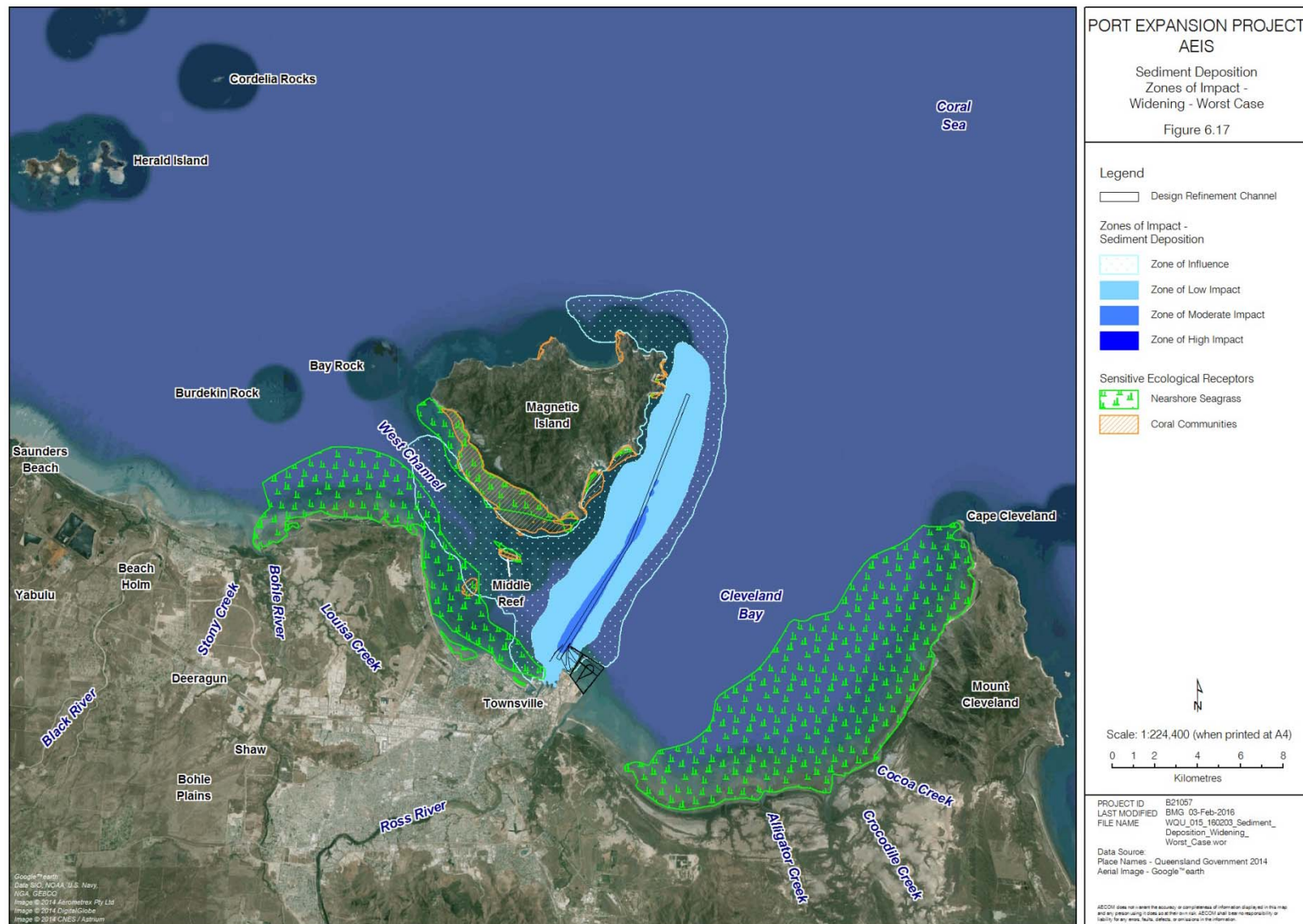


Figure 6.17 Sediment Deposition Zones of Impact – Stage 1 (Widening) – Worst Case

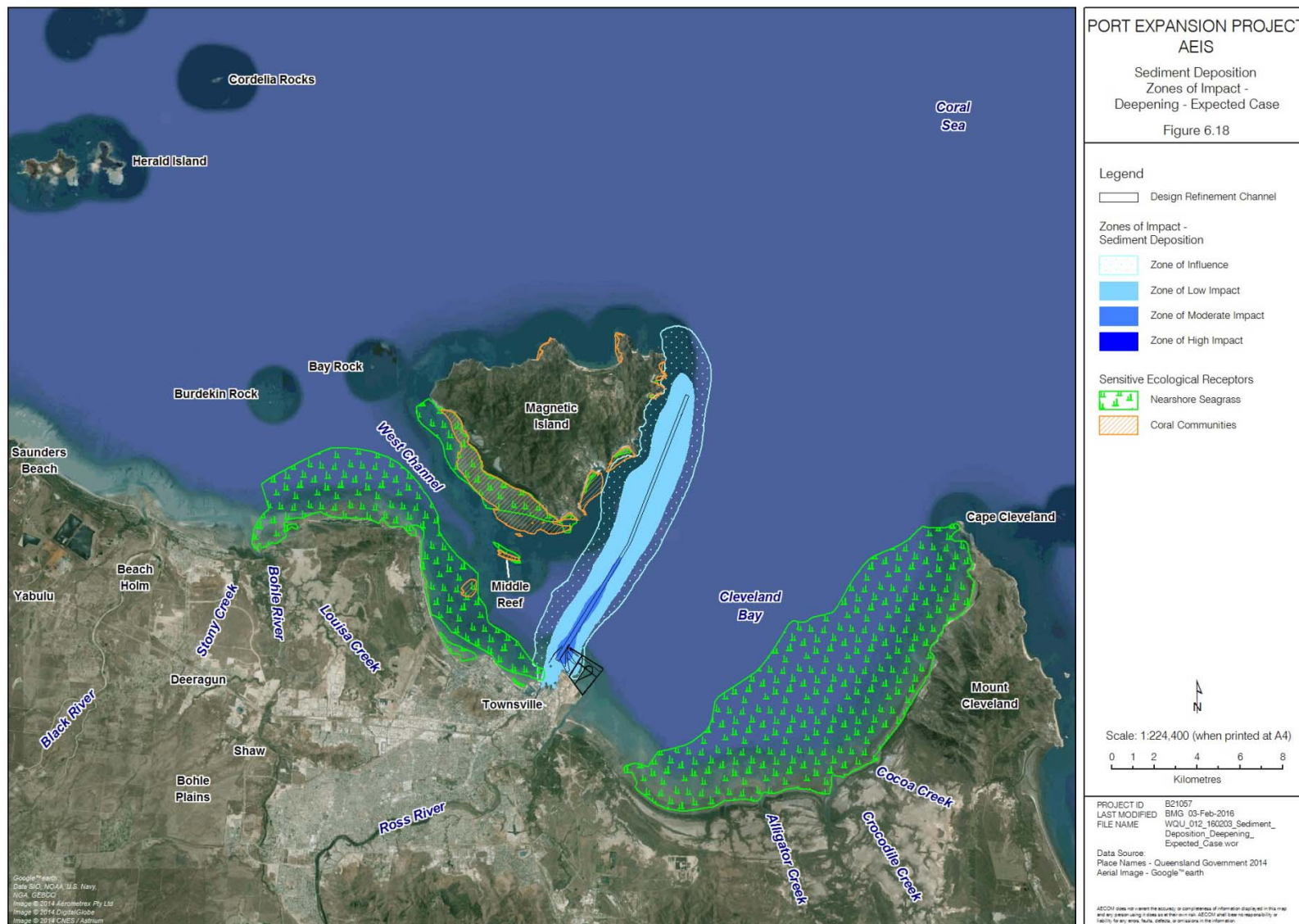


Figure 6.18 Sediment Deposition Zones of Impact – Stage 3 (Deepening) – Expected Case

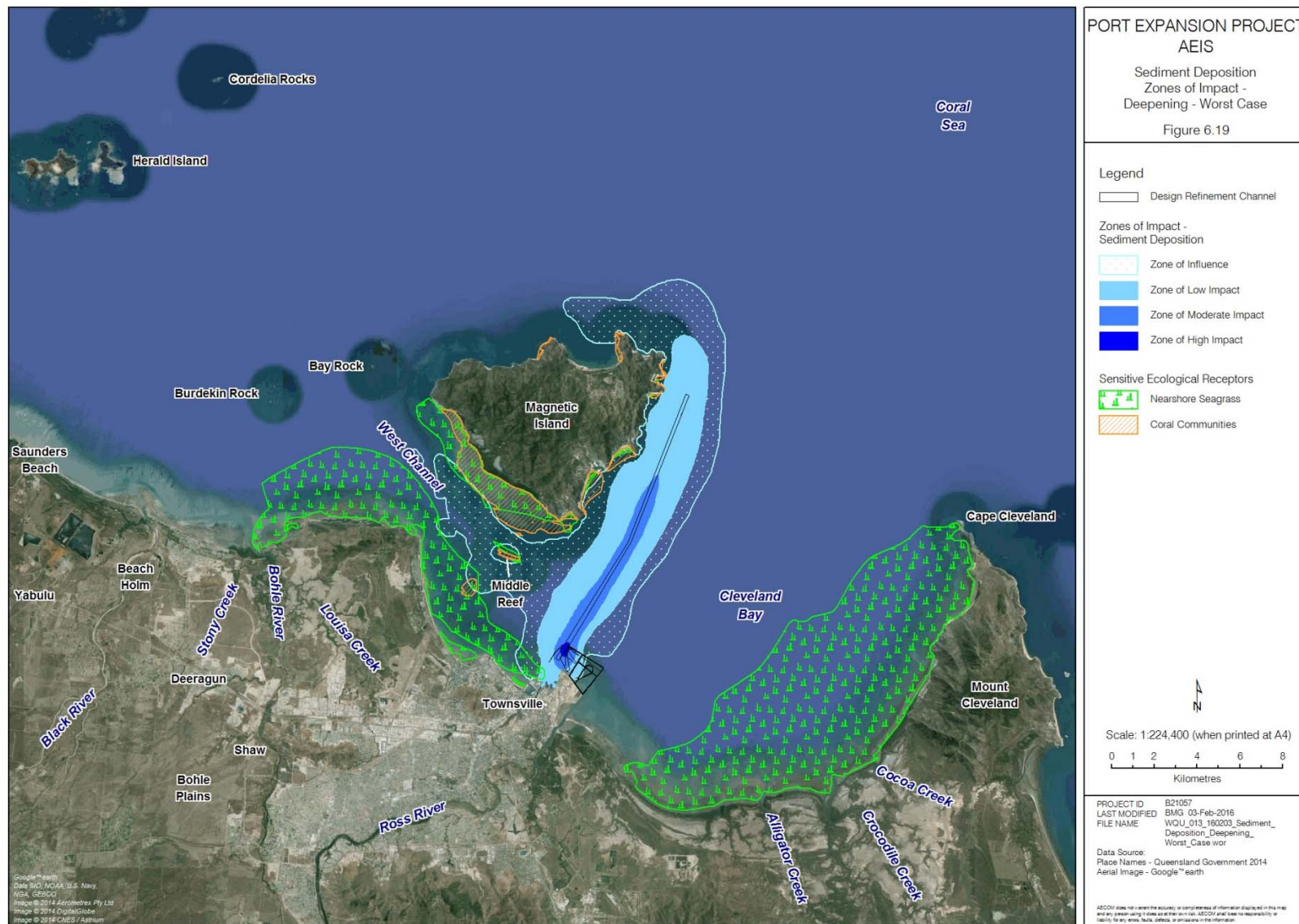


Figure 6.19 Sediment Deposition Zones of Impact – Stage 3 (Deepening) – Worst Case

Maintenance dredging

As discussed further in Section 5.0 (Coastal Processes), the ultimate development of the PEP is predicted to increase the volume of maintenance dredging by approximately 14% with the design refinement, mostly due to the increased channel width. This section presents the findings of additional modelling of maintenance dredging using the increased volume of material.

A maintenance dredging campaign was modelled assuming an additional 14% of maintenance dredge material. The model results were assessed using the water quality zones of impact methodology, with results presented in Figure 6.20. These results indicate the following.

- There will be a zone of influence (detectable plumes but negligible impacts predicted) along the channel areas extending to the west past Middle Reef, and also in the marine DMPA. The only zone of impact is a zone of low impact predicted to occur in a relatively localised area near the channel bend.
- The impacts predicted from the slightly increased maintenance dredging campaign are similar to previous assessments of maintenance dredging undertaken in 2013 (BMT WBM 2013) and in 2014 (BMT WBM 2014). These assessments involved modelling of typical and worst case maintenance dredging campaigns, and found that impacts from annual maintenance dredging under different periods are predicted to be negligible, with zones of impact restricted to areas within and immediately adjacent to dredging and placement areas only. The change in turbidity due to dredging at sensitive receptor locations is predicted to remain well within the range of variability in ambient water quality of Cleveland Bay.
- These previous studies also concluded cumulative impacts from maintenance dredging and placement impacts have been assessed and indications are that the relative contribution of dredge sediment to overall sedimentation processes operating in Cleveland Bay are minimal and cumulative impacts on water quality (between years) and marine habitats that are currently in poor (recovering) condition are not expected. Furthermore, maintenance dredging during increased turbidity from flood plumes will not be expected to noticeably contribute to impacts on ecosystems due to the flood plumes.

Therefore, based on the above finding, it is concluded that negligible impacts are predicted from maintenance dredging.

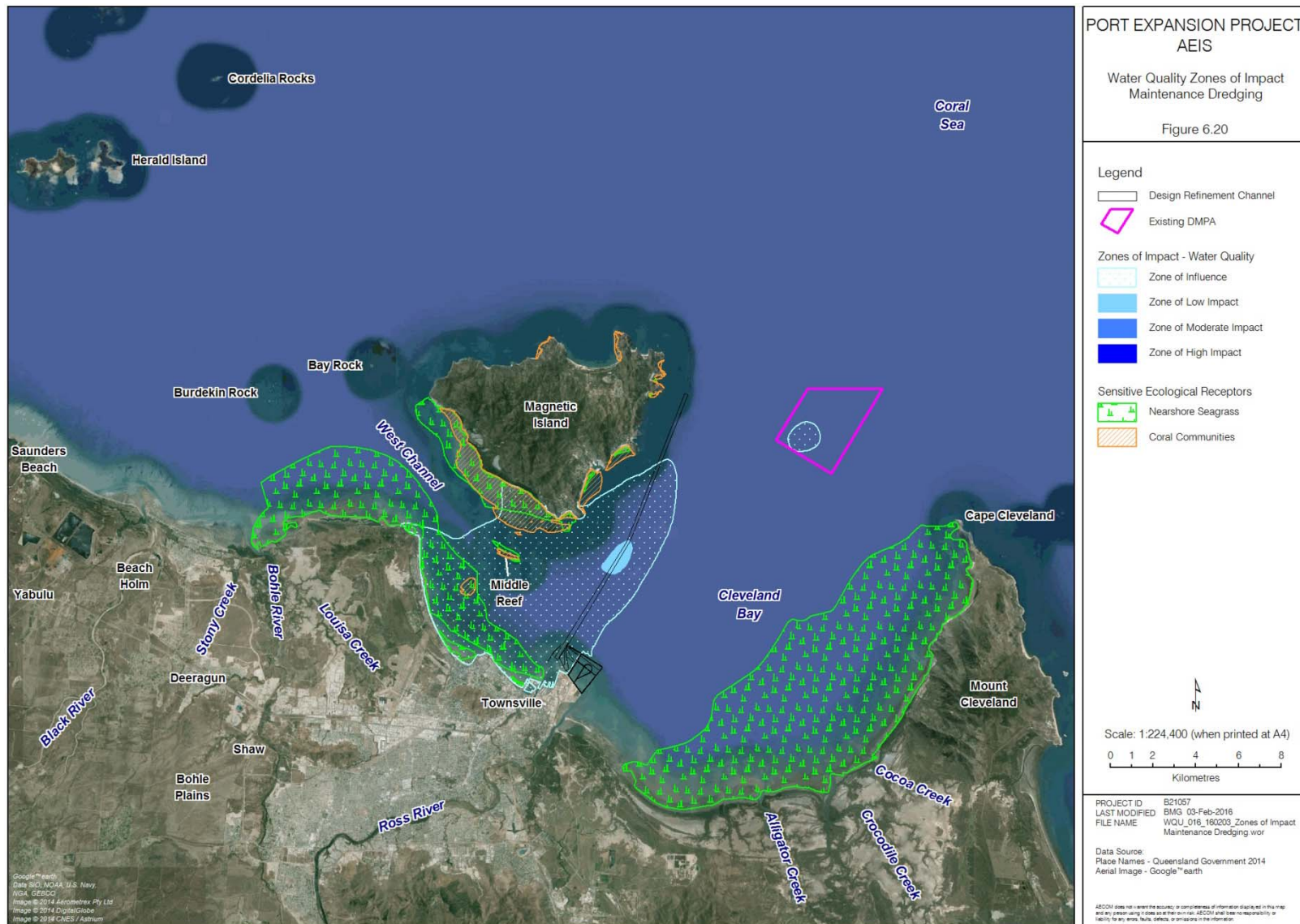


Figure 6.20 Water Quality Zones of Impact – Maintenance Dredging

Tailwater impacts

As dredge material is placed into reclamation, the supernatant water (i.e. excess water overlaying the dredge material) will be discharged from the south-eastern corner of the reclamation into the mouth of the Ross River (Figure 6.21).

To assess the potential impacts from tailwater discharges, tailwater from the reclamation during dredging was simulated in all modelling scenarios. The results indicated that the suspended sediments discharged in the tailwater will be negligible relative to the receiving environment. There were minimal turbidity plumes which were localised near the tailwater discharge location in the percentile contour plots (Appendix A2), and the magnitude of these turbidity plumes was too low to show up in any of the zones of impact figures presented above.

Therefore, based on this, it is concluded that *negligible* impacts are predicted from tailwater discharges from the reclamation during dredging works.



Figure 6.21 Tailwater Discharge Location from the Reclamation Area

Summary of findings

The revised impact assessment indicates that the largest impact from dredging operations is predicted to occur during the channel widening (Stage 1) and channel deepening (Stage 3) of the Platypus and Sea Channels when dredging is undertaken by a TSHD. Turbid dredge plumes from dredging during Stage 2 will be limited to the outer harbour area, and will not disperse over a wide area (i.e. do not disperse near any sensitive ecological receptors).

Dredging by the mechanical dredger is predicted to produce insignificant turbid dredge plumes relative to the TSHD dredging.

Impact assessment using 'zones of impact' indicates that during Stages 1 and 2, the coastal waters along the north-eastern coast of Magnetic Island are predicted to fall within the zone of low impact (potential low level sub-lethal impacts of sensitive receptors, if present) during the Worst Case scenario only. During the Expected Case, all zones of impact will be limited to the channel and adjacent areas where sensitive ecological receptors are not known to occur. Note that these findings relate to the unmitigated dredging case.

Zones of moderate impact (moderate sub-lethal impacts/small scale mortality of sensitive receptors, if present) are predicted to occur during the Worst Case scenario only, and in localised areas near to the channel bend where sensitive ecological receptors are not known to occur.

Sediment deposition during Stage 1 and Stage 3 will be predicted to result in zones of low impact extending close to the Magnetic Island coastline but not into areas of sensitive ecological receptors.

Based on these assessments, *minor* impacts (as defined in the EIS) are expected during dredging works due to low level of potential impacts to water quality (and sensitive ecological receptors) along the coastal waters of Magnetic Island. Due to the likelihood (possible) of these minor impacts occurring, the risk rating is considered to be *low*. Despite the low risk rating, these impacts can be further mitigated with measures discussed in the following section.

As discussed further in the Cumulative Impacts section (Section 25.0), the above impact predictions should be considered in the context of the condition of sensitive ecological receptors (e.g. seagrass and corals) prior to dredging. If the condition is poor and resilience is low, the impacts may be greater than predicted. To address this, the Dredge Management Plan (DMP) includes a requirement to assess the condition of seagrass and corals in areas likely to be affected by dredging, prior to commencement of dredging and development of trigger levels by the Technical Advisory Committee (TAC).

6.3.4.2 Mitigation measures

The mitigation measures which were specified in the EIS still remain relevant and are to be implemented as part of the capital dredging campaign.

If the mitigation measures described above and in the DMP are implemented, the residual risk rating to marine water quality is considered to be *low*.

6.3.5 Summary

The following table summarises the revised impact assessment based on the design refinement, including a revised risk rating, additional mitigation measures required, and a revised residual (mitigated) risk rating.

Table 6.6 Assessment Summary Table – Marine Water Quality

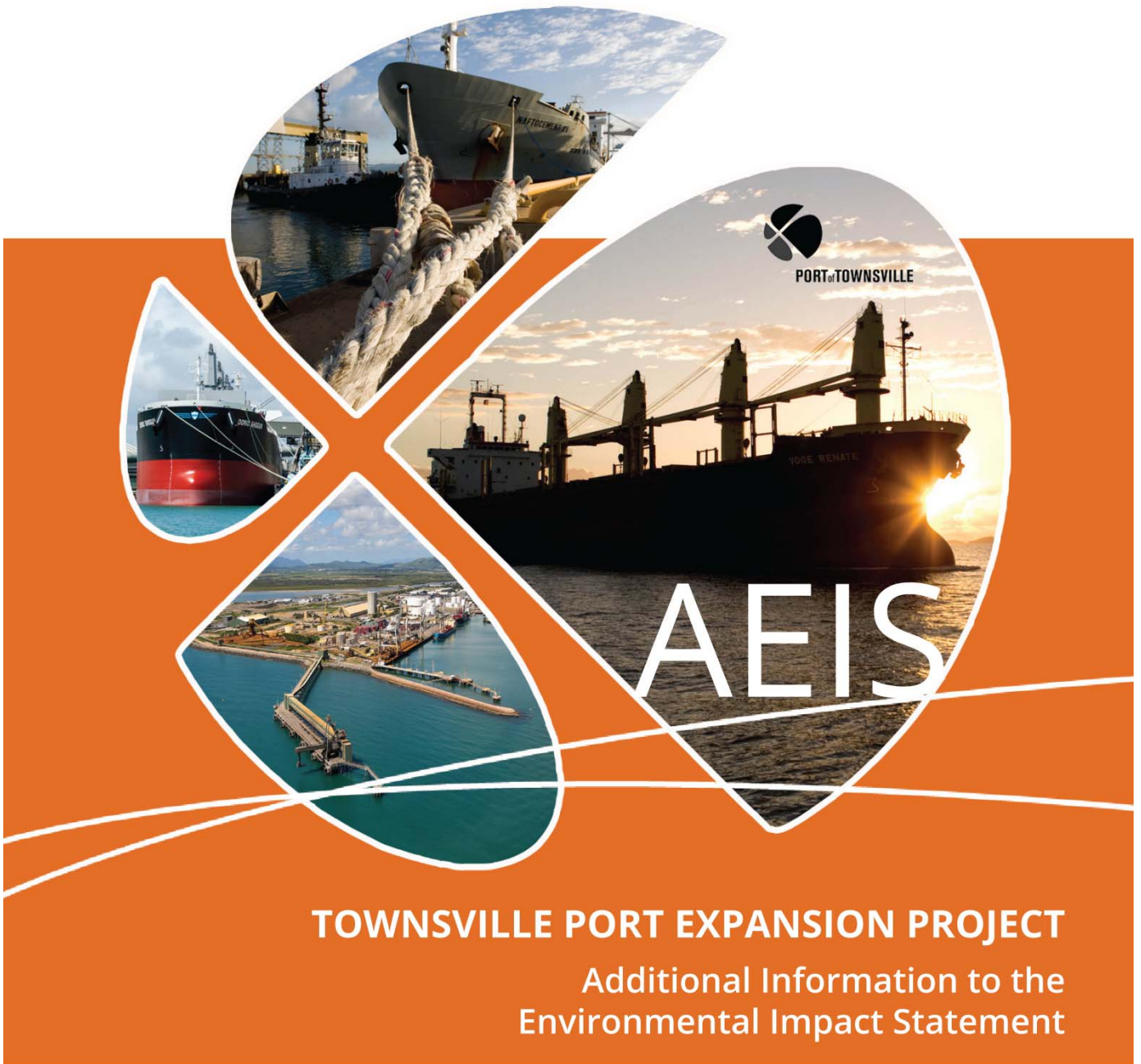
Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Dredging	Generation of turbid plumes - <i>TSHD</i>	Local Scale: Minor Dredging of the outer harbour and Sea/Platypus Channels will create turbid plumes, with zones of low impact predicted to occur along the north-eastern coast of Magnetic Island during the Worst Case Scenario only, and a zone of moderate impact in the immediate vicinity of the dredge.	Likely	Medium	Implement standard mitigation measures as per the DMP. Implement additional mitigation measures, including development and implementation of a Reactive Monitoring Program (RMP) with appropriate triggers and corrective actions.	Low
		Broader Scale: Minor While turbid plumes at the dredge site and surrounds are expected, the plume will disperse the further away from the impacting area and is unlikely to impact on the broader values. Zones of impact largely located near the dredged channel area.	Unlikely	Low	As above	Low
	Generation of turbid plumes – <i>mechanical dredge</i>	Local Scale: Negligible Dredging of the outer harbour and Sea/Platypus Channels will create very minor turbid plumes in the immediate vicinity of the dredge.	Likely	Low	Implement standard mitigation measures as per the DMP.	Low
		Broader Scale: Negligible Turbid plumes are unlikely to impact on the broader values.	Unlikely	Low	As above	Low
	Mobilisation of contaminants into the water column	Local Scale: Minor Dredging of the outer harbour and Sea/Platypus Channels may mobilise nutrients/heavy metals into the water column potentially affecting water quality near sensitive habitats.	Possible	Low	Further sediment quality testing prior to dredging.	Low
		Broader Scale: Negligible Unlikely to impact on the broader values.	Unlikely	Negligible	Nil	Negligible

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Reclamation	Generation of turbid plumes	Local Scale: Minor Discharge of tailwater will create turbid plumes potentially resulting in localised zones of impact immediately adjacent to the tailwater discharge point.	Possible	Low	Management of tailwater discharge quality through the implementation of a tailwater management plan. Use of appropriately designed sedimentation pond to reduce TSS. Implementation of best management sediment and erosion control plans.	Low
		Broader Scale: Negligible The turbid plumes from the tailwater will disperse and be unlikely to impact on the broader values.	Unlikely	Negligible	As above	Negligible
	Mobilisation of contaminants into the water column	Local Scale: Minor Discharge of tailwater may mobilise nutrients/heavy metals into the water column potentially affecting water quality near sensitive habitats.	Possible	Low	Management of tailwater discharge quality through the implementation of a tailwater management plan.	Low
		Broader Scale: Negligible Any contaminants in plumes from the tailwater will disperse and be unlikely to impact on the broader values.	Unlikely	Negligible	Nil	Negligible
	Discharge of acidic tailwater from acid sulfate soil (ASS) in reclamation	Local Scale: Minor Discharge of acidic tailwater due to presence of ASS in reclamation ponds may adversely impact sensitive ecological receptors in the vicinity of the tailwater release.	Likely	Medium	Manage ASS in accordance with the ASS Management Plan. Management of tailwater discharge quality through the implementation of tailwater management plan.	Low
		Broader Scale: Negligible The acidic tailwater will be diluted in the broader receiving waters and be unlikely to impact on the broader values.	Unlikely	Negligible	As above	Negligible

6.4 Conclusion

With the design refinement and the refined impact assessment methodology, it is predicted that during the Worst Case scenario only, zones of low impact will extend from the dredge area to waters adjacent to the north-eastern coast of Magnetic Island, where sensitive ecological receptors are known to occur. It is predicted these zones of impact can be mitigated through the implementation of various mitigation measures, including a reactive monitoring program (RMP) to validate impact assessment findings and monitor key thresholds for impacts as a trigger for corrective actions.

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SECTION 7

Marine Sediment Quality



7.0 Marine Sediment Quality

7.1 Introduction

Marine sediment quality of the Project area and surrounds are discussed in Chapter B.5 (Marine Sediment) of the Environmental Impact Statement (EIS). Maintenance dredging of port areas has been undertaken in Cleveland Bay for over 100 years in order to maintain navigable shipping channels, berths and vessel swing basins. Capital dredging works have also been required from time to time as a result of expansion to Port of Townsville (POTL) infrastructure. Therefore, marine sediments in Cleveland Bay, particularly in the vicinity of port infrastructure and the main shipping channel (i.e. the Port Expansion Project footprint) have a long history of regular disturbance from dredging activities.

However, as discussed in the Water Quality section (Section 6.0), while it is accepted that there is some level of anthropogenic sources of sediments in Cleveland Bay (dredging, port activities and other urban development), the general consensus is that the sediment in Cleveland Bay is predominantly derived from sediments deposited during the Holocene period (e.g. Larcombe and Ridd 1994, and Orpin 1999).

Catchment land use practices and discharges from anthropogenic coastal sources have at times resulted in elevated levels of nutrients and other contaminants in places, particularly in Ross River, Ross Creek and nearshore areas of Cleveland Bay. Coastal sediments throughout Cleveland Bay also have the potential for acid generation when exposed to the air because of their natural sulphur content (i.e. potential acid sulfate soils as discussed in Chapter B.5 of the EIS).

Marine sediments in the reclamation area, outer harbour, Platypus Channel and Sea Channel are broadly characterised by two strata, described by Golder (2008a) as follows:

The surface layer of recent (in a geological timescales sense) seabed sediments generally consisted of approximately 60 to 70% silts and clays with some sand zones (i.e. a mixture of soft silty clay to clayey silt, with loose sand, silty sand and clayey sand also present). Shell fragments and organic materials commonly occurred in this layer. The surface materials represented potential acid sulfate sediments and, also due to their soft and compressible nature, were considered unsuitable for use as reclamation fill or as the foundation support material for marine structures. This surface layer had a thickness of approximately 1 to 1.5m on the seabed in the outer harbour and reclamation areas. In the Platypus and Sea channels this surface layer was usually thinner, in the order of 0.5 to 1.0m.

Beneath the surface layer was a subsurface layer of harder sandy clays and sands (i.e. a mixture of stiff to hard clays and sandy clays, with dense clayey sands and sands also present).

A number of submissions were received in response to the EIS which are relevant to marine sediment quality. Key issues raised from the submission process include:

- inadequate assessment of mercury and cyanide in dredged material
- inclusion of diuron and furan data in assessment
- adequacy of sediment quality data
- assessment of particulate nutrients.

Responses to these key issues raised in submissions are provided in the following sections.

7.2 Response to Submissions

7.2.1 Inadequate assessment of mercury and cyanide in dredged material

Seven submissions raised matters on inadequate assessment of mercury and cyanide in dredged material which could be released into the water column as a result of capital dredging. Specifically, the submissions questioned if high concentrations of mercury and cyanide are located within a deposition layer (approximate depth of 2 m), believed to have originated from mining practices in the early 1900s in the Charters Towers area. Submissions suggest that mercury and cyanide from gold mining practices may have been transported down the Burdekin River and into Cleveland Bay.

A range of studies have analysed mercury in sediments at various sediment depths in Cleveland Bay and none of these studies have found mercury levels in elevated concentrations. Golder (2008b) found that mercury concentrations were below laboratory detection limits (and screening levels) in all samples in the outer harbour. URS (2008) measured trace metal/metalloid concentrations at Berth 11, adjacent to Townsville outer harbour, and found that all trace metals/metalloids (including mercury) were below screening levels.

Based on historical sampling bioavailability and ecotoxicity testing of sediment by Hydrobiology (2003a), found that mercury concentrations were below screening levels in all samples. Most recently, POTL has only analysed sediment samples for nine key metal/metalloid contaminants of concern (antimony, arsenic, cadmium, chromium, copper, nickel, lead, silver and zinc) because all others had been found consistently below the limits of detection. Furthermore, mercury is not considered a contaminant of concern for the Port of Townsville (GHD, 2008) and as a result is not part of the routine monitoring program.

URS (2010) reported that there are no known natural resources of mercury (Hg) in the Port of Townsville catchment area. Nevertheless, URS (2010) analysed for mercury in the analysis of Berth 12 dredge area sediments and found that mercury was in low concentrations and below NAGD screening levels for all samples.

In regards to cyanide, it is not typically tested as part of sediment quality studies due to its limited presence in environment. Therefore, it is considered highly unlikely that cyanide would be present in concentrations of concern in marine sediments in Cleveland Bay.

Notwithstanding the above, the potential impacts from mercury and cyanide will be reduced as the revised Project design now includes placement of all dredge material in reclamation instead of the marine DMPA.

Based on the above, it is considered highly unlikely that mercury and/or cyanide would present a risk from disturbance of dredge material as part of the PEP. Further testing of marine sediments prior to dredging, as part of sediment Sampling and Analysis Plan, provides a further safeguard to ensure this outcome.

7.2.2 Inclusion of dioxins and furans data in assessment

Two submissions raised the lack of data for dioxins and furans in the marine sediment quality assessment. Specifically, the submission suggested that all data be presented and discussed, including the dioxin and furan data that is known to have been collected in early 2013.

Geochemical Assessments (2013) conducted sediment sampling and analysis on behalf of POTL for their maintenance dredging permit. On request from DEHP, this sampling also included testing for dioxins and furans.

As the EIS was submitted in late 2012, this data was not yet available for inclusion in the Marine Sediment chapter of the EIS. However, the Geochemical Assessments (2013) report is now available and the findings can be summarised as follows.

- Concentrations of dioxins/furans in sediment at the Port of Townsville decrease with distance from fluvial inputs. The concentration of dioxins/furans in a single core in Ross Creek suggests a historical source of these contaminants.
- Concentrations of dioxins/furans in sediment at the Port of Townsville (maximum 18.4 pg TEQ/g) are higher than those reported for other areas in Queensland, but well below background values for these contaminants in Port Jackson. The mean concentration of dioxins/furans in sediment within maintenance dredge areas within the Port of Townsville was 1.80 pg TEQ/g (maximum 3.06 pg TEQ/g).
- There is no widely accepted sediment quality guideline value for dioxins/furans in Australia. The mean concentration of dioxins/furans in all sediments collected in maintenance dredging areas at the Port of Townsville (1.80 pg TEQ/g medium bound) exceeded the Canadian Environmental Quality Guideline ISQG value (0.85 pg TEQ/g), but not PEL value (21.5 pg TEQ/g) for these compounds in sediment. Adjusting the reported concentrations of dioxins/furans in the sediment by an amount reported for blank concentrations would reduce mean concentrations of PCDD/Fs in maintenance dredge sediment to 1.30 pg TEQ/g.

Geochemical Assessments (2013) concluded by stating that the sediment quality assessment found that maintenance dredge areas are not enriched in dioxins/furans above ambient baseline levels and therefore sediment proposed for dredging in POTL's maintenance dredge areas is classified as acceptable for unconfined ocean disposal.

As dioxins/furans would be restricted to the upper layers of sediment deposited over the last few decades (i.e. maintenance dredging material), lower layers of consolidated sediment (capital dredging material) would be expected to contain lower levels of dioxin/furans than the upper layers discussed above.

7.2.3 Adequacy of sediment quality data

Five submissions raised the inadequacy of sediment quality data used in the assessment of marine sediment in the EIS. In particular, the submission raised that all sediments (to the full extent of dredge depths) had not been tested as per the National Assessment Guidelines for Dredging (NAGD) 2009, and the sediment quality assessment was based on limited historical data.

The EIS acknowledged that further testing of sediments would be required at a later stage as part of a detailed sediment Sampling and Analysis Plan required for a Sea Dumping Permit from the Commonwealth government. However, the revised project design now includes placement of all dredge material in reclamation, sediment testing (including a full sediment chemistry assessment) will still be undertaken to inform how the material will be managed in the reclamation.

7.2.4 Assessment of particulate nutrients

Five submissions raised the inadequacy of the assessment on particulate nutrients in the EIS. Specifically, the submissions stated particulate nutrients were not included in the sediment analysis.

In response to these submissions, the assessment of nutrients in sediment focused on dissolved nutrient species (e.g. ammonia and nitrate) due to the known toxic effects on aquatic biota, particulate nutrients (i.e. total nitrogen and total phosphorus) were also included in the assessment and discussed in the Marine Sediment chapter (Chapter B.5) and the Marine Water Quality chapter (Chapter B.4) of the EIS.

As part of the EIS, sediment samples were collected from sediments at six sites and analysed for particulate nutrient concentrations in porewater and elutriates. Of particular relevance are the relationships of the elutriate results to relevant water quality guideline values. This is because the elutriate tests attempt to measure resultant water column concentrations following some degree of dilution (dilution of 1:4).

The results presented in Chapter B.5 (Marine Sediment) of the EIS indicated that total nitrogen (TN) in elutriate samples (initial dilution of 1:4) from the six sites ranged from 0.3 mg/L to 2.35 mg/L, while total phosphorus (TP) ranged from 0.02 mg/L to 0.04 mg/L. These values are slightly elevated when compared to water quality guideline values (QWQG 2009), which are 0.2 mg/L for TN and 0.02 mg/L for TP. However, NAGD (2009) states that a dilution of 1:4 would greatly overestimate water quality impacts, given that, within an initial four-hour dilution period following dredging, dilutions in the order of a hundred times or more (and often much more) would normally be expected.

Therefore, made in the EIS in regard to dissolved nutrients, concentrations of particulate nutrients would likely be diluted sufficiently during dredging and that negligible impacts would be expected. Furthermore, the revised design now has all dredge material being placed in reclamation (i.e. no unconfined marine placement), further reducing the potential impacts to the marine environment.

7.3 Revised Environmental Impact Assessment

7.3.1 Legislation and policy

Since the initial release of the EIS, there have been important legislative changes at both the State and Commonwealth level. A new regulation under the *Great Barrier Reef Marine Park Regulations 1983* (Cth) was introduced on 2 June 2015 which sets out to prevent the placement of capital dredge material in the Marine Park. Specifically, the regulation prevents GBRMPA from granting permission for placement of capital dredge material in the Marine Park.

In addition, the *Sustainable Ports Development Act 2015* (Qld) prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

The PEP design has been revised so that there is no longer a requirement for placement of dredge material at the DMPA, therefore negating the need for a Sea Dumping Permit under the *Environment Protection (Sea Dumping) Act 1981* and associated sediment sampling in accordance with the National Assessment Guidelines for Dredging (NAGD). However, a sediment Sampling and Analysis Plan will still be required prior to dredging and placement in reclamation.

7.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. This revision focusses on amendments to the extent of dredging and reclamation works. As a result of these changes, additional sediment quality data was collected in these areas (Appendix A1).

Furthermore, all dredge material will now be placed into reclamation, with unconfined marine placement in a marine DMPA no longer part of the project design.

7.3.3 Supporting studies

Supporting studies relevant to this section of the AEIS include Appendix A1 (Additional Field Studies Report), which includes additional sediment quality data collected in areas affected by the revised design.

7.3.4 Revised assessment

7.3.4.1 Impact assessment

Despite refinements to the project design (i.e. no marine placement), sediment quality data will still be collected prior to commencement of works as part of a Sampling and Analysis Plan. The impacts as summarised in Chapter B.5 (Marine Sediment) of the EIS generally remain relevant, except for those that relate to unconfined marine placement in the marine DMPA (as all dredge material will be placed into the extended reclamation).

7.3.4.2 Mitigation measures

Mitigation measures to reduce the impact on marine sediment quality are outlined in the updated Construction and Operational EMPs provided in Appendices B2 and B3 of the AEIS, and summarised in Table 7.1.

7.3.5 Summary

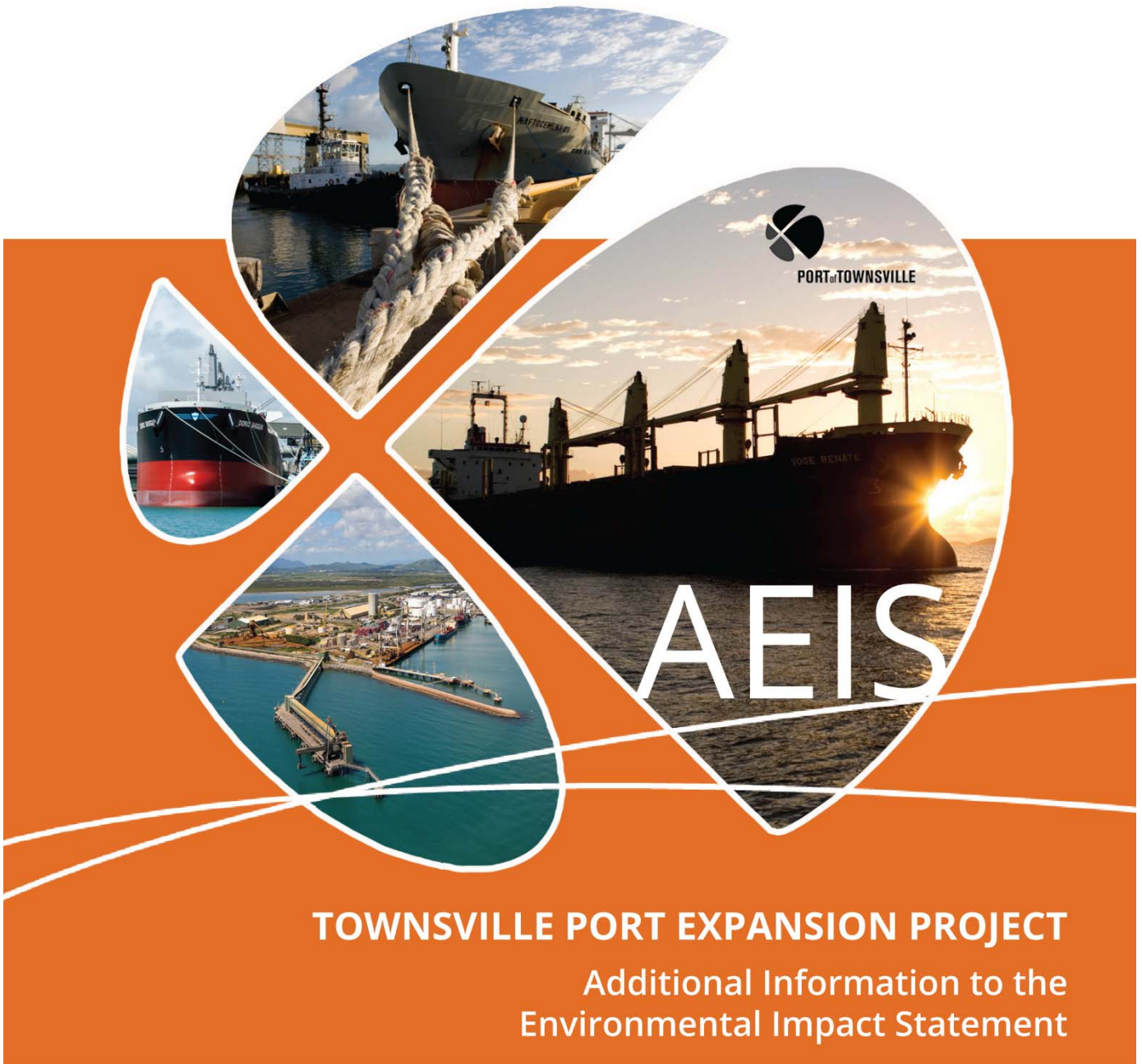
The following table summarises the revised impact assessment based on the design refinement, including a revised risk rating, any mitigation measures that are required, and a revised residual (mitigated) risk rating.

Table 7.1 Summary of Marine Sediment Quality Impacts and Mitigation

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Disturbance and mobilisation of contaminated sediments during construction	Dredging in the outer harbour area	Moderate	Possible	Medium	Undertake further sediment testing prior to commencement of works. If contaminated hotspots are detected, material will be dredged only using a mechanical dredger and not a TSHD to reduce mobilisation of contaminants.	Low
	Dredging in Platypus and Sea channels	Moderate	Unlikely	Low	See above for Dredging in the outer harbour area.	Low
Placement of material in reclamation	Acid sulfate soil oxidation and release	Moderate	Possible	Medium	ASS management practices – refer to ASS report.	Low
	Dewatering of dredge material	Moderate	Possible	Medium	Monitor and manage dewatering, seepage or runoff waters if they occur (see DMP).	Low
Operational impacts to future marine sediment quality	Potential decline in sediment quality, in or adjacent to Project footprint, as a result of increased trade product handling and storage	Low	Possible	Low	Undertake risk based monitoring and/or regular sampling in accordance with NAGD.	Low

7.4 Conclusion

The refined design for the PEP is not expected to significantly impact upon marine sediment quality values on site or within the surrounding area and with the implementation of mitigation measures to manage impacts as described above and in the construction and operational EMPs, the overall impact to marine sediment quality is considered low.



SECTION 8

Marine Ecology



8.0 Marine Ecology

8.1 Introduction

Cleveland Bay is a natural embayment located adjacent to Townsville. Despite significant changes to Townsville's coastal zone as a result of urban (Scheltinga and Heydon 2005) and port development (Anderson *et al.* 2002), Cleveland Bay supports a broad range of significant marine ecological values and functions. Particularly notable marine ecological values supported by Cleveland Bay include the following.

- A wide diversity of marine habitat types including intertidal beaches, mangrove forests, saltmarshes, intertidal shoals, subtidal soft sediment habitats, rock walls, coral reefs and rocky shores.
- One of the largest seagrass meadows in the broader region (Rasheed and Taylor 2008).
- Coral communities of high biodiversity significance, particularly those around Magnetic Island.
- Habitats for a wide range of fish and shellfish species of direct economic significance.
- Significant feeding areas for marine turtles, dugongs and dolphins, which are listed as threatened or migratory under Commonwealth and/or state legislation.
- Habitat for a range of other threatened or otherwise listed marine megafauna species, including whales and sharks protected under the *Environment Protection and Biodiversity Act 1999*.

A number of submissions were received in response to the EIS that are relevant to marine ecology. Key matters raised from the submission process include the following:

- adequacy of reef surveys at Cockle Bay
- presence of stromatolites in Geoffrey Bay
- adequacy of marine ecology baseline data and impact assessment
- bioaccumulation of metals in marine fauna
- assessment of impacts to turtles and turtle habitat
- assessment of impacts to marine mega fauna, including dolphins
- adequacy of underwater noise assessment
- assessment of noise impacts to larval fish
- assessment of impacts to marine habitat values at anchorage sites
- assessment of impacts on the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area (GBRWA)
- assessment of indirect impacts to Bowling Green Bay Ramsar site
- assessment of impacts from marine pests
- resilience of marine ecosystems
- habitat management plans instead of species management plans.

Submissions received relevant to cumulative impacts and environmental offsets are addressed in Sections 25.0 and 27.0 respectively. Responses to these key matters raised in submissions are provided in the following sections.

8.2 Response to Submissions

8.2.1 Adequacy of reef surveys at Cockle Bay

Five submissions were received regarding the adequacy (spatial coverage) of contemporary reef survey data for Cockle Bay.

Chapter B.6.3.5 of the EIS describes reef benthos community structure along the coast of Magnetic Island, based on existing data and a targeted field survey undertaken in 2012. It was noted that reef communities show great variation over time in response to disturbance and recovery cycles, and that the 2012 survey was undertaken one year after a disturbance event (Cyclone Yasi).

A survey campaign was carried out in September 2014 to provide a contemporary assessment of reef communities in Cockle Bay. The survey was carried out to address specific matters raised in submissions regarding spatial replication of surveys at Cockle Bay, but also to assess whether there was evidence of recovery in coral communities

since the 2012 survey. The 2014 survey used the same methodology as adopted in the March 2012, thereby allowing a direct assessment of changes to reef communities over that time period. Additional sites were added to Cockle Bay reef to increase spatial coverage of the survey.

The methodology and findings of the September 2014 sampling campaign are presented in Appendix A1 (Additional Field Studies Report). In summary, the survey found the following.

- There was great spatial variability in habitat characteristics and benthic community structure across the reef.
- Similar to results from 2012, Cockle Bay continued to be numerically dominated by macroalgae, with hard corals typically sub-dominant. At the Cockle Bay site that was surveyed on both occasions (C2), seagrass was recorded in 2014 but not in 2012, suggesting there recovery was occurring. This was consistent with seagrass recovery patterns recorded by James Cook University over this timeframe (see also Section 8.2.3 below).

8.2.2 Stromatolites in Geoffrey Bay

Two submissions were received stating there was no reference to stromatolites purported to exist in Geoffrey Bay.

A review of peer reviewed publications was undertaken to assess the ecology of stromatolites on Magnetic Island reefs. Shiba *et al.* (1991) examined aerobic heterotrophic bacteria taken from a range of biota (including, where possible, stromatolites) at sites throughout Australia. Sampling was carried out at Cape Cleveland and Magnetic Island (Arcadia, Horseshoe and Radical Bays), but no stromatolites were collected for analysis (although aerobic bacteriochlorophyll containing bacteria (ABB); a type of bacteria that can form stromatolites, were collected in intertidal algal mats from Magnetic Island). No other specific references to stromatolites in Cleveland Bay were found in the scientific literature.

A survey was carried out in September 2014 at Geoffrey Bay to identify any features (outcrops of rock or coral) bearing any similarity to stromatolites or microbial mats. Dr Jane Mellors from James Cook University was also consulted regarding the status of stromatolites at Geoffrey Bay. Dr Jane Mellors provided information and several photos of structures that are currently the subject of research by James Cook University researchers.

Eight points of interest were recorded on transects at Geoffrey Bay, several of which appeared to be dead coral fragments with microbial/ algal coverings that resembled photos of potential stromatolites supplied by Dr Jane Mellors. While the structures at points 335 and 336 were covered in a thick microbial mat, they differed greatly in morphology to the dome-shaped structures of Shark Bay in Western Australia. Whether these mounds have been created by microbes (true stromatolites), or if they are microbial coverings on dead coral skeletons could not be ascertained during the field trip (by visual survey alone, without destructive sampling).

Information supplied by Dr Jane Mellors suggests that these structures may be low-profile stromatolite mounds, as personally communicated by Professor John Talent (Emeritus Professor of Geology, Macquarie University) in Farabegoli *et al.* (2007). While there is nothing in the primary literature to suggest that the structures are stromatolites, Macquarie University lecture notes by Professor John Talent refer to them, as do interpretive signs located in Cairns.

On this basis, it is concluded stromatolites could be present in Geoffrey Bay, although this will need to be confirmed through further research. There is no information on the tolerances of stromatolites to excess sediment, most likely due to their apparent rarity. For impact assessment purposes (see Section 8.3.4.1 of the AEIS), it has been conservatively assumed that stromatolites (like seagrass and corals) require the maintenance of existing water quality conditions to persist.

8.2.3 Adequacy of marine ecology baseline data and impact assessment

A total of 23 submissions were received regarding the adequacy of baseline data and/or impact assessments relating to marine ecology. The following matters were specifically identified with respect to adequacy of baseline data.

Seagrass Watch data that were not included in the EIS - the Seagrass Watch data provided in the EIS provides a sufficient account of temporal variability in intertidal seagrass cover in Cleveland Bay up to and including 2010. Seagrass Watch monitoring data are now available up to 2013, and show that seagrass meadows declined between 2009-2011, coincident with successive years of wet weather conditions. Seagrass Watch data shows that seagrass cover increased at all Cleveland Bay sites between 2012 and 2014, indicating that meadows were in a recovery phase during this period (Figure 8.1, Figure 8.2). Similarly, meadow monitoring carried out by James Cook University found that seagrass meadow extent had increased between 2011 and 2013, but had not recovered to pre-2009 levels (Davies *et al.* 2013). Seagrass meadows are expected to have low resilience during this recovery phase (Davies *et al.* 2013), particularly those at Magnetic Island which had notably low cover and a limited seed bank (Seagrass Watch 2014).

Benthic habitat mapping -The benthic habitat mapping presented in the EIS provides a spatially comprehensive assessment of subtidal substrate types in Cleveland Bay. Seabed habitats were surveyed using sonar-based methods, and a total of 94 sites were sampled using underwater video. Data were interpolated to generate benthic habitat maps. Furthermore, 152 benthic infauna samples were collected for this assessment (from 38 sites). These

data complements existing work on benthic fauna communities referenced in the EIS (GHD 2009; GHD 2011; Cruz-Motta 2000; Cruz-Motta and Collins 2004; C&R Consulting 2007). It is acknowledged that the species composition and ecology of soft sediment benthic communities on the north Queensland coast are far less studied than some other species and communities (e.g. marine megafauna, seagrass, corals etc.). The available information is considered sufficient to determine the likely composition of benthic communities.

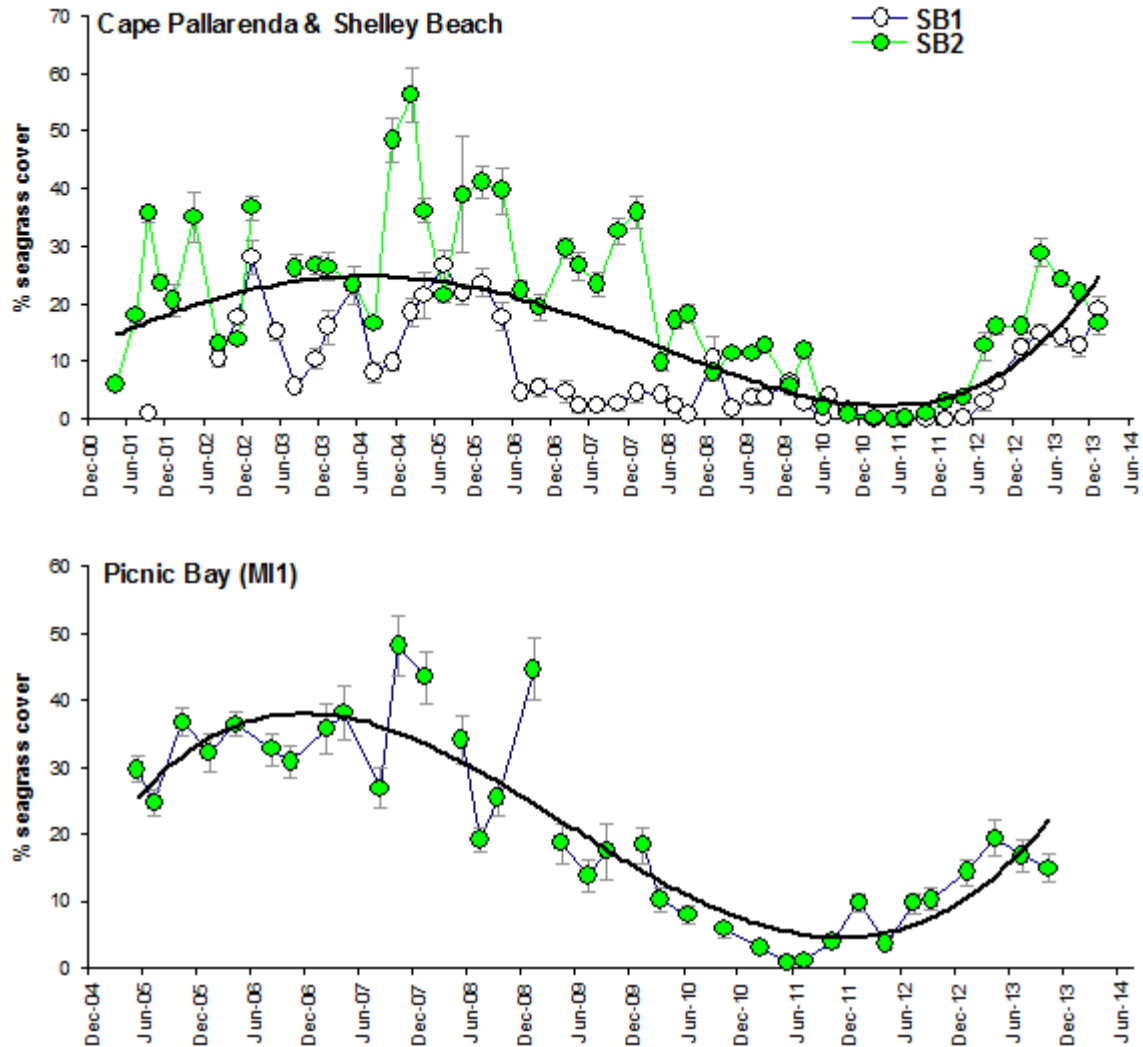


Figure 8.1 Seagrass percent cover at Cape Pallarenda (CP) and Shelley Beach (SB) (mainland coastal intertidal sites), and Picnic Bay (Data from the Reef Rescue Marine Monitoring Program; www.seagrasswatch.org)

Existing marine pest survey data (refer to Chapter B.6.3.8 of the EIS) - As outlined in the EIS, a port wide baseline survey of non-indigenous species was undertaken by James Cook University and the CRC Reef in November 2000 (Neil *et al.* 2001). This study is now out of date and it is acknowledged that although not a regulatory requirement, further surveys are required in this regard.

Marine megafauna species survey data (refer to Chapter B.6.3.7.2 of the EIS -) The EIS describes the relative abundance of key marine megafauna species found in Cleveland Bay, which is based on quantitative sampling methods (i.e. counts per unit sampling effort). A description of the sampling methodology is provided in Appendix K4 of the EIS. No empirical data are available for several very uncommon marine megafauna species that are known or possibly occur in Cleveland Bay.

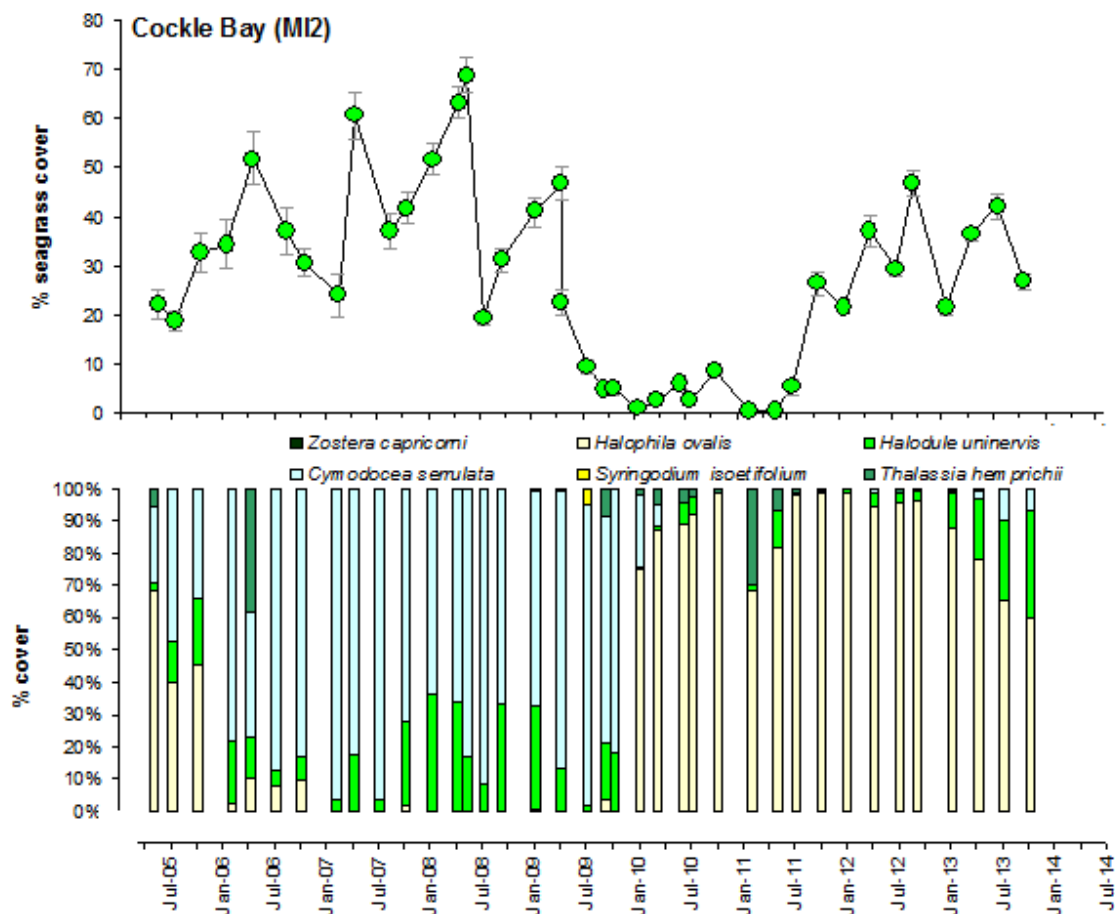


Figure 8.2 Seagrass per cent cover and species composition at Cockle Bay Magnetic Island (Data from the Reef Rescue Marine Monitoring Program; www.seagrasswatch.org)

8.2.4 Bioaccumulation of metals in marine fauna

Five submissions were received regarding the bio-accumulation of mercury in marine biota. Mercury and many other metals found in marine sediments cannot be readily excreted and can accumulate over the life of aquatic organisms. Animals that are high in the food chain (e.g. fish, birds and humans) can accumulate these metals through the consumption of prey, resulting in metal biomagnification. The accumulation of mercury and some other metals can lead to adverse health effects.

Chapter B.5 (Marine Sediment Quality) of the EIS presented existing data on contaminant concentrations in sediments, and did not identify mercury as a contaminant of concern. A Sampling and Analysis Plan for the PEP is required to be developed and implemented prior to commencement of dredging in accordance with requirements set out in the National Assessment Guidelines for Dredging (NAGD). This sampling program will provide an indication of contaminant concentrations in sediments (including mercury).

In addition, the results of the revised assessment have been considered in light of the 2014 Impact Guidelines for OUV of the WHA as outlined in Section 26.0 of the AEIS.

8.2.5 Assessment of impacts on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area

A total of 45 submissions were received regarding the potential impact of the Project on the OUV of the GBRWHA. The submissions typically relate to the impact of sediment released by dredging and disposal on marine features underpinning the OUV of the GBRWHA.

The potential impacts of turbidity and sedimentation on sensitive ecological receptors is discussed in Chapter B.6.4.4 of the EIS. The EIS concluded that impacts to sensitive receptors (corals, seagrass) will likely occur in the absence of appropriate mitigation measures. This finding took into account the existing low levels of resilience of seagrass and coral communities, and their sensitivity to further disturbance (both acute and chronic impacts).

The dredging program has been refined and reassessed in this AEIS, which necessitated new modelling assessments. The modelling results for the revised design are documented in Appendix A2 (Modelling Report). The refined Project (as outlined in 2.0 of the AEIS) involves no sea disposal and reduction of dredging by the TSHD.

Additional background water quality data has been collected from a range of sites throughout Cleveland Bay, which together with information on tolerance limits of seagrass, provides a basis for developing thresholds for assessing potential sediment impacts. Appendix A1 (Additional Field Studies Report) presents these additional water quality data and Section 6.0 (Water Quality) of the AEIS describes the thresholds used to identify impact zones. The findings of the re-assessment are discussed in section 8.3.2 below, and specifically consider the potential for impacts to the Outstanding Universal Value of the GBRWHA.

8.2.6 Assessment of impacts to turtles and turtle habitat

12 submissions were received regarding the impacts of the Project on turtles and their habitat.

Chapter B.6.3.7.2 of the EIS describes habitats values of Cleveland Bay and the wider Townsville region for sea turtles. An additional review of existing information was carried out to assess the values of Cockle Bay as a turtle foraging habitat, Magnetic Island as a turtle nesting habitat, and channels as resting areas. The information review suggests the following.

- Cockle Bay is a significant foraging habitat for turtles, particularly green turtles. In their submission of the EIS, DEHP advises that “*Approximately 200 green turtles and 6 hawksbill turtles have now been flipper tagged while foraging in Cleveland Bay. The majority of turtles captured... (were)... found to be using the intertidal seagrass and algal flats found within Cockle Bay. Cockle Bay would be classified as supporting a regionally significant population of foraging green turtles.*” Tracking studies undertaken in November 2010 – July 2011 and 2011, demonstrate that juvenile green turtles show significant site fidelity, and only undertook small scale movements around the reef flat (see Appendix K4 of the EIS). As discussed in Chapter B.6.4.5 of the EIS, it is therefore important that dredging does not result in modifications to the availability of food resources for turtles, particularly given the recent local population declines due to successive wet weather years.
- Sandy beaches on Magnetic Island are used by turtles for nesting. Magnetic Island is not classified as a major turtle rookery in a state or national context, but will contribute to the maintenance of turtle populations. Lighting impacts to turtles and mitigation are discussed in Chapter B.6.4.8.1 of the EIS.
- While turtles are typically most abundant around seagrass meadows and reefs, they also traverse navigation channels as they move between feeding areas between Magnetic Island and eastern Cleveland Bay. Turtles may also rest in channel areas, or head to deeper waters (i.e. bottom of the channel) for refuge when disturbed (Pers. Comm. C. Limpus, 14-3-14). This behaviour increases their susceptibility to vessel strike by ships. Stranding data show that vessel strike is a common cause of turtle mortality on the Queensland coast, however there are too few data to determine the relative importance of ships versus fast-moving small craft to total mortality. Vessel strike impacts are considered in Chapters B.6.4.6 and B.6.4.9 of the EIS.

In addition to the residual low risk of impacts posed to turtles, the selected dredge window for dredging by the TSHD noted in Section 8.3.4.2 (avoiding spring/summer months, primarily for the benefit of seagrass and corals) will provide the further advantage of minimising potential disruptions to turtle nesting.

The construction of off-channel turtle resting habitats was considered as a potential mitigation measure. This would consist of dredging small cul-de-sacs off the navigation channel that are filled with logs. The suggested mitigation measure has the potential to be a significant navigation hazard as well as a threat to life. Further if the logs broke free, these could catastrophically impact either a large ship, ferry or recreational vessel in the wider waterspace as waterlogged logs typically sit just below the waterline. Townsville is exposed to cyclonic activity and the suggested mitigation is not feasible. This had been confirmed with the regional harbour master.

8.2.7 Assessment of impacts to marine mega fauna, including dolphins

Since the submission of the EIS, the conservation status of the Australian snubfin dolphin *Orcaella heinsohni* (formerly *Orcaella brevirostris*) and the Australian humpback dolphin *Sousa sahulensis* (formerly *Sousa chinensis*) has been revised. Both species are now classified as Vulnerable species (previously Near Threatened) under the Queensland *Nature Conservation Act 1992*. Their status under the *Environment Protection and Biodiversity Conservation Act 1999* remains unchanged, being Listed Migratory and Cetacean species. Given the listing now as threatened species, further background on these species is provided below for completeness, noting that much of this information was previously provided in the EIS.

Australian Snubfin Dolphin distribution and abundance

Australian Snubfin Dolphin *Orcaella heinsohni* has a geographic distribution that is restricted to tropical and subtropical zones of Australia, and southern New Guinea (Beasley *et al.* 2005). It is an uncommon nearshore coastal species in most areas, and is often found in small groups (Parra 2005; 2006a).

This species inhabits riverine, estuarine and coastal waters. This species generally occurs in waters less than 15 m deep, within 10 km of the coast and within 20 km of a river mouth (Parra, Corkeron, & Marsh, 2004). They appear to favour shallow waters (1-2 m deep) where seagrass is present and waters near river/creek mouths (GHD 2011).

The species has an opportunistic generalist diet, feeding on fish and cephalopods (octopus, squid etc.) from coastal, estuarine and nearshore reef habitats (Parra, 2006; Parra & Jedensjö, 2009). Australian snubfin dolphins commonly occur in the vicinity of the Port of Townsville, with the Ross River and Creek mouths, and adjacent seabeds, considered to represent foraging habitat for the species in this area. Snubfin dolphins are frequently observed in waters adjacent to the port, typically in association with bait fish food resources (GHD 2012). The targeted monitoring undertaken by GHD (2012) emphasises the importance of waters near the Ross Creek and Ross River mouths, as well as near the creeks along eastern Cleveland Bay, as nearshore dolphin habitat (Figure 8.1). Incidental sightings showed snubfin dolphins also commonly occurred close to the harbour and shipping channel (Figure 8.2, GHD 2012).

The estimate for the Australian snubfin dolphin 'sub-population' in 2002 in Cleveland Bay was 63 individuals (95% confidence interval = 51-88) (Parra, Corkeron, & Marsh, 2006; Parra, Schick, & Corkeron, 2006). Of this number 51 were observed in more than one calendar year between 1999 and 2002 and certain individuals repeatedly came back to specific areas in the broader Cleveland Bay area. Note that researchers from James Cook University are presently undertaking research to update these (10+ year old) population estimates in the Townsville region, for both Australian snubfin and Australian humpback dolphins, but that the outcomes of this research are not yet available.

Looking at the broader Townsville region, Parra (2006) found two core use areas for this species: one west of Cape Pallarenda, around the mouth of the Black and Bohle Rivers; the other around the Port of Townsville, including around highly modified habitats such as breakwaters (see Figure 8.3). The study did not indicate the presence of two distinct sub-populations, with photographic evidence suggesting that individuals travel between the two core areas. Further, while some snubfin dolphins may be permanent residents of the Cleveland Bay area, most tend to have short residence times, typically leaving the bay after 3 to 30 days (Parra *et al.* 2006). They will usually spend periods of over a month away before entering the bay again (Parra 2006) and likely have large home ranges extending to 100's km.

GHD (2011a) concluded that the recurrent use of Cleveland Bay by adult and calf snubfin and Australian humpback dolphins for foraging, indicates that this area, particularly around the mouth of Ross Creek and River, is an important feeding area at a local scale. There is limited information on the reproductive ecology of this species, although in Cleveland Bay Australian snubfin dolphins calves have been observed year- round (Parra, 2006; Parra, Corkeron, & Marsh, 2006).

Australian Humpback Dolphin distribution and abundance

Similar to *Orcaella heinsohni*, the geographic distribution of the Australian humpback dolphin *Sousa sahulensis* (formerly with *S. chinensis*) encompasses the tropical and subtropical east and west coasts of northern Australia and southern New Guinea. *Sousa sahulensis* occurs in a broad range of coastal habitats including coastal lagoons, enclosed bays, estuaries and open coastal waters (Jefferson and Karczmarski 2001).

Also like the Australian snubfin dolphin, Australian humpback dolphin generally occurs in waters less than 15 m deep, within 10 km of the coast and within 20 km of a river mouth (Parra, Corkeron, & Marsh, 2004). Australian Humpback Dolphins do not display any preference for turbid or clear-waters, and have been recorded from a broad range of coastal habitats including coastal lagoons, enclosed bays, and open coastal waters (Jefferson & Karczmarski, 2001). The species is also an opportunistic generalist predator, with a diet consisting of fish and crustaceans (Parra, 2006; Parra, Schick, & Corkeron, 2006).

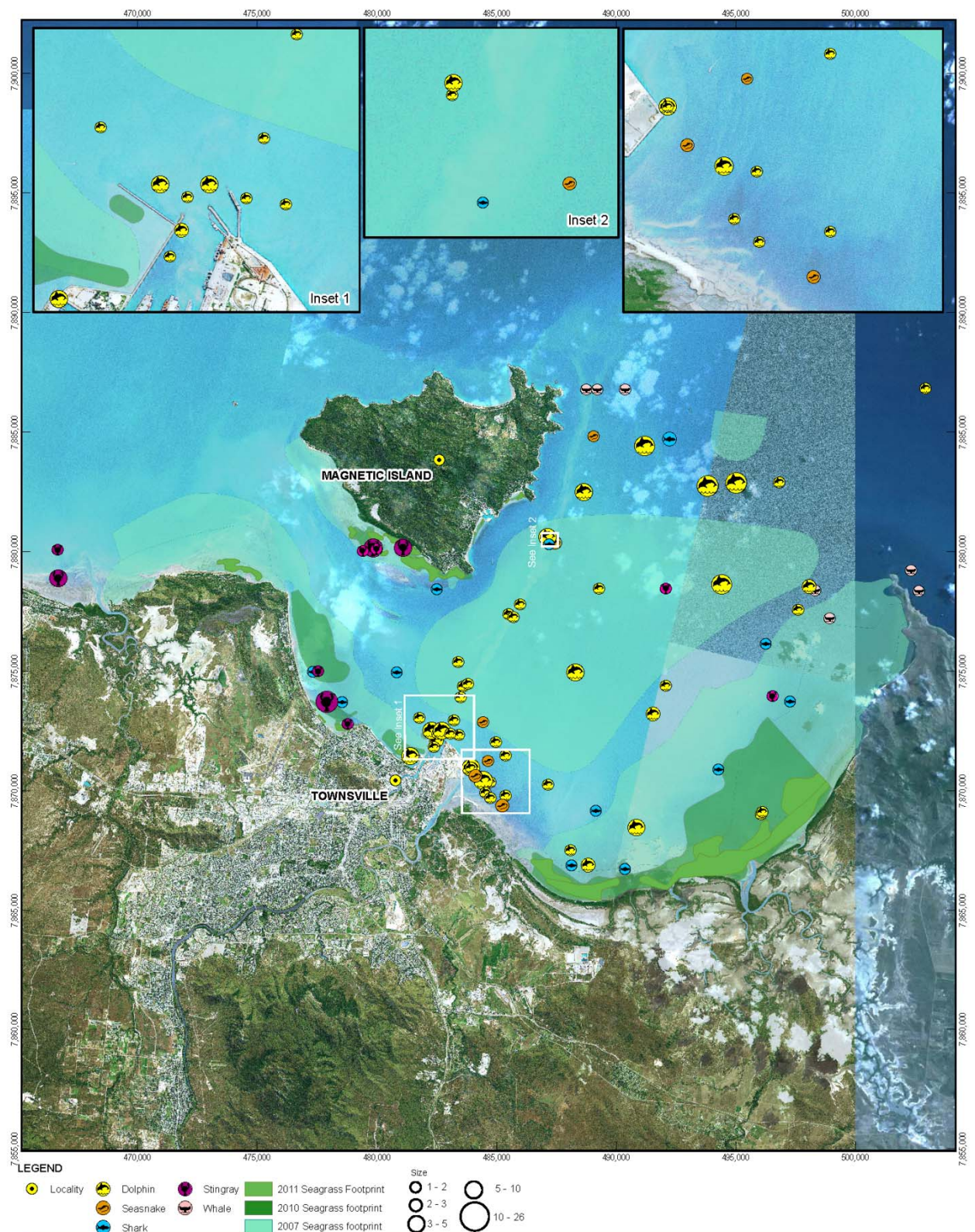


Figure 3.18

Figure 8.1 Nearshore dolphin (and other megafauna) sightings from multiple surveys, 2008 to 2012 (GHD 2012)

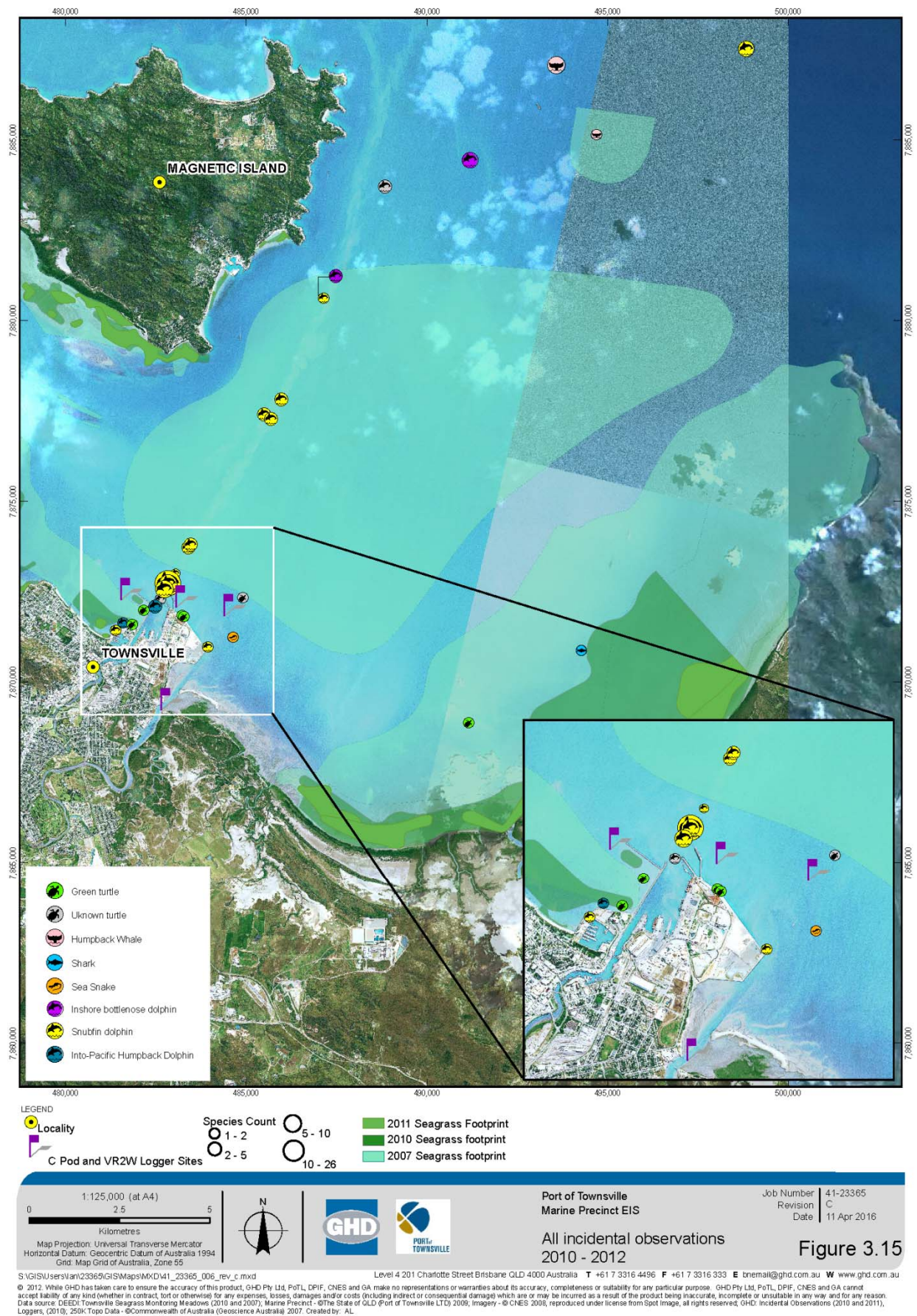


Figure 8.2 Incidental nearshore dolphin sightings

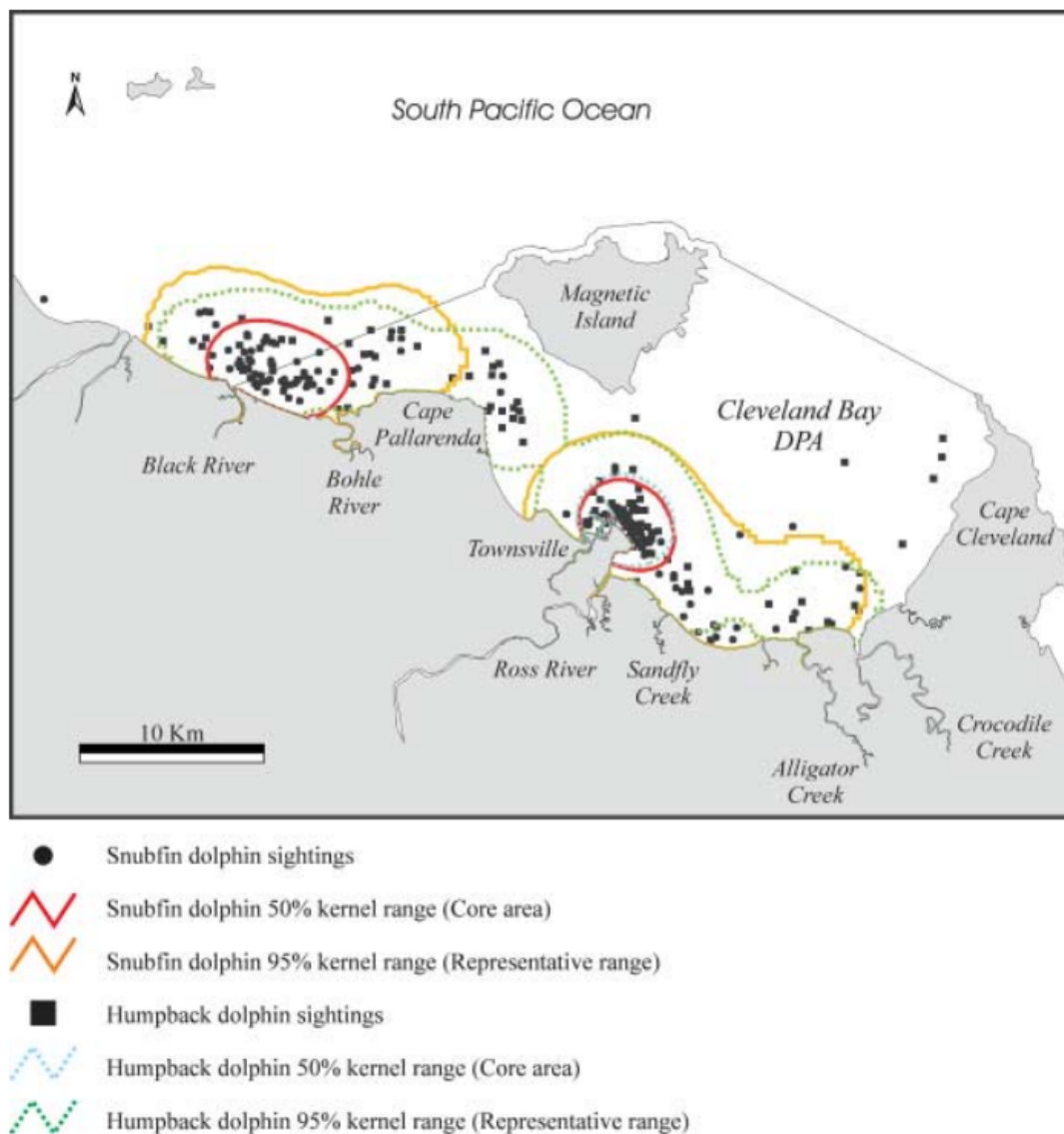


Figure 8.3 Core areas and representative ranges of Australian snubfin and Australian humpback dolphins in the Townsville region (figure from Parra 2006)

In the Townsville region, the representative range for this species extended throughout nearshore waters from Cape Cleveland to Black River. Their core area was located 17 km² area around the Port of Townsville (Parra 2006, Figure 8.3), including highly modified habitats in this area such as breakwaters, the harbour and dredged channels. In this locale, the Ross River and Ross Creek mouths and adjacent seabeds are considered to represent feeding habitat for Australian humpback dolphin.

Parra *et al.* (2006) estimated that the Australian humpback dolphin sub-population in Cleveland Bay during 2002 was 54 (95% confidence limit = 38 to 77). Of this number 32 were observed in more than one calendar year between 1999 and 2002. This species, like Australian snubfin dolphin, has a wide home-range (up to 395 km²; Hung in DSEWPC 2012) and undertakes regular movements in and out of Cleveland Bay. While some Australian humpback dolphins may be permanent residents of the Cleveland Bay area, most tend to have short to moderate residence times, typically leaving the bay after 10 to 140 days (Parra *et al.* 2006). In terms of habitat usage, this species has mainly been observed to be foraging in the area, including foraging behind trawlers (Parra, 2006).

Biodiversity values and habitat significance for threatened nearshore dolphins

The occurrence of migratory species, and their habitat utilisation when present, needs to be considered in the context of the broader population, and their wider distribution and habitat availability. In this regard it is necessary to establish whether the area affected by the Project is an 'important habitat' for impact assessment purposes. The Matters of National Environmental Significance Significant Impact Guidelines 1.1 (Department of the Environment 2013) provides guidance by defining important habitat for migratory species as:

- *habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or*

- *habitat that is of critical importance to the species at particular life-cycle stages, and/or*
- *habitat utilised by a migratory species which is at the limit of the species range, and/or*
- *habitat within an area where the species is declining.*

In the context of the above:

- ecologically significant proportion of population:
 - Both species have been recorded in the PEP area in low numbers (GHD 2011, 2012), feeding and/or moving between feeding areas at the mouths of the tidal creeks/ivers within (i.e. Ross Creek and River mouth) and near Cleveland Bay (e.g. core usage area recognised west of Cape Pallarenda).
 - While a total population estimate is not available for Australian snubfin dolphin, Parra (2006b) estimated that the east Queensland coast population was likely in the thousands rather than 10's of thousands. It is estimated that the total number of mature Australian snubfin dolphin is fewer than 10,000 (DoE SPRAT database 2016). The Cleveland Bay sub-population of Australian snubfin dolphin recorded by Parra *et al.* (2002a) was 64-76 individuals. The home ranges of this species can extend 100's km outside Cleveland Bay, and individuals typically had a residence time of up to a month before emigrating outside Cleveland Bay. There is emerging evidence from case-studies in north-western Australia (Brown *et al.* 2014) and central-southern Queensland (Cagnazzi *et al.* 2011) that this species may exist as metapopulations of small, semi-isolated sub-populations.
 - The Australian humpback dolphin is more widely distributed than Australian snubfin dolphin, extending from Exmouth Gulf in the west, to the QLD/NSW border region in the east. The Australian humpback dolphin population in Australia is thought to number in the 1000's rather than 10,000's (Parra *et al.* 2002). Similar to Australian snubfin dolphin, Australian humpback dolphins are not permanent residents, with individuals regularly immigrating and emigrating outside Cleveland Bay.
- No formal critical habitat assessment has been undertaken for **these species in Queensland or Australia. Within Cleveland Bay, the abundance of both species is highest at Ross River and Ross Creek mouths, and also appears to favour seagrass meadows and Cape Pallarenda. The low abundance of both species within the Project area does not suggest that this represents a particularly high value habitat. Like other nearshore environments throughout Cleveland Bay (and elsewhere), the Project area is expected to provide potential foraging habitat for individuals when they are residing in Cleveland Bay.**
- As outlined above, the Project area is not at the limit of the species' range.
- There is presently no empirical evidence available to suggest that the species are declining in the Townsville region, and no other major marine projects of this scale planned for the area in the near future. The lack of long term empirical survey data does however limit the ability to detect long-term changes in population size (Parra *et al.* 2006). Key threats to the species are outlined in the following section.

Resistance/resilience of threatened near-shore dolphins

The resistance and resilience of these threatened nearshore dolphins to the development are primarily dependent on: the biological, physiological and ecological traits of the species; the resilience of their habitats and resources; and the magnitude, extent and timing/frequency of Project disturbances (in the context of other natural and/or anthropogenic disturbances). Here we outline the key resilience characteristics of these species relevant to the Project, namely:

- feeding behaviour (and sensitivity to turbidity)
- dietary requirements
- site fidelity
- capacity to reproduce
- overall population size
- key threats to species.

These are considered in relation to the Project in the impact assessment (Section 8.3.4).

Within their core use area at the Port of Townsville, both species appear to utilise highly modified habitat such as dredged channels and waters in close proximity to breakwaters. While the nearby river mouths and seagrass beds likely remain their preferred habitat, their common occurrence around the ports indicates some capacity to adapt to, and coexist with, such developments. More broadly, the preferred nearshore habitat of both of these dolphin species represents a highly dynamic environment. These nearshore environments are highly turbid, subject to periodic physical disturbance (storms, cyclones, floods) have characteristically highly temporally variable water quality conditions. As a result, invertebrate and fish food resources in the nearshore areas will be reasonably robust and typically comprised of species that are capable of rapid recovery.

This has important implications in terms of resistance of near-shore dolphin species to changes in environmental conditions. In this regard, near-shore dolphins have the following biological characteristics that allow them to cope with altered environmental conditions.

- Feeding behaviour and turbidity. Nearshore dolphin species are capable of successfully foraging in turbid waters. Dolphins often stir up bed sediments when foraging for benthic prey, resulting in limited to no visibility for prey detection. It is thought that dolphins detect prey using echolocation rather than visual cues (Mustoe, 2006; Mustoe, 2008). On this basis, nearshore dolphins therefore have adaptations that allow them to feed in high turbidity waters (Parra & Jedensjö, 2009).
- Opportunistic diet. Both nearshore dolphin species are considered to be 'opportunistic-generalist feeders' (Parra & Jedensjö, 2009). Gut contents analysis performed on dolphins captured along the Queensland coast (Parra & Jedensjö, 2009) found that both dolphins primarily fed on a range of demersal and pelagic fish species commonly found in estuarine and shallow nearshore habitats. In addition to fish, snubfin dolphins were found to feed on squid and cuttlefish, which typically occur in the water column. The opportunistic, generalist diet of these species reduces their susceptibility to changes in availability of particular prey types.
- Both dolphin species have home ranges extending at least 100's km outside Cleveland Bay and can, therefore, temporarily move from habitats that have sub-optimal environmental conditions.

Despite possessing a range of adaptations that allow a degree of resistance to short-term changes in environmental conditions, both nearshore dolphin species are considered to have low capacity to recover from population declines, as:

- Both are long-lived species with low reproductive rate. While the reproductive ecology of these species has not been well studied, most Delphinids bear one calf every two to three years (DSEWPC, 2012e; DSEWPC, 2012d). Consequently, these species will have slow rates of population recovery.
- Both species have small overall population sizes, and also have small local sub-population sizes. A substantial decline in dolphin numbers will be expected where the viability of local sub-populations is substantially reduced.
- Both species are under increasing threat from human activities. In this regard, both species have narrow habitat requirements, being restricted to near-shore habitats (often around river mouths and seagrass meadows). These environments are subject to the high levels of anthropogenic pressures. Key threats include habitat loss and degradation, entanglement in gill nets and shark nets, pollution (both direct and indirect impacts) and vessel strike from fast-moving watercraft (Parra, Corkeron, & Marsh, 2004; DSEWPC, 2012d; DSEWPC, 2012e).

Submission responses

26 submissions were received regarding the impacts of the Project on megafauna (including dolphins) and their habitat.

Chapter B.6.6 of the EIS discusses cumulative impacts on dolphins, and concludes: *"measurable adverse impacts to marine biodiversity values at localised (nearshore Cleveland Bay) spatial scales are expected. In particular, proposed future port projects could reduce available foraging area for nearshore dolphin species, possibly resulting in reduced numbers of dolphins visiting the local area"*. POTL has undertaken a range of investigations to assess habitat usage patterns of marine megafauna in the port area and wider Cleveland Bay (e.g. GHD 2011, 2012), which will continue to be considered in future port planning and environmental impact assessment studies.

Further detail and explanation is provided in the revised impact assessment presented in Section 8.3.4.

8.2.8 Adequacy of underwater noise assessment

Four submissions were received regarding noise impacts to megafauna. Chapter B.6.4.7 of the EIS considers impacts of noise on marine fauna, which is based on previous work undertaken by GHD for Port of Townsville Limited. This also considers mitigation measures, which includes a commitment to develop a Marine Megafauna Management Plan to manage noise impacts to fauna. Mitigation measures include:

- shut down / stop work procedures if marine megafauna are observed within defined exclusion zones
- water-based noise activities (pile driving in particular) will be commenced gradually to provide warning to nearby marine megafauna (i.e. ramp-up / soft-start procedure)
- noise mitigation measures to attenuate underwater noise such that the identified hazard level can be reduced as far as practicable, including:
 - use of a resilient pad (dolly) will be used where feasible between the pile and hammer head
 - air curtains to attenuate noise levels where practicable
 - dredge staging to manage piling noise attenuation.

The plan will be developed in conjunction with an appropriately qualified underwater noise consultant, and will include the implementation of contemporary management measures.

8.2.9 Noise impacts to larval fish

Acoustic cues are used by larval fish to detect suitable habitat for settlement (Holles *et al.* 2013; Slabbekoorn *et al.* 2010). Anthropogenic noise can have multiple effects including (Slabbekoorn *et al.* 2010): (i) stress and avoidance behaviour; (ii) masking of natural acoustic cues that facilitate detection of suitable settlement sites (e.g. waves

crashing on reefs). Project activities during the construction phase (e.g. vessel traffic movements, piling, dredging) could therefore interfere with larval fish settlement behaviour.

The timing of spawning and settlement varies greatly among species. Unlike broadcast spawning corals, there is no distinct breeding season in all reef fish species, although many commercially significant reef fish tend to spawn during spring and summer months (e.g. Russell 2001). The use of generic 'seasonal windows' to mitigate impacts from construction activities may therefore protect some but not all species. On this basis there are no practical measures that can mitigate this impact.

Two fish species listed as threatened have the potential to occur in Cleveland Bay: green sawfish *Pristis zijsron* and whale shark *Rhincodon typus*. Based on available (limited) reproduction data for these species:

- *Pristis zijsron* – this species return seasonally (wet season) to inshore coastal waters adjacent to the northern Australian region to breed and pup (Peeverell 2005). This species does not have a larval stage as it is a live-bearer. Therefore, the above mentioned acoustic noise issues discussed above are not relevant to this species.
- *Rhincodon typus* – this species is also a live bearer. This species is not known to pup in Australian waters (SPRAT database 2016).

8.2.10 Assessment of impacts to marine habitat values at anchorage sites

The Magnetic Island Nature Care Association (MINCA) submission raised the impacts of anchorages on habitat. Any anchoring that does occur will result in disturbance of benthic habitat at the anchor site. This could have cumulative impacts if anchoring frequency greatly increases and anchorages are inappropriately managed. Marine anchorage areas for commercial vessels are currently being investigated by the Regional Harbour Master and relevant agencies. The preferred anchorage locations are areas that have been previously disturbed by historical trawling and support relatively simplified soft sediment habitats and epibenthic communities that are representative (i.e. not unique) of habitats found nearby. The increase in vessel and anchoring requirements as a result of PEP are being considered as part of this process.

8.2.11 Assessment of cumulative impacts on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area

212 submissions (includes form letter submissions) raised the assessment of cumulative impacts on the OUV of the GBRWHA. The EIS considered cumulative impacts to the OUV of the GBRWHA. Guidelines have now been released by the Australian government to assist in the assessment of potential impacts to the OUV of the WHA. Refer to Section 8.3.4 and Section 25.0 (Cumulative Impacts) for an assessment of impacts of the revised design which adopts the new guidelines.

8.2.12 Assessment of indirect impacts to Bowling Green Bay Ramsar site

Two submissions were received regarding the levels of impacts (both direct and indirect) of the Project on the Bowling Green Bay Ramsar site. Chapter B.6.4.14.5 of the EIS considers both direct and indirect impacts to the Ramsar site. It is concluded that "*It is...highly unlikely that the proposal will adversely impact on Bowling Green Bay Ramsar site or its supporting values*", based on the path and direction of modelled plumes and re-suspended sediments. This conclusion remains current.

8.2.13 Assessment of impacts from marine pests

Two submissions were received regarding potential impacts of marine pests. Chapter B.6.4.10 of the EIS considers potential impacts associated with introduced marine pests, and defines the risk level as low to medium. As outlined in this section, a construction stage marine pest management plan will be developed to minimise risk of marine pest introductions. This plan will be developed in accordance with DAF and other regulatory agency requirements. Marine pest management strategies will be developed during operational phase by port customers, in accordance with agency requirements.

8.2.14 Resilience of marine ecosystems

12 submissions were received regarding the impacts of the proposal on marine ecosystems that currently have low resilience. The current poor condition and low resilience of coastal ecosystems in Cleveland Bay and the wider Great Barrier Reef region is extensively described and considered in the Chapter B.6 (Marine Ecology) of the EIS. Furthermore, the potential impacts of the revised design on marine ecosystems (see Section 8.3.4) is considered to be conservative, recognising the existing low resilience levels.

As per Appendix B1 (Dredge Management Plan), the condition of marine ecosystems will be evaluated prior to commencement of dredging, with trigger values developed and approved by a scientific panel of experts (Technical Advisory Committee).

8.2.15 Habitat management plans instead of species management plans

The NQ Dry Tropics submission suggested that species management plans should be replaced by habitat management plans. Marine fauna management plans are required to minimise the risk of direct, construction related impacts to marine megafauna. Habitat or ecosystem management plans are not fit for purpose in this regard.

Notwithstanding this, the need for managing potential impacts of the PEP at the habitat level is acknowledged in the EIS. Habitat protection management actions form core components of the Dredge Management Plan (see Section C2.1), and offset commitments (see Section B23.3), and implicitly consider key existing stressors on marine ecosystems within Cleveland Bay.

The Dredge Management Plan (DMP) (Appendix B1) outlines management actions relating to construction phase impacts. Specifically, the DMP identifies measures designed to minimise the potential for dredging generated plumes to impact on sensitive habitats (particularly seagrass meadows and reefs). The timing and staging of dredging also takes into account critical life-cycle periods of corals and seagrasses, particularly recognising the current low levels of resilience of benthic primary producer habitats.

Section 27.0 (offsets) of the AEIS outlines commitments to better protect and enhance marine habitats in Cleveland Bay, or to better understand the land and water ecosystems, thereby providing a means for formulating management actions. This includes:

- an extension to Cleveland Bay Fish Habitat Area (additional 1,240 ha)
- improving water quality entering the GBRWHA through funding of the NQ Dry Tropics Sustainable Agriculture Program
- funding of research that seeks to identify the source of sediments within grazed properties and within Cleveland Bay, thereby improving the ability to better manage catchment pollutant impacts on marine habitats
- development of a Long Term Ecosystem Health Assessment in Cleveland Bay
- funding research into better understanding marine megafauna distribution and abundance and baitfish schooling triggers in Cleveland Bay.

8.3 Revised Environmental Impact Assessment

8.3.1 Legislation and policy

There are no major legislation or policy changes since submission of the EIS relevant to the assessment of marine ecology. The EIS omitted discussion regarding State marine parks declared under the *Marine Parks Act 2004*. The Great Barrier Reef Coast Marine Park is a State Marine Park that runs the length of Commonwealth GBRMP, and encompasses tidal waters up to highest astronomical tide. The Great Barrier Reef Coast Marine Park is managed under the *Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004* as a multiple use marine park. The PEP footprint falls only within the port exclusion zone and outside of the GBRMP.

The two inshore dolphin species (Australian snubfin dolphin *Orcaella heinsohni* and Australian humpback dolphin *Sousa sahulensis*) have had their conservation status upgraded from Near Threatened to Vulnerable species under the Queensland *Nature Conservation Act 1992*. Their conservation status under the *Environment Protection and Biodiversity Act 1999* remains unchanged.

8.3.2 Design refinement

The revised design includes widening of the channel, the removal of the offshore marine disposal of capital dredge material, and an increase in the size of the reclamation area. These changes will affect marine ecological receptors due to changes in turbid plumes and habitat loss from reclamation. These impacts are assessed in Section 8.3.4.

The PEP revised design components relevant to the marine ecology assessment include the following:

- the size of the reclamation will be increased from approximately 100 to approximately 150 ha to accommodate more dredge material (including breakwaters)
- the channel will be widened and only partially deepened (previous design included deepening and targeted widening).

8.3.3 Supporting studies

Additional field studies (Appendix A1), water quality assessment (Section 6.3.4.1) and Technical Modelling Report (Appendix A2).

8.3.4 Revised assessment

8.3.4.1 Impact assessment

Table 8.1 is a summary of the predicted extent of habitat loss or modifications as a result of various port construction and operation activities for the revised design case. Figure 8.4 and Figure 8.5 shows the extent of habitat loss or modification due to these activities.

Direct modifications associated with dredging and reclamation

Construction of the port facilities and associated reclamation will result in the direct loss of 152 ha of soft-sediment habitat (compared to approximately 100 ha in the original design). A total of 264 ha of soft sediment habitat will also be disturbed by dredging activities (inclusive of the existing dredged channel, which will be deepened).

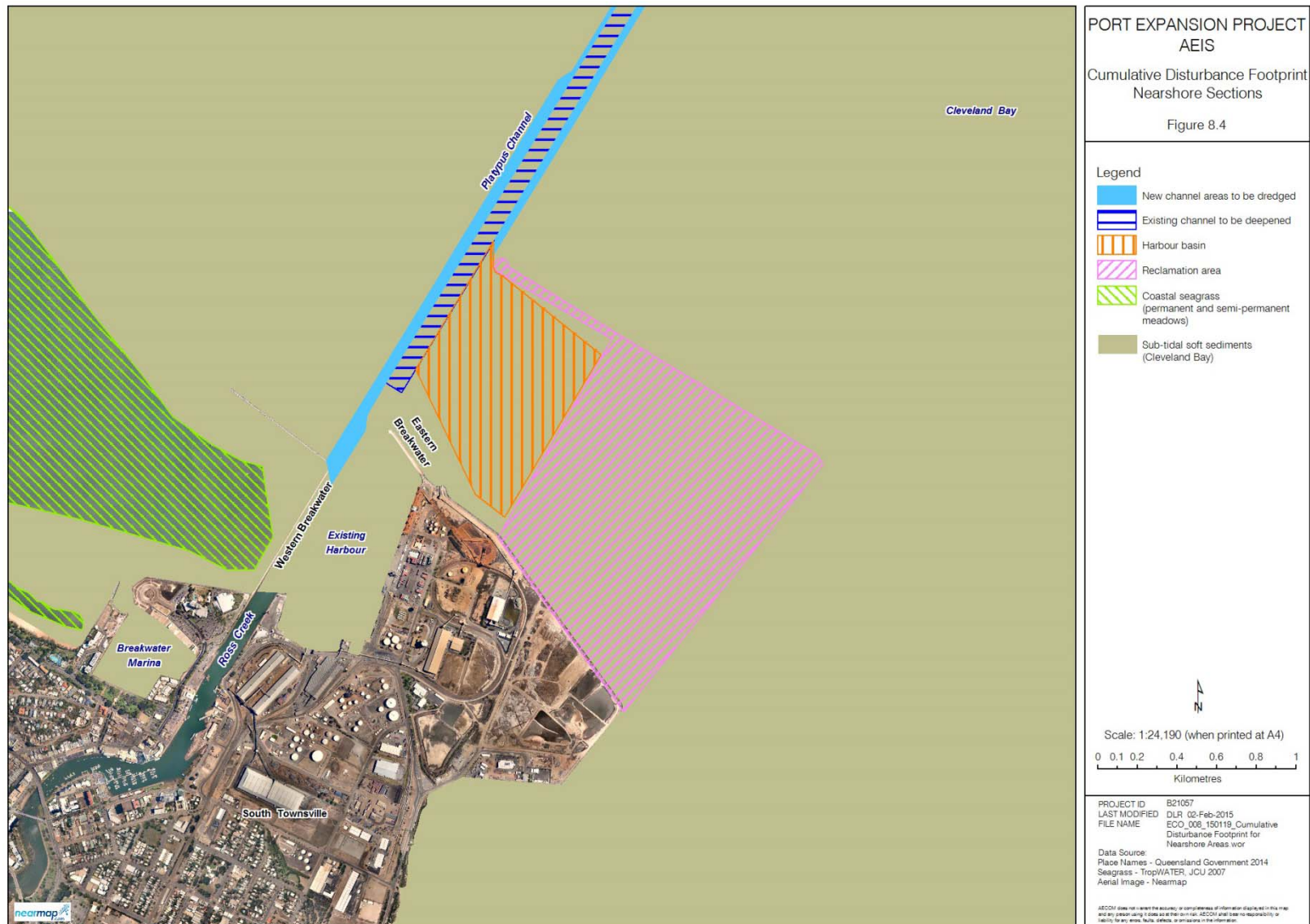


Figure 8.4 Cumulative disturbance footprint for the outer harbour Project area and nearshore sections of the navigation channel

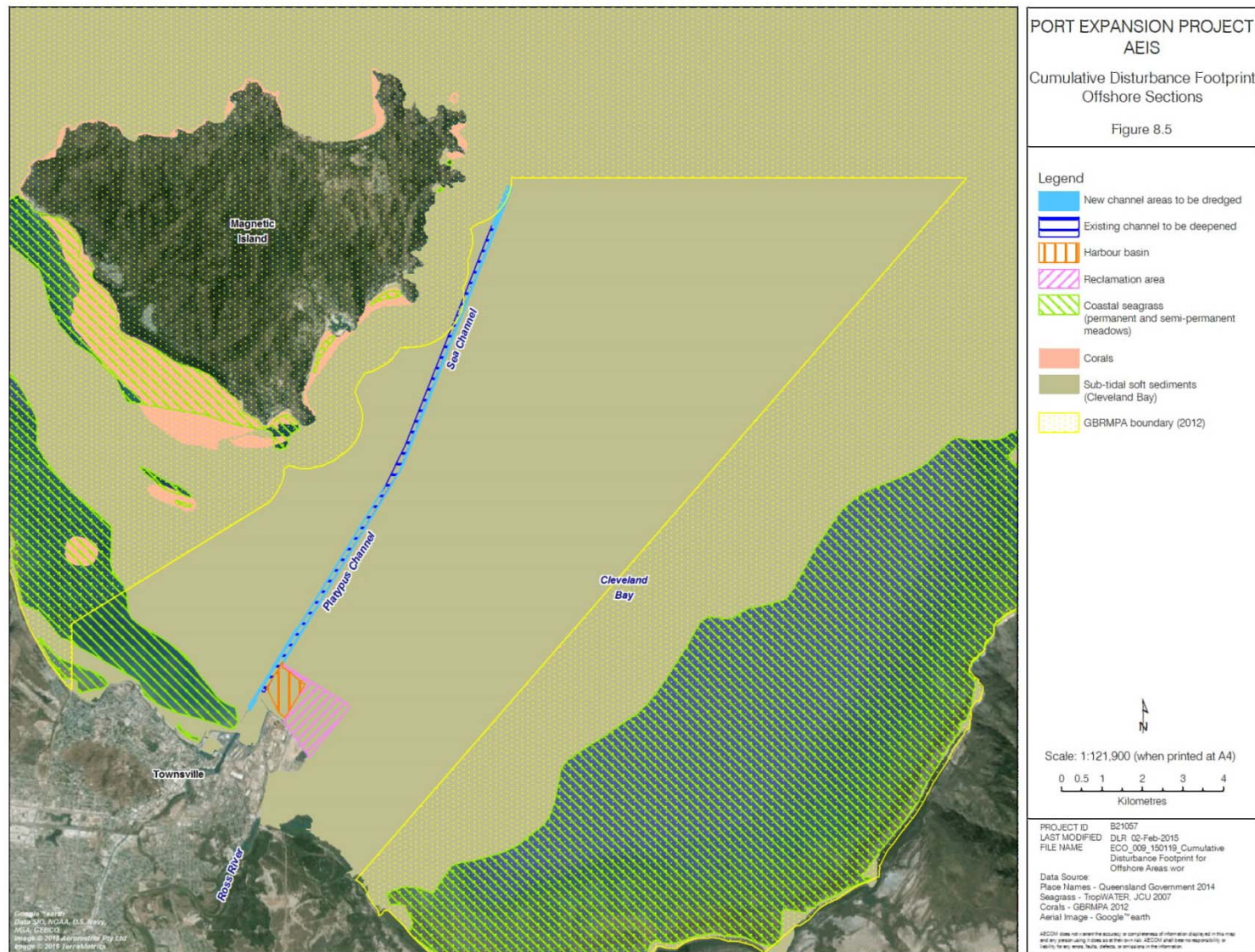


Figure 8.5 Cumulative disturbance footprint for the offshore sections of the navigation channel

Table 8.1 Area of disturbance within each impact location

Phase	Activity	Impact Type	Habitat	Area (ha)
Direct Irreversible Losses and Gains				
Construction, Operation	Reclamation	Loss of soft sediment habitat	Sub-tidal soft sediments	152 ha
Construction, Operation	Reclamation	Increase in rock wall habitat	Rock wall habitat	12.6 ha (net gain)
		Increase in rock wall habitat (including Western Breakwater)	Rock wall habitat	15.6 ha (net gain)
Direct Habitat Disturbance Associated with Dredging				
Construction, Operation	Dredging and deepening of harbour basin (outside reclamation footprint)	Habitat modification - Increase in depth; ongoing disturbance by maintenance dredging	Sub-tidal soft sediments	65 ha
Construction, Operation	Deepening of the existing navigation channel	Habitat modification - Increase in depth; ongoing disturbance by maintenance dredging	Sub-tidal soft sediments	123 ha
Construction, Operation	Deepening, widening and/or lengthening of navigation channel in previously undredged areas	Habitat modification - Increase in depth; ongoing disturbance by maintenance dredging	Sub-tidal soft sediments	76 ha
Indirect Temporary Changes due to Turbidity/Sedimentation *				
Construction	Dredging of port area and navigation channels	Turbid plume – Zone of Low, Moderate or High Impact (i.e. potential detectable effects)	Coastal seagrass (maximum recorded extent)	0 ha
			Reefs	0 ha
Construction – Worse Case	Dredging of port area and navigation channels	Turbid plume – Zone of Low Impact (Sub-lethal effects, medium term recovery) (Nb: Zone of Moderate or High Impact not predicted to align with location of seagrass or reef)	Coastal seagrass (maximum recorded extent)	8.8 ha
			Reefs	66.8 ha (widening) – Stage 1 77.6 ha (deepening) – Stage 3
Construction – Expected Case	Dredging of port area and navigation channels	Turbid plume – Zone of Low Impact	Coastal seagrass (maximum recorded extent)	0 ha
			Reefs	0 ha

Note: Areas of coastal seagrass based on maximum recorded extent (i.e. 2007). No seagrass or corals occur in zones of impact for expected case

As discussed in Appendix A1 (Additional Field Studies Report), the soft sediment habitat to be lost or disturbed is well represented within the nearshore environments of Cleveland Bay, and benthic communities here are neither rich nor abundant compared to other parts of Cleveland Bay. It is expected that dredging of the navigation channel will create benthic habitat conditions that are similar to those found within the existing navigation channel. As discussed in Appendix A1 (Additional Field Studies Report), existing benthic habitats and macroinvertebrate assemblages within the navigation channels are highly simplified and have low diversity compared to adjacent undredged areas. These navigation channels are subject to ongoing disturbance as a result of maintenance dredging and propeller wash. While in a modified condition, it will be expected benthic habitats and communities within the navigation channel will continue to support similar benthic communities and ecological functions as found in the existing channels.

The greatest biodiversity values supported in areas to be lost or disturbed is the provision of habitat for the two state listed Vulnerable nearshore dolphins (*Orcaella heinsohni* and *Sousa sahulensis*). As outlined in Chapter B.6.4.5.2 of the EIS, waters surrounding the Port of Townsville, as well as the mouths of Ross Creek and Ross River, represent locally important feeding areas for both species. These species also forage throughout Cleveland Bay and have another core use area west of Cape Pallarenda. As outlined in the EIS, reclamation will result in the localised loss of soft-sediment subtidal habitat and foraging areas for the two nearshore dolphin species, resulting in displacement of dolphins foraging in the proposed development footprint. During construction, these species will be more reliant on habitats elsewhere in Cleveland Bay, west of Cape Pallarenda and elsewhere in the broader home range (i.e. outside the Townsville region). Following rock wall construction, based on current usage patterns in the Port, it is expected they will continue to occur around the new rock wall (i.e. reclamation boundary).

As discussed in the EIS, both species are opportunistic foragers and have wide home ranges. While the Project is unlikely to cause a significant impact to the population status of these species, there is a clear need for further research to fill knowledge gaps regarding broad and local-scale movement patterns of these dolphin species, and the relative importance of different habitat patches at both local (i.e. within Cleveland Bay) and regional spatial scales. As outlined in the EIS, POTL has undertaken a range of investigations to assess habitat usage patterns of marine megafauna in the port area and wider Cleveland Bay, which will need to be considered in future port planning and environmental impact assessment studies. The protection of tidal habitats within the Fish Habitat Area extension as proposed as an offset to the PEP will further enhance marine habitats in Cleveland Bay used by these dolphin species.

Incursion of sea channel into GBRMP

The revised design has reduced the length of the Sea Channel by about 1.7 km since the EIS design. As shown in Figure 8.5, this has avoided a direct impact into the Great Barrier Reef Marine Park General Use Zone.

Habitat fragmentation and effects to hydrodynamics

As for the design adopted in the EIS, the refined project design has been developed to avoid forming a barrier to tidal currents and fluvial flows from the Ross Creek. The Project will not create a barrier to the movement patterns of mobile fauna between Ross Creek and Cleveland Bay. Furthermore, the Port Expansion Project will not form a barrier between the eastern and western sections of the outer harbour Project area, although marine fauna will need to travel a greater distance to move around the reclamation area. Such changes are expected to result in highly localised changes to marine fauna movement patterns (impacts measured in 100s of metres of the final structure), however such changes are not expected to result in detectable changes to the habitat, biodiversity or fisheries values of Cleveland Bay, or populations status of resident marine fauna.

Based on modelling results presented in the Appendix A2 (Modelling Report):

- The reclamation and increased water depths resulting from dredging will result in minor changes to local hydrodynamics, being confined to changes (± 0.2 - 0.3 m/s) in velocity magnitude in the immediate vicinity of the proposed breakwaters and reclamation area. Minor, localised effects to benthic communities are expected in these areas.
- The increased water depth and changes to hydrodynamics in the harbour area will result in the same localised changes to benthic communities as predicted in the EIS. In this regard, an increase in fine sediments is likely to favour species that prefer fine sediments (e.g. some suspension-feeders).
- The predicted minor changes to sediment transport processes in Cleveland Bay are not expected to result in significant changes to benthic fauna or seagrass assemblages.

Turbidity and sedimentation impacts due to dredging

Impact Thresholds

Section 6.0 provides a detailed description of the methodology and findings of the potential impacts of dredge-generated turbid plumes on water quality, and sediment deposition. The methodology and impact thresholds adopted in Section 6.0 consider tolerances of marine ecological receptors, and are therefore applicable to this marine ecology impact assessment. As outlined in Section 6.0, four zones of impact were defined based on severity of potential impact to marine ecological receptors.

Potential impacts

In summary, based on the expected case (impact zones figures are presented in Section 6.0):

- For both channel deepening and widening, reefs occur in the predicted zone of influence for both TSS (Figure 6.10 and Figure 6.14) and sediment deposition (Figure 6.16 and Figure 6.18), but not in any of the impact zones (Table 8.1). For both deepening and widening, all reefs along eastern Magnetic Island from Gowrie Bay to the eastern margin of Cockle Bay Reef are located in the predicted zone of influence. The closest reef to any of the potential impact zones is the northern end of Geoffrey Bay, which occurs directly adjacent to the channel. As reefs do not fall into any impact zones, significant impacts to corals are not predicted for the expected case, including Cockle Bay.
- For both channel deepening and widening, Magnetic Island coastal seagrass meadows occur in the predicted zone of influence for both TSS and sediment deposition, but not in any of the impact zones (Table 8.1). Seagrass assemblages within the zone of influence are located on the east and south-east coast of Magnetic Island, and are comprised of *Halodule uninervis*, *Halophila spinulosa*, *H. ovalis*, *Cymodocea serrulata* and (in some years), *Thalassia hemprichii* (Davies *et al.* 2015). In 2014 these seagrass meadows were rated as being in Very Good (Geoffrey Bay and Nelly Bay) and Good (southern Magnetic Island) condition, following a three year recovery period after extreme weather and climate related losses leading up to 2011 (Davies *et al.* 2015). Davies *et al.* (2015) suggest that the present day good condition of seagrass will have at least partially restored meadow resilience compared with the recent past. Assuming seagrasses remain in a similar, or better, condition at the time of dredging, together with the predicted low sediment concentrations, significant impacts to seagrasses are

not expected for the expected case. Impacts may be worse than predicted if seagrass condition drastically declines between now and the Project commencement.

- For both channel deepening and widening, coastal seagrass meadows from Cape Pallarenda to the Strand occur in the predicted zone of influence for both TSS and sediment deposition, but not in any of the impact zones (Table 8.1). Seagrass assemblages within this area are comprised of *Halodule uninervis*, *Halophila ovalis*, and *Cymodocea serrulata* (Davies *et al.* 2015). In 2014 these seagrass meadows were rated as being in Good condition, following a three year recovery period after extreme weather and climate related losses leading up to 2011 (Davies *et al.* 2015). Assuming seagrasses remain in a similar, or better, condition at the time of dredging, significant impacts to seagrasses in this area are not predicted to occur for the expected case. Impacts may be worse than predicted if seagrass condition drastically declines between now and the Project commencement.

In summary, based on the worse case (impact zones figures are presented in Section 6.0):

- For both channel deepening and widening, reefs occur in the predicted zone of influence for both TSS (Figure 6.11 and Figure 6.15) and sediment deposition (Figure 6.17 and Figure 6.19), and the zone of low impact for TSS (Table 8.1). For both deepening and widening, all reefs along eastern and southern Magnetic Island from the eastern headland of Horseshoe Bay to the western margin of Cockle Bay Reef are located in the predicted zone of influence. Reefs from Florence Bay south to Nelly Bay (including Geoffrey Bay) occur in the zone of low impact for TSS. It is possible that stress could occur to corals in the zone of low impact, especially if dredging were to be undertaken during and following unfavourable climatic periods when coral resilience is low. The most recent published coral monitoring data for the Burdekin region (Thompson *et al.* 2014) shows that reefs (including Magnetic Island and Middle Reef) are in poor condition, reducing their resilience to further stress. It is therefore important that mitigation measures are put in place to ensure that any stress to corals does not manifest as injuries or mortality.
- For both channel deepening and widening, Magnetic Island coastal seagrass meadows occur in the predicted zone of influence for both TSS and sediment deposition, and zone of low impact (Table 8.1). Seagrass assemblages within the zone of low impact occur at Geoffrey Bay and Nelly Bay on the eastern coastline of Magnetic Island. Stress to seagrass meadows could occur to seagrass in this zone. While these meadows are currently in good condition, mitigation measures should be implemented to minimise the risk of impacts, especially if climatic processes leading up to dredging result in declines to seagrass meadow condition. Impacts may be worse than predicted if seagrass condition drastically declines (e.g. due to a major cyclonic disturbance etc.) between now and the Project commencement.
- For both channel deepening and widening, coastal seagrass meadows from Saunders Beach to the Strand (including Cape Pallarenda) occur in the predicted zone of influence for both TSS and sediment deposition, but not in any of the impact zones (Table 8.1). Significant impacts to seagrasses in this area are not predicted to occur for the worse case.

Note that deepwater ephemeral seagrass has been previously recorded in Cleveland Bay on one occasion (in 2007), following successive years of drought conditions. Should seagrass re-establish in this area it is possible that some impacts (not necessarily mortality) could occur, primarily limited to seabed areas near the channel where this coincides with the Zone of High Impact.

Monitoring and other measures outlined in Section 8.3.4.2 below will be critical to mitigating such effects and ensuring that impacts are managed within acceptable limits (as listed under mitigation in Section 8.3.4.2). Ongoing monitoring of coastal seagrass and reef community condition will form a key component of the Reactive Monitoring Program that will be undertaken during dredging.

In the unlikely event that seagrass mortality occurs as a result of increased turbidity, recovery could occur through a number of mechanisms, which are discussed in Section 6.1.5.4 of the EIS. These include the following:

- Seagrass species found in the study area can reproduce both sexually and asexually, providing multiple mechanisms for relatively rapid recovery (Coles *et al.* 2004).
- Where vegetative growth is not possible (e.g. extensive plant mortality), recovery will be dependent on germination of seeds stored in the seed bank at that location. Seeds may be able to survive in a dormant condition for two to three years and still remain viable (Campbell and MacKenzie 2004, Orth *et al.* 2006). A poor seedbank was recorded in Magnetic Island meadows in 2013, but those at mainland sites (Cape Pallarenda) were in better condition.
- Mainland seagrass meadows at Cape Pallarenda and Cape Cleveland are not expected to be affected, thereby providing potential propagule sources for potentially affected areas at Magnetic Island. Hydrodynamic modelling shows that during ebbing tides (prevailing winds), currents flow between mainland meadows at Cape Pallarenda and Cape Cleveland to southern and eastern Magnetic Island, forming a potential linkage for seagrass propagules between these areas.

As discussed in the EIS, the rate of recovery will be dependent on factors such as the location, magnitude and extent of disturbance, seed bank and meadow condition, as well as the season and environmental conditions during the

recovery period. Rapid recovery (measured in months to 10s of months) will be expected in the event that impacts were low magnitude and seagrass had high resilience, but longer recovery timeframes (measured in years) will be expected if mitigation measures are not in place, and seagrass was in poor condition.

As discussed in the EIS, the tolerance of corals to low light conditions varies greatly between species. While coral species in Cleveland Bay have adaptations to cope with periodic high sedimentation and turbidity levels (e.g. heterotrophic feeding, mucous secretions), levels outside the range of natural variability generally cannot be tolerated in the medium to long term.

The potential for impacts to reef communities (particularly corals), like seagrass, also depends on ambient conditions at the time of dredging, as well as other disturbances (e.g. a major cyclone could occur and impact seagrass or coral communities prior to Project commencement). Turbidity levels are largely driven by variations in the wind-wave climate and rainfall, as discussed in Chapter B.4 (Marine Water Quality) of the EIS. It is therefore expected that corals may be closer to their critical light limits and sedimentation tolerance limits during wet periods with high winds than lower wind, dry periods. It is notable however that patterns in turbidity can show a high degree of variability across a range of other temporal scales, and that other factors can lead to stress in corals (e.g. high water temperature, disease, predation etc.).

Assuming environmental conditions are poor leading up to and during dredging (i.e. high water temperature, low salinity, high nutrients and sediments), there is a greater potential for excess sediment created by dredging to affect corals and possibly other reef species (including macroalgae, soft corals, other filter feeders and possibly stromatolites). This is particularly the case given the existing poor condition of coral communities around Magnetic Island following successive years of extreme weather-related disturbances. It is therefore important that mitigation measures are put in place to manage potential impacts to corals and other reef species.

As discussed in Sections 6.3.4.2 and 8.3.4.2, mitigation strategies will be developed and implemented to minimise the risk of impacts to sensitive ecological receptors. Modelling presented in Section 6.3.4.2 demonstrates that dredge plumes could extend to reefs and seagrass meadows along the coast of Magnetic Island. However, overall, the residual risk rating for seagrass and corals is classified as Low (for areas in Zone of Influence) to Low-Medium (for areas in Zone of Low Impact). It is therefore not expected that dredge plumes will have a significant impact on key feeding habitats used by marine megafauna, including the important turtle foraging habitats at Cockle Bay and elsewhere along Magnetic Island.

8.3.4.2 Mitigation measures

Mitigation measures will be required to minimise the potential for turbid plumes to impact seagrass and coral assemblages along eastern and southern Magnetic Island. A hierarchy of controls will be followed as follows, as outlined in the DMP:

- Avoidance of late spring and summer months by the TSHD, noting that (see the EIS for details):
 - corals and seagrass may be under stress from (i) high temperatures; (ii) high turbidity and low salinity associated with floods
 - the spring and early summer period (together with other less extreme summer periods) may represent key periods for seagrass growth and resilience building
 - mass coral spawning occurs during November, with recruitment of broadcast spawners occurring thereafter
 - summer represents a key turtle nesting period.
- Minimisation Using Monitoring Controls - Development and implementation of a reactive water quality and coral monitoring program (RMP). Dredging activities will be modified or suspended in the event that monitoring detects exceedance/s of trigger values. The trigger values are based on both sub-lethal effects guidelines (i.e. changes in turbidity relative to background) and direct impact response guidelines (i.e. coral bleaching and/or mortality), which will illicit different management responses. An advisory body will be established that oversees the development and implementation of the reactive monitoring program.

Other mitigation commitments outlined in the EIS will also be applied.

With respect to offset requirements, the relevant MNES and MSES significant impact criteria were consulted for the threatened species of key concern in the context of this Project (i.e. nearshore dolphins, *Orcaella heinsohni* and *Sousa sahalensis*). For determining significant impacts to these species as MNES, the criteria for Listed Migratory Species are recommended under the Matters of National Environmental Significance Significant Impact Guidelines 1.1 (Department of the Environment 2013). These criteria are listed under MNES in Table 8.2. Note that no specific guidelines are provided for Listed Cetaceans in the MNES guidelines.

Under the State Significant Residual Impact Guidelines (DEHP 2014), criteria for threatened species are listed under 'Protected Wildlife Habitat', including any area of habitat (e.g. foraging, nesting, roosting or breeding habitat) for an animal that is endangered, vulnerable or a special least concern animal. Criteria for threatened wildlife and their essential habitat are as listed under MSES in Table 8.2.

As detailed in Table 8.3 below:

- Both dolphin species use sound for navigation, feeding and avoiding predators (through echo location) and also for communication. Construction works are expected to generate noise that will compromise the ability of dolphins to communicate, navigate and echo locate by sound. During the construction period, nearshore dolphins will likely avoid the reclamation construction footprint at times when noisy, or otherwise disturbing, construction activities are underway. This will lead to the displacement of these species in waters directly adjacent to the construction area during the construction phase. Noise disturbance will be temporary and intermittent throughout the construction period.
- The locally important dolphin feeding habitats at the mouths of the Ross Creek and Ross River will not be directly affected by the PEP.
- The proposed reclamation would result in the permanent loss of habitat used by nearshore dolphins. The habitat types (sediment types, hydrodynamics, depths, water quality) and benthic communities present in the proposed reclamation area are similar throughout the nearshore environments of the wider port area, and are not known or likely to contain unique feeding resources or functional values.
- Based on observations of dolphins within and adjacent to existing berth and breakwater areas (GHD 2011), it is expected that the dolphins will use waters in the vicinity of the new breakwater (i.e. PEP reclamation boundary) in the same manner.
- Dolphins will need to swim a slightly greater distance around the Port Expansion Project area to move between the feeding areas at the Ross River and Ross Creek mouths. No significant impacts to broad-scale movements are expected (i.e. to and from the wider Cleveland Bay, seagrass meadows, or core area west of Cape Pallarenda). The proposal will not fragment the local populations of these species, nor pose ecologically significant impediments.

Table 8.2 MNES and MSES Significant Impact Guidelines and Relevant PEP Impact Assessment for threatened nearshore dolphins

	Impacting Process	Timescales
MNES (Listed Migratory Species)		
<i>An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:</i>		
1. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles, or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;	Direct Permanent loss of habitat in proposed reclamation area (i.e. highly localised), but no direct impacts to the locally important foraging habitats at mouths of Ross River and Ross Creek, or to seagrass meadows	Permanent – Construction and operational phases
	Indirect No significant modifications to habitats outside the reclamation footprint, noting no major changes to hydrodynamics, water quality, sediment quality or benthic communities Dolphins currently forage adjacent to the existing seawall and port facilities, and this is expected to continue post construction of the new seawall	Temporary - Construction phase
2. result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or	The action is unlikely to result in the invasive pests (or cause disease) causing serious impacts to habitat values for nearshore dolphins	Construction and operational phases
3. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour of an ecologically significant proportion of the population of a migratory species.	Possible temporary displacement of both species from waters near the construction zone during construction phase (noise, boat traffic)	Temporary and intermittently during construction phase
	See 1.	See 1.
MSES (Protected Wildlife Habitat, including any area of habitat - e.g. foraging, nesting, roosting or breeding habitat - for an animal that is endangered, vulnerable or a special least concern animal):		
<i>An action is likely to have a significant impact on endangered and vulnerable wildlife if the impact on the habitat is likely to:</i>		
4. lead to a long term decrease in the size of a local population; or	See 1 and 3 Significant impacts to important habitat near the river mouths (and seagrass) not expected	See 1 and 3
5. reduce the extent of occurrence of the species; or	See 4	See 4
6. fragment an existing population; or	See 4	See 4
7. result in genetically distinct populations forming as a result of habitat isolation; or	See 4	See 4
8. result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or	See 2	See 2
9. introduce disease that may cause the population to decline; or	Not applicable	Not applicable
10. interfere with the recovery of the species; or	See 4 Current population trend unknown, no confirmation that population is in a state of decline or recovery	See 4
11. cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.	See 3	See 3

Table 8.3 Rationale advising no significant impact to nearshore dolphins with respect to key significant impact criteria

MNES (Migratory Species): Will the action substantially modify, destroy, isolate an area of important habitat for a migratory species? MSES (Endangered and Vulnerable Wildlife): Will the action cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species?		
Impact Matter	Significant Residual Impact?	Rationale
Will the development impact on the species during construction?	No	There is likely to be a temporary impact during construction as the animals are displaced from the reclamation footprint. However the intensity, scale, magnitude and duration of the impact are not expected to preclude use and transit of the area during construction periods and will not preclude use of the habitat (direct reclamation footprint excluded) in the future once works are completed (see below). Mitigation measures are set out in the CEMP/DMP to avoid or otherwise minimise adverse impacts from piling and to reduce incidence of adverse vessel interaction. Contingency and response measures will be implemented for any harmful interaction in accordance with government guidance, noting it is considered highly unlikely works will cause a significant injury or mortality to an individual given the highly mobile nature of the species. Accordingly, this temporary impact of displacement is not considered to be a significant residual impact to the species.
Destruction of an important habitat leading to potential impacts to the population of the species	No	The reclamation will result in the loss of 152 ha of habitat that is currently used as feeding habitat by the species. There is not any practical design or mitigation measures that could be implemented by the PEP to further minimise this impact other than to not proceed with the Project (e.g. not reclaim the land). The size of the reclamation responds to the commercial and operational needs for port expansion but also the requirements of the Commonwealth and State government to beneficially re-use capital dredge material and prohibition on the placement of such material at sea. The feeding habitat in the Project area is part of a broader sub-regional habitat for the species as defined in Parra (2006). For the sub-population frequenting Cleveland Bay, this includes their representative range from Black River to eastern Cleveland Bay and contains similar habitats to Ross River/Ross Creek at the mouths of the Black and Bohle Rivers, and Sandfly, Alligator and Crocodile Creeks. The area lost to reclamation makes up < 1% of this overall sub regional unit. The individuals of the species likely transit and forage for food across all suitable habitats within this sub regional unit. The habitat range of these species extends well beyond this sub-regional unit. These species are known to be highly mobile with home ranges extending outside Cleveland Bay, and individuals typically have a short (snubfin) to moderate (humpback) residence time in the bay, often spending periods of a month or more away before returning (Para <i>et al.</i> 2006). It is considered likely that they use areas to the south (Bowling Green Bay) and further north (Halifax Bay to Luncinda) as well as around Magnetic Island. There is no data or evidence to suggest that the individuals present in the sub-region display any genetic distinctiveness or specifies specific behavioural patterns but this remains a knowledge gap. Once construction is completed, it is considered likely that the dolphins will continue to use the remaining undisturbed habitat areas immediately adjacent to the reclamation based on documented observations of dolphin numbers following completion of both the Eastern Reclaim and Marine Precinct projects (see below). In this context, the Project does not propose any significant residual impacts on undisturbed habitats (e.g. no permanent changes to hydrodynamics, water quality and sediment quality). The habitat affected is soft bottom feeding habitat which is part of broader habitat range used by the species. The habitat affected is not at the limit of the species range. The habitat is not within an area where the species is known to be declining. On this basis, the loss of habitat from the reclamation is not considered to be a significant residual impact on the species.

MNES (Migratory Species): Will the action substantially modify, destroy, isolate an area of important habitat for a migratory species? MSES (Endangered and Vulnerable Wildlife): Will the action cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species?		
Once completed, will the new reclamation impact on how the dolphins use or transit the area?	No	Based on the monitoring data and observations undertaken by GHD and the Port (GHD 2011, 2012), the species appear to be able to successfully co-exist with the existing port and to accommodate the impacts of major expansion projects including the Eastern Reclamation, TPIX and Marine Precinct. The PEP reclamation is not expected to affect migratory patterns or limit transit of the animals any more than the existing reclamation will. The reclamation will not cause any notable or significant change to hydrodynamics of the adjacent undisturbed soft bottom benthic environment used by the dolphins. As evidenced by the cetacean studies and monitoring undertaken to date, it will be expected that following the initial period of displacement (as above), once the works are completed, the species will continue to use the undisturbed areas of the Project area as feeding habitat. To this end, there is anecdotal information that the dolphins will also preferentially use the artificial rock wall habitat from time to time to augment their feeding habitat and will also seek respite/resting opportunities in the more confined waters within the breakwaters or dredged channels. On this basis, the loss of habitat from the reclamation is not considered to be a significant residual impact on the species.

8.3.5 Summary

Table 8.4 is a summary of key impacts to marine ecology, and revised risk ratings based on the revised design.

Table 8.4 Revised Impact Assessment Summary – Marine Ecology

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
1) Impacts on seagrass	1a. Turbid plumes and sedimentation resulting from dredging leading to the temporary loss or stress to coastal seagrass meadows in areas along eastern and southern Magnetic Island	Worse case scenario: Minor to Moderate (Zone of Low Impact)	Possible	Medium	See Section 8.3.4.2. Implement standard mitigation measures as per the DMP. Implement additional mitigation measures, including: - Avoidance of dredging using TSHD late spring and summer months to minimise potential impacts to key life-history functions - Develop and implement a Reactive Monitoring Program with appropriate triggers and corrective actions.	Low (Unlikely)
		Expected Case scenario: Minor (Zone of Influence only)	Possible	Low		Negligible (Highly Unlikely)
2) Impacts on corals	2a. Turbid plumes and sedimentation resulting from dredging leading to coral stress and/or mortality	Worse case scenario: Minor to Moderate (Zone of Low Impact)	Possible	Medium	As for 1a	Low (Unlikely)
		Expected Case scenario: Minor (Zone of Influence only)	Possible	Low		Negligible (Highly Unlikely)
3) Impacts on soft sediment habitats and invertebrate communities	3a. Turbid plumes and sedimentation resulting from dredging channels, berths and harbour basin leading to the temporary effects to benthos	Minor	Likely	Medium	As for 1a	Medium (Likely)
	3b. Removal of habitat and fauna through reclamation (irreversible) and capital dredging (temporary) resulting in detectable impacts to soft sediment communities in the wider Cleveland Bay area and/or significant effects to GBRWHA values	High	Highly Unlikely	Medium	Nil (Potential opportunities for offsetting impacts will be examined)	Medium (Highly Unlikely)
	3c. General disturbance and degradation of benthic communities in the harbour basin through day to day port operations (maintenance dredging, stormwater discharges, spills etc.)	Minor	Likely	Medium	Implementation of stormwater and waste management measures	Medium (Likely)

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
	3d. Changes to hydrodynamics and morphology due to operation of new harbour facilities and channels leading to changes in benthic communities within the direct footprint	Minor	Likely	Medium	Nil	Medium (Likely)
4) Impacts of hard substrate habitat on reef-associated species	4a. Loss of existing rock wall due to reclamation 4b. Expansion of rock wall habitat associated with the new harbour facilities	Potential beneficial (local scale, some reef associated species only)	Almost certain	Positive benefit (local scale, some reef associated species only)	N/A	Positive benefit (local scale, some reef associated species only)
5) Impacts to marine megafauna	5a. Light spill from construction plant and port facilities leading to disorientation of hatchlings or nesting adults	Moderate	Unlikely	Low	Light management procedures to minimise light spill to the marine environment to the greatest extent possible noting navigational and WHS safety requirements.	Low (Unlikely)
	5b. Increase in rubbish production increasing the risk of entanglement and/or ingestion of marine debris by turtles and marine mammals	Moderate	Possible	Medium	Waste management procedures implemented by construction contractors and operator	Low (Rare)
	5c. Increase in noise during construction leading to marine fauna temporarily avoiding affected area (displacement)	Moderate	Likely	Medium	Construction phase megafauna management plan Visual checks for megafauna, and implement strategies to avoid interactions	Medium (Possible)
	5d. Injury/mortality to marine megafauna resulting from the use of dredge plant or noise generated by construction activities	Moderate	Possible	Medium	Construction phase megafauna management plan Tickler chains on TSHD dredge head Ensure suction on TSHD is ceased prior to hoisting the dredge head Visual checks for megafauna, and implement strategies to avoid interactions	Low (Highly Unlikely)
	5e. Loss of food resources and habitat as a result of construction and port facility operation leading to displacement of marine megafauna	Moderate	Likely	Medium	Refer to 1a for turbidity/ sedimentation impacts Refer to 3b for offsets	Medium (Likely)

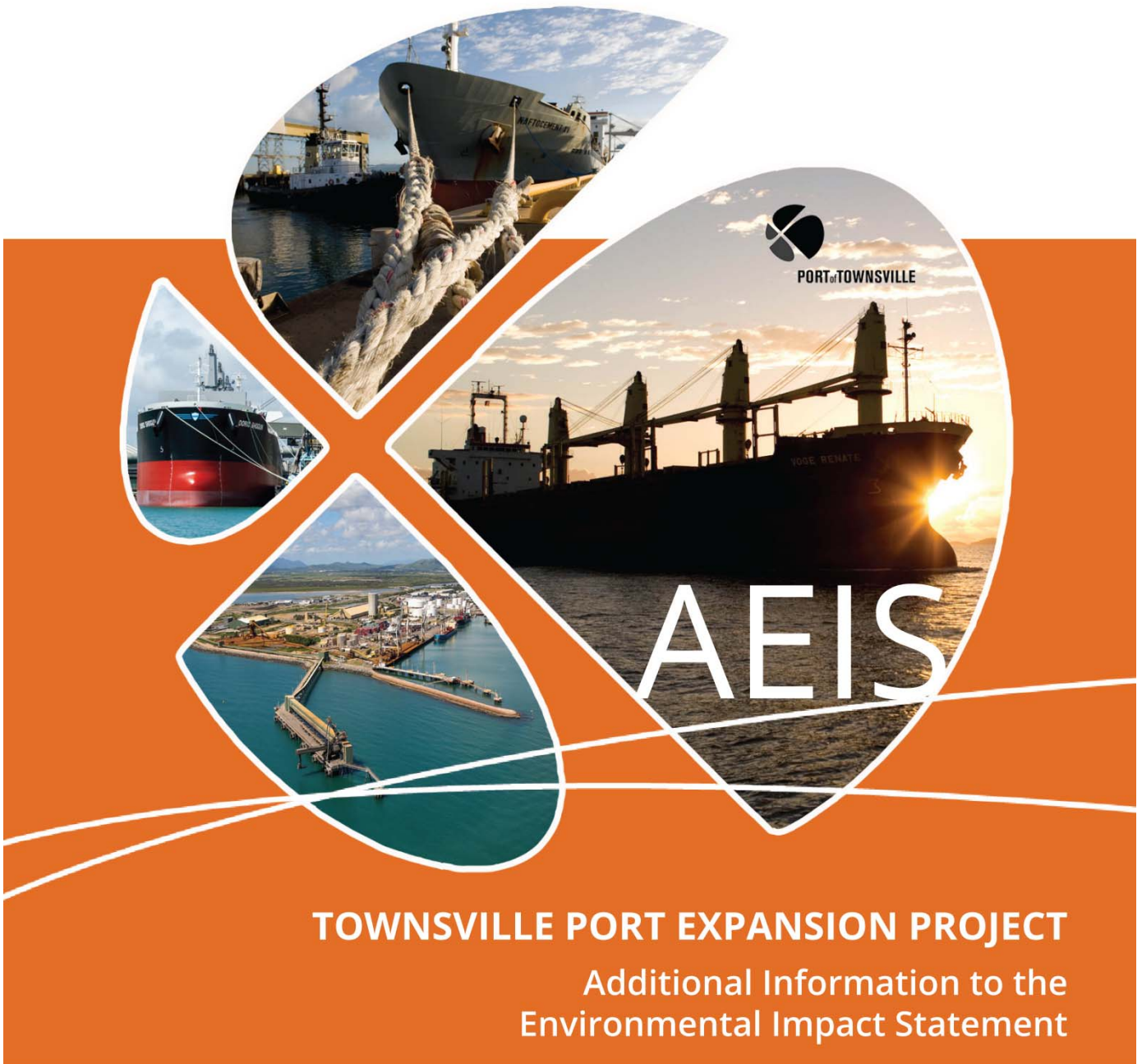
Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
	5f. Increased potential for hydrocarbon or other contaminant spill from vessels or on-site facilities, potentially leading to direct effects to marine megafauna or their prey (construction, operation)	High	Unlikely	Medium	Develop hazardous material handling procedures Implement emergency response procedures in general accordance with the <i>Queensland Coastal Contingency Action Plan</i> Spill response training for staff	Medium (Unlikely)
	5g. Increase in vessel traffic during construction phase potentially leading to an increase in vessel strike risk or habitat disturbance due to prop wash	High	Possible	Medium	As for 5c Go slow zones for construction vessels	Medium
	5h. Increase in vessel traffic during operational phase potentially leading to an increase in vessel strike risk or habitat disturbance due to prop wash	High	Possible	Medium	Nil	Medium
6) Impacts on fisheries production	6a. Loss of fisheries habitat associated with reclamation (irreversible) and dredging activities (temporary)	Moderate	Likely	Medium	Refer to 3b for offsets Monitoring to assess recovery of benthos and seagrass following dredging activities	Medium (Likely)
	6b. Displacement of economic species due to construction related disturbance	Moderate	Unlikely (at Cleveland Bay wide scale)	Low	Nil	Medium (Local) Low (Regional)
	6c. Increased potential for hydrocarbon or other contaminant spill from vessels or on-site facilities, potentially leading to direct effects to economic species or their prey (construction, operation)	High	Unlikely	Medium	As for 5f	Medium (Unlikely)
7) Marine pests	7a. Increased potential marine pest introductions	High	Possible	Medium	Implement State and Commonwealth biofouling and ballast management requirements	Medium (Possible)
8) Impacts to GBRMP	8a. Deepening of the portion of the Sea Channel within the GBRMP leading to changes to benthic habitats and communities	N/A (No longer part of the design)	N/A (No longer part of the design)	N/A (No longer part of the design)	N/A (No longer part of the design)	N/A (No longer part of the design)
	8b. Dredge plume impacts to marine ecology	Minor to Moderate (Zone Moderate Impact) – Worse case only Minor (Zone of Influence) – Expected Case	Possible Possible	Medium Low	As for 1a	Low (Unlikely) Negligible (Highly Unlikely)

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
9) Impacts to FHA	9a. Dredge plumes leading to loss of seagrass, and subsequent reduction in the abundance of economic species supported by the FHA	Moderate	High Unlikely	Low	Refer to 1a.	Low (Rare)
10) Impacts to GBRWHA values (marine ecology)	10a. The key impacts relate to the irreversible loss of soft sediment habitat due to reclamation, and ongoing impacts associated with day to day operations of the port facility. Temporary impacts to corals, seagrass and benthic fauna could occur as result of dredge plumes, and noise generated by dredging, piling and construction activities is also likely to result in the temporary avoidance of construction areas by megafauna and fish. Potential changes to natural values supporting the OUV of the GBRWHA.	High	Unlikely	Medium	Refer to 1 – 9 above Impacts to benthos to be offset	Medium
11) Impacts on Ramsar site	11a. Dredge plumes leading to loss of seagrass, and subsequent reduction in the abundance of marine megafauna supported by the site	Worse case/expected case scenario: Minor (No impact)	Highly Unlikely	Low	Refer to 1a.	Low

8.4 Conclusion

Key findings from the revised impact assessment include the following.

- The design refinement in the outer harbour will not create additional impacting processes to those considered and reported in the EIS. While the reclamation area for the design refinement is larger than reported in the EIS, the impact risk levels remain the same as reported previously.
- Dredge plume modelling was undertaken for the design refinement. If unmitigated dredge plumes are expected to extend to coastal environments along Magnetic Island, which support sensitive ecological receptors (reefs and seagrass meadows). However, given the magnitude and frequency of plumes in relation to background conditions, the residual risk rating for seagrass and corals is classified as Low.
- Mitigation measures are proposed to minimise the potential for turbid plumes to impact seagrass and coral assemblages along eastern and southern Magnetic Island. To ensure that potential impacts can be contained to acceptable levels, a hierarchy of controls will be followed as follows:
 - avoidance of late spring and summer months (see the EIS for details) during TSHD dredging
 - development and implementation of a Reactive Monitoring Program (including water quality and coral monitoring program).
 - significant impacts to the OUV of the GBRWHA are not expected (refer to OUV section in Cumulative Impact Section 25.0).



SECTION 9

Terrestrial Ecology



9.0 Terrestrial Ecology

9.1 Introduction

Terrestrial ecology values of the Project area and surrounds are described in Chapter B.7 (Terrestrial Ecology) of the Port Expansion Project (PEP) Environmental Impact Statement (EIS). The existing reclamation area provides opportunistic habitat for a number of shorebirds, with various species observed breeding on the existing artificial revetments. Better quality, largely undisturbed habitat is present to the south and outside of the Project area in the form of the Ross River sandspit and mouth. This area is considered a significant breeding, foraging and roosting habitat area for shorebirds in the region. Other intertidal areas in the region also provide habitat opportunities for these species.

The PEP will result in the loss of the existing northern port revetment which is considered to provide opportunistic habitat. The loss is a result of the expansion reclamation area. The expansion will include the construction of a longer revetment area, which may be utilised by frequenting species in the future. The PEP is unlikely to change the sediment deposition patterns of the area to the south of the port, specifically the Ross River sand-spit as discussed in Section B.7.4.2 of the EIS.

This section provides information to address submissions received in response to the PEP EIS relevant to terrestrial ecology. More specifically, key matters raised from the submission process include:

- loss of access to artificial avifauna habitat in the Project area
- degradation of avifauna habitat in the vicinity of the Project area
- disruption to avifauna behaviour and movement patterns
- adequacy of weed and animal pest management
- environmental offsets
- cumulative impacts associated with current and future development of greater region.

Submissions received relevant to offsets are addressed in Section 27.0 of the AEIS.

Section B.7.6 of the EIS addressed cumulative impacts of existing and proposed development in proximity to the Project area relevant to terrestrial ecology. The AEIS has addressed cumulative impacts in line with the *Framework for Understanding Cumulative Impacts Supporting Environmental Decisions and Informing Resilience-Based Management of the Great Barrier Reef World Heritage Area* (GBRMPA Guidelines) (refer Section 25.0 of the AEIS)

9.2 Response to Submissions

9.2.1 Loss of access to artificial avifauna habitat in the Project area

Three submissions raised the loss of access to artificial avifauna habitat in the Project area. The impact to avifauna habitat in the Project area is addressed in Section B.7.3 of the EIS. Shorebirds are capable and known to colonise areas subject to human activity, with some species more tolerant than others (Paton, Ziembicki, Owen, & Heddle, 2000, 37). Constructed breakwaters and revetments in the Port area are used opportunistically by shorebirds for roosting and foraging during certain periods of the day and year. These areas are subject to existing human activity, including boating and vehicle activity, light and noise. They do not form a habitat area considered critical or essential to the long-term viability of any frequenting shorebird species, but rather demonstrate the ability of visiting shorebirds to adapt to disturbed, industrial environments.

Shorebird species utilising opportunistic habitat on site have also been recorded roosting and foraging on naturally occurring intertidal areas to the south and outside of the Project area (e.g. Ross River sandspit) and the wider region. These areas are considered to be of better quality and less disturbed, with the sandspit in particular, providing a significant roosting, foraging and breeding habitat area for shorebird species.

The project design has been with the land reclamation area and associated artificial revetment extended. It is anticipated that construction activities will result in a temporary partial loss of opportunistic shorebird habitat in the Project area as existing breakwaters and revetments are replaced and extended. It is noted that construction activities are limited to the area to the north of the existing reclamation area so that the marine precinct and surrounding area will remain unmodified.

The design is not expected to significantly impact upon shorebird populations or extent of habitat areas in the region. Shorebirds frequenting the Project area are not solely restricted to the Project area and are known, in greater numbers, from nearby higher quality habitat areas such as the Ross River sandspit. Habitat areas in the wider region are capable of accommodating increases in shorebirds as they are often underutilised due to the global decline in shorebird population numbers associated with the loss of a number of global critical habitat areas (Nebel, Portera, & Kingsford, 2008).

Shorebirds roosting and foraging in opportunistic habitat in the Project area will be monitored prior to and during construction activities to identify species and numbers and observe their relocation off site in accordance with the Construction Environmental Management Plan (Appendix B2).

9.2.2 Degradation of avifauna habitat in the vicinity of the Project area

Four submissions raised the degradation of avifauna habitat in the surrounding area, with particular emphasis on Ross River.

The impact to avifauna habitat in the vicinity of the Project area is addressed in Section B.7.3 of the EIS. Shorebird species have been recorded roosting, foraging and breeding on the Ross River sandspit and intertidal areas of Cleveland Bay, with these areas recognised as good quality, naturally occurring habitat.

These habitat areas are located proximate to the Port area, which currently supports operational industrial development and are subject to associated operational disturbance including noise, light and boating activity. Shorebird activity proximate to the Port area, particularly breeding, indicates frequenting species have adapted to these disturbances. Species frequenting close to the Project area are also known to forage, roost and breed in other habitat areas in the wider region and are not considered to rely solely on the Port area or the Ross River sandspit.

The Project construction works will involve the expansion of the reclamation area, which may temporarily disrupt shorebird activity in the vicinity of the Project area; however, the bulk of proposed PEP infrastructure is located to the north, further away from the Ross River sand-spit. Measures to manage light and noise generated during construction and operation of the PEP are outlined in Section 9.2.3.

Potential indirect impacts from changed hydrology and sedimentation as a result of the PEP are discussed in Section B.7.4.2 of the EIS and section 5 of the AEIS. The likely morphological response in the vicinity of the Ross River entrance and the coastline to the east is expected to involve a slight increase in the rate of net sediment accumulation in the area. The propagation of waves from the dominant easterly direction is expected to continue to be unaffected after construction of the new reclamation. Since fine sediments were accumulating in that area already due to the existing Port reclamation and given that the prevailing easterly wave direction is not significantly modified, construction of the new reclamation is not likely to result in any substantive change in the long term morphological condition.

The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case. The increased extent and shielding of the new reclamation may have the effect of slightly accelerating the rate of progradation, thereby continuing to provide habitat opportunities for avifauna.

One submission also recommended a monitoring program and public awareness campaign to provide the public with information on local biodiversity and species richness of the region. POTL acknowledges this recommendation and has proposed to incorporate this recommendation within its monitoring and awareness programs. Monitoring has been included in the Construction Environmental Management Plan (Appendix B2) and POTL will investigate opportunities to collaborate with local community groups where beneficial.

9.2.3 Disruption to avifauna behaviour and movement patterns

Three submissions raised the impact of noise and light emissions generated from the Project on shorebird roosting and foraging activities on site and in the wider area. Impacts of noise and light emissions are addressed in Sections B.7.4.4 and B.7.4.5 of the EIS. Shorebirds currently reside and forage in and adjacent to the Project area where they are subject to varying and continued industrial noise and vibration and artificial night-time light. Shorebirds have been observed, often in significant numbers, on intertidal areas adjacent to Benwell Road and near the mouth of the Ross River, as well as on existing artificial revetments in the eastern reclamation area, indicating an ability to colonise new and disturbed areas in the vicinity of noise and artificial light generating activities.

Noise and vibration emissions are expected to increase above the average ambient noise level during high-noise generating construction activities such as piling; however, this will occur intermittently over a 20 year construction program. These intermittent noise and vibration emissions are expected to potentially discourage or disrupt bird visitation to the port revetments close to the reclamation. Furthermore, the Project will result in an overall increase in artificial revetment area, providing a net gain in habitat area for those frequenting species over the longer term.

Artificial night time light is also expected to increase with the expansion of port operations; however, modelling indicates this will not increase light levels above natural levels in critical habitat areas due to the siting of proposed infrastructure being to the north-west of known bird habitats (refer to Section B.7.4.5 of the EIS). Light emissions generated from existing port operations have not discouraged migratory birds from roosting and breeding on the existing artificial revetments suggesting an ability to acclimatise to such conditions. This also applies to bats and other nocturnal fauna using habitats along the existing natural shoreline. The PEP alleviates that potential risk by constructing and operating on port land seaward of the existing natural shorelines.

Management of noise and light emissions are addressed in Sections B.7.5.3 and B.7.5.4 of the EIS. The Construction Environmental Management Plan (Appendix B2) and the Operational Environmental Management Plan (Appendix B3) will be implemented to manage noise, vibration and light impacts. Measures to mitigate impacts

include using designated transport routes to access site; maintaining plant and equipment; and shielding light sources or orientating light sources / noise-emitting equipment away from foreshore environments, where possible. With the implementation of these measures, the impact to avifauna behaviour in the long-term is considered low.

Submission also requested further information regarding noise and light generated from different projects and operations and along access routes to the port. POTL is responsible for the management of port land and manages noise and light emissions on the boundary of port land only. The management of noise and light emissions on surrounding land including access route is the responsibility of the respective tenant or landholder.

Submissions raised the impact of the Project on distributional ranges of waterbirds and migratory and threatened species. Birds currently residing and / or foraging in or adjacent to the Project area are not highly restricted species. Proposed works will have temporarily localised impacts to roosting and foraging activities and displacement of residing populations on the existing artificial revetment but are not expected to significantly reduce or modify the distributional range of avifauna species.

9.2.4 Adequacy of weed and animal pest management

Two submissions requested further information on how biosecurity will be managed to prevent the introduction and / or reduce the spread of weed and animal pests to surrounding land and fauna habitat areas.

Weed and animal pest management is addressed in Section B.7.4.3 and B.7.5.5 of the EIS. Mitigation measures, monitoring, reporting and corrective action procedures for the management of weeds and animal pests during construction and operational phases are detailed in the Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3). Measures include but are not limited to enforcing weed wash down procedures for vehicle and plant entering / exiting the site; limiting vehicle and plant movement in known weed infested areas; ensuring imported fill material is weed free; and active control and monitoring of weed infestation and feral animals on site.

POTL is responsible for the management of port land and as such manages weeds and animal pests in the boundary of port land only. The management of weeds and animal pests on surrounding land is the responsibility of the respective proponent or landholder; however, there is a clear benefit to a coordinated approach to managing invasive species on a local and regional scale. POTL will investigate opportunities to work with adjacent proponents and landholders to manage weeds, such as through scheduling of works together.

Previous studies identified weed infestations on land surrounding the port (refer to Section B.7.3.3 of the EIS). With the implementation of mitigation measures outlined in the Construction Environmental Management Plan (Appendix B2) these measures, the risk of introduction and / or spread of weeds and animal pests on port land and to surrounding land from PEP activities are considered low.

9.3 Revised Environmental Impact Assessment

9.3.1 Legislation and policy

No legislation or policy changes occurring since the preparation of the EIS and relevant to the assessment of terrestrial ecology, affect the assessment of these values. Changes to the conservation status of some species previously assessed have occurred since the EIS, these have been updated below.

9.3.1.1 Nature Conservation Act 1992

The protection of threatened species in Queensland is administered through the *Nature Conservation Act 1992*. The *Nature Conservation (Wildlife) Regulation 2006* lists threatened species in Queensland and has been revised multiple times since the preparation of the EIS. These changes to the Regulation applicable to the PEP are summarised in Table 9.1. Changes to offset policies and management are provided in Section 27.0 of the AEIS. The species likelihood table (Appendix L1 of the EIS) has also been updated in order to reflect changes in species status under the *Nature Conservation Act 1992* (refer Appendix A7).

Table 9.1 Changes to *Nature Conservation Act 1992* status of terrestrial fauna species identified in the EIS as occurring or potentially occurring within the Project area

Common Name	Scientific Name	Status*
Common sandpiper	<i>Actitis hypoleucos</i>	SL
Australian swiftlet	<i>Aerodramus terraereginae</i>	C
Fork-tailed swift	<i>Apus pacificus</i>	SL
Cattle egret	<i>Ardea ibis</i>	SL
Beach stone-curlew	<i>Esacus magnirostris</i>	V
Ruddy turnstone	<i>Arenaria interpres</i>	SL
Eastern osprey	<i>Pandion cristatus</i>	SL

Common Name	Scientific Name	Status*
Masked booby	<i>Sula dactylatra</i>	SL
Red-footed booby	<i>Sula sula</i>	SL
Brown booby	<i>Sula leucogaster</i>	SL
Glossy ibis	<i>Plegadis falcinellus</i>	SL
Sharp-tailed sandpiper	<i>Calidris acuminata</i>	SL
Sanderling	<i>Calidris alba</i>	SL
Red knot	<i>Calidris canutus</i>	SL
Red-necked stint	<i>Calidris ruficollis</i>	SL
Great knot	<i>Calidris tenuirostris</i>	SL
Greater sand plover	<i>Charadrius leschenaultii</i>	SL
Lesser sand plover	<i>Charadrius mongolus</i>	SL
Red-capped plover	<i>Charadrius ruficapillus</i>	C
Lesser frigatebird	<i>Fregata ariel</i>	SL
Common tern	<i>Sterna hirundo</i>	SL
Black-naped tern	<i>Sterna sumatrana</i>	SL
Bridled tern	<i>Onychoprion anaethetus</i>	SL
Little tern	<i>Sternula albifrons</i>	SL
White-winged tern	<i>Chlidonias leucopterus</i>	SL
Black-faced cuckoo-shrike	<i>Coracina novaehollandiae</i>	C
White-bellied cuckoo-shrike	<i>Coracina papuensis</i>	C
Eastern reef egret	<i>Egretta sacra</i>	C
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	C
Latham's snipe	<i>Gallinago hardwickii</i>	SL
Sooty oystercatcher	<i>Haematopus fuliginosus</i>	C
White-bellied sea eagle	<i>Haliaeetus leucogaster</i>	C
Brahminy kite	<i>Haliastur indus</i>	C
Whistling kite	<i>Haliastur sphenurus</i>	C
Grey-tailed tattler	<i>Tringa brevipes</i>	SL
Wood sandpiper	<i>Tringa glareola</i>	SL
Black-winged stilt	<i>Himantopus himantopus</i>	C
Barn swallow	<i>Hirundo rustica</i>	SL
Caspian tern	<i>Hydroprogne caspia</i>	SL
Crested tern	<i>Thalasseus bergii</i>	C
Broad-billed sandpiper	<i>Limicola falcinellus</i>	SL
Bar-tailed godwit	<i>Limosa lapponica</i>	SL
Black-tailed godwit	<i>Limosa limosa</i>	SL
White-billed storm petrel	<i>Fregetta grallaria grallaria</i>	C
Star Finch (eastern, southern)	<i>Neochmia ruficauda ruficauda</i>	E
Rainbow bee-eater	<i>Merops ornatus</i>	SL
Short-tailed shearwater	<i>Ardenna tenuirostris</i>	SL
Wedge-tailed shearwater	<i>Ardenna pacifica</i>	SL
Eastern curlew	<i>Numenius madagascariensis</i>	V
Little curlew	<i>Numenius minutus</i>	SL
Whimbrel	<i>Numenius phaeopus</i>	SL

Common Name	Scientific Name	Status*
Ruff	<i>Philomachus pugnax</i>	SL
Pacific golden plover	<i>Pluvialis fulva</i>	SL
Grey plover	<i>Pluvialis squatarola</i>	SL
Rufous fantail	<i>Rhipidura rufifrons</i>	SL
Masked owl (northern)	<i>Tyto novaehollandiae kimberli</i>	V
Radjah shelduck	<i>Tadorna radjah</i>	C
Australian ibis	<i>Threskiornis molucca</i>	C
Sacred kingfisher	<i>Todiramphus sanctus</i>	C
Common greenshank	<i>Tringa nebularia</i>	SL
Marsh sandpiper	<i>Tringa stagnatilis</i>	SL
Terek sandpiper	<i>Xenus cinereus</i>	SL
Bare-rumped sheath-tail bat	<i>Saccolaimus saccolaimus nudiclunatus</i>	E
Coastal sheath-tail bat	<i>Taphozous australis</i>	V
Striped-tailed delma	<i>Delma labialis</i>	C
Ornamental snake	<i>Denisonia maculata</i>	V
Plant	<i>Peripleura scabra</i>	C
Plant	<i>Solanum sporadotrichum</i>	C

Status: Common (C) Special Least Concern (SL), Vulnerable (V), Endangered (E)

9.3.1.2 Environment Protection and Biodiversity Conservation Act 1999

Threatened fauna and flora may be listed under Section 178 of the *Environment Protection and Biodiversity Conservation Act 1999*. There have been some updates and additions on the status of protected species relevant for this Project which is reflected in Table 9.2 below.

Table 9.2 Changes to status of *Environment Protection and Biodiversity Conservation Act 1999* listed terrestrial flora and fauna species identified in the EIS as occurring or potentially occurring within the Project area.

Common Name	Scientific Name	Status
White-billed storm petrel	<i>Fregetta grallaria grallaria</i>	V
Star finch (eastern, southern)	<i>Neochmia ruficauda ruficauda</i>	E
Eastern curlew	<i>Numenius madagascariensis</i>	CE
Australian painted snipe	<i>Rostratula australis</i>	E
Masked owl (northern)	<i>Tyto novaehollandiae kimberli</i>	V
Koala	<i>Phascolarctos cinereus</i>	V
Bare-rumped Sheath-tail Bat	<i>Saccolaimus saccolaimus nudiclunatus</i>	CE
Striped-tailed delma	<i>Delma labialis</i>	Removed
Ornamental Snake	<i>Denisonia maculata</i>	V
Shrubby bush pear	<i>Marsdenia brevifolia</i>	V

Status: Common (C) Special Least Concern (SL), Vulnerable (V), Endangered (E), Critically Endangered (CE)

9.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. The design is likely to impact upon terrestrial ecology values through the expansion of the reclamation area, which is expected to create additional artificial habitat that may be opportunistically utilised by shorebird species over the long term.

9.3.3 Supporting studies

Due to several legislative changes of species status, the species likelihood table of threatened, migratory and marine species detected during desktop reviews and site surveys was revised based on desktop review (Appendix A7). No other additional studies were necessary in the assessment of the design.

New Protected Matters and Wildlife Online Searches were undertaken on the 28th of January 2016, in order to address potential legislative changes that might have occurred since the AEIS. The Protected Matters Search was based on a central coordinate of the PEP, with a 5km buffer. The Wildlife Online Search was based on the following

coordinates (Latitude: 19.2158 to 19.2746 Longitude: 146.8107 to 146.8776) as this captures the expanded reclamation footprint of the Project area.

9.3.4 Revised assessment

9.3.4.1 Impact assessment

Impacts associated with the design are expected to be similar to that identified in Section B.7.4 of the EIS, with the exception of the creation of additional artificial habitat.

Table 9.3 Summary of change in artificial revetment structures with design

Artificial Revetment / Breakwater Structures in Outer Harbour	Length of created structure	Loss of existing structure	Net Gain
Overall length - EIS layout	5,120m*	1,280m	3,840m
Overall length - AEIS design layout	5,700m*	1,090m	4,610m
Increase from EIS to AEIS layout		770m	

* Including 1.0 km Western Breakwater, if Western Breakwater is required.

Table 9.4 Summary of change in artificial reclamation areas with refined design

Reclamation / Settlement Pond Area in Outer Harbour	Area Gained (Approx.)
Overall area created by EIS layout	100ha
Overall area created by AEIS refined layout	150ha

A total net gain of approximately 150 ha of reclamation area / settlement pond area in outer harbour (Table 9.5) and 4,240 m of artificial revetment area (Table 9.3) will be created as part of the design.

9.3.4.2 Mitigation measures

Mitigation measures to reduce the impact on the Project on terrestrial ecological values are outlined in the updated Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3) of the AEIS and summarised in Table 9.5.

9.3.5 Summary

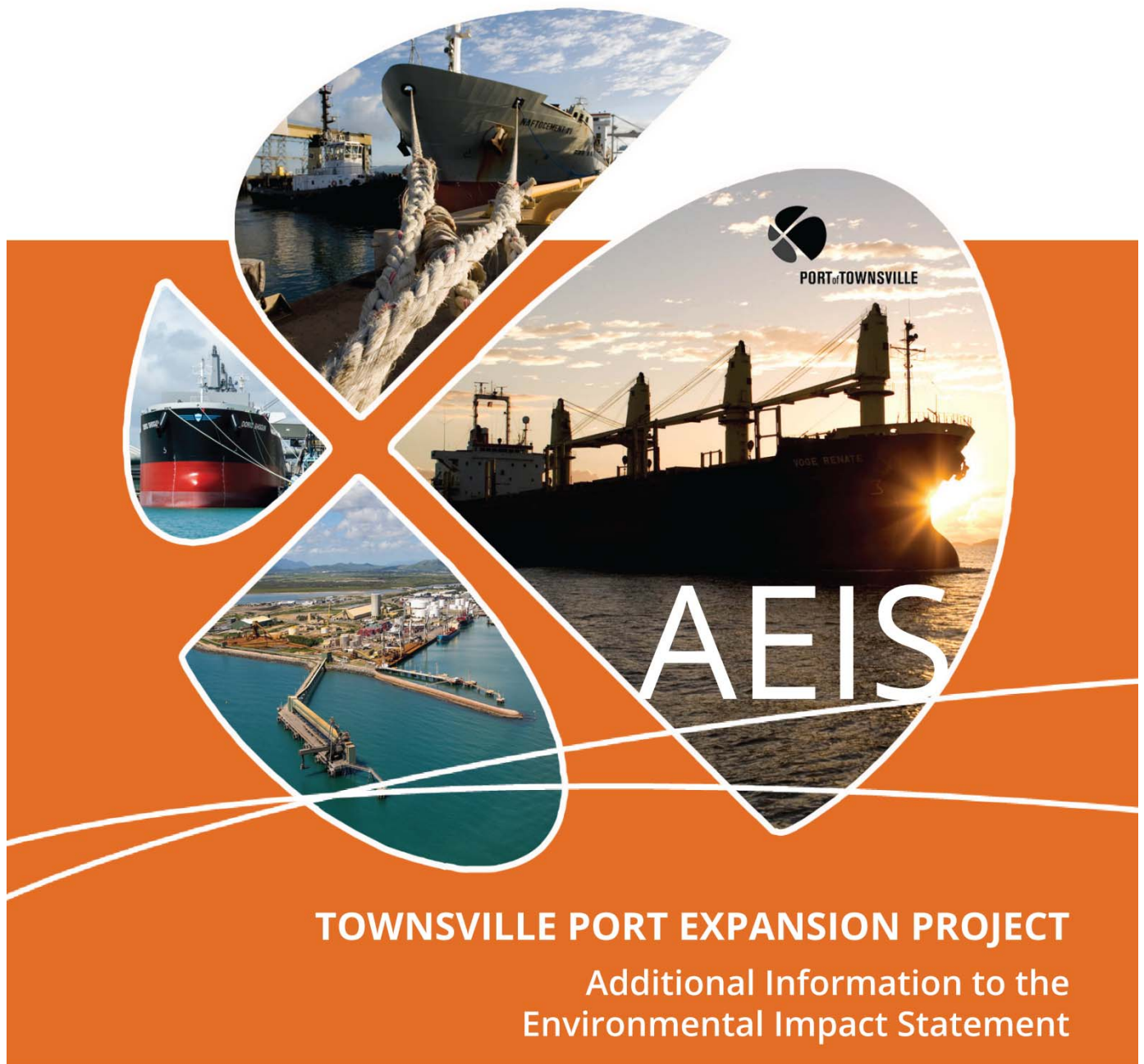
Table 9.5 provides a summary of the mitigation measures proposed to reduce impacts of the Project on terrestrial ecological values.

Table 9.5 Summary of Terrestrial Ecology Impacts and Mitigations Measures

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures ^	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Injury and / or loss of fauna through vehicle / machinery movement.	Construction / Operation	High	Possible	Medium	Limit speed of vehicles. Limit vehicle use to designated access routes.	Low
Loss of access to artificial avifauna habitat.	Construction of breakwaters and reclamation	Moderate	Almost Certain	High	Recreate and extend constructed breakwater and revetment areas.	Low
Degradation of avifauna habitat in vicinity of Project area.	Construction of breakwaters and reclamation	Moderate	Possible	Medium	Weed and animal pest management on site. Sedimentation and water quality monitoring.	Low
Noise / vibration or light emissions leading to disruption to fauna behaviour / movement patterns.	Construction of breakwaters and reclamation	Moderate	Likely	Medium	Maintain plant equipment and machinery. Use low-noise equipment where possible. Orientate light / noise-emitting equipment away from foreshore. Shield light sources.	Low
Introduction and / or spread of weeds.	Construction of breakwaters and reclamation	Moderate	Possible	Medium	Mandatory weed wash down for at risk vehicles or activities. Limit vehicle movement through weed infested areas. Ensure imported fill material is weed free. Active control and monitoring.	Low
Introduction and / or spread of animal pests.	Construction of breakwaters and reclamation	Moderate	Unlikely	Low	Active control and monitoring.	Low
Noise / vibration emissions leading to disruption to fauna behaviour / movement patterns.	Operation	Minor	Possible	Low	Use low-noise equipment where possible. Adhere to noise restrictions. Maintain plant equipment and machinery.	Low

9.4 Conclusion

The PEP is not expected to significantly impact upon terrestrial ecological values on the Project site or in surrounding areas. POTL has committed to undertake monitoring prior to and during the construction stage of the PEP and where beneficial, collaborate with local community groups. With the implementation of mitigation measures as described above in Table 9.5 and in the Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3), the overall impact to terrestrial ecology is considered low.



SECTION 10

Climate Change and Natural Disasters

Risk



10.0 Climate Change and Natural Disasters Risk

10.1 Introduction

Impacts of climate change and natural disasters on the Port Expansion Project (PEP) are described in Chapter B.8 (Climate Change and Natural Disaster Risk) of the Environmental Impact Statement (EIS). Impacts from the PEP on climate change are described in Chapter B.11 (Greenhouse Gas) of the EIS and Section 13.0 of the Additional Information to the Environmental Impact Statement (AEIS).

This section provides information to address submissions received in response to the PEP EIS relevant to climate change and natural disaster risks on the Project. Key matters raised from the submission process include:

- consideration of climate change when assessing the environmental impacts of the Project
- climate change impacts on project design and operation.

10.2 Response to Submissions

10.2.1 Consideration of climate change when assessing the environmental impacts of the Project

Four submissions requested further consideration of climate change when assessing the environmental impacts of the Project. The submissions specifically referred to impacts on the regions ecology and erosion at The Strand.

The revised cumulative impact assessment in Section 25.0 of the AEIS has been updated to address the role of climate change directly influencing the condition of the Great Barrier Reef. The revised cumulative impact assessment discusses potential climate change impacts and projected impacts from the Project in light of the other stressors.

One submission further questioned whether the PEP will exacerbate erosion impacts to The Strand under a future climate. This matter is addressed in Section 5.0 and Appendix A2 of the AEIS. Section 5.2.7 of the AEIS addresses potential beach erosion impacts. It is concluded that any change to beaches (such as The Strand) caused by the construction of breakwaters and reclamation will be minor. Monitoring of vulnerable locations is proposed and if necessary minor local dune strengthening will be undertaken to mitigate impacts. The coastal processes assessment also predicts that there will be a slight reduction in wave energy reaching The Strand due to the protection afforded by the reclamation. This is anticipated to reduce the likelihood and severity of major storm erosion, thereby providing a positive benefit to The Strand.

10.2.2 Climate change impacts on project design and operations

Four submissions questioned whether the potential impacts of climate change were adequately considered in planning the design and operational capacity of the PEP, specifically in terms of flood levels and management of natural disasters.

One submission further questioned the adequacy of the flood study in quantifying flood impacts on surrounding properties. The submission also requested potential variations in flood levels, flow and inundation as a result of the Project be identified. A Flood Impact Study was carried out in accordance with the Terms of Reference and is included in Appendix G of the EIS. The study was confirmed to be adequate for the purposes of the EIS by the Department of Environment and Heritage Protection on 28 August 2013.

The flood model has been revised in response to the design refinement process and future development of the Townsville State Development Area. The study adheres to the same methodology as the EIS and confirmed that the PEP will not result in any significant change in the extent and / or severity of catchment flooding given the Project is effectively located offshore from the mouth of the Ross River and Ross Creek. The revised design includes widening and shortening of the channel and expansion of the land reclamation area. Flood impacts and management measures were updated as a result of this revision and are summarised in Section 4.0. There is no change in impact of flooding extent or duration as a result of the revised design or future development of the Townsville State Development Area as presented in the Chapter B.2 (Water Resources) of the EIS and Section 4.0 of the AEIS.

One submission further raised that the Townsville City Council Coastal Hazard Adaptation Strategy was not considered in the assessment of potential impacts associated with sea level rise and cyclonic storm surge. Impacts and management of sea level rise and cyclonic storm surge on the PEP are addressed in Chapter B.8 (Climate Change and Natural Disaster Risk) of the EIS. The Coastal Hazard Adaptation Strategy was omitted from this assessment following advice from Townsville City Council and the Department of Environment and Heritage Protection, on the basis that as strategic port land is governed under the jurisdiction of the Port of Townsville (POTL) and not Townsville City Council, and the Coastal Hazard Adaptation Strategy was a pilot project. The strategy includes climate adaptation recommendations from a number of industrial facilities. Furthermore, many of the

inundation projections from the strategy are inconsistent with mandated Townsville City Council flood maps and hence are not endorsed by Townsville City Council.

Notwithstanding this, the PEP design has considered all relevant legislation, policies and design guidelines relating to climate change and natural disaster. Climate change resilience will continue to form a key design consideration during the detailed design. The Port of Townsville has successfully operated for over 150 years and is experienced in managing construction and operation of a port in tropical North Queensland.

It is noted that the one in one hundred storm water levels used in developing the EIS have now been updated by Townsville City Council and these updated levels will be used in detailed design.

10.3 Revised Environmental Impact Assessment

10.3.1 Legislation and policy

The Queensland Coastal Management Plan has been revised since the release of the EIS. The present Queensland Coastal Management Plan was gazetted in March 2014. The Plan is administered under the *Coastal Protection and Management Act 1995*. The Plan provides non-regulatory policy guidance to coastal land planners and managers. The Plan does not address land-use planning or development regulated under the *Sustainable Planning Act 2009*.

The Queensland Coastal Plan references climate variability but is not intended to provide prescriptive guidance on climate adaptation. The State government is presently developing a climate adaptation plan, but this is not expected to be completed until late 2016.

10.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. Revised modelling and assessment of climate and natural disaster risks on the PEP indicates no change to the impact of the PEP, in terms of infrastructure and environmental management requirements.

10.3.3 Supporting studies

Flood modelling was revised as part of the AEIS to assess the flood impacts and risks associated with the increased reclamation footprint. This is discussed in Section 4.0 of the AEIS.

10.3.4 Revised assessment

10.3.4.1 Impact assessment

Whilst the revised design has expanded the reclamation area, the design of the revetments, reclamation area and channel is consistent with the design assumptions and complies with the relevant regulatory requirements and codes associated with the design. Potential climate change and natural disaster impacts on the revised design are considered consistent with the impacts presented in Chapter B.8 (Climate Change and Natural Disaster) of the EIS.

10.3.4.2 Mitigation measures

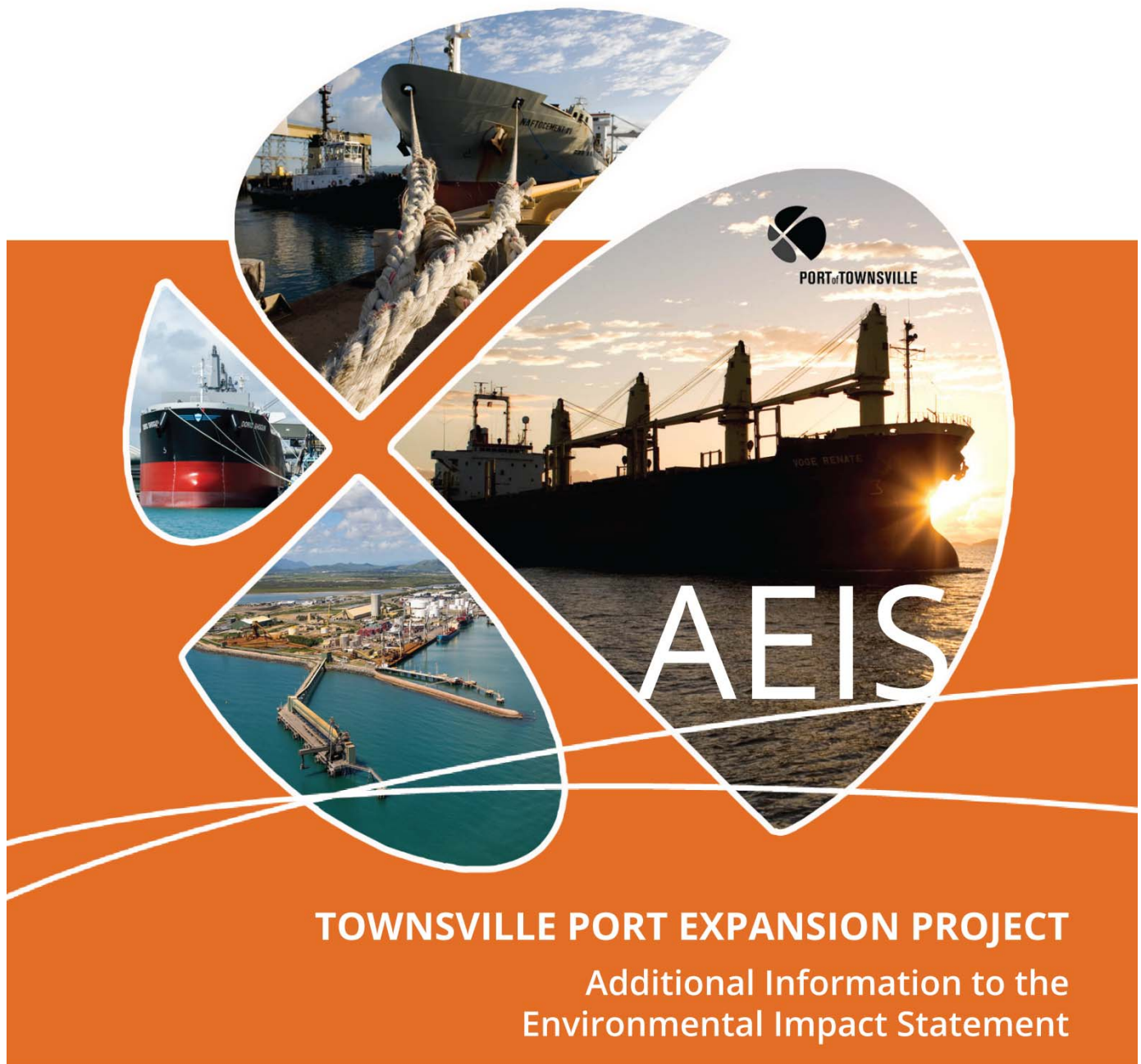
Climate change and natural disaster management measures for the PEP are outlined in the Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3) which will be updated, if necessary, prior to each stage of construction.

10.3.5 Summary

Section B.8.4 of the EIS considers the risks of potential climate change and natural disaster impacts on the PEP. As the design assumptions have not changed, the impacts of climate change and natural disaster risk on the PEP are consistent with that identified in Section B.8.4 of the EIS.

10.4 Conclusion

The PEP design has considered all relevant legislation, policies and design guidelines relating to climate change and natural disaster. Through continued consideration of climate change and natural disaster risks during the PEP detailed design phase and by implementing mitigation measures and contingency plans, the PEP is expected to be able to achieve and maintain an appropriate level of climate change protection and resilience.



SECTION 11

Air Quality



11.0 Air Quality

11.1 Introduction

Air quality impacts and mitigations are discussed in Chapter B.9 (Air Quality) of the Environmental Impact Statement (EIS). The air quality impacts associated with the construction of the Port Expansion Project (PEP) were assessed with predicted concentrations of particulates at identified sensitive receptor locations. It was predicted that the regulatory criterion for PM_{10} will be exceeded at sensitive receptors close to the western boundary of the PEP over the course of the modelling period. The predicted short-term exceedances were predicted to occur at a frequency of between 0 to 13 days per year, with adverse impacts over longer time periods not expected.

Changes in methodology and approach were necessary to address submissions made in response to the EIS. The key matters identified during the consultation period include:

- air quality impacts from operational activities
- assessment of shipping emissions for the Project
- inclusion and refinement of the Conceptual Reactive Monitoring Program.

11.2 Response to Submissions

11.2.1 Air quality impacts from operational activities

14 submissions requested assessment of air quality impacts from the existing operational activities at the Port and/or future operational activities of the PEP. Dust emissions from existing port operations are currently quantified by monitoring data collected by a continuous air quality monitoring station at the Coast Guard site. This station is part of a Department of Environment and Heritage Protection network of air quality monitoring stations throughout Queensland. As identified in Section B.9.3.4.1 of the EIS, this monitoring station is adjacent to the western boundary of the port and collects PM_{10} data. A summary of the background data collected at this site is presented in Table B.9.2 of the EIS.

Long term particulate monitoring data from a historically POTL operated monitoring site (situated near Berth 10) was obtained from 1994 to 2011. Data from this location was analysed in the EIS and presented in Table B.9.3 of the EIS. This data was used to represent the background dust concentrations.

The Department of Environment and Heritage Protection advised in March 2014 that impacts from future operational activities will be dealt with under future approval processes and at this stage further assessment of the Project is not required. Emissions from future operational activities will need to be assessed as part of a development application for the newly created PEP area which will be considered on a case by case basis.

11.2.2 Assessment of shipping emissions for the Project

Two submissions related to the shipping emissions discussed in the EIS. One requested the inclusion of shipping emissions in the revised assessment. An emission inventory for combustion emissions from ships whilst at port has been developed. These emissions were included in three modelling scenarios to quantify impacts of ship emissions at nearby sensitive receptors. Shipping emissions are assessed in Section 11.3.4.1 of the AEIS.

In addition to particulate matter, discussed in Section B.9.3.2 in the EIS, combustion gases from ship emissions have been included (Nitrogen Dioxide, Carbon Monoxide and Sulfur Dioxide). To retain consistency with the EIS, particulate matter smaller than 2.5 micrometres in diameter ($PM_{2.5}$) was not considered for construction activities, however $PM_{2.5}$ was considered as part of the shipping emissions. Health effects of the modelled particulate and combustion gas have been included in Appendix A4.

The second submission raised a number of concerns relating to the potential for aesthetic impacts from the operation of the port. In particular, the aesthetic issues raised were as follows:

- the increase in the black plumes of smoke from foreign vessels (apparently not bound by Australian emission standards)
- the sickly (and unhealthy) odour of bunker oil
- the foul and pungent odour of cattle manure and urine
- the increase in dense black and dark brown particulate which already falls on residences on The Strand and other suburbs such as Yarrawonga, and vessels in the Breakwater Marina.

The concerns in relation to black smoke relate to the visual emissions from ships burning poor quality fuel, which is an acknowledged historical problem in the shipping industry worldwide. The cause of the black plumes of smoke are predominantly the ship engines when steaming to or from the port under their own power. Ships can and have in the past utilised poorer quality fuels when steaming and as such led to the perception of visual impacts from the

shipping. In addition to the visual concerns, the use of poor quality fuel has also contributed to odour releases from the ships as the poorer quality fuels often have higher sulfur contents which have a stronger odour when released.

When the ships are at port (the majority of the time spent in the Townsville area), the ship's main engines are not being used and the only emissions are from ship power generation and boiler emissions. The shipping industry is needing to address the increasing concerns in relation to visual and odorous emissions at port and are responding in the following manner:

- moving toward the use of low sulfur fuel when at port for the auxiliary engines and boilers
- use of low sulfur fuels when approaching visually sensitive or odour sensitive areas.

As an example of where this is occurring, is within Sydney Harbour. New regulations have recently been passed requiring cruise ships to use low sulfur fuel (when within Sydney Harbour) and are due to be enacted on 1 July 2016. In addition, industry within the Sydney harbour is voluntarily implementing similar arrangements with their haulage fleets in expectation that the Cruise ship regulations will be expanded to cover all heavy material.

Although there are no current requirements for ships to comply with the two points listed above for the Port of Townsville, given the trends in the industry and the recent changes in the NSW regulations, it is expected that these changes will be implemented at other major ports within Australia. These changes will lead to the reduction in the appearance of smoke plumes and the elimination of the odour and aesthetic concerns raised in relation to the PEP EIS.

The reduction in black smoke will also have the effect of the reduction in particulate emissions from the ships close to the port and hence will reduce the potential for particulate deposition at residential areas bordering the port.

Odour associated with cattle manure and urine is presumably a comment in relation to the export of live cattle from the port. This is an operational aspect that is beyond the scope of this assessment. However, any operation on the newly expanded Port would need to be undertaken in a manner consistent with best practice, including the management of run-off and solid waste. These aspects would need to be managed to ensure odour emissions comply with the Queensland DEHP odour requirements and would be assessed prior to the commencement of any live cattle export.

11.2.3 Inclusion and refinement of Reactive Monitoring Program

The Department of Environment and Heritage Protection requested further details of the reactive monitoring program, specifically the associated trigger levels. Draft dust monitoring trigger values have been developed as a part of this AEIS and are provided in Section 11.3.4.2 of the AEIS.

11.3 Revised Environmental Impact Assessment

11.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. The legislative and policy changes did not impact on the assessment of air quality values presented in the EIS, or the management of these values.

The *Environmental Protection (Air) Policy 2008* (EPP [Air]) sets ambient air quality objectives for priority air pollutants in Queensland. Table 11.1 presents air quality objectives for particulates and combustion gases included in this air dispersion modelling assessment, making reference to the environmental values the criteria were specifically developed to protect. It should be noted the objectives for the particulates and combustion gases listed below are not applicable to air emissions experienced within a workplace that are emitted from that workplace, i.e. the objectives do not apply to the construction site itself.

These criteria are designed to provide a level to meet the health and well-being environmental value. In addition to the criteria above, the Department of Environment and Heritage Protection criteria for deposited dust and the New South Wales Environment Protection Agency criteria for annual average PM_{10} (DEC, 2005) as follows were also used for assessment:

- deposited dust (dustfall) limit of 120 mg/m².day averaged over 4 weeks
- annual average PM_{10} criterion of 30 $\mu\text{g}/\text{m}^3$.

Table 11.1 Queensland EPP (Air) ambient air quality objectives

Indicator	Averaging Period	EPP (Air) Criteria	Environmental Value	Units
TSP	1 year	90	Health and well-being	$\mu\text{g}/\text{m}^3$
PM ₁₀	24 hours	50*	Health and well-being	$\mu\text{g}/\text{m}^3$
PM _{2.5}	24 hours	25	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	8	Health and well-being	$\mu\text{g}/\text{m}^3$
NO ₂	1 hour	250	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	62	Health and well-being	$\mu\text{g}/\text{m}^3$
CO	8 hours	11,000	Health and well-being	$\mu\text{g}/\text{m}^3$
SO ₂	1 hour	570	Health and well-being	$\mu\text{g}/\text{m}^3$
	24 hours	230	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	57	Health and well-being	$\mu\text{g}/\text{m}^3$

* 5 days allowable exceedances per year. On this basis, the sixth highest predicted 24-hour concentration has been compared with the criterion.

11.3.2 Design refinement

The Project design has been refined as described in Section 2.0 of the AEIS. The refined design has not fundamentally changed the air quality impacts identified in the EIS. Sources of dust are largely unchanged from those assessed in the EIS (refer Section B.9.3 of the EIS). The design refinement has allowed the construction activities to be clearly defined, resulting in a more accurate breakdown of when the activities are likely to occur. This has resulted in some activities that were modelled in the EIS as being concurrent, are no longer occurring concurrently and thereby reducing dust emissions during any given construction stage.

In addition, the staging of the overall works is different from the EIS resulting in a changed number of modelling scenarios that have been examined by the air quality assessment. The construction works for the revised PEP are expected to be undertaken in 3 stages (Stages 1 to 3).

11.3.3 Supporting studies

An assessment has been undertaken considering the revised design for the PEP. The assessment of the revised design was undertaken using an air quality impact assessment methodology as outlined in the EIS. The methodology incorporated the following aspects.

- A dispersion modelling assessment using the CALPUFF dispersion model. The CALPUFF settings were consistent with those used in the EIS and is considered the most appropriate model for the coastal environment in which the PEP is situated.
- Regional meteorology which has been processed into a region wide wind field, which incorporates terrain and land use influences. To ensure consistency with previous studies, the meteorology used the same data as the EIS. No guideline or model changes have been released since the EIS that will necessitate a change to the meteorological data used for the modelling.
- Receptor list consistent with the receptors assessed in the EIS. The receptor list was considered to still provide a good list of representative locations at which the impacts from the revised PEP could be assessed and then compliance inferred to the surrounding environment beyond the receptors.
- Site specific on-site construction activities, activity specific mitigation measures and project scheduling were compiled into an inventory, which is considered to be reflective of the expected operations on the refined PEP.
- Background particulate and combustion gas concentrations measured at the port were incorporated with the modelling results.

The incorporation of these aspects of the assessment ensures that the assessment is robust and consistent with expectations in the Terms of Reference. Appendix A4 summarises the aspects of the assessment that have been modified relevant to the background data, air quality objectives and findings of the revised dispersion modelling.

11.3.4 Revised assessment

The following sections focus on the revised assessment of the construction activities and the mitigation measures recommended ensuring the predicted dust levels are achieved when construction commences.

11.3.4.1 Impact assessment

The assessment of the impacts associated with the revised design of the PEP has been considered both in isolation from background concentration (assessed the incremental addition of particulate and combustion gases to the

environment from the PEP activities) and cumulatively (expected overall dust concentrations taking into consideration the existing levels of particulate and combustion gases in the environment). The cumulative assessment combines emissions from PEP (construction emissions incorporating mitigation for the construction activities) and shipping (emissions without mitigation) with emissions from existing operating facilities, industries and other background sources in the Townsville area through the monitoring data collected around the Port. Impacts from the proposed PEP construction emissions in isolation and cumulatively are presented in the following section.

PEP Construction Stage Scenarios and Receptors

Dispersion modelling investigations need to include how sources are operating and how they combine to impact on their surroundings. The PEP construction stages and the equipment expected to be used has been defined in detail in Appendix A4.

As part of the revised design of the PEP, three scenarios have been developed to represent the operations during the long period of construction activities (one for each of the revised PEP construction stages). The three modelling scenarios are described as follows.

- Stage 1 Scenario: Dust and shipping emissions for construction Stage 1, with haul roads unsealed. The haul roads are assumed to run from the boundary of the existing sealed section of road to approximately the centre of the Stage 1 reclamation area. The length of the unsealed haul road was modelled as 1 km (2 km round trip per vehicle). Wind erosion emissions were included for approximately 25 ha of the reclamation area.
- Stage 2 Scenario: Dust and shipping emissions for construction Stage 2, with internal haul roads from construction of Stage 1 which have been sealed to a degree whereby negligible dust is emitted. This scenario assumed unsealed haul road distance of 1 km and that the initial entry road onto the PEP had been sealed. Wind erosion emissions were included only for newly reclaimed land in Stage 2 — reclaimed land from Stage 1 was assumed to be sealed (through surface sealing or vegetation).
- Stage 3 Scenario: Dust and shipping emission sources for construction Stage 3 with internal haul roads from construction of Stage 1 and 2 which have been sealed to a degree whereby negligible dust is emitted. Wind erosion emissions were included only for newly reclaimed land in Stage 3 — reclaimed land from Stage 1 and 2 was assumed to be sealed (through surface sealing or vegetation).

Further details of the above scenarios and their relevant emission sources have been provided in Appendix A4.

Details of the receptors assessed for this study are shown in Table 11.1. Receptor locations situated where peak impacts may occur are shown on Figures 11.1, 11.2 and 11.3.

Table 11.2 Sensitive Receptor Locations

Receptor ID	Modelled Receptor Location	Approximate Distance from PEP (km)	Receptor Type
1	The Ville Resort - Casino – Top Floor	1.4	Commercial
2	The Ville Resort - Casino – Floor 6	1.4	Commercial
3	The Ville Resort - Casino – Floor 3	1.4	Commercial
4	Corner Archer and Ross Streets, South Townsville	1.8	Residential
5	55 Macrossan Street, South Townsville	1.9	Residential
6	29 Hubert Street, South Townsville	2.0	Residential
7	Breakwater Quays	1.6	Residential
8	Townsville CBD	2.7	Residential
9	Corner of The Strand and Gregory Street, North Ward	2.6	Residential
10	91 The Strand, North Ward	3.1	Residential
11	Corner of The Strand and Howitt Street, North Ward	3.6	Residential
12	North Ward Sports Grounds	3.2	Public Space

PEP impacts in isolation

The incremental predicted particulate and combustion gas concentrations from the three modelled stages of the PEP have been presented in the following section. No background particulate concentrations have been included in the results presented in Table 11.2, Table 11.3 or Table 11.4.

Construction dust

The results for the dispersion modelling for the three construction scenarios are presented in this section. Predicted 6th highest 24 hour average PM₁₀ and annual average PM₁₀ concentrations from PEP emissions in isolation at each modelled sensitive receptor are presented in Table 11.3. Predicted concentrations were well below the relevant criteria at all sensitive receptors.

Table 11.3 Predicted PM₁₀ concentrations – Revised PEP in isolation

Receptor ID	Predicted PEP Contribution PM ₁₀ (µg/m³)					
	6th Highest 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	5.0	5.2	4.0	1.8	1.8	1.3
2 – Casino Floor 6	6.8	6.8	4.9	2.3	2.2	1.7
3 – Casino Floor 3	12.8	12.4	8.8	3.7	3.5	2.7
4 – Archer and Ross	14.7	13.5	10.5	3.0	3.1	2.3
5 – Macrossan	17.9	17.7	15.4	3.5	3.8	2.8
6 – Hubert	13.9	15.8	10.0	1.9	2.6	1.8
7 – Breakwater	12.2	13.1	11.0	3.2	3.1	2.6
8 – CBD	6.7	6.3	5.1	1.4	1.5	1.2
9 – Strand and Gregory	11.9	15.5	11.4	2.6	3.4	2.5
10 – Strand	12.1	14.4	11.4	2.8	3.5	2.7
11 – Strand and Howitt	9.9	15.8	12.3	3.0	3.8	2.9
12 – North Ward	7.9	8.8	6.9	1.7	1.9	1.4
Criteria	50			30		

Figure 11.1, Figure 11.2 and Figure 11.3 show the concentration contours for modelled 24 hour PM₁₀ in isolation from the background – i.e. dust from the PEP construction activities only, for Scenarios 1, 2, and 3 respectively. The contours shown on each figures denote the 6th highest 24 hour PM₁₀ concentrations.

Maximum predicted 24 hour average PM₁₀ concentrations at each sensitive receptor have been calculated to satisfy a request by the Department of Environment and Heritage Protection to show the highest predicted PM₁₀ levels from the PEP construction activities. Maximum PM₁₀ concentrations are presented in Table 11.4.

Table 11.4 Predicted Maximum 24 Hour Average PM₁₀ concentrations – Revised PEP in isolation

Receptor ID	Predicted PEP Contribution PM ₁₀ Maximum 24 Hour Average (µg/m³)		
	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	7.3	6.3	4.9
2 – Casino Floor 6	10.2	8.1	5.9
3 – Casino Floor 3	18.0	14.0	11.4
4 – Archer and Ross	29.2	28.4	21.6
5 – Macrossan	37.2	33.0	26.0
6 – Hubert	26.9	24.3	16.8
7 – Breakwater	20.2	19.5	12.6
8 – CBD	16.6	15.2	10.6
9 – Strand and Gregory	20.2	28.4	17.4
10 – Strand	15.3	17.4	19.2
11 – Strand and Howitt	14.9	17.4	16.0
12 – North Ward	17.8	13.8	11.2

All predicted PM₁₀ concentrations for PEP emissions in isolation were predicted to be below criteria at all sensitive receptors for all scenarios. Following the refinement of the construction stages and the associated activities, the predicted PM₁₀ levels listed in Table 11.3 and 11.4 are shown to comply with their short term criterion and as such further analysis of the data was not deemed necessary (as was the case for the EIS air quality predictions).

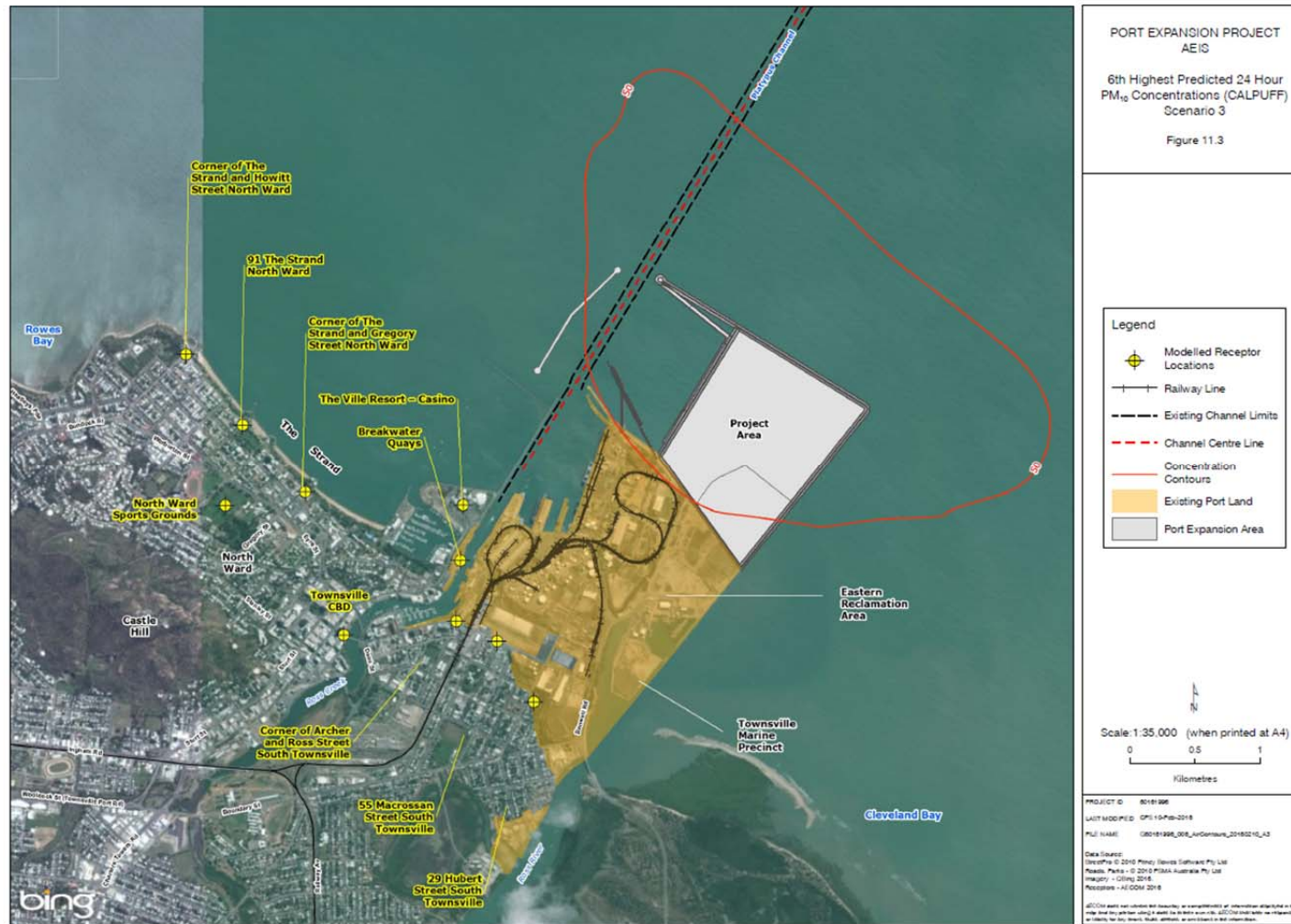
Predicted annual average TSP concentrations and dust deposition rates at sensitive receptors from PEP emission in isolation are presented in Table 11.5. Predicted TSP and dust deposition impacts were well below criteria at all sensitive receptors.

Table 11.5 Predicted TSP Concentrations and Dust Deposition Rates – PEP in Isolation

Receptor ID	Predicted PEP Contribution Annual Average TSP ($\mu\text{g}/\text{m}^3$)			Predicted PEP Contribution Dust Deposition Rate ($\text{g}/\text{m}^2/\text{month}$)		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	5.7	5.5	4.0	0.00	0.00	0.00
2 – Casino Floor 6	9.1	7.2	5.3	0.00	0.00	0.00
3 – Casino Floor 3	7.2	11.1	8.3	0.00	0.00	0.00
4 – Archer and Ross	8.6	9.6	7.2	0.04	0.02	0.01
5 – Macrossan	4.6	12.2	8.7	0.04	0.03	0.01
6 – Hubert	7.6	8.4	6.2	0.02	0.01	0.00
7 – Breakwater	3.4	9.6	7.8	0.06	0.04	0.02
8 – CBD	6.2	4.7	3.8	0.02	0.01	0.01
9 – Strand and Gregory	6.6	10.0	7.8	0.03	0.03	0.02
10 – Strand	7.0	10.7	8.6	0.03	0.02	0.02
11 – Strand and Howitt	3.8	11.3	8.7	0.02	0.02	0.02
12 – North Ward	3.8	5.9	4.5	0.02	0.01	0.01
Criteria	90			4		

Figure 11.1 6th Highest Predicted 24 Hour PM₁₀ Concentrations (CALPUFF) Scenario 1

Figure 11.2 6th Highest Predicted 24 Hour PM₁₀ Concentrations (CALPUFF) Scenario 2

Figure 11.3 6th Highest Predicted 24 Hour PM₁₀ Concentrations (CALPUFF) Scenario 3

Particulate and combustion gas emissions from shipping

Dispersion modelling results for shipping emissions for Stage 1, Stage 2 and Stage 3 are presented in Appendix A4. All particulate and combustion gas concentrations were predicted to fall below the respective criteria. The predicted particulate and combustion gas concentrations in Appendix A4 combine emissions from ships berthed at both the existing port and the PEP. Predicted particulate and combustion gas concentrations due to port operations in isolation were well below relevant air quality criteria for all particulate and combustion gases at all sensitive receptors.

Contour plots of predicted 1 hour average NO₂ concentrations for Stage 1, Stage 2 and Stage 3 are also presented in Appendix A4.

Cumulative airshed conditions

This section presents predicted cumulative particulate and combustion gas concentrations at sensitive receptors – i.e. the sum of predicted PEP contribution and the adopted background particulate and combustion gas concentrations discussed in Appendix A4. Background concentrations of particulates and selected combustion gases are based around measurements taken from the Townsville area and are considered to be a reasonable estimation of the existing levels of dust and combustion gases in the Airshed.

Construction dust

Predicted cumulative 24 hour average and annual average PM₁₀ concentrations at nearby sensitive receptors are presented in Table 11.6. These values were calculated by adding the adopted 24 hour average background PM₁₀ concentration (24.7 µg/m³) to each predicted 24 hour concentrations from the model. Applying a uniform background concentration to each modelled hour is a conservative approach to estimating cumulative impacts.

Table 11.6 Predicted cumulative PM₁₀ concentrations at sensitive receptors – Revised PEP

Receptor ID	Predicted Cumulative PM ₁₀ (µg/m ³)					
	6th Highest 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	29.7	29.9	28.7	23.2	23.2	22.7
2 – Casino Floor 6	31.5	31.5	29.6	23.7	23.6	23.1
3 – Casino Floor 3	37.5	37.1	33.5	25.1	24.9	24.1
4 – Archer and Ross	39.4	38.2	35.2	24.4	24.5	23.7
5 – Macrossan	42.6	42.4	40.1	24.9	25.2	24.2
6 – Hubert	38.6	40.5	34.7	23.3	24.0	23.2
7 – Breakwater	36.9	37.8	35.7	24.6	24.5	24.0
8 – CBD	31.4	31.0	29.8	22.8	22.9	22.6
9 – Strand and Gregory	36.6	40.2	36.1	24.0	24.8	23.9
10 – Strand	36.8	39.1	36.1	24.2	24.9	24.1
11 – Strand and Howitt	34.6	40.5	37.0	24.4	25.2	24.3
12 – North Ward	32.6	33.5	31.6	23.1	23.3	22.8
Criteria	50			30		

Long term annual average PM₁₀ concentrations were predicted to be below criteria at all sensitive receptors. Short term 24 hour average PM₁₀ concentrations were predicted to be below criteria at all sensitive receptors for all modelled scenarios.

Following completion of the reassessment of Air Quality impacts as part of the AEIS, DEHP have advised of a possible reduction in the PM₁₀ annual average criteria (following the review and addition of a long term criteria to the Air Quality NEPM). The newly adopted PM₁₀ annual average NEPM limit is 25µg/m³. The levels predicted by the AEIS modelling fall below the new NEPM criteria with the exception of two receptors during Stage 2 of construction (exceedance margin of 0.2µg/m³). These minor exceedances shown by the modelling are able to be appropriately managed on ground through the proposed mitigation measures including the site based reactive monitoring program. It should be noted that the Project site based reactive monitoring program will have appropriately set limits to meet relevant legislative standards at the time of each stage.

Predicted cumulative annual average TSP concentrations and dust deposition rates at sensitive receptors are presented in Table 11.7. Cumulative TSP and Dust Deposition values were calculated by adding the adopted annual average background TSP concentration (43.6 µg/m³) and average dust deposition rate (1.4g/m².month) to each relevant predicted concentration from the model. Cumulative impacts were predicted to be well below criteria at all sensitive receptors.

Table 11.7 Predicted cumulative TSP concentrations and dust deposition rates at sensitive receptors – Revised PEP

Receptor ID	Predicted Cumulative Annual Average TSP ($\mu\text{g}/\text{m}^3$)			Predicted Cumulative Dust Deposition Rate ($\text{g}/\text{m}^2/\text{month}$) ¹		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	49.3	49.1	47.6	1.40	1.40	1.40
2 – Casino Floor 6	52.7	50.8	48.9	1.40	1.40	1.40
3 – Casino Floor 3	50.8	54.7	51.9	1.40	1.40	1.40
4 – Archer and Ross	52.2	53.2	50.8	1.44	1.42	1.41
5 – Macrossan	48.2	55.8	52.3	1.44	1.43	1.41
6 – Hubert	51.2	52.0	49.8	1.42	1.41	1.40
7 – Breakwater	47.0	53.2	51.4	1.56	1.44	1.42
8 – CBD	49.8	48.3	47.4	1.42	1.41	1.41
9 – Strand and Gregory	50.2	53.6	51.4	1.43	1.43	1.42
10 – Strand	50.6	54.3	52.2	1.43	1.42	1.42
11 – Strand and Howitt	47.4	54.9	52.3	1.42	1.42	1.42
12 – North Ward	47.4	49.5	48.1	1.42	1.41	1.41
Criteria	90			4		

Shipping emissions

Cumulative impacts of shipping emissions combined with uniform background particulate and combustion gas concentrations are calculated for all scenarios modelled. Predicted cumulative NO_2 concentrations at nearby sensitive receptors are presented in Appendix A4. Short term 1 hour concentrations and long term annual average concentrations are predicted to be below criteria at all sensitive receptors.

11.3.4.2 Mitigation measures

Concentrations at nearby sensitive receptors were predicted to comply with their respective assessment criteria. To achieve this level of compliance, the dispersion modelling assumed a range of active mitigation measures that should be applied as part of any well managed earthworks project. Measures such as road watering, road sealing (where practicable), stockpile management, water sprays, equipment maintenance and windbreaks have been assumed and should be applied to the development to ensure the predicted dust levels are achieved. The mitigation measures recommended in the EIS (Section B.9.5.1) are considered to be sufficient for the revised design. The details of the final distribution and management of these measures will be defined as part of the development of the Construction Environmental Management Plan (Appendix B2) which will be updated prior to construction.

In addition to these active mitigation measures, other passive mitigation options should also be considered, particularly for projects that have a large footprint and recognising the fact that construction projects need to be managed to allow some flexibility in the range of equipment used on site. Passive mitigation refers to measures that indirectly affect the generation of dust, such as reactive monitoring plans that allow the management of the site through the monitoring of the dust that is emitted from the site. The following conceptual reactive monitoring program has been provided as an example of what may be implemented on the PEP development.

Conceptual Reactive Monitoring Program

Where possible, dust-generating activities should be undertaken during the morning when the prevailing winds will typically blow any particulate matter away from receptors. In the afternoon, when the prevailing winds will blow dust from the site towards receptors, additional care should be taken to manage and mitigate emissions through measures outlined above (details such as equipment type, monitoring location and other operational procedures will be further defined in the CEMP).

Where a monitoring system is continuous in nature, trigger levels can be used as an early warning system for the monitoring of ambient air quality impacts on the local environment. The trigger levels are generally set below a relevant assessment criteria to alert staff prior to the concentration reaching the relevant criterion value.

If a trigger level is exceeded, the following reactive management program is to be followed. The program is designed as a three stage approach; Investigate, Action and Stop Work.

- The Investigate stage is designed to identify the issue, the likely reasons and formulate a response should the Action stage be reached.
- The Action stage is designed to implement those measures formulated in the Investigate stage and review their effectiveness.
- Should the Stop Work stage be reached, there is a high likelihood that the criterion may be reached. All works should stop at this stage until the measured levels are below the Action level.

Should the Action trigger level PM_{10} be reached, an investigation should be conducted to determine the source/s of the dust and to evaluate the appropriate measures to be implemented. Measures in addition to those already included, dust control measures may include the following actions:

- increased use of a water cart or water sprays to suppress dust in open areas or roadways
- installation of temporary sheeting to cover localised exposed areas or stockpiles and covering soil stockpiles that will remain on the site for more than 24 hours (where practicable)
- ensuring excavated material is moist at the time of exposure and handling
- consolidation of material stockpiles
- use of chemical dust-suppressants (provided the chemicals do not pose a risk of contamination or an environmental hazard due to proximity to water or an occupational health and safety hazard)
- use of alternative coverings such as hydromulch to stabilise the surface of open disturbed areas
- use of additional dust suppression features on items of dust generating plant and equipment
- covering surfaces where appropriate
- all trucks transporting spoil or fill on the site are to be covered
- ceasing works when works are generating unacceptable dust levels (as defined through the Construction Environmental Management Plan (Appendix B2)).

Table 11.8 provides details of an indicative reactive management program.

Table 11.8 Reactive management program

Trigger Stage	Averaging Period	Trigger Value ($\mu\text{g}/\text{m}^3$)	Primary Responsibility	Action Required
Investigate	1-hour	Triggers will be considered on a stage by stage basis depending on the nature of the expected activities.	Identified prior to the commencement of each stage of work.	Undertake review of possible dust sources operating during the average period. Identify possible control measures for these activities, action taken if deemed necessary.
Action	1-hour	Triggers will be considered on a stage by stage basis depending on the nature of the expected activities.	Identified prior to the commencement of each stage of work.	Ensure implementation of the control actions identified in Investigate Stage. Effectiveness of control actions to be reviewed and escalate where appropriate. Identify long-term solutions to dust issues.
Stop Work	1-hour	Triggers will be considered on a stage by stage basis depending on the nature of the expected activities.	Identified prior to the commencement of each stage of work.	Targeted shut down of relevant activities until the measured levels are below the stated Action Stage trigger value.

Trigger Value Calculation

Trigger level calculations are based around actual background monitoring data and as such should be prepared using up-to-date monitoring data immediately prior to the commencement of work. The trigger levels need to be calculated prior to the commencement of the construction works.

The following calculations present a conceptual calculation of trigger levels assuming a background concentration of particulate emissions. Calculations of the trigger level values were based around the objective of remaining below the 24 hour average PM_{10} criterion at the port boundary monitoring location, or other relevant location determined prior to each stage.

The total of all 1 hour average concentrations throughout the day (i.e. the sum of individual 1 hour concentrations) needs to fall below $1200 \mu\text{g}/\text{m}^3$ ($50 \mu\text{g}/\text{m}^3 \times 24$ hourly results = $1200 \mu\text{g}/\text{m}^3$). The process for calculating the 1 hour trigger levels is discussed below.

The ambient PM_{10} concentration is equal to approximately $25 \mu\text{g}/\text{m}^3$ (based on results from the existing monitoring location). Assuming an 11 hour operational day and subsequently, 13 non-operational hours, the maximum daily sum of 1 hour average concentrations was calculated as follows:

- Daily 1 hour average maximum total = $1200 \mu\text{g}/\text{m}^3 - (13 \times 25 \mu\text{g}/\text{m}^3) = 875 \mu\text{g}/\text{m}^3$

Over the working day, therefore, the 1 hour average concentration should stay below the following value:

- Investigation Trigger Value = $875 \mu\text{g}/\text{m}^3 / 11 \text{ hours} = 80 \mu\text{g}/\text{m}^3$

In regards to the Action trigger value, the objective is to prevent exceedance of the criterion due to two consecutive elevated 1 hour average results. As calculated above, the allowable daily maximum value of the summed hourly concentrations is $875 \mu\text{g}/\text{m}^3$. To ensure this value is not exceeded in a two hour period, the Action trigger value is as follows:

- Action Trigger Value = $875 \mu\text{g}/\text{m}^3 / 2 \text{ hours} = 437.5 \mu\text{g}/\text{m}^3$

The Stop Work criterion represents a concentration whereby the daily assessment criteria will likely be exceeded if this value is exceeded. On this basis, the shutdown value is simply equal to the daily allowed total, resulting in the Stop Work trigger value as follows:

- Stop Work Trigger Value = $875 \mu\text{g}/\text{m}^3$

11.3.5 Summary

The following Table 11.9 provides a summary of the mitigation measures proposed to reduce impacts of dust and shipping emissions generated by the Project. Mitigation measures will be outlined and implemented through the Construction Environmental Management Plan (refer Appendix B2) and Operational Environmental Management Plans (refer Appendix B3).

It should be noted that the lack of exceedances noted in this report is a direct result of the application of standard mitigation measures rather than an expectation that limited dust will be generated. Should the mitigation measures assumed in the dispersion modelling not be applied, then the level of dust impact would be expected to be much higher and the compliance with criteria cannot be expected.

Table 11.9 Summary of air quality impacts and mitigation measures

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Shipping emissions leading to degradation of air quality amenity at sensitive receptors.	Construction / Operation	Low	Unlikely	Low	Promote the use of low sulfur fuels when berthing at the port	Low
Increased dust emissions leading to degradation of air quality amenity at sensitive receptors.	Construction	Moderate	Possible	Medium	Implement appropriate dust control measures including: - covering trucks when transporting fill - sealing newly reclaimed land as soon as practicable by vegetation and/ or chemical sealants - use of water sprays on stockpiled or disturbed areas - use of water sprays (water trucks) on trafficked areas to minimised dust generation - implement Reactive Monitoring Program and trigger values.	Low
Increased fuel combustion emissions leading to degradation of air quality amenity at sensitive receptors.	Construction / Operation	Negligible	Almost Certain	Low	Turn engines off while parked on site. Regularly maintain equipment, plant and machinery Implement site speed limits. Reduce haul road lengths. Manage vehicle movement to prevent queuing / idling.	Low

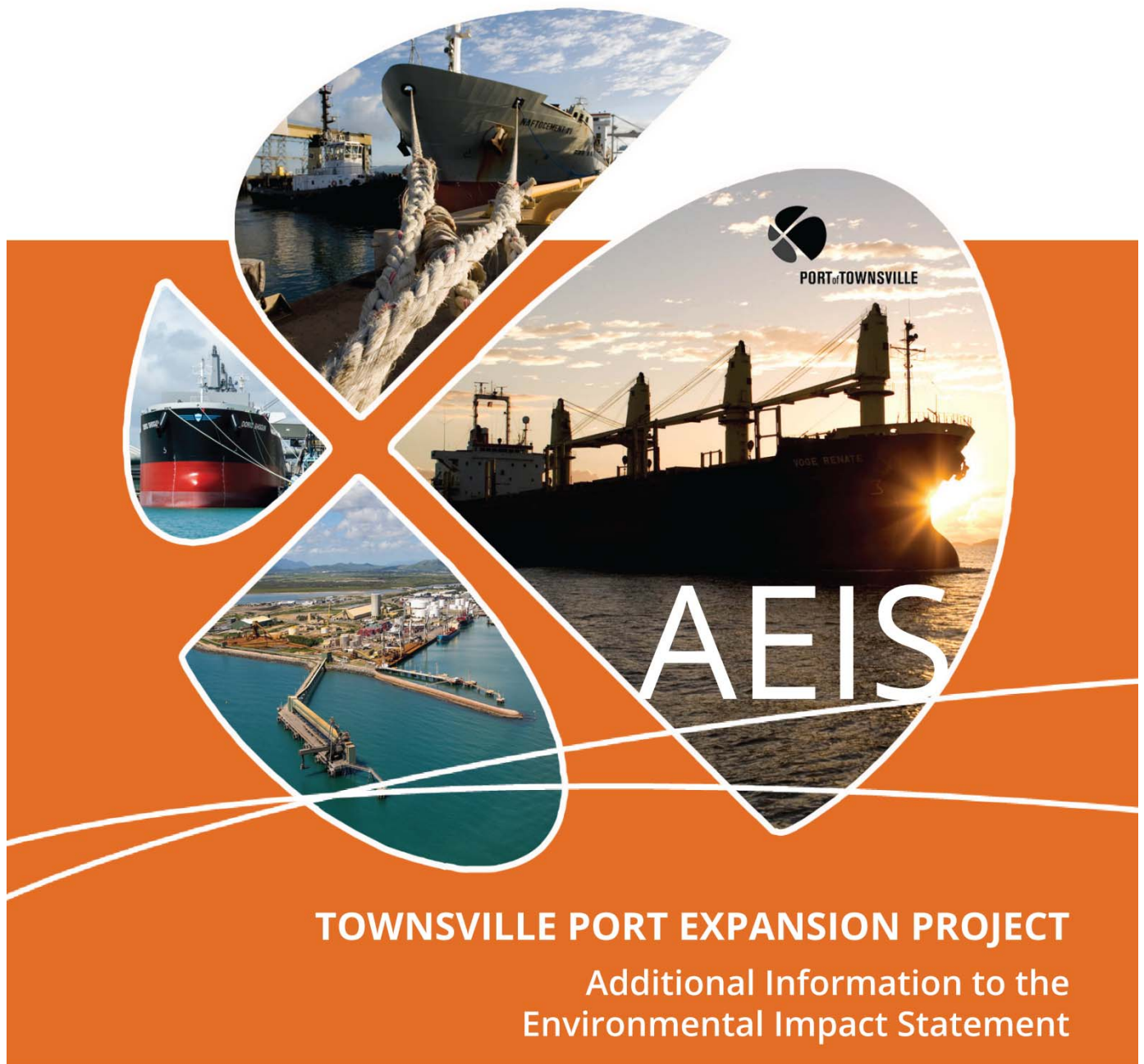
11.4 Conclusion

The air quality impacts associated with the construction of the PEP were reassessed following the refinement of the PEP design and construction staging. The shipping emissions at both the existing port and the PEP were also included in the assessment. Following the redesign of the construction staging, there was a general decrease in the overall dust emissions expected from the Project, leading to a lower predicted dust concentration than those reported in the EIS at sensitive receptors beyond the boundary of the port.

Concentrations of PM₁₀ and TSP were predicted to be below the *Environmental Protection (Air) Policy 2008* criteria (established for health and well-being) for all averaging periods, at all modelled sensitive receptors. Dust deposition rates were predicted to be below the criterion for dustfall, also designed for the preservation of the well-being of surrounding areas, at all modelled sensitive receptors. Concentrations of NO₂, SO₂, CO, and PM_{2.5} from shipping emissions were predicted to be below the *Environmental Protection (Air) Policy 2008* criteria (established for health and well-being) for sensitive receptors for both short term and long term averaging periods. The overall risk to health and well-being from shipping emissions was considered to be low.

In order to minimise dust emissions from the PEP construction activities, a range of activity specific and project wide mitigation measures should be implemented. Measures adopted for specific construction activities and the trigger levels defined to ensure the ongoing management of dust from the site should be applied to ensure the compliance with the dust criteria. An Air Quality Management Plan, which outlines mitigation measures and site practices to minimise the generation of dust from the site, particularly during periods where the meteorological conditions are likely to transport the dust off-site, should be prepared and implemented for both the construction and operational periods of the development. All activities on the site should be undertaken with the objective of preventing visible emissions of dust beyond the site boundary. In the event of visible dust emissions occurring at any time, all practicable dust mitigation measures, including cessation of dust-generating works, should be identified and implemented.

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SECTION 12

Noise and Vibration



12.0 Noise and Vibration

12.1 Introduction

Noise impacts of the Port Expansion Project (PEP) are described in Chapter B.10 of the PEP Environmental Impact Statement (EIS). The Project area supports existing port facilities with the nearest sensitive receptors identified approximately 1.4 km from the PEP boundary. The existing ambient environment is characterised by traffic and port activity noise.

This chapter provides information to address submissions received in response to the PEP EIS relevant to noise and vibration. More specifically, key issues raised from the submission process include:

- clarification of construction phase noise monitoring and mitigation measures
- land transport noise leading to increased disturbance of sensitive receptors (community)
- noise attenuation through a building façade
- night noise leading to increased disturbance of sensitive receptors
- application of the World Health Organization (WHO) Guidelines
- consistency in the complaints handling process
- land transport noise disrupting terrestrial fauna behaviour and movement patterns (refer to Section 9.0)
- underwater noise disrupting marine fauna behaviour and movement patterns (refer to Section 8.0)
- cumulative impacts associated with increased in maritime activity (refer to Section 25.0).

12.2 Response to Submissions

12.2.1 Clarification of construction phase noise monitoring and mitigation measures

10 submissions queried the proposed approach to noise monitoring and implementation of mitigation measures, with an emphasis on piling activities and fixed noise-emitting plant. An adaptive approach to implementing noise monitoring and management strategies during construction activities is discussed in Sections B.10.5.1.5 and B.10.5.2.4 of the EIS. Noise monitoring will be undertaken in accordance with the relevant standards at sensitive receptors during construction works identified as likely to cause community disturbance (such as piling or where noise-emitting plant is to be fixed in a stationary location for a significant amount of time) and in response to community complaints.

Environmental Management Plans (EMP) outlining monitoring, reporting and corrective action procedures for the construction and operational phases of the proposed development are provided in C.2.2 and C.2.5 of the EIS. In the event of exceedances of construction noise goals, noise-generating activities and equipment will be reviewed and mitigation measures (such as community consultation, timing of equipment use and use of acoustic enclosures) investigated to assess appropriateness to the Project and implemented where practicable. Monitoring activities will continue following all corrective action to assess the adequacy of those actions to mitigate the issue.

Townsville City Council further recommended an appropriate action plan be implemented and disseminated to relevant stakeholders. Stakeholder consultation and complaints management in association with noise is addressed in Sections B.10.5.1.4 and B.10.5.2.2 of the EIS. The Port of Townsville Limited (POTL) will update an established complaints handling procedure to accommodate the PEP and information regarding how to submit a noise enquiry will be provided on the POTL website.

12.2.2 Land transport noise leading to increased disturbance of sensitive receptors

Four submissions requested further information on how impacts of increased rail and site traffic noise on nearby sensitive receptors (community) are addressed. A road traffic noise impact assessment is provided in Section B.10.4.8 of the EIS. In addition to assessing road noise this section provides context for the exclusion of rail infrastructure from the assessment. POTL does not have developmental control or authority over rail servicing current or future port operations and therefore any impact associated with rail infrastructure must be addressed under a separate approval submitted by the relevant proponent.

12.2.3 Noise attenuation through building façades

The Department of Environment and Heritage Protection (DEHP) queried the relevancy of attenuation levels through an open window in Section B.10.4.6.1 of the EIS. The insertion loss through open windows of 10-15 dB previously assumed in the EIS to determine the *Environmental Protection Policy (Noise) 2008* night-time external noise goal has been revised to a more conservative insertion loss of 5-10 dB. The updated table summarising the operational noise goals, reflecting this reduced insertion loss through open windows, is provided in Table 12.1 below.

Table 12.1 Update to EIS Table B.10.12 Summary of external noise goals applicable at nearest noise sensitive receivers

Period	Time	Environmental Protection Policy (Noise) 2008 $L_{Aeq, adj. 1hr}$ dB(A)	Planning for Noise Control $L_{Aeq, 1hr}$ dB(A)	World Health Organisation guidelines L_{Aeq} dB(A)	ECOACCESS Low Frequency dB(Lin)
Day	7am – 6pm	50	28 – 48*	40 – 45**	50 dB(Lin) Screening test (indoors)
Evening	6pm – 10pm	50	28 – 46*	40 – 45**	
Night	10pm – 7am	35 – 40**	28 – 44*	35 – 40**	

* These are specific for each noise sensitive receiver. Table B.10.13 (of the EIS) displays the Planning for Noise Control noise goals for each noise sensitive receiver.

** Assuming a 5-10 dB reduction through open windows

12.2.4 Night noise leading to increased disturbance of sensitive receptors

Two submissions were received regarding night-time noise from the PEP exceeding ambient background levels. Predicted noise levels for construction plant and equipment (based on continuous operation in an unmitigated environment) at noise-sensitive receptors (including Breakwater Quays) are tabulated in Tables B.10.6 and B.10.7 of the EIS with a comparison to known pre-construction noise levels at residential areas presented in Section B.10.4.3.1 of the EIS. Construction noise levels at sensitive receptors are predicted to be no higher than the pre-construction noise levels. Environmental Management Plans provided in Appendix B2 and Appendix B3 outline measures to mitigate noise generation and respond to exceedances including the investigation and implementation of alternative methods to construction and operation where practicable.

One submission also requested clarification on the assessment against the sleep disturbance criteria. The impact of night-time construction noise is discussed in Section B.10.4.3.2 of the EIS and is assessed against known pre-construction ambient and background noise levels measured at the nearest sensitive receptors. A comparison of night-time construction noise against a relevant sleep disturbance criterion is discussed in Section 12.3.4.1 of this AEIS. As noise emission from plant and equipment typically used at night during construction works is quasi-steady in nature (as piling works are not planned to occur at night), the night-time construction noise emission has been assessed against the L_{Aeq} noise descriptor, rather than an L_{max} noise descriptor, for consistency.

12.2.5 Application of the WHO Guidelines

DEHP has sought the *Night Noise Guidelines for Europe 2009* (the 2009 WHO Guidelines) to be applied to the assessment rather than the *Guidelines for Community Noise 1999* (the 1999 WHO Guidelines). The 1999 WHO Guidelines were used in the EIS to inform the derivation of noise criteria, primarily the recommendation of a 30 dB(A) L_{Aeq} noise level inside bedrooms. These guidelines are considered the most appropriate for this assessment as:

- The Terms of Reference (ToR) did not require an assessment of the long term average emissions or the 2009 WHO Guidelines although these were available at the time the ToR was issued.
- The 2009 WHO Guidelines are considered complementary to, rather than a replacement of the 1999 WHO Guidelines. The 40 dB descriptor utilised in the 2009 WHO Guidelines refers to a different measure, namely the $L_{night, outside}$, which is a long term average measured over every night of the year. Conversely, the 'typical worst case' noise impact scenario from the PEP has been assessed in the EIS, to which the 1999 WHO Guidelines' L_{Aeq} value of 30 dB inside bedrooms is more applicable.
- The 1999 WHO Guidelines limit of 30 dB(A) L_{Aeq} is consistent with the *Environmental Protection Policy (Noise) 2008* (EPP [Noise]) Acoustic Quality Objective inside dwellings at night-time, which is intended to protect the environmental value of "health and wellbeing in relation to the ability to sleep".
- An assessment of the 2009 WHO Guidelines $L_{night, outside}$ noise descriptor requires a different approach to the EIS noise assessment. This would require an assessment of the long term average emissions, including consideration of changing meteorological conditions and operating conditions over the entire year and is inconsistent with the comparison against the "typical worst case" scenario presented in the EIS

The 1999 WHO Guidelines are considered most appropriate for the PEP EIS assessment and will continue to be utilised to inform the acoustic assessment for this Project.

12.2.6 Consistency in complaints handling process

Townsville City Council recommended a consistent approach between POTL and council to handling noise complaints associated with the PEP. As stated in Section B.10.5.1 of the EIS, POTL has an established complaints handling procedure which will be updated to accommodate the PEP. Information regarding noise issues and enquiries will be made available on the POTL website in accordance with the PEP consultation program. POTL will work closely with Townsville City Council and DEHP to capture and consistently manage any complaints.

12.3 Revised Environmental Impact Assessment

12.3.1 Legislation and policy

The Queensland Department of Transport and Main Roads document *Road Traffic Noise Management Code of Practice 2008* has been superseded with the *Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise 2013*. The calculation methodology, noise goals and applicability are unchanged between the versions used for the EIS, and for the current report.

12.3.2 Design refinement

The project design has been further refined as described in Section 2.0 of the AEIS. The extent of dredging and reclamation works has been updated as a result of the project design refinements. Construction staging has altered from the EIS and accordingly noise impacts associated with construction have been revised.

Broadly, the design refinement has resulted in the following changes to the PEP EIS relevant to the noise and vibration assessment:

- construction noise impact, due to an increase in land reclamation area (Section B.10.4.3.1 Tables B.10.4, B.10.5, B.10.6 and B.10.7)
- operational noise impacts, due to the revised berth arrangement (Sections B.10.4.6.1, B.10.4.6.2 and B.10.4.6.3)
- construction phase traffic volumes and resulting traffic noise impacts (Section B.10.4.8.2)
- cumulative impacts, associated with the change in operational noise impacts (Sections B.10.6).

An updated summary of noise and vibration impacts are discussed in Section 12.3.4.1 of this Report.

12.3.3 Supporting studies

The assessment of operational noise emissions from the PEP when it is fully constructed, assumed to be by 2031, was updated to reflect the revised PEP layout and is discussed later in this chapter.

12.3.4 Revised assessment

12.3.4.1 Impact assessment

Construction Phase - Traffic Noise

This section addresses Section B.10.4.8.2 of the EIS, specifically the construction phase traffic noise impact to dwellings on Boundary Street. The traffic assessment of the staged construction of the PEP indicated that Stage 2 (Year 2025) will generate the typical highest traffic volumes and so was considered the critical construction stage in terms of potential impacts on the surrounding road network and traffic noise emissions.

At that time, volumes of approximately 240 cars (during peak times) and 7 heavy vehicles per hour are estimated to access the site during May 2025, based on the updated traffic flows as a result of the design refinement. This forecast traffic flow represents approximately 8-13% of the forecast background traffic volumes on Boundary Street for that year. As such, the contribution to overall peak hour traffic noise levels on Boundary Street from PEP construction traffic is less than 1 dB, and is therefore not considered to represent a significant contribution to the traffic noise environment at that time.

Construction Noise - Daytime Sources

This section addresses Section B.10.4.5.1 of the EIS, specifically the daytime construction phase noise impact to nearby sensitive receptors, based on revised staging and associated traffic generation. Refinements to the Project approach have resulted in a larger reclamation area, with dredgers, dozers, front-end loaders and traxcavators (i.e. tractor-excavators) operating 24 hours per day. The noise impact from these activities was assessed in Table B.10.4 of the EIS.

The staging refinement is also expected to delay certain construction activities, such as piling activities; however, the severity and duration of impact is expected to be similar to that identified in Section B.10.4.5.1 of the EIS.

Construction Noise – Night-time Sources

This section addresses Section B.10.4.5.1 of the EIS, specifically the night time construction phase noise impact to nearby sensitive receptors, based on the changes to staging and associated traffic generation. Most of the construction activities associated with the PEP will be undertaken during normal daytime hours (6:30 am to 6:30 pm), 6 days per week. Several of the processes however are proposed to be carried out over 24 hours, 7 days a week. A summary of these activities and the reason that the night-time works are required is as shown in Table 12.2.

Table 12.2 Update to EIS Table B.10.5 .24 hour Construction Works Plan

Construction Activity	Stage	Duration	Reason for Night-time Works
Dredging	Stage 1	4.5 years	Due to volume of materials removed, 24/7 dredging during construction is time-critical to the completion of the Project. Reduced dredging hours would unreasonably prolong the construction period and increase potential environmental impacts.
	Stage 2	4.3 years	
	Stage 3	2.3 years	
Rock Supply / Placement	Stage 1	11 months	Due to the volume of materials to supply, 24/7 delivery of materials to the site during construction is time-critical to the completion of the Project (pending relevant conditions at individual quarries). Reduced supply hours would unreasonably prolong port construction and therefore the construction period and increase potential environmental impacts. The impact on road traffic can also be reduced by spreading the traffic volumes during the night.
	Stage 2	11 months	
	Stage 3	-	
Wharf construction	Stage 1	11 months	The nature of the wharf construction works over water, with limited access to work fronts, requires 24/7 activities to limit the duration and best utilise marine plant. When concrete is poured in large volumes, it will need to be done as a continuous process to ensure that it sets correctly.
	Stage 2	2.8 years	
	Stage 3	18 months	
Reclamation fill	Stage 1	4.5 years	The source of the reclamation fill will be dredged material, therefore the activities will run concurrently with the dredging operation.
	Stage 2	4.5 years	
	Stage 3	2.3 years	

Activities associated with night-time works, and their predicted unmitigated noise impact to the nearest sensitive receptors, are summarised in Table 12.3. The reference sound pressure levels were sourced from Australian Standard AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*, British Standard BS 5228-1:2009 *Code of practice for noise and vibration on construction and open sites Part 1: Noise* and from AECOMs in house database.

The estimated noise impact has been calculated by assessing noise emission from individual pieces equipment operating at the closest point in the PEP footprint to each relevant receiver. A correction has been made to account for the percentage of time each item of equipment will operate at night (on a typical worst case basis), and it has been assumed that the intervening ground is flat, without allowance for any shielding from terrain or buildings.

Due to the preliminary nature of the construction methodology, a more detailed assessment is not practical and as such the assessment does not consider multiple pieces of equipment operating at different locations simultaneously. However this has been mitigated by applying conservative assumptions in terms of equipment location and intervening topography and on this basis the impacts outlined in Table 12.3 are considered indicative of the likely night-time impacts.

It is noted that the Townsville Marine Precinct is a commercial precinct with daytime occupancy only. As such it is not considered sensitive at night and night time noise levels have not been calculated.

The predicted noise levels at the noise-sensitive receivers are presented as external noise levels as described in Section B.10.4.3.2 of the EIS.

Table 12.3 Update to EIS Table B.10.7 Typical Predicted Noise Levels from Construction Plant and Equipment – Night –time Construction Works. Merges with EIS Table B.10.6.

Plant	Typical Sound Pressure Level at 10 m, dB(A)	% of Night-time Operations	Predicted noise level at nearest noise-sensitive receptors L_{Aeq} dB(A)				
			29 Hubert Street	55 Macrossan Street	5 Breakwater Quays	The Ville Resort-Casino	1 Esplanade
Barge	76	20%	23	24	26	27	10
Work boat	78	20%	25	26	28	29	12
Bulldozer	81	70%	34	34	37	38	21
Concrete truck	80	70%	33	33	36	37	20
Crane	82	80%	35	36	38	39	22
Mechanical Dredge	82	100%	36	37	39	40	23
Excavator/Traxcavator	79	100%	33	34	36	37	20
Front End Loader	82	100%	36	37	39	40	23
Generator (diesel)	71	100%	25	26	28	29	12
Truck (> 20 tonne)	79	75%	32	33	35	36	19
Tug for barge	82	10%	26	27	29	30	13

Based on the measured night-time pre-construction noise levels at residential areas, the typical night-time construction noise levels identified in the above table for individual items of equipment are:

- Below the existing average night-time ambient noise levels of 46 to 49 dB(A) for all activities.
- At or below the existing average night-time background noise levels of 38 to 45 dB(A) for all activities.
- Compliant with the EPP (Noise) night-time acoustic quality objective, and 1999 WHO night-time guideline value of 35- 40 dB(A) L_{Aeq} , for all construction activities. The acoustic quality objective of the EPP (Noise) is intended to protect the environmental value of health and wellbeing, in relation to the ability to sleep. Similarly, the 1999 WHO Guideline value is intended to protect against the critical health effect of sleep disturbance.

Operational Phase

This section addresses Sections B.10.4.6.1, B.10.4.6.2 and B.10.4.6.3 of the EIS, specifically the operational phase noise impact to nearby noise sensitive receivers.

Table 12.4 below presents the results of noise modelling (under the meteorological conditions described in Section B.10.3.5 of the EIS) at 2 metres above local ground level for the residential locations and at the uppermost floor for The Ville Resort – Casino. As the Port will operate 24/7, they can represent either daytime or night-time predicted noise levels. Predicted exceedances of both noise goals (Planning for Noise Control and World Health Organization) are shown in **bold** in Table 12.4. A discussion of the relevant noise guidelines is provided in Appendix A6.

A series of noise contour plots for the predicted external noise levels at 2 metres above local ground level are given in Appendix A6. Noise goals and predicted noise levels for noise-sensitive receivers presented below and in the contours are for noise external to the dwelling/building.

Table 12.4 Update to EIS Table B.10.14 Predicted typical operational external noise levels at nearest noise-sensitive receivers, calendar year 2031

Location	Noise Goal Range, dB(A)		Forecast LA _{eq} Noise Level, dB(A)		
	Planning for Noise Control*	World Health Organization	Neutral, D Class Calm	D Class 3m/s SE wind	D Class 3m/s S wind
29 Hubert Street	41	35 – 40	43	41	39
55 Macrossan Street	35	35 – 40	44	42	40
5 Breakwater Quays	44	35 – 40	46	50	44
The Ville Resort - Casino	42	35 – 40	46	51	45
1 Esplanade, Picnic Bay, Magnetic Island	28	35 – 40	28	31	30
Townsville Marine Precinct	N/A	70	48	45	43

*Most stringent Planning for Noise Control noise target for each location provided

As the noise guidelines provided by the Planning for Noise Control document are applicable to external noise levels, and the Environmental Protection (Noise) Policy provides an internal guideline noise value for commercial activities, no Specific Noise Level targets are set for the Townsville Marine Precinct.

Comparison against Planning for Noise Control noise goals

The operation of the expanded portion of the Port in calendar year 2031 is expected to produce noise levels of up to 43 dB(A) at 29 Hubert Street, 44 dB(A) at 55 Macrossan Street, 50 dB(A) at Breakwater Quays, 51 dB(A) at The Ville Resort – Casino and 31 dB(A) at 1 Esplanade, Picnic Bay, Magnetic Island. At Hubert Street, the Planning for Noise Control noise goals is forecast to be exceeded by up to 2 dB(A). This is considered borderline compliant as a difference of 1-2 dB is not generally perceptible. It is noteworthy that the Planning for Noise Control noise goal is slightly more lenient than the World Health Organization noise goal at this receptor.

Forecast exceedances at Macrossan Street and Breakwater Quays are more significant. This is discussed further below.

Comparison against World Health Organization guidelines

As the World Health Organization guidelines presented here are in relation to the potential for sleep disturbance, the night time assessment period is the most important and is discussed below.

External noise levels at Hubert Street, Macrossan Street, Breakwater Quays and The Ville Resort – Casino from the operating Port Expansion Project under the identified prevailing wind conditions are predicted to exceed the World Health Organisation guidelines by up to 11 dB(A) (at the Casino). This is examined in subsequent sections.

Table 12.4 shows external noise levels of up to 48 dB(A) are predicted at the Townsville Marine Precinct from the Port Expansion Project. Typical reduction across a standard commercial façade (closed windows and doors, air conditioned) is 20 dB; therefore, the internal guideline level of 45 dB(A) for the commercial properties at the Townsville Marine Precinct is likely to be readily achieved.

The predicted external noise levels at the Magnetic Island location are forecast to be below the lower World Health Organization limit under all modelled meteorological conditions.

Operational Phase - Breakwater Quays and 55 Macrossan

This section addresses Section B.10.4.6.1 of the EIS, specifically the operational noise impact to Breakwater Quays dwellings with the reduced insertion loss through an open window as discussed in Section 12.2.3 of this Report. This section also addresses the operational noise impact to 55 Macrossan Street.

At Breakwater Quays, the predicted typical worst case operational noise level is 50 dB(A) L_{Aeq} . This exceeds the WHO 1999 and EPP (Noise) night-time external noise goal of 35-40 dB(A) L_{Aeq} by 10-15 dB(A), assuming windows are open. Similarly at 55 Macrossan Street, the predicted typical worst case operational noise level is 44 dB(A) L_{Aeq} . This exceeds the World Health Organization and EPP (Noise) night-time external noise goal of 35-40 dB(A) L_{Aeq} by 4-9 dB(A), assuming windows are open.

The following points are noted in relation to these receptors.

- The predicted noise impact is based on the assumption that all six PEP berths and associated plant and equipment are operational, including the use of both 30 tonne cranes. However it is noted that the construction, and hence operation, of the six berths associated with the PEP are staged over 10 years, namely:
 - 2021 – Berth 12 is operational
 - 2025 – Berth 12 and 14 are operational
 - 2026 – Berth 12, 14 and 15 are operational
 - 2027 – Berth 12, 14, 15 and 16 are operational
 - 2031 – All six berths are operational.

As such, the operational PEP noise impact is predicted to be less than that predicted in the EIS until the Year 2031, with a gradual increase in operational noise levels between 2021 and 2031.

- Post 2031, as the predicted noise levels in the EIS are based on the typical worst case operating conditions of the PEP and worst case meteorological conditions, it follows that during most operational situations where there is less port activity (fewer ships berthed) and/or different meteorological conditions, the noise impact will be lower. Indeed, of the three meteorological conditions assessed for 55 Macrossan Street, one condition gave rise to noise levels predicted to comply with the WHO noise goal, and a second gave rise to a marginal 2 dB(A) exceedance of this noise goal.
- Currently the Breakwater Quays development is incomplete, with only three dwellings built at the time of this AEIS. It is however noted that these dwellings are of a contemporary construction, which given the North Queensland climate would typically include openable windows, mechanical ventilation and air-conditioning. Typical reduction across a contemporary dwelling façade with windows closed is predicted to be at least 20 dB(A). The provision of air-conditioning also allows dwelling occupants to keep external doors and windows closed during periods of peak Port operation. Therefore, internal noise levels as a result of peak Port operations inside these dwellings are predicted to achieve the EPP (Noise) night-time acoustic quality objective, and 1999 WHO night-time guideline value, with windows closed.
- As discussed in Section B.10.6 of the EIS, the noise levels at the Breakwater Quays receptor is also predicted to increase in the future, independent of the PEP, and attributable to:
 - noise from an expanded casino operation, resulting in increased mechanical plant noise, car park noise and vehicle movement noise (along Sir Leslie Thiess Drive)
 - noise from the Breakwater Quays development when built out, resulting in increased domestic noise, watercraft noise and mechanical plant noise.

The cumulative effect of all these developments is expected to increase the actual noise environment at the Breakwater Quays development, and hence at the time of its operation, the additional impact of the PEP on the noise environment will correspondingly be less.

On this basis, noise impacts are considered to be manageable through the measures discussed in Section B.10.5.2.1 of the EIS, and no additional noise mitigation is recommended for the Breakwater Quays development and Macrossan Street receptor.

Operational Phase – The Ville Resort – Casino

The predicted external noise level of 51 dB(A) at the hotel building of The Ville Resort – Casino is forecast to exceed the external criteria by up to 16 dB(A). It is noted that all of the hotel rooms are air conditioned, allowing patrons to keep external doors and windows closed, for which an outdoor-to-indoor noise reduction of at least 20 dB(A) is expected. Therefore, internal noise levels as a result of port operations in hotel rooms are predicted to comply with the World Health Organization's indoor sleep and night time guidelines.

Comparison against existing noise levels

Based on the measured daytime noise levels (refer to EIS Section B.10.3.3) and the predicted noise levels presented in Table 12.4 of this Report, these worst-case operational Port noise levels are:

- below the existing daytime average ambient average noise levels of 51 to 57 dB(A) at all receptor locations
- up to 8 dB(A) higher than the existing daytime background "typical quietest" noise levels of 38 to 45 dB(A).

When compared to the measured night time noise levels, these worst-case operational Port noise levels are:

- below the existing night time average ambient average noise levels of 46 to 49 dB(A) at all modelled receptor locations except The Ville Resort – Casino and 55 Macrossan Street, where the predicted worst-case operational Port noise levels is forecast to be 2 dB higher than the existing ambient noise levels at this location
- up to 11 dB(A) higher than the existing night time background "typical quietest" noise levels of 32 to 41 dB(A).

Therefore, the operational noise emitted from the expanded portion of the Port under certain prevailing wind conditions is likely to be audible at the nearest mainland receptors. A discussion of mitigation measures to address the predicted noise emissions in relation to the Planning for Noise Control noise goals is provided in Section B.10.5.2 of the EIS. These mitigations measures are considered to continue to be appropriate, notwithstanding the changed impacts as a result of the design refinement.

Low frequency noise

This section addresses Section B.10.4.6.3 of the EIS. The draft ECOACCESS *Guideline for the Assessment of Low Frequency Noise* provides an initial screening assessment for the audibility of low frequency noise.

The following two requirements are specified as part of this screening test:

- the overall sound pressure level within dwellings does not exceed 50 dB(Lin)
- the overall dB(Lin) level within dwellings does not exceed the dB(A) level by more than 15 dB.

Where these conditions are not met, there is an increased likelihood that low frequency noise may be audible and additional assessment by way of measurement is recommended. It is noted that this initial screening test only identifies the risk of increased audibility as detailed below.

The predicted external noise levels at the identified receptors under the worst-case weather conditions for each receptor are summarised in Table B.10.15 below. The predicted noise levels at the noise-sensitive receivers are external noise levels.

Table 12.5 Update to EIS Table B.10.15 Predicted worst-case external noise levels at sensitive receivers

Location	Overall dB(Lin)	Overall dB(A)	Difference dB
29 Hubert Street, South Townsville	56	43	13
55 Macrossan Street, South Townsville	55	44	12
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	63	50	12
The Ville Resort - Casino	63	51	12
1 Esplanade, Picnic Bay, Magnetic Island	46	31	15
Townsville Marine Precinct	62	48	14

In order to relate the above external noise predictions to noise levels within the dwelling (where the screening test is applied), a correction is generally applied to the external noise predictions. However this correction is dependent on the building façade material(s), size of the window opening and the internal surfaces of the dwelling. For the purpose of discussion, the internal dB(Lin) noise levels are assumed to be 0-5 dB(Lin) below the external levels, assuming the intrusive noise has significant low frequency content.

Both requirements of the screening test are met outside the receptor at 1 Esplanade, Picnic Bay, Magnetic Island, and as such they are likely to also be met inside this receptor. Accordingly, there is a low probability of significant low frequency noise audibility within these areas.

Whilst the predicted noise levels outside The Ville Resort – Casino and the Townsville Marine Precinct have a significant level of exceedances (up to 13 dB(Lin)), it is noted that hotel rooms and commercial areas within these two receptors are generally air-conditioned, allowing users to keep external doors and windows closed. Accordingly, there is a low probability of significant low frequency noise audibility within these areas.

The predicted external noise levels at the Macrossan Street and Hubert Street receptors exceed the first screening test requirement by 5-6 dB(Lin), whilst the Breakwater Quays development has predicted noise levels which exceed the first screening test requirement by up to 13 dB(Lin). Accordingly, there is a moderate to significant probability of significant low frequency noise audibility within these areas during adverse weather conditions and with windows open.

It is however noted that the 5-6 dB(Lin) exceedance of the first screening test requirement at the Macrossan Street and Hubert Street receptors may be ameliorated by closing the windows during peak port activity. Similarly, the dwellings at Breakwater Quays are of a contemporary construction, which given the North Queensland climate would typically include operable windows, mechanical ventilation air-conditioning; this allows external windows and doors to be closed at during periods of peak port operation.

On this basis, noise impacts are considered to be manageable through the measures discussed in Section B.10.5.2.1 of the EIS, and no additional noise mitigation is recommended for the mainland receptors.

Cumulative Impacts

This section addresses Section B.10.6 of the EIS, specifically EIS Table B.10.20, Table B.10.21 and the discussion thereafter, to reflect the updated 2031 PEP operational noise impact as discussed earlier in this Report.

Table 12.6 Update to EIS Table B.10.20 Cumulative noise levels – day time port operations

Location	Estimated cumulative noise levels L_{Aeq} dB					
	Existing 2011 day-time noise levels	Predicted Townsville Marine Precinct noise levels	Total noise levels (without the Port Expansion Project)	Worst-case predicted Port Expansion Project noise levels	Total noise levels (with the Port Expansion Project)	Estimated increase with the Port Expansion Project
29 Hubert Street, South Townsville	51	36	51	43	52	1
55 Macrossan Street, South Townsville	57	34	57	44	57	0
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	52	28	52	50	54	2
The Ville Resort - Casino	59	30	59	51	60	1
1 Esplanade, Picnic Bay, Magnetic Island	40*	14	40	31	41	1
Townsville Marine Precinct	59**	59	62	48	62	0

* Estimated from AS 1055.2 (Standards Australia, 1997b)

** Estimated based on measured noise levels at The Ville Resort - Casino; the closest measurement location to the Townsville Marine Precinct

Table 12.7 Update to EIS Table B.10.21 Cumulative noise levels – night time port operations

Location	Estimated cumulative noise levels L_{Aeq} dB					
	Existing 2011 night-time noise levels	Predicted Townsville Marine Precinct noise levels	Total noise levels (without the Port Expansion Project)	Worst-case predicted Port Expansion Project noise levels	Total noise levels (with the Port Expansion Project)	Estimated increase with the Port Expansion Project
29 Hubert Street, South Townsville	46	-	46	43	48	2
55 Macrossan Street, South Townsville	49	-	49	44	50	1
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	48	-	48	50	52	4
The Ville Resort - Casino	52	-	52	51	55	3
1 Esplanade, Picnic Bay, Magnetic Island	30*	-	30	31	34	4
Townsville Marine Precinct	52**	-	52	48	53	1

* Estimated from AS 1055.2 (Standards Australia, 1997b)

** Estimated based on measured noise levels at The Ville Resort - Casino

Based on the above estimation of future noise levels, the cumulative daytime operational noise impact of the proposed Port expansion and the known Townsville Marine Precinct is negligible (i.e. up to 2 dB(A)). It is noted that a change in noise levels of 1-2 dB(A) is not generally perceptible.

The night-time cumulative noise levels of the existing and future Port operations (excluding the Townsville Marine Precinct, which is inactive at night) indicates a small but generally not perceptible (i.e. less than 3 dB(A)) change in amenity for the residences at 29 Hubert Street and 55 Macrossan Street. At 5 Breakwater Quays, 1 Esplanade, Picnic Bay, Magnetic Island and The Ville Resort – Casino, the estimated cumulative impact of all known Port-related developments begins to be noticeable at a 3-4 dB increase in combined effect when compared to the developments in the absence of the proposed Port expansion, although it is noted that the resultant cumulative noise to 1 Esplanade, Picnic Bay, Magnetic Island continues to remain below the World Health Organization noise goal for sleep disturbance, as discussed earlier in this section.

In reality, however, the noise levels at these receivers from sources other than the proposed Port expansion are also expected to increase, such that the noise contribution from the Port expansion alone becomes less significant. Other future sources, which at this stage cannot be quantified, include:

- noise from an expanded casino operation (e.g. building services noise, car park and vehicle noise from Sir Leslie Thiess Drive)
- noise from the Breakwater Quays development (as yet incompletely developed) (e.g. building services noise, car park and vehicle noise from Sir Leslie Thiess Drive)
- noise from general growth and development of the city centre and Flinders Street East
- noise from vehicles on the Townsville Port Access Road
- noise from upgraded rail operations within both the Port area and the Eastern Access Corridor.

The cumulative effect of all these developments is expected to increase the actual noise environment in the vicinity of the Port, and hence at the time of its operation, the additional impact of the Port expansion on the noise environment at that time will correspondingly be less. These factors and contributions can be more meaningfully assessed in the future at stages when applications by port tenants are undertaken.

12.3.4.2 Mitigation measures

The predicted impacts of the PEP with the design refinement have been reviewed and are predicted to be similar to those reported in the EIS. Accordingly, the mitigation measures summarised in the EIS are still considered to be appropriate and adequate to manage noise emissions generated by the PEP, in consideration of the design refinement.

12.3.5 Summary

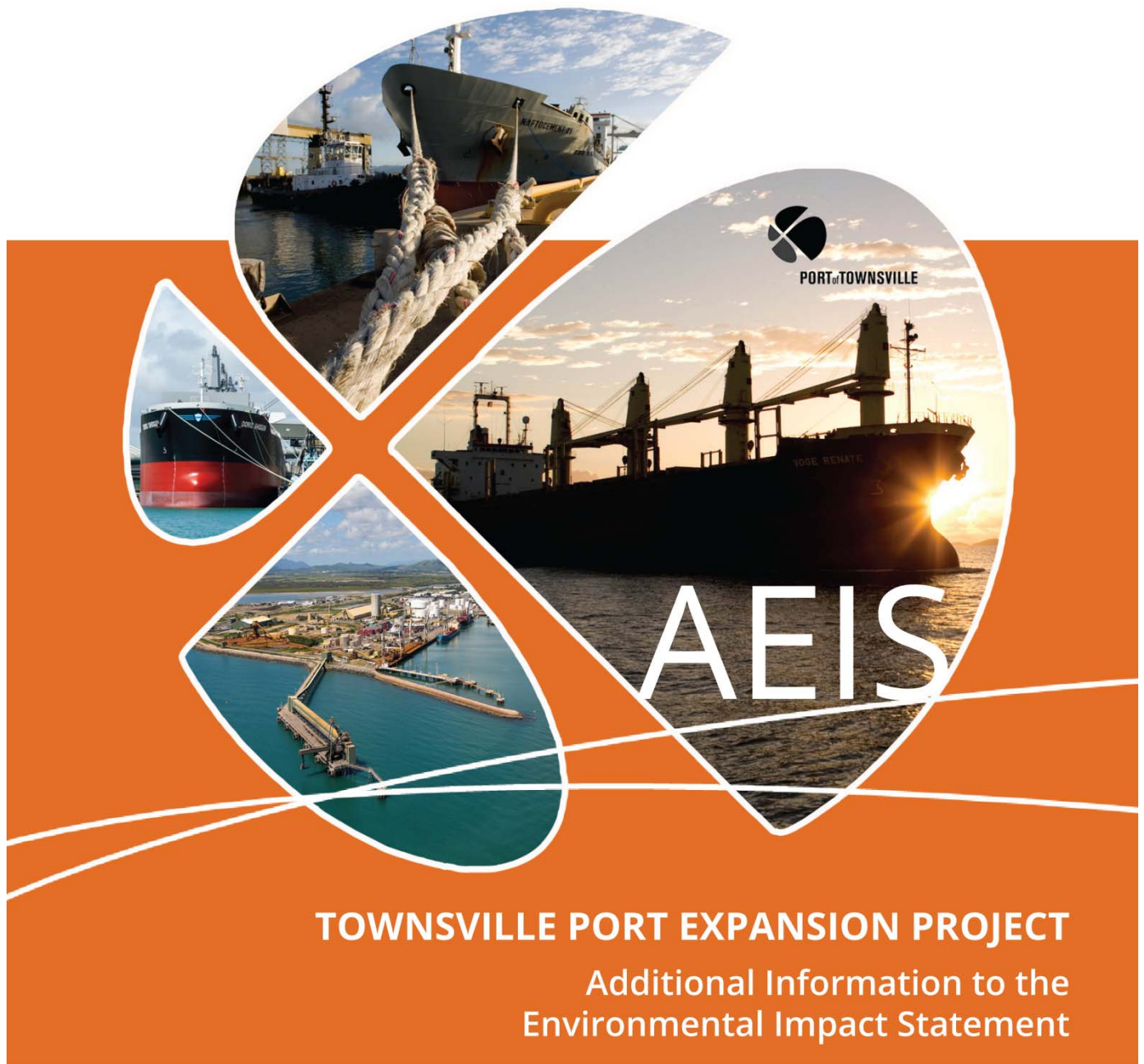
The following table provides a summary of the mitigation measures proposed to reduce impacts of noise and vibration emissions generated by the Project. Mitigation measures will be outlined and implemented through the Construction and Operational Environmental Management Plans.

Table 12.8 Summary of Noise & Vibration Impacts and Mitigation Measures

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Increased noise leading to degradation of acoustic amenity to local sensitive receptors.	Construction	Medium	Almost Certain	High	Equipment to be in good working condition. General good site working practices to be implemented. Construction activities that may potentially cause noise impact prior to each stage and appropriate controls to be identified and implemented.	High
Increased noise leading to degradation of acoustic amenity to regional sensitive receptors.	Construction	Minor	Almost Certain	Medium	Early identification of potential impacted areas and community concerns with timely communication to stakeholders of planned construction activities. Noise to be monitored and corrective actions taken if complaints received.	Medium
Increased vibration leading to degradation of acoustic amenity to local sensitive receptors.	Construction	Negligible	Unlikely	Negligible	Equipment to be in good working condition. General good site working practices to be implemented.	Negligible
Increased noise leading to degradation of acoustic amenity to local sensitive receptors.	Operational	Medium	Almost Certain	High	Mitigation measures such as barriers, enclosures etc. are largely impractical and are not recommended. Equipment to be in good working condition.	High
Increased noise leading to degradation of acoustic amenity of regional sensitive receptors.	Operational	Minor	Almost Certain	Medium	Noise to be monitored and corrective actions taken if complaints received. Individual port tenants to consider noise as part of the Integrated Development Assessment System (IDAS) process	Medium
Increased vibration leading to degradation of acoustic amenity of local sensitive receptors.	Operational	Negligible	Almost Certain	Low	Equipment to be in good working condition. General good site working practices to be implemented	Low

12.4 Conclusion

The changes made as part of the design refinement are not envisaged to substantially alter the outcome of the Noise and Vibration assessment in the EIS. The PEP is predicted to generate impacts of up to moderate significance (risk magnitude) to local sensitive receptors. As these impacts are classified as 'almost certain' this results in a high residual risk rating at the local level. Noise impacts on a regional scale are of lesser magnitude (minor) and therefore the residual risk rating is lower (medium). The implementation of mitigation measures outlined in the EIS are considered appropriate to manage noise impacts to nearby noise sensitive receivers, but would not change the overall risk level.



SECTION 13

Greenhouse Gas Emissions



13.0 Greenhouse Gas Emissions

13.1 Introduction

Greenhouse gas emissions from the Port Expansion Project (PEP) construction and operational activities are discussed in Chapter B.11 (Greenhouse Gas) of the Environmental Impact Statement (EIS). Emissions generated by the PEP will contribute to existing concentrations of greenhouse gases in the atmosphere such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). This has secondary consequences through its contribution to climate change impacts. This section provides information to address submissions received in response to the PEP EIS relevant to greenhouse gas emissions arising from the construction and operation of the PEP and assesses the impacts of the revised design.

Key matters raised during the submission process include:

- greenhouse gas flow-on impacts associated with the export of coal through the PEP
- cumulative impact contributions as a result of the PEP on the Great Barrier Reef.

One submission raised the potential emissions as a result of anoxic organic sediment disturbance during the construction process. This is addressed in Section 3.2.8 of the Additional Information to the Environmental Impact Statement (AEIS).

13.2 Response to Submissions

13.2.1 Greenhouse gas flow-on impacts associated with the export of coal through the PEP

Four submissions raised the matter of future coal exports through the PEP contributing to global climate change through the combustion of coal at its final destination.

The Port of Townsville is a multi-cargo port which imports and exports cargo to support North Queensland and the broader development initiatives of Northern Australia. The Port currently is not, and is not proposing to become a dedicated coal port such as Abbot Point, as referenced in one submission. Whilst the PEP EIS has identified coal as one potential future trade depending on industry demand, any such cargo export will be subject to separate assessment and approvals process and is not specifically addressed in this EIS.

In accordance with the Terms of Reference, the greenhouse gas assessment for the EIS focused on the construction and operation of the infrastructure itself, and not emissions associated with increased trade volumes likely to be enabled by the PEP as a transport linkage.

Emissions associated with increased cargo flows through the Port during operation are difficult to quantify, given the uncertainties regarding future cargo volumes and types. Emissions associated with these cargos will be addressed through other statutory processes (e.g. emissions from new coal mines will be covered by approvals processes associated with those mines).

In line with Section 9 of the *National Greenhouse and Energy Reporting Act 2007*, emissions associated with cargo passing through the Port are outside the scope of this Project.

13.2.2 Cumulative impact contributions as a result of the PEP on the Great Barrier Reef

Two submissions raised the matter of the PEP contributing to cumulative impacts on the Great Barrier Reef, including through the flow-on impacts resulting from the burning of coal cargo at international locations.

Whilst the EIS does not consider cargo flows through the Port as discussed above, Section 25.0 of the AEIS documents a comprehensive cumulative impact assessment that has been undertaken to assess the potential impacts of the PEP on sensitive ecological receptors. The cumulative impact assessment was undertaken in accordance with the *Framework for Understanding Cumulative Impacts Supporting Environmental Decisions and Informing Resilience-Based Management of the Great Barrier Reef World Heritage Area*.

13.3 Revised Environmental Impact Assessment

13.3.1 Legislation and policy

On 17 July 2014, the *Clean Energy Act 2011* was repealed by the Commonwealth government. This meant that from 1 July 2014, the Carbon Pricing Mechanism was abolished. The Commonwealth government replaced it with the *Direct Action Plan*, a policy consisting of programs such as the Emissions Reduction Fund directed at reducing carbon emissions.

The Emissions Reduction Fund came in to effect on 13 December 2014. The government has provided \$2.55 billion to establish the Fund and support businesses pursuing emissions reduction activities. It involves the use of a 'reverse auction' mechanism, where businesses can sell their carbon abatement, with the government purchasing the lowest cost per tonne of abatement. This is targeted at encouraging businesses to invest in the most cost-efficient emissions reduction methods and will be monitored by the Clean Energy Regulator. The Fund utilises mechanisms associated with the existing *National Greenhouse and Energy Reporting Act 2007* to evaluate carbon emissions from business and industrial entities. The first Emissions Reduction Fund auction was held in April 2015. At the first auction, the average price per tonne of abatement was \$13.95. The second auction was held in November 2015, with the average price per tonne of abatement being \$12.25.

The PEP is not likely to be directly affected by costs from a carbon price as outlined in Section B.11.2.3 of the EIS. Port tenants are likely to be responsible for the majority of future operational emissions.

The updated National Greenhouse Accounts Factors (August 2015) were used to undertake the AEIS revised greenhouse gas impact assessment.

13.3.2 Design refinement

The Project design has been refined as described in Section 2.0 of the AEIS. The revised design has increased the greenhouse gas emissions footprint of the PEP.

13.3.3 Supporting studies

Aside from the revised assessment provided below, no additional studies were required to adequately address comments received from submissions in relation to greenhouse gas.

13.3.4 Revised assessment

13.3.4.1 Impact assessment

The design refinement expands the reclamation area by approximately 50 ha to the north east to avoid sea placement of dredged material. The revised design and construction staging is expected to result in increased emissions. The peak intensity of greenhouse gas emissions of the PEP will be reduced by spreading the emissions profile over a longer duration.

All construction emissions were re-assessed, including:

- fuel use for the transport of construction materials from the quarry to site
- fuel use for onsite machinery
- fuel use for the capital dredging operations
- embodied emissions of the construction materials.

Emissions from stationary energy sources (e.g. lighting for night works) was not assessed due to a lack of specific data.

The revised design has comparable operational capabilities to the EIS. As a result, operational emissions calculated in Chapter B.11 (Greenhouse Gas) of the EIS are considered to remain unchanged. Whilst not able to be captured and presented, it is noted that overall emissions within the outer harbour will be reduced. This is as a result of Berth 12 being incorporated within the PEP, thereby reducing the overall berth number in the outer harbour from 8 to 7.

Table 13.1 summarises the reassessed greenhouse gas emissions produced for each source of emissions in the construction phase of the PEP.

Table 13.1 Revised AEIS Greenhouse Gas Emissions for the Construction Phase of the revised design

Scope	Source of Emissions	t/CO ₂ -e			
		Stage 1	Stage 2	Stage 3	Total
1	Transportation of materials	23,451	22,895	24	46,369
1	Onsite machinery	24,554	26,923	23,370	74,847
1	Capital dredging	33,717	15,731	38,300	87,748
3	Embodied energy emissions	12,404	40,135	29,021	81,560
Total		94,126	105,684	90,714	290,524

Transportation of Materials

Almost all greenhouse gas emissions from the transportation of materials occur in Stages 1 and 2, where all of the breakwater and revetment core material and rock armour is delivered from the quarry/s to the Project site. Table 13.2 shows the greenhouse gas emissions from transportation activities for each stage of the Project.

Table 13.2 Emissions from transportation activities by stage

Stage	Activity	Total emissions (CO ₂ -e)
1	Delivery of breakwater and revetment core material and armour	23,427
	Earthworks, pavement formation layers, delivery of materials, civil works for trunk services and utilities	24
2	Delivery of breakwater and revetment core material and armour	22,825
	Earthworks, pavement formation layers, delivery of materials, civil works for trunk services and utilities	71
3	Earthworks, pavement formation layers, delivery of materials, civil works for trunk services and utilities	24
All stages		46,369

Onsite Construction Plant and Machinery

Onsite machinery is required for construction works associated with the development of the reclamation (excluding emissions relating to transportation of materials outside of the new reclamation footprint or emissions related to dredging). As shown in Table 13.1, greenhouse gas emissions from onsite machinery will be greatest in Stage 2. The mechanical handling of the dredged materials and compaction into the reclamation along with the construction of revetments and breakwater structures during each stage will be the main contributors to the total emissions from onsite machinery. The increase of emissions in Stage 2 is as a result of the marine structure, deck and pavement construction associated with the development of Berth 14, Berth 15 and Berth 16, in addition to the mechanical handling.

Table 13.3 shows the fuel consumption rates for each type of onsite machinery. The most energy intensive (i.e. least fuel efficient) onsite machinery are likely to be bulldozers. Although when total hours of use are considered, the onsite machinery that contributes the most greenhouse gas emissions are likely to be the on-road dump trucks. On-road dump trucks are being used to transport good quality engineering fill from land sources to form the capping layer over the reclamation and pavement sub-base.

Table 13.3 Onsite machinery fuel consumption rates

Onsite Machinery	Fuel consumption (L/hr)
Barge mounted pile drivers	15
Bobcats	8
Bulldozers	80
Concrete trucks	25
Cranes – mobile	15
Cranes – large	30
Excavators	40
Graders	36
Off-road dump trucks	40
On-road dump trucks	20
Paving machines	20
Stone column or wick drain rigs	20
Track machines	20

Onsite Machinery	Fuel consumption (L/hr)
Tugs for barge	50
Utility vehicles	10
Workboats	50

Capital Dredging

Of the four emissions sources listed in Table 13.1, capital dredging contributes the most greenhouse gas emissions. The energy intensity of the dredging machinery is a key factor driving this (refer to Table 13.4). The majority of emissions from capital dredging works are from Stages 1 and 3, where the channel is widened and deepened. The dredging machinery that accounts for the most greenhouse gas emissions are the hopper barges due to the number required as well as being required over most of the project duration to support the mechanical dredging operations.

Despite the small Trailer Suction Hopper Dredge having the greatest fuel consumption, it contributes less total greenhouse gas emissions than either the hopper barges or the mechanical dredge because it is working for far fewer hours in total (dredging work will be approximately 6 months).

Table 13.4 Dredging machinery fuel consumption rates

Dredging Machinery	Fuel consumption (L/hr)
Hopper barges	200 and 250
Large mechanical dredge	215
Small hopper barges	125
Small mechanical dredge	107.5
Small Trailer Suction Hopper Dredge	1,500
Small tug	50
Survey boat	50
Work boat	50

Embodied Energy Emissions

Embodied energy emissions are those released during the production and manufacture of construction materials. These emissions are mainly associated with the construction of structural elements of the Project, particularly wharves and other landside and terminal infrastructure. Geotextile, concrete and steel were the construction materials considered in this greenhouse gas emissions assessment.

Table 13.5 shows the emissions associated with each of these materials for each stage of the Project. Steel is the primary source of embodied energy emissions. This is due to both the quantities of steel required and steel's high emissions intensity (2.23 tonnes CO_{2-e} / tonne) compared to concrete (0.209 CO_{2-e} / tonne). Emissions from embodied energy will be greatest for Stages 2 and 3, mostly due to the development of wharves for Berth 14, Berth 15 and Berth 16 in Stage 2 and Berth 17 and Berth 18 in Stage 3.

Table 13.5 Embodied energy emissions by stage

Stages	Emissions (t/CO _{2-e})			
	Stage 1	Stage 2	Stage 3	Total
Geotextiles	268	172	0	440
Concrete	3,662	12,088	8,728	24,478
Steel (reinforcement and piles)	8,474	27,875	20,293	56,642
Total	12,404	40,135	29,021	81,560

Emissions Intensity

The emissions intensity of each stage of the Project is directly associated with the intensity of construction activities. Stage 3 is likely to be the most emissions intensive stage with approximately 30% of Stage's emissions due to capital dredging. Table 13.6 below shows the overall stage duration, total emissions and approximate emissions intensity of each Project stage.

Table 13.6 Emissions intensity by each construction stage

Stage	Construction Start Date	Stage Duration (years)	Total Emissions (t/CO ₂ -e)	Emissions Intensity (t/CO ₂ -e /year)
1	2017	4.5	94,126	20,916
2	2023	4.5	105,684	23,485
3	2030	2.5	90,714	36,285

AEIS and EIS Greenhouse Gas Emissions Profile comparison

Predicted emissions from the construction phase of the PEP have changed due to the design refinement. Table 13.7 compares the previous greenhouse gas emissions with the re-assessed emissions produced from each source in the construction phase.

Table 13.7 Comparison of EIS and AEIS Greenhouse Gas Emissions for the Construction Phase

Scope	Source of Emissions	t/CO ₂ -e		
		EIS	AEIS*	% Change
1	Transportation of materials	39,788	46,369	17%
1	Onsite machinery	31,555	74,847	137%
1	Capital dredging	80,591	87,748	9%
3	Embodied energy emissions	85,940	81,560	-5%
	Total	237,874	290,524*	+22%

*Changes to the emissions factor for diesel fuel resulted in overall AEIS emissions being 8% higher than the EIS (refer to Errata List Appendix C3).

Overall the design change is anticipated to increase greenhouse gas emissions. The increase from the EIS is approximately 22%, with the largest changes in emissions originating from the transport of materials to site and in onsite machinery. Changes to emissions from each source are explained below.

- Emissions from **transportation of materials** to the site have increased from the EIS by approximately 17%. Construction of the larger reclamation area requires additional good quality material for capping and pavements to be transported to the larger reclamation area from onshore sources.
- **Onsite machinery** emissions have increased substantially, by 137%. The expansion of the reclamation area, from approximately 100 ha to approximately 150 ha, requires more trips by onsite machinery to deliver material to the reclamation area, increasing overall emissions.
- **Capital dredging** emissions have increased, by approximately 9%. Capital dredging works are taking place over a longer period of time, requiring more energy consumption from dredgers. Additionally, as all dredging material is being delivered to the reclamation area, more delivery of dredged material via hopper barges will be required.
- **Embodied energy emissions** have reduced by 5%. This is because the total provision of berth length has reduced by approximately 6% since the EIS following the inclusion of Berth 12 in the Project.

Figure 13.1 provides a breakdown by source of greenhouse gas emissions from the construction phase for all stages of the PEP.

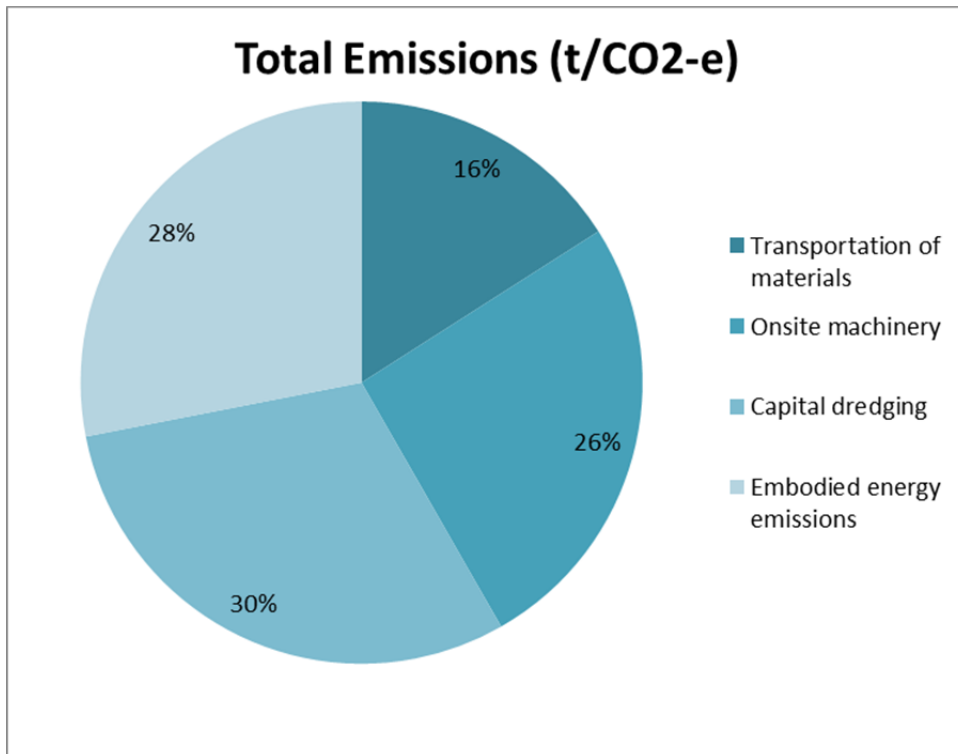


Figure 13.1 AEIS Greenhouse Gas Emissions from the Construction Phase by Source

13.3.4.2 Mitigation measures

There has been no change to the mitigations measures as a result of the AEIS. Mitigation measures to reduce the impact of greenhouse gas emissions from the construction and operation of the PEP are outlined in the updated Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3).

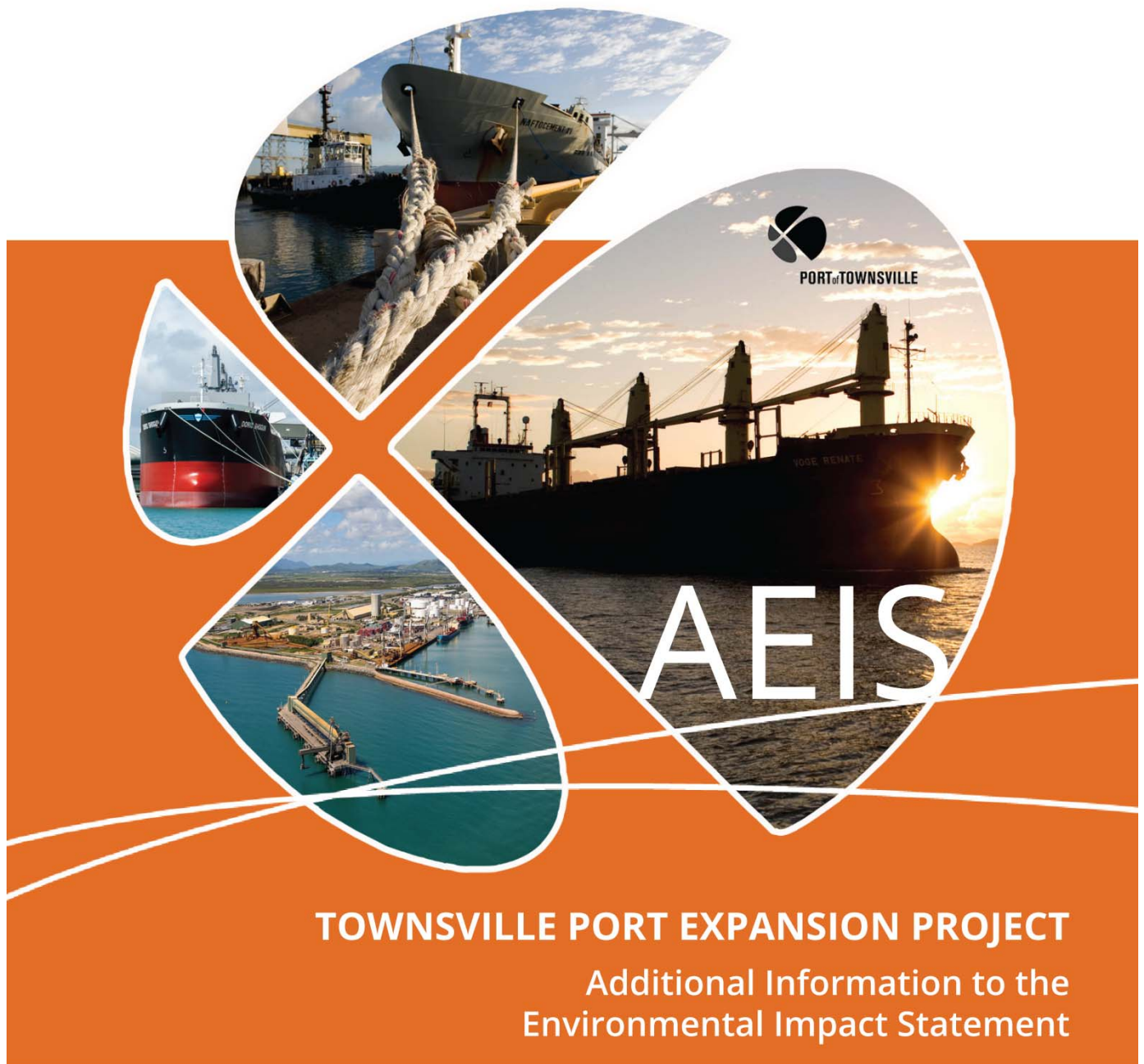
13.3.5 Summary

Greenhouse gas emissions have increased compared to the EIS as documented in the revised assessment. Whilst the greenhouse gas emissions have increased in scale, the mitigation measures provided in Section B.11.5 of the EIS remain relevant for the revised design.

13.4 Conclusion

The design refinement is anticipated to increase greenhouse gas emissions by approximately 22% compared to the EIS, with the largest changes in emissions originating from onsite machinery as a result of the larger reclamation area. Whilst the greenhouse gas emissions have increased in scale, the mitigation measures provided in the EIS remain relevant for the revised design.

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SECTION 14

Waste



14.0 Waste

14.1 Introduction

Waste management associated with the Port Expansion Project (PEP) is described in Chapter B.12 (Waste) of the Environmental Impact Statement (EIS). The construction and operation of the PEP will generate a variety of waste that requires appropriate storage, handling and disposal management to reduce impact to the environment, community and port users. The Port of Townsville Limited (POTL) manages waste in the common areas of the Port under its existing Environmental Management System. Existing and future port tenants are required to implement waste measures prior to commencing individual operations.

This section provides information to address submissions received in response to the EIS, relevant to waste and the implications of the revised design on these values. Key matters raised from the submission process include:

- clarification about the role of Townsville City Council's waste management network in managing saline discharges and waste from vessels
- a request for more detailed information on hazardous materials proposed to be stored on site.

14.2 Response to Submissions

14.2.1 The role of Townsville City Council's waste management network in managing saline discharges and waste from vessels

Additional information was requested by two submissions regarding the waste management network. Measures to manage waste generated by the PEP and port tenants are described in Section B.12.5.2 of the EIS and further discussed below.

Townsville City Council requested further information regarding wastes discharged into the sewerage network, including saline discharges. The type of wastewater discharge proposed as part of the PEP construction and operation is comparable to other POTL reclamation projects such as the Townsville Marine Precinct and is not proposed to include significant volumes of saline discharges.

Wastewater discharge generated by construction and operational activities associated with the PEP will be received within Townsville City Council's sewerage infrastructure and treated at the Cleveland Bay Wastewater Treatment Facility, in accordance with the infrastructure planning studies carried out by Townsville City Council, and existing Port practices.

Occasionally military vessels that visit Townsville have saline wastewater systems. These vessels are required to discharge saline wastewater to the Townsville City Council sewerage network while berthing at the Port. To minimise the impacts of these discharges on the Cleveland Bay Wastewater Treatment Plant, the effluent is diluted where possible by mixing with other flows.

Ballast water discharge from vessels is managed by individual ship operators under the controls of the Commonwealth Department of Agriculture and Water Resources. All international vessels operating in Australian waters, including the Great Barrier Reef Marine Park, must manage their ballast water in accordance with Commonwealth requirements. These vessels must exchange ballast water for clean water from the deep ocean prior to entering Australian waters. All discharge activities at berth must be undertaken in accordance with State and Commonwealth requirements and regulations.

The Great Barrier Reef Marine Park Authority requested consideration of shore-based reception facilities for ship generated waste. POTL is responsible for the management of waste generated by construction and operational activities under its direct control. Individual port tenants are responsible for negotiating individual trade waste agreements with licenced contractors to remove site generated wastes (excluding sewage) and for arranging the removal of regulated waste to a licensed reception facility as well as adhering to the relevant regulatory requirements regarding the disposal of quarantine wastes. Quarantine wastes from vessels must be removed and treated in line with strict national guidelines.

14.2.2 Detailed information on hazardous materials proposed to be stored on site

The Department of Environment and Heritage Protection requested detailed information on the hazardous materials to be stored and / or used on the PEP including environmental toxicity data and biodegradability.

The types of hazardous materials that will be used during the construction of the PEP will be typical of a large infrastructure project. Whilst detailed information on hazardous materials is not available at the current design stage, all hazardous materials to be used during construction of the PEP will be identified prior to commencement, and appropriate storage facilities will be established (where required) in accordance with regulatory requirements.

All hazardous materials used or stored on site under POTL control will be added to the hazardous materials register along with appropriate safety data sheets. Hazardous materials will be handled, used and disposed of in accordance with the safety data sheets and only handled by personnel trained in their appropriate use and handling.

Tenants and port operations outside the control of POTL will be responsible for the safe handling and storage of hazardous materials in their leased areas, in accordance with POTL procedures and regulatory requirements. POTL currently undertakes regular inspections of POTL controlled port operations to ensure compliance. This will be extended to include PEP construction and operation activities.

14.3 Revised Environmental Impact Assessment

14.3.1 Legislation and policy

The *Environmental Protection (Waste Management) Regulation 2000* was repealed on 29 August 2014. A number of provisions from the regulation were retained to maintain an appropriate level of management proportionate to the risk associated with waste. Amendments were made to the *Environmental Protection Regulation 2008* to give effect to the transfer of retained provisions from the expiring Regulation in relation to waste tracking.

The *Environmental Protection and Other Legislation Amendment Act 2014* partly commenced on 30 September 2015. This Act includes provision to amend the *Environmental Protection Act 1994* and the *Environmental Protection Regulation 2008*. Some of the amendments have not yet commenced as necessary implementation arrangements need to be completed or appropriately coordinated. With regards to the PEP waste management, the *Environmental Protection and Other Legislation Amendment Act 2014* replaces the existing beneficial use approval approach in the *Waste Reduction and Recycling Act 2011* with 'end of waste codes and approvals'. This will help meet increased 'resource productivity' set out in the Queensland waste and recycling strategy.

Updates to the legislation and policy in relation to waste do not impact on the assessment presented in the EIS or the refined design.

14.3.2 Design refinement

The revision focusses on amendments to the extent of dredging and reclamation works, however, it does not alter waste management associated with the PEP.

14.3.3 Supporting studies

No additional studies were required to assess the revised design and address submissions received from respondents.

14.3.4 Revised assessment

14.3.4.1 Impact assessment

The impacts of waste generated by the Project are consistent with that identified in Section B.12.4 of the EIS.

14.3.4.2 Mitigation measures

Waste will be managed through the implementation of the waste management hierarchy detailed in B.12.5 of the EIS. As a part of implementing the waste hierarchy mitigation measures identified in Table 14.1 and Table 14.2 will be put in place over the construction and operation of the Project.

Mitigation measures are also outlined in the existing Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3). The POTL Environmental Management System will be updated to accommodate wastes likely to be generated by the PEP.

14.3.5 Summary

A summary of the mitigation measures proposed to reduce impacts of the Project associated with waste generation is presented in Table 14.1 and Table 14.2.

The main construction works for the PEP relate to building revetments, undertaking dredging works for channel improvements and land reclamation. These types of construction works do not generate large volumes of waste. As a result Table 14.1 relates to secondary wastes from associated construction activities, such as temporary construction facilities. Table 14.2 details wastes from typical port operational activities.

Table 14.1 Construction Phase - Mitigation Measures

Waste	Mitigation Measures
Concrete and bricks	- Provide separate stockpile for waste concrete or brick products to avoid contamination with any other waste stream assisting its potential re-use. - Re-use onsite as hard fill. - Removal to recycling facility.

Waste	Mitigation Measures
Timber	- Provide separate stockpile or bin. - Use excess or waste timber in other construction processes where possible.
Pavement and asphaltic products	- Provide appropriate bunded and covered locations for the storage of asphaltic products. - Re-use excess products either on or off site or dispose of appropriately.
Metals	- Provide separated stockpile or bin for storage, one for each ferrous and nonferrous metal. - Remove to recycling facility.
Hydrocarbons, chemicals and other liquids (excluding sewage)	- Provide specific waste bins/receptacles to isolate liquid wastes. - Provide onsite storage and handling compatible with local recycling facilities to separate recyclable waste from non-recyclable waste. - Avoid comingling with other waste streams. - Store in appropriately bunded area.
Sewage	- Work with licensed contractor to accurately determine the number of temporary ablution facilities required during the construction phase. - Sewage to be removed via a temporary connection to reticulated waste water system if possible.
General office waste	- Provide facilities for the appropriate separation of wastes for recycling. - Engage licensed waste contractor to regularly remove and dispose of waste at licensed facilities and maintain waste disposal areas. - Educate staff to reduce waste. - Where possible source materials from suppliers who participate in the Australian Packaging Covenant. - Implement recycling and reuse industry practice procedures where practical. - Storage in sealed bins to reduce vermin attraction. - Store and remove garbage to minimise pest attraction and breeding potential.
Hazardous and potentially hazardous waste	- Maintain inventory and material safety data sheets for hazardous substances. - Store in appropriately bunded area. - Bring only the minimum required amount of any substance required by construction activities to site. - Store drums and storage containers when empty or containing residual amounts of substances in bunded area. - Collect empty drums for re-use or recycling.

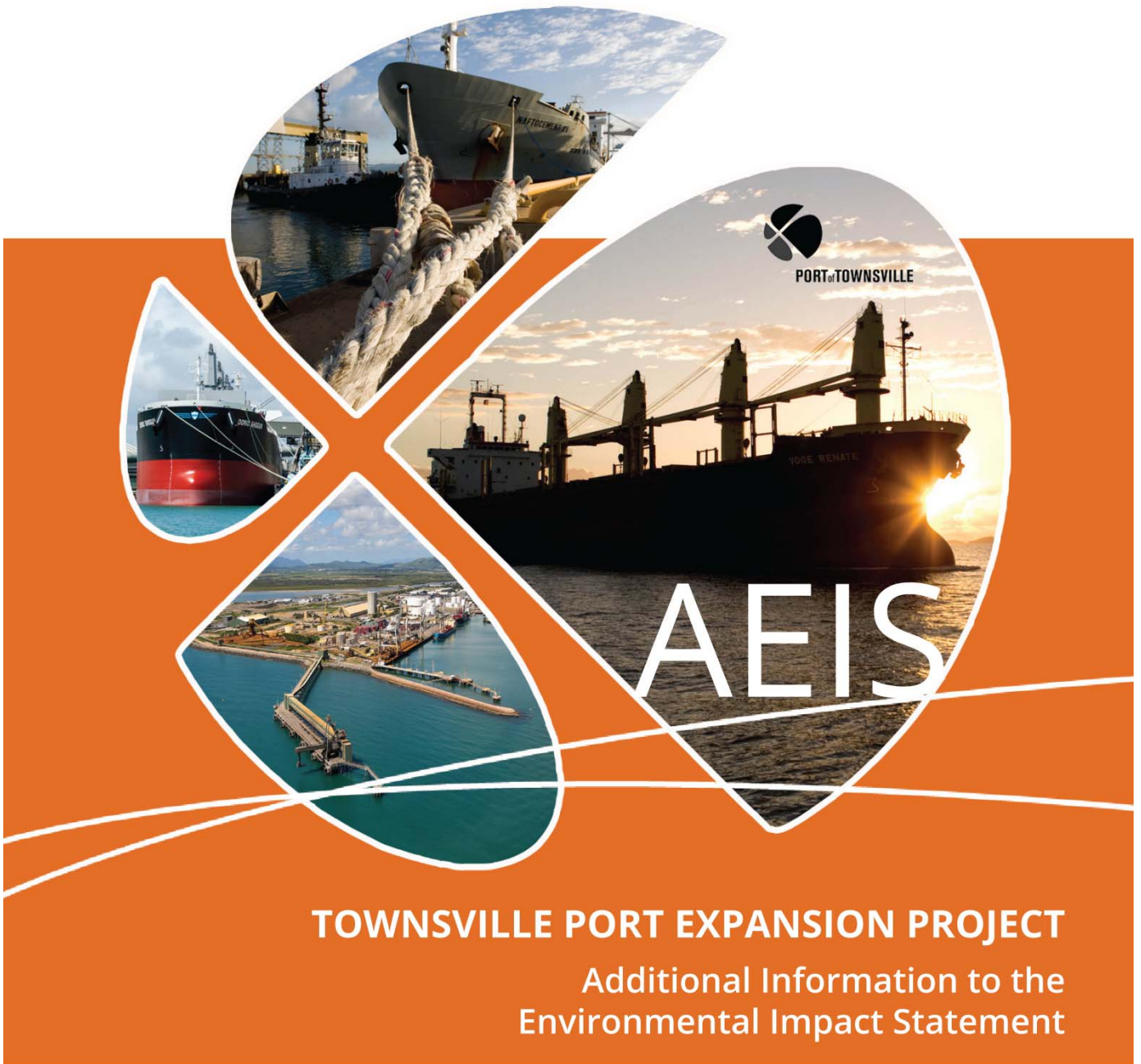
Table 14.2 Operational Phase - Mitigation Measures

Waste	Mitigation Measures
Garbage	- Identify specific waste management locations in the Project Area during detailed design. Supply designated collection bins or other appropriate containers to facilitate segregation and encourage waste recycling or re-use. Use internationally recognised signage. - Keep loose waste and bins covered to secure waste to prevent wind, rain or animals spreading litter or contaminants through the port. - Maintain the Project Area in a clean and tidy manner and progressively remove waste from site and do not allow to stockpile. - Collect and dispose wastes from ships (liquid and other) by licensed contractors and at licensed waste disposal facilities. - Remove any trade or regulated waste by a licensed trade waste contractor to a licensed reception facility. - Store and remove garbage to minimise pest attraction and breeding potential.
Wastes from commercial cargo activities (incidental waste, spills etc.)	- Transport cargos in correct containers, which are maintained and handled in accordance with industry and manufacturer standards. - Operators to implement appropriate training for staff involved in the handling of cargo.
Hydrocarbons, chemicals and miscellaneous liquid wastes	- Handle liquids in accordance with the appropriate material safety data sheets and manufacturer specifications. - Transport and store chemicals in containers fit for purpose. - Use spill kits to address spills as necessary. - Call emergency services to assist with hazardous material spills.
Sewage	- Dispose greywater and sewage from the Project Area to the Townsville City Council local sewerage system. Prior to finalisation of the PEP design, provide Townsville City Council with likely flow volumes and trunk connection points for water and sewerage and undertake a network analysis to assess potential impacts on existing infrastructure. - Individual port tenants to negotiate trade waste agreements with licensed contractors for removal of wastes not able to be disposed of to the domestic sewerage infrastructure.

Waste	Mitigation Measures
Hazardous waste	- Port tenants to develop and maintain a complete inventory, including materials safety data sheets, of chemicals to be used on their respective sites. Store chemicals and fuels, including empty drums, in appropriately banded areas in accordance with relevant regulations. Keep the volumes of chemicals/fuels on site to a minimum. Remove waste chemicals and fuels from the site by licensed waste contractors to approved waste facilities. - Handle and dispose any contaminated material in accordance with legislative requirements.
Quarantine waste	- Record the movement and quantities of regulated and quarantine wastes. - Ships berthing at the Port of Townsville to adhere to relevant MARPOL annexes and other legislative requirements with regard to the disposal of quarantine wastes.

14.4 Conclusion

The PEP will generate waste associated with construction and operational activities. With the implementation of mitigation measures presented in the EIS and also provided in Table 14.1 and Table 14.2, the potential impact to the environment, community and port users, from waste will be appropriately managed.



SECTION 15

Social



15.0 Social

15.1 Introduction

Social values relevant to the Project area and surrounds are discussed in Chapter B.13 (Social Environment) of the Environmental Impact Statement (EIS). The Port has played a significant role in the economic development of Townsville and a significant role in supporting much of the prosperity in the region by providing product access to larger markets overseas and interstate.

The principal benefits of the Port Expansion Project (PEP) are expected to primarily result from the strengthening of Townsville's job and housing markets through additional direct and indirect employment provided by the PEP. Further indirect social benefits are expected to result from increased trade potential through greater port capacity resulting from the PEP.

This section provides information to address submissions received in response to the PEP EIS relating to social impacts.

Key matters raised from the submission process include:

- Indigenous employment opportunities
- adequacy of public consultation
- social impacts on Magnetic Island
- loss of business and tourism on Magnetic Island
- potential impacts on recreational fishing activities and publicly accessible areas
- impacts of PEP works and ongoing dredging on The Strand.

15.2 Response to Submissions

15.2.1 Indigenous employment opportunities

The Department of Aboriginal and Torres Strait Islander and Multicultural Affairs requested clarification on the Indigenous employment figures presented in the EIS. Section B.13.3.1 of the EIS identified the social and cultural areas of influence affecting the Project at the local, district, regional and state levels. The social impact assessment in the EIS was undertaken based on these study areas (refer to Figure 15.1). The Regional Study Area included the local government areas of Townsville, Hinchinbrook, Burdekin, Charters Towers, Palm Island, McKinlay, Richmond, Flinders, Cloncurry and Mount Isa. The District level is represented by the Townsville local government area. The Local Study Area included the Project area, the existing port and surrounding suburbs of South Townsville, parts of Railway Estate and Magnetic Island. The Local Study Area does not include Palm Island; however Palm Island and other suburbs of Townsville were included within the Regional Study Area.

The proportion of the Indigenous population of the District Study Area and Local Study Area is estimated to be approximately 6.1% and 4.9% of the total population (based on Queensland Treasury and Trade, *Queensland Regional Profiles – Townsville City Local Government Area*, February 2015). In comparison, this is higher than the estimated Queensland proportion of 3.6% for the same period. The Indigenous population on Palm Island is estimated at 2,203 persons representing 94.3% of the total population of the island. The figures are based on 2011 ABS Census figures adjusted by additional Queensland Treasury and Trade information.

The ABS 2011 Census Community Profile figures for Townsville shows the estimated available Indigenous labour force for the District Study Area (i.e. Townsville) was approximately 4,333 persons; Townsville labour in comparison estimated approximately 111,737 persons at the time of the Census. Based on the 2011 Census figures, the available Indigenous labour force represents approximately 3.9% of the total Townsville labour force. The Port's ongoing commitment to promote at least 10% Indigenous employment for capital projects is both the statutory requirements and is higher than the comparative proportion of the available Indigenous labour force across Townsville, based on the 2011 Census figures.

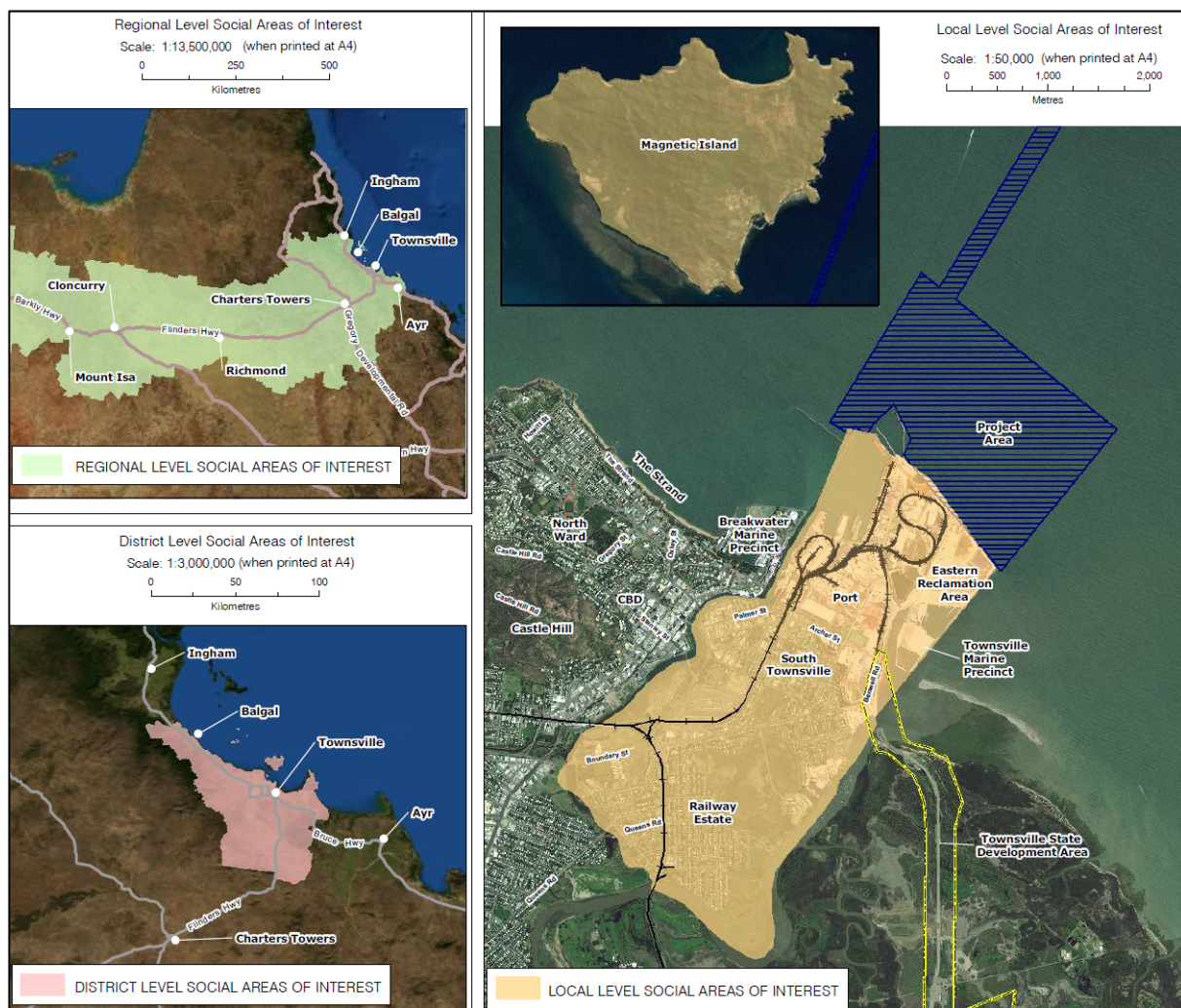


Figure 15.1 Regional, District and Local Study Areas

The Department of Aboriginal and Torres Strait Islander and Multicultural Affairs also requested further information regarding POTL's Local Industry Participation Plan. The Port has a strong commitment to Traditional Owner engagement and employment for its projects and encourages a similar approach from its contractors. The PEP will be developed in line with Commonwealth and State government requirements for equal opportunity employment.

Apart from statutory obligations and its Local Industry Participation Plan, POTL commits to ensuring that the community will be adequately informed of upcoming employment opportunities associated with the PEP. This is to ensure the Local Industry Participation Plan is implemented and to provide an opportunity for other businesses in the Regional Study Area to leverage opportunities that will arise through the PEP.

A submission by the Townsville City Council (TCC) requested the TCC Reconciliation Action Plan (RAP) 2013 be considered in the assessment. The RAP represents the council's commitment to Aboriginal and Torres Strait people within its community. The RAP is a specific operational document that TCC can use to guide actions and interactions within the community and is consistent with other legislative requirements, this plan has been considered and POTL's approach is aligned as outlined below.

The Port has a number of policies and practices (including the POTL Cultural Heritage Management Plan) that are specifically intended to ensure Aboriginal and Torres Strait Islanders have access to employment at the Port and are effectively consulted as part of the Port's planning processes. This includes a range of affirmative employment actions under State policies and extends to the PEP. In this regard the framework for Aboriginal and Torres Strait Islander interaction is aligned and is consistent with the vision of the council's RAP.

15.2.2 Adequacy of public consultation

TCC requested further information regarding the public consultation undertaken for the EIS. Details of the public consultation for the PEP EIS are outlined in Section A.2.5 of the EIS and Section 1.0 of the Additional Information to the Environmental Impact Statement (AEIS). Public consultation was undertaken during and prior to the preparation of the PEP EIS in accordance to requirements of the Commonwealth EIS Guidelines issued under the *Environment Protection and Biodiversity Conservation Act 1999* and the Queensland Government Terms of Reference issued under the *State Development and Public Works Organisations Act 1971*. As a part of the public consultation period in conjunction with the release of the EIS, the following was undertaken:

- staffed public information displays on Magnetic Island and in South Townsville
- letter box drop
- soft copies available on websites
- CD's posted on request
- advertising to promote information displays in the local media
- stakeholder and regulator briefings as required
- static displays at Townsville City Council Library/Council Customer Service Centres and Magnetic Island Country Club
- Project hotline, Project email address and reply paid postal address
- communication information on POTL website
- email updates to all registered database stakeholders including elected representatives, primarily stakeholders, special interest groups and the community.

Section A.2.5.1.1 provides a consultation overview. Formal consultation commenced July 2011 and concluded with the release of the Terms of Reference in October 2011. This preliminary consultation was undertaken to inform stakeholders of the Project and identify matters for inclusion in the EIS. The preliminary consultation did not target specific groups (e.g. Aboriginal and Torres Strait people or people with disabilities) but was sufficiently broad and open to any person who wished to participate.

One submission also raised the opportunities for itinerants visiting to the region to participate in the consultation process for the EIS. As identified above, consultation was undertaken in accordance with the requirements and relevant legislation which prescribed the process to provide opportunities for community involvement and awareness. As well as local interest, a number of tourists also participated in the public consultation process, through visiting the staffed public information display at Magnetic Island. As well as meeting statutory obligations, the response from submitters outside of the immediate Townsville area, including submitters from interstate and overseas, illustrates that the public consultation has been far reaching.

15.2.3 Social impacts on Magnetic Island

227 submissions (includes form letter submissions) raised the potential effects of the PEP on the lifestyle, amenity and social character of Magnetic Island. The social characteristics of Magnetic Island were incorporated in the social baseline study referred to in Section B.13.3.1.4 of the EIS which identified Magnetic Island as a part of the Local Study Area as well as the suburbs of South Townsville and Railway Estate.

The social baseline study included an assessment of population and households, labour force, housing and accommodation, socio-economic indices for areas, and population and community profile projections. Specific technical aspects which may also have social effects were further assessed in other chapters. This included land use impacts, visual impacts, noise, traffic, ecological effects and marine based effects.

Specific reference was given to Magnetic Island where potential direct impacts could be identified and where there was sufficient quantitative or qualitative data available to attribute impacts to specific communities on Magnetic Island or other locations. Potential impacts on people travelling to and from Magnetic Island by public ferry were also considered. Community views and expectations were also surveyed and collated as background information to support the preparation of the EIS. This was undertaken during the early phases of the EIS process and included community information sessions with Magnetic Island residents, distribution of survey forms and the establishment of a Project information hotline.

A universal aspect of the form letters was the potential impact of the PEP on lifestyle, amenity and social character of Magnetic Island however no specific action, activity or method of mitigation was suggested in the majority of these submissions. These values were recognised in the EIS and significant work undertaken in the supporting studies to ensure the dredging impacts can be suitably managed and mitigated. The design refinement subsequently undertaken in response to submissions and legislative change further reduces dredging impacts with all material placed in the reclamation and a large proportion of the dredging being undertaken by a mechanical dredge. Whilst this requires substantially longer dredging period, and longer period where a dredge can be viewed, this results in a

significantly smaller turbidity plume and protection for the sensitive environments and embayments around Magnetic Island. The Port is committed to ongoing community engagement with Magnetic Island residents and businesses to facilitate a mutual understanding, and to proactively identify any social impacts as a result of the PEP, should they arise.

These submissions also raised the impact the PEP may have on the lifestyle and amenity of the Magnetic Island community. Section B.13.4 of the EIS assessed different aspects of lifestyle for the Local Study Area. The lifestyle of the surrounding area (including Magnetic Island) is diverse, and is influenced by the natural and built landscape, types of activities that can be accessed (e.g. work, recreation, home-living, education and social) and community perceptions about the values that such lifestyle experiences potentially offer.

Chapter B.10 (Noise and Vibration) and Chapter B.17 (Scenic Amenity) of the EIS addressed noise and light impacts of the PEP. As a result of the revised design these assessments were updated and provided in Section 12.0 and 19.0 of the AEIS respectively. Noise and light impacts associated with the construction and operation of the PEP are not expected to adversely affect Magnetic Island residents. Adverse impacts on community well-being, including community and lifestyle values were identified as being important during the pre-consultation phase of the PEP. After the implementation of mitigation measures, it was determined the residual impact on lifestyle and community wellbeing will remain low. The impact to community wellbeing and lifestyle are not expected to differ from that identified in the EIS.

The Port has been a significant part of the Townsville and Magnetic Island landscape for 150 years. This has included significant periods of development and residential growth around the Port including on Magnetic Island and along the foreshores that have direct views of the Port. Townsville Port is identified as a Priority Port for Queensland and as the northern most of the four priority ports needs to service the North Queensland economy to keep the jobs, developments and goods in our region for our region.

Indirect effects are expected to be beneficial through increased trade capacity at the Port, which in turn is expected to contribute to economic growth within the region. Economic growth may lead to an increase in population, a potential increase in visitors to Magnetic Island and diverse employment opportunities within the region. This latter aspect may provide for greater population stability on Magnetic Island for people dependent on employment opportunities, including opportunities on the mainland. This is expected to increase employment opportunities and the ability to support additional services to the area. Increased economic activity and employment prospects are regarded as being synonymous with improved community prosperity and well-being.

Additional assessments have been undertaken as part of the AEIS and in response to submissions, and to consider the design refinement, including:

- Section 5.0 (Coastal Processes and Hydrodynamics)
- Section 6.0 (Marine Water Quality)
- Section 8.0 (Marine Ecology)
- Section 11.0 (Air Quality)
- Section 12.0 (Noise and Vibration)
- Section 16.0 (Traffic and Transport)
- Section 19.0 (Scenic Amenity)
- Section 21.0 (Economic Development)
- Section 25.0 (Cumulative Impacts)
- Section 26.0 (Outstanding Universal Value).

15.2.4 Loss of business and tourism on Magnetic Island

232 submissions (includes form letter submissions) were received regarding the potential effects of dredging on tourism in the surrounding suburbs, particularly Magnetic Island. More specifically, the impact of dredging was raised, on peak tourism periods, notably as a result from potential increases in water turbidity resulting from dredge activity. It was raised that this may potentially result in adverse economic effects which may further translate into broader adverse social effects on residences and businesses, including potential loss of income and loss of employment opportunity.

The economic and tourism values of the surrounding suburbs and broader Townsville region, and the impacts of the PEP on these values are addressed in Chapter B.19 (Economic Environment) of the EIS and Section 21.0 of the AEIS. The PEP will not limit the operation of existing land uses on the mainland or Magnetic Island. This includes access to public areas which may be used for recreational purposes, with the exception of the immediate proposed dredge operations in keeping with maritime legislation safety requirements.

To consider the potential impacts that the PEP could have on tourism operators on Magnetic Island an assessment was carried out focusing on the tourism operators who utilise the foreshore and fringing reefs as the basis of their operations. In order to translate the projected environmental impacts to Sensitive Environmental Receptors into estimated economic impacts to tourism operators, factors to convert marginal ecological impacts to marginal costs are required. The objective of this calculation is to provide a first-order estimate of the monetised impacts to vessel-based snorkelling and boat tour operators on Magnetic Island.

The assessment estimated a potential monetised impact to tourism operators if tourism operators were to be impacted, and concluded that if such short-term changes in turbidity at the most popular snorkelling and diving operations was identified as being caused by the major capital dredging, then the monetised calculations could form an estimate of financial impacts.

The Port is committed to ongoing community engagement with Magnetic Island residents and businesses to facilitate a mutual understanding, and to proactively identify any social impacts as a result of the PEP, should they arise.

15.2.5 Potential impacts on recreational fishing activities and publicly accessible areas

14 submissions raised potential effects of dredging on marine water quality and marine ecology within Cleveland Bay and the subsequent effects this may have on recreational fishing and public use of foreshore areas. Key areas included the use of Cleveland Bay waters and foreshore areas, including around Magnetic Island. The likely impacts on marine water quality and marine ecology have been the subject of further study which is discussed in Sections 6.0 and 8.0 of this AEIS.

Access to Cleveland Bay and foreshore areas is not expected to vary from the present situation. Historically, the Port has been operating with navigation and security control restrictions within port lands and port infrastructure. Access to Port land is also subject to existing restrictions precluding general public access. The PEP is entirely within the designated Port limits and is generally consistent with the intended use of the designated area under the *Port of Townsville Land Use Plan 2013* (POTL, 2013).

The use of the Cruise Ship Terminal, which opened in October 2013 and is an integral part of the Port's ongoing operations, will not be affected by the PEP other than a potential increase in tourists facilitated through improved channel access allowing more cruise ship visits. Existing public access to foreshore land along Ross Creek is proposed to remain and is not expected to be affected by the PEP. Overall public access to foreshore areas and Cleveland Bay waters is not expected to significantly change as a result of the PEP.

15.2.6 Impact of PEP works and ongoing dredging on The Strand

Seven submitters raised the potential impact of the PEP and maintenance dredging on the social values of The Strand. The PEP includes expansion of the existing Port facilities in keeping with the growth needs of Townsville and the region. Growth has been ongoing since the Port's establishment which has become part of the industrial waterfront development of Townsville and forms a key part of the city's social history and its built landscape character. This includes the views and vistas that are enjoyed from The Strand. Scenic Amenity is discussed in Section 19.0 of the AEIS and while the Port forms a prominent part of the Cleveland Bay landscape, when viewed from The Strand, it only represents a small part of the overall expanse of the view and its proposed expansion has been shown to represent only a minor increase in its prominence, once completed.

The proposed construction of the PEP, including dredging works for the reclamation area and channel improvements is expected to have a gradual impact on the changing landscape of Cleveland Bay. Potential sediment transport impacts on The Strand from dredging operations are discussed in Section 5.0 of the AEIS. Construction works for the PEP is not expected to affect the recreational use or public access of The Strand foreshore or beaches.

15.3 Revised Environmental Impact Assessment

15.3.1 Legislation and policy

There have been no significant changes in the legislation or policy frameworks that directly relate to social considerations of the PEP. The Queensland government has introduced a range of land use planning policies since the PEP EIS. These recognise the Ports positive role in the economic development of the region and the need to keep pace with demand and future development as demonstrated by Townsville being declared a priority port. This is specifically intended to support the social structure of Townsville and North Queensland through the provision of greater employment opportunity, increased access to goods and additional investment into the region.

Social characteristics of Townsville and the region are generally also determined by demographic characteristics as recorded by the ABS census and some State surveys compiled by the Queensland Government Statistician's Office (i.e. previously Office of Economics and Statistical Research (OESR)). The PEP EIS largely relied on ABS 2011 Census information supplemented by additional OESR updated predictions projections. Revised OESR information is available for the 2012 information that was used in the compilation of the social impact assessment that formed part of the EIS. A new census will be undertaken in 2016. While revised population projections are expected to reflect continued population growth within Townsville and the region, changes on Magnetic Island and the immediate

suburbs surrounding the Port are expected to be slight and unlikely to affect the PEP or substantially change its impact on those areas.

The EIS made reference to the *TCC City Plan 2005* at the time of its finalisation and formal public consultation stage. The City Plan 2005 was the statutory planning scheme that applied to the Project area at the time the EIS was completed and during the public consultation stage. The council has since adopted a new City Plan. Details regarding the new planning scheme are addressed in Section 3.0 of this AEIS. The PEP is consistent with the preferred planning outcomes in the new City Plan.

15.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. The revised design is not anticipated to materially change the impacts on social values described in the Section B.13 of the EIS.

15.3.3 Supporting studies

No additional social impact studies were undertaken.

15.3.4 Revised assessment

15.3.4.1 Impact assessment

The PEP is not expected to result in adverse social impacts during its construction or operation. The social values that characterise the Local, District and Regional Study Areas are not expected to change as a result of the revised design.

Minor impacts are predicted from temporary changes to water quality as a result of the dredge campaign, and land construction. Potential amenity impacts are also discussed in a number of AEIS sections relating to specific amenity aspects, including:

- Section 5.0 (Coastal Processes and Hydrodynamics)
- Section 6.0 (Marine Water Quality)
- Section 8.0 (Marine Ecology)
- Section 11.0 (Air Quality)
- Section 12.0 (Noise and Vibration)
- Section 16.0 (Traffic and Transport)
- Section 19.0 (Scenic Amenity)
- Section 21.0 (Economic Development)
- Section 25.0 (Cumulative Impacts)
- Section 26.0 (Outstanding Universal Value).

Positive social benefits are expected in terms of potential employment during construction and operation, as well as increased access to goods and additional investment into the region as a result of increased trade facilitation through the modernisation and expansion of the Port's facilities. This is highlighted in recent changes to Commonwealth and State policies which recognise the Port of Townsville as a key strategic port asset for the economic development of North Queensland and Northern Australia.

The revised design is consistent with the legislative and policy changes that affect other aspects of the Port's operation and future expansion. Notably, this includes potential influences on the social characteristics of the area, including employment opportunity, incomes and secondary investment and the attraction of other services as a result of economic growth facilitated by the Port's expansion.

15.3.4.2 Mitigation measures

Mitigation measures to reduce the impact on the Project on social and amenity values are outlined in the updated Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3) of the AEIS.

15.3.4.3 Summary

Section B.13.4 of the EIS provides a summary of the mitigation measures proposed to reduce potential impacts of the Project on the social environment. The revised design is consistent with the assessment provided in the EIS. Management of community impacts through the development and implementation of appropriate mitigation measures, including the development and implementation of an overarching Stakeholder Engagement Management Plan and continuation of the Port Community Partnership Forum (or similar), will provide a mechanism to identify, monitor and address social impacts as a result of the PEP, should they arise.

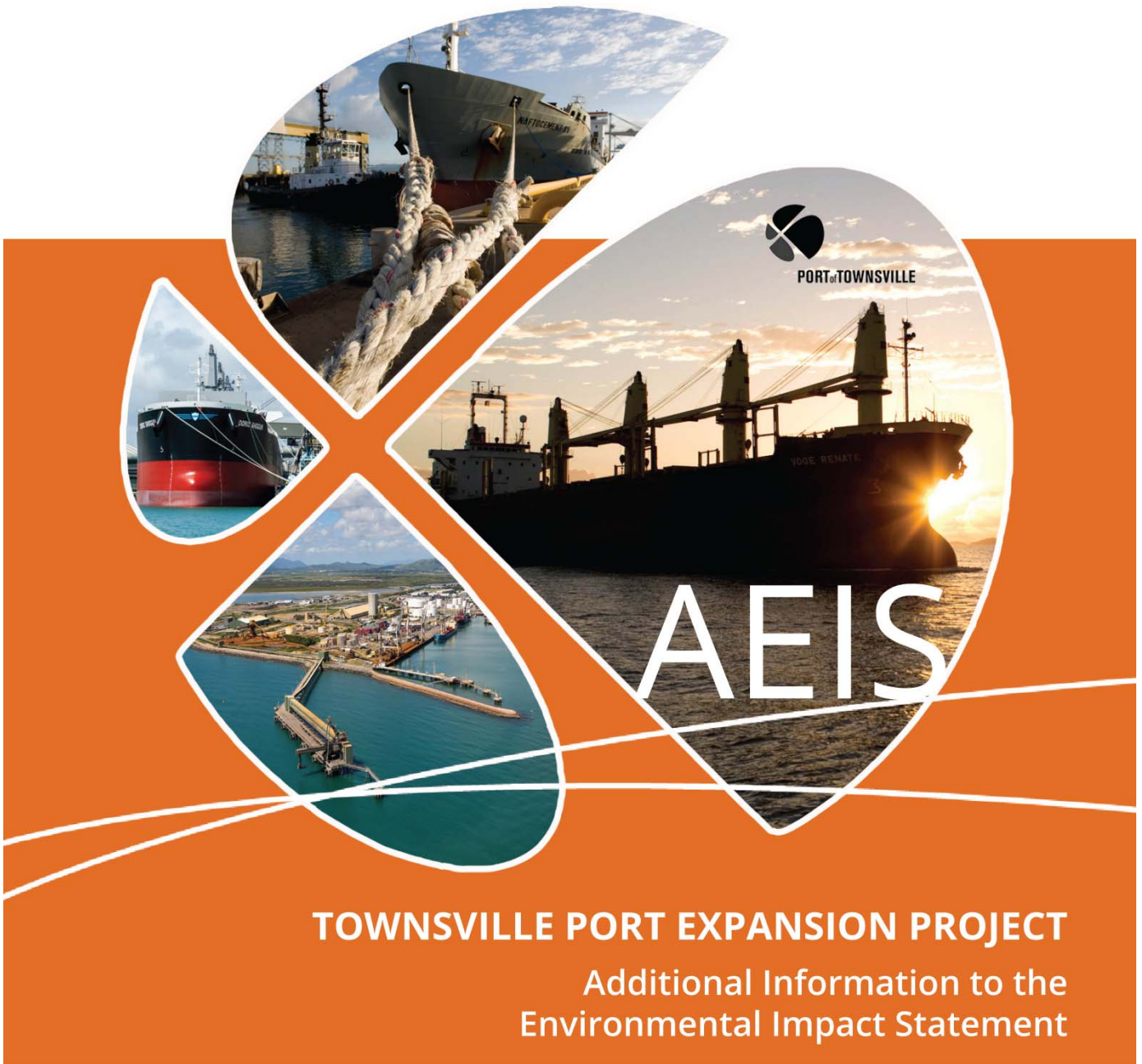
15.4 Conclusion

The revised design is consistent with the EIS assessment and consistent with policy frameworks at the Commonwealth and State level. The EIS found that overall the PEP is expected to have a range of positive social benefits at a regional, district and local level; it also identified the potential for temporary impacts on amenity values, mostly related to construction of the Project. This has been reflected in a number of the submissions received through the EIS process.

The positive economic impacts of the PEP are expected to provide a number of secondary benefits to the community, including Magnetic Island. In the short term the PEP will provide opportunities for new trades to utilise the Port, including larger cruise ships which are currently restricted from visiting Townsville. In the longer term the Project continues to support the development Northern Australia as one of Queensland's priority ports.

The Port is committed to ongoing community engagement with Townsville and Magnetic Island residents and businesses to facilitate a mutual understanding, and to proactively identify any social impacts as a result of the PEP, should they arise. Mitigation measures proposed in the EIS remain appropriate, as well as relevant, to current environmental protection requirements and the revised design.

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SECTION 16

Transport and Infrastructure



16.0 Transport & Infrastructure

16.1 Introduction

Transport and infrastructure requirements and impacts associated with the Port Expansion Project (PEP) are discussed in Chapter B.14 (Transport and Infrastructure) of the Environmental Impact Statement (EIS). The PEP will result in an increase in traffic associated with the transportation of plant, equipment, products, wastes, personnel, rock armour and core material from local quarries. With the implementation of mitigation measures the PEP is not expected to significantly impact upon existing transport infrastructure and networks.

This section provides information to address submissions received in response to the PEP EIS, relevant to transport and infrastructure. Key matters raised from the submission review process include:

- inclusion of detailed quarry locations and haulage routes in the assessment
- adequacy of pavement impact assessment
- adequacy of Traffic Operations Assessment
- impact to rail network and rail safety
- consideration of future development impacts
- inclusion of detailed public transport, parking and pedestrian facilities
- traffic related impacts on amenity.

16.2 Response to Submissions

16.2.1 Inclusion of detailed quarry locations and haulage routes in the assessment

Two submissions raised the impact of construction haulage activities on the existing transport networks. It was requested that quarry locations and the proposed haulage routes to the Port are identified and assessed.

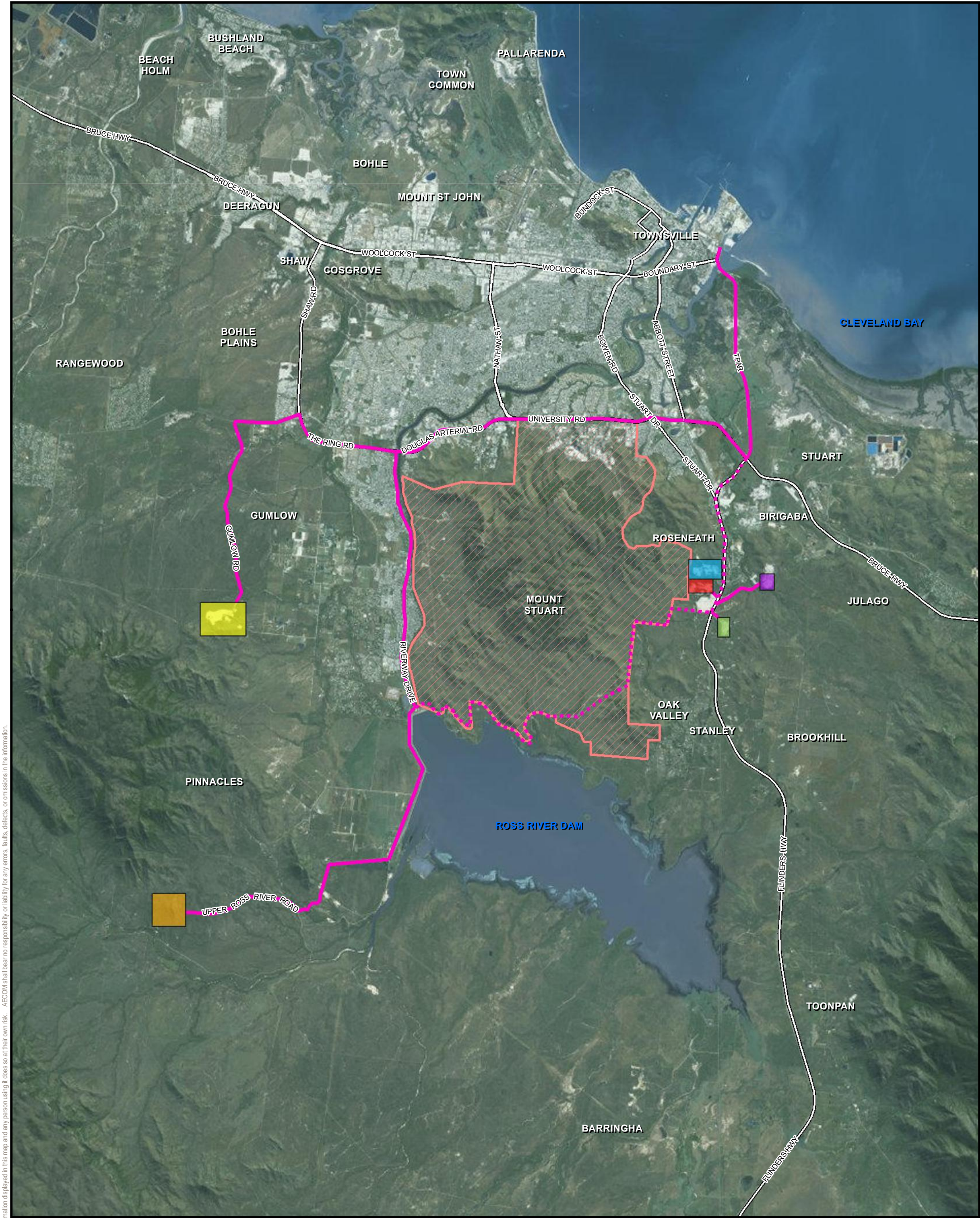
The preferred quarries for the construction of the reclamation and the associated haulage routes to transport this material to the Port is identified in Section B.14.3.2.4 of the EIS. These locations and haulage routes are indicative at this stage of the Project as a number of factors that influence route selection are subject to confirmation prior to the commencement of the revised staging. These factors include the individual annual quarry quantity limits, armour rock availability, Department of Transport and Main Roads (DTMR) proposed road works program, vehicle classifications constraints, existing pavement condition, and community expectations.

The proposed POTL Granitevale Quarry has been identified in the EIS as the primary source of armour rock for the PEP. Despite the expectation that the Granitevale Quarry will provide the majority of material, it is likely that there will be times that material will need to be supplemented by additional quarries in the region to avoid delays in the construction program. The EIS identified potential material sources adjacent to the Flinders Highway and west of the Ross River Dam. In addition to the Granitevale Quarry, these sources include:

- Holcim Quarry
- Hanson construction materials
- Boral construction materials
- McCahill Brothers Quarry.

An indicative haulage plan is provided as Figure 16.1 to illustrate the preferred quarry locations and potential haulage routes relative to the Port. It is expected that approximately 50% of the quarry material will be sourced from the Granitevale Quarry and the remaining material will be sourced from other local quarries and hauled via the Flinders Highway. It is envisaged that regardless of the quarry/s selected that the Townsville Port Access Road will be the preferred access route into the Port to minimise impacts to the community. A Road Impact Assessment, including a Pavement Impact Assessment and Traffic Operations Assessment, is proposed to be undertaken during detailed design, and provided a minimum of six months prior to haulage of quarry material commencing, to assess potential impacts to the State Controlled Road Network based on staging requirements and final haulage route.

One submission also requested detailed information on operational traffic associated with freight routes, terminal and distribution centres. At this stage of the Project individual port tenant and their operations are unknown. Relevant approvals for tenant operations will be required at the time of development.



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DATUM GDA 1994, PROJECTION MGA ZONE 55
0 0.5 1 2 3 4 5
Kilometers
1:120,000(when printed at A3)

LEGEND

- Highways
- Defence Haul Route Option
- Potential Haul Route Option
- Mount Stuart Defence Reserve
- Quarry
 - Boral Construction Materials
 - Hanson Construction Materials
 - Holcim
 - McCahill Brothers Quarry
 - Pinnacles Quarry
 - Granitevale Quarry

NOTES:

- All routes (except Defence Haul Route Option) are TMR B-double approved routes (haulage vehicle types are unknown, so it is possible the options would be revised based on route approval, if larger than B-double).
- Defence Haul Route Option is on defence land, so in not a publicly owned road. It therefore does not have a route classification.

Data Source:
Roads, Localities - StreetPro 2010.
Options, Offset Area, POTL and - AECOM 2014.
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PORT EXPANSION PROJECT AEIS

Haul Route Options

PROJECT ID 60161996
CREATED BY CFS
LAST MODIFIED 21 Mar 2016
VERSION 1

Figure
16.1

16.2.2 Pavement Impact Assessment

DTMR requested a Pavement Impact Assessment be undertaken including further information on the extent of impacts to pavement and how these impacts will be mitigated. A preliminary analysis, based on the DTMR *Guidelines for Assessment of Road Impacts of Development* was undertaken in Section B.14.4.2 of the EIS, to identify the likely magnitude of pavement impacts due to predicted heavy vehicle movements generated during construction and operation.

The preliminary analysis was performed based on an increase in equivalent standard axles in excess of 5% or greater than background traffic. This analysis suggested the threshold will likely be exceeded for heavy vehicles during the construction and operational phases of the PEP. The assessment also recommended government agencies be consulted to develop an appropriate agreement for associated maintenance, upgrades and rehabilitation requirements.

A meeting was held with DTMR in October 2014 to clarify a number of points related to their EIS submission. From this meeting it became apparent that the key matter for DTMR was quarrying and potential haulage routes, in particular the proposed route from Granitevale Quarry along Riverway Drive.

In response to the DTMR submission, and to ensure that adequate forward planning is achieved, POTL has carried out the detailed Pavement Impact Assessment on Riverway Drive. Following agreement of the Pavement Impact Assessment report a process was undertaken to formulate an agreed set of conditions regarding pavement impacts, potential timing, and appropriate reimbursement for rehabilitation costs. The conditions resulting from the Pavement Impact Assessment form part of the Development Application for the Granitevale Quarry which was finalised in March 2016 and submitted to Townsville City Council (TCC) for final approval consideration.

The Pavement Impact Assessment has been undertaken in accordance with relevant standards and DTMR 'GAIRD' guidelines and based upon measured and forecast traffic volumes at the time of the assessment. The assessment also considered the planned upgrade of Riverway Drive by DTMR. It is proposed that unless there is a significant change to the route assessed in the Development Application, the Pavement Impact Assessment will form part of the Traffic Impact Assessment proposed to be carried out in future to assess road safety matters, before commencing construction.

16.2.3 Adequacy of Traffic Operations Assessment

DTMR and TCC raised queries regarding the adequacy of the Traffic Operations Assessment undertaken as part of the EIS, with a request for a short and long term Traffic Master Plan. Section B.14.4 of the EIS provides an assessment of transport related impacts relevant to the PEP, based on construction and operational assumptions outlined in Appendix Q.1 and Q.2 of the EIS. This assessment is based on baseline data, with applicable growth rates and other contributing factors applied. This was considered the most appropriate method of assessment based on the scope and scale of the PEP. Further, changes to the transport network, since the time of carrying out the baseline studies, and as highlighted in the submissions, illustrate how quickly Traffic Operations Assessments become outdated. This supports the case for assessment closer to the time of construction.

As a result of the design refinement updates, the earliest that road traffic impacts could now increase will be approximately 2017 when Stage 1 construction could commence. The assessment will include the provision of a reliable Network Impact Assessment, based on known transport and infrastructure at the time and will address concerns raised by DTMR and TCC regarding adequacy of assumptions.

Assumptions regarding timing, volumes and haulage details applied to the construction and operation of the PEP have changed with the design refinement and the impact on the assessment of the PEP are addressed in Section 16.3.2. Changes to traffic volumes have been assessed through a series of semi-quantitative comparisons of traffic scenarios. This information has been presented to illustrate the likely changes to construction traffic impacts as a result of the refined staging. It is accepted that this assessment will need to be refined prior to the construction of Stage 1.

The DTMR submission also raised the assessment of road intersections, noting that only those within the immediate vicinity of the Port were assessed as part of the EIS. This approach was chosen as the use of these intersections by PEP construction related traffic had a higher level of certainty, particularly given the 30 years over which various phases of construction were proposed. In addition, Sidra was used to assess only those intersections where PEP related volumes were predicted to be 5% or greater than background traffic.

A Road Safety Assessment will be undertaken prior to the commencement of construction (i.e. Stage 1) as part of the detailed design process and subsequent approvals. This is considered more appropriate given the nature of known traffic volumes and road/intersection upgrades rather than at the level of reporting required in an EIS / AEIS.

All impact assessments will be undertaken in accordance with the relevant standards at the time, with timing determined with DTMR.

16.2.4 Impact to rail network and rail safety

The DTMR submission requested a description and analysis of all rail level crossings proposed to be utilised by PEP during the construction and operation phases to be included in the EIS, with specific reference to the application of the Australian Level Crossing Assessment Model (ALCAM) tool; the identification of rail safety impacts; and associated amelioration measures to mitigate these impacts.

Construction haulage routes proposed to be used for the PEP do not cross any Open Level Crossings. Construction haulage or operational tasks are unlikely to affect rail assets based on current preferred routes. This will be confirmed upon finalisation of construction details and haul routes prior to the commencement of Stage 1.

Construction and operational impacts to the rail network and rail safety will be confirmed, in accordance with the ALCAM, as part of the detailed design of Stage 1 with appropriate mitigation measures identified and agreed upon in consultation with DTMR. It should be noted with current road projects underway, specifically Cluden to Vantassel Road, Open Level Crossings will be upgraded to overpasses and therefore not be impacted.

As previously discussed it is proposed to finalise and submit the required assessments a minimum of six months prior to haulage of quarry material commencing.

16.2.5 Consideration of future development impacts

TCC requested that the assessment consider previous planning studies, schemes and models as impacts and this information be used as input into the traffic analysis. The traffic analysis will be revised prior to construction of Stage 1 (2017) to account for any considerable changes to magnitude of impacts that may have occurred since the original assessment was completed. A cumulative assessment, including consideration of relevant previous studies at the time of the assessment, will also be considered prior to construction.

At this time, the DTMR Riverway Drive upgrade is the only known future development with direct impact on the construction of the PEP as it falls within the proposed haulage routes. All other commercial/residential developments, and other major planning projects in the vicinity, still valid at the detailed design phase, will be considered in the pre-construction assessments.

16.2.6 Inclusion of detailed public transport, parking and pedestrian facilities

TCC raised the lack of detail on public transport, parking, pedestrian/cycling facilities and end of trip facilities in the EIS. POTL is responsible for the management of traffic and transport facilities under its direct control only (i.e. in common areas on Port land). POTL adheres to the safety and security requirements of Ports in Australia under a range of State and Commonwealth legislation. As part of these requirements, public access is currently restricted and primarily managed through the controlled access points (Port gates). It is anticipated that the PEP will be governed under the same security provisions that are currently in place at the Port and public access will not be permitted.

Port tenants are responsible for the management of traffic and transport facilities within their leased areas. Port tenants and operations are subject to trade demand and as such, cannot be identified with certainty, at this time. All port tenants and operations must however, adhere to the Port Land Use Plan (POTL, 2013), POTL guidelines and relevant legislative requirements ensuring compliance relevant to transport and traffic facilities and management.

TCC also requested that the PEP include provisions for pathway network planning and connection with the TCC Central Business District (CBD) Master Plan and Public Transport Strategy. These provisions are not applicable on Port of Townsville land and therefore have not been considered in this assessment. Whilst POTL is currently collaborating with TCC in relation to Ross Creek Priority Development Area including some Port areas, this will not include the PEP which is proposed for internal port operations only. Operational requirements for movement around the PEP, and including the movement of ships' crews, will be managed internally by POTL and considered further at the detailed design phase.

16.2.7 Traffic related impact on amenity

TCC raised the assessment of noise generated by increased railway and site traffic associated with the PEP. Noise and vibration impact to surrounding sensitive receptors are addressed in Section 10.4.8 of the EIS and further clarified in Section 12.0 (Noise and Vibration) of the AEIS. The assessment of noise and / or vibration from the railway servicing the current and future Port operations was excluded from the assessment as the railway falls under Queensland Rail jurisdiction and is not within the Port of Townsville's development control or authority.

Another submission received raised environmental and human health impacts of increased traffic and exports as a result of the PEP. The revised design has resulted in haulage routes for construction traffic being refined to avoid the use of Boundary Street for bulk materials haulage where possible. The majority of heavy vehicle traffic is proposed to use the purpose built Townsville Port Access Road as detailed in section 16.3.4. Port tenants are responsible for the management of traffic and transport facilities within their leased areas. Port tenants and operations are subject to trade demand and as such, cannot be identified with certainty at this time. All port tenants and operations must however, adhere to the Port Land Use Plan (POTL, 2013), POTL guidelines and relevant legislative requirements ensuring compliance with relevant safety standards.

Potential environmental and human health impacts as a result of the PEP are also considered in the impact assessments for Air Quality (Chapter B.9), Noise and Vibration (Chapter B.10), Terrestrial Ecology (Chapter B.7) and Health and Safety (Chapter B.20) in the EIS. Further information is provided in the relevant sections of the AEIS.

16.3 Revised Environmental Impact Assessment

16.3.1 Legislation and policy

There have been no known legislation or policy changes since the preparation of the EIS relevant to the assessment of transport and infrastructure. All applicable standards and legislation will be considered during the detailed design phase.

16.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. This revision has resulted in revised staging for the PEP, impacting a number of transport and traffic assumptions/details that were based on the original EIS staging.

There has been no refinement to the design of transport related infrastructure. However, detailed assessments of transport impacts are to be undertaken as part of the detailed design phase and prior to construction of Stage 1. At this time the information will be available and relevant to the respective construction stage, and details will be known with greater certainty.

As raised in TCC and DTMR submissions, the following will be reassessed and submitted a minimum of six months prior to haulage of quarry material commencing:

- travel split assumptions for haulage routes
- movements allowed at intersections
- layout configurations with consideration to Townsville Port Access Road
- revised modelling and intersection analysis – based on known haulage routes, updated assumptions
- Road Safety Assessment, including consideration of public safety
- relevant monitoring plans.

Many of the above mentioned items will form part of the Road Impact Assessment and Traffic Operations Assessment. The Pavement Impact Assessment will be utilised as a part of this process.

The following will be considered prior to operation of the PEP where relevant:

- import and export volume splits
- train size assumptions through intersections
- shipping volumes
- public transport needs.

16.3.3 Supporting studies

No additional studies were required to assess the revised design and adequately address submissions received as a result of the public consultation period.

Changes to traffic volumes, due to the refined design, have been assessed through a series of semi-quantitative comparisons of heavy and light vehicle traffic movements. This information is based on the revised staging and extrapolation of original traffic assumptions and is summarised in the Figure 16.2. This figure illustrates potential vehicle movements during each construction stage.

Commitments to undertake the following, either during detailed design or prior to construction, as identified in the above sections, include:

- compliance with legislation/acts/standards current at time of detailed design
- consideration to detail and assumption refinements noted in Section 16.3.2 above
- confirmation of detailed haulage routes
- impact assessments (Road Impact Assessment, Traffic Operations Assessment) a minimum of six months prior to haulage of quarry material commencing
- Road Safety Audit a minimum of six months prior to haulage of quarry material commencing
- relevant monitoring plans for construction.

16.3.4 Revised assessment

16.3.4.1 Impact assessment

The design refinement expands the reclamation area by approximately 50 ha to the north-east to avoid sea placement of dredged material. Transportation of materials to the site has increased from the EIS by approximately 17%. Construction of the larger reclamation area requires additional good quality material for capping and pavements to be transported to the larger reclamation area from onshore sources.

The types of impacts associated with the revised refinement are expected to be consistent with those originally identified in Section B.14.4 of the EIS, however the number and rate of vehicle movements has increased as a result of the larger reclamation. Average numbers of heavy vehicles hauling armour rock from quarry sources has increased during Stage 1 and Stage 2, for a limited period during placement of revetments and the breakwater. Whilst the average number of traffic movement is higher at these times (by 4-6 vehicle movements per hour), the duration that material is being hauled at this intensity has reduced since the EIS, as illustrated in Figure 16.2. During the remainder of the Project construction, average heavy vehicle movements are either similar or less than predicted in the EIS.

Haulage routes have been refined since the EIS. The EIS utilised data that was captured prior to the completion of the Townsville Port Access Road and a number of route options were still being considered to haul armour rock. With the Townsville Port Access Road now functional it is proposed that heavy vehicle construction traffic will avoid the use of Boundary Street for bulk materials haulage where possible, as illustrated in Figure 16.1. This will significantly decrease the potential traffic impact on Boundary Street compared to the EIS.

Light vehicle peaks have also changed since the EIS as illustrated in Figure 16.2. Typically highest peaks for light vehicles occur during berth construction, whilst heavy vehicle traffic movements are higher during bulk material haulage periods of the Project.

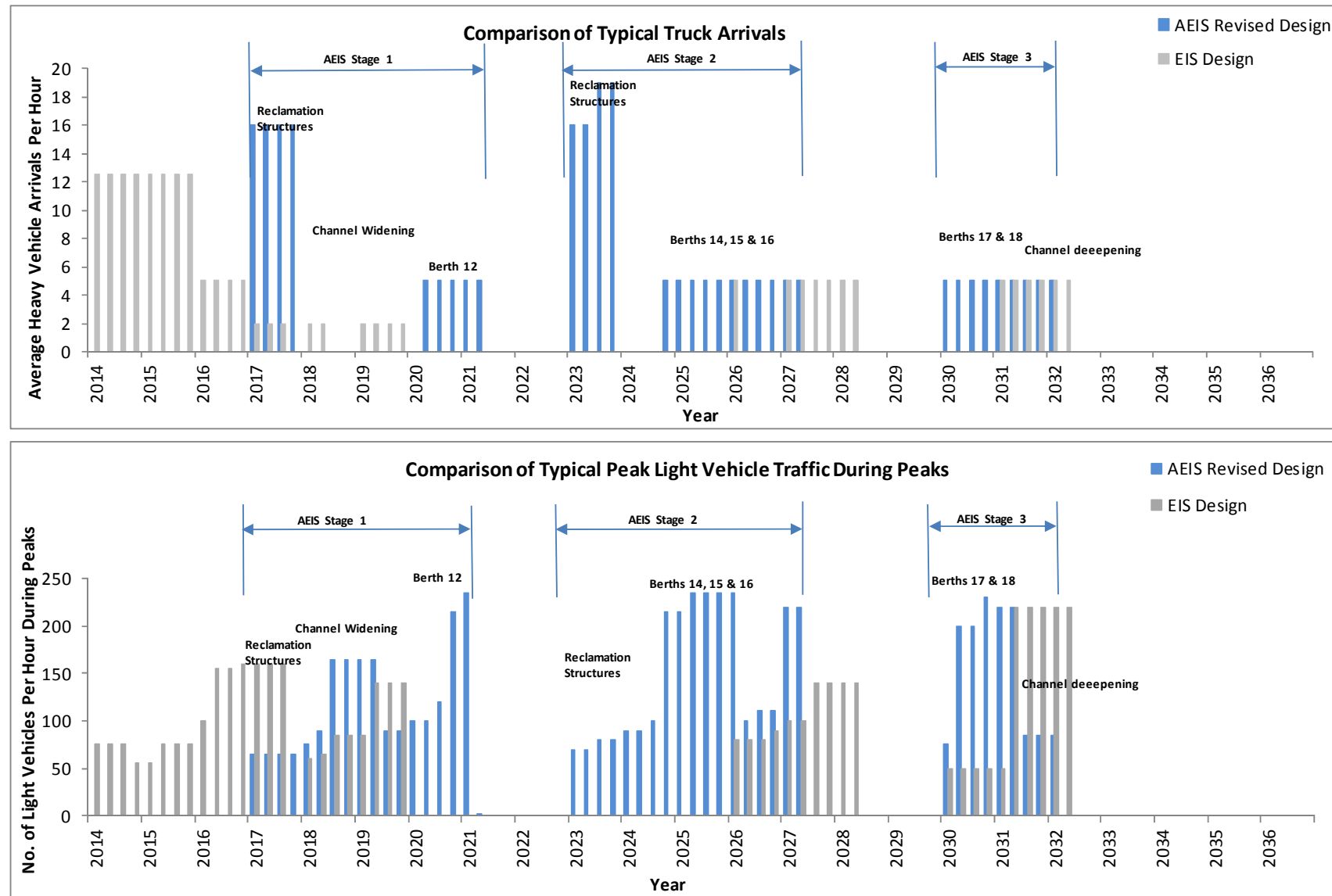


Figure 16.2 Comparison of traffic volumes from EIS to the revised design AEIS

16.3.4.2 Mitigation measures

Mitigation measures to reduce the impact of the PEP, in regards to transport and infrastructure, are outlined in the updated Construction Environmental Management Plan (refer to Appendix B2) and Operational Environmental Management Plans (refer to Appendix B3) of the AEIS.

16.3.5 Summary

Table 16.1 provides a summary of the mitigation measures proposed to reduce impacts of the Project on transport infrastructure. Mitigation measures will be outlined and implemented through the Construction Environmental Management Plan and the Operational Environmental Management Plan.

Table 16.1 Summary of Transport and Infrastructure Impacts and Mitigations Measures

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Road Network						
Medium – term amenity reduction and increased safety risk along main haulage route due to heavy vehicle transport during revetment and breakwater construction.	Construction activities	Moderate	Likely	Medium	Undertake additional impact assessments (Road Impact Assessment, Traffic Operations Assessment) submitted a minimum of six months prior to haulage of quarry material commencing. Undertake Road Safety Audit to be submitted a minimum of six months prior to haulage of quarry material commencing. Update the Port Community Forum as required for any transport and safety issues.	Medium
Decrease in operational efficiency of key intersections.	Construction activities	Moderate	Likely	Medium	Investigate opportunities for intersection improvements to mitigate against additional traffic impacts from construction related activities.	Low
Pavement degradation as a result of increased load intensity.	Construction activities	High	Likely	High	Determine the need for pavement rehabilitation and maintenance in consultation with DTMR and/or TCC. Consider future planning projects (i.e. Riverway Drive) in allocating haul routes.	Medium
Decrease in operational efficiency of key intersections.	Operational activities	Moderate	Likely	Medium	Investigate cost effective solutions to alleviate additional traffic impacts from the expanded port activities.	Low
Pavement degradation as a result of increased load intensity.	Operational activities	Moderate	Almost certain	High	Determine the need for pavement rehabilitation and maintenance in consultation with DTMR and/or TCC.	Low
Rail						
Ongoing efficiency of existing and planned rail networks.	Construction activities	Negligible	Unlikely	Negligible	Nil	Negligible
Ongoing efficiency and operation of rail infrastructure.	Construction activities	Negligible	Unlikely	Negligible	Nil	Negligible
Reduced performance of rail network (Mount Isa Line) due to significant increase in demand.	Operational activities	Moderate	Likely	Medium	Work with government to further implementation of the 'Mount Isa Rail Infrastructure Master Plan' to address the future rail capacity requirements.	Medium
Increase in demand locally between Stuart and the Port on the rail network (North Coast Line).	Operational activities	Minor	Likely	Medium	Work closely with Queensland Rail to identify appropriate trigger points and when viable, plan for the rail access via the Eastern Access Corridor.	Low
Conflicting rail movement congesting rail and road networks (Town and Port track).	Operational efficiency and capacity	Moderate	Likely	Medium	Work closely with Queensland Rail to identify appropriate trigger points and when viable, plan for the development of rail along the Eastern Access Corridor. This will provide sufficient capacity for the PEP rail requirements and will provide an opportunity to address existing port rail efficiency, capacity and amenity issues.	Low

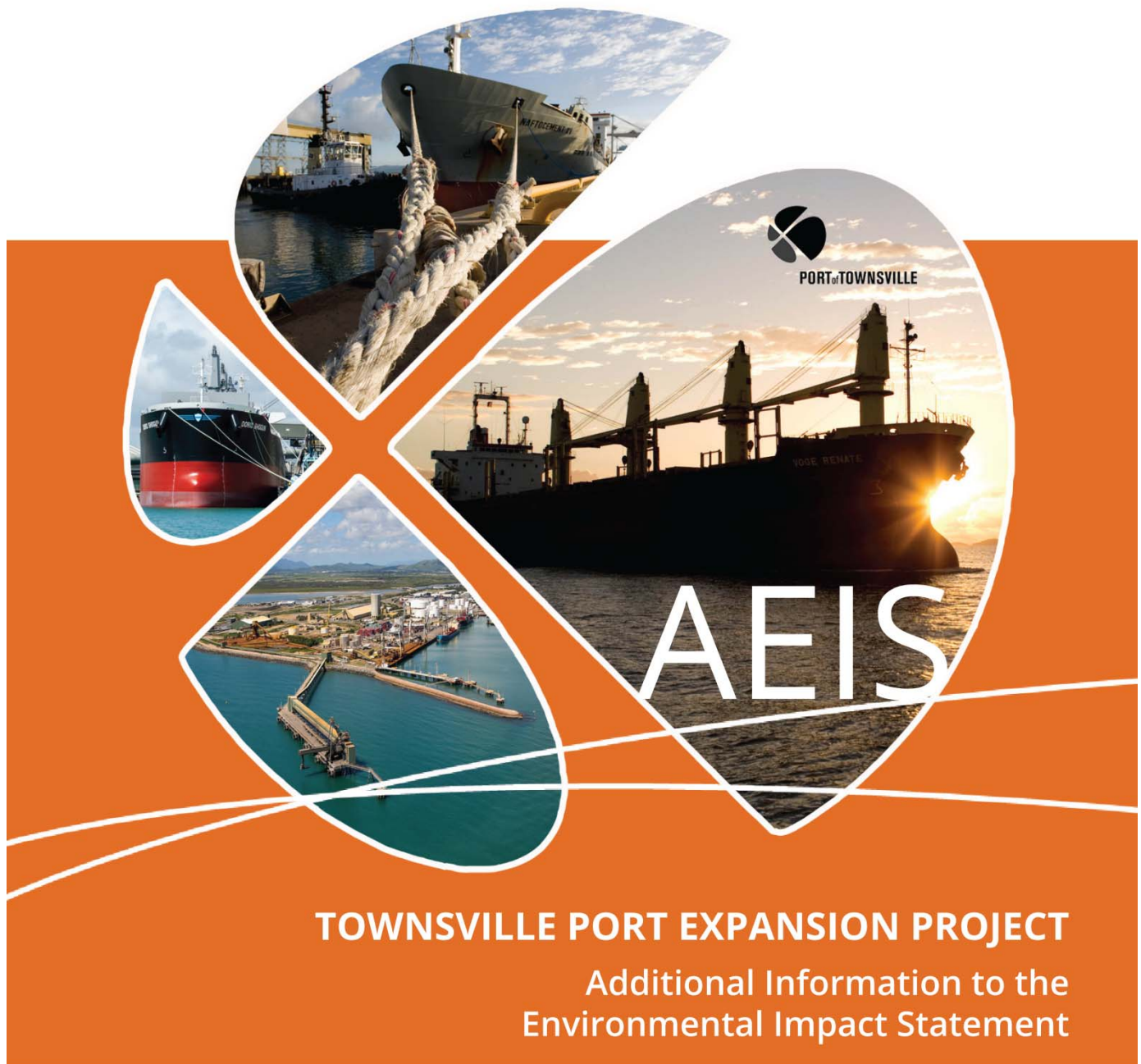
Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Increased rate of rail infrastructure degradation.	Increased rail traffic	High	Likely	High	Work with Queensland Rail to determine progressive rail infrastructure renewal programmes in anticipation of increased rate of degradation.	Medium

16.4 Conclusion

The PEP is not expected to significantly impact upon transport infrastructure on site (within Port) or within the surrounding area. All impacts, mitigations measures, assumptions, and assessments will be reviewed and revised as necessary during the detailed design phase.

A Pavement Impact Assessment has been completed since the EIS and has been submitted as part of a separate Development Application for the proposed Granitevale Quarry to support DTMR future planning. A Road Impact Assessment, including the aforementioned Pavement Impact Assessment, Traffic Operations Assessment, and any other relevant mitigation plans or measures, audits, and management policies, will be undertaken prior to construction of Stage 1, at a time agreed with DTMR, or other applicable agency as required.

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17.0 Indigenous Cultural Heritage

17.1 Introduction

Indigenous cultural heritage values and the impacts of the Port Expansion Project (PEP) on these values are described in Chapter B.15 (Indigenous Cultural Heritage) of the Environmental Impact Statement (EIS). The Project area is highly modified, however still plays a role in understanding the Indigenous cultural landscape and values of the greater Townsville region.

This section provides information to address submissions received in response to the PEP EIS, relevant to the proposed design refinement and the potential implications on Indigenous cultural heritage.

It was raised by one submission whether adequate consultation with the Palm Island indigenous community had been carried out during the EIS consultation process.

17.2 Response to Submissions

17.2.1 Adequacy of Palm Island community consultation

One submitter questioned whether the Palm Island community was aware of the Project. The Indigenous community of Palm Island are located approximately 64 kilometres north of Townsville and are not recognised as the traditional owners of the Project area or surrounding land. Section B.15.3 of the EIS identified the traditional owners of the Project area and surrounds as being the Bindal and Wulgurukaba People. Cultural heritage investigations for the EIS were undertaken in consultation and cooperation with traditional owners.

A range of consultation activities were undertaken as part of the EIS process. This included advertisements in local, state and national newspapers detailing the Project and submission process. The consultation was undertaken to provide the greater community, including residents of Palm Island, an opportunity to comment on the Project. It is not anticipated that the Project will impact upon the Indigenous community of Palm Island.

17.3 Revised Environmental Impact Assessment

17.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. The legislative and policy changes did not impact on the assessment of Indigenous Cultural Heritage values presented in the EIS, or the management of these values.

17.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. This revision focusses on amendments to the extent of dredging and reclamation works. The revised design does not impact upon the likelihood of items or places of Indigenous cultural heritage value present, nor impact on items or places of Indigenous cultural heritage values in the Project area.

17.3.3 Supporting studies

No additional studies were required or recommended to assess the revised design, address comments received from public submissions, or to manage impacts associated with the Project on Indigenous cultural heritage values.

17.3.4 Revised assessment

17.3.4.1 Impact assessment

Impacts of the Project on Indigenous cultural heritage values remain consistent with those identified in Section B.15.4 of the EIS.

17.3.4.2 Mitigation measures

Mitigation measures to consider the potential impact of the Project on Indigenous cultural heritage values are outlined in the existing POTL *Cultural Heritage Management Plan* and the updated Construction Environmental Management Plan (Appendix B2). Potential impacts and mitigation measures remain consistent with those identified in Section B.15.5 of the EIS.

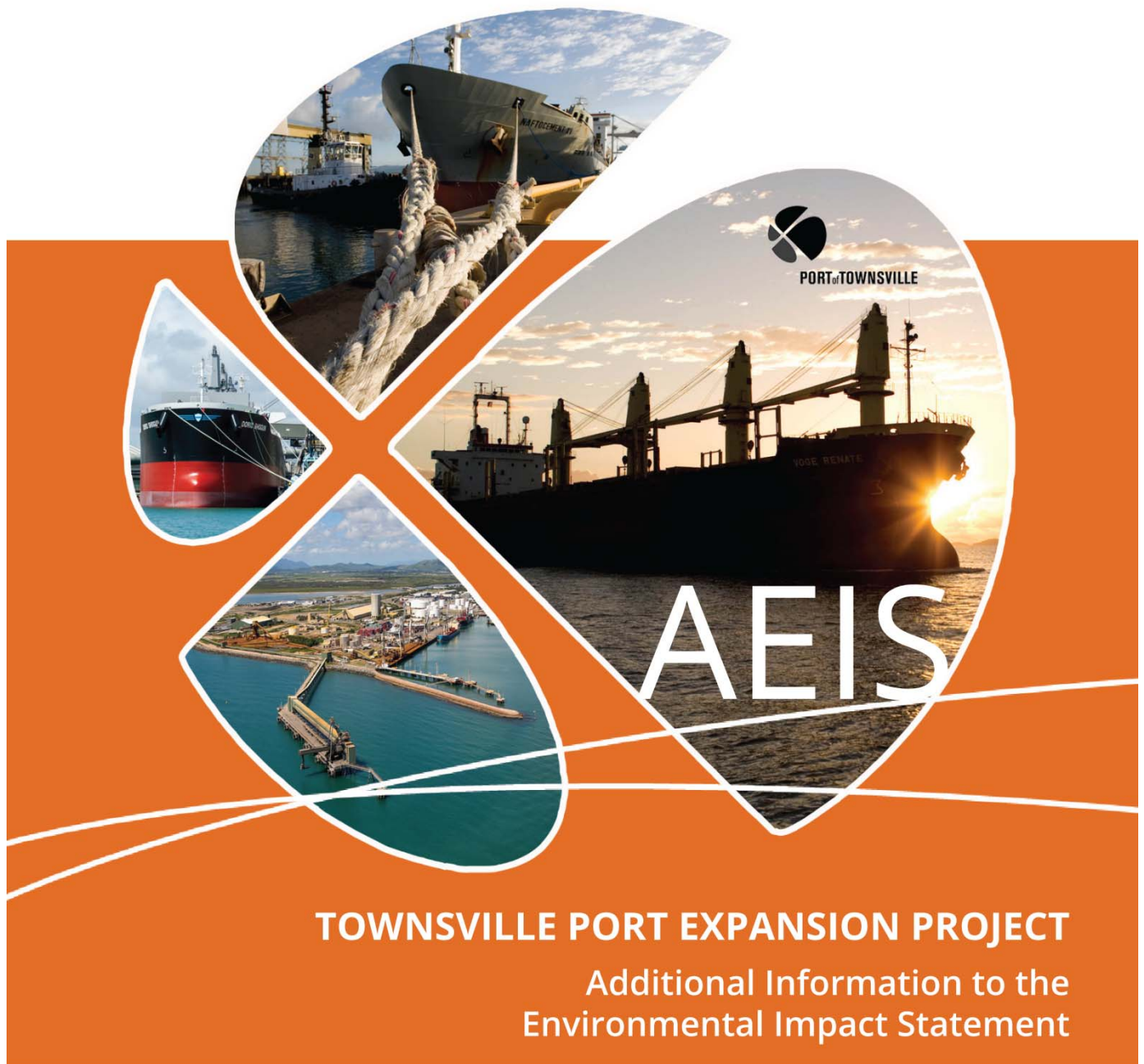
17.3.5 Summary

Section B.15.4 of the EIS provided an assessment of potential impacts that may result from construction and operation of the PEP, relevant to Indigenous cultural heritage. The revised design is consistent with the assessment provided in the EIS and the mitigation provided to reduce the impact on Indigenous cultural heritage in Section B.15.5 of the EIS.

Mitigation measures will be outlined and implemented through the *Cultural Heritage Management Plan* and the Construction Environmental Management Plan (Appendix B2).

17.4 Conclusion

The PEP is expected to have a negligible impact upon Indigenous cultural heritage values on site or within the surrounding area. With the implementation of mitigation measures, the potential for discovering items of Indigenous cultural heritage values during construction works will be appropriately managed.



SECTION 18

Non-Indigenous Cultural Heritage



18.0 Non-Indigenous Cultural Heritage

18.1 Introduction

Non-Indigenous cultural heritage values and impacts of the Port Expansion Project (PEP) on these values are described in Chapter B.16 (Non-Indigenous Cultural Heritage) of the Environmental Impact Statement (EIS). No registered items or places of non-Indigenous cultural heritage significance, recorded shipwrecks or known aeroplane crash sites are located within or adjacent to the Project area. Places of non-Indigenous cultural heritage significance are known in the wider area, but lie outside the planned development area and transit corridors. It is unlikely that areas of non-Indigenous cultural heritage significance will be impacted upon by the Project. The potential remains for unregistered items of heritage value to be present within sub-tidal areas.

This section provides information to address submissions received in response to the PEP EIS relevant to non-Indigenous cultural heritage and the implications of the proposed revised design on these values.

One matter was raised from the submission process regarding notification of discovery.

18.2 Response to Submissions

18.2.1 Notification of discovery

The Department of Environment and Heritage Protection (DEHP) made reference to Part 9 of the *Queensland Heritage Act 1992* regarding the notification of any discovery of items with heritage values in the reclamation area to the department and recommended the inclusion of this requirement in the relevant environmental management plans.

Section B.16.4.2 of the EIS recognises this requirement and to ensure this is implemented the Construction Environmental Management Plan has been revised to include non-Indigenous cultural heritage values in its cultural heritage management measures (refer Appendix B2). This specifically addresses inclusion of non-Indigenous cultural heritage awareness in the cultural heritage induction and notification requirements in the event of a discovery.

18.3 Revised Environmental Impact Assessment

18.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. The legislative and policy changes did not impact on the assessment of Non-Indigenous Cultural Heritage values presented in the EIS, or the management of these values.

18.3.2 Design refinement

The project design has been revised as described in Section 2.0. This revision focusses on amendments to the extent of dredging and reclamation works. The revised design does not change the magnitude or likelihood of encountering items or places of non-Indigenous cultural heritage.

18.3.3 Supporting studies

No additional studies were required to assess the revised design, address comments received from public submissions or recommended to manage impacts associated with the Project on non-Indigenous cultural heritage values.

18.3.4 Revised assessment

18.3.4.1 Impact assessment

Impacts of the Project on non-Indigenous cultural heritage values remain consistent with that identified in Section B.16.4 of the EIS.

18.3.4.2 Mitigation measures

Mitigation measures to reduce the potential impact of the Project on non-Indigenous cultural heritage values are outlined in the updated Construction Environmental Management Plan provided in Appendix B2. Potential impacts and mitigation measures remain consistent with those identified in Section B.16.5 of the EIS.

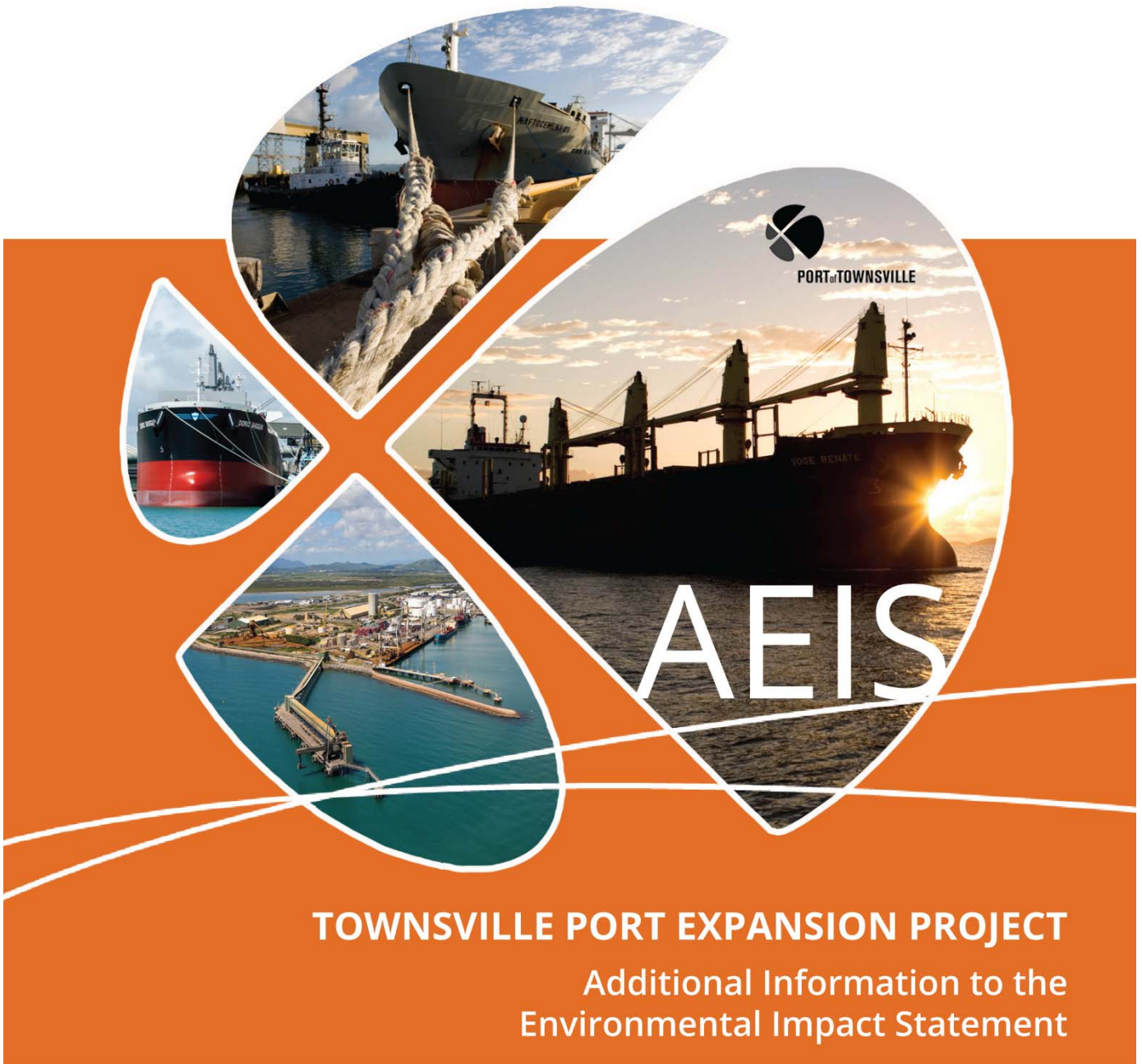
18.3.5 Summary

Section B.16.4 of the EIS provided an assessment of potential impacts that may result from the construction and operation of the PEP, relevant to non-Indigenous cultural heritage. The revised design is consistent with the assessment provided in the EIS and the mitigation provided to reduce the impact on non-Indigenous cultural heritage is Section 16.5 of the EIS.

Mitigation measures will be outlined and implemented through the Construction Environmental Management Plan (refer Appendix B2).

18.4 Conclusion

The PEP is expected to have a negligible impact upon any non-Indigenous cultural heritage values on site or within the surrounding area. With the implementation of the updated mitigation measures, any discovery of items of heritage values during construction works will be appropriately managed and reported.



SECTION 19 Scenic Amenity



19.0 Scenic Amenity

19.1 Introduction

The landscape and visual values of the Project area and surrounds are discussed in Chapter B.17 (Scenic Amenity) of the Port Expansion Project (PEP) Environmental Impact Statement (EIS).

Townsville is located within the low lying coastal plain of the Ross River and Bohle River, and the landscape in and around Townsville includes several prominent rugged outcrops of granite rock, notably Castle Hill, Mount Louisa, Mount Stuart, and Mount Cook at Magnetic Island. The 'visual landscape character' (TCC, 2005) of these outcrops, including the ridges, steep slopes and stands of natural vegetation are unique city landmarks or focal points, which provide a distinctive skyline to the city. Castle Hill and Mount Stuart are both recognised as areas of high scenic amenity (DCILGPS, 2000).

The city has evolved in close association with the Port of Townsville (established in 1864 for the export of agricultural products from the hinterland), located at the mouth of the Ross River and separated from the city centre and recreational activities, such as the marina and entertainment centre by Ross Creek.

The city is located between two wetland landscapes (Townsville Town Common National Park to the north and Bowling Green National Park to the south) and in close proximity to Magnetic Island. These areas provide a distinctive natural backdrop to the city and are valuable recreational assets enjoyed by residents and both domestic and international tourists.

This section provides information to address submissions received in response to the PEP EIS relevant to scenic amenity. Key matters raised on the EIS include:

- adequacy of the scenic amenity impact assessment
- consideration of coal export not reflected in the visual impact assessment
- no data in regard to View 10, Nelly Bay on Magnetic Island
- impacts on the aesthetic values of the Great Barrier Reef World Heritage Area
- impacts and mitigation measures for increased levels of lighting.

19.2 Response to Submissions

19.2.1 Adequacy of the Scenic Amenity Impact Assessment

Four respondents raised the methodology adopted for the scenic amenity impact assessment, including the omission of data or reference to specific reports from the scenic amenity impact assessment.

Aspects of the selected methodology that were questioned by respondents are discussed below in section 19.2.4. In relation to the omission of reference to other reports relevant to the scenic baseline. It is acknowledged that the additional background documents identified by respondents were either not referred to or not published at the time of undertaking the EIS assessment include Townsville City Council's, *Townsville Scenic Amenity Study* (GHD, 2011) and various documents regarding the aesthetic values of the Great Barrier Reef, including *Defining the Aesthetic Values of the Great Barrier Reef* (Context Pty Ltd, 2013). Documents relating to aesthetic values of the Great Barrier Reef prepared for Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (now Department of the Environment (DoE)) are considered in Section 19.2.4.

The *Townsville Scenic Amenity Final Report* (GHD, 2011) was prepared to inform the *Townsville City Plan 2014* (TCC, 2014). This work was unavailable at the time of undertaking the field assessment for the EIS. This document has since been reviewed to determine its relevance, identifying if further assessment is required or whether it influences the conclusions of the scenic amenity assessment presented in Chapter B.17 (Scenic Amenity) of the EIS.

The methodology for the *Townsville Scenic Amenity Study* is based upon the *South East Queensland Regional Plan, Implementation Guideline No. 8* (Queensland Government, 2007), which determines amenity on the basis of visual exposure (i.e. "a measure of the extent to which a place in the landscape is seen from public viewing locations") and scenic preference (i.e. "the rating of the community's liking for scenery of open space compared to areas occupied by built structures, measured using photographs. It includes people's visual response as well as other sensory and emotional responses."). Scenic preference ratings are defined between 0 (least preferred) and 10 (most preferred).

The Port is assessed as having a scenic preference rating of 3 in Table 2 of the report (Scenic Preference Ratings) (GHD, 2011). Figure 1 of the report maps Scenic Preference Values. This shows the Port has lower scenic preference values whilst Castle Hill and most of Magnetic Island are highly preferred. Figure 2 of the report identifies a number of significant viewpoints in the region. These include Castle Hill, The Strand, Mount Stuart, Cape Pallarenda, Nelly Bay, Horseshoe Bay, the Picnic Bay Jetty and viewpoints along the ferry route to Magnetic Island. No significant viewpoints are identified around Cleveland Bay. These vantage points are consistent with those

assessed in the viewpoints selected to illustrate potential impacts of the PEP. Figure 3 in the report illustrates the composite scenic amenity values. An extract of the composite scenic amenity values in the vicinity of the Project area is reproduced as Figure 19.1 (source: (GHD, 2011), p.13).

This figure illustrates that the majority of the mainland landscape around Townsville is assessed as being of moderate scenic amenity (typically around a value of 5). Pockets of higher scenic amenity of between 8 and 10 relate to areas such as Mount Stuart, Castle Hill and Magnetic Island. Lower scenic amenity values (2) are associated with land in the vicinity of the Port.

Table 5 of the report identifies the key 'Coastal Landscape issues'; noting that '*scenic management of harbour and port areas*' is a key management issue for Regional Cities (defined as the landscape that "*focuses on Queensland's major coastal urban centres. These centres are typically located on a major river and include Cairns and Townsville*").

The study recommends protection of high value scenic landscapes (typically a rating of 6 or above) and some defined management areas. Within these zones it is recommended that a visual impact assessment is prepared for proposed development projects. The Port does not fall within these defined areas.

A stakeholder consultation exercise informed the study and the study notes the importance of the scenic amenity of Townsville as '*a key gateway for tourists to the Great Barrier Reef*'. Table 16 of the report examines opportunities to improve the scenic amenity in the Townsville Region identifying "*Improve the visual outlook of the industrial areas around the Port as they are very prominent from the Strand*" as a potential outcome. During the consultation, The Great Barrier Reef Marine Park Authority noted that "*Townsville is a "gateway" for minor tourism activities, however is a significant "gateway" for recreational activities, with high boat ownership, particularly accessing the inshore areas. Therefore, the scenic value of Townsville from the ocean looking inland is extremely high. Mountain ridgelines and the perception of "undisturbed coastline" e.g. treed foreshore with no visible rooflines would have high value*".

The Port is also recognised to be extremely visible from The Strand and is considered as unattractive by a respondent during consultation activities for the study.

The findings of the *Townsville Scenic Amenity Study* (GHD, 2011) are consistent with the baseline information and assessment presented in Chapter B.17 (Scenic Amenity) of the EIS. The key views assessed in the EIS are also consistent with the significant viewpoints considered in the study; no additional significant viewpoints are identified. The high scenic value of Magnetic Island (Viewpoint 10) (refer Table B.17.14 of the EIS) and vantage points such as Castle Hill (Viewpoint 3) (refer Table B.17.7 of the EIS) and Mount Stuart (Viewpoint 4) (refer Table B.17.8 of the EIS) are addressed in the EIS assessment. The relatively lower scenic amenity value of port activities is also acknowledged through the scenic amenity assessment and mitigation measures identified in Chapter B.17.5 of the EIS.

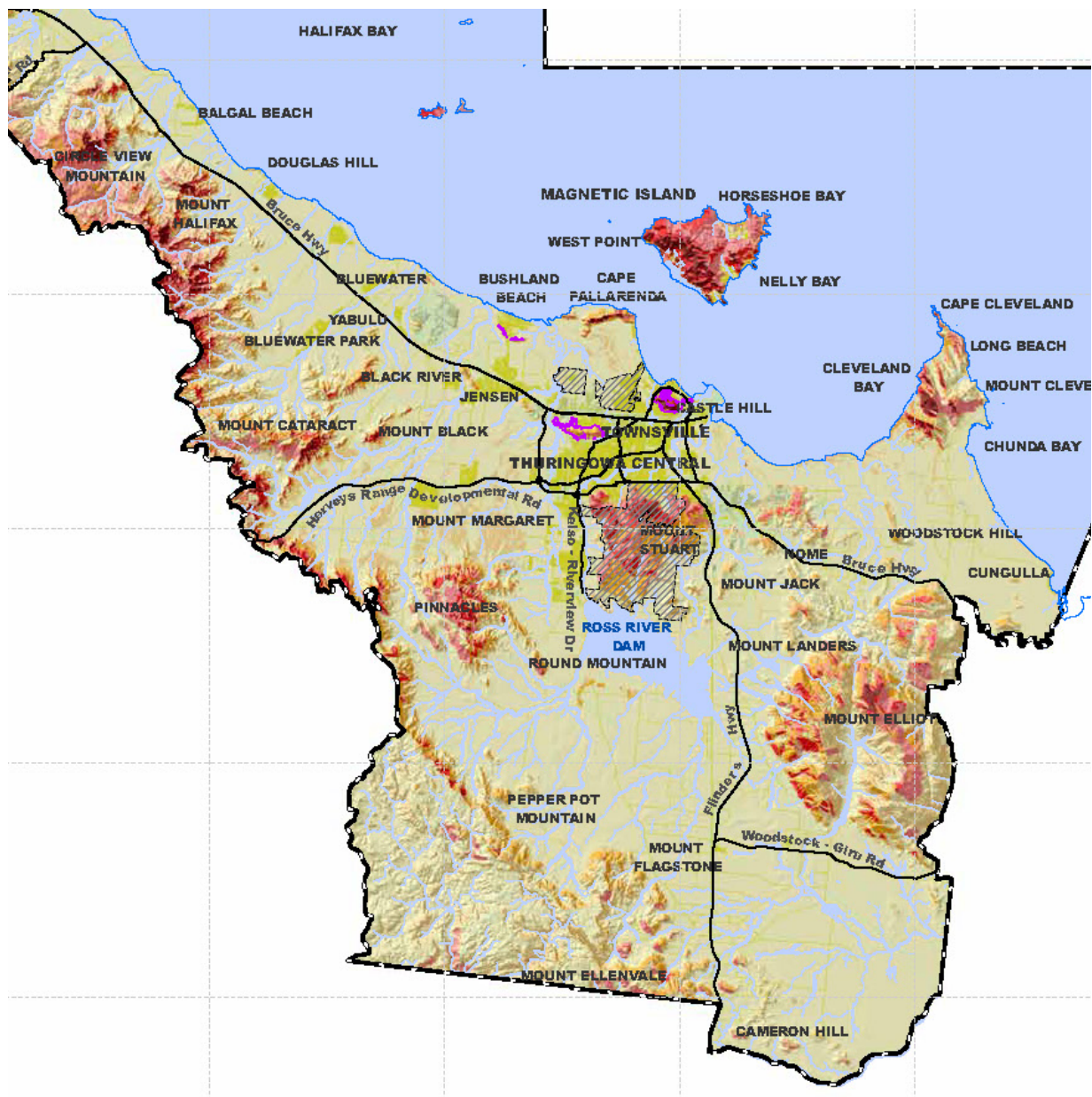


Figure 19.1 Extract of Townsville Scenic Amenity Assessment Scenic Amenity Values (GHD, 2011)

19.2.2 Consideration of particulates from increased export from the Port

The Alliance to Save Hinchinbrook Inc raised that an increase in black and dark-brown particulates is not reflected in the visual impact assessment.

The Project and subsequent impact assessment, focuses on altering the land and sea footprint of the Port to enable the Port to sustain long-term viability of the communities in North Queensland, and as such do not focus on the specific individual cargoes that may be handled in the future.

Whilst the Port presently does not handle coal cargoes, future trade conditions may deem the handling of some coal desirable from a trade perspective. The Port is not a dedicated coal port and the rationale for the Project is not underpinned by future coal exports.

The basis of the impact assessment is described in Section B.17.1.3 of the EIS. This section nominates the key visible infrastructure anticipated comprising a new breakwater, reclamation area (now approximately 150 ha to accommodate dredged material (refer Section 19.3.2 of the AEIS)) and infrastructure such as rail, roads and navigation aids. The cargo operations behind the wharf would be determined on a case-by-case basis by tenants for each berth and would be subject to separate assessments once the certainty of need and form are confirmed.

It is expected that above-wharf facilities for port users in the PEP could include storage sheds, conveyors, shiploaders/unloaders, material facilities, administration and amenities buildings, tank farms and pipelines. An

indicative configuration was considered in the impact assessment for the operational phase comprising conveyors, storage, loading and unloading of cargo.

19.2.3 Viewpoint 10, Nelly Bay on Magnetic Island

Townsville City Council noted that the summary of impact information for Viewpoint 10 – Nelly Bay, Magnetic Island was not provided in Table B.17.18 of the EIS. The omission of the summary of Viewpoint 10 – Nelly Bay was an oversight and has been corrected in the revised assessment (refer Table 19.7 in Section 19.3.4.1.3 of the AEIS).

19.2.4 Impacts on aesthetic values of the Great Barrier Reef World Heritage Area

Four submissions questioned the adequacy of the EIS to meet Australia's obligations under the World Heritage Convention. The submissions consider that the scenic amenity tool has been misused as a surrogate for assessing world heritage aesthetics. One of these submissions states that scenic amenity policy has "no relevance" to protection of aesthetic value of GBRWHA. It notes that scenic amenity assessment is not the determinant of desired scenic condition. This matter is addressed below in Section 19.2.4.2 with regards to the Project impacts on aesthetic values of the Great Barrier Reef World Heritage Area.

19.2.4.1 Response regarding the assessment technique

Section 5.2.1 of the PEP Terms of Reference (ToR) (Appendix A1 of the EIS) sets out the requirements for the scenic amenity and lighting impact assessment, whilst Section 5.5 (i), (vi) EIS Guidelines (Appendix A2 of the EIS) specifies the inclusion of "*simulated viewfields of the proposal showing its visual impact from the adjacent coastline, nearby inhabited islands and the Great Barrier Reef World Heritage Area*".

Chapter B.17 (Scenic Amenity) presents the findings of this assessment. There is no reference to the combined assessment of aesthetic values. The methodology used in the EIS acknowledges the absence of nationally recognised methodologies for visual assessment and subsequently, addressed visual values in accordance with the widely adopted national, *Draft National Wind Farm Development Guidelines* (EPHC, 2010) and international guidelines for Landscape and Visual Impact Assessment (LI & IEMA, 2002) which is consistent with the subsequent edition (LI & IEMA, 2013); (SNH & CA, 2006).

The ToR also refers to the 2001 methodology set out in the Queensland Coastal Plan: State Planning Policy for Coastal Protection Guideline Annex 3—*Determining scenic preference in the coastal zone* (DEHP, 2011). The specific requirements of the 2011 Queensland Coastal Plan have been incorporated into a wider more comprehensive assessment of scenic amenity impacts. An *Obtrusive Light Study* (AECOM, 2012a) (Appendix S2 of the EIS) was also undertaken to assess lighting impacts of the Project as per the ToR. The approaches used in the EIS and AEIS are consistent with that adopted in other EIS studies for coastal development elsewhere in Queensland. Lighting impacts on migratory waders are assessed in Appendix L2 (Potential Effects of Light on Migratory Waders (AECOM, 2012)).

The submissions dispute the technique for being simplistic and 'relativistic' i.e. because it compares the change in the relative apparent areas of elements in the selected viewpoints, which are already influenced by port development. This is the approach consistently adopted internationally in scenic amenity assessment (Landscape and Visual Impact Assessment) and responds directly to the requirements of the ToR (Section 5.2.1). This comparative approach is typically used or recommended in most methodologies endorsed at the time of undertaking the assessment by the Queensland government (including the *Queensland Coastal Plan* (DEHP, 2011) and other documents such as *South East Queensland Regional Plan Implementation Guideline Number 8 Scenic Amenity* (DI, 2007)). Whilst acknowledging the matter could result in incremental erosion of visual values over a wider area, this approach is considered appropriate for the AEIS and would result in identification of the most significant scenic amenity impacts. This approach would, for example, result in scenic amenity impacts of greater significance being identified where development affected a pristine previously undeveloped area. It also identifies that there are adverse visual impacts associated with expansion of the existing port on particular views, therefore, does not infer that all ports are equal, i.e. "A port and a larger, busier port are both ports but this does not mean there is no difference in character and aesthetic appeal or repugnance", which was the matter raised in one submission.

It is evident that scenic amenity values need to be considered in conjunction with other aspects and in relation to wider consideration of aesthetic impacts (refer Section 19.2.4.2). For example, the economic assessment (Chapter B.19 (Economic Environment) of the EIS) concludes that port development is not feasible elsewhere and would be inconsistent with the *Queensland Ports Strategy* (DSDIP, 2014a) that states necessary development will be concentrated in the existing priority ports (including Townsville) and no new ports will be developed. Arguably, if port development is necessary, the visual (and wider aesthetic) values of the GBRWHA would be less compromised by developing an existing port where visual values are already diminished than expanding into pristine environment elsewhere, which is consistent with the PEP.

19.2.4.2 Response to requirement for broader consideration of aesthetic values

Understanding of World Heritage and National Heritage Values of the area are included in Section B.17.2 of the EIS and are assessed through the inclusion of specific viewpoints documented in Section B.17.4 of the EIS.

Components that contribute to aesthetic values are addressed throughout the EIS (Sections B.6.3.2.1, B6.4.14, B.23.2, and B.24).

Since the writing of the EIS, the report titled, *Defining the aesthetic values of the Great Barrier Reef*, was published by the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) (now Department of the Environment) (Context Pty Ltd, 2013). The report considers the aesthetic values of the GBRWHA, however, it currently has no legal status in relation to the assessment of impacts and acknowledges that further work is required to define an appropriate methodology.

Consideration of the implications of this report to the assessment of aesthetic values is described below.

The report, *Defining the Aesthetic Values of the Great Barrier Reef* (Context Pty Ltd, 2013), evaluates aesthetic values in relation to the World Heritage system, defines aesthetic values based on a range of sources including tourist literature and community perceptions, and suggests a preliminary sensitivity impact assessment method for the aesthetic values identified.

The report acknowledges that there are:

'no systematic methodologies for, or approaches to, the assessment of aesthetic importance or natural beauty in the World Heritage system'...

and, consequently

'...the aesthetic values are almost always limited to visual aspects...' (p. viii).

The report considers that aesthetic values should be more broadly defined and evaluated and adopts the following definition based on the Comprehensive Regional Assessment of National Estate values (O'Brien & Ramsay, 1991):

"Aesthetic value is the response derived from the experience of the environment or particular natural and cultural attributes within it. This response can be to either visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors that have a strong impact on human thought, feeling and attitudes" (emphasis as per the report p.33)

An assessment method is put forward based on attributes, elements, character, visual aspects, risk assessment, vulnerability assessment and sensitivity. Environmental attribute (typology) is based on main groups including: coral reefs, islands, open water, inshore lagoon and coastal and estuarine ecosystems. Key experiential attributes include: sense of beauty, naturalness, tranquillity, solitude, remoteness, discovery and spiritual dimension.

The recommended approach for assessing impact entails the following stages.

1. Identifying the activity using the comprehensive strategic assessment list.
2. Identifying the impacts (or threats) resulting from the activity using the comprehensive strategic assessment list.
3. Calculating risk based on the GBR outlook report approach (likelihood and consequences).
4. Determining the nature of the impact based on the project team judgement.
5. Determining sensitivity by identifying attributes affected, sensitivity (using sensitivity tables) based on environmental attribute and experiential attribute based on sensitivity statements: GBRMPA and project team.
6. Combining risk/exposure and sensitivity to define impact level based on project team judgement.

A number of Retrospective Statements of Outstanding Universal Value were identified through the study and are summarised in Appendix 2 of the report as follows.

Table 19.1 Retrospective Statements of Outstanding Universal Value (Appendix 2, *Defining the aesthetic values of the Great Barrier Reef* (Context Pty Ltd, 2013)).

Ref #	Statement of Outstanding Universal Value	Attributes
(vii) Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance		
1	The Great Barrier Reef is of superlative natural beauty above and below the water, and provides some of the most spectacular scenery on earth.	See 1.2, 1.3, 1.4, and 1.7 in this table
1.1	It is one of a few living structures visible from space, appearing as a complex string of reefal structures along Australia's northeast coast.	Coral reefs (whole of system)
1.2	From the air, the cast mosaic patterns of reefs, islands and coral cays produce and unparalleled aerial panorama of seascapes comprising diverse shapes and sizes.	Aerial scenery
1.3	The Whitsunday Islands provide a magnificent vista of green vegetated islands and white sandy beaches spread over azure waters.	Whitsunday Islands scenery
1.4	This contrasts with the vast mangrove forests in Hinchinbrook Channel, or the rugged vegetated mountains and lush rainforest gullies periodically cloud-covered on Hinchinbrook Island.	Hinchinbrook channel mangroves Hinchinbrook Island morphology

Ref #	Statement of Outstanding Universal Value	Attributes
		Hinchinbrook Island vegetation
1.5	On many of the cays there are spectacular and globally important breeding colonies of seabirds and marine turtles and Raine Island is the world's largest green turtle breeding area.	Seabird breeding colonies
		Turtle breeding colonies
		Raine Island green turtle breeding area
1.6	On some continental islands, large aggregations of over-wintering butterflies periodically occur.	Overwintering butterfly aggregations
1.7	Beneath the ocean surface, there is an abundance and diversity of shapes, sizes and colours: for example spectacular coral assemblages of hard and soft corals, and thousands of species of reef fish provide a myriad of brilliant colours, shapes and sizes.	Reef fish diversity
		Coral diversity, health and structure
		Water clarity
		Overall marine species diversity and abundance
1.8	The internationally renowned Cod Hole is one of many significant tourist attractions.	Potato cod (site specific)
		Cod Hole dive site
1.9	Other superlative natural phenomena include the annual coral spawning, migrating whales, nesting turtles, and significant spawning aggregations of many fish species.	Whales
		Coral spawning
		Turtle rookeries
		Fish aggregations

The report identifies a number of 'extended descriptions' that are set out in Section 4.4.3 of the report. These refine the detail of the Retrospective Statements of Outstanding Universal Value (OUV) outlined in Table 19.1.

Sensitivity statements are defined for both the environmental and experiential attributes described above (Table 5.3 and 5.4 of the report). Sensitivity and impact assessment are considered for a wide range of activities including, of relevance to the current assessment, the following activities:

- shipping
- industrial development (including ports).

The assessment for shipping includes the following description:

"Shipping refers to the movement and anchoring of large vessels within the GBR... Shipping is also closely associated with ports and industry; these are considered separately below. Shipping movements through the GBR are reported to be gradually increasing, in response to industrial and mining development (GBRMPA 2009: 75). While the potential for shipping to have a major impact, especially through groundings and oil or chemical spills, most ships travel safely through the GBR and incidents are relatively few. Other potential impacts include introduction of species for elsewhere, although to date this is mainly in port areas (GBRMPA 2009: 76). These impacts can be grouped based on the nature of the impact. Some will impact on environmental attributes, some on experiential attributes, and some on both. The actual impacts will depend on the location and amount of the activity. For example, the location will determine which environmental and experiential attributes are present and may be affected, and the amount of the activity may cause an increase in the sensitivity (as indicated in Tables 5.3 and 5.4)."

Shipping is concluded to have the following risk:

"... the overall Risk for the Activity of Shipping is Medium, and the potential extent of impacts varies in scale from Local to Regional, but is primarily Local. Shipping may result in a range of mainly indirect impacts on a range of the environmental attributes – habitats and species – which together reflect a significant array of aesthetic values. The experiential attributes of beauty and naturalness would be equally impacted. The experiential attributes of tranquillity, solitude and remoteness would be impacted by the presence of ships, especially through noise, lights at night, the number of ships present at any one time and the overall daily number of ships present or in transit."

The assessment for industrial development (including Ports) includes the following description:

"Ports and the associated shipping activities are an important activity in the GBR, with 10 major trading ports, 3500 ships and 9700 voyages in 2007; increasing ship movements is being driven by industrial and mining activity (GBRMPA 2009: 75). The impacts of port development and use include construction impacts, loss and fragmentation of coastal habitats, dredging and seabed disturbance, changes in coastal processes and water movements. Generally these impacts are localised (GBRMPA 2009: 76)".

Industrial Development (including Ports) is concluded to have the following risk:

“... the overall Risk for the Activity of Industrial Development (including ports) appears to be similar to Urban Development – that is High for coastal and in-shore ecosystems, but probably Medium for the balance of the GBR. The potential extent of impacts varies in scale from Local to Regional. The experiential attributes of beauty and naturalness appear to be the most impacted, along with tranquillity, solitude and remoteness in some locations and as a result of some activities.... Given the relationship between ports and shipping, it should be noted that the experiential attributes of tranquillity, solitude and remoteness are likely to be impacted by the presence of ships, especially through noise, lights at night, the number of ships present at any one time and the overall daily number of ships present or in transit.”.

Overall the potential impact of these activities is concluded to be as shown in Table 19.2:

Table 19.2 Overall potential impact of activities on aesthetic values

Activity	Risk	Scale	Sensitivity (Experiential)	Potential Impact
Shipping	Medium	Local	Low-Medium	Medium
Industrial development	High	Local	Very High	High-Very High

The report defines a number of ‘special places’ in the Great Barrier Reef. The area around Townsville does not feature within this assessment although Magnetic Island is noted, including aspects such as dugongs, whales, the view to Magnetic Island, crystal clear bays surrounded by boulders, relaxation, sense of ‘home’ close to mainland and “Awesome boating, cruising, landscape, fishing”. The report notes that:

“The ‘crystal clear waters’ and ‘relaxation’ of Magnetic Island was also noted in the GBRMPA workshop exercise but this probably reflects its position close to Townsville, GBRMPA’s base” (p.114).

Whilst a potential method for the detailed assessment of aesthetic values in projects based on the Retrospective Statements of Outstanding Universal Value has been suggested this has not yet been sufficiently refined and the report concludes that it:

“provides a valuable resource that can be drawn on in various ways including ... Providing the basis on which a ‘how to’ manual for the assessment of aesthetic values in the World Heritage system and more generally (e.g. in the assessment of National Heritage nominations) could be developed through refining the methodology, including assessment of values, conceptual mapping and assessment of sensitivity and impacts concluded that the report provides a valuable resource formally adopted”.

In the absence of a formally adopted methodology for the assessment of aesthetic values, the current assessment concludes that impacts on the environmental and experiential attributes identified by the study and explored above in relation to the context of Townsville are largely addressed by the component studies of the EIS as provided in Table 19.3 of the AEIS.

Table 19.3 Assessment of EIS Studies with relevance to aesthetic characteristics of the GBRWHA

Attribute	Relevant EIS Assessment
Environmental attributes	
coral reefs	Marine ecology the underwater visual impacts on the reef can be inferred (refer Chapter B.6 (Marine Ecology)).
islands	Terrestrial ecology and scenic amenity (the detailed visual impacts on terrestrial habitats can be inferred; more general impacts are considered in Chapter B.17 (Scenic Amenity, including specific viewpoint assessment)).
open water / inshore lagoon	Marine water (refer chapters B.4 (Marine Water)), marine sediment (refer Chapter B.5 (Marine Sediment)), marine ecology (refer Chapter B.6 (Marine Ecology)) and scenic amenity (refer Chapter B.17 (Scenic Amenity), including in relation to shipping. A new viewpoint assessment numbered 14 (The Forts Lookout, Magnetic Island) is provided in Table 19.6 and Table 19.7.
	Marine ecology visual impacts on the reef can be inferred (refer Chapter B.6 (Marine Ecology)).
coastal and estuarine ecosystems	Marine and terrestrial ecology visual impactson the reef can be inferred (refer chapters B.6 (Marine Ecology) and B.7 (Terrestrial Ecology), respectively).
Experiential attributes	
beauty	Scenic amenity – Chapter B.17 (Scenic Amenity) considers visual sensitivity based on attributes including the character of the viewpoint and the number of viewers which are reflective of the beauty and interest of the view.
naturalness	Scenic amenity (including scenic preference assessment based on former State Planning Policy 3/11: Coastal Protection, which measures the change in preferred attributes).
tranquillity	Acoustic assessment is addressed in Chapter B.10 (Noise and Vibration).

Attribute	Relevant EIS Assessment
solitude	Not applicable due to the existing urban context of the port.
remoteness	Not applicable due to the existing urban context of the port.
discovery	Social impact assessment (including community issues) is addressed in Chapter B.13 (Social).
spiritual dimension	Social impact assessment (including community issues) is addressed in Chapter B.13 (Social).

The matters raised in the Retrospective Statements of OUV are discussed in the relevant section of the EIS and summarised in Table 19.4.

Table 19.4 Assessment of EIS studies with relevance to outstanding universal values of the GBRWHA

Ref #	Statement of Outstanding Universal Value	Relevant EIS Assessment
(vii) Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance		
1	The GBR is of superlative natural beauty above and below the water, and provides some of the most spectacular scenery on earth.	Above water impacts – refer Chapter B.17 (Scenic Amenity). Below water impacts – refer chapters B.4 (Marine Water), B.5 (Marine Sediment Quality) and B.6 (Marine Ecology) (consequent scenic impacts on divers can be inferred). The ambient turbidity around the eastern side of magnetic Island is typically around 5 NTU (around 70- 85 cm visibility) refer Section 6 (Marine Water Quality).
1.1	It is one of a few living structures visible from space, appearing as a complex string of reefal structures along Australia's northeast coast.	N/A – the scale of the proposed development would not impact on this Outstanding Universal Value.
1.2	From the air, the cast mosaic patterns of reefs, islands and coral cays produce and unparalleled aerial panorama of seascapes comprising diverse shapes and sizes.	Views from the air are considered in the Scenic Amenity Assessment (noting the scale of the proposed development would not impact on this Outstanding Universal Value).
1.3	The Whitsunday Islands provide a magnificent vista of green vegetated islands and white sandy beaches spread over azure waters.	N/A – does not apply to this geographical location.
1.4	This contrasts with the vast mangrove forests in Hinchinbrook Channel, or the rugged vegetated mountains and lush rainforest gullies periodically cloud-covered on Hinchinbrook Island.	N/A – does not apply to this geographical location.
1.5	On many of the cays there are spectacular and globally important breeding colonies of seabirds and marine turtles and Raine Island is the world's largest green turtle breeding area.	Refer chapters B.7 (Terrestrial Ecology) and B.6 (Marine Ecology).
1.6	On some continental islands, large aggregations of over-wintering butterflies periodically occur.	Refer Chapter B.7 (Terrestrial Ecology).
1.7	Beneath the ocean surface, there is an abundance and diversity of shapes, sizes and colours: for example spectacular coral assemblages of hard and soft corals, and thousands of species of reef fish provide a myriad of brilliant colours, shapes and sizes.	Refer Chapter B.6 (Marine Ecology) (consequent scenic impacts on divers can be inferred).
1.8	The internationally renowned Cod Hole is one of many significant tourist attractions.	N/A – does not apply to this geographical location.
1.9	Other superlative natural phenomena include the annual coral spawning, migrating whales, nesting turtles, and significant spawning aggregations of many fish species.	Below water – refer Chapter B.6 (Marine Ecology) (consequent scenic impacts on divers can be inferred).

In conclusion, the report, *Defining the Aesthetic Values of the Great Barrier Reef* (Context Pty Ltd, 2013), provides a useful baseline of the aesthetic values of the barrier reef and provides some initial guidance on the future development of an integrated methodology to assess the potential impacts of a proposal against those values. The scenic amenity assessment, undertaken in line with the Project ToR, provides assessment of those matters relevant to visibility and scenic amenity of the GBRWHA through the selection and assessment of representative viewpoints including key scenic vantage points.

19.2.5 Impacts and mitigations measures for increased levels of lighting

Three submissions noted that the additional night lighting will be visible and dominate the coast skyline diminishing the natural aesthetics.

In order to understand the likely impacts of lighting associated with the Project, a night-time site survey had been completed for the viewing points to input the scenic amenity assessment presented in Chapter B.17 (Scenic Amenity) of the EIS. An Obtrusive Lighting Study (AECOM, 2012a) has also been undertaken and is included in Appendix S2 of the EIS. It concludes that there would be a minor-moderate magnitude of impact resulting in a medium risk level with appropriate mitigation “will not cause a considerable impact on the surrounding environment”.

Mitigation measures discussed in Section B17.5 remain relevant. These include measures to manage lighting during construction and operations and in particular lighting design to reduce light spill from the Project are incorporated in the Environmental Management Plans (Part C of the EIS).

19.3 Revised Environmental Impact Assessment

19.3.1 Legislation and policy

There have been no significant changes to legislation since the preparation of the EIS. The two principal pieces of guiding legislation for the purposes of scenic amenity assessment are the *Environment Protection and Biodiversity Conservation Act 1999* and *Great Barrier Reef Marine Park Act 1975*, which remain current. Additional work has been undertaken to explore the values of the Barrier Reef as described above. This includes the Great Barrier Reef Region Strategic Assessment (DSEWPaC, 2014), as well as the Defining the Aesthetic Values of the Great Barrier Reef (Context Pty Ltd, 2013) (refer Section 19.2.4.2). In addition DSWPaC have produced the Interim Guidelines on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area – for Proponents of Actions (DSEWPaC, 2013).

Other changes include the repeal of the Queensland Coastal Plan (DEHP, 2011), which was applicable at the time the EIS was prepared, and adoption of the Townsville City Plan (TCC, 2014) by Townsville City Council. These documents were raised in submissions on the EIS and are discussed below.

19.3.1.1 Interim Guidelines on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area

The *Interim Guidelines on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area – for Proponents of Actions* (DSEWPaC, 2013a) sets out requirements with regards to the assessment of proposed actions that are likely to have a significant impact on the outstanding universal value of the GBRWHA. It is noted that the department is currently developing full guidelines. The interim guidelines note that:

“When referring a proposed action under the EPBC Act you must consider impacts to outstanding universal value of the Great Barrier Reef World Heritage Area. Attributes of the outstanding universal value of the Great Barrier Reef World Heritage Area that may be impacted as a result of actions include, but are not limited to: views from the air, ground and underwater...”

Chapter B.17 (Scenic Amenity) of the EIS considers impacts on views from the ground and air. As previously noted, impact on views underwater can be reasonably inferred from the findings of the marine water, marine sediment, marine ecological and economic assessments.

19.3.1.2 Queensland Coastal Plan

The *Queensland Coastal Plan* (October 2012) has been repealed and is no longer applicable. The *State Planning Policy SPP 3/11: Coastal Protection* has also been superseded by *Draft Coastal Protection State Planning Regulatory Provision*.

The new *Coastal Management Plan* (DEHP, 2014) commenced on 18 March 2014, which provides non-regulatory policy guidance. It notes that coastal resources are valued for scenic amenity but makes no specific recommendations with regards to the protection or evaluation of scenic values. Therefore, the scenic preference rating assessment undertaken in Chapter B.17 (Scenic Amenity) of the EIS is no longer mandatory. Regardless, Port Planning and Townsville City Council Planning are generally complementary and the scenic preference rating is still useful for reference purposes.

19.3.1.3 Townsville City Plan

The Townsville City Plan was adopted on 13 October 2014 (TCC, 2014). As noted in the EIS, the Port is exempt from complying with the requirements of the plan. 3.4.4 *Element - Strong and connected community*, provides specific outcomes relating to scenic amenity include the following:

1. *“Townsville maintains the scenic amenity values and iconic features that contribute to its character and sense of place. Development in areas of high scenic amenity is limited to minimise the potential for deterioration of the scenic values.”*

2. *Areas of high scenic amenity generally include elevated and vegetated areas which may also contain significant ecological and other environmental values. These include:*
 - a) *mountainous backdrops, including Mount Elliot, Mount Cleveland, the Pinnacles, Many Peaks Range and Hervey Range to Paluma;*
 - b) *significant hills and ridgelines within and framing urban areas, including Castle Hill, Mount Stuart and Mount Louisa; and*
 - c) *coastal headlands, foreshores and waters, including The Strand, Magnetic Island, Cape Pallarenda, Cape Cleveland, Cleveland Bay and Halifax Bay.*
3. *Development is sited and designed to be sensitive to the landform, vegetation and other characteristics that contribute to scenic amenity values in all parts of the city.*
4. *Nonurban land is protected to define the edges to the city, and to protect nonurban landscape values. Urban and rural residential development does not occur in rural areas."*

Components as outlined in the Townsville City Plan are adequately considered in the scenic amenity assessment and do not require further assessment in the AEIS.

19.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. Key components of the Project anticipated during the construction and operational phases that are relevant to scenic amenity impact assessment include those items listed previously with the following modifications.

- The creation of approximately 150 ha of reclaimed land (expansion of an additional 50 ha to that previously proposed behind the berths to provide for cargo storage and handling infrastructure, including rail infrastructure. This land is to be created from material reclaimed from the outer harbour and channel dredging and include internal bunds to facilitate effective land reclamation.
- The widening of the Platypus Channel will be on the west side of the channel with the eastern edge remaining.
- The width between toelines will be 180m at the outer harbour and reducing to 135m at the junction with the Sea Channel.
- The widening of the Sea Channel will be on the east side of the channel (opposite side from Magnetic Island) with the western edge remaining. The width between toelines will be 135m at the junction with the Platypus Channel reducing to 120 m at the sea end.
- Requirement for the western breakwater is yet to be confirmed.

The expansion of the land reclamation is a result of the removal of offshore placement of dredge material. The significance of these changes is considered in relation to each of the viewpoints in Section 19.3.4 below.

19.3.3 Supporting studies

No additional studies were required to assess the revised design or address comments received from public submissions. An additional viewpoint has been assessed from Magnetic Island to give further consideration to the impacts of the additional shipping and potential anchorage site on views from the World Heritage Listed Magnetic Island. This is considered with the overall assessment of impacts in Section 19.3.4.

19.3.4 Revised assessment

19.3.4.1 Impact assessment

Refinements to the project design may potentially affect the severity of impacts to visual values of the area, including extent of visibility and impacts on key views. The impacts as summarised in Section B.17.4 of the EIS, remain relevant. The potential for impacts based on the revised design is discussed below.

19.3.4.1.1 Zone of Theoretical Visibility Assessment

As the ground level of the new extension area is the same as the area formerly assessed it is not considered likely that the Zone of Theoretical Visibility would change to any meaningful degree. Therefore, a new Zone of Theoretical Visibility assessment has not been prepared and the impact of the extension is considered in relation to the selected representative viewpoints.

19.3.4.1.2 Representative Viewpoint Assessment

Using the method set out in the EIS which has not been changed for the reasons described above, this section provides an assessment of the anticipated effects and subsequent impacts on scenic amenity associated with the revised design. The assessment has been organised into the following key receptor groups identified in the EIS:

- Offsite receptors: nearby residences/properties; residents living in Townsville's outer suburbs and nearby townships; residents, visitors and tourists visiting local attractors; residents and visitors using recreational tracks; residents and visitors travelling along scenic tourist drives and motorists using major and minor roads in the Study Area; users of aircraft such as airplanes, hot air balloons or paragliders. In addition information is provided on underwater receptors.
- Onsite receptors: people visiting and working at the Port of Townsville.

A number of photomontage representations were compiled and included in the EIS to illustrate the long-term visual implications of the PEP. All were produced based on a theoretical layout. Actual above-wharf projects would be based on the requirements of the future port tenants and products, and would be subject to separate development approvals. It is noted that these montages have not been updated to show the expanded land reclamation for the purposes of the AEIS as they are considered to be sufficiently illustrative of the location and nature of the likely impact. However, the descriptions and assessment of the proposed development have been updated where appropriate for each of the selected viewpoints to describe any changes that are likely to arise as a result of the additional land area. A summary of the changes in contrast to the previous assessment is described in Table 19.5.

Table 19.5 Comparative assessment of design refinement against original EIS assessment

Assessment	Significance Assessment in relation to Design Refinement
Baseline	
Viewpoint 1: The Rocks Guesthouse, Cleveland Terrace, Melton Hill	No change: From this angle and distance, the additional land reclamation area is located beyond the area already considered, so this would not significantly change the extent of visibility of the expansion works or consequent significance of visual impact.
Viewpoint 2 – Holiday Inn Tower in Townsville CBD	No change: The additional land reclamation area is located beyond the area already assessed in the EIS. Whilst the additional land would be visible it would not significantly change the visual impact of the expansion works.
Viewpoint 3 – Castle Hill	No change: The expanded land reclamation area is located beyond the area already assessed in the EIS but, due to the elevated nature of this vantage point, would be a noticeable increase in land area. This would encroach to a slightly greater extent on the view of open water between the coast and Magnetic Island. Whilst the additional land reclamation area would be visible it occurs within the context of existing port activities so does not significantly affect the magnitude of change or significance of the impact.
Viewpoint 4 – Mount Stuart Scenic Lookout	No change: The additional land reclamation area would be discernible and slightly extends the extent of port land visible to the north and east of the existing area. However, due to the distance this represents a minor incursion into the overall view so would not change the magnitude of change category or the significance of the change overall.
Viewpoint 5 – The Strand Pier	No change: The additional land reclamation area is located behind the expansion area already assessed in the EIS. As the new land would be located entirely beyond the area already assessed there would be no change in the magnitude of change or significance of the change from this vantage point.
Viewpoint 6 – Kissing Point Rock Pool	No change: From this vantage point, the additional land reclamation area is located behind the expansion area already assessed in the EIS so is only likely to be perceptible if additional elevated structures are constructed on this additional land area. As the new land would be located entirely beyond the area and structures already assessed the magnitude of change and significance would not meaningfully change.
Viewpoint 7 – Western Breakwater, near Townsville Entertainment Centre	No change: From this vantage point, the additional land reclamation area is located behind the expansion area already assessed so the magnitude of change is not anticipated to meaningfully change.
Viewpoint 8 – Freemasons Pallarenda Park	No change: From this vantage point, the additional land reclamation area is located behind the expansion area already assessed so the magnitude of change is not anticipated to meaningfully change.
Viewpoint 9 – Passenger Ferry Route between Townsville and Magnetic Island	No change: From this vantage point, the additional land reclamation area would be visible resulting in a slight further increase in incursion of land into the open water landscape east of the former proposed reclamation area. However, the overall magnitude of change and significance would not be changed by the slight increase in visible land as a result of the Project description.
Viewpoint 10 – Nelly Bay, Magnetic Island	No change: The additional area of land reclamation area would marginally extend the appearance of the developed area eastwards and northwards; however due to the distance and angle of view this does not affect the overall magnitude or significance of the proposed change.
Viewpoint 11 – Hawkings Point Lookout, Magnetic Island	No change: The additional expansion area would be perceptible from this vantage point, extending the extent of the developed area slightly eastwards and northward. However, at this distance the magnitude of change would not change as a result of this, so the significance of the impact would remain as currently assessed.
Viewpoint 12 - Northerly View from Benwell Road, South of the Townsville Marine Precinct	No change: From this location the additional reclamation area would be perceptible to a small extent, but is largely screened by foreground activities and the reclamation area assessed in the EIS. Therefore the magnitude of change is assessed to be the same.

Assessment	Significance Assessment in relation to Design Refinement
Viewpoint 13 – Indicative View from the Air	No change: The additional reclamation area arising from the design modification would be noticeable in its entirety from this 'birds-eye' vantage point but, due to scale and the long - distance of the viewer from the development, this is not considered to change the magnitude of impact or significance of the impact.

An additional viewpoint has been included in the AEIS in response to submissions in order to consider further the impacts of the PEP, including shipping movements on views from Magnetic Island National Park. This viewpoint has been labelled as Viewpoint 14 and, therefore, appears out of sequence in the text, in order to maintain the original viewpoint numbering to allow easier cross referencing between the EIS and AEIS.

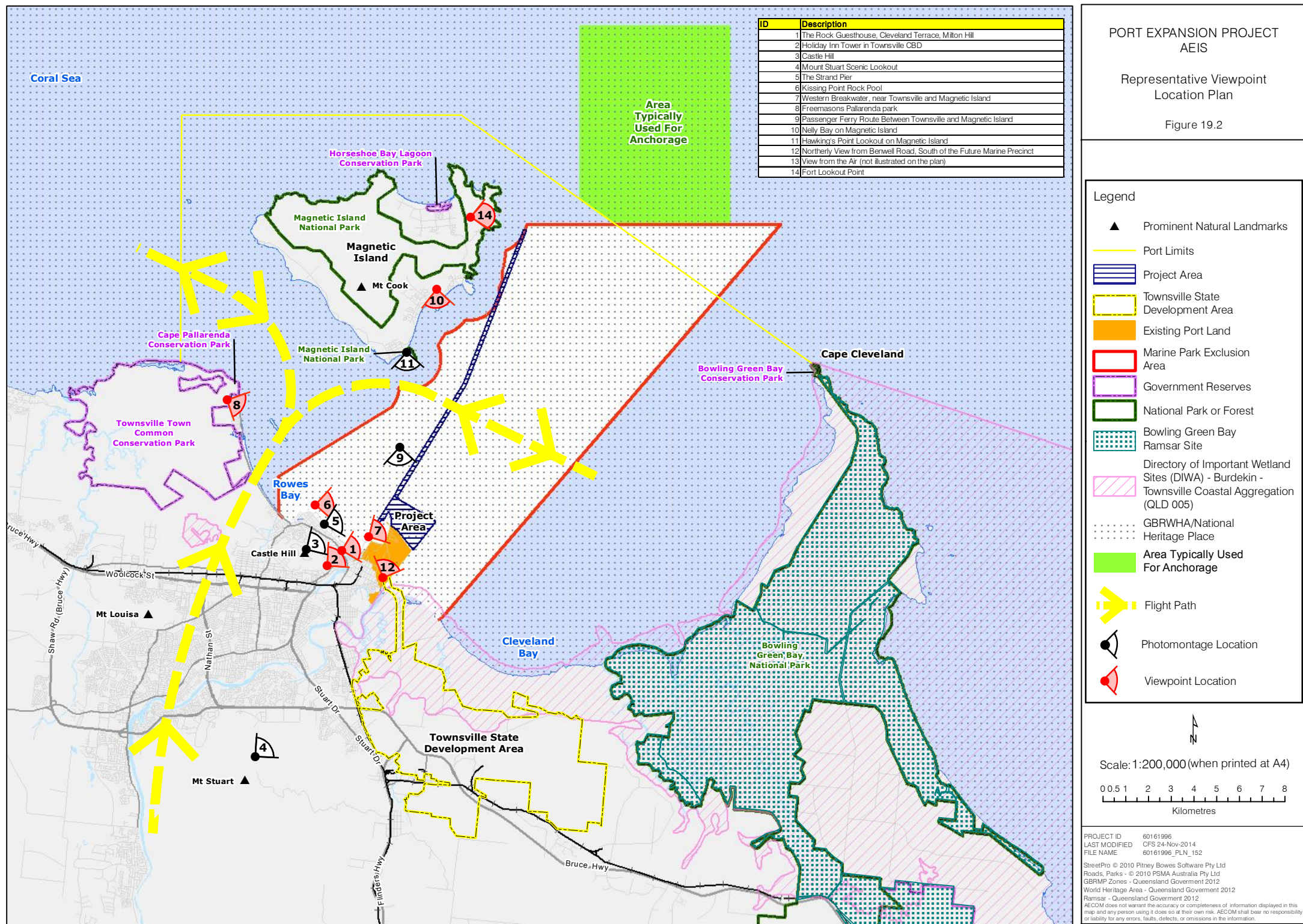


Table 19.6 Viewpoint 14 – Forts Lookout, Magnetic Island

Assessment	Description
Baseline Assessment	
Location and description	- This viewpoint represents elevated north-easterly to south-easterly views from the Forts Lookout near the Signal Station located on the Forts Track, located in the north-eastern part of Magnetic Island National Park towards Cleveland Bay. - Magnetic Island is an island off the coast of Townsville featuring 'spectacular natural landscapes and seascapes including boulder-strewn headlands, hoop pines, sandy beaches and fringing coral reefs' (DERM, 2006a). - The Forts is a key lookout is a key vantage point identified in the Magnetic Island National Park walking track map (QPWS, 2011) that offers panoramic views north to Horseshoe Bay, eastwards across the WW2 communications tower and Florence Bay and south to Cleveland Bay. - The Forts is a popular lookout that attracts a medium number of people daily, including tourists, visitors, and residents using walking tracks for recreation and fitness. - This viewpoint has been selected to represent the impact on the scenic values of the GBRWHA and GBRMP. However, this viewpoint has been selected to consider the impact of shipping movements on views from Magnetic Island as opposed to port infrastructure which is addressed by Viewpoints 10 and 13. The waterscape in the middle ground to the east and south is located in the area excised from the GBRMP. However, the shoreline and the landscape of Magnetic Island and the wider seascape of the Coral Sea are located within the GBRWHA which is recognised for its 'exceptional natural beauty and aesthetic importance'. - The Port is approximately 14 km in direct distance to the south-southwest of this viewpoint. The shipping channel is located approximately 2.4 km and the typically used anchorage area is located approximately 4.8 km from this view point.
Key sensitivities	- The natural, cultural and historical value of Magnetic Island National Park, resulting in a popular tourist destination and iconic national asset. - The viewpoint represents views from a location of national importance where the user's interest is specifically focused on the landscape.
Overall inherent sensitivity	High
Evaluation	
Judgement of magnitude of change (during both the construction and operational phases)	The view is of the wider GBRWHA. The shipping and dredging activities would impact this and similar views of the GBRWHA and GBRMP from walking tracks within the Magnetic Island National Park. Activities associated with the PEP during construction and operation would be detectable from this elevated viewing location which overlooks the Sea Channel. Dredge operations would be visible during construction. Shipping movements would be visible during operation. It is assumed that at peak times up to 10 ships up to Panamax size would pass through the channel per day. No anchorage is permitted within or adjacent to the Sea Channel as shown on Figure 19.2; however, an unofficial area currently used for anchorage is located in the Coral Sea north-east of the Sea Channel. The additional berths within the Port may decrease the requirement for offshore anchorage; however, for the purposes of this assessment it has been assumed that this practice will continue. Ships travelling to the Port and recreational boats can already be seen from this location, as indicated on the viewpoint. As a result of the PEP, it is anticipated there will be a noticeable increase in the number of shipping movements, although this would occupy a relatively small area of the view. This would potentially decrease the sense of 'remoteness' of the GBRWHA but the broader scenic values of the GBRWHA would be maintained. As this viewpoint involves walking some distance uphill within a national park it is anticipated to have very limited numbers of people at night. However, as it is not closed to the public at night, it is considered in the assessment. The baseline lighting assessment illustrated that a high level of existing lighting exists associated with the Port and Townsville CBD, which lies some distance from the vantage point, and the increase would be barely perceptible. Additional light associated with the ships may be perceptible but would not be perceived as an adverse effect on views.
Judgement of significance of impact (daytime)	Moderate adverse impact, due to the high sensitivity to change combined with a minor magnitude of change.
Judgement of significance of impact (night)	Moderate neutral impact, due to the high sensitivity to change combined with a minor magnitude of change.

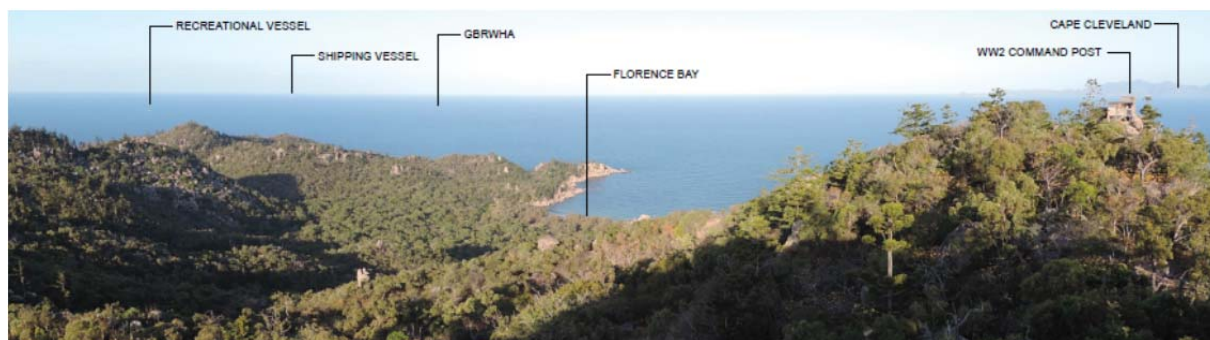


Figure 19.3 Viewpoint 14 – The Forts Lookout Magnetic Island

19.3.4.1.3 Scenic Amenity Impact Assessment Summary

The anticipated impacts of the Project on scenic amenity during the daytime are summarised in Table 19.7. These are based on the 14 selected representative viewpoints and take into account the existing port facilities and document the anticipated change in impact due to the Project. Night-time impacts due to lighting are typically of the same significant level but are more neutral in effect since many viewers would prefer night-time views of port lighting and would access vantage points (such as Castle Hill) to enjoy the view.

Table 19.7 Summary of Impact on Publicly Accessible Viewpoints

Viewpoint	Overall inherent sensitivity	Magnitude of Change	Significance of unmitigated impact	Significance Change from EIS
Nearby residence/property				
Viewpoint 1 – The Rocks Guesthouse, Cleveland Terrace, Melton Hill (refer Figure B.17.10 of the EIS)	Medium	Moderate (noticeable)	Moderate (adverse)	No change
Residents living in Townsville's CBD and outer suburbs				
Viewpoint 2 – Holiday Inn Tower in Townsville CBD (refer Figure B.17.11 of the EIS)	High	Moderate (noticeable)	Moderate (adverse)	No change
Local attractors				
Viewpoint 3 – Castle Hill (refer Figure B.17.12 and Figure B.17.13 of the EIS)	High	Moderate (noticeable)	Moderate (adverse)	No change
Viewpoint 4 – Mount Stuart scenic lookout (refer Figure B.17.14 and Figure B.17.15 of the EIS)	High	Minor (detectable)	Moderate (neutral)	No change
Viewpoint 5 – The Strand Pier (refer Figure B.17.16 and Figure B.17.17 of the EIS)	Medium	Moderate (noticeable)	Moderate (adverse)	No change
Viewpoint 6 – Kissing Point Rock Pool (refer Figure B.17.18 of the EIS)	Medium	Moderate (noticeable)	Moderate (adverse)	No change
Viewpoint 7 – Western breakwater, near Townsville Entertainment Centre (refer Figure B.17.19 of the EIS)	Medium	High (considerable)	Moderate (adverse)	No change
Viewpoint 8 – Freemasons Pallarenda Park (refer Figure B.17.20 of the EIS)	Medium	Moderate (noticeable)	Moderate (adverse)	No change
Viewpoint 9 – Passenger ferry route between Townsville and Magnetic Island (refer Figure B.17.21 and Figure B.17.22 of the EIS)	Medium	Moderate (noticeable)	Moderate (neutral)	No change
Viewpoint 10 – Nelly Bay on Magnetic Island (refer Figure B.17.23 of the EIS)	Medium	Moderate (noticeable)	Moderate (adverse)	No change
Recreational tracks				
Viewpoint 11 – Hawkings Point Lookout, Magnetic Island (refer Figure B.17.24 and Figure B.17.25 of the EIS)	High	Moderate (noticeable)	Moderate (adverse)	No change
Viewpoint 14 – Forts Lookout, Magnetic Island (refer Figure 19.3 of the AEIS)	High	Moderate (noticeable)	Minor (adverse)	Not previously assessed
Roads				
Viewpoint 12 – Northerly view from Benwell Road, south of Townsville Marine Precinct (refer Figure B.17.26 of the EIS)	Medium	Minor (detectable)	Minor (neutral)	No change

Viewpoint	Overall inherent sensitivity	Magnitude of Change	Significance of unmitigated impact	Significance Change from EIS
Air				
Viewpoint 13 – Representative view from the air (refer Figure B.17.27 of the EIS)	Medium	Minor (detectable)	Minor (neutral)	No change
People visiting and working at the port				
No viewpoints used to represent views from this receptor group				

19.3.4.2 Mitigation measures

The submissions requested the need for careful consideration to be given to the scenic amenity impacts of the proposals during the construction and operational phases of the Project.

Mitigation measures to reduce the visual amenity impact by the Project are outlined in the existing POTL Construction and Operational Environmental Management Plans, in accordance with the existing POTL Environmental Management System. The POTL Environmental Management System will be updated to accommodate the following measures.

- Management of lighting to reduce direct light spill from the site are consistent with the existing Operational Health and Safety and land use codes.
- Suitable measures are outlined in Section B.17.5 of the EIS and would need to be explored further at detailed design phase.

Implementation of other control measures would include the following.

- The new site will be fenced and access controlled in a similar manner to the existing port.
- POTL tenant activities will comply with existing port operational protocols and meet the overall environmental requirements established for the port and other conditions (e.g. buildings and equipment are to comply with maximum height and visual amenity provisions established by the port).
- Fugitive dust (refer to Air Quality, Chapter B.9 of the EIS, and amended Air Quality Section 11.0).
- Stormwater releases (refer to Water Resources, Chapter B.2 of the EIS, and amended Water Resources Section 4.0).
- Suspended sediment from dredging (refer to Dredge Management Plan, Chapter C2.1 of the EIS, and Appendix B1 of the AEIS).
- Waste control measures, including shipping waste (Chapter B.12 of the EIS, and Section 14.0 of the AEIS).
- Progressive stabilisation of reclaimed land and reducing disturbed and exposed areas (e.g. access road verges).
- Exterior lighting is to comply with relevant guidelines.

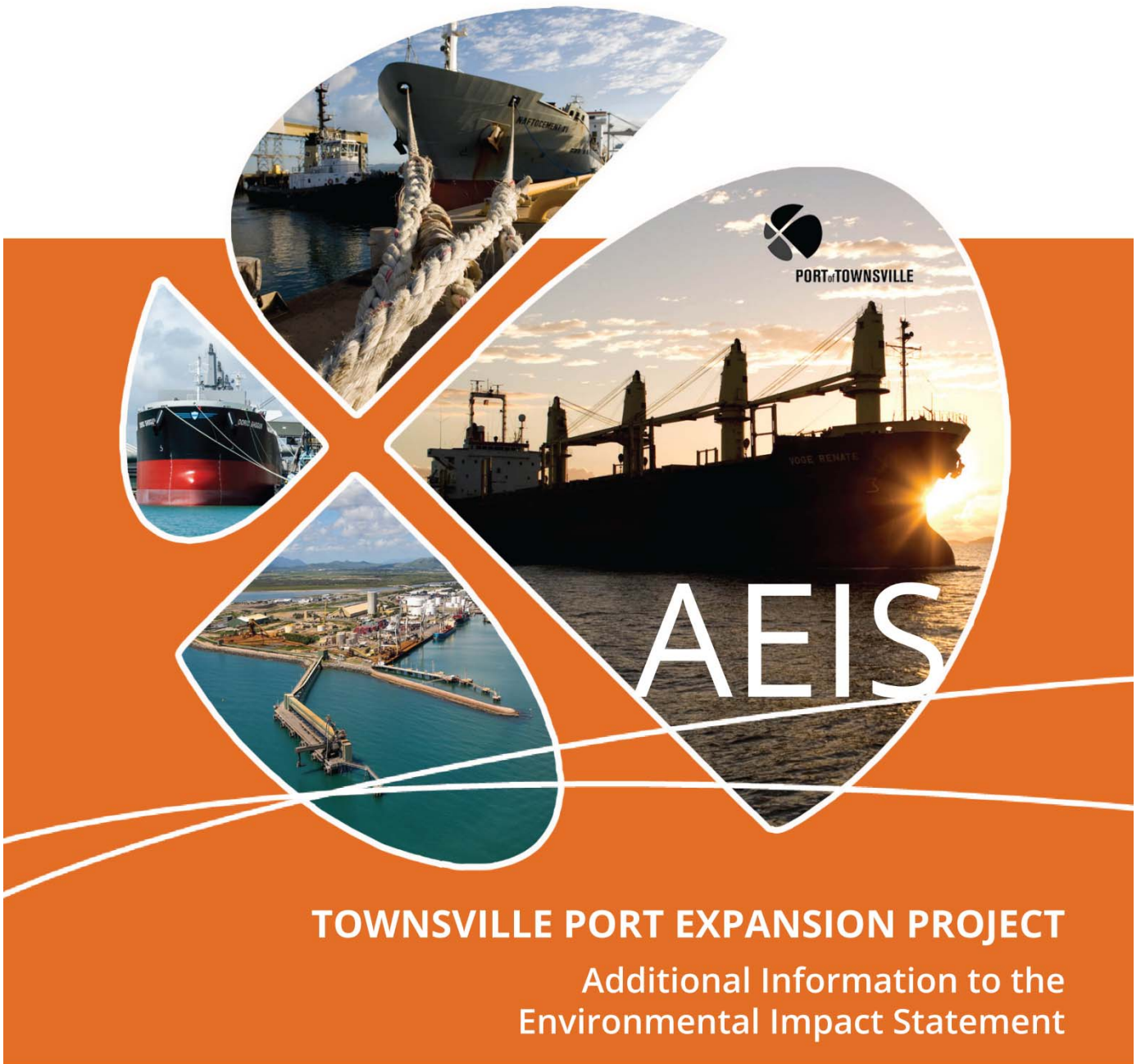
19.3.5 Summary

The revised design remains current with the overall risk ratings provided in Section B.17.7 of the EIS. The risks are based on the worst case scenario i.e. those impacts to scenic amenity occurring within relatively close proximity to the PEP. Beyond the identified study area, scenic amenity values would not be directly affected.

19.4 Conclusion

The Project will affect the views of several near and distant receptors in the Townsville/Magnetic Island locality. Impacts of moderate significance would be generated at the local level. As these impacts are classified as 'almost certain' this results in a high residual risk rating at the local level, including views within the GBRWHA. Scenic amenity impacts on the wider GBRWHA are of lesser significance and low risk due to visual containment. These impacts arise principally as a result of cumulative and perceptual aspects.

The implementation of mitigation measures to manage impacts on visual values as identified in the EIS would assist in integrating the port infrastructure into its landscape context at a local level but would not change the overall risk level.



SECTION 20

Port Operations



20.0 Port Operations

20.1 Introduction

The impacts of the Port Expansion Project (PEP) on port operations are addressed in Chapter B.18 (Port Operations) of the Environmental Impact Statement (EIS). The PEP is essentially a progressive expansion of the existing Port and its current operations. Operations at the port will be conducted under the existing management framework of Port of Townsville Limited (POTL) and in accordance with the policies and regulation of other relevant regulatory bodies and maritime authorities. Measures to manage any potential impacts on the environment, vessel safety and operational efficiency of the PEP will not involve major changes to existing management measures or POTL or port users.

The progressive development of the PEP will occur in response to trade demand. POTL, as the port authority, will be responsible for the development of the PEP in terms of the dredging and land reclamation activities. On a case by case basis, POTL may also be responsible for the development of wharves and associated port infrastructure. The development of any new cargo handling facilities will most likely be the responsibility of port tenants or cargo owners. In either case, the proponents of those new facilities will be responsible for any additional approvals related to those facilities at the time of their proposal. POTL will continue to manage the operations of port users through lease and licence agreements.

This section provides information to address submissions received in response to the PEP EIS, relevant to port operations. More specifically, key matters raised in the submission process include:

- adequacy of shipping forecast data to assess management needs
- management of shipping activities in the Great Barrier Reef Marine Park
- adequacy of navigational hazard management on the rock wall
- inclusion of detail on anchorage requirements and management
- impact to non-PEP vessel movements and interactions
- requirements of the Vessel Traffic Management Plan
- adequacy of spill management measures.

20.2 Response to Submissions

20.2.1 Adequacy of shipping forecast data to assess management needs

Maritime Safety Queensland (MSQ) submission requested additional shipping forecast data to assess future shipping and traffic management needs and demand for port facilities and suggested that the EIS reference to the *Great Barrier Reef Shipping: Review of Environmental Implications* Report (PGM, 2012) was used as a justification for the projected increase in shipping, despite no demonstrated evidence of increased shipping in recent years.

Chapter B.19 (Economic Environment) of the EIS summarises the need for the PEP based on prepared trade forecasts to the 2039/40 fiscal year. The PEP is planning to enable the timely development of additional infrastructure, in response to trade demand, to ensure sufficient capacity ahead of the expected demand. Forward planning will allow sensible port development over the longer term. Having approvals in place reduces the time from demand identification to infrastructure development. This aims to avoid capacity constraints impacting on trade growth opportunities. As trade throughput increases, the volume of shipping will increase, however, the shipping forecasts also take account of the global trend for the increase in vessel sizes, and as described in Chapter 21.0, the anticipated use of larger ships on the east coast of Australia.

Section B.18.4.3 of the EIS addressed future navigational arrangements. As noted above, POTL are positioning the future port to be able to take advantage of the anticipated increase in vessel size occurring in the global fleet. Changes to the channel configuration and the introduction of larger ships will impact the ship operations and navigation arrangements at the Port of Townsville. Any increase in shipping as a result of the PEP will occur over time as new trades come on line. This increase will be incremental, and as is the case with any operational changes, MSQ will be consulted to ensure the safety of shipping at the Port. For example, if a new trade was to anticipate the use of significantly different or larger vessels, MSQ will be a key part in the detailed development of operating protocols within the Port and the detailed design phase of that trade's infrastructure within the PEP.

Port of Townsville in 1993 had 463 cargo vessel visits and in 2015 had just fewer than 700 cargo vessel visits. This is a similar timescale as proposed in PEP as such there is demonstrated evidence of increased shipping and ship visits on the timescale of this Project.

20.2.2 Management of shipping activities in the Great Barrier Reef Marine Park

Queensland Tourism Industry Council's submission raised environmental risks associated with allowing trans-shipping activities in the Great Barrier Reef Marine Park, noting shipping rules and regulations must be effective and

supported by strong enforcement and appropriate penalty regimes. Trans-shipping is not proposed as a part of PEP operations.

One submission raised the need to consider the increased shipping traffic within the World Heritage Area. Management of safety and environmental risks associated with shipping and vessel activity within the Great Barrier Reef Marine Park are controlled by the Australian Maritime Safety Authority (AMSA) and Great Barrier Reef Marine Park Authority. MSQ are responsible for determining permitted shipping activities within the Great Barrier Reef Marine Park compliance monitoring and enforcement of penalties for non-compliance with regards to environmental and safety management.

20.2.3 Adequacy of navigation hazard management on the rock wall

The MSQ submission also raised the lighting and illumination of the rock walls for navigational hazard management. Lighting and illumination requirements for the new rock wall, during construction and on completion of the land reclamation, will be determined in consultation with the Regional Harbour Master (RHM) during the detailed design phase of each stage and / or prior to construction. POTL will adhere to the standard safety requirements relevant to lighting and illumination of the rock wall, consistent with safe navigation.

20.2.4 Inclusion of detail on anchorage requirements and management

The MSQ submission requested additional information on future anchorage requirements as a result of the PEP and methods to manage any increase in anchorage requirements.

Future anchorage requirements for operations associated with the PEP were investigated as part of the *Preliminary Engineering and Environment Study* (Maunsell AECOM, 2009). Anchorage requirements are not envisaged to significantly increase as a result of the PEP. POTL has no legislatively ability to direct or require anchorage as it lies outside of POTL's jurisdiction. Management of the anchorage area is undertaken by the Regional Harbour Master (RHM) in line with State and Commonwealth requirements.

The MSQ submission also raised the adequacy of monitoring of benthic impacts from anchoring and discharge of pollutants and / or waste materials. The discharge of pollutants and / or waste materials is heavily regulated in Australia, Queensland and the Great Barrier Reef Marine Park. All vessels are required to comply with regulations and AMSA, Great Barrier Reef Marine Park Authority and MSQ have a range of enforcement tools available for compliance monitoring and penalty enforcement relevant to waste management and discharge offenses. As PEP provides additional berthing capacity it will somewhat alleviate the requirement for anchorage and PEP is not expected to require additional anchorage areas beyond the areas currently used by vessels. No additional benthic sampling has been undertaken at the anchorage area.

20.2.5 Impact to non-PEP vessel movements and interactions

The MSQ submission raised interactions between the PEP and non-PEP vessel traffic and the impact of movements and access to the shipping channel. More specifically, it was raised regarding channel speed limits and the potential for delays to the Townsville-Magnetic Island ferry and non-PEP vessel access to Ross Creek.

The shipping channel is currently subject to speed limits and it is envisaged these limits will remain in place and extend to the full outer harbour. This is not expected to significantly impact upon smaller commercial or recreational vessels with shallower drafts as there is no requirement for those vessels to remain in the channel and the majority of these vessels already exit the channel at the existing breakwater. The PEP is not anticipated to interfere with this practice. Should the western breakwater be required, a gap has been included in the preliminary design to allow this practice to continue. This will ameliorate any loss in transit time due to speed limits enforced in the channel.

Shipping movements in the channel are not expected to be significantly impacted during construction of the PEP. Dredging activities associated with the PEP construction will be undertaken to minimise interaction and disruption to operational shipping movements within the channel, in accordance with current practices. The channel widening during Stage 1 dredging will have minimal impact to commercial vessel operations. The channel deepening during Stage 3 will require the dredge to operate within the active shipping channel. Priority will be given to commercial vessels at all times. Additional time allowance has been made during the dredge program to ensure that the dredge is not operating in the channel whilst commercial vessels are approaching or sailing in the channel. Appropriate controls, management and regular dialog will be developed in consultation with MSQ and implemented to ensure any shipping / dredging interactions are appropriately managed.

MSQ raised recreational vessel access to boat ramp facilities in Ross Creek. The PEP will not impede recreational vessel access to Ross Creek and as outlined above the proposed gap in any future western breakwater will ensure that any impact of extension to speed limits within the channel are minimised. Details of the western breakwater design will be confirmed during the detailed design phase and in consultation with MSQ to ensure all safety and navigation requirements are adequately met.

The demarcation of the new outer basin area and the impact to the boating community was also raised. The new outer basin area will be marked with public access restricted during construction activities. Upon completion, the

new outer basin area will be a port operational area and managed similarly to the current Inner Harbour with strict limitations in place for water restricted zones, navigation safety and infrastructure protection.

20.2.6 Requirements of the Vessel Traffic Management Plan

MSQ requested additional information on performance objectives relevant to ensuring safe navigation of vessels and reporting of vessel interactions. A submission was also received regarding the likelihood of accidents due to increased shipping traffic. A Vessel Traffic Management Plan is provided in Part C of the EIS. This plan will act as a template for individual contractors to develop their own Vessel Traffic Management Plans specific to their operations. All Vessel Traffic Management Plans will be developed in accordance with the *Port Procedures, Information for Shipping and Standard for Marine Construction Activities* (draft), and will be submitted to POTL and RHM for approval. Vessel Traffic Management Plans will outline performance objectives as well as navigation hazard management and reporting requirements.

The Maritime Operations Management Plan provided in Part C of this AEIS will also be updated in accordance with the *Port Procedures, Information for Shipping and Standard for Marine Construction Activities* (draft), and subject to any amendments to these documents. The Maritime Operations Management Plan will be updated prior to each stage of the PEP and will be submitted to the RHM for approval.

20.2.7 Adequacy of spill management measures

Two submissions were received regarding the adequacy of the current spill management measures. The PEP will rely on the existing POTL spill management measures which will be reviewed independently of the PEP. They will be applied to the construction and operation of the PEP. Spill management measures will also be reviewed with MSQ and RHM prior to Stages 1, 2 and 3 where new berths are developed, to ensure their adequacy. This review will include first strike response measures.

MSQ raised the management of ballast water. Ballast water discharge from vessels is managed by individual ship operators under the control of the Commonwealth Department of Agriculture and Water Resources. All international vessels operating in Australian waters, including the Great Barrier Reef Marine Park, must manage their ballast water in accordance with Commonwealth requirements. These vessels must exchange ballast water for clean water from the deep ocean prior to entering Australian waters. All discharge activities at berth must be undertaken in accordance with State and Commonwealth requirements and regulations.

20.3 Revised Environmental Impact Assessment

20.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. The legislative and policy changes did not impact on the assessment of port operations presented in the EIS.

20.3.2 Design refinement

The project design has been revised and modified to further reduce potential impact to the marine environment. This revision has resulted in updated staging for the PEP, impacting the timing and duration of channel dredging and berth construction.

The western breakwater option and creation of a gap to facilitate non-PEP vessel movement out of the channel will be assessed and confirmed as part of the detailed design phase.

20.3.3 Supporting studies

No additional studies were required to assess the revised design and adequately address comments received from public submissions.

20.3.4 Revised assessment

20.3.4.1 Impact assessment

The design refinement modifies the timing and duration of channel dredging. Impacts associated with this refinement are expected to be similar to that identified in Chapter B.18 (Port Operations) of the EIS. Non-PEP vessels will still be able to exit the channel at the end of the existing breakwater and the western breakwater option can retain this gap to facilitate movement if required. Dredging activities will be undertaken to minimise disruption to shipping movements in accordance with current practice.

20.3.4.2 Mitigation measures

Section B.18.5 of the EIS identifies mitigation measures to reduce the impact the Project has on port operations. The mitigation identified in the EIS remains current for the revised design. Mitigation measures will be outlined and implemented through the following management plans:

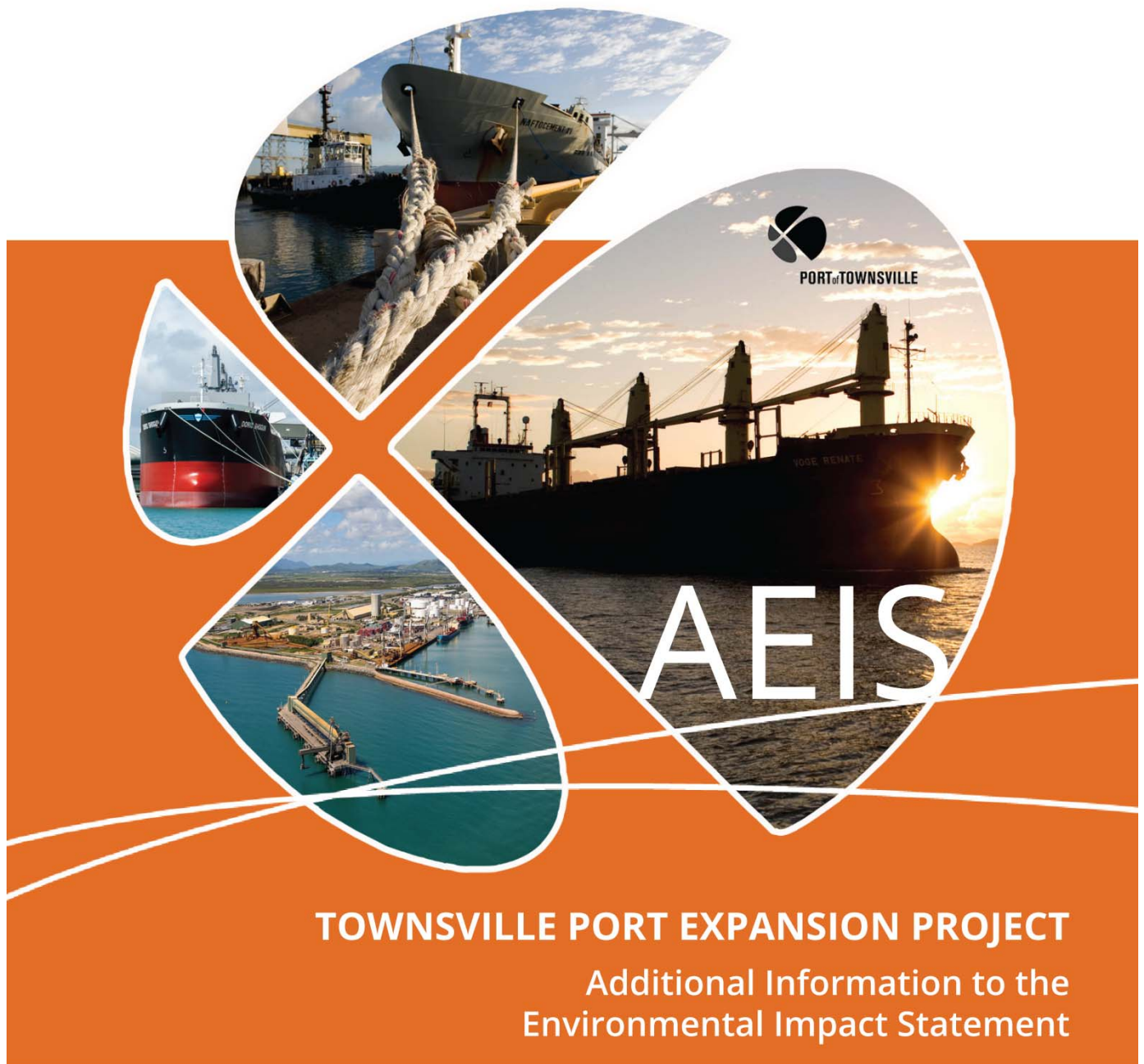
- Construction Environmental Management Plan (Appendix B2 of the AEIS)
- Operational Environmental Management Plan (Appendix B3 of the AEIS)
- Vessel Traffic Management Plan (Chapter C2.3 of the EIS)
- Maritime Operations Management Plan (Chapter C2.4 of the EIS).

20.3.5 Summary

Section B.18.4 of the EIS provides an assessment of potential impacts and proposed mitigation measures in regards to port operations. Management plans identified in Section 20.3.4.2 above will be updated were required prior to construction and operation of the PEP.

20.4 Conclusion

The incremental development of the PEP over several decades is not expected to significantly impact upon port operations and with the implementation of mitigation measures as described in the Construction Environmental Management Plan (Appendix B2), Operational Environmental Management Plan (Appendix B3), Vessel Traffic Management Plan and the Maritime Operations Management Plan the overall impact to port operations is considered to remain low.



SECTION 21

Economic Development



21.0 Economic Development

21.1 Introduction

The economic environment and the economic impact from the development of the Port Expansion Project (PEP) are discussed in Chapter B.19 (Economic Development) of the Environmental Impact Statement (EIS). The economic assessment discussed the existing and future demand for Port capacity. The assessment defined and assessed a base case against the expected developed port to identify any positive or negative impacts during the construction and operation phases. The estimated economic benefit (in present values), of the Project was estimated to be of around \$1,500 million. Socio-economic impacts were also assessed, including housing, commercial fishing, labour markets and employment.

This section provides responses to submissions from public consultation and the results of new analysis that identifies the economic role of the Port in the region, and regional risks resulting from capacity constraints of the Port. This chapter section is not intended to represent a business case for the PEP, or an update on an existing business case for the PEP, however the information presented here is required under the Terms of Reference to provide context for economic impacts.

Key matters raised within the submission process include:

- justification of the need to expand the Port of Townsville in context of present berth utilisation
- the role of the port in the economic stability, sustainability and development of North Queensland and the risks and flow-on effects of removing this capacity
- consideration of using alternative ports to cater for increased demand, especially any future coal exports
- the need to accommodate larger vessels
- coal exports through the Port of Townsville
- economic impacts of the Port Expansion Project to tourism, especially on Magnetic Island
- greater economic impacts to Great Barrier Reef (GBR) Outstanding Universal Value (OUV)
- changes to base data demographics.

21.2 Response to Submissions

21.2.1 Justification for the need to expand the Port of Townsville in context of present berth utilisation

There were 26 submitters who identified that global economic conditions have changed since the EIS was produced and raised that the PEP might not be required. Submissions cited the current port capacity and speculated that sufficient space exists without further expansion. The Department of State Development, Infrastructure and Planning also identified the need to consider opportunities for improved efficiencies as an alternative to accommodating some of the growth at the port. Submitters mostly used historical berth utilisation statistics as an indicator of port capacity and therefore used historical berth utilisation rates to question the need for future expansion.

While the historical berth utilisation figures may suggest additional capacity is available, berth utilisation is only part of the picture. Rather, it is port performance, reliability and economic throughput that are most suitable indicators of port capacity and therefore basis for increased capacity rather than historical berth utilisation statistics.

Port capacity can be defined as the maximum traffic a port terminal can handle (Martin Soberon, 2012). Port capacity is therefore effectively a function of the reliability and economic performance that are determined by factors such as the level of traffic and the commercial activity occurring at each individual port, channel infrastructure and materials handling equipment.

Due to the differences between individual ports, measuring and defining port performance is not standardised (Fourgeaud, 2000). However, a number of key performance indicators (KPIs) may be used for measuring port performance. For example, berth occupancy, ship dwell time, cargo handling performance and utilisation of materials handling equipment are commonly used.

Operational port performance, which can be measured in terms of output, productivity and utilisation, is also a reflection of port capacity. Output is the volume or tonnage of cargo a terminal handles over a period of time, productivity is the work rate of the resources of a terminal, and utilisation is the ratio of time a resource is used over the total time it is available.

When considering the marine part of operations, optimal capacity for a port (in terms of berth numbers) is a balance between berth utilisation and ship waiting time. When berth utilisation is high this leads to low operational costs at the expense of high ship waiting time (anchorage delays). Conversely, for a port with a high number of berths (and hence lower berth utilisation), there will be low ship waiting times but high operating costs (De Weille & Ray, 1974).

Therefore considering historical berth utilisation alone is not a good indicator of either port capacity or future need. Berth utilisation is also impacted by the availability of the resources required for loading/unloading vessels, shipping mix, ship scheduling policies, terminal layout, channel access (including waiting for tide conditions and under keel clearance (UKC) and availability of product.

Furthermore, when considering berth utilisation, it is important to remember that it is not possible to fully utilise a berth at all times. That is, 100% utilisation is never achievable. The time required to pilot vessels between the inner harbour and berth, the process of mooring and clearing the berth and harbour and delays waiting for correct tide and under-keel clearance, as well as maintenance windows, must all be taken into consideration. In addition POTL has been undertaking a range of improvements of existing infrastructure which have progressively had one or more berths being unavailable during these works. For the existing berths at Townsville, other factors such as proximity to other berths and associated access restrictions are also applicable. According to BITRE (2013) a berth utilisation at or exceeding 80 per cent is an indication of a berth close to, or at, full capacity. Depending upon the physical arrangement of the berths, and other factors, the full capacity figure may be much lower. Berths operating at 80 per cent utilisation are somewhat unusual and often restricted to either single high demand product berths, or bulk port single cargo berths. It can often be the case that when the berth utilisation is high, the overall port efficiency is low, as high berth utilisation generally implies that a number of vessels will be at anchor. Hence the utilisation figure at maximum capacity is not the same at every port.

Since the publication of the EIS, Queensland Nickel imports have ceased due to the current liquidation of the company. There are a range of commercial issues still to be resolved. Queensland Nickel asserts that a reopening of the refinery is possible; this would clearly require the use of Berth 2. Should the refinery not resume operations, Berth 2 has a number of physical limitations (primarily draft and wharf structural strength) which would restrict its' use for a range of other cargoes. In the case of Berth 2 becoming available, it is not a viable substitute for the vessel types being catered for by PEP and therefore has no significant impact on the need for PEP.

21.2.2 Current Berth Occupancy at Port of Townsville

Berth occupancy (utilisation) and total tonnage for the Port of Townsville from 1997 to 2014 is shown in Figure 21.1 below. There is a general upward trend in utilisation of berths since 1997 and a substantial variation across individual berths. In Figure 21.1, optimum berth capacity is shown for each berth in the right hand column. These figures were estimated in 2007 prior to various capacity improvements which POTL has commenced in parallel to this PEP.

There is substantial variation in the optimum utilisation for the various berths at Port of Townsville. For example, for Berth 8, optimum utilisation is as low as 35% whereas for Berth 2 it is 65%. This variability is due to many factors including the berth arrangement and access restrictions as a result of berth arrangement, specific onshore cargo handling infrastructure, channel capacity including dimensions and any associated tidal or draft restrictions, and the overall efficiency of the general terminal layout. In the case of Berth 8, the 35% optimum utilisation is primarily the result of access restrictions that are in place for Berth 8 as a result of the proximity of Berth 7. Historically, access to Berth 8 is not available to vessels over a certain beam when there is a vessel in Berth 7. When works at Berth 8 are complete and Berth 7 is completely demolished, the optimum utilisation at Berth 8 will increase.

The optimum utilisation value of 65% for Berth 2 is the highest of all the berths in the Port. It is noteworthy that this berth is used for single cargo by a single operator who is able to schedule their vessel arrival time. It has the capability to share cargo handling cranes with the adjacent Berth 3 and illustrates the optimal utilisation that could be expected in a fully optimised port without the physical constraints of the existing breakwaters, berth arrangement and channel restrictions.

In addition, due to ongoing upgrades, Berth 7 has been under demolition, and Berth 10 has not been operational for periods in the 2011/12, 2012/13, 2013/14 Berth 8 has also been unavailable for operations for many months over recent years as a result of port works. These outages are reflected in the lower utilisation figures for these berths over recent years. Once the upgrades are completed it will improve the optimum utilisation figures.

Port of Townsville Limited**Berth Occupancy 1997/1998 to 17 October 2014**

Includes Cargo, Navy, Passenger & Other vessels

Berth Occupancy																			Optimum Berth Occupancy
Berth	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	
Berth 1	20.39%	16.38%	23.02%	20.96%	16.59%	16.58%	17.48%	21.19%	21.50%	20.68%	24.03%	22.98%	20.95%	22.44%	31.56%	31.70%	26.54%	25.26%	60%
Berth 2	55.41%	58.20%	54.89%	51.11%	49.63%	59.12%	58.23%	56.57%	54.13%	52.97%	60.62%	52.72%	62.73%	62.89%	68.06%	76.10%	55.40%	56.51%	65%
Berth 3	40.10%	40.60%	52.08%	49.35%	46.61%	49.54%	46.93%	49.44%	50.61%	51.53%	55.90%	58.83%	62.26%	70.77%	80.20%	87.81%	81.46%	77.87%	50%
Berth 4	43.63%	31.65%	28.17%	30.38%	28.86%	30.55%	30.72%	32.56%	32.46%	44.16%	46.82%	42.90%	35.71%	35.07%	63.00%	71.53%	53.12%	50.39%	40%
Berth 7	35.36%	27.02%	24.26%	40.41%	32.53%	35.60%	29.48%	35.66%	40.85%	39.45%	42.29%	40.58%	45.21%	51.54%	72.15%	56.50%	39.64%	40.95%	50%
Berth 8	46.11%	28.27%	43.00%	35.29%	31.22%	37.10%	40.99%	29.77%	27.46%	30.55%	32.70%	26.34%	27.10%	35.19%	6.58%	0.13%	0.65%	7.79%	35%
Berth 9	40.57%	28.94%	39.86%	42.14%	27.09%	33.01%	33.72%	30.67%	37.79%	39.46%	44.65%	35.38%	36.40%	39.55%	66.74%	58.57%	40.34%	40.04%	55%
Berth 10	34.99%	22.51%	27.26%	29.75%	25.88%	30.58%	25.15%	18.42%	27.11%	25.19%	40.82%	29.40%	28.09%	22.89%	17.57%	1.05%	39.33%	53.85%	45%
Berth 11	8.96%	13.42%	12.94%	13.75%	14.56%	11.98%	14.14%	14.54%	13.60%	12.18%	18.59%	19.40%	19.49%	25.84%	30.27%	23.32%	15.81%	9.16%	55%
Total	36.17%	29.67%	33.94%	34.79%	30.33%	33.79%	32.98%	32.09%	33.95%	35.13%	40.71%	36.50%	37.55%	40.69%	48.46%	45.19%	39.14%	40.20%	

Includes Cargo, Navy, Passenger & Other vessels

Berth utilisation for berth 8 & 10 not adjusted and excluding PB Towage tugs & Maintenance visits

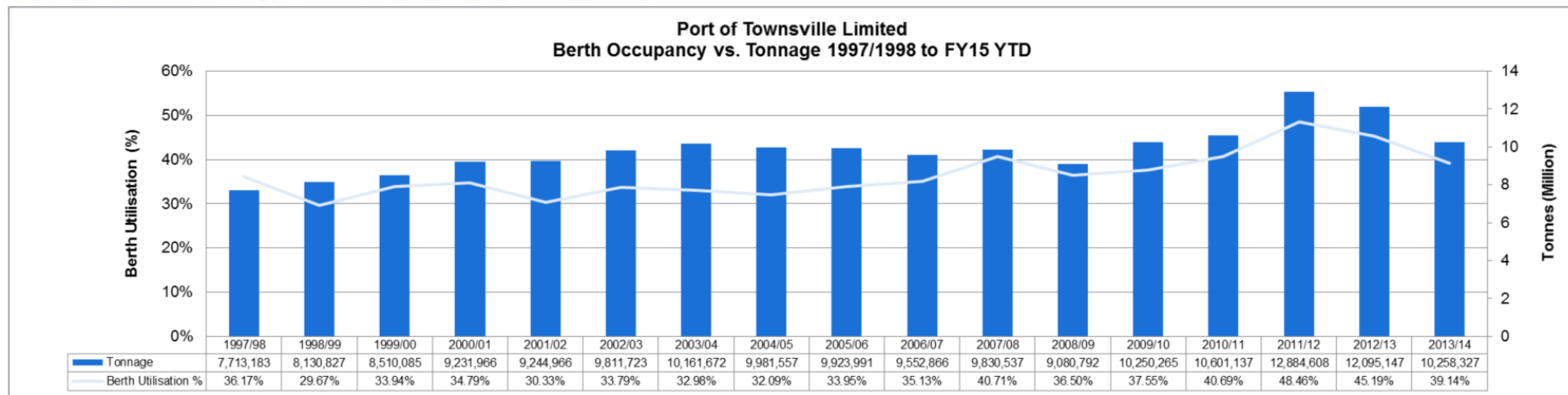


Figure 21.1 Berth Occupancy (1997-2015) and Tonnage Port of Townsville 1997-2014)

21.2.2.1 Comparison of Port of Townsville Berth Utilisation with other ports

Some examples of port expansion projects that have occurred in a port with “low” historical berth utilisation rates are provided below to illustrate how berth utilisation varies across ports.

To compare Port of Townsville Berth Utilisation with other ports, the table below illustrates berth utilisation for Victorian ports for the years ending 30 June 2006 – 2010 (Essential Services commission 2011). Table 21.1 illustrates how berth utilisation varies across ports. It is also important to note that despite these relatively low berth utilisation rates, major port expansions are underway in Victoria.

Table 21.1 Berth utilisation (%) for Victorian Ports, 2006 - 2010

Port	2006	2007	2008	2009	2010
Melbourne	29.5	31.2	30.9	29.0	28.1
Geelong	36.0	37.0	34.0	41.0	32.0
Portland	45.8	30.0	32.4	27.8	28.6
Hastings	20.2	19.7	20.4	14.8	7.7

The Victorian ports listed above have recent utilisations below 50 percent, however have developed or are implementing expansion strategies to accommodate growth in future trade. Individual approaches differ according to existing land usage and infrastructure. For example, Portland and Hastings port expansions focus on land use planning to gain efficiencies in cargo handling. Expansions at Port of Melbourne include channel deepening, and a new container terminal at Webb Dock to take port traffic off local roads.

The expansion strategy for Port of Geelong addresses land and sea transport infrastructure requirements that will take into consideration larger vessels, larger trucks and new commodities. For the marine side, the larger vessels will require increased channel dimensions (including at the berth) to maintain safe passage of vessels. A historical and future change to the global vessel fleet, particularly the shift towards larger vessels, was a major driver for the expansion of infrastructure in the Port of Geelong.

Therefore use of only historical berth utilisation statistics is an inadequate tool to assess if further port expansion is necessary and is inconsistent with best-management port practices. Whilst POTL continuously seeks to improve efficiencies and work within the existing port, to minimise capital costs, the proposed expansion to the Port of Townsville is required to accommodate medium and long-term future growth in trade volume over a planning horizon to 2040 and beyond. Additional berths, land reclamation, and modifications to improve accessibility for vessels will ensure the port remains attractive to shippers and allow for increased shipping movements and access, decrease in ships at anchor and remove current constraints on growth. The staged future planning is also considered to be consistent with the *Sustainable Ports Development Act 2015*.

21.2.3 The role of the port in the economic stability, sustainability and development of North Queensland and the risks and flow-on effects of removing this capacity

There were 230 submissions (includes form letter submissions) which questioned the role of the port in the region.

The Port of Townsville is the gateway to the region for a range of imports including general cargo, construction material and motor vehicles. The Port facilities have critical infrastructure for the central, western and northern Queensland region and support the region in a number of sectors: defence; oil, gas and fuel; mining and metals; agriculture; and tourism.

The Port of Townsville is critical to the ongoing survival of regional industries including Queensland Sugar Limited, and global companies including but not limited to, Glencore, South 32, and Incitec Pivot.

The value of cargo which transits the wharves in the Port is estimated to be in excess of \$8 billion per year.

In terms of the above sectors the port's role at present and in the future are summarised as follows.

21.2.3.1 Defence

Townsville has a longstanding history hosting The Australian Defence Force. Townsville presently hosts Lavarack Barracks, RAAF Base Townsville, Mount Stuart Training Area and Townsville Field Training Area. These are critical frontline ready-deployment capabilities for the Australian Defence Force.

The Port of Townsville was identified in the 2009 *Defence White Paper* as a critical component of Australia's defence force operations. Recent infrastructure upgrades to the Port support Defence capability include the development of the Landing Helicopter Dock vessel at the new multi-user terminal at Berth 10.

The 2016 Australian Defence White Paper identifies investment in national defence infrastructure – including the Army, Navy and Air Force bases in northern Australia, including Townsville as a focus of the White Paper. The White

Paper acknowledges the Defence fuel installations as critical enablers for the generation of Defence capability. The government will continue to improve Defence's fuel resilience and capacity to transport bulk fuel to support of bases and operations. This will include upgrades to existing Defence fuel infrastructure as well as improvements to Defence ability to utilise commercial fuel supplies. The Port has a bulk fuel line to Berth 9 to provide a high flow rate supply of diesel fuel for defence and other vessels.

The Port also caters for other cargo supporting Defence assets in Townsville which include Lavarack Barracks, RAAF Base Townsville and the Townsville High Range Training Area.

21.2.3.2 Tourism

The new multi-user facility at Berth 10 includes a cruise ship terminal which provides cruise liners with a dedicated berth containing a commercial hub. This facility has the capacity to allow home porting of cruise vessels in the future and proposed improvements to the channel included in PEP will increase the certainty of access for a number of cruise vessels.

The communities of Magnetic Island and Palm Island are serviced from the Ross Creek precinct that lies within the boundaries of the Port. Ferry services are presently supplied by SeaLink Queensland that operates 4 vessels and employs around 70 staff in the region, as well as Fantasea which is predominately a car ferry service but also includes passengers. Multiple tourism operators on these islands are also underpinned by the facilities at the Port facility so that visitors can be supplied whilst on Magnetic Island.

Future development projects such as Townsville Waterfront Priority Development Area, will provide an improved experience of the waterfront area that showcases Townsville, the port and the CBD. There will potentially be a variety of public open spaces and a mixed use development to showcase the relaxed lifestyle of Townsville and the CBD.

The Port also maintains the navigational channel that allows safe passage for tourism vessels to the Great Barrier Reef.

21.2.3.3 Fuel and fuel products

North Queensland is reliant upon the import of fuel, bitumen, oil and gas. The Port hosts four fuel terminals that contain storage tanks and road / rail load-out facilities.

ATOM operates one terminal on behalf of BP, while Viva Energy operates two terminals on behalf of themselves and Caltex. Puma Energy operates two terminals (one bitumen, one fuel) on behalf of themselves.

Further to the fuel facilities, there are also two bitumen import and storage facilities, located in the Viva Energy terminal and a second one located at the rear of Berth 2 operated by Puma Energy. These facilities are critical for maintaining road infrastructure in North Queensland, underlined by Viva Energy currently progressing with a major upgrade to their facility.

Petroleum products for all companies are imported through a multi-user facility at a dedicated Bulk Liquids Berth (Berth 1). Approximately 1 million tonnes of oil, gas, acid and petroleum products are imported annually through berth 1. This generally comprises around 900,000 tonnes of fuels:

- around 540,000 tonnes or 635 million litres of diesel
- around 180,000 tonnes or 228 million litres of Jet A1
- around 180,000 tonnes or 250 million litres of gasoline products including Unleaded Petrol blends and Avgas
- around 180,000 tonnes of heavy Fuel Oil (for Queensland Nickel)
- bitumen products (including finished bitumen and bitumen feed stock).

The Townsville terminals supply customers directly by road tankers, road trains and limited rail tankers. The B-double configured road tankers have a capacity of approximately 52,000 litres. The road trains have a capacity of 105,000 litres. The local semis have a capacity of 35,000 – 40,000 litres. Customers supplied in this way include retail sites (petrol stations), transport companies, mining companies and regional distributors. Major users, such as the cane farmers of the region, are supplied through regional distributors.

Locally, Townsville airport and Department of Defence is supplied with Jet A1 from the Townsville terminal. Major airlines such as Qantas and Virgin Australia refuel every 737 flight at Townsville with this Jet A1 fuel, using in the order of 15 million litres each month.

Further afield, Cloncurry and Mount Isa depots are supplied by road train and rail tankers from Townsville. Notably, Aurizon which operates on the Mount Isa to Townsville rail line is itself a major customer of the terminal, with the diesel for the locomotives being imported through the Terminal. Townsville is the only port in Queensland that can load rail wagons directly with fuel.

It is believed that the majority of mine sites in the north-west, who together represent a significant diesel user, generally carry approximately 8 days' supply on their own sites, while there is generally 2 to 3 weeks supply in the supply chain for domestic customers of both diesel and gasoline (including LPG).

Other major diesel users include the transport companies which support the banana growers around Tully, and the cane farmers in both the Herbert and Burdekin districts.

The users of Avgas include the general aviation sector, and specialist services such as the rescue helicopter.

The sulphuric acid terminal provides storage facilities for the import and export of acid for the industrial and mining activities for North Queensland. Acid is a byproduct of zinc refining, and is also a major component in the manufacturing of fertiliser and other industrial activities.

21.2.3.4 Individual facilities reliant upon the port

The North West Queensland Mineral Province, located in Mount Isa represents a large proportion of minerals in Australia. Minerals mined from this region are exported as refined product or as mineral concentrates through the Port of Townsville. Key mineral exports include refined copper and copper concentrate, silver, lead ingots and lead concentrates, zinc metal and zinc concentrates and magnetite on occasion. Hence the Port serves as critical infrastructure for the minerals exported from central and Northern Queensland.

Summary descriptions of these major exporters' operations are provided in Table 21.2 below.

Table 21.2 Summary of operations of Major Uses

Major Users	Description of Port operations
Defence	The Port has been designated as critical defence infrastructure.
Glencore	Glencore own and operate multiple mines in the Mount Isa and Cloncurry area, including the Ernest Henry Mine which produces and processes copper, gold and magnetite (production of magnetite is presently not underway). In 2011 this mine produced around 100,000 tonnes of copper in concentrate and 130,000 ounces of gold in concentrate. Along with the Enterprise, X41, and George Fisher underground mines, and the Black Star and Handlebar Hill open-pit zinc mines, the Glencore portfolio represents a global-scale mining operation in central and northern Queensland, with the majority of the produced minerals and concentrates exported through the Port of Townsville.
Incitec Pivot	Incitec Pivot Limited (IPL) produces ammonium phosphate fertilisers from a combined mine and ore processing facility at Phosphate Hill, located around 150 kilometres south of Mount Isa. The annual production is around 975,000 tonnes, the majority of which was historically exported through Berth 8 at the Port of Townsville. This operation will move to the upgraded Berth 8 in early 2015.
Queensland Nickel	Queensland Nickel at the Yabulu refinery uses around 4 million tonnes of nickel and cobalt bearing laterite ores, imported through Berth 2, along with around 180,000 tonnes of Heavy Fuel Oil (HFO), imported through Berth 1. The refinery also uses electricity from the grid and LNG piped from Moranbah as energy sources to refine the ore into nickel and cobalt products. Some of these products are then exported through Berth 3 at the port. Queensland Nickel's ore represents the single largest product handled through the port.
Queensland Sugar Limited	The Townsville Sugar Terminal is located behind Berth 9 at the Port of Townsville. This terminal is operated by Queensland Sugar Limited (QSL). QSL manages around 70% of raw sugar exports in Australia through six bulk terminals in Queensland. Sugar for the Townsville Sugar Terminal is sourced from the Burdekin growing area which is the largest sugar producing region in Australia. The four Burdekin mills produce around 1.2 to 1.5 million tonnes of raw sugar annually. The Townsville bulk sugar terminal was established in 1950 and has a present storage capacity of 760,000 tonnes. The storage capacity is such that timely export of sugar is required each season to ensure the mills are able to remain operational. QSL also operate the Molasses Terminal behind Berth 4 on behalf of Wilmar Sugar.
South 32	The largest single global producer of lead and silver is the Cannington mine, located 200 km south-east of Mount Isa. This underground mine, owned by South 32, also hosts a metallurgical processing facility. The concentrate is transported by rail to dedicated storage and ship-loading facilities at the Port of Townsville, and exported through Berth 11.

21.2.3.5 Current Port trades

Figure 21.2 shows the port throughput since 2002/03. A list of the specific cargoes are provided in Table 21.3.

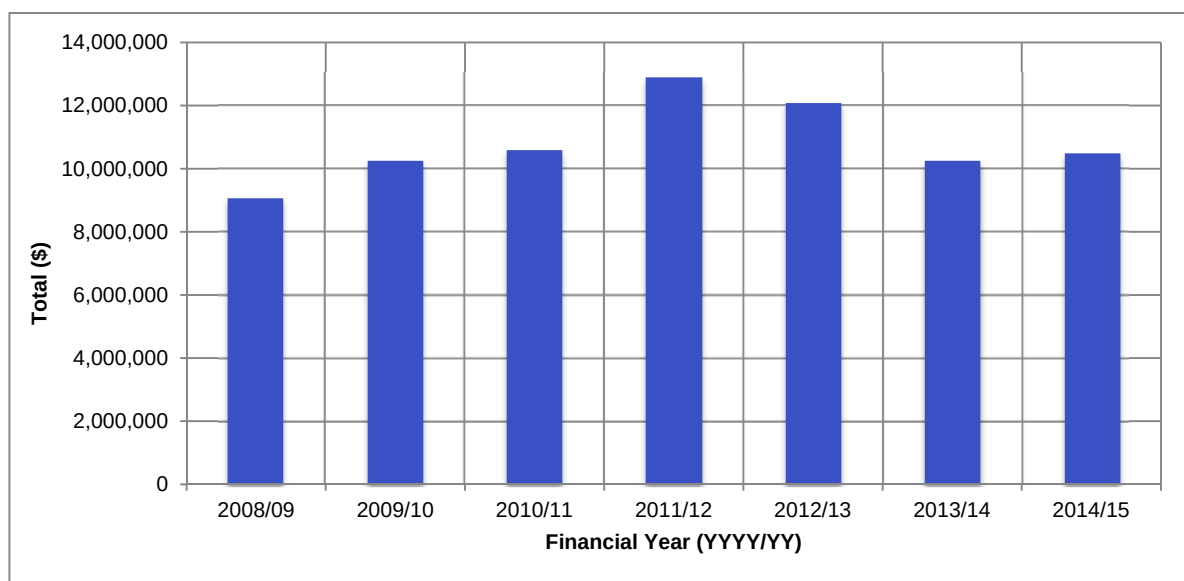


Figure 21.2 Port of Townsville Trade Statistics - Townsville Throughput

Following a peak in 2011/12, total throughput has reduced over the last two years. However, as demonstrated in the analysis of berth utilisation, a short term reduction in throughput whilst partly a result of weakening global and regional economic conditions, importantly also demonstrates that changes in the global and regional shipping fleet, and other bottlenecks in the port supply chain are restricting the port throughput. In other words, rather than simply concluding that the role or demand for port services is waning, it demonstrates that the capacity and configuration of the port needs to be updated to reflect regional external changes in the shipping fleet and behaviour of shippers. This is further discussed in the following section.

Table 21.3 Trade throughput summary (tonnes) (POTL, 2008 - 2013)

Trade	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Import							
Cement	460,538	453,124	466,668	482,254	540,158	503,908	414,645
Fertiliser	91,600	113,691	87,775	96,817	118,814	157,962	114,356
General Cargo	152,086	188,726	211,621	300,493	265,215	254,596	263,869
Concentrates Nickel	41,439	0	13,311	52,714	16,283	69,132	63,063
Concentrates Zinc	228,476	158,341	258,309	250,230	322,078	251,841	282,856
Metals - Copper Anode	31,655	98,964	30,630	73,564	97,968	77,055	47,005
Mixed Hydroxide Percipate	0	0	0	0	0	0	8,117
Motor Vehicles	15,500	28,166	19,329	27,092	24,224	19,150	22,819
Nickel Ore	2,618,563	3,680,603	3,719,507	3,978,616	3,958,967	3,160,244	2,926,579
Petroleum Products	987,897	1,016,206	941,103	1,111,296	1,112,244	1,087,606	939,699
Sulphur	101,703	103,812	103,746	112,733	102,460	52,909	79,210
Sulphuric Acid	37,578	0	24,067	63,396	112,980	22,398	26,517
Import Total	4,767,034	5,841,634	5,876,067	6,549,205	6,671,391	5,656,801	5,188,733
Export							
Fertiliser	773,619	779,810	828,105	866,066	810,338	637,203	923,987
General Cargo	150,018	150,126	145,404	191,633	163,846	171,126	219,604
Livestock - Cattle	76,204	45,031	23,888	10,863	2,072	100,905	152,890
Magnetite	0	0	278,476	846,523	773,177	386,662	153,095
Meat & By-Products	6,832	15,129	27,188	21,288	13,014	5,633	8,427
Metal Cons - Copper	454,050	302,138	213,874	180,492	276,305	227,734	136,615
Metal Cons - Lead	325,585	401,910	381,792	373,058	354,773	387,697	369,176
Metal Cons - Lead/Silver	42,330	64,960	14,257	0	1,705	31,755	10,176
Metal Cons - Zinc	544,104	695,858	776,315	808,480	889,953	755,588	1,117,553

Trade	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Metal Cons - Zinc Ferrites	67,218	56,726	154,328	210,651	210,175	252,513	226,857
Metals - Refined Copper	205,500	201,358	228,520	272,221	198,633	257,536	314,855
Metals - Refined Nickel	1,146	11,548	17,733	27,967	16,998	17,773	14,863
Metals - Refined Zinc	158,945	137,143	289,014	156,889	139,109	175,451	155,567
Metals - Smelted Lead	153,192	152,029	113,658	164,430	129,623	132,563	109,201
Metals - Zinc Oxide	0	0	24,339	0	0	0	0
Molasses	244,463	185,237	233,710	381,782	254,731	271,032	247,856
Motor Vehicles	0	0	0	0	0	0	50
Petroleum – Contaminated Oil	5,566	1,667	3,259	8,628	6,978	5,955	0
Sand/Gravel/Coke	0	8,181	0	0	0	0	0
Sugar	1,078,520	1,190,898	958,720	1,490,541	1,091,626	784,400	1,140,806
Sulphuric Acid	30,497	11,432	12,488	5,502	0	0	0
Timber	0	0	0	318,696	90,700	0	0
Export Total	4,317,787	4,411,181	4,725,069	6,335,708	5,423,756	4,601,526	5,301,578
Grand Total	9,084,821	10,252,815	10,601,137	12,884,913	12,095,147	10,258,327	10,490,311

Note:

- Sugar figures for Lucinda included for 2012/13 so totals agree with published totals from POTL Annual Report.
- While 2012/13 data is included in Table 3, the data wasn't available in time to be included in the analysis.

21.2.3.6 Impact of not having sufficient port capacity

The information presented above describes the pivotal role the port plays in supporting North Queensland communities and industry sectors. An economic input-output model was developed to understand the economic impacts to North Queensland industries and communities of current constraints at the port. The model investigated hypothetical disruption scenarios where specific vessels would be unable to gain access to the port as a result of hypothetical reductions in available channel depth. The model was constructed using measured historical data and considered real impacts that would occur to real trades should the disruption become real. By implication, the impacts of not having future trades occur can be inferred.

The current Port of Townsville access channel is maintained at a declared depth of -11.7 m LAT, which provides all tide access for Handymax size cargo vessels (40 000 – 50 000 DWT) and limited tidally assisted access for Panamax class vessels (65 000 – 80 000 DWT).

Handymax size cargo vessels, generally 150-200 metres in length, are the most common vessel presently used for general cargo operations in the shallower ports such as Townsville. These vessels typically have a loaded draft of around 11.0 m and needs 12.3 m of water depth in the channel and swing basin to allow these vessels to access the port. The mean low water spring (MLWS) level in Townsville is +0.77 m LAT, so there is sufficient water depth for Handymax shipping to transit the channel during most tides.

Trading ships, such as Panamax class type vessels, are built longer and/or wider than Handymax cargo vessels in order to access a trade through the Panama Canal. The common Panamax size vessel is generally 32.3 m wide, 225 m long and with a laden draft of up to 14.5 m. As a result of the available dredged depth in the Port's access channels, these vessels can only transit the Port of Townsville during short high tide windows when they are fully laden.

The Panama Canal is presently being widened under the Panama Canal Expansion project (due for imminent completion). This will allow post-Panamax Plus or new Panamax ships to traverse the canal and this is incentivising a global change in the mean beam or width of vessels. The Port Expansion Project will provide enhanced access for Panamax and unrestricted access for Handimax vessels. However, the following discussion relates to the present shipping which accesses the port through the existing channels, but is applicable to all future channels.

The following three scenarios were considered and described in Table 21.4:

1. All tide access restricted to Handysize vessels (40,000 deadweight tonnage)
2. All tide access restricted to small Handysize vessels (25,000 deadweight tonnage)
3. All tide access restricted to small Handysize vessels (10,000 deadweight tonnage).

Port data were combined with supply-chain analysis information to quantify the key supply chain interdependencies. Table 21.4 shows an example of these inter-dependencies.

Table 21.4 Scenarios considered for vessel access

Scenario	Largest vessel that can sail loaded in channel		% Vessels unable to sail loaded in channel	
	All tides	High tides	All tides	High tides
1	Handysize (30,000 deadweight tonnage)	Handysize (40,000 deadweight tonnage)	29%	16%
2	Small Handysize (20,000 deadweight tonnage)	Handysize (25,000 deadweight tonnage)	70%	50%
3	Small Handysize (10,000 deadweight tonnage)	Small Handysize (12,000 deadweight tonnage)	87%	78%

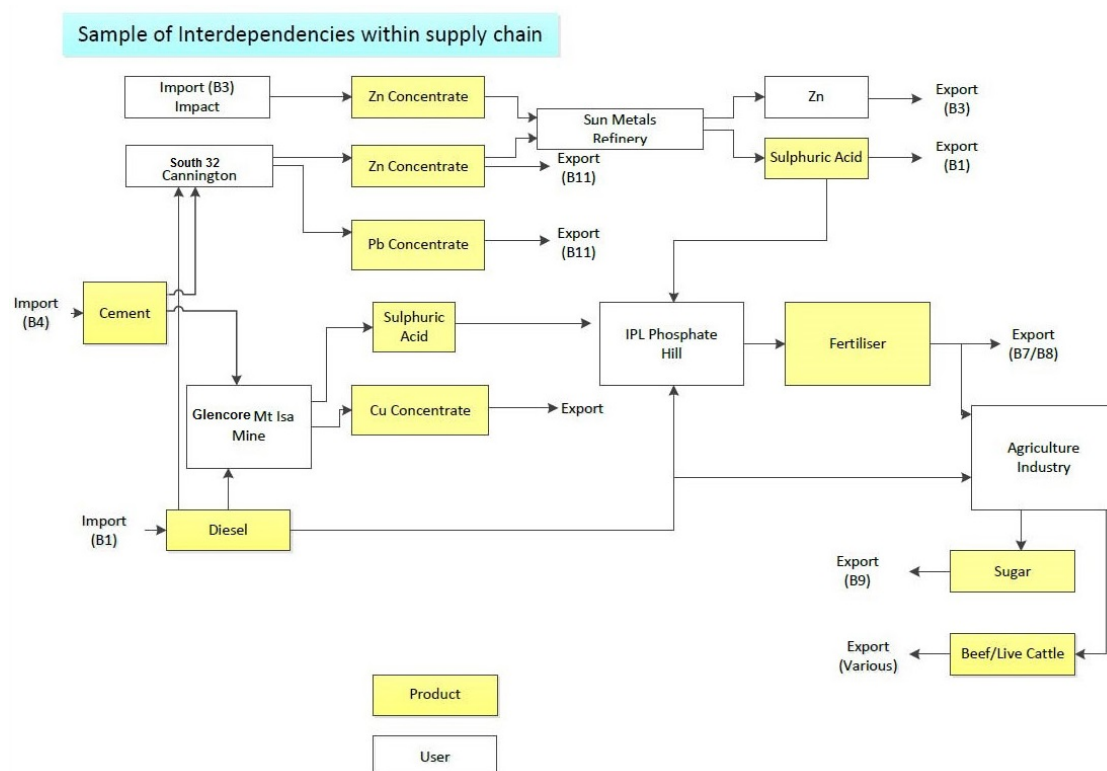


Figure 21.3 Sample of Interdependencies within Supply Chain

The economic impacts were estimated using regional multipliers calculated from a State-level Input-Output table (Australian Bureau of Statistics, 2012b). This table was derived using the latest national Input-Output table (2008-09) prepared by the Australian Bureau of Statistics as part of the Australian National Accounts (Australian Bureau of Statistics, 2012a), and adjusted by AECOM to reflect Queensland inter-industry transactions and final demand flows. The adjustments were based on information and data at the State-level within the Australian National Accounting System and on Census data.

The Queensland Office of Economic and Statistical Research have developed regional Input-Output tables, the most recent being for 1996-97. It is important that the relationships between the regions and the State underlying these earlier tables are recognised. This is not because industries in a particular region will necessarily have different production methods to those in the rest of Queensland, but because the import-intensity at a regional level could be significantly different than would be found in the State-level table.

The table for Northern Queensland (which mainly captures Townsville activities) has been used as a reference source to compare the regional multipliers to the State level multipliers for that year. The resulting ratios were applied to the multipliers derived from the latest State level Input-Output table to impute regional multipliers for the latest year. These multipliers were then reviewed to take account leakages of expenditures and factor incomes from the region.

To measure economic impact, four multipliers are used:

- output (gross revenue or turnover)
- value added (which can be directly compared to gross State product and gross regional product)

- household income
- employment.

Two types of multipliers can be calculated.

- Type 1 multipliers - measure the direct and production-induced impacts of a stimulus or activity. The latter impacts refer to the subsequent rounds of purchases of inputs by businesses supplying the direct suppliers of the stimulus or activity (industrial flow-on effects).
- Type 2 multipliers - capture the Type 1 effects and also measure the consumption-induced effects that flow from the expenditure of income that is earned from the production of additional output.

Previous port impact studies have used Type 2 multipliers because of the labour intensity of port operations and their importance as places of employment to the communities in which they are located (Bureau of Transport Economics (2000; 2001a; 2001b), Econsearch (2009)).

Multipliers are usually presented in terms of '\$ per unit of output'. However, employment multipliers are expressed in terms of jobs (full-time equivalent positions, or full time equivalents) per million dollars of output. The multiplier values used to calculate the impact on the regional economy of the disruption of vessel access to the Port of Townsville are presented in Table 21.5.

Table 21.5 Type 2 multipliers (Northern Statistical Division) for transport support services and storage industry

Measure	Direct effects ^(a,b)	Flow-on effects	Total impact ^(c)
Output ^(d)	1.37	2.24	3.62
Value added ^(d)	0.57	1.06	1.63
Household income ^(d)	0.26	0.49	0.76
Employment ^(e)	3.7	8.0	11.7

Notes:

(a) From Queensland Input-Output Table 2008/09, 111 industries, imputed by AECOM from Australian Bureau of Statistics National Input-Output tables. This industry classification includes port-related activities.

(b) The effects of the change in output in the transport support services and storage industry including the purchases of inputs required from other industries in order to produce the change in output in the transport support services and storage industry.

(c) Totals may not sum exactly due to rounding.

(d) Dollar impact per \$1.00 of output change in the transport support services and storage industry.

(e) Number of full time equivalent jobs per \$1 million of output in the transport support services and storage industry. The values derived from the 2008/09 Input-Output table have been reduced to allow for increases in the general price level since then (the implicit price deflator for State Final Demand for Queensland has been used).

21.2.3.7 Assessment Results

Table 21.6 sets out the derivation of the change in final annual demand for port-related output for each scenario. The calculations are for an average year over the four-year period 2008/09 to 2011/12.

The derived change in final demand suggests a linear relationship exists between changes in tonnage and changes in port-related output (this implicitly assumes that the different types of cargo affected have the same cargo handling requirements and support service requirements in the Port). However, in reality there will be differences in factors such as profitability, capital intensity, average income and labour intensity.

The change in final annual demand for port-related output in dollar terms has been estimated by assuming that the value of POTL output (i.e. the value of services provided by POTL) accounts for about 17 percent of total port-related output (the value of services provided by all port-related firms and organisations). This is the average of the corresponding percentages for the ports of Gladstone (19 percent), Mackay (23 percent) and Port Kembla (9 percent) (Bureau of Transport Economics (2001a; 2001b), Econsearch (2009)). Based on information collected from port users during this study, POTL accounts for about 15 percent of total port-related employment.

Table 21.6 Derivation of change on final demand for port-related output

Disruption scenario	Estimated reduction in port throughput (tonnes) ^(b)	As % of total port throughput ^(c)	Annual change in final demand for port-related output ^(d)
1	5,525,515	47%	\$215 million
2	7,693,222	65%	\$300 million
3	10,137,177	86%	\$395 million

Notes:

(b) Calculated as average parcel size x number of ships impacted per outage. Average of four financial years from 2008/09 to 2011/12.

(c) Total port throughput over the four-year period averaged 12.1 million tonnes. For the purpose of the analysis, this was adjusted to 11.8 million tonnes to allow for cargoes for which information is unavailable on average parcel size and therefore on estimated trips per year.

(d) Assuming that POTL accounts for about 17 percent of total port-related output (value of services).

The regional economic impacts associated with 3 disruption scenarios are shown below.

21.2.3.8 Scenario 1 - All tide access restricted to Handysize vessels (40,000 deadweight tonnage)

The regional economic impacts associated with Scenario 1 are shown Table 21.7. These figures are based on the multiplier values in Table 21.5 and the change in final demand for port-related output in Table 21.6.

Table 21.7 Regional economic impacts of disruption to vessel access to Port of Townsville - Scenario 1

Measure	Direct effects	Flow-on effects	Total impact ^(b)
Lost output (\$ mill)	296	483	779
Lost value added (\$ mill)	123	227	350
Lost household income (\$ mill)	57	106	163
Employment reduction (FTE) ^(a)	803	1,726	2,529

Notes:

(a) Number of jobs (full-time equivalent positions).

(b) Totals may not sum exactly due to rounding.

Table 21.7 shows the following in Scenario 1.

- The direct effects of disruption to vessel access to the Port are estimated to be \$296 million in lost output while the total impact, after allowing for flow-on effects, is estimated to be \$779 million in lost output for the region.
- In terms of lost value added, the direct effects are estimated to be \$123 million while the total impact, after allowing for flow-on effects, is estimated to be \$227 million. The estimated loss of contribution to Gross Regional Product is equivalent to about 2.9 percent for the region and 3.3 percent for Townsville Local Government Area.
- In terms of lost household income, the direct effects are estimated to be \$57 million while the total impact, after allowing for flow-on effects, is estimated to be \$163 million.
- In terms of employment, the direct effects are a loss of 803 full time equivalent positions while the total impact, after allowing for flow-on effects, is a loss of 2,529 full time equivalent positions. This is equivalent to about 2.9 percent of total employment in the region and 3.5 percent for Townsville Local Government Area.

21.2.3.9 Scenario 2 - All tide access restricted to small Handysize vessels (25,000 deadweight tonnage)

The regional economic impacts associated with Scenario 2 are shown in Table 21.8. The figures are based on the multiplier values in Table 21.5 and the change in final demand for port-related output in Table 21.6.

Table 21.8 Regional economic impacts of disruption to vessel access to Port of Townsville - Scenario 2

Measure	Direct effects	Flow-on effects	Total impact ^(c)
Lost output (\$ mill)	412	673	1,085
Lost value added (\$ mill)	171	317	488
Lost household income (\$ mill)	79	148	227
Employment reduction FTE) ^(b)	1,117	2,403	3,521

Notes:

(a) Based on multipliers in Table 21.5 and change in final demand for port-related output in Table 21.6.

(b) Number of jobs (full-time equivalent positions).

(c) Totals may not sum exactly due to rounding.

Table 21.8 shows the following in Scenario 2.

- The direct effects of disruption to vessel access to the Port are estimated to be \$412 million in lost output while the total impact, after allowing for flow-on effects, is estimated to be \$1,085 million in lost output.
- In terms of lost value added, the direct effects are estimated to be \$171 million while the total impact, after allowing for flow-on effects, is estimated to be \$488 million. The estimated loss of contribution to Gross Regional Product is equivalent to about 4.1 percent for the region and 4.6 percent for Townsville Local Government Area.
- In terms of lost household income, the direct effects are estimated to be \$79 million while the total impact, after allowing for flow-on effects, is estimated to be \$227 million.
- In terms of employment, the direct effects are a loss of 1,117 full time equivalent positions while the total impact, after allowing for flow-on effects, is a loss of 3,521 full time equivalent positions. This is equivalent to about 4.0 percent of total employment in the region and 4.9 percent for Townsville Local Government Area.

21.2.3.10 Scenario 3 – All tide access restricted to small Handysize vessels (10,000 deadweight tonnage)

The regional economic impacts associated with Scenario 3 are shown in Table 21.9. These figures are based on the multiplier values in Table 21.5 and the change in final demand for port-related output in Table 21.6.

Table 21.9 Regional economic impacts of disruption to vessel access to Port of Townsville - Scenario 3

Measure	Direct effects	Flow-on effects	Total impact ^(c)
Lost output (\$ mill)	543	887	1,429
Lost value added (\$ mill)	226	417	643
Lost household income (\$ mill)	104	195	299
Employment reduction (FTE) ^(b)	1,472	3,167	4,639

Notes:

(a) Based on multipliers in Table 21.5 and change in final demand for port-related output in Table 21.6.

(b) Number of jobs (full-time equivalent positions).

(c) Totals may not sum exactly due to rounding.

Table 21.9 shows the following in Scenario 3.

- The direct effects of disruption to vessel access to the Port are estimated to be \$543 million in lost output while the total impact, after allowing for flow-on effects, is estimated to be \$1,429 million in lost output.
- In terms of lost value added, the direct effects are estimated to be \$226 million while the total impact, after allowing for flow-on effects, is estimated to be \$643 million. The estimated loss of contribution to Gross Regional Product is equivalent to about 5.4 percent for the region and 6.0 percent for Townsville Local Government Area.
- In terms of lost household income, the direct effects are estimated to be \$104 million while the total impact, after allowing for flow-on effects, is estimated to be \$299 million.
- In terms of employment, the direct effects are a loss of 1,472 full time equivalent positions while the total impact, after allowing for flow-on effects, is a loss of 4,639 full time equivalent positions. This is equivalent to about 5.3 percent of total employment in the region and 6.5 percent for Townsville Local Government Area.

The results of the Economic Impact Assessment are shown in Table 21.10.

Table 21.10 Summary of Economic Impact Assessment Results

Scenario	Total Impact			
	Lost Output (\$ million)	Lost Value Added (\$ million)	Lost Household Income (\$ million)	Employment Reduction (FTE)
1	779	350	163	2,529
2	1,085	488	227	3,521
3	1,429	643	299	4,639

An economic disruption model that describes the impacts of channel restrictions on economic activity was developed. This model was based on actual historical trades and hence considered the impacts of the present channel being restricted. By implication, economic impacts of restricting future trades can be estimated.

In summary, short-term lost output of three access restriction scenarios ranged from \$779M to \$1,429M. This result suggests that future trades that may be foregone as a result of a lack of sufficient capacity in the port land-based and channel infrastructure could be at least of this magnitude. The model confirms the impact of future trade if the port does not support future expansion.

21.2.4 Consideration of using alternative ports to cater for increased demand, especially any future coal exports

14 submissions suggested that alternative ports should be used to cater for increased demand, especially for any future coal exports. This is a common outcome in communities where a proposed activity may occur as the strong preference is often for this to not occur near them i.e. Not in my backyard. The possible use of alternative ports is discussed in this section.

The general attributes of other ports along the Queensland coast are detailed in Table 21.11 below. As the gateway for the Mount Isa minerals province, it is not economically feasible to use an alternate Port to Townsville for these products. Nevertheless, a brief discussion of the suitability of other ports for other cargos follows.

Table 21.11 Alternative Ports

Port	Attributes and Suitability as an Alternative
Port of Lucinda	The Port of Lucinda, located around 140 km north of Townsville consists of a single trestle jetty. The port is a dedicated sugar loading port with on-shore handling and storage facilities and the product being transported to the end of jetty ship-loader via conveyer belt. The typical annual throughput is around 350,000 tonnes. During 2011 and 2012 the facility was out of commission as a result of damage suffered during Cyclone Yasi and sugar was trucked to Townsville for export. There is no rail access into Lucinda from the North Coast Line and limited storage space. Without further development, Lucinda does not present an alternative to Townsville for sugar export, or other trade.
Port of Mourilyan	The Port of Mourilyan is located around 270 kilometres north of Townsville. Like the Port of Lucinda, Mourilyan is a sugar export terminal comprising on-shore handling and storage facilities and a single loader mounted on a small wharf. The navigable depth is 10.1 metres below datum. In 2011/2012 the Port of Mourilyan had an annual throughput of around 450,000 tonnes. Without further development, Mourilyan does not present an alternative to Townsville for sugar export, or other trade.
Port of Cairns	The Port of Cairns is the most northern general cargo port on the eastern seaboard; located around 350 kilometres from Townsville. The Port of Cairns is not designated as a priority port; rather it is a small general purpose regional port that can accommodate bulk and general cargo, cruise shipping, fishing fleet, and reef passenger ferries. The Port of Cairns lacks the bulk material handling equipment and storage facilities that are required to process high volumes of bulk materials efficiently. The design depth of the channel is 8.3 metres and during 2011/12 the Port of Cairns had an annual throughput of around 1.0 million tonnes. Without significant development, Cairns is not a suitable alternative port for the bulk exports or imports, or for the volume of most other cargoes which presently use Townsville.
Abbot Point	The Port of Abbot Point is located around 190km south of Townsville just north of Bowen. Abbot Point services central Queensland coal mines and remains primarily a coal port. As a coal port, Abbot Point contains rail in-loading facilities, coal handling and stockpiling areas. A single trestle jetty and conveyor connecting to two offshore berths and two ship loaders extend offshore to a distance of 2.8 kilometres. Abbot Point is a deepwater port with depths at the berths around 17-18 m below LAT. The 2011/12 annual throughput for the Port of Abbot Point was approximately 13.6 million tonnes.

Port	Attributes and Suitability as an Alternative
	With further development, Abbot Point may be suitable for the export of bulk products such as mineral concentrates, magnetite or additional coal. For products other than coal, an upgrade of the facility would be required, and consideration would need to be given to the capacity constraints currently facing Abbot Point port.
Port of Mackay	The Port of Mackay is situated around 390 kilometres south of Townsville. The Port hosts 4 berths for the export of sugar, sugar product and grain, as well as the import of petroleum products and the import and export of break-bulk general cargo. The 4 berths are serviced by three ship loaders and terminal operations include fuel terminals, sugar and grain storage and scrap metal. The design depth of the berths ranges from 10.6 to 13 meters. In 2011/12 the total throughput at the Port was 2.7 million tonnes. In general, some general cargo could be diverted from Townsville to Mackay port. Consideration would need to be given to dealing with capacity constraints at Mackay. Without considerable development, Mackay would be unsuitable for the export of mineral concentrates.
Port of Gladstone	The Port of Gladstone is located 829 kilometres south of Townsville. The port expedites the exports of coal, alumina, aluminium, and cement. The port of Gladstone is a major Australian bulk port, but also processes containerised cargo and general cargo. The annual total throughput for the Port of Gladstone in 2011/12 was 83.8 million tonnes. With further development at Gladstone, some of the general cargo and bulk cargo could be diverted from Townsville to Gladstone.
Port of Brisbane	The Port of Brisbane Queensland's southern-most bulk and cargo port and is located at the mouth of the Brisbane River, which is around 1,400 kilometres south of Townsville. The Port of Brisbane hosts 29 operating berths of there are 7 dedicated container berths, and 11 bulk and general cargo berths for multipurpose, wet and dry bulk commodities and general cargo. The Port of Brisbane had an annual tonnage of 37.2 million in 2011/12. Access to the Port is by Moreton Bay where deep-water channels are a minimum 280m wide and the minimum depth is 15.0m Lowest Astronomical Tide. The Port of Brisbane could handle additional containerised cargo, but would require further development to be able to handle bulk cargo such as mineral concentrates or nickel ore.

21.2.4.1 Assessment of practicality of alternative ports

The Port of Townsville had historically considered the feasibility of an alternative greenfield port site. The process that was undertaken is described in the Project Description (refer Section 2.0 of the AEIS). Importantly, developing a new port on a greenfield site will now be in contradiction to the Queensland Ports Strategy and *Sustainable Ports Development Act 2015*.

The practicality of the using alternative existing ports is governed by the following factors:

- the need for loading infrastructure and a suitable port configuration for the cargoes in question
- the need for capacity in linear infrastructure to alternate ports, i.e. the existence of suitable road and rail access with the capacity to safely transfer the cargo in question in or out of the port
- environmental considerations associated with the use of the alternative port, including the impact of developing suitable infrastructure and supporting infrastructure.

For example, whilst the ports at Mackay and Cairns would presently have berthing capacity that are too shallow, both of these ports are unable to handle mineral concentrates as a result of the existing port configuration and lack of loading infrastructure. The suitable berths in Cairns are not connected to the required rail infrastructure. Cairns port also lacks bottom discharge pits, rotary wagon tippler equipment or a suitable concentrates stockpile area.

Whilst the outer harbour at the Port of Mackay has direct rail access for up to 20 tonne rail axle loads and several balloon loops, all of the rail bottom discharge facilities are designed for food grade export cargoes (sugar and grains). This infrastructure is unsuitable for the present rail wagons used for concentrates in Townsville. Furthermore, the risk of food contamination prevents these facilities, including conveyers and loaders, from being suitable for alternative cargoes.

Abbot Point, a coal terminal, would result in similar issues. Apart from the obvious disruption to the coal handling processes, the lack of a northern access angle from the North Coast Line and tippler infrastructure would need to be resolved.

Alternate ports lack the capacity for road and rail infrastructure. For example, the train sizes required for transportation of some concentrates are much larger than conventional trains. While this is manageable for the

limited number of trains on the Mount Isa rail line, which travels directly to Townsville, it would be unacceptable on the North Coast Rail Line to Cairns or Mackay where train densities are substantially greater.

Using road transport to carry over a million tonnes from Townsville, or direct from the North West Mineral Province, would impose unreasonable demands on the regional and local road networks. The required 30,000 or more movements at 25 tonnes each would require facilities to service a continuous large stream of truck arrivals, for example a single train unloading 4,000 tonnes is equivalent to 160 semi-trailers. Additionally, some of the zinc concentrate produced in the North West is bound for Sun Metals Refinery near Townsville. As a result, a transport supply chain from Mount Isa to Townsville would still need to be maintained. In the case of Cairns, if it was used as an alternative, the most likely scenario is for double handling by truck from Townsville, resulting in additional traffic and costs. Initial calculations suggest that using a closer alternative port such as Cairns may add between 35 to 70 dollars per tonne for transport costs, which would likely be unsustainable for many central and western Queensland mining operations, in addition to adding noticeable and often considerable costs to basic community goods and services in the Townsville region.

21.2.4.2 Other considerations

A key consideration in the investigation of alternatives is the environment impacts of road, rail and shipping. For example, the argument was made by 10 submitters that the port should not have to be expanded as alternative ports could be used to handle future trades; thereby avoiding environmental impacts associated with port expansion. However the environmental impacts of using alternate ports must also be taken into account.

In order for the comparison of alternate ports to be complete, the relative secondary impacts of road or rail transport need to be considered to another port by comparison over shipping the same distance. The comparison does not include, for example, impacts associated with international shipping as in the comparison the number of ships entering and leaving Australian territorial waters is the same just entering or departing via different ports.

Energy Use

Not expanding the Port of Townsville and directing shipping through other ports would require cargoes to be then transported to the relevant receiver port by either road or rail. This has consequences for energy use and carbon emissions, and other environmental consequences such as collisions with wildlife.

Table 21.12, extracted from Dekker *et al* (2012) shows a comparison of energy use and emissions of various transport models. The results presented in this table show that per tonne of cargo transported per kilometre, road transport can require an order of magnitude (10 times) more energy by comparison to shipping, and as a result lead to nearly an order of magnitude of more carbon and greenhouse gas emissions.

Similarly, shipping requires around one quarter of the energy by comparison to diesel rail, and produces less than half of the equivalent carbon dioxide emissions. Therefore diverting trades through other ports as a strategy to avoid expanding the Port will lead to additional energy requirements and emissions (up to ten-fold increase).

Table 21.12 Energy use and emissions for typical units of different modes (Dekker *et al*, 2012)

Energy use / emissions g/t/km	1,000 TEU container vessel	6,600 TEU container vessel	Rail-electric	Rail Diesel	Heavy Truck	Boeing 747-400
kWh/t/km	0.014	0.018	0.043	0.067	0.18	2.00
CO ₂	7.48	8.36	18	17	50	552
SO _x	0.19	0.21	0.44	0.35	0.31	5.69
NO _x	0.12	0.162	0.10	0.00005	0.00006	0.17
PM ₁₀	0.008	0.009	N/A	0.008	0.005	N/A

*Refer to Section 11.0 of the AEIS for details on air quality

21.2.5 The need for accommodating larger vessels

Nine submissions questioned the need for the Port Expansion to cater for larger vessels. Indeed, the need for the dredging of the channel underpinned a number of matters raised in submissions.

Section 21.2.1 above discussed optimum berth utilisation and the trend in berth utilisation at the Port. It highlighted the need for ports to remain internationally competitive by being able to accommodate the medium and longer term changes in global vessel sizes.

Section 21.2.3 investigated the potential economic consequences of port capacity restrictions leading to trades being foregone.

This section discusses:

- how the present capacity of the navigational channel is restricting trade to the Port

- how changes in the global shipping and trade dynamics will lead to pressure for regional ports to be able to accommodate larger vessels.

Entry to the Port is through the Platypus and Sea Channels. The nominal width of these channels is 92 metres and no passing lanes are available. Over recent years around 65 vessels a year (2 million tonnes of cargo) have access restricted by tidal and wind conditions.

Similarly, the Port estimates that up to 10 vessels per month pass Townsville en route to Brisbane, these vessels are unable to enter the port as a result of the capacity of the navigational channel. These vessels unload at Brisbane, and cargo is trucked or railed back to North Queensland. In 2014, of the 186 vessels that berthed at the Port of Brisbane, only 41 of these vessels would be able to berth at the Port of Townsville. The Port estimates that this results in over 100 000 TEU (Twenty foot Equivalent Units) being transported by road or rail, at least half of which could be avoided if these vessels were able to enter Townsville. Furthermore the within-Queensland costs per container could be halved.

The Port Expansion Project, as described in the EIS, included the dredging of the Platypus and Sea Channels to allow all-tides access to the Port for Panamax vessels. Panamax vessels typically have a length in the order of up to 230 m, a beam (width) in the order of 32 m, and a laden draft (depth under water) in the order of 12.5 m. As such, they are presently only able to enter the Port either lightly loaded, or with the additional depth provided by high tide.

In 2016, upgrade works to the Panama Canal will be completed and the historical restriction on Panamax vessel beams of 32 m will be lifted. This restriction has been in place to allow vessels to safely traverse the Panama Canal. The opening of new sections of the Panama Canal, will allow the New Panamax class of vessels to use the Canal. Importantly for Townsville Port, it will also allow the existing 'post Panamax' vessels to use the Canal. Post Panamax vessels have beams in the order of 43 m and include design features that enhance their performance. An increase in beams reduces the need for ballast, which subsequently reduces displacement and drag (WWL, 2014).

Figure 21.4 and Figure 21.5 below provides dimensions of Panamax and Post Panamax vessels in the world fleet. The standardisation of the Panamax vessel beam in the order of 32 m is evident. Typical Panamax vessels which visit Townsville Port are in the 60,000 to 70,000 DWT size range, though as noted above, the larger vessels are often light loaded due to tidal restrictions.

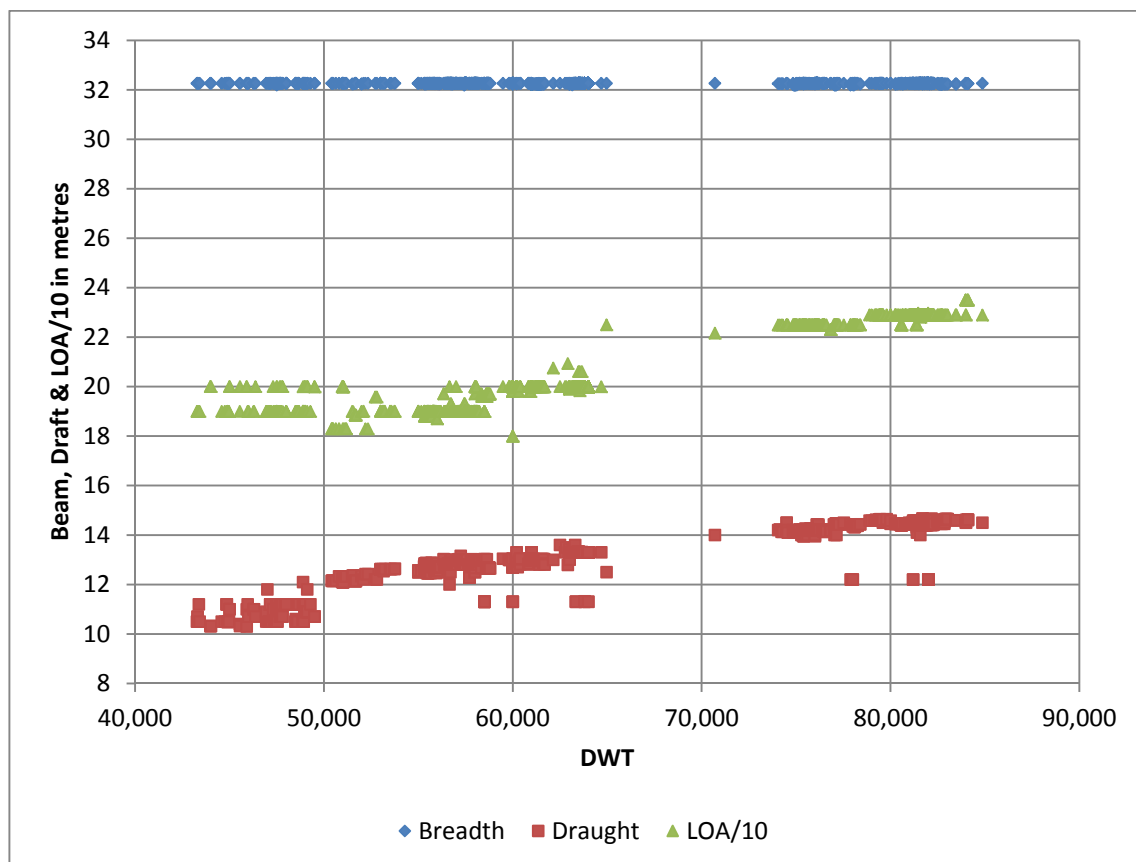


Figure 21.4 Sizes of Panamax Bulk Carriers. The length scale used is the LOA (Overall length) divided by 10 (LOA/10)

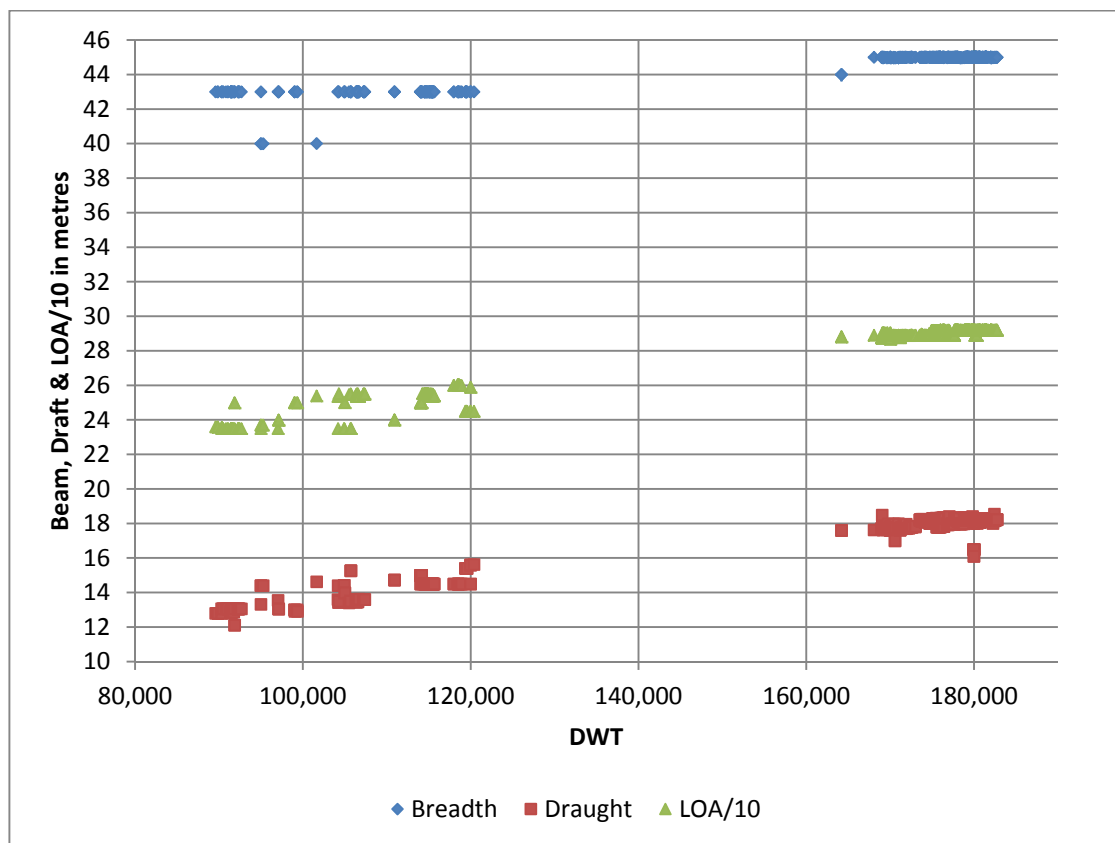


Figure 21.5 Sizes of Post Panamax Bulk Carriers. The length scale used is the LOA (Overall length) divided by 10 (LOA/10)

In lieu of the full deepening existing channels as proposed in the EIS, the design refinement of a widened channel will allow the Post Panamax vessels with a 43m beam access to Townsville. It is anticipated that Post Panamax vessels up to 100,000 DWT will have access to Townsville under the revised case.

In the case of the global container fleet, for example, this benefit is illustrated in Figure 21.6 below. Figure 21.6 also illustrates that the global trend to larger ships is not new. Historically, the 'ideal' size container ship has been fixed due to navigational limitations in regions of the world (for example, the Panama Canal) and to ensure stacking of containers is standardised and efficient (Eurans Ltd, 1998-2014).

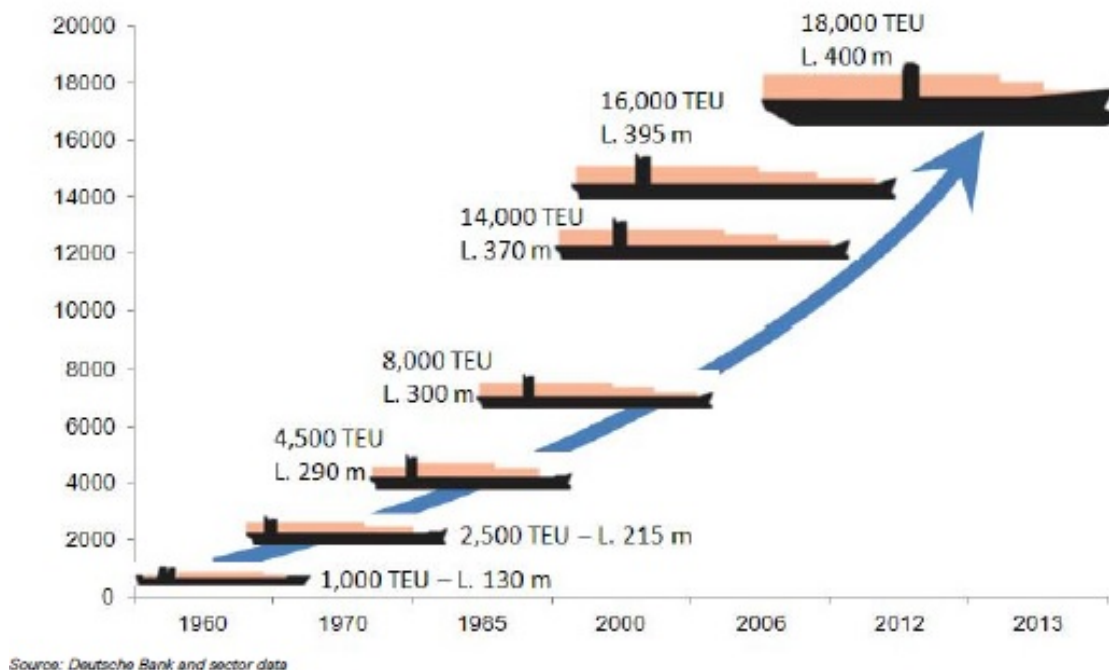


Figure 21.6 Evolution of vessel sizes

The emerging trades that a wider channel at the Port of Townsville will cater for include:

- expansion of the containerised cargo (supported by a larger regional base, as well as expansion in the range of products being containerised)
- fuels (driven by loss of Australian refineries and a need to cater for the longer range vessels i.e. via LR1 and LR2s out of Asia)
- car vessels (loss of Australian manufacturers and increase in population continues to drive an increase in the vehicle imports)
- opportunistic use by the leisure cruise industry.

Townsville port needs to respond not only to the increase in the world's fleet but also to the vessels currently servicing other ports in Australia, particularly on the east coast, as Townsville will typically be a port of call particularly for container vessels. Ultimately the desired situation is that Port of Townsville is able to accommodate container vessels using the 8000-10000 TEU as a good benchmark (noting that tidal limitations might apply). This is generally the post and new Panamax fleet. Larger vessels with scheduled routes to key southerly ports can dock at Townsville as highlighted above, this results in cheaper products particularly for the regional areas. This allows regional distribution rather than distribution from Brisbane.

The container trade is expected to increase to cater for the following.

- Increased cargo discharge from vessels on route (improved economic return for importers and local businesses).
- Limited capacity on rail and improved economic return for importers and local businesses compared to road transport.
- A trend in increased containerisation of some cargos and or products. For example there is a growing trend in the containerisation of agricultural products in Indonesia and China; increasing demand for the containerisation of smaller volume break-bulk, high value products or bulk products particularly if these are to be transhipped either to smaller ports or on to container based ports.
- An expanding regional population requires additional infrastructure, equipment, products, services and consumable products. A large component of which is handled via the port of Townsville.
- Increase in equipment imports to support a growing population base, and industry in the area be it project cargo e.g. turbines for power plants, pre constructed sections of mining equipment, the mining equipment itself or mining consumables such as tires. Given Townsville's proximity to, and relationship with, the western minerals province it is a natural fit for this project cargo to be handled via Port of Townsville.

In addition to containerised trade, car imports are increasing. This trend is enhanced by the ongoing downsizing of the Australian auto manufacturing sector. Slab-sided car vessels in general have high windage, which means that

can be difficult to navigate in confined areas such as navigation channels, so a narrow channel is challenging for these to navigate. A channel that can cater for a 40-44m beam vessel will allow the flexibility required to service this growing industry as well as cater for the new vessels class (Hero Class).

Import of cars direct from Korea, Thailand and Japan has increased by 30% in the last four years. Car imports are expected to increase by 80% in next five years (based on Townsville trade statistics and discussions with importers). Some of these increases relate to the growth in the market and the availability of a refurbished Berth 10 facility at Port of Townsville, but some changes are in response to the impending cessation in car manufacturing in Australia and changes to trade agreements with Asian countries announced recently. More Ro-Ro (roll-on roll-off) ships can now unload directly at Port of Townsville with vehicles to be distributed throughout North Queensland. Previously some ships bypassed Townsville and unloaded in Brisbane and then the cars were trucked back to North Queensland.

There is an increasing requirement for provision of Fuel (including avgas) for the Townsville Region, the Western mineral province and surrounding areas. As these population centres grow demand for fuel increases this will need to be catered for. As previously outlined the closing of refineries in Australia will result in the need for larger (long range vessels) to be accommodated as this material will now be imported rather than moved via coastal shipping.

Over 1.1 million tonnes of Diesel, Jet A1 fuel, Avgas, oil, petroleum products for domestic use is presently imported annually through the Port of Townsville to supply communities, mines and industries from Townsville to Mount Isa, Cloncurry, as well as to the north and south of Townsville. This trade is based on the needs of these communities and is only just keeping pace with demand at this point in time. The emergence of major export-based refineries in Asia operating on a lower cost base has transformed the industry resulting in the impending closure of the Bulwer Refinery in Brisbane (not an event forecast in the trade scenarios modelled for the EIS), there is an intention by fuel companies to use larger, long range Aframax-sized ships (LR1 and LR2s) to transport fuel from southeast Asia to Australia, including Port of Townsville. These fuel ships are wider and deeper than the forecast bulk trade ships (a beam of up to 44 m and draught of up to 15 m). Access to the Port of Townsville by these ships limited due to tidal restrictions and would still have to be partially loaded. To increase options and improve access to this trade the channel would first have to be widened, then deepened.

The cruise industry along the east coast of Australia and there are presently around 54 vessels active in the region. Presently 26% of these are unable to enter the Port as a result of constraints in the capacity of the navigation channel (Table 21.13).

Table 21.13 Vessel details

Vessel	Cruise Line	Length (m)	Requires PEP to be able to enter the Port
Albatros	Phoenix Reisen	185	
Amadea	Phoenix Reisen	193	
Amsterdam	Holland America Line	238	
Arcadia	P & O	289	Requires PEP
Artania	Phonex-Reisen	231	
Asuka II	Nippon Yusen Kaisha	240	
Aurora	P & O	270	Requires PEP
Astor	Cruise Voyages	176	
Balmoral	Fred Olsen	218	
Black Watch	Fred Olsen	177	
Carnival Spirit	Carnival	294	Requires PEP
Celebrity Century	Celebrity Cruises	248	Potential-subject to weather (RHM approval required)
Celebrity Millennium	Celebrity Cruises	294	Requires PEP
Columbus II	Hapag Lloyd	181	
Crystal Symphony	Crystal Cruises	238	
Crystal Serenity	Crystal Cruises	250	Potential-subject to weather (RHM approval required)
Dawn Princess	Princess Cruise	261	Requires PEP
Sun Princess	Princess Cruise	262	Requires PEP
Diamond Princess	Carnival	290	Requires PEP
Europa	Hapag Lloyd Cruises	197	
Insignia	Oceana Cruises	180	
L'Austral	Ponant Cruises	142	
Legend of the Seas	RCL	264	Requires PEP
Magellan (Cruise)	Cruise and Maritime Voyages	222	

Vessel	Cruise Line	Length (m)	Requires PEP to be able to enter the Port
MSC Orchestra	MSC Cruises	293	Requires PEP
National Geographic	National Geographic	103	
Ocean Princess	Princess Cruises	181	
Oceanic Discover	Coral Princess Cruises	63	
Orion	Linblad Expeditions	104	
Pacific Dawn	P & O	245	Will require RHM (Regional Harbour Master) approval
Pacific Jewel	P & O	247	
Pacific Pearl	P & O	247	
Pacific Princess	Princess Cruises	181	
Paul Gauguin	Paul Gauguin Cruises	157	
Queen Elizabeth	Cunard	294	Requires PEP
Queen Mary 2	Cunard Line	294	Requires PEP
Rhapsody of the Seas	RCL	279	Requires PEP
Radiance of the Seas	RCL	293	Requires PEP
Sea Princess	Princess Cruise	261	Requires PEP
Seabourn Odyssey	Seabourn Cruise Lines	200	
Seabourn Quest	Seabourn Cruise Lines	198	
Seven Seas Mariner	Regent Seven Cruises	204	
Silver Discover	Silversea Cruises	103	
Silver Spirit	Silversea Cruises	196	
Silver Shadow	Silversea Cruises	186	
Silver Whisper	Silversea Cruises	185	
Superstar Gemini	Star Cruises	230	
Superstar Libra	Star Cruises	216	
Superstar Aquarius	Star Cruises	230	
Star Piscies	Star Cruises	177	
The Taipan	Star Cruises	86	
Volendam	Holland America Line	238	
Pacific Eden	P & O	219	
Pacific Aria	P & O	219	

These longer vessels are also generally wider and therefore a wider navigation channel will allow larger cruise vessels to berth at Townsville. This would provide a much-needed boost to Townsville's economy through additional tourism activities generated through passenger visits, including potential benefits to Magnetic Island.

21.2.6 Coal exports through the Port of Townsville

18 submissions expressed that coal may be exported from the port in the future. However it is unclear from most of these submissions whether they are in response to a general disagreement with coal mining and burning and therefore the handling of coal by the port, or whether there is a view that coal should be exported through other ports such as Abbot Point.

The impact assessment undertaken through the PEP EIS focuses on altering the land and sea footprint of the port to enable the port to sustain the long term viability of the communities in North Queensland, and as such do not focus on the specific individual cargoes that may be handled in the future.

Whilst the Port presently does not handle coal cargoes, it is possible future trade conditions may deem the handling of some coal desirable from a trade perspective. In such case, the port will need to meet relevant impact assessment and approvals requirements of the time. However, the port is not a dedicated coal port as such, and therefore the rationale for the Project is not underpinned by future coal exports.

Using other ports as an alternative to the Project is addressed in 21.2.4 above.

21.2.7 Economic impacts to tourism on Magnetic Island

261 submissions (includes form letter submissions) sought more information and assessment on the potential and probable impacts to tourism operation on Magnetic Island, in particular vessel-based tourism operations. The following section provides a baseline assessment for the existing tourism derived from available desktop data.

Detailed contemporary tourism data for Magnetic Island are not readily available. Available data sets are often incomplete, not regularly updated and can be difficult to interpret in terms of the causal relationships between

tourism activity and external effects. This may be partly due to the comparatively small scale of the island as a tourist destination in comparison to the much larger tourism markets within the Great Barrier Reef region of Cairns, Port Douglas and the Whitsundays which are located to the north and south respectively.

There is no government policy or standardised industry accepted distinctions to determine the effects of the tourism market on different sectors of the economy. For example, visitors may purchase goods and services such as accommodation, food and drink, car hire, fuel and other retail items which may equally or in greater proportions also apply to local residents. This especially applies to Magnetic Island, which is a developed suburb of the Townsville Local Government Area.

Records obtained from local government and private enterprises on tourism operators that utilise Magnetic Island (generally differ in their detail), are incomplete or are likely to be out-of-date making correlation and verification across the different records impractical. Due to the general lack of reliable data, the assessment is primarily qualitative in nature utilising quantitative data where available. The tourism characteristics for Magnetic Island are assessed in terms of the likely effects of the PEP.

Available desktop information that has been used to describe specific characteristics and effects of tourism in the Townsville area include the following:

- The Commonwealth Government “National Long-term Tourism Strategy” (AEC, 2011)
- Great Barrier Reef Marine Park Authority “Great Barrier Reef Region Strategic Assessment Strategic Assessment Report” (GBR Strategic Assessment) (GBRMPA, 2014)
- Townsville Enterprise Limited, “Townsville North Queensland Tourism Opportunity Plan 2009-2019” (AEC Group Limited, 2009)
- Townsville City Council “Economic Development Plan 2013-2017” (Townsville City Council, 2013)
- Townsville North Queensland “Destination Tourism Strategy 2012-2016” (TNQ, 2012)
- Townsville City Council Tourism Data Base
- Townsville Enterprise Tourism Data Base
- Magnetic Island tourist operator brochures
- Australian Bureau of Statistics 2011 Census information
- Office of Economic and Statistical Research information
- Queensland Regional Statistical Information System (QRSIS) (QTT, 2015)
- Sealink Queensland Market Research in conjunction with James Cook University (Sealink Queensland, 2014).

Tourism characteristics of Townsville that were able to be identified from the desktop assessment include:

- the number of tourism operators on Magnetic Island
- the natural assets utilised by tourism operations
- demographic and economic indicators for the contribution that tourism provides to Townsville community and economy, where available.

21.2.7.1 National Long-term Tourism Strategy

The Australian Government, formally Department of Resources, Energy and Tourism, prepared the National Long-term Tourism Strategy in 2009 in partnerships with State governments, management authorities and tourism enterprise representative groups. The National Long-term Tourism Strategy included a profile of tourism experiences and characteristics for the Townsville region based on stakeholder consultation and a tourism product audit (i.e. included Cairns-Townsville Experiences Audit Report which forms a part of the National Long-term Tourism Strategy). The profile provides a summary of tourism assets in the area and identifies potential gaps in the market, based on the results of the survey findings.

Based on the consultation with tourism industry operators and representatives from the Townsville CBD, the study identified the following tourism related characteristics.

- Townsville does not regard itself as a tourist destination and most tourism ‘product’ has a strong dependence on locals. Much of the accommodation available is also focussed on business visitors or inter-regional visitors.
- Much of Townsville’s international visitation is stopovers on east coast road trips.
- International tourists who do stay for significant periods in Townsville report enjoying the feel of a real / authentic Australian town. Many only discover what it has to offer by accident.
- Appeal is as an escape from the tourist trail.

- Townsville is focussed on developing a CBD with infrastructure and events to appeal to locals. Much of this infrastructure and events appeals to tourists.
- International tourists in Townsville still ask primarily for reef experiences (also, to a lesser degree rainforest). There is disappointment that access to the reef from Townsville for tourists is generally unavailable (other than options for advanced divers such as Yongala).
- Tourists in Townsville participate more into the local lifestyle (particularly in winter), rather than do specific tourist activities.

It is generally accepted that Magnetic Island is the most recognised destination in the Townsville region for international tourists. However, the National Long-term Tourism Strategy found that the Island's recognition and visitation levels are well below other destinations in Far North Queensland. Magnetic Island was found to offer clear experiences based on 'nature in Australia' and 'coastal lifestyle'. The report identifies that Magnetic Island's key experience is 'accommodation', being nestled amongst bush, wildlife and beaches. Other activities and products that the Island has to offer are generally supporting or are a part of the accommodation experience.

21.2.7.2 The Great Barrier Reef Strategic Assessment

Tourism is considered in the Strategic Assessment Report the GBR Strategic Assessment defines tourism as:

"...commercial activities that provide transport, accommodation or services to people who are visiting the Region principally for enjoyment".

Tourism within the GBR Marine Park offers a wide range of tourism experiences, however while visitation does occur across most of the GBR, activity is consistently focused on a small portion of the Marine Park, with more than 85% of all tourism activity management occurring in about 7% of the region (see Figure 21.7).

Figure 21.7 illustrates the distribution of tourism activity in the Great Barrier Reef Marine Park in 2012. Tourism use of the Great Barrier Reef is strongly focused offshore of Cairns, Port Douglas and the Whitsunday Island. The figure accounts for full day visits (more than three hours) and part day visits (less than three hours).

It is evident from the Strategic Assessment that tourism within Townsville and Magnetic Island holds a lesser value than other key areas within the GBRMP area but is comparable to other locations outside of the key tourist areas.

Townsville is included in the Townsville/Whitsunday Management Area of the GBR Marine Park. Specific figures for tourist visitation to Townsville is not available and using aggregate numbers for the management area is heavily skewed by the high figures for the Whitsundays.

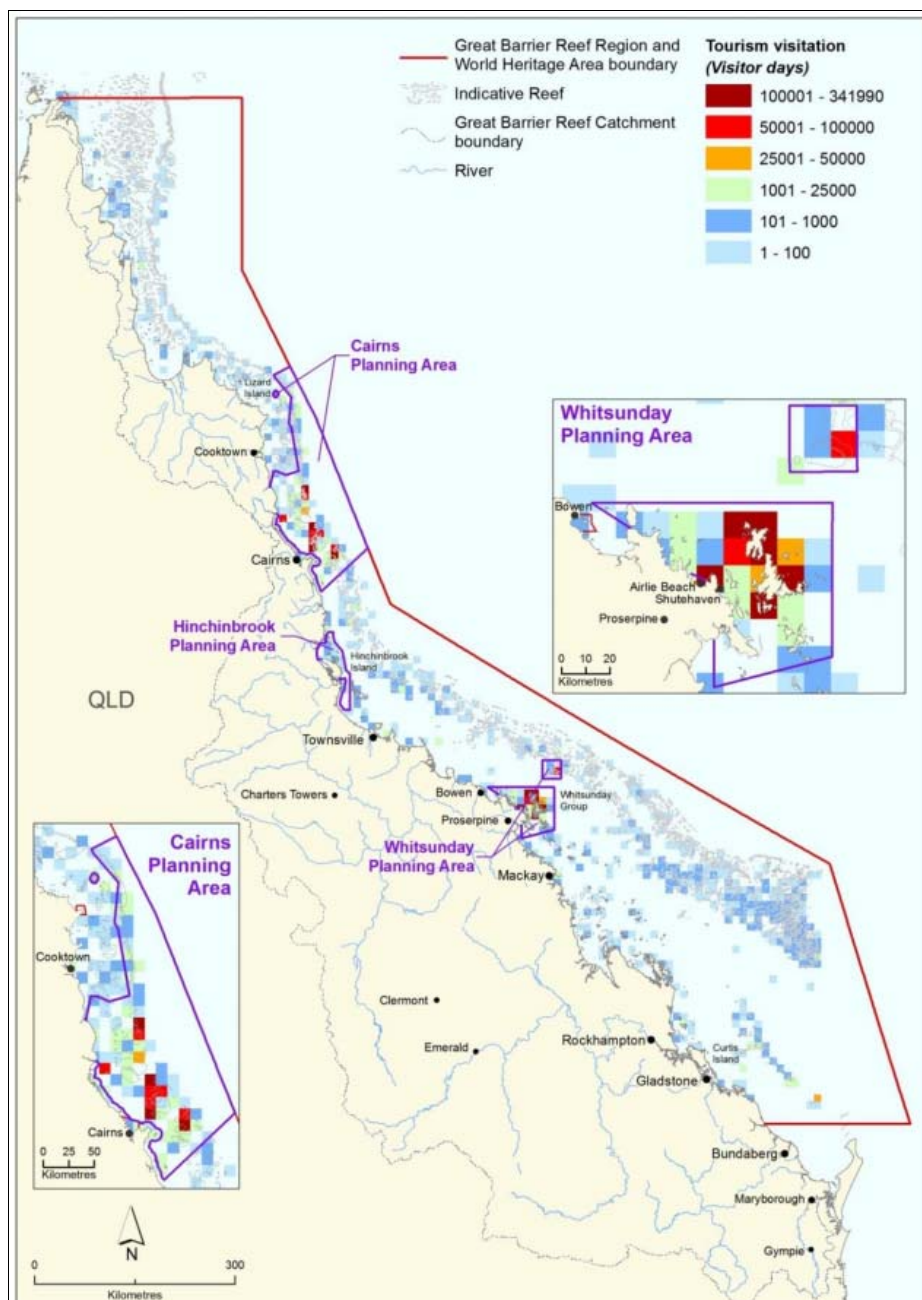


Figure 21.7 Distribution of Tourism activity in the Great Barrier Reef Marine Park

21.2.7.3 Townsville North Queensland Tourism Opportunity Plan 2009-2019

The Tourism Opportunity Plan provides direction for the sustainable development of tourism in the Townsville North Queensland region to 2019. The study relies on data up to 2008, therefore has been used primarily to illustrate the trend and general tourism market of the region.

The Tourism Opportunities Plan acknowledges the indicators of tourism activity in Townsville North Queensland are lower than the neighbouring areas of Mackay-Whitsundays and Tropical North Queensland regions. The plan identifies industries that generally service a tourism economy, such as Accommodation, Cafes and Restaurants and Retail Trade comprise a lower proportion of North Queensland's Economic output than the Queensland average.

The Plan details that tourism markets are notoriously volatile and strongly affected by economic conditions, major events. In 2007/08 domestic visitation was made up of 38.3% of holiday visitors, 33.1% were visiting family and friends and the remaining 28.6% were visiting for business.

21.2.7.4 Townsville City Council Economic Development Plan 2013-2017

The Townsville City Economic Development Plan identifies Townsville's key tourism strengths including assets such as the Strand, Magnetic Island, significant major events, a large visiting friends and relatives market and a growing business sector. The plan identifies approximately 25% of visitors to the Townsville region travel to Magnetic Island.

The plan identifies a Tourism Precincts Development Strategy which specifically targets three tourism destination precincts in Townsville being, Townsville CBD, Magnetic Island and Balgal Beach and Surrounds. These areas have been identified because they either possess a high level of existing tourism activity and investment and/or a high potential for further tourism development. The development strategy identifies key initiatives and actions to help promote and increase tourism levels.

21.2.7.5 Destination Tourism Strategy 2012-2016

The Destination Tourism Strategy provides the framework to guide tourism industry development in the Townsville North Queensland region by coordinating stakeholders in a common direction to maximise the tourism potential of the destination so as to achieve a balance of economic, social and environmental outcomes.

The key strategies identified included target markets, marketing and promotion, product and infrastructure development and industry development. The strategy also identifies opportunities for growth and implementation. The strategy identifies Magnetic Island as a potential sustainable destination for growth through potential innovative tourism projects.

21.2.7.6 Other sources of desktop information

Australian Bureau of Statistics (ABS) and the Office of Economic and Statistical Research (OESR) provide data sets on individual suburbs and local government areas. This assessment has utilised the community profiles from both departments.

Townsville City Council holds a Townsville Tourism Operators Database with a list of known operators in the region. In discussions with Council representatives it was advised that the database is in the process of being developed and not yet complete or up to date.

Other sources of desktop information include Magnetic Island tourism operator brochures, google searches and advertisements. These sources of information are used in the assessment to help quantify the number of operators located on the island and their activities. It is important to note that this information is not exhaustive and is very specialised.

21.2.7.7 Existing values and characteristics

Based on available information, Magnetic Island generally attracts two types of tourists, the local based tourist and the visiting tourist. Local based tourists are residents of North Queensland who go to Magnetic Island for a short stay. Visiting tourists include those not from the North Queensland region, whether visiting from interstate or overseas.

A study by Sealink and James Cook University in 2011 identifies over half of visitors to Townsville were undertaking day trips to Magnetic Island. Of these visits, the highest rated factors influencing the decision to travel to Magnetic Island included 'somewhere to relax', spending time in natural environment, seeing wildlife and adventure activities. The lowest rated factors of influence included learning about culture and history, buying products unique to the region and seeing production of local arts and crafts (JCU, 2011a).

According to the OESR and ABS data, Magnetic Island had 214 registered businesses during the year of 2011-12. Desktop reviews found Magnetic Island has approximately 60 accommodation providers, including resorts, hostels, hotels/motels, bed and breakfast and holiday houses/apartments and approximately 25 commercial food and dinner operators which come in the forms of restaurants, bars and takeaway, and are approximately 21 retail providers.

A 2011 Magnetic Island Visitor survey showed that there was no difference with expenditure, 40% of respondents in both visitor categories (i.e. from Townsville region and visitors from Australia and overseas) spending \$100 or less during their visit to Magnetic Island. Specific tourism related businesses at Magnetic Island are described under the following categories:

- accommodation & food services
- retail trade
- employment.

21.2.7.8 Accommodation & Food Services

The QRSIS (Queensland Regional Statistical Information System) identifies 28 businesses on Magnetic Island as 'Accommodation and food services' (QTT, 2015). Desktop reviews identified approximately 60 accommodation providers and 25 food and dining services. However, the business counts for 'Small business' identified 227 businesses on Magnetic Island (QTT, 2015). The concept of a 'small business' is considered intuitive; there is no

consistently used definition. Common definitions categorise small businesses based on their number of employees and annual revenue (Connolly, Norman, & West, 2012).

Due to the size of individual accommodation and food providers on the island, in terms of revenue and employees, the assumption can be made that majority of these businesses identify as a small business as opposed to accommodation and food services. It could also be assumed that this shows there is a larger number of small scale accommodation and food providers.

21.2.7.9 Retail trade

The Queensland Regional Statistic Information System (QRSIS) identified 17 businesses in the category of 'retail trade' in the business counts from 2013/14 for Magnetic Island (SA2/318021483 – Magnetic Island) (QTT, 2015). Interrogation of local government and tourism agency databases suggest that these businesses sell a range of goods including food, fashion, home supplies, plants, pharmaceuticals, art, fuel and bait, among others. However, it is important to note that the service catchment for these businesses includes the residential population of Magnetic Island as a suburb of Townsville and the visiting / tourist population. It is difficult to quantify and separate the amount of business and / or profit that is generated from visitors to the island and the amount that is generated from the residential population.

21.2.7.10 Employment

Tourism is an activity that cannot be identified directly from employment data. This is because tourism is not an industry or sector, but rather is a collection of activities that are supported partly through the spending habits of leisure and business visitors. Visitors purchase services and goods such as accommodation, food and drink, car hire, fuel and other retail items, but local residents also purchase these items.

The 2011 ABS Working Population Profile for Magnetic Island shows that 656 people were counted as working in different ANZSIC (Australian and New Zealand Standard Industry Classification) industries as shown in Table 21.14. The table shows that industry employment for Magnetic Island is dispersed across industry sectors. The figures do not differentiate between those people who work on the island and those who work on the mainland. According to ABS 2011, the total number of people employed that reside on Magnetic Island, 43 indicated that their method of travel to work was specifically by ferry. However, 170 people indicated their method of travel to work was via 'other two methods' and 'other 3 methods (ABS, 2011)'. An assumption can be made that due to the nature, size and transport available on the island that at least half are travelling to the mainland by ferry and utilising public transport, car or foot as the additional methods to get to their place of work.

Table 21.14 Employment by Industry Sector - Magnetic Island

Industry Sector	No. Employed
Agriculture, forestry and fishing	6
Mining	18
Manufacturing	34
Electricity, gas, water and waste services	19
Construction	105
Wholesale trade	12
Retail trade	109
Accommodation and food services	191
Transport, postal and warehousing	58
Information media and telecommunications	11
Financial and insurance services	11
Rental, hiring and real estate services	32
Professional, scientific and technical services	54
Administrative and support services	52
Public administration and safety	69
Education and training	65
Health care and social assistance	97
Arts and recreation services	23
Other services	24
Inadequately described/Not stated	26
Total	1,016

Separate identification of a tourism sector and distinction between those industries which primarily service residential versus visitor trade on Magnetic Island is not directly possible from the categories in Table 21.14. The table does show that of all of the industries, 'accommodation and food services' represent the sector with the highest proportion

of employed people (19%) reside on Magnetic Island. Accommodation and food services can be a supportive industry to tourism but may also be utilised by local residents especially 'food services').

21.2.7.11 Potentially impacted tourism operations

To assess the potential impacts that the PEP Project could have on tourism operators on Magnetic Island, this assessment focuses on the tourism operators who utilise the foreshore and fringing reefs as the basis of their operations. As mentioned above, detailed contemporary tourism data for Magnetic Island is not readily available. Available data sets are often incomplete, not regularly updated and can be difficult to interpret in terms of the causal relationships between tourism activity and external effects.

There are seven primary vessel-based tour operators for dive and snorkel businesses which utilise several inshore reefs around Magnetic Island. These reefs are located off Nelly Bay, Geoffrey Bay, Alma Bay, Arthur Bay and Florence Bay. Websites do not contain a schedule of operations but it is understood that the businesses work on a demand and 'good weather' basis. Websites for these business also identified between 1 and 4 persons were employed by the business.

Projected economic impacts to tourism values

In order to translate the projected environmental impacts to Sensitive Environmental Receptors into estimated economic impacts to tourism operators, factors to convert marginal ecological impacts to marginal costs are required. The objective of this calculation is to provide a first-order estimate of the monetised impacts to vessel-based snorkelling and boat tour operators on Magnetic Island.

The methodology applied involving using the projected changes to water quality and monetising changes to visibility using existing ecological economics willingness to pay estimates for monetising changes in visibility. The specific steps in the calculation include:

1. Identify studies that have estimated the monetary value of changes in underwater visibility
2. Identify the visibility and water quality data required for these studies
3. Estimate number of visitors that may be impacted
4. Estimate impacts.

A number of studies have investigated wider economic values of the GBR, as summarised by in Stoecki *et al* (2011) and these include the studies of KPMG (2000), Carr and Mendelsohn (2003), Windle and Rolfe (2005), Kragt *et al.* (2006), Access Economics (2007), Oxford Economics (2009), and Prayaga *et al.* (2010).

However, the majority of these studies have focused on attempting to estimate the total economic value of the GBR. It is now well accepted that estimates of Total Economic Value have little utility in impact assessment studies as it is the marginal impact that is under consideration.

Furthermore, most, if not all of the studies identified above did not adequately consider the spatial distributions of how the ecosystem values are distributed across the GBR. In particular, the studies failed to distinguish, how much tourism comes from the islands in the middle shelf zone, and outer reefs. As a result, without this demarcating of cause and effect, or demarcation of impacts and the spatial distribution of relevant values, it is almost impossible to disentangle impacts to values.

Given these shortfalls, the following three studies (Table 21.15) have been used to translate changes to water visibility into monetised impacts.

Table 21.15 Studies undertaken to translate changes to water visibility into monetised impacts

Location	Study type	Key values	Reference
Puerto Rico	Compared estimated values of water clarity using contingent valuation method (CVM) and choice experiment (CE) methods for tourists.	Value of increasing water quality from 'murky' to 2 feet of visibility values at \$54 (CVM method), and \$51 (CE method) per visitor day.	Loomis and Santiago (2013)
Red Sea	Stated-preference (choice modelling) for tourists.	Willingness to pay US\$1.20 per dive for a 50% increase in visibility.	Wielgus <i>et al.</i> (2003)
GBR	Choice modelling for Qld residents.	\$5.55 per household per year for every 1% increase in water quality from pre-European levels.	Windle and Rolfe (2011)

These studies, that used slightly different methodological approaches, provide valuations ranging from \$54 per day to \$1.20 per dive, to \$5.55 per household per % increase. The latter example was not targeted at snorkelling, diving or swimming operations, and rather general willingness to pay for increased water quality in the GBR lagoon.

The change in visibility used in the first two studies used either a 50% increase in visibility, or a change from 'murky' to 2 feet of visibility. These changes are relevant to the diving or snorkelling experience as tourism experiences are generally best represented by estimates of water clarity, commonly expressed as the underwater visibility length. For example, divers and snorkelers assess water quality by how far away objects can be seen underwater.

By contrast, whilst a number of water quality parameters are widely reported, these are mostly based on scientifically-relevant biological or chemical properties. Clarity is now commonly measured and assessed in units of NTUs (Nephelometric Turbidity Units) as this parameter can be directly measured by electronic sensors. Before electronic sensors were developed, water clarity was measured by dropping a black and white disc in the water. Measurements taken using these 'Secchi' disks can be difficult to translate to NTU measured by electronic sensors.

Valuation studies use metrics of visibility change, two stated the following: a change from 'murky' to 2 feet visibility, and a 50% increase in visibility. The water quality section provides estimates of the dredging-induced changes to turbidity (using units of NTU). Results presented in the Section 6.0 (Marine Water Quality) of the AEIS, for example suggest that for 95% of the data, the ambient turbidity around the eastern side of Magnetic Island is typically around 5 NTU (around 70- 85 cm visibility), increasing to around 15 NTU (around 40 cm visibility as increasing turbidity leads to less visibility) during the dredging campaign in Stage 1 when the TSHD dredger is operating.

Assuming a linear relationship between changes in NTU and visible depth over this range, this change is around a halving of the visible range on average during the dredging campaign. In reality this will change over periods of hours as a result of winds, tides and the actual location of the dredger at the time. However for the purposes of this calculation it is assumed that during the TSHD dredging campaign on average there will be a 50% decrease in the visibility at the main snorkelling sites.

Based on the capacity of the identified seven major vessel-based snorkelling tour operators on Magnetic Island, the maximum capacity is 31,390 dives per year. This is based on all of the vessels holding full vessel tours every day and all passengers entering the water.

In reality most of the vessels are on average likely to operate on one in three days, average across the whole year, and average occupancy is likely to be closer to 40%. The updated total number of dives then becomes around 4,185 per annum. For a 16.5 week TSHD dredging campaign in Stage 1, this becomes 1,328 impacted dives for the year during Stage 1 TSHD campaign.

Given that the per-dive cost is around \$50 per person, a willingness to pay value for additional visibility of \$20 per dive was selected based on the two most relevant studies. When applied to 1,328 dives per year for Stage 1, this becomes a total monetised impact to tourism operators of \$26 559 in total for the sector for Stage 1 TSHD dredging.

Therefore if such short-term changes in turbidity at the most popular snorkelling and diving operations was identified as being caused by the major capital dredging, then these calculations could form an estimate of financial impacts.

21.2.8 Greater economic impacts to GBR OUV

39 submissions also raised if the projected economic benefits of the Project would be outweighed by greater costs to the economic value of the Great Barrier Reef.

The expected direct and cumulative impacts are described in the marine ecology and cumulative impacts chapters. Of relevance, the long term impacts are expected to be loss of soft sediment sub-tidal habitat at the site of the expanded reclamation, and changes to visual amenity. Both of these whilst being long-term impacts, are local in scale and therefore by definition do not impact the wider Great Barrier Reef economic values.

Similarly, the cumulative impact assessment demonstrates that if unmitigated dredging were to occur, the season following an individual or series of significant natural disturbances, the risk of long-term degradation to Sensitive Environmental Receptors increases. However assuming that the proposed mitigation measures discussed in Section 6 of the AEIS are incorporated, then the impacts to the greater GBR OUV is assessed to be negligible (refer section 25.0 and 26.0 of the AEIS). This result is also consistent with the observed impacts from the previous major capital dredging campaign that also featured a defensible and intense short and long term environmental monitoring program.

21.2.9 Changes to base data demographics

The census data was current at the time of writing the EIS; however this section contains an update on key demographic statistics based on updated information received following the production of the EIS.

21.2.9.1 Population

Table 21.16 shows the population of the NET by Local Government Area. The NET has experienced a steady increase in population over the period 2006 to 2012, mainly driven by development in the Townsville and Whitsunday Local Government Areas, which accounts for 76.9% of the population of the region.

In contrast, several of the smaller Local Government Areas with less than 2,000 inhabitants (Flinders and Richmond) exhibit negative growth over this period. The size of these areas is such that their decreasing population exerts little

impact on the overall NET situation, which shows population growth of 8.2% between 2006 and 2012. Table 21.17 shows a summary population profile.

Table 21.16 Population by Local Government Area (ABS, 2012b)

Local Government Area	Population		Share of NET 2012
	2006	2012	
Burdekin	18,085	17,914	6.32%
Burke	531	555	0.20%
Carpentaria	2,076	2,186	0.77%
Cloncurry	3,366	3,425	1.21%
Croydon	274	325	0.11%
Doomadgee	1,170	1,374	0.48%
Charter Towers	12,155	12,431	4.39%
Etheridge	900	924	0.33%
Flinders	1,911	1,831	0.65%
McKinlay	955	1086	0.38%
Mount Isa	21,114	22,628	7.99%
Richmond	969	844	0.30%
Townsville	165,278	184,526	65.12%
Whitsunday	31,355	33,324	11.76%
Total NET	260,139	283,373	100%

Table 21.17 Population Profile

Component	Townsville (%)		Queensland (%)		Australia (%)	
	2006	2012	2006	2012	2006	2012
Age distribution						
0 to 14 years	21.4	20.7	20.4	19.9	19.6	18.9
15 to 24 years	16.7	15.6	14.1	13.9	13.9	13.6
25 to 34 years	15.4	14.4	13.9	14.1	14.0	14.4
35 to 44 years	14.8	13.9	14.7	14.1	14.8	14
45 to 54 years	13.2	13.3	13.7	13.4	13.8	13.5
55 to 64 years	9.4	10.6	11.1	11.3	10.9	11.4
65+ years	9.0	11.5	12.1	13.1	13.0	14.2
15 to 64 years	69.5	67.8	67.5	66.8	67.4	66.9
Household type						
Lone person	21.3	22.0	22.8	22.8	24.4	24.3
Group	5.3	5.2	4.5	4.7	3.9	4.1
Family	73.4	72.7	72.7	72.4	71.7	71.5
couple with children	44.5	43.0	43.3	42.8	45.3	44.6
couple without children	37.2	38.8	39.1	39.5	37.2	37.8
lone with children	16.6	16.5	15.9	16.1	15.8	15.9

Source: (ABS, 2012b),

Townsville experienced a small increase in the share of people aged 55 and over, as well as a small decrease in the share of people in age groups between 0 and 44. These variations in the age distribution were in line with the trends generally observed in the state and in the country. In both censuses the total proportion of people in the age group 65 and upwards in Townsville were actually smaller than in Queensland and Australia. Townsville also has a higher proportion of people younger than 24 years compared with the state and Australia. The median age in Townsville is 33 years, while the median age in Queensland is 36 years. Overall, Townsville has a slightly younger population than the state and national averages.

In 2012, families comprising a couple with children were the most common household type in Townsville (43%), followed by couples without children (38.8%) and lone persons (22%). There was a marginal reduction in the percentage of couples with children living in a household and a similar sized increase in the percentage of households comprised of couples without children. There is little difference between household profiles in Townsville, Queensland or Australia.

Table 21.18 Population Growth, Migration and Location (ABS, 2012b)

Component	Townsville (%)	Queensland (%)	Australia (%)
Population growth (2008 to 2012)	8.7	7.6	6.4
Fertility rate (2012))	2.0	2.1	1.9
Standardised-death rate (2012)	6.4	5.9	5.7
Population background (2011)			
Indigenous population	6.1	3.6	3
Overseas born	19.9	26.3	30.2
Mobility (over 5 years) *	40.4	36.4	31

* Mobility refers to the share of population that have not been living at the same address five years ago.

Table 21.18 shows population growth and its components. The overall population growth of Townsville (8.7%) is higher than the rate in Queensland and Australia. According to the Queensland's Office of Economic and Statistical Research (OESR, 2012a), the fastest growing Local Government Areas between 2011 and 2031 are projected to be Whitsundays and Townsville, with an average annual growth rate of 2.2%.

In terms of population composition, data from the Australian Bureau of Statistics shows 6.1% of the population is indigenous and 19.9% of Townsville residents were born overseas. These percentages clearly differ at the state and national level, where there is only approximately half of this proportion of indigenous population and a much higher proportion of the population born overseas.

The rate of mobility is measured as the proportion of people that have not lived in the same address over the last five years. In Townsville this rate is 40.4%, higher than in Queensland and Australia.

21.2.9.2 Labour Force

Table 21.19 presents labour force data, including income data, workforce size, labour force participation and unemployment for Townsville in comparison with Queensland and Australia.

The workforce size in Townsville has decreased marginally, by less than 0.1%, over the period 2006 to 2011. The size of the Australian workforce has increased, however by less than 1%, whilst Queensland has demonstrated a 3.4% increase in workforce size. Labour force participation rates in Townsville were lower in 2011 than 2006, however, these rates remain greater than those in Queensland and Australia.

The unemployment rate in Townsville was below Queensland and Australia in 2011. This was an improvement on the 2006 position, when the unemployment rate in Townsville was above the state and Australia. Between 2006 and 2011 the unemployment rate decreased in Townsville from 5.5% to 5.1%, whilst over the same time period, rates increased in Queensland from 5.0 to 6.1% and Australia from 5.1 to 5.6%.

The income data indicates that wage and salary incomes in Townsville were very similar to those in Australia in 2011, but higher than those in Queensland. Between 2006 and 2011 wage and salary income in Townsville increased at a similar rate to Queensland and Australia. The average investment income in Townsville (\$4,219) is relatively low compared with the Queensland and Australian averages (\$6,968 and \$8,329 respectively) and actually reduced between 2006 and 2011 compared to increasing averages in Queensland and Australia. In 2011, the average total income in Townsville was \$52,256, which is slightly higher than the Australian average \$52,234, and greater than the Queensland average.

In Townsville, the 2011 census indicated wage and salary earners were mostly professionals (17.3%) and technicians and trade workers (16.7%), followed by administrative workers (14.3%) and community and personal service providers (12.2%). Compared with Queensland and Australia, Townsville has proportionately fewer people with bachelor level degrees or higher level education, and have proportionately fewer people employed as managers and professionals, but have proportionately more people employed as technicians, trade workers and community and personal service occupations. This is consistent with the data on wage and salary incomes.

It was observed in the *Townsville Futures Plan* that defence and tourism are important activities in Townsville (Table 21.20). Defence is included in the category 'public administration and safety', which accounted for 11.9% of Townsville Local Government Area employment in 2011. Defence is especially important as Townsville is home to a major Royal Australian Air Force base and Lavarack Barracks Army base.

As previously discussed, tourism is an activity that cannot be identified directly from employment data. This is because tourism is not an industry or sector, but rather a collection of activities that are supported partly by spending from leisure and business visitors. Visitors purchase services and goods such as accommodation, food and drink, car hire, fuel and other retail items, but local residents also purchase these items. Estimates of tourism impacts

require data on visitor-spend by sector, and by how much accommodation and food sectors buy from other providers in a region (backwards linkages). Other public and private services are also required to support the population, for example health care, education, retail and energy. The proportions of employment by sector are shown in Table 21.20.

Table 21.19 Labour Force Data (ABS, 2012b)

Component	Townsville		Queensland		Australia	
	2006	2011	2006	2011	2006	2011
Average personal finance						
Wage/salary income (\$)	39,577	52,272	37,680	49,863.5	40,276	51,922
Investment income (\$)	4,559	4,219	6,546	6,968.5	7,025	8,329
Superannuation and annuity income (\$)	19,675	22,960	22,383	21,738.4	23,503	23,483
Total income (\$)		52,256		49,057		52,234
Labour market						
Workforce size	91,928	91,714	2,097,340	2,171,073	10,577,883	10,658,458
Total employment (%)	94.5	94.9	95.0	93.9	94.9	94.4
Unemployment rate (%)	5.5	5.1	5.0	6.1	5.1	5.6
Participation rate (%)	70.7	66.6	64.4	62.8	63.5	61.4
Qualifications (% total population)						
Postgraduate degree (%)	1.8	2.2	1.9	2.7	2.6	3.6
Graduate diploma and graduate certificate (%)	1.0	1.2	1.2	1.4	1.4	1.7
Bachelor degree (%)	9.7	10.7	10.0	11.7	11.6	13.5
Others: advanced diploma, diploma, certificate (%)	37.6	39.7	37.3	38.5	36.9	37.1
Total with qualifications (%)	50.0	53.8	50.4	54.3	52.5	55.9
Occupations (wage and salary earners)						
Managers (%)	9.9	9.8	12.4	12	13.2	12.9
Professionals (%)	16.2	17.3	17.1	18.9	19.8	21.3
Technicians and trade workers (%)	16.9	16.7	15.4	14.9	14.4	14.2
Community and personal service (%)	11.7	12.2	9.1	10	8.8	9.7
Clerical and admin workers (%)	14.8	14.3	14.8	14.7	15.0	14.8
Sales workers (%)	9.9	9.7	10.4	9.8	9.8	9.4
Machinery operators and drivers (%)	8.0	8.2	7.2	7.3	6.6	6.6
Labourers (%)	10.8	9.9	11.9	10.6	10.5	9.4
Others (%)	1.7	1.8	1.8	1.8	1.8	1.9

Table 21.20 Employment by Sector (2011) (TFPT, 2011; ABS, 2012b)

Sector	Townsville Local Government Area (%)	Queensland (%)
Public administration and safety	11.9	6.7
Wholesale trade	3	3.6
Healthcare and social assistance	12.5	11.9
Construction	9.9	9.0
Manufacturing	7.6	8.4
Education and training	8.1	7.9
Accommodation and food services	6.9	7.0
Transport port and warehousing	5.1	5.3
Professional, scientific and technical services	4.7	6.5
Other services	3.7	3.9
Retail trades	10.7	10.7
Administration and support services	3	3.2
Mining	2.9	2.6
Financial and insurance services	1.6	2.7
Rental, hiring and real estate	1.6	1.8
Information media and telecoms	1.4	1.2
Electricity, gas, water and waste	1.6	1.2
Arts and recreation	1.3	1.4
Agriculture, forestry and fishing	0.5	2.7

This shows the economy of Townsville is diversified, with a wide range of services including health, education, wholesale and retail trades. The table also shows that in terms of employment, wholesale trade, manufacturing, professional, scientific and technical services, financial and insurance services, agriculture, forestry and fishing were lower than in the Queensland entirely.

21.2.9.3 Housing

The median rents across the 14 Local Government Areas of Townsville and the NET are presented in Table 21.21 below. The median rent across the wider Study Area differs widely across the Local Government Areas. The highest median rent per week is in the Whitsunday Local Government Area at \$306 per week. The lowest median rent per week is in Etheridge Local Government Area at \$79 per week. Across the NET, the average median rent is \$146 per week.

The median rent for Townsville has varied over the last four years. There has been a downward trend in rent between December 2009 and September 2010, but the median rent increased by an average of \$10 per week for houses and \$20 per week for units during the first quarter of 2011. The Herron Todd White report (2011) suggests that 'tightening vacancy rates means that rents may continue rising over the near term'.

Table 21.21 Median Rent and Housing Loan Repayments (2011) (ABS, 2006)

Local Government Area	Median Rent (\$/weekly) 2011	Median Housing Loan Repayment (\$/monthly) 2011
Burdekin	180	1,300
Burke	80	1,230
Carpentaria	110	898
Cloncurry	102	1,500
Croydon	115	844
Doomadgee	105	303
Charters Towers	170	1,350
Etheridge	79	650
Flinders	100	693
McKinlay	88	975
Mount Isa	250	2,000
Richmond	100	715
Townsville	290	1,733
Whitsunday	306	2,100
Average NET	146	1,164

21.3 Conclusion

The proposed expansion to the Port of Townsville is required to accommodate medium and long-term future growth in trade volume over a planning horizon to 2040 and beyond, and to ensure that the port remains attractive to shippers as the global fleet increases in size. Additional berths, land reclamation, channel widening and modifications to improve accessibility for vessels will allow for increased shipping movements and remove the current constraints on future growth.

While a summary view of the berth utilisation figures may suggest the port has capacity available, this is not the case. Optimum berth utilisation for any particular berth depends upon a number of factors. It is a fact that multi-cargo ports such as Townsville are not able to achieve utilisations as high as those achieved in contemporary single cargo ports and in many instances over the last five years some berths have been over their optimum capacity.

An economic disruption model was developed to assess the potential impacts of channel restrictions on economic activity on Townsville. The model simulated the potential impacts of the channel being restricted, and by implication, economic impacts of restricting future trades can be estimated. In summary, economic impact of three short-term vessel disruption or access restriction scenarios ranged from \$779M to \$1,429M. This result suggests that future trades at this magnitude will be missed as a result of insufficient capacity within the port land-based and channel infrastructure.

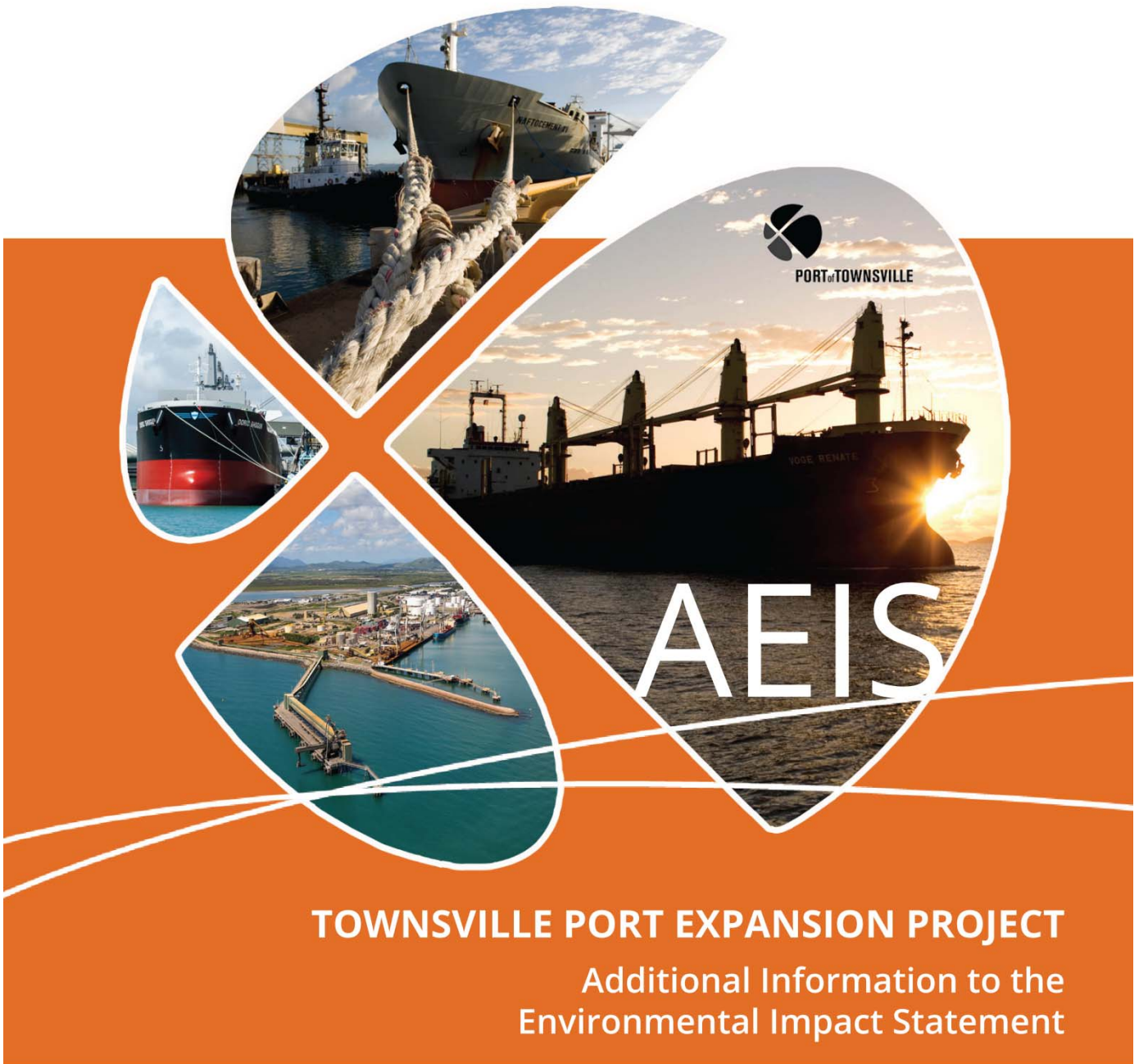
In response to the matters raised about the need to avoid dredging in the Marine Park the design refinement has investigated alternatives to the proposed deepening of the channels, which would provide an equivalent increase in channel capacity. In lieu of deepening the existing channels as proposed in the EIS, the design refinement of a widened channel will allow the Post Panamax vessels with a 43m beam access to Townsville. It is anticipated that Post Panamax vessels up to 100,000 DWT will have access to Townsville under the revised case. This compares favourably against the typical Panamax vessels which currently visit Townsville Port being in the 60,000 to 70,000 DWT size range.

To assess the potential impacts that the PEP could have on tourism operators on Magnetic Island, an assessment was carried out focusing on the tourism operators who utilise the foreshore and fringing reefs as the basis of their operations. The assessment utilised similar international studies to assign an approximate economic impact to the 16.5-week TSHD dredging campaign in Stage 1 (potentially impacting 1,328 dives). It was conservatively found that a total monetised impact to tourism operators was approximately \$26,559.

In relation to the potential greater economic impacts of the PEP on the GBR Outstanding Universal Value, the expected direct and cumulative impacts are described in the marine ecology and cumulative impacts chapters. The long term impacts are expected to be loss of soft sediment sub-tidal habitat at the site of the expanded reclamation, and changes to visual amenity. Both of these whilst being long-term impacts, are local in scale and therefore by definition do not impact the wider Great Barrier Reef economic values.

The cumulative impact assessment similarly demonstrates that if dredging were to occur the season following an individual or series of significant natural disturbances, then the risk of long-term degradation to Sensitive Environmental Receptors subsequently increases. However, assuming that the proposed mitigation measures discussed in Section 6 of the AEIS are implemented, then the impacts to the greater GBR OUV is assessed to be negligible (refer section 25.0 and 26.0 of the AEIS). This result is also consistent with the observed impacts from the previous major capital dredging campaign that featured a defensible and intense short and long term environmental monitoring program.

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SECTION 22

Health and Safety



22.0 Health and Safety

22.1 Introduction

Chapter B.20 (Health and Safety) of the Environmental Impact Statement (EIS) describes the health and safety values of the broader community, onsite workforce, suppliers, visitors and other stakeholders, and addresses occupational hazards and relevant risks associated with the construction and operation of the Port Expansion Project (PEP). The design, construction and operation of the PEP will be undertaken in accordance with regulatory requirements at the time of each stage to minimise health and safety risks to personnel, property and the broader community. Health and safety risks associated with the PEP will be managed through the ongoing implementation of the Port of Townsville Limited (POTL) management systems.

This section provides information to address submissions received in response to the EIS relevant to health and safety and the impacts of the proposed revised design on these values. Key matters identified from the submission process include:

- mosquito management in sediment ponds
- management of flammable liquid fuels during ship transfers
- management of future port tenants and export / import materials.

22.2 Response to Submissions

22.2.1 Mosquito management in sediment ponds

Townsville City Council requested further information regarding the management of mosquitos in sediment pond bunds surrounding the new rail loop. Mosquito management measures during the construction and operational phases were addressed in Chapter C.2 (Construction Environmental Management Plan) and Chapter C.5 (Operational Environmental Management Plan) of the EIS and have been revised to extend management from the wet season to the entire year. The revised Construction Environmental Management Plan and Operational Environmental Management Plan are provided in Appendix B2 and Appendix B3 of the AEIS respectively.

Site inspections will be routinely undertaken during the construction and operational phases to identify mosquito breeding areas and chemical control measures will be used where required. Chemical control measures will be implemented by POTL in common areas and by tenants in leased areas, as required and in accordance with POTL procedures and relevant regulatory requirements.

22.2.2 Management of flammable substances during ship transfers

The Department of Justice and Attorney-General – Hazardous Industries and Chemicals Branch submission recommending specific controls be considered to manage the risk to personnel during unloading of liquefied petroleum gas (LPG) cargoes at the port. The risk to personnel unloading and storage of gas was identified in Appendix U.3 of the EIS. Existing POTL management systems will be updated to accommodate the PEP.

The Construction Environmental Management Plan (Appendix B2) has been updated to include measures to manage risks to PEP personnel in association with hazardous material ship transfers including restrictions on working near ships during unloading activities.

Concerns were raised by one submission regarding the risks associated with discharging cargoes of flammable liquid fuels and storage at the port. Flammable liquid fuels are those which have a flash point of less than 61°C. The handling and storage of hazardous materials including flammable liquids associated with the construction of the PEP will be undertaken in accordance with POTL management systems and regulatory requirements. The existing POTL management systems will be updated to accommodate construction and operation activities associated with the PEP.

One submission queried the potential for LPG odours to be generated during berthing activities. There is no connection with LPG odours and the berthing of vessels, and the EIS does not address future tenants or products due to the timescale of the Project. The existing POTL management systems provide management and monitoring of environmental factors that have the potential to extend impacts beyond the port boundaries. Management and monitoring activities will be undertaken during construction and operational phases in accordance with current POTL procedures and to ensure compliance with regulatory requirements.

22.2.3 Management of future port tenants and export / import materials

Three submissions requested further information regarding the siting and development of facilities to handle hazardous chemicals at the port and the potential risks associated with discharging flammable liquid fuels at the port. The handling, storage and disposal of hazardous materials used in the construction of the PEP and POTL operated activities will be undertaken in accordance with POTL management systems and regulatory requirements,

as addressed in Chapter B.20 (Health and Safety) of the EIS. Measures to manage hazardous materials during construction and operation activities are further outlined in the Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3).

Tenants and port operators are responsible for developing and implementing safety management plans to manage their own operations, including spills, within their tenancies, in accordance with regulatory requirements and POTL management systems. POTL have developed procedures and guidelines for safety management at the port, including for the management of spills and POTL undertakes regular reviews of their own operations to ensure compliance. This includes safe handling, storage, use and disposal of hazardous materials and response to spills.

One submission raised the potential impact of spills associated with exporting uranium whilst another submission queried the impacts of increased traffic associated with the export of mining goods on human health once the PEP is operational. The Port of Townsville is a multi-cargo port that imports and exports cargo to support North Queensland and the broader development initiatives of Northern Australia. Whilst the PEP EIS has identified mining exports as potential future trade, any such cargo export will be subject to separate assessment and approvals processes and is not specifically addressed in this EIS. Uranium has not been identified as a potential cargo in the PEP EIS.

Future industry development at the Port will be subject to separate approvals and regulatory requirements including requirements for work health and safety management and spill management.

22.3 Revised Environmental Impact Assessment

22.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. The legislative and policy changes did not impact on the assessment of health and safety values presented in the EIS, or the management of these values.

22.3.2 Design refinement

The project design has been revised as described in Section 2.0 of the AEIS. This revision focusses on amendments to the extent of dredging and reclamation works and does not impact upon the management of health and safety values.

22.3.3 Supporting studies

No additional studies were required to assess the revised design and address comments received from submissions on health and safety management.

22.3.4 Revised assessment

22.3.4.1 Impact assessment

Impacts of the Project on health and safety management remain consistent with that identified in Section B.20.4 of the EIS. POTL has undertaken a number of reclamation projects in the past and is well placed to manage health and safety associated with the Project.

22.3.4.2 Mitigation measures

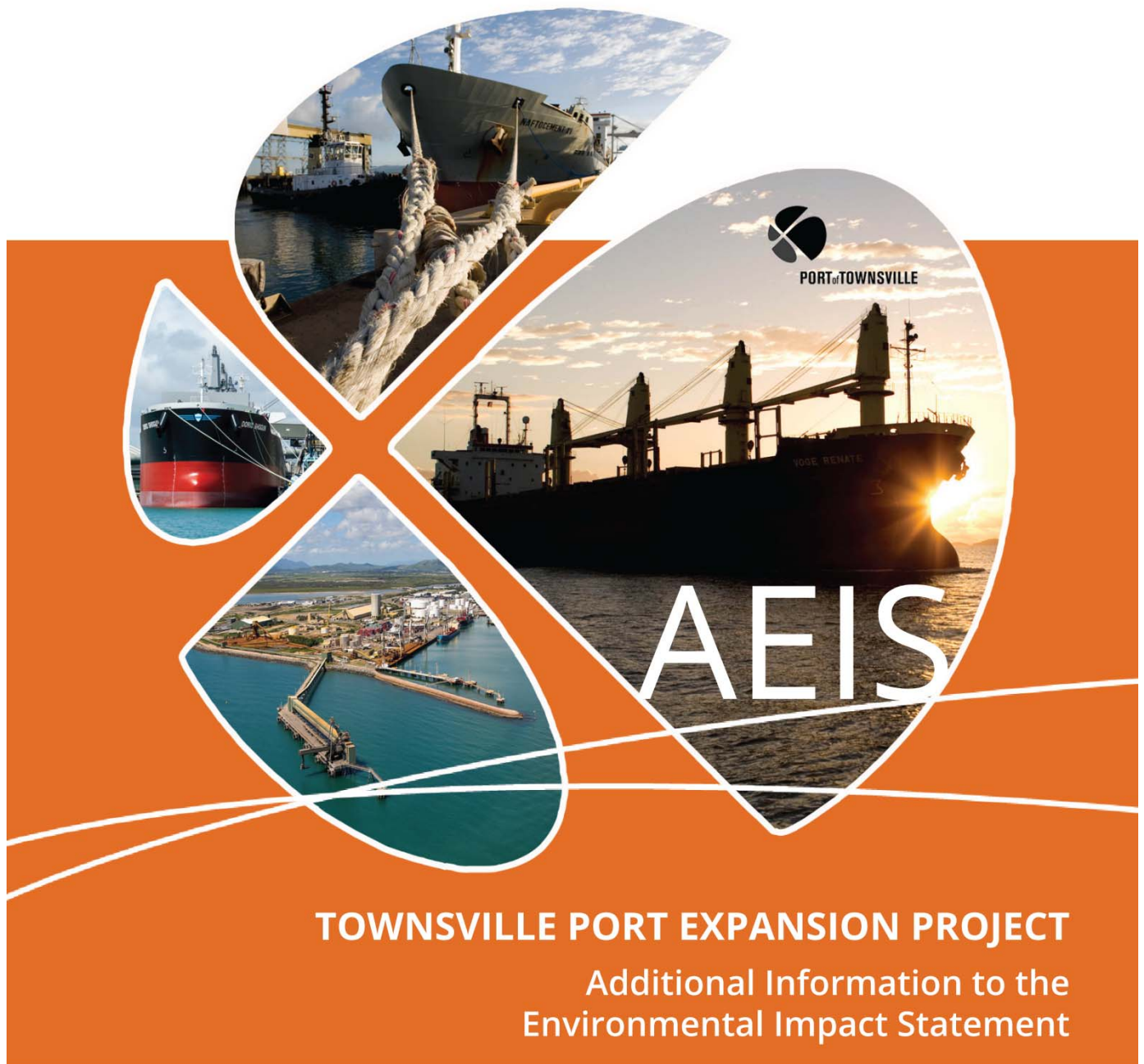
The design, construction and operational phases of the PEP are covered by an extensive regulatory framework extending beyond the health and safety legislation. Health and safety management measures for the PEP are outlined in the updated Construction Environmental Management Plan (Appendix B2) and Operational Environmental Management Plan (Appendix B3) which will be updated in POTL management systems prior to construction of each stage.

22.3.5 Summary

Section B.20.4 of the EIS provided a risk assessment regarding health and safety for the PEP. The revised design is consistent with the assessment provided in the EIS. Management of health and safety will be updated in POTL management systems prior to construction of each stage. Tenants and port operators are responsible for developing and implementing safety management plans to manage their own operations.

22.4 Conclusion

POTL has undertaken a number of reclamation projects in the past and is well placed to manage health and safety associated with the Project. POTL currently manages health and safety risks through their management systems. With the implementation of mitigation measures through these mechanisms, the Construction Environmental Management Plan (Appendix B2) and the Operational Environmental Management Plan (Appendix B3), the PEP is not expected to significantly impact upon existing procedures and framework or responses to safety issues.



SECTION 23

Security, Property and Infrastructure



23.0 Security, Property and Infrastructure

23.1 Introduction

The Port of Townsville is recognised as essential infrastructure which, if destroyed, degraded or rendered unavailable for a short or an extended period, would significantly impact social and economic values (NCTC, 2005). The nature of maritime business and infrastructure associated with the Port of Townsville Limited (POTL) falls within statutory requirements that provide safeguards against unlawful interference with maritime transport and establishes security levels for POTL projects and infrastructure.

Chapter B.21 (Security, Property and Infrastructure) of the Environmental Impact Statement (EIS) informs the design and operation of risk management and contingency systems. The construction and operation of the PEP will require variation and modification of the existing security, property and infrastructure management arrangements to suit the operational nature of the PEP, risk of security events and degree of preparedness required to mitigate the risk.

This section provides information to address submissions received in response to the EIS relevant to security, property and infrastructure and the implications of the revised design on these values. One submission was received regarding emergency management, vulnerability and potential for explosions proximate to the Townsville city.

23.2 Response to Submissions

23.2.1 Management of Project security risks proximate to Townsville city

One submission raised the vulnerability of the PEP to human interactive events such as fire, terrorism and sabotage, and the impact of such disasters on Townsville city given the proximity of the Port to highly populated areas.

Management of security risks are addressed in Chapters B.21 (Security, Property and Infrastructure) and Chapter B.22 (Emergency Management) of the EIS. The PEP is to be located on reclaimed land on the seaward boundary of the existing port further away from residential areas than current port operations. POTL manages security risks associated with operations and land through the Maritime Security Plan. This plan was developed in accordance with the *Maritime Transport and Offshore Facilities Security Act 2003* and is routinely audited by the Commonwealth Office of Transport Security. This plan will be updated and incorporated in the PEP in accordance with the *Maritime Transport and Offshore Facilities Security Act 2003* and the *Customs Act 1901*.

Project specific security management plans will be developed and implemented as required regarding mitigation of the potential adverse effects of security or terrorist events, including preparation for managing the effects of an event and effectively responding to, and recovering from, an event. POTL management systems as discussed in Chapter B.22 (Emergency Management) of the EIS are in place and identify, prevent and respond to emergency situations at the Port. Changes to security management in association with the PEP will be communicated in conjunction with the POTL Emergency Risk Management Committee and the Townsville Local Disaster Management Group for translation into the Townsville District Disaster Management Plan and, where applicable, the State Disaster Management Plan.

23.3 Revised Environmental Impact Assessment

23.3.1 Legislation and policy

The Commonwealth *Maritime Transport and Offshore Facilities Security Act 2003* and the *National Counter Terrorism Plan* (2005, 2nd edition) have undergone amendments. The Queensland government approved a new *2013-2018 Queensland Counter-Terrorism Strategy*. Current legislation and strategy will not directly impact on the function of the PEP.

23.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. This design refinement focusses on amendments to the extent of dredging and reclamation works and will not impact upon the adequacy of measures to manage security associated with the PEP.

23.3.3 Supporting studies

No additional studies were required to assess the revised design and address submissions received from respondents relating to security, property and infrastructure of the PEP.

23.3.4 Revised assessment

23.3.4.1 Impact assessment

Impacts of the PEP on security management remain consistent with that identified in Section B.21.4 of the EIS.

23.3.4.2 Mitigation measures

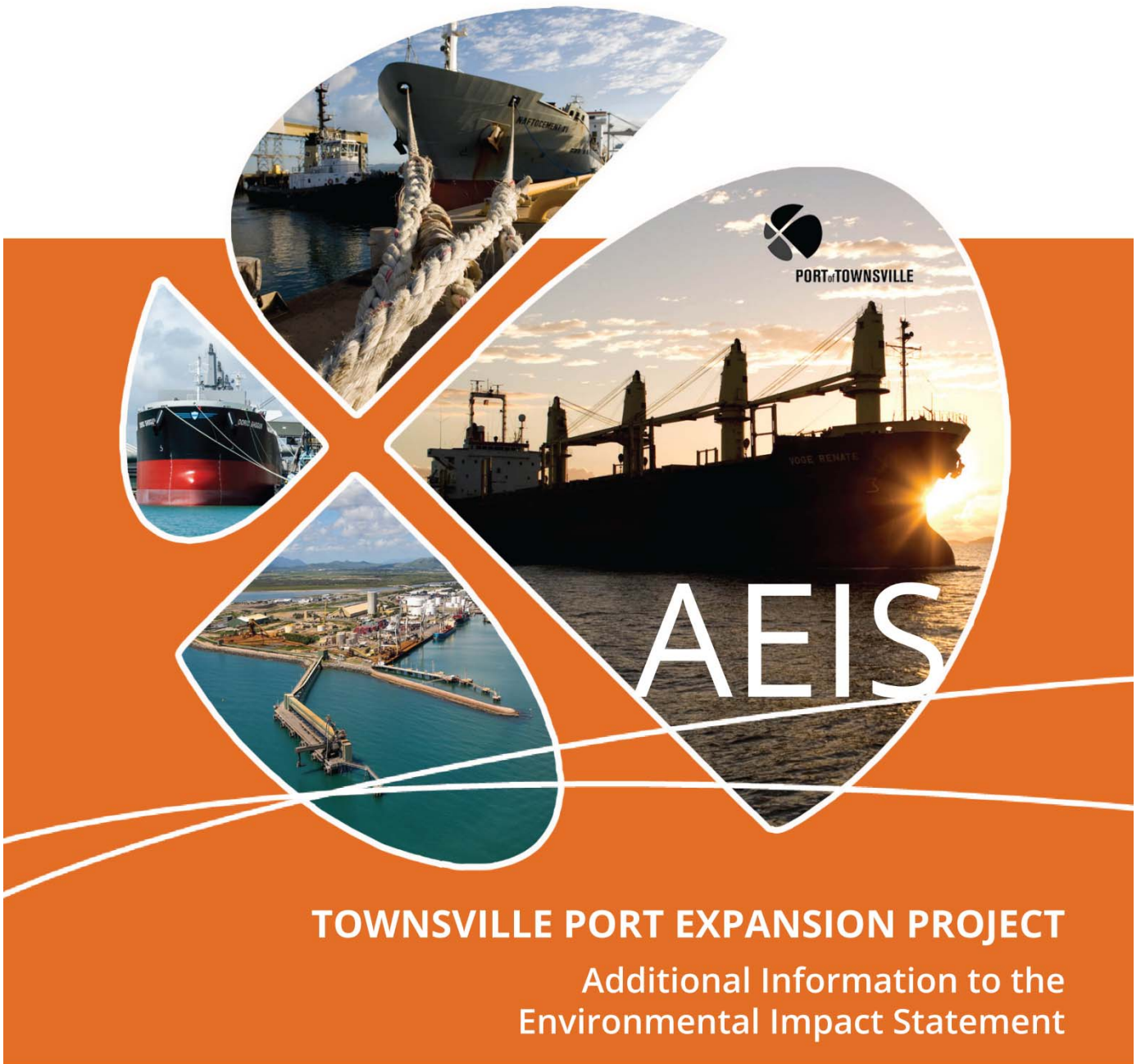
POTL has an approved Maritime Security Plan in place which will be updated to include the PEP. Mitigation measures for security management for the PEP are consistent with that identified in Section B.21.5 of the EIS.

23.3.5 Summary

Section B.21.4 of the EIS provided an assessment of potential impacts from a range of natural and human interaction events. The revised design is consistent with the assessment provided in the EIS. Management of security risks will be updated in the Maritime Security Plan and POTL management systems prior to construction of each stage.

23.4 Conclusion

POTL currently manages security risks associated with essential infrastructure through their Maritime Security Plan and Emergency Management Plan in accordance with regulatory requirements. With the implementation of mitigation measures described in Section B.21.5 of the EIS, the PEP is not expected to significantly impact upon existing procedures and framework, response to emergency situations or maintenance of secure infrastructure and facilities.



SECTION 24

Emergency Management



24.0 Emergency Management

24.1 Introduction

Emergency management and response requirements associated with the Port Expansion Project (PEP) include extreme climatic events, natural hazards and hazards resulting from human actions. Potential impacts from natural and human influenced events are detailed in Chapter B.22 (Emergency Management) of the Environmental Impact Statement (EIS).

Emergency management planning for the PEP is consistent with current Port of Townsville Limited (POTL) procedures and plans and adheres to relevant regulatory requirements. Emergency management for all current and future POTL operations is delivered through the POTL Emergency Response Procedures, Safety Management System, Environmental Management Systems, POTL's Security Plan and through the management of critical infrastructure.

During the design, construction and operation stage of the PEP emergency management planning will be undertaken by POTL in conjunction with the port engineering team and include key stakeholders such as port developers, builders and contractors, port users, customs and relevant regulatory agencies. This will be dependent on final operations, area layout, customs obligations and port use and will be undertaken as part of the PEP risk management process.

This section provides information to address submissions received in response to the PEP EIS relevant to emergency management and the implications of the proposed revised design on these systems. These key matters include:

- location of medical personnel and facilities on site
- role of agencies in development of emergency management plans
- inclusion of liquefied petroleum gas (LPG) management in these emergency plans.

24.2 Response to Submissions

24.2.1 Location of medical personnel and facilities on site

The Queensland Ambulance Service requested additional information regarding the location of medical personnel or medical / first aid facilities on site. This information will be provided to regulators following detailed design of the Project and when final operational use and requirements are known. All POTL medical facilities will be sited and operated in consultation with the relevant authorities. POTL will provide first aid facilities and suitable trained people in accordance with the *Work Health and Safety Act 2011*.

24.2.2 Role of agencies in development of emergency management plans

The Department of Community Safety (now Queensland Fire and Emergency Service and Queensland Ambulance Service) requested for factors that increase the potential for paramedic response to the Project area or may impact upon any emergency response, such as vehicle access and road closures, to be communicated to relevant regulatory agencies. Appropriate access will be provided at all times and staff will be available to direct emergency services by the safest and shortest route.

The Department of Community Safety recommended Queensland Ambulance Service are involved in the development of emergency plans and communicate changes to plans and response to strategies to the Local Disaster Management Group. POTL emergency management plans and procedures are prepared in consultation with the existing port Emergency Management Committee and relevant regulatory agencies including the Queensland Ambulance Service where required.

24.2.3 Inclusion of LPG management in these emergency plans

The Department of Justice and Attorney-General – Hazardous Industries and Chemical Branch provided a recommendation to ensure emergency management plans provide specific measures to manage the risks of LPG associated with boiling liquid expanding vapour explosion and loss of containment from the LPG wharf line and terminal. Future Port tenants cannot be determined at this time, however standard site evacuation plans are required for all operations. Hazards associated with gas escape and explosions are identified in Section B.22.3 of the EIS.

Port operators and tenants are responsible for developing and implementing emergency and safety management plans for their operations in accordance with current POTL emergency and safety procedures and regulatory requirements. This includes the safe storage, handling, use and disposal of hazardous materials including LPG.

24.3 Revised Environmental Impact Assessment

24.3.1 Legislation and policy

Legislation and policy changes that have occurred since the development of the EIS are identified in Section 1.0 of the AEIS. In relation to Emergency Management the *State Disaster Management Plan 2013-2014* and *Handbook 203:3006 Environmental Risk Management – Principles and Processes* have been updated, these will not affect the current stage of the PEP, but will be considered as a part of the Project risk management process.

24.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. This refinement focusses on amendments to the extent of dredging and reclamation works and does not impact upon the management and response to emergency situations.

24.3.3 Supporting studies

No additional studies were required to assess the revised design and address comments received from the submissions on emergency management.

24.3.4 Revised assessment

24.3.4.1 Impact assessment

Impacts of the Project on emergency management are consistent with that identified in Section B.22.4 of the EIS.

24.3.4.2 Mitigation measures

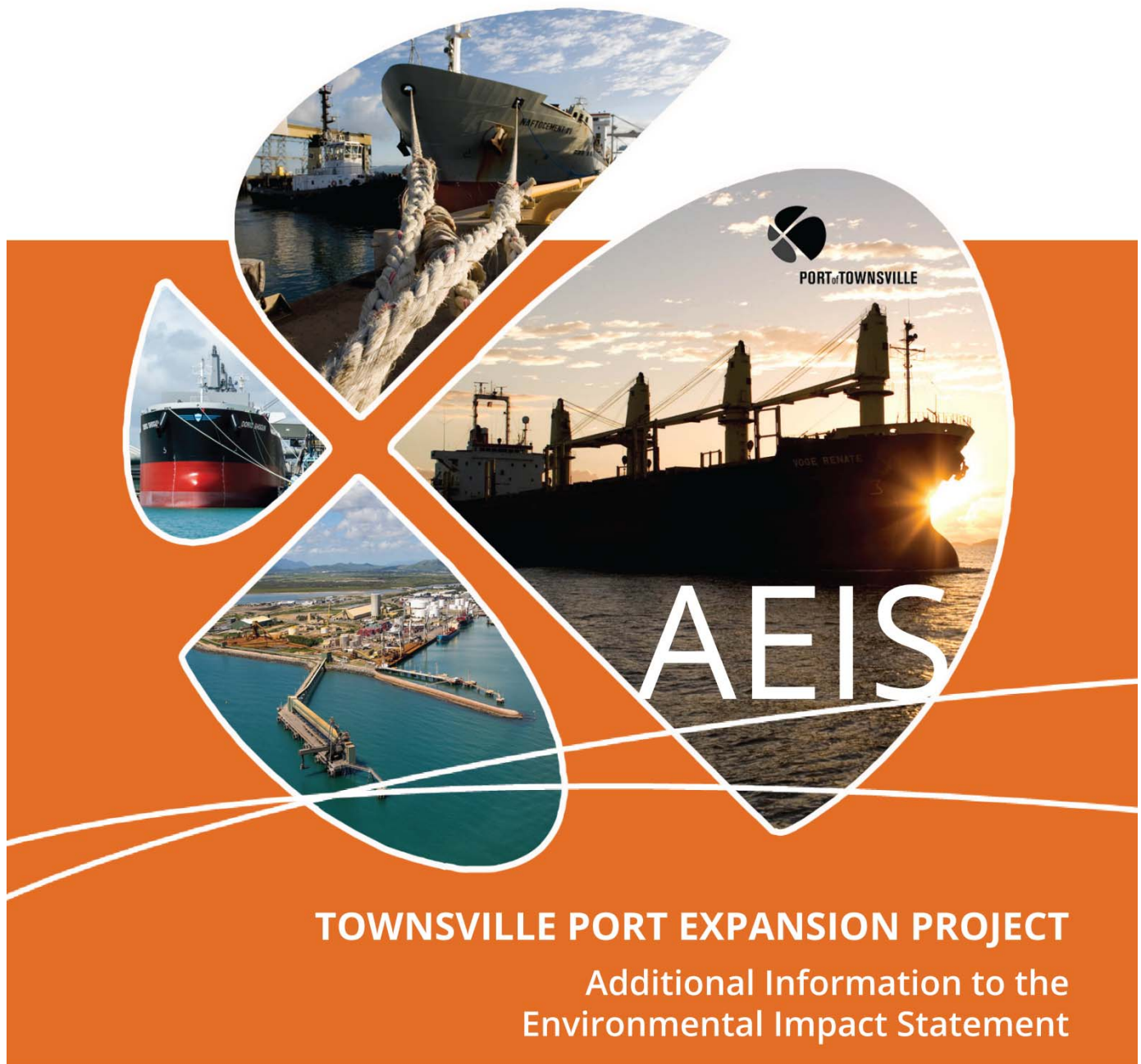
Mitigation and management of additional potential impacts from natural and human related events are consistent with Section B.22.5 of the EIS. Mitigation and management of potential impacts will be incorporated into existing emergency management measures implemented by POTL. Mitigation of disasters and catastrophic impacts are also addressed at district and State levels through the respective disaster management groups delivering plans and preventative programs.

24.3.5 Summary

Section B.22.4 of the EIS provided an assessment of emergency management risk for the PEP. The revised design is consistent with the assessment provided in the EIS. Mitigation measures as identified in Section B.22.5 of the EIS remain current. Emergency management for all current and future POTL operations is delivered through the POTL Emergency Response Procedures, Safety Management System, Environmental Management Systems, POTL's Security Plan and through the management of critical infrastructure.

24.4 Conclusion

POTL currently manages emergency risks through the POTL Emergency Response Procedures, Safety Management System, Environmental Management Systems, POTL's Security Plan and through the management of critical infrastructure and in support of the POTL Emergency Management Committee and Local Disaster Management Group. With the implementation of mitigation measures through these mechanisms, the PEP is not expected to significantly impact upon existing procedures and framework and emergency response services locally or regionally.



SECTION 25

Revised Cumulative Impacts

Assessment



25.0 Revised Cumulative Impacts Assessment

25.1 Introduction

This section provides information to address submissions received in response to the Port Expansion Project (PEP) Environmental Impact Statement (EIS) regarding cumulative impacts. This information supplements the assessment provided in Chapter B.24 (Cumulative Impacts) of the EIS.

Submissions sought more information on the relative role of projected impacts from the PEP in light of other stressors acting on the Cleveland Bay and the greater Great Barrier Reef (GBR) environment. Submissions also sought information over the present resilience of the GBR and how the Project may impact upon this resilience. Further information was also sought on how the Project may impact Outstanding Universal Value (OUV) of the GBR World Heritage Area (WHA) which is addressed in Section 26.0 of the Additional Information to the Environmental Impact Statement (AEIS).

Submissions also sought further information on whether project-related effects may impact eco-tourism operations. Other submissions sought specific information on other stressors such as cyclones, bleaching, and catchment runoff.

In relation to cumulative impacts, two questions were commonly posed:

- given recent natural hazards such as floods and cyclones in the GBR, whether potential impacts from the Project will further reduce the resilience of key GBR ecosystems to unacceptable levels
- what the relative role of the project impacts will be by comparison to impacts from these other stressors.

A number of submitters also questioned:

- the compatibility of dredging and material placement within the boundaries of the WHA
- the role of climate change in influencing the condition of the GBR.

A revised cumulative impact assessment was undertaken to address matters raised. This assessment was undertaken in accordance with the *Framework for Understanding Cumulative Impacts Supporting Environmental Decisions and Informing Resilience-Based Management of the Great Barrier Reef World Heritage Area* (GBRMPA Guidelines) (Anthony, Dambacher, Walshe, & Beeden, 2013).

25.2 Response to Submissions

245 submissions (including form letter submissions) related to the cumulative impact assessment. Possible impacts from the proposed dredging operations need to be viewed in light of other processes and activities (jointly referred to as stressors) acting upon sensitive ecological receptors in the region. The resultant cumulative impacts can include the following types of impacts:

- additive (linear or non-interacting) or multiplicative (non-linear and interacting) cumulative impacts of either:
 - different aspects of the same project combining to amplify impacts
 - multiple similar human/anthropogenic activities acting in the same region (for example, multiple capital dredging activities occurring in close proximity over the same relevant impact time periods)
- far field (in a geographic or food web cascading impacts sense) impacts of a single activity
- potential project impacts in the context of other natural and anthropogenic impacting processes. For example, the impacts of dredging needs to be considered in the context of cyclones, reduced water quality from runoff, bleaching and other factors that influence sensitive ecological receptors.

It is common for cumulative impact assessments to primarily focus on the first category (additive and multiplicative impacts) that typically consider other similar major infrastructure projects that are planned nearby. However, these 'nibbling' impacts caused by multiple similar activities occurring in the same region encompass only a small subset of potential cumulative impacts.

The impacts arising from other projects or different stages of this Project are considered in Section 6.0 (Marine Water Quality) and Section 8.0 (Marine Ecology) of the AEIS. The responses to submissions, contained in the revised cumulative impact assessment presented in this Section primarily focus on investigating the potential impacts of the proposed dredging on identified sensitive ecological receptors in the context of other major processes impacting on the same sensitive ecological receptors.

Consistent with recently released guidelines, including the GBRMPA **Cumulative Impacts Framework** (Anthony, Dambacher, Walshe, & Beeden, 2013), the focus of this assessment has been on two particular sensitive ecological

receptors; namely corals and seagrasses. More distant impacts (i.e. cascading effects through the food web) are not assessed in detail in this section as these have been considered in other sections, such as Section 8.0.

Given that the assessment of cumulative environmental impacts in Australia continues to remain an emerging concept with limited policy guidance, the approach applied in this assessment draws on existing accepted cumulative impact approaches, including the methodology developed by the United States Council on Environmental Quality (i.e. *Considering Cumulative Effects Under the National Environmental Policy Act*) and the Canadian Environmental Assessment Agency (i.e. *Cumulative Effects Assessment Practitioners' Guide*).

The structure of this section is largely based upon the GBRMPA Cumulative Impacts Framework. This framework uses qualitative and quantitative modelling to provide a systems-level understanding of how cumulative stressors may affect coral reef and seagrass ecosystems in the GBRWHA that underpin Matters of National Environmental Significance (MNES), including the OUV of the GBRWHA.

The cumulative impacts approach applied as part of the AEIS is fundamentally risk-based and as such is consistent with the international risk standard ISO 31 000.

The assessment approach involves determining the characteristics and impacts of major stressors (both project and non-project) acting on the sensitive ecological receptors, and then investigating the individual and combined impacts of all of these stressors.

The specific steps of this cumulative impact assessment methodology (and the corresponding references within this AEIS) are listed below.

1. Select a set of appropriate sensitive ecological receptors as identified in the GBRMPA Cumulative Impacts Framework (Section 25.3.1).
2. Identify all likely stressors acting on the selected sensitive ecological receptor (Appendix A5, Section 1.2).
3. Characterise project stressors acting on sensitive ecological receptors (Appendix A5, Section 1.3).
4. Characterise the non-project stressors on sensitive ecological receptors (Appendix A5, Section 1.3).
5. Determine the frequency of occurrence and impacts or consequences to sensitive ecological receptors of these stressors acting individually (Appendix A5, Section 1.4 and 1.5).
6. Investigate how these stressors acting together may impact the sensitive ecological receptors, and identify the relative role of project related impacts in the context of impacts from the non-project related stressors (Section 25.3.3).
7. Identify possible worst-case combinations of both project and non-project stressors (Section 25.3.3.1).

The outcomes from this analysis provide an informed understanding of the relative role of project-related impacts, in the context of the impacts of other stressors acting within the study area. It also identifies the particular combinations or timing of stressors that should be considered when planning the implementation of the Project. The assessment is included in Section 25.3 below.

Background information to support this assessment is included in Appendix A5 of this AEIS

25.3 Revised Impact Assessment Approach

25.3.1 Sensitive ecological receptors

This cumulative impact assessment focuses on two key sensitive ecological receptors identified in the GBRMPA Cumulative Impacts Framework: coral reefs and seagrass beds, which were identified to be at a higher risk in Section 8.0 of the AEIS. This focus is consistent with the submissions on the EIS and the GBRMPA Cumulative Impacts Framework (Anthony, Dambacher, Walshe, & Beeden, 2013).

The following sections summarise the known distributions of these two key sensitive ecological receptors. The study area used is consistent with the sections of the AEIS (refer Section 8.0 of the AEIS).

Corals

Cleveland Bay supports a network of near-shore reefs which form part of an extensive system of near-shore reefs within the *Coastal Central Reefs Bioregion* (GBRMPA, 2012). The location of coral reefs within Cleveland Bay are shown in Figure 25.1.

Reef habitats in Cleveland Bay include shallow fringing reefs and rocky shores around Magnetic Island, the reef platform of Middle Reef, and smaller reef areas between the mainland and Magnetic Island (e.g. Virago Shoal).

Figure 25.3 Stafford-Smith and Veron (1992) recorded at least 258 species of hard corals on reefs in Cleveland Bay and surrounds. This represents over half of the total number of hard coral species recorded in the GBR (405 hard coral species) (Fabricius K., 2009). On a GBR wide scale, the species richness recorded on Cleveland Bay reefs is considered to be moderate (DeVantier, De'ath, Done, Turak, & Fabricius, 2006).

The fringing reefs of Magnetic Island typically have the highest hard coral cover along the reef slopes, whereas the reef flats are also colonised by macroalgae and seagrass (particularly at Cockle Bay Reef). C & R Consulting (2007) classified reefs as follows based on the relative cover of hard corals and macroalgae.

- Middle Reef, Nelly Bay West and Arthur Bay - very high live coral cover and low algal cover
- Nelly Bay East and Florence Bay feature - live coral cover and relatively low algal cover
- Picnic Bay, Geoffrey West and Geoffrey East, – relatively low live coral and algal cover.

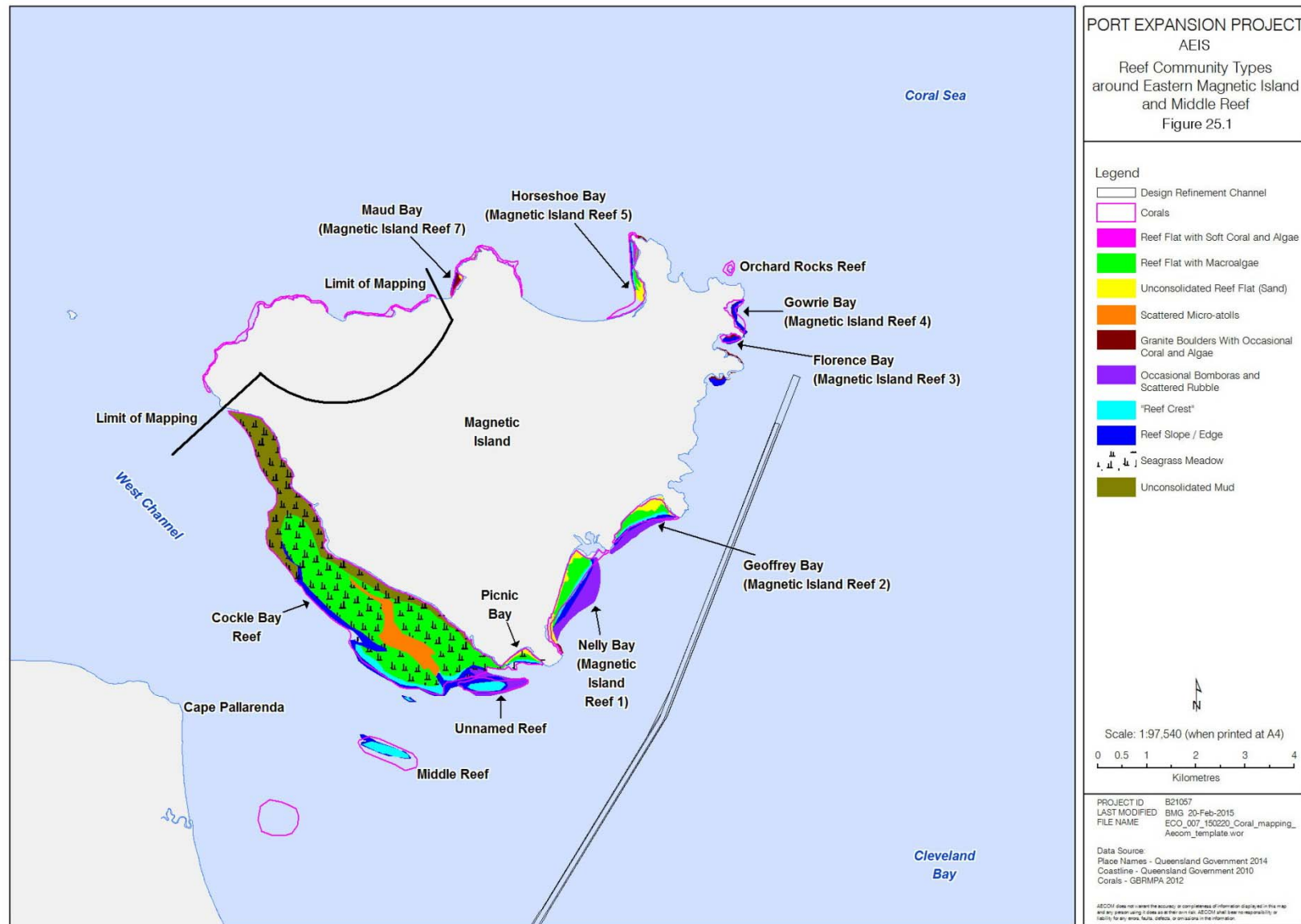


Figure 25.1 Distribution and Extent of Reefs within Cleveland Bay

Seagrass

Cleveland Bay contains extensive and diverse seagrass meadows (Figure 25.2). Eight species of seagrass have been recorded in Cleveland Bay (Rasheed & Taylor, 2008), namely *Zostera muelleri*, *Halodule uninervis*, *Syringodium isoetifolium*, *Cymodocea serrulata*, *Halophila spinulosa*, *Halophila ovalis*, *Halophila decipiens* and *Thalassia hemprichii*.

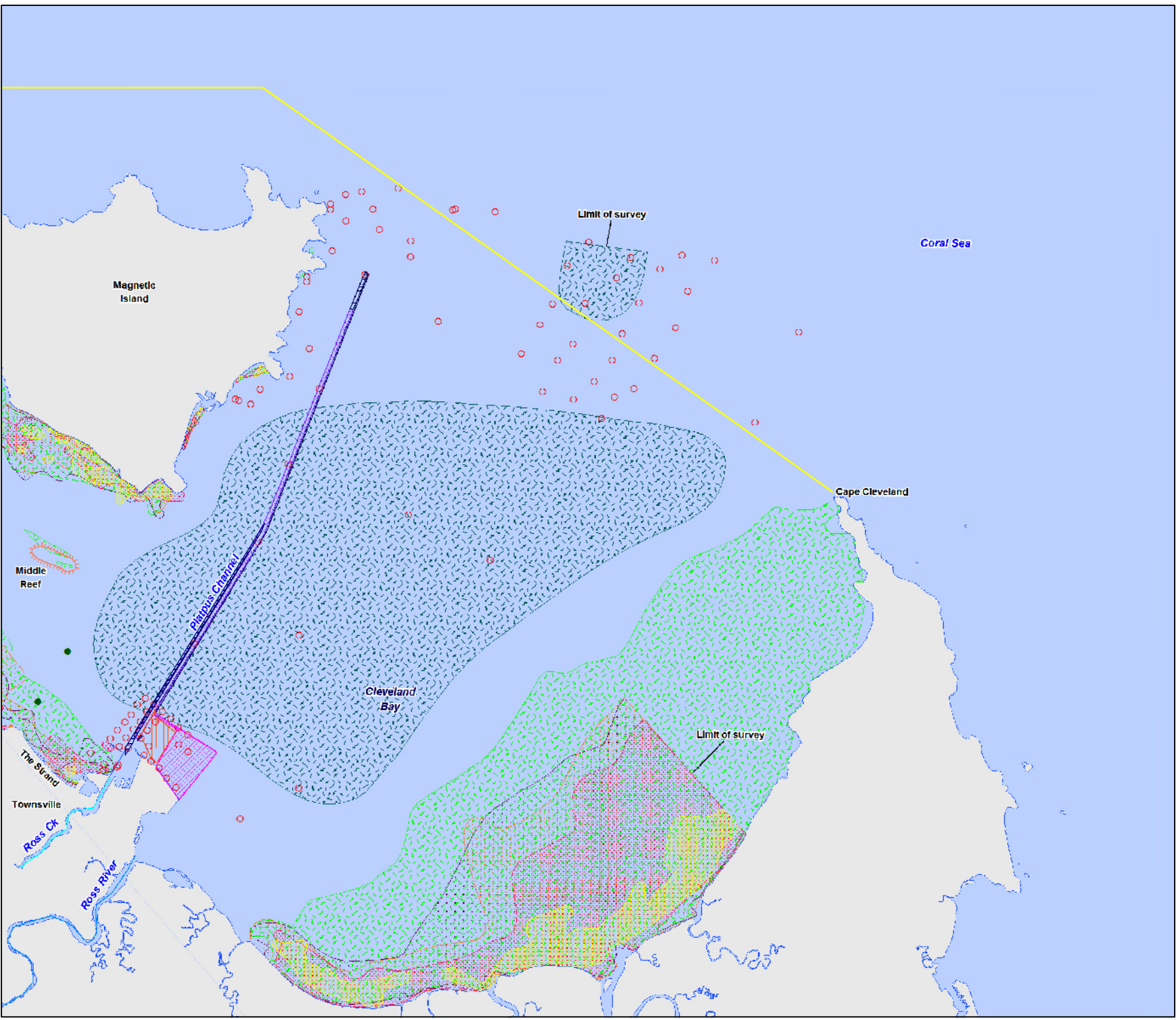
Seagrass is not known to occur in the Port's inner or proposed outer harbour areas, although shallow water and intertidal seagrass beds occur near the mouth of the Ross River and Townsville (Strand) waterfront.

More details can be found in Chapter B.6 (Marine Ecology) of the EIS and Section 8.0 of the AEIS.

PORT EXPANSION PROJECT
AEIS

Distribution and Extent of
Seagrasses within Cleveland Bay

Figure 25.2

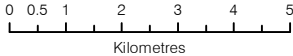


Legend

- Video Site - No Seagrass Observed
- Video Site - Seagrass Observed
- Ross River
- Ross Creek
- Port Limits
- ▨ Channel to be Dredged
- ▤ Existing Channel to be Deepened
- ▧ Harbour Basin
- ▩ Reclamation Area
- 2007 Coastal Seagrass (Permanent and Semi-permanent Meadows)
- 2007 Deepwater Seagrass (Sparse Ephemeral Meadows)
- Monitoring Meadows (McKenna and Rasheed 2012)
- 2008
- 2009
- 2010
- 2011



Scale: 1:135,000 approx. (when printed at A4)



PROJECT ID 60161996
LAST MODIFIED CFS 28-09-2016
FILE NAME 60161996_PLN_039_3

Data Source:
Distribution and Extent of Seagrasses within Cleveland Bay
(Source: McKenna and Rasheed 2012), Figure 7.8 - BMT WBM 2012.

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

25.3.2 Summary of relevant background information

Relevant background information that advised the preparation of this revised cumulative impact assessment is contained in Appendix A5.

The background information presented includes:

- identification of the potential stressors that may impact upon sensitive ecological receptors (Appendix A5, Section 1.2)
- characterisation of the likelihood of occurrence of these stressors (Appendix A5, Section 1.3)
- consideration of how the distribution and condition of the sensitive ecological receptors varies over time (Appendix A5, Section 1.4)
- the risk of impacts of these individual stressors on sensitive ecological receptors in Cleveland Bay (Appendix A5, Section 1.5).

Consistent with recently released guidelines GBRMPA Cumulative Impacts Framework (Anthony, Dambacher, Walshe, & Beeden, 2013), the focus of this assessment has been on two particular sensitive ecological receptors ; namely corals and seagrasses. As outlined in Chapter B.6 (Marine Ecology) of the EIS and further discussed in Section 8.0 of the AEIS, the main risk to the sensitive ecological receptors are:

- reduced water clarity (increased turbidity)
- increased sedimentation rates in the vicinity of the sensitive ecological receptors.

Both seagrasses and corals have shown sensitivity to periods of elevated turbidity and sedimentation rates. Therefore any mechanism that mobilises fine sediments must be considered to be a stressor for the sensitive ecological receptors in the study area. This includes both project related and non-project related mechanisms, and as such, capital dredging impacts from the proposed Project need to be considered in the context of other stressors operating on these sensitive ecological receptors.

The stressors considered in this Cumulative Impact analysis included:

- large-scale external drivers, including climate change derived ocean warming and ocean acidification
- strong synoptic weather events, especially cyclones
- contribution of sediments, nutrients and pesticides, from land-use changes and sediments re-mobilised by dredging activities
- fishing, tourism and marine transport stressors.

These stressors were summarised into the following categories as per the GBRMPA Cumulative Impacts Framework (Anthony, Dambacher, Walshe, & Beeden, 2013).

- 1) Intense weather events (i.e. cyclones)
- 2) Large scale externalities
- 3) Dredging and catchment land use practices
- 4) Fishing, marine tourism and transport.

Key-cause effect relationships were identified to define links (risk pathways) between these four stressors and ecological endpoints (sensitive ecological receptors) (Appendix A5, Figure 1.1). Each of these stressors is then described in terms of their variability and likelihood of occurrence and risk of impact on the condition of sensitive ecological receptors and the corresponding consequences of this occurrence.

The background and historic data provided in Appendix A5 has been used to advise the cumulative assessments that are detailed below.

25.3.3 Cumulative and interactive impacts

This section describes the assessment of risks to sensitive ecological receptors by considering the likelihood of occurrence and consequences of the stressors firstly acting individually, and then in combination.

The GBRMPA Cumulative Impacts Framework recommends the use of Bayesian Belief Networks for undertaking some of the risk assessment tasks. Networks based on theoretical principles developed and provided in the Framework have been considered and discussed in this analysis. However the networks provided in the guidelines are not based on data, primarily due to a lack of available data. Therefore, as a result of the same lack of available data, two additional modelling tasks were performed to provide insight into the individual and cumulative impacts of all the stressors acting on the sensitive ecological receptors .

25.3.3.1 Comparison of damages

When considering, comparing and assessing the damages of episodic natural hazards a standard actuarial approach is to annualise the potential damages so that the total or long-term average annual damages (AADs) can be compared. This approach forms the basis of flood damage planning in most states in Australia (for example the Queensland Government Guidance on the Assessment of Tangible Flood Damages (Department of Natural Resources and Mines, 2002).

Estimates of average annual damages for the sensitive ecological receptors were developed by using the collated data on the return interval (frequency) of cyclones, bleaching events, capital and maintenance dredging, and estimated damages from historical events described in the scientific literature (Appendix A5, Section 1.3).

Direct damage estimates from the Project were based on the estimates presented in Section 8.0 of the AEIS and in this analysis it has been assumed that capital dredging has in the past taken place on average every 25 years. Damages from all stages were combined in these calculations and are assumed to be worst-case scenarios.

The data used to develop the average annual damages curves are shown in Table 25.1. It is noted that CoTs refers to outbreaks of Crown of Thorns Starfish (*Acanthaster planci*).

Corals

Table 25.1 Parameter values used for the average annual damages estimates for corals in the study area

Descriptor	Return Interval (years)	AEP (Annual Exceedance Probability)	Estimated % Sensitive Environmental Receptors damaged within study area	References
Cyclones				
Category 5	100	0.01	90	Lukoschek <i>et al</i> (2013) GBRMPA (2011) Nott and Hayne (2001) [Cyclone Yasi]
Category 4	50	0.02	63	Ayling (1991) [Cyclone Joy, included sites over 200 km away from path].
Category 3	20	0.05	20-75	Done <i>et al</i> (1991) Puotinen (2007) [Cyclone Ivor] [Cyclone Hamish] Woolsley <i>et al</i> (2012)
Category 2	10	0.10	40	Puotinen (2007)(2005) [Cyclone Justin]
Category 1	5	0.18	~20	Connell <i>et al</i> (1997) [multiple cyclones- see Appendix A5 in Connell <i>et al</i> . (1997)]
Bleaching				
Projected	100	0.01	>90	Hoegh-Guldberg (2011) Yara <i>et al</i> (2014)
2002 event	20	0.05	54	Equivalent to 18% strong bleaching, 54% some bleaching over whole GBR in 2002 event. Berkelmans <i>et al</i> (2004)
1998 event	10	0.10	42	Berkelmans <i>et al</i> (2004)
Annual	1	0.63	0	Bleaching does not presently occur annually in Cleveland Bay.
Increased turbidity from floods				
Extreme floods	200	0.005	80	Extrapolated from (Ayling, A.M. and A.L. Ayling, 1998).
2011 floods	100	0.01	22	Osborne <i>et al</i> (2011).
Typical wetter La Nina flows	7	0.13	3	Nominal value representing 'press' effect.
Typical (El Nino)	1	0.63	1	Nominal value representing 'press' effect.
CoTS				
Extreme event	100	0.01	30	Nominal value.
Major event	15	0.064	19	Lourey, Ryan & Miller (2000).
Minor event	1	0.63	0.5	Fabricsius <i>et al</i> (2010) estimate an average annual GBR average loss from CoTS of 0.5% per year.
Dredging				
Capital	25	0.04	2	From PEP AEIS and POTL 1993 campaign.
Maintenance	1	0.63	0	From maintenance dredging PEP EIS.

The results from the average annual damages estimates are shown in Figure 25.3 to Figure 25.7. In each of these figures the Annual Exceedance Probability (AEP) is plotted on the x-axis and the % mortality on the y-axis. Note that different x-axis scales are used.

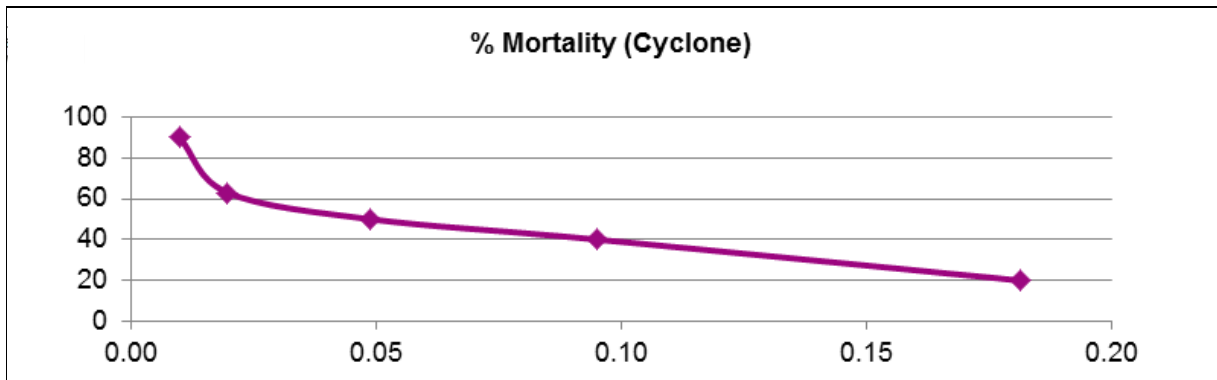


Figure 25.3 Damage plots for coral reefs based on the damage estimates – Cyclones.

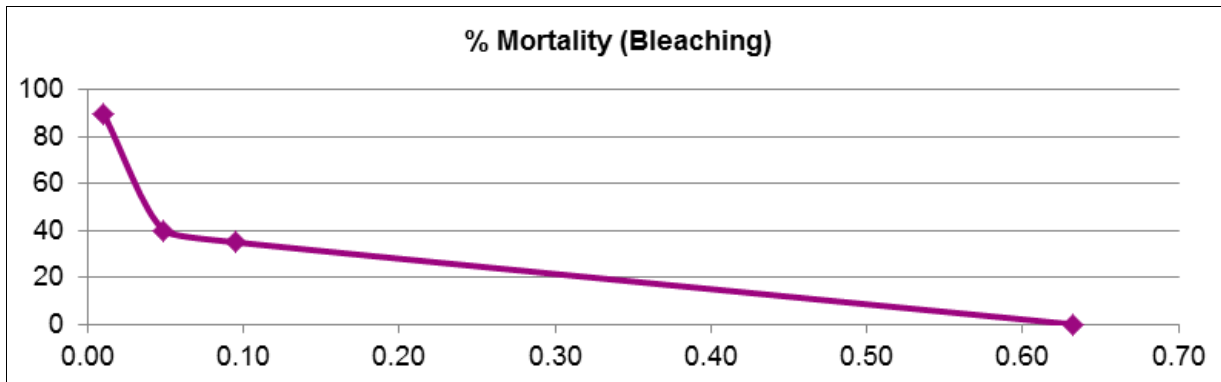


Figure 25.4 Damage plots for coral reefs based on the damage estimates – Bleaching.

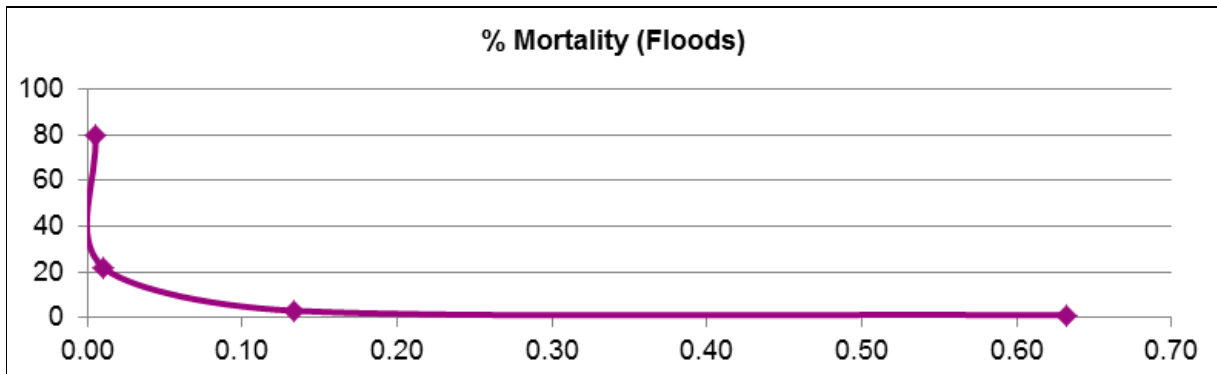


Figure 25.5 Damage plots for coral reefs based on the damage estimates – Floods.

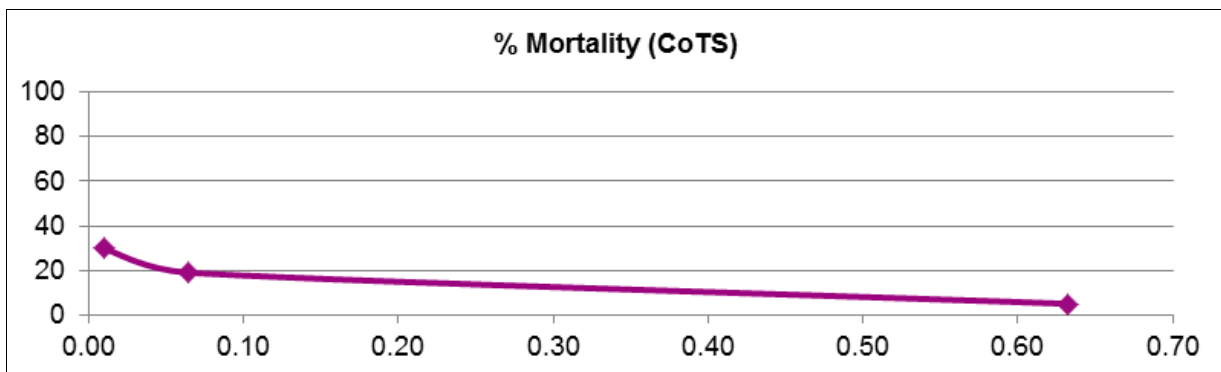


Figure 25.6 Damage plots for coral reefs based on the damage estimates – CoTS.

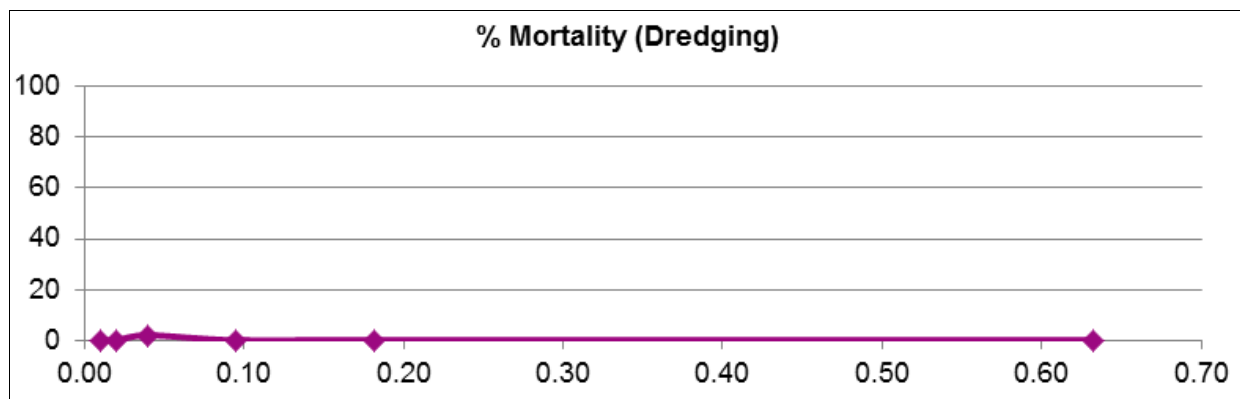


Figure 25.7 Damage plots for coral reefs based on the damage estimates – Dredging.

The average annual damages for each stressor are estimated by calculating the integral or area beneath each average annual damages curve. These values are shown in Table 25.2. The results shown in this table indicated that on average, the largest source of stress for the coral reefs in the study area is bleaching, followed by CoTS and cyclones.

Table 25.2 Estimated average annual damages for stressors on coral reefs

Source of stressor	Estimated average annual damages (%/yr)
Cyclones	7
Bleaching	15
Floods	2
CoTS	10
Dredging	>0.1

Seagrass

Table 25.3 shows the parameter values used for the seagrass damage model. Once again the damage estimates from dredging are based on information provided in the Section 8.0 (Marine Ecology).

Table 25.3 Parameter values used for the average annual damages estimates for seagrasses in the study area

Descriptor	Return Interval (years)	AEP (Annual Exceedance Probability)	Estimated % sensitive ecological receptors damaged within study area	References
Cyclones				
Category 5	100	0.01	95	(Poiner Ian, 1993) (Rasheed M. M., 2014)
Category 4	50	0.02	63	(Sachithanandam, 2014)) [Cyclone Lehar- category 4]
Category 3	-	-	-	Insufficient data available
Category 2	-	-	-	Insufficient data available
Category 1	5	0.18	10	Seagrass Watch
Increased turbidity from floods				
Extreme floods	200	0.005	60	Preen <i>et al</i> (1995) Campbell and McKenzie (2004)
2011 floods	100	0.01	30	Seagrass Watch monitoring data. Rasheed <i>et al</i> (2014) (McKenzie, 2014)
Typical wetter La Nina flows	7	0.13	5	Nominal value representing 'press' effect.
Typical (El Nino)	1	0.63	1	Nominal value representing 'press' effect.
Dredging				
Capital	25	0.04	3	From PEP AEIS and POTL 1993 campaign.
Maintenance	1	0.63	1	From maintenance dredging PEP EIS.

The results from the average annual damages estimates are shown in Figure 25.8 to Figure 25.10. In each of these figures the Annual Exceedance Probability (AEP) is plotted on the x-axis and the % mortality on the y-axis. Note that different x-axis scales are used.

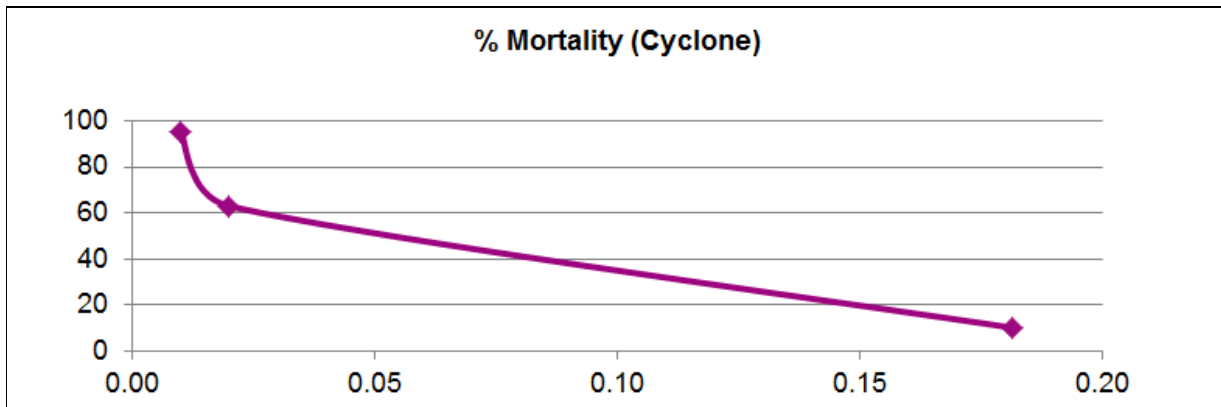


Figure 25.8 Damage plots for seagrass meadows based on the damage estimates – Cyclones.

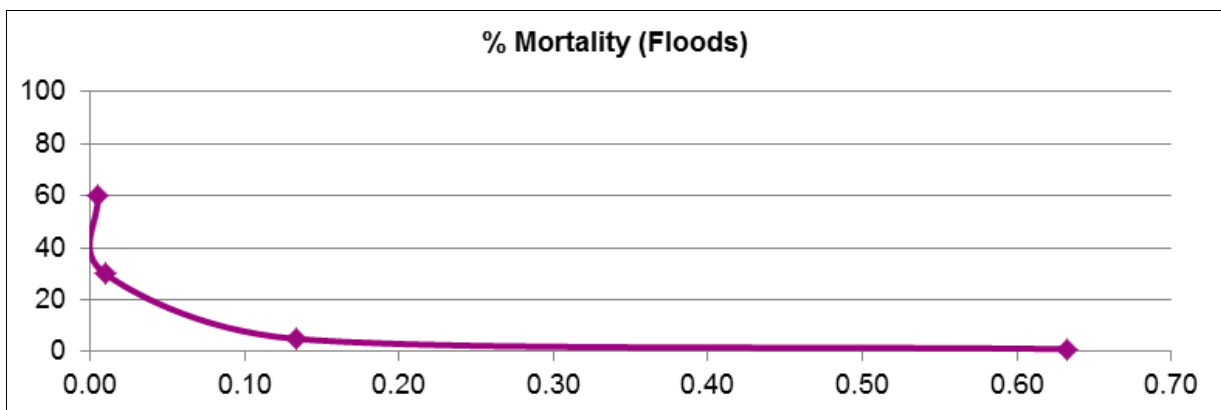


Figure 25.9 Damage plots for seagrass meadows based on the damage estimates – Floods.

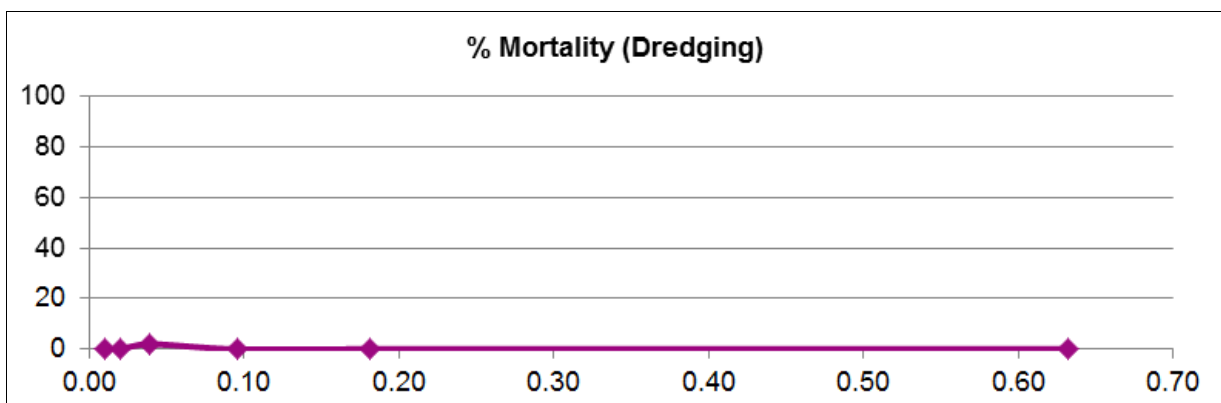


Figure 25.10 Damage plots for seagrass meadows based on the damage estimates – Dredging.

The average annual damages for each stressor are estimated by calculating the integral of area beneath each average annual damages curve. These values are shown in Table 25.4. For seagrass meadows, the largest stressors considered in this analysis are associated with cyclones and floods.

Table 25.4 Estimated average annual damages for each stressor for seagrass meadows

Source of stressor	Estimated average annual damages (%/yr)
Cyclones	7
Floods	3
Dredging	0.2

The average annual damage calculations demonstrate the very minor role that dredging plays in impacting coral cover and seagrass cover by comparison with the other major stressors.

25.3.3.2 Possible interactive effects

There has been considerable recent attention given to the condition of the sensitive ecological receptors in the GBRWHA and concerns that the overall resilience of many parts of the reef is low. For example, Figure 8.2 from the most recent Outlook Report (GBRMPA, 2014) shows the downward trend in coral health index from inshore reefs see Figure 25.11. The Burdekin region shown in this figure includes Cleveland Bay.

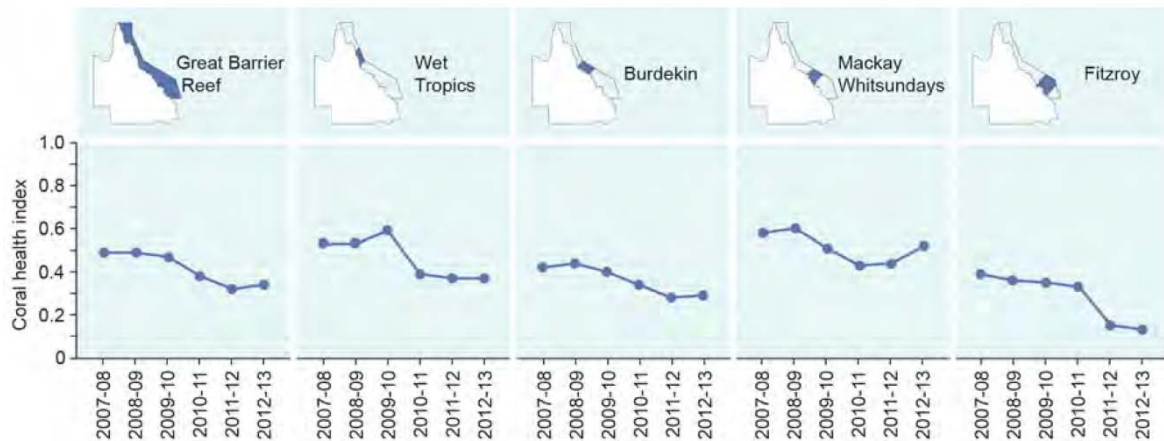


Figure 25.11 Changes in coral health of inshore reefs, 2008-2013; GBR Outlook Report Figure 8.2 (GBRMPA, 2014).

The reduced resilience in the GBR has commonly been attributed to the cumulative or combined impacts of a number of stressors. For example, the most recent 2014 Reef Outlook Report identifies that:

“as a result of chronic disturbances such as poor water quality and outbreaks of coral disease, as well as a recent series of acute disturbances such as crown-of-thorn starfish outbreaks, coral bleaching events and cyclones, which have left insufficient time for many coral colonies to recover between events”.

Of these, the overall greatest risks are seen to be posed by large scale external stressors (Figure 9.1 from the 2014 Outlook Report); especially ocean warming leading to bleaching. This is consistent with the analysis of individual stresses presented above.

The average annual damages analysis presented above led to the ranking of the individual stressors based on their probable impacts and average recurrence. However this assessment did not consider the combined action of these stresses acting either concurrently or close together.

Two possible classes of interaction were considered:

- (a) co-incident occurrence of multiple stressors
- (b) incidence of a stressor whilst the sensitive ecological receptors are recovering from a previous stressor event.

Figure 25.12 shows the occurrence of major cyclones and bleaching events by latitude over recent decades in the GBR.

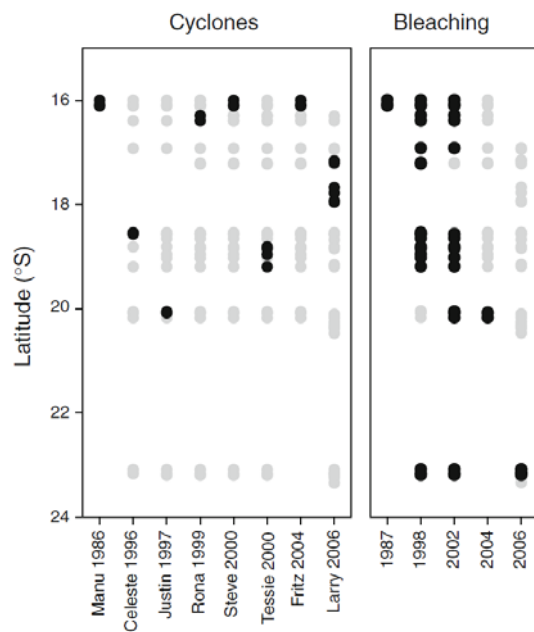


Figure 25.12 Spatial-temporal location of cyclone (left) and bleaching (right) events on the GBR. Each point represents a reef sampled at a particular latitude and time. Grey Symbols indicate no impact to coral communities, while black symbols indicate impacted reefs (Thompson & Dolman, 2010).

The results shown in Figure 25.12 demonstrate that both bleaching and cyclones are common features of the GBR. However it also demonstrates the differences in spatial scales whereby bleaching events often impact more reefs in comparison to cyclones. These results also show that bleaching events and cyclones do not often co-occur at the same time and the same place.

To examine the potential relationship between cyclones and bleaching events, category 4 and 5 cyclones and major bleaching events are plotted along with the ENSO (El Niño Southern Oscillation) signal (Figure 25.13). This shows that there is mostly no overlap between cyclone and bleaching events.

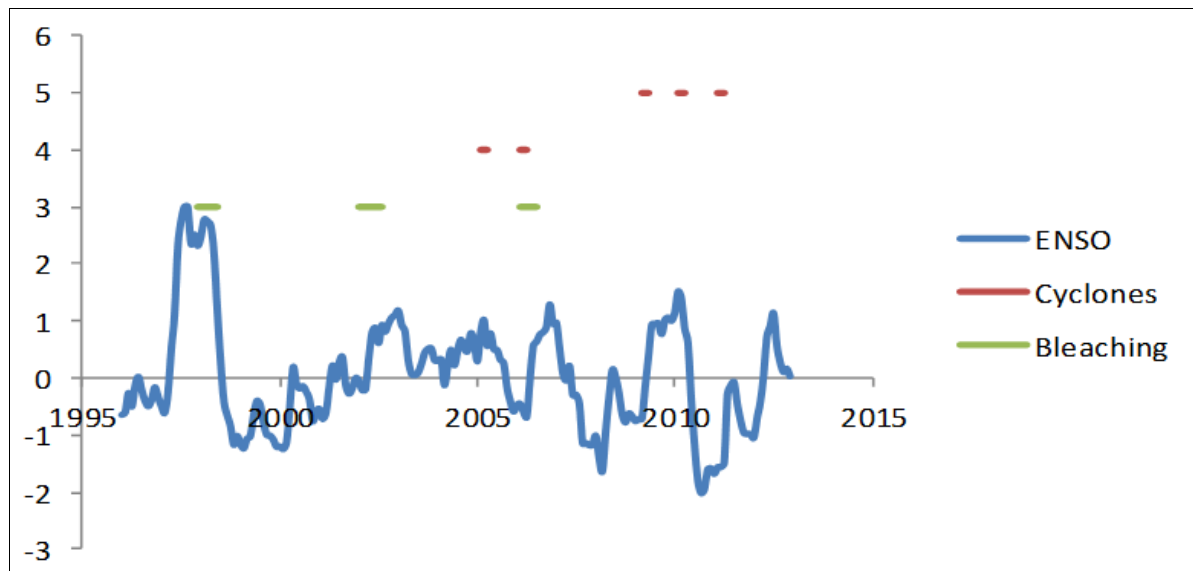


Figure 25.13 ENSO cycles, bleaching and major cyclones for the Great Barrier Reef. Figure produced from collating available data. Y-axis shows ENSO Index.

This then implies that co-occurrence of cyclones and bleaching are unlikely to be common, despite both stressors individually being common. However, given the recovery period of either event is in the order of years to decades, there is likely to be considerable overlap in either a cyclone or a bleaching event to occur during the recovery period of either event.

Carrigan and Puotinen (2014) also highlight another source of interaction. This study highlights that cyclones can actually reduce the impact of bleaching events when they follow bleaching events. The mechanism for this is that

cyclones can upwell cooler water that acts to mix with the warmed water that was causing the bleaching. This study estimated that at some reefs in their study area in the Caribbean, the likelihood of co-occurrence of thermal stress and cyclone cooling was as much as 31%.

Given the return periods estimated above, it implies at present, on average reefs and seagrasses in Cleveland Bay are likely to experience large cyclone events and /or a bleaching event reasonably routinely. However, the recovery period for either of these events is 10-20 years and therefore on average, at present, the reefs and seagrass meadows are recovering from either or both a cyclone event or bleaching event.

This same argument applies to major rain events, that are at the highest intensity during La Nina conditions. For example, following the large floods in 2011, seagrass beds in Cleveland Bay only returned to average distributions in 2013, two years after the event.

Given the relatively long recovery periods (multiple years) and the frequency of natural hazards (on average a few years), it is clear most, if not all reefs on the GBR rarely reach any sort of ecological successional plateau.

25.3.3.3 Coral and seagrass cover models

Consistent with the weight of evidence approach, the cumulative impacts assessment uses a range of models in order to understand how the different stressors can impact on the sensitive ecological receptor in the study area. For example, the average annual damages model detailed above seeks to quantify the relative impacts of the different stressors averaged over periods of years. From this, the relative importance or ranking of the different stressors can be determined.

The coral cover model, presented here, investigates the relative timing of impacts and recovery of different stressors on coral cover. This model seeks to understand the potential impacts of co-occurrence of dredging operations and other external stressors such as bleaching and cyclones.

The principle underpinning this model is to use the least complicated population dynamics formulation to capture the fundamental impact and growth of corals. Whilst more complicated models have been developed, these require data and parameter values that are largely unavailable for the inshore reefs in the study site.

The model formulation is based on the Schaefer logistic population growth model. The fundamental population model is used for the study of marine populations and this formulation supports classical marine fisheries stock assessment science. In this application the model is applied to investigate changes to coral cover and seagrass cover. Once again more complicated models can, and have been developed that consider for example different taxa of corals, or growth of coral and macro-algae. However, coral cover is perhaps the most robust and commonly used indicator for this application, as described in Osborne *et al* (2011).

Whilst it is recognised that perhaps the greatest source of uncertainty surrounding the decline of coral reefs globally is the relative roles of global as opposed to local disturbances (Knowlton & Jackson, 2008) it does not preclude that the present resilience of sensitive ecological receptors can be investigated by considering the likelihood, impacts and importantly recovery times from individual stressors. It has been suggested that reduced coral cover resulting from local effects reduces the ability of coral reefs to recover from globally-induced bleaching events. However Knowlton and Jackson (2008) highlight that there is no evidence to support this. By contrast, corals that have suffered exposure from acidification resulting in weaker structural skeletal strength are likely to become more impacted by mechanical destruction from cyclones.

There has also been speculation that coral reef systems exhibit alternate stable states consisting of a system dominated either by coral (demonstrating high coral cover), or a system dominated by turf macroalgae. Whereby once a system is in the turf microalgae dominated state, it is difficult to revert back to the coral dominated state. If this were the case, the logistic growth model may not be the most appropriate population trajectory function as it does not account for hysteresis that can occur when the system changes over time in a way not described by this model.

It is clear that reefs dominated by live coral colonies (>20% coral cover), can co-exist close to reefs dominated by algal turf (< 5% coral cover); Lecchini *et al* (2011), however what is not clear is whether GBR inshore reefs can seamlessly transition between these two states, or if once they fall into the algal turf state that it is difficult to revert back to a coral dominated state. Such hysteresis (whereby ecological communities do not seamlessly transition back and forth between different states) can be triggered by Allee effects (particular stresses on small population sizes) when coral cover is reduced to very low levels, the ability to recover becomes difficult. Allee effects in coral reefs can be triggered when coral populations get very low and reproduction success becomes very low as a result of lack of critical mass of gametes (i.e. reproductive failure). Therefore, this is most likely to occur when a number of reefs are simultaneously impacted. An example of this was when some eastern Pacific reefs went extinct during the 1982-1983 El Nino event (Glynn & De Weerd, 1991; Glynn & Colgan, 1992).

As there are no alternative credible population growth functions available, the logistic formulation is used here as the most acceptable formation for the increase and decrease in coral cover.

Based on the studies of Osborne *et al.* (2011) and others, GBR-wide storms, especially cyclones, and outbreaks of CoTS have had the largest impact on coral colonies; accounting for around one-third of damage each. Storms such as large cyclones tend to cause high intensity impacts over a very short period of time through mechanical damage as opposed to CoTS outbreaks that can inflict damage over periods of 2 – 3 years.

Over recent decades the impacts caused by coral bleaching and disease have been less by comparison to impacts from storms and CoTS. However, as described above climate change projections suggest, over this century the incidence of bleaching events will increase both in frequency and scale so that sometime later this century bleaching will be the dominant impacting process on coral colonies on the GBR.

As discussed above, past studies have claimed the post-European settlement (mid-1800s) fine sediment inflows into the GBR lagoon in some wet seasons will be at least five-fold greater than the inflows from the same catchments that will have occurred prior to large-scale land clearing. It has also been argued that these additional inflows will reduce the number of days available for benthic productivity. Chronic loss of productivity can lead to loss of condition, which in turn can lead to increase in disease (Haapkyla, Melbourne-Thomas, Flavell, & Willis, 2013).

In this model chronic impacts from increased number of days of reduced turbidity is represented through increased disease. The seagrass model also uses a logistic or Schaefer formulation for the seagrass cover trajectory through time. Based on the lack of recovery of some seagrass beds in the North Atlantic (De Jonge, De Jong, & van Katwijk, 2011), it has been speculated that seagrass beds can reach critical population thresholds where recovery either never occurs, or is unexpectedly slow. In such cases populations can form into one of two alternate stable states (healthy and almost non-existent). Dredging impacts used in this assessment are taken as the worst possible case impacts as described in Section 8.0.

In such cases once a population level has fallen below a critical population state and it falls into the other stable state, it can be almost impossible for population recovery to occur. However, the Seagrass Watch data collected to date demonstrated for the meadows in Cleveland Bay, the extreme 2011-2013 wet seasons led to almost complete loss of cover. Following this event these meadows recovered to similar % cover levels that were observed prior to the event. This demonstrates that for these meadows the population contraction and recovery is well estimated by the logistic model.

Corals: Baseline and Model Findings

The coral cover model parameters are presented in Table 25.5. The values shown in Table 25.5 are discussed below. The model domain consists of the study area, which stretches along the coast approximately 25 km.

Over a GBR-wide scale, Osborne *et al.* (2011) note that there are on average a disturbance around every four years. In addition, the same study highlighted that the inner and mid-shelf regions of the GBR experienced periods of almost continuous disturbance up to around 2002, following which recovery has been underway. Furthermore, the same study suggests that the major stressor on this recovery has been outbreaks of CoTS.

It is suggested that across the whole GBR the mean baseline coral cover is around 27-33% (Osborne, Dolman, Burgess, & Johns, 2011). For the inshore reefs in the central region, the baseline is 32% (Figure 25.14, Figure 25.15).

Table 25.5 Parameters used in the coral cover model

Parameter	Value	Reference
Maximum coral cover (carrying capacity)	80%	Osborne <i>et al.</i> (2011); Knowlton and Jackson (2008).
Current level of coral cover	32%	Osborne <i>et al.</i> (2011).
Intrinsic recovery rate following storms	0.15	Osborne <i>et al.</i> (2011).
Intrinsic recovery rate following disease	0.16	Osborne <i>et al.</i> (2011).
Intrinsic recovery rate following bleaching	0.12	Osborne <i>et al.</i> (2011).
Intrinsic recovery rate following CoTS	0.22	Osborne <i>et al.</i> (2011).
Intrinsic recovery rate following floods	0.20	Assumed.
Intrinsic recovery rate following dredging	0.15	Assumed.
Loss of coral cover during major storms	80%	Fabricius <i>et al.</i> (2008).
Loss of coral cover during disease	variable	Haapkyla, Melbourne-Thomas, Flavell, & Willis, (2013).
Loss of coral cover during bleaching	35%	Marshall & Baird (2000); Carrigan & Puotinen (2014).
Loss of coral cover CoTS	19%	Lourey <i>et al.</i> (2000).
Loss of coral cover during floods	5%	Wooldridge, S. (2009).
Loss of coral cover during dredging	2%	Section 8.0 (Marine Ecology) of the AEIS (Stage 1 TSHD).

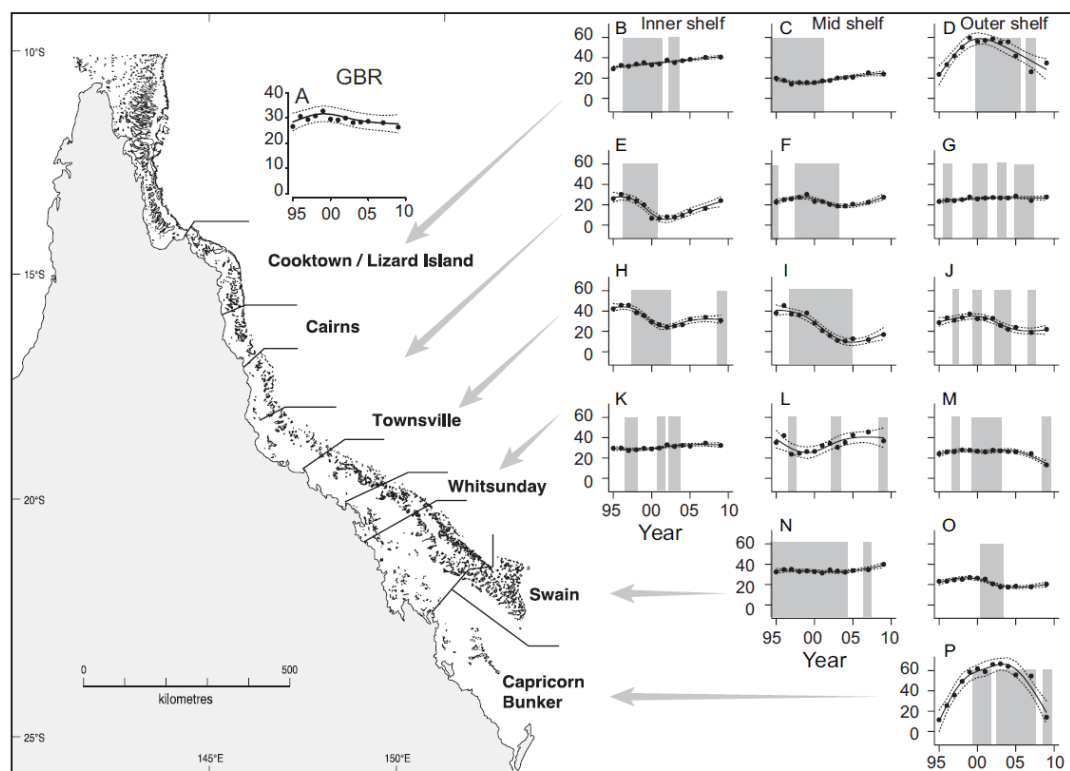


Figure 25.14 Temporal trends in percent cover of hard coral on the GBR (1995-2009) (Osborne, Dolman, Burgess, & Johns, 2011)

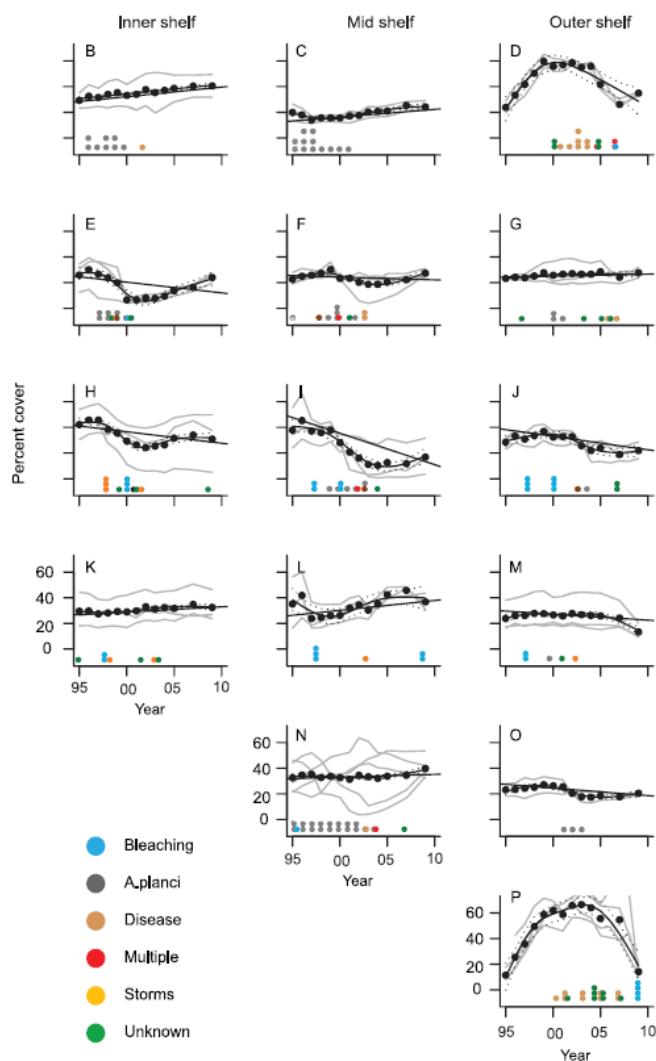


Figure 25.15 Temporal trends in percent cover of hard coral on the GBR (1995-2009) (Osborne, Dolman, Burgess, & Johns, 2011) Note: *A. planci* also known as CoTS

Figure 25.16 shows the base case using the available monitoring data. The blue points represent the observed coral cover estimates derived from the monitoring program. The red points show the modelled trajectory of coral cover. A lack of availability of more recent comprehensive monitoring data constrains the development of up-to-date projections, although surveys completed during this assessment (refer Section 8.0 of the AEIS) suggest the rate of decline has slowed down, if not halted.

The future state of coral cover assessed under three separate scenarios (Table 25): Scenario 1 considers a recovering coral cover in the absence of repeated major hazards followed by the project capital dredging. Scenario 2 considers no intervening recovery and Scenario 3 considers ongoing degradation. The results for these scenarios are shown in Figure 25.17 to Figure 25.19.

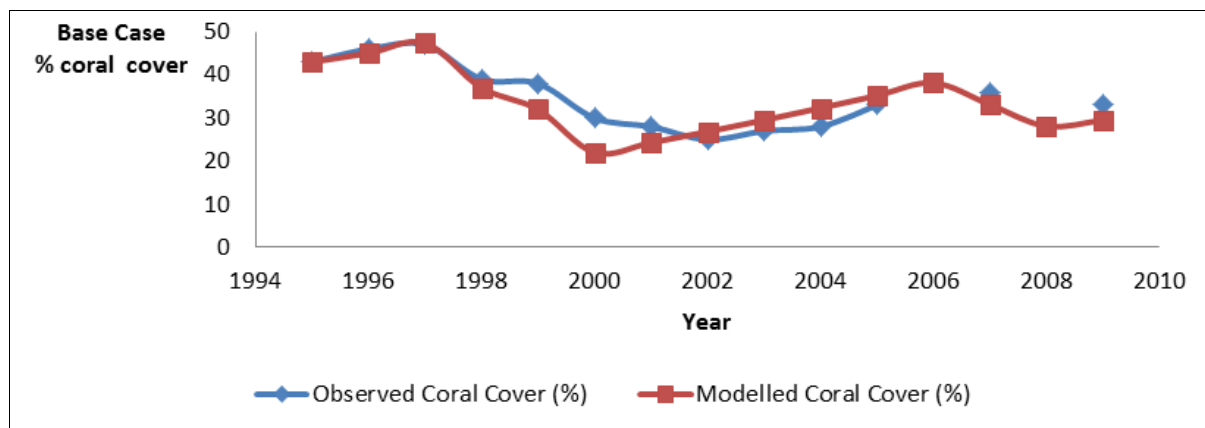


Figure 25.16 Base case for the coral cover model

Table 25.6 Coral cover modelling scenarios

Scenario post project capital dredging	Coral cover trajectory
1 – No repeated major hazards	Few major stressors between 2009 and commencement of capital dredging in 2017. Coral cover increasing.
2 – No intervening recovery	Some stressors between 2009 and commencement of capital dredging in 2017. Coral cover constant prior to dredging.
3 – Ongoing degradation	Multiple stressors between 2009 and commencement of capital dredging in 2017. Coral cover declining prior to dredging.

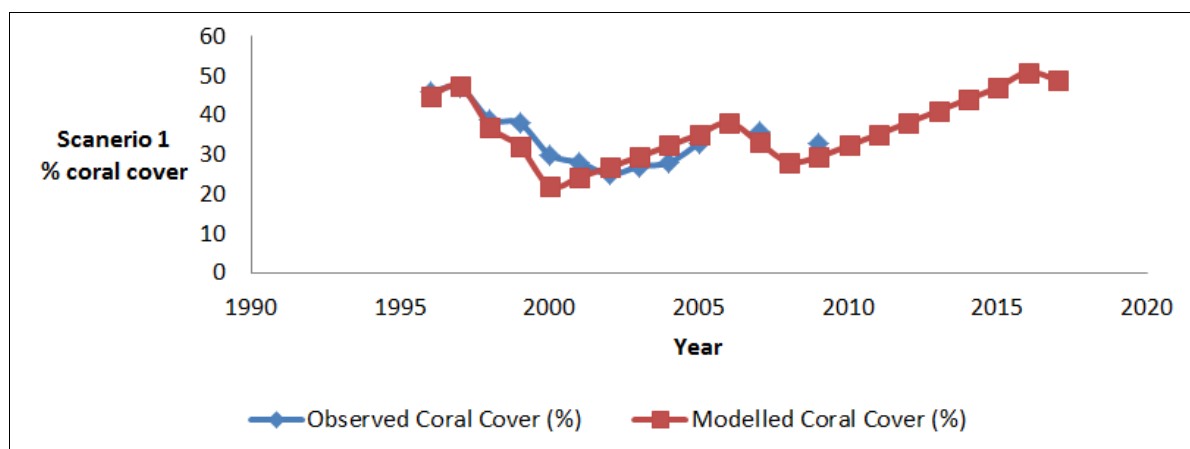


Figure 25.17 Scenario 1 coral cover model

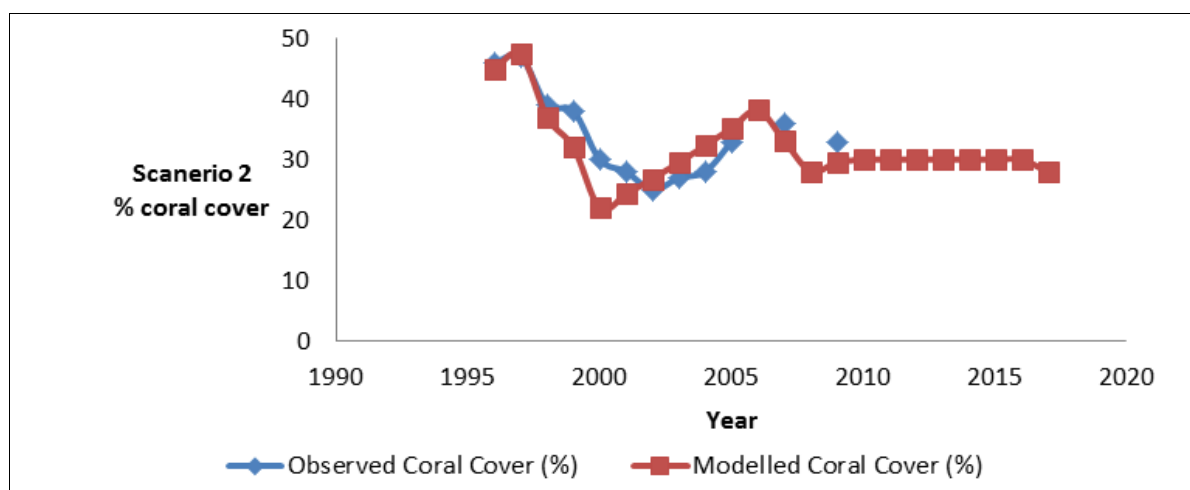


Figure 25.18 Scenario 2 coral cover model

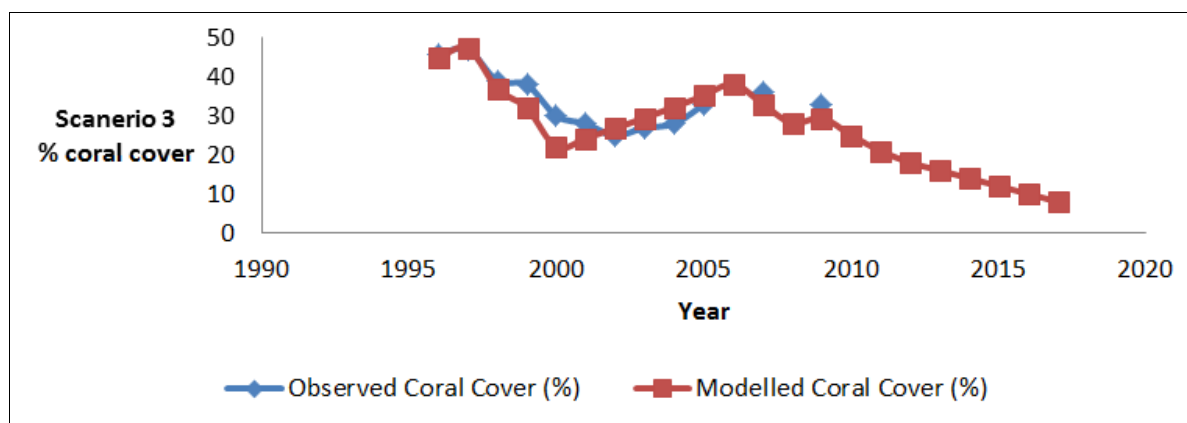


Figure 25.19 Scenario 3 coral cover model

All of the simulations show that dredging, if the worst-case impacts were to arise, could result in a reduction in coral cover during the year of dredging. However what this means to the coral population depends on the recent trajectory, which in turn is dependent upon the stressors occurring in preceding years. For example, if coral cover consistently declined for multiple years preceding a capital dredging campaign, then it will be expected that the decline will continue for another year (Scenario 3).

By contrast, in Scenarios 1 and 2 even a capital dredging campaign should not result in a precipitous decline in the coral cover.

Seagrass: Baseline and Model Findings

The seagrass cover model parameters are presented in Table 25.7. The values shown in Table 25.7 are discussed below.

Table 25.7 Parameters used in the seagrass cover model

Parameter	Value	Reference
Maximum cover (carrying capacity)	50%	James Udy (Healthy Waterways Partnership).
Current level of cover	30%	Seagrass watch and POTL/JCU monitoring.
Intrinsic recovery rate following storms, floods	1.3-0.35. Closest fit using 0.4	Observed recovery of Cleveland bay seagrasses [= $\ln(2)/(\text{time for population to double})$].
Intrinsic recovery rate following dredging	1.3-0.35	Assumed to be same as for floods.
Loss of seagrass cover during major storms, floods	10-30%. Closest fit using 15%	2011 event (Seagrass Watch).
Loss of seagrass cover during proposed dredging	3%	Section 8.0 (Marine Ecology) of the AEIS (Stage 1 TSHD).

The model implicitly assumes that the major impacting factor on seagrass cover is the underwater light environment, although the recovery parameter values used actually implicitly incorporate other factors. It is recognised that extreme temperatures also play a role in mortality (Collier & Waycott, 2010), however these impacts are presently considered to be small by comparison to changes in the light environment (Erftemeijer, 2006); (Waycott, Longstaff, & Mellors, 2005).

The distribution of seagrass beds typically follow a seasonal onshore-offshore migration with increased incoming irradiation allowing seagrass meadows to extend into deeper waters during the summer seasons. This migration can be somewhat independent of the density of seagrass cover used in most monitoring programs, and forms the basis on the logistic model used here.

The parameter value for the maximum percent seagrass cover was derived from the Seagrass Watch field guidelines (<http://www.seagrasswatch.org/Methods/2012/Fieldbooklets>). The intrinsic growth rate parameter was estimated by averaging the post-2011 flood recovery rates from the Townsville regional sites covered by Seagrass Watch (Rasheed M. M., 2014).

The worst-case impacts of dredging were estimated from the work presented in Section 8.0 of the AEIS. The data were derived from the Picnic Bay site and hence it is assumed that all the meadows in the study area will follow the same trajectory. Figure 25.20 shows the base case model.

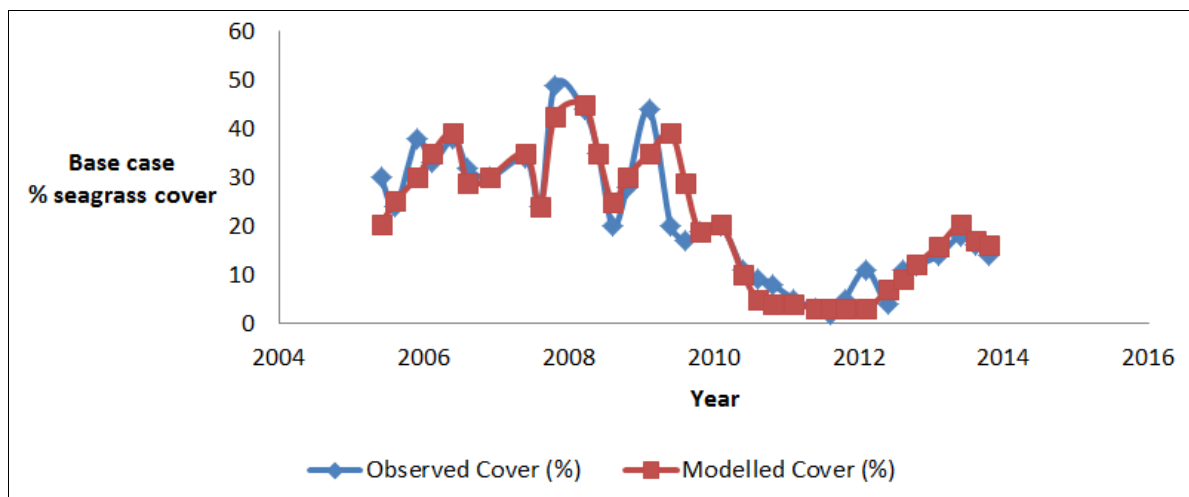


Figure 25.20 Base case seagrass model

The following figures show the future state of seagrass meadows in three separate scenarios (Table 25.8). Scenario 1 considers a recovering cover in the absence of repeated major hazards followed by capital dredging. Scenario 2 considers no intervening recovery and Scenario 3 considers ongoing degradation. The following Figure 25.21 to Figure 25.23 present the results of these scenarios.

Scenario 3 could only occur if continuous stressors occurred in the years leading up to the capital dredging. In such a case seagrass cover could return to similar low levels as experienced following the 2011 floods.

The coral cover and seagrass models presented here assumed the dredging activities will not have any mitigation applied, and are the worst-case.

Table 25.8 Seagrass cover model scenarios

Scenario	Seagrass cover trajectory
1	Few major stressors between 2009 and commencement of capital dredging. Seagrass cover increasing.
2	Some stressors between 2009 and commencement of capital dredging. Seagrass cover constant prior to dredging.
3	Multiple stressors between 2009 and commencement of capital dredging. Seagrass cover declining prior to dredging.

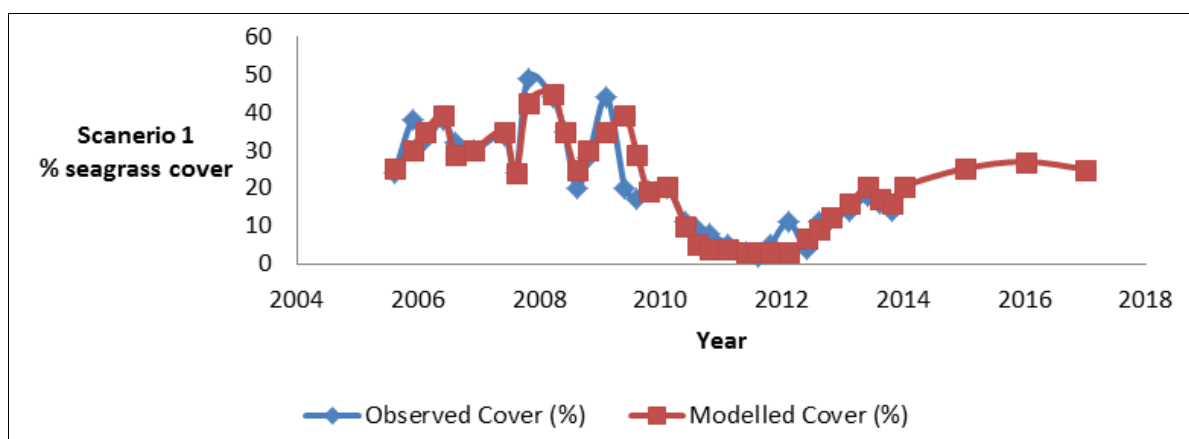


Figure 25.21 Scenario 1 results

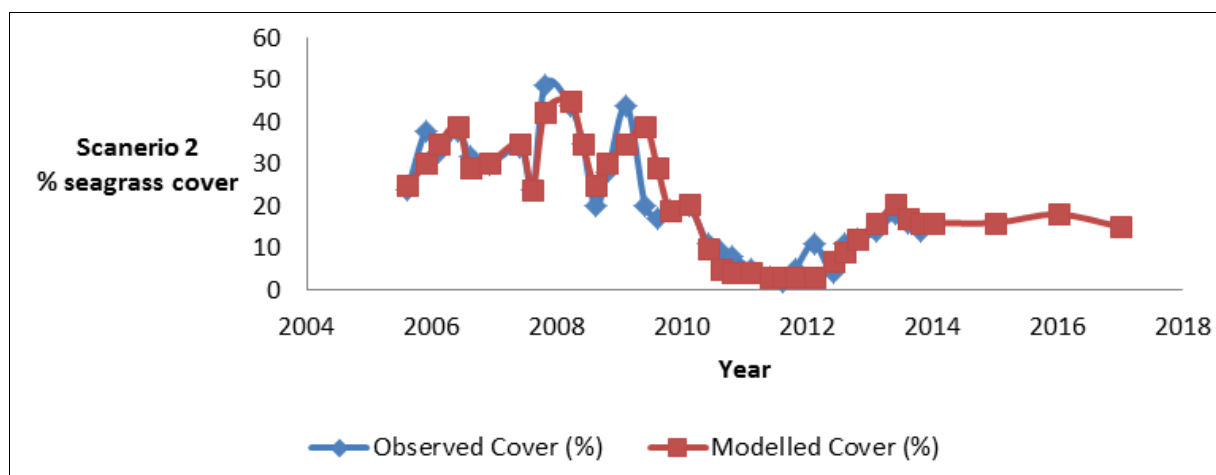


Figure 25.22 Scenario 2 results

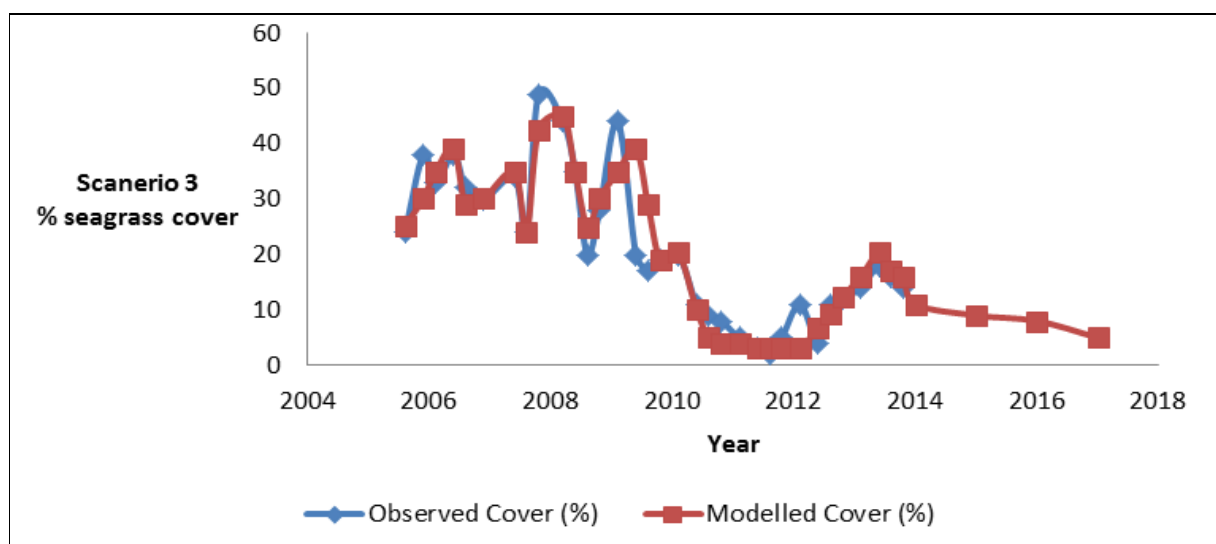


Figure 25.23 Scenario 3 results

25.3.3.4 Bayesian modelling

The approach taken in this cumulative impact assessment is one of 'weight of evidence' whereby evidence is developed using multiple approaches.

An increasingly common approach to integrating cause-effect relationship between multiple stressors and ecological endpoints, in this case the identified sensitive ecological receptors, is to develop a Bayesian Belief Network model (Gibbs M. T., 2006). Bayesian Belief Network encapsulate a range of knowledge of cause-effect linkages into one model in which relationships between stressors and sensitive ecological receptors are described by conditional probability distributions. Such a model has been developed by CSIRO and AIMS and details can be found in the GBRMPA Guidelines. This model from the Guidelines is considered, along with a discussion on other models that are presently under development but not yet available for use.

The GBRMPA Cumulative Impacts Framework for assessing cumulative impacts provides details of the Bayesian Belief Network developed for seagrass meadows and coral reefs. The Bayesian Belief Network developed by CSIRO (Figure 25.24 and Figure 25.25) are novel as the model structure and key internal model relationships (probability distributions) are generated from directional loop analyses that consider binary interactions between different parts of the system.

In the CSIRO models, as shown in Figure 25.24 and Figure 25.25, the grey boxes represent input conditions set by the user. The yellow boxes represent the probability of a change in coral/seagrass conditions base resulting from these input conditions. These Bayesian Belief Network models, that are based on theoretical relationships, were interrogated to confirm the structure of the influence diagram (Appendix A5, Figure 1) and confirm that the key stressors used in this analyses are the dominant drivers of the sensitive ecological receptors in the study area. However, these models do not represent models or networks for a specific, existing location. Hence the exact

magnitudes of the resulting probabilities are indicative only and should not be compared with data modelling from any specific location.

Specific Bayesian Belief Network using observed data are presently being generated by both AIMS, and under a research program being led by Professor Bob Pressey from James Cook University. These models are presently in the proof of concept stage and hence are not available for use in this assessment. However it is expected that they will be a key tool in future cumulative impact assessments.

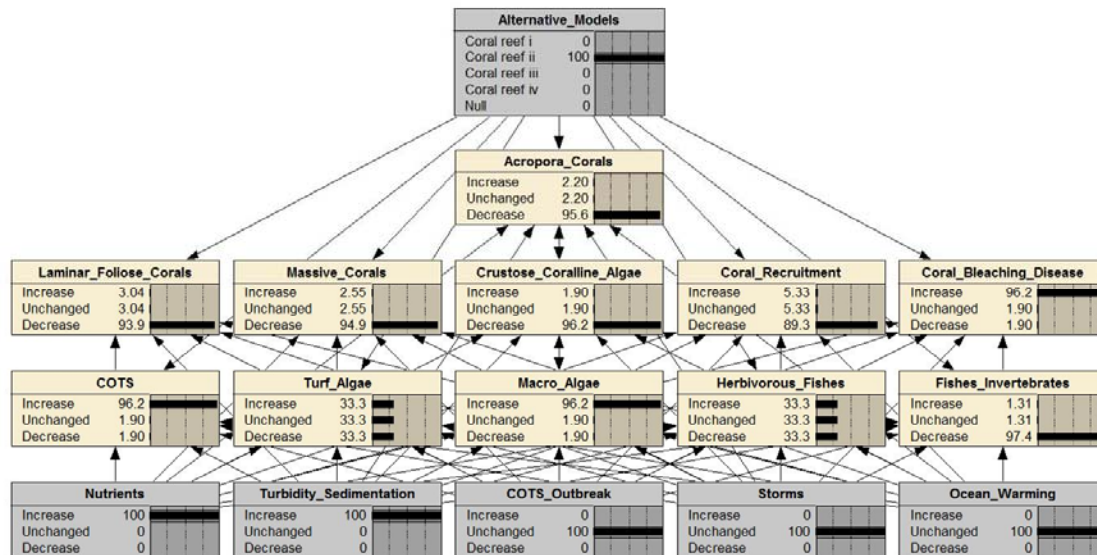


Figure 25.24 Coral Bayesian Belief Network

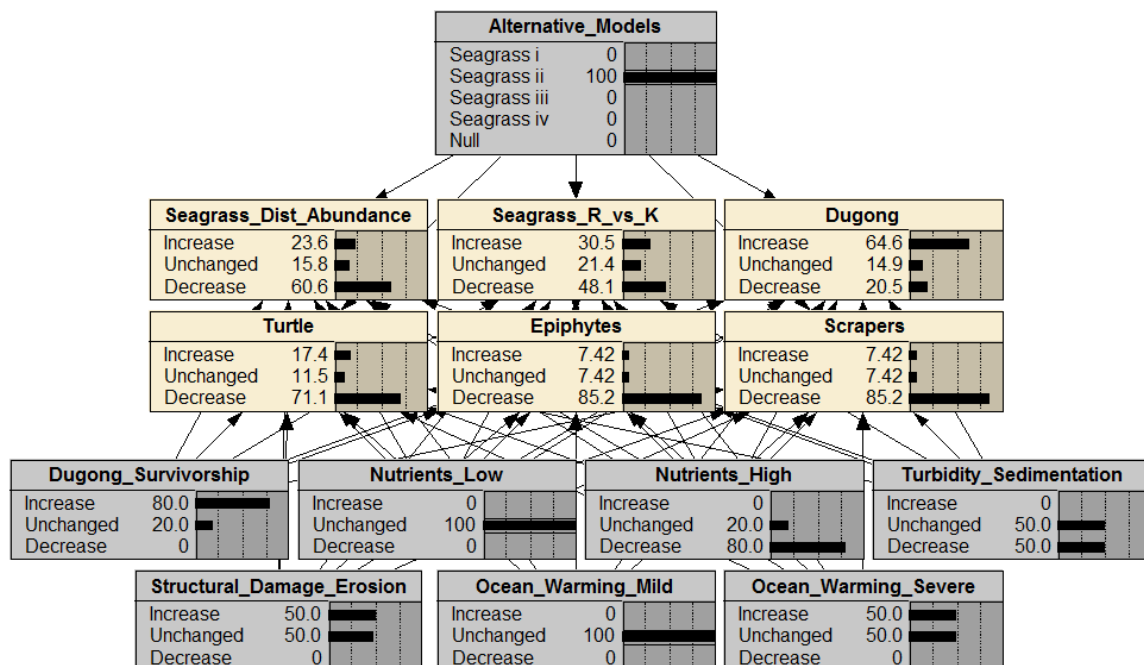


Figure 25.25 Seagrass Bayesian Belief Network

25.4 Conclusion

A large number of submitters sought more information on how the predicted project impacts will compare to impacts from other stressors acting within the study area and GBR in general, and what consideration should be given to the timing of the Project with respect to other stressors impacting sensitive ecological receptors.

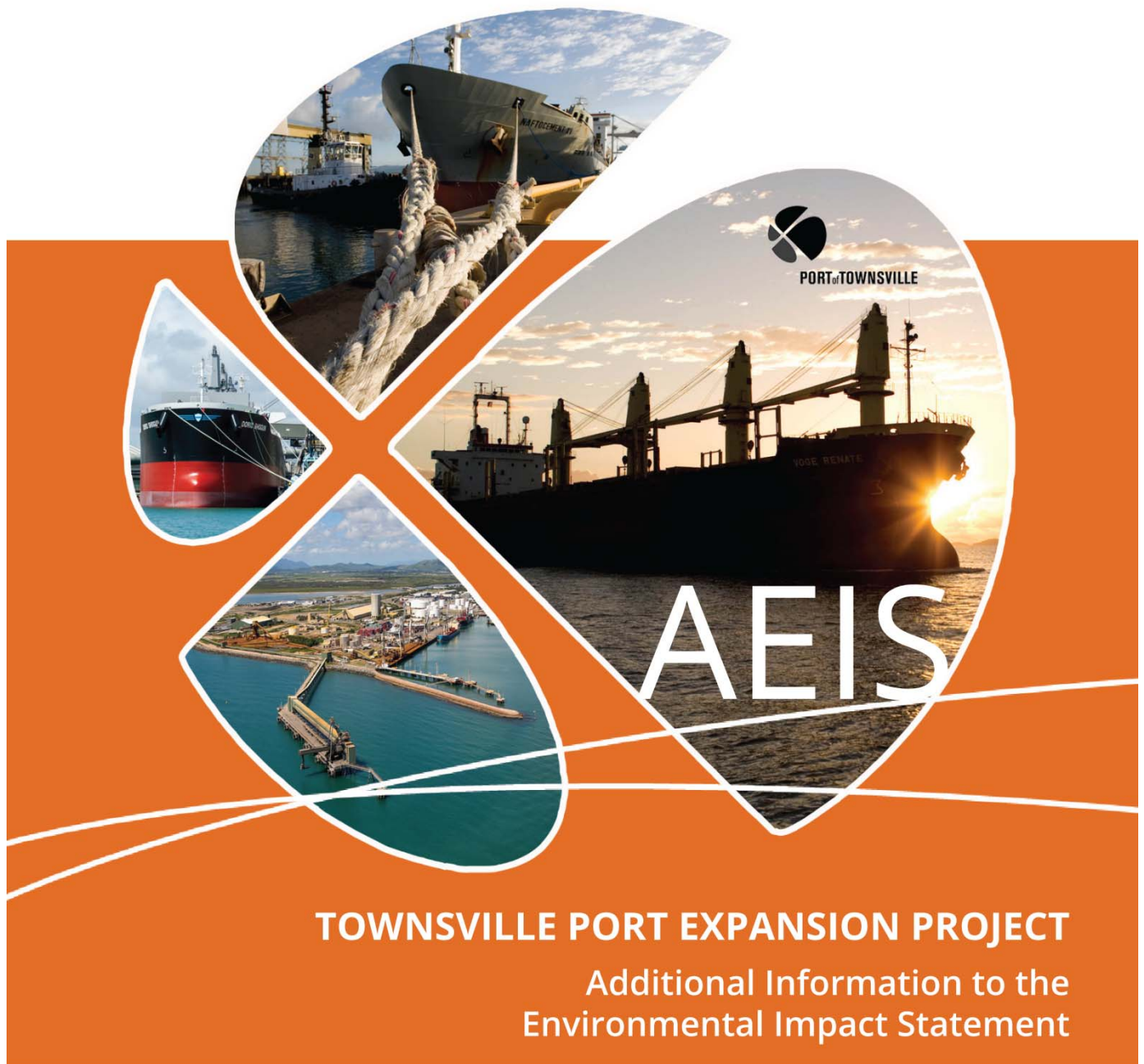
The cumulative impacts assessment presented here is consistent with the GBRMPA guidelines. Specifically, it has identified the key other stressors acting on sensitive ecological receptors, assessed their relative roles and impacts and investigated the relative timing of different stressors.

The key results from this revised Cumulative Impact Assessment are as follows.

- Research suggests that the near-shore environment of the GBR, including Cleveland Bay has featured relatively high turbidity over geological timescales (pre European settlement). The availability of large relic sediment stores in the study area resulting in frequent periods of elevated turbidity as local winds and tidal currents routinely re-suspend these 'old' sediments.
- Post European settlement has seen significant development of the GBR catchment. This has resulted in increased loads of fine sediments entering the GBR lagoon. The majority of these sediments are thought to fall out of the water column and be deposited near river mouths. Ongoing sediment transport can transport some of these away from river mouths although these volumes are thought to be small by comparison to the existing sediment stores.
- The near-shore environment of the GBR, including the sensitive ecological receptors in the study area, are routinely impacted by stressors, including cyclones, CoTS outbreaks and bleaching events.
- The impacts predicted by the PEP are generally considerably less than impacts occurring from other stressors.
- The timing of capital dredging using a TSHD should consider major events such as bleaching or cyclones that impact the study area and occurred over the previous wet seasons.

The main recommendation from this revised Cumulative Impact Assessment is consideration should be given to the state of sensitive ecological receptors in the study area prior to capital dredging being undertaken. The risk management actions outlined in the Dredge Management Plan (Appendix B1) should be undertaken prior to capital dredging being undertaken. In particular trigger levels for managing the impacts of dredging need to be cognisant of the bio-condition of sensitive ecological receptors at the time of dredging activities.

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SECTION 26

Outstanding Universal Value



26.0 Outstanding Universal Value

26.1 Introduction

This section provides information to address submissions received in response to the Port Expansion Project (PEP) Environmental Impact Statement (EIS) relevant to assessment of impacts from the Project on the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area (GBRWHA).

Of the total submissions, 101 sought more information on the relative role of projected impacts from the PEP in light of other stressors acting on Cleveland Bay and the broader Great Barrier Reef (GBR) environment. These have been addressed in Section 25.0 (Cumulative Impact Assessment) of the AEIS. Five submissions sought information on how the Project may impact OUV of the GBRWHA, these matters are addressed below.

26.2 Response to Submissions

26.2.1 Impact from the Project on the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area

10 submissions were received regarding the scale of the Project, the threats to the GBR region from other known stressors (including other port projects) and the degraded condition and low resilience of local marine habitats (e.g. around Magnetic Island and in Cleveland Bay). These submitters were of the view that the Project would adversely impact the OUV of the GBRWHA and on that basis the Project should not proceed.

More specific comments from submissions about OUV included:

- the incompatibility of dredging and material placement within the boundaries of the GBRWHA
- that the EIS had failed to identify/define the ecological significance of Cleveland Bay in the context of the larger GBRWHA.

The AEIS has re-assessed potential impacts from the Project to OUV based on the new Guidelines (EPBC Act referral guidelines) produced by the Australian Government, Department of Environment (2014) and based on the findings of the revised environmental impact assessment.

Given their strong links to OUV, this section also discusses the consistency of the revised design with new documentation that has been released since the EIS including the Great Barrier Reef Region Strategic Assessment (2014) and the Reef 2050 Long-Term Sustainability Plan (2015). These are described in Section 26.3 below.

26.3 Revised Environmental Impact Assessment

26.3.1 Legislation and policy

Great Barrier Reef Strategic Assessment

In response to the United Nations Educational, Scientific and Cultural Organization (UNESCO) mission, a comprehensive Strategic Assessment of the GBRWHA and adjacent coastal zone was undertaken by the Australian and Queensland Governments between 2012 and 2014. The assessments were carried out under Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and form part of the Australian Government's response to the World Heritage Committee's concerns about development impacts on the WHA (The State of Queensland, 2013; Great Barrier Reef Marine Park Authority, 2014).

Overall, the assessment found that:

... the OUV of the GBRWHA remains largely intact and the Reef remains one of the most resilient tropical marine ecosystems in the world. However the accumulation of impacts through time and over an ever increasing area is diminishing the Reef's health (from Preface - pg. 2).

Recommended changes to management of ports and dredging in the Strategic Assessment that are relevant to the Additional Information to the Environmental Impact Statement (AEIS) include the following.

- Improving certainty regarding the location of ports, and reducing further fragmentation of coastal ecosystems through a Queensland Ports strategy that concentrates port development to around long-established major ports in Queensland.
- Supporting a strategic approach to the planning, assessment and management of port development, including long-term integrated planning for the network of trading ports on the GBR coast, with a view to achieving environmental, social and economic sustainability at a reef-wide scale.
- Contributing to the development of improved governance arrangements across GBR ports aimed at strengthening coordination between responsible agencies across all jurisdictions, focusing on efficient and sustainable development of ports and associated activities.

- Improving understanding and management of environmental impacts from dredging and dredged material disposal in the GBRWHA, recognising the current uncertainty surrounding the duration, intensity and extent of predicted dredge material plumes, and their impacts on the Region's values. In particular by:
 - exploring with proponents and government agencies all alternatives which may avoid and reduce the need for dredging and dredge material disposal, and provide better environmental outcomes
 - ensuring dredging and dredge material disposal decisions take account of the GBR hydrodynamic and water quality guidelines, and do not exceed ecosystem thresholds
 - working with port corporations, other agencies and proponents to identify and address critical information needs, and to promote research and development into innovative best practice arrangements to mitigate cumulative impacts of port activities within the region.

Reef 2050 Plan

In its 2014 decision, the World Heritage Committee requested that a long term plan be prepared that, 'results in concrete and consistent management measures that are sufficiently robust, effectively governed and adequately financed to ensure the overall long term conservation of the property and its OUV, including in view of addressing cumulative impacts and increasing reef resilience' (World Heritage Committee, 2014).

In response to the threats posed to the GBRWHA, the Australian Government and Queensland State Government drafted the *Reef 2050 Long-Term Sustainability Plan* (2050 Plan) (Australian Government and Queensland Government, 2015). The Plan outlines measures for identifying, protecting, conserving, presenting and transmitting of the Reef's OUV for future generations.

Actions with the 2050 Plan that are relevant to ports and dredging (and therefore the AEIS) include the following:

- Objective WQO2 which states that, 'Over successive decades the quality of water in or entering the Reef from all sources including industrial, aquaculture, port (including dredging), urban waste and stormwater sources has no detrimental impact on the health and resilience of the Great Barrier Reef'
- Actions WQA 14 – 22 outline relevant to reducing the impact of ports and dredging on water quality.

OUV Guidelines

Since the EIS was released there has been substantial further guidance provided about the OUV of the GBR including finalisation of EPBC Act referral guidelines published by the Australian Government Department of the Environment (DoE, 2014). These guidelines have been used in the reassessment of the Project in this updated section.

The Guidelines outline that OUV is the key reference point for the protection and management of world heritage properties and is the central idea of the World Heritage Convention. Broadly, the meaning of OUV is as follows.

- Outstanding: For properties to be of outstanding universal value they should be exceptional, or superlative — they should be the most remarkable places on earth.
- Universal: Properties need to be outstanding from a global perspective. World Heritage listing does not aim to recognise properties that are remarkable from solely a national or regional perspective.
- Value: What makes a property outstanding and universal is its "value", or the natural and/or cultural worth of a property. This value is determined based on standards and processes in the Operational Guidelines for the Implementation of the World Heritage Convention (the Operational Guidelines) (Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage, 2013).

The Attributes that contribute to the OUV of the GBRWHA are identified in the *Statement of Outstanding Universal Value* which was prepared retrospectively to capture the values of the property at the time of listing in 1981. While a starting point for assessment, it is noted in the OUV Guidelines that the Attributes identified in the Statement for the GBRWHA are examples only and do not represent the full suite of attributes contributing to the OUV of the property, nor are they geographically specific.

Under the Statement of OUV, the following Criteria from the Convention underpin the listing of the GBRWHA site.

- Criterion vii - Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
- Criterion viii - Be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.
- Criterion ix - Be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.

- Criterion x - Contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Table 26.1 lists the four criteria under which the site has been listed and highlights with italicised blue text those values/features that are considered particularly noteworthy at a local (Cleveland Bay) scale and therefore represent a local articulation of relevant OUV.

UNESCO undertook a reactive monitoring mission in 2012 at the request of the World Heritage Committee at its 35th session in Paris. The mission assessed the state of conservation of the GBRWHA and the resulting report (Douvere, 2012) concluded that while the overall OUV has likely been maintained, the environmental quality of parts of the Great Barrier Reef ecosystem have declined since the time of inscription in 1981. This is particularly relevant for inshore areas of the reef south of Cooktown.

Table 26.1 Attributes underpinning World Heritage Listing of the GBRWHA (items in italicised blue text indicates local values that are present and noteworthy in the local [Cleveland Bay] context)

Relevant Criteria			
Criterion vii	Criterion viii	Criterion ix	Criterion x
▪ <i>superlative natural beauty above and below the water</i> ▪ <i>string of reef structures</i> ▪ <i>mosaic patterns of reefs, islands and coral cays produce an unparalleled aerial panorama of seascapes</i> ▪ <i>green vegetated islands</i> ▪ <i>spectacular sandy beaches</i> ▪ <i>azure waters</i> ▪ <i>vast mangrove forests</i> ▪ <i>vegetated mountains</i> ▪ <i>lush rainforest gullies</i> ▪ <i>breeding colonies of seabirds and marine turtles</i> ▪ <i>green turtle breeding</i> ▪ <i>over-wintering butterflies</i> ▪ <i>coral assemblages of hard and soft corals</i> ▪ <i>thousands of species of reef fish</i> ▪ <i>coral spawning</i> ▪ <i>migrating whales</i> ▪ <i>nesting turtles</i> ▪ <i>significant spawning aggregations of many fish species</i>	▪ continental shelf ▪ flat-topped hills of eroded limestone ▪ continental islands ▪ coral cays ▪ new phases of coral growth ▪ old massive corals ▪ <i>coral reef ecosystem</i> ▪ <i>inshore fringing reefs, mid-shelf reefs, and exposed outer reefs, including examples of all stages of reef development</i> ▪ <i>processes of geological and geomorphologic evolution</i> ▪ <i>unique and varied seascapes and landscapes</i> ▪ continental slope ▪ deep oceanic waters ▪ abyssal plains	▪ <i>significant diversity of reef and island morphologies reflects ongoing geomorphic, oceanographic and environmental processes</i> ▪ cross-shelf, longshore and vertical connectivity ▪ coral reefs, sand banks and coral cays ▪ beds of <i>Halimeda</i> algae ▪ evolution of hard corals ▪ other fauna, including microfauna ▪ <i>over 4000 species of molluscs, over 1500 species of fish, plus a great diversity of sponges, anemones, marine worms, crustaceans, and many others</i> ▪ <i>vegetation on the cays and continental islands</i> ▪ important role of birds, such as the Pied Imperial Pigeon, in processes such as seed dispersal and plant colonisation ▪ numerous shell deposits (middens) ▪ fish traps ▪ story places ▪ marine totems	▪ <i>diversity supports marine and terrestrial species (global conservation significance)</i> ▪ <i>coral reefs (400 species of corals in 60 genera)</i> ▪ <i>diversity of mangroves</i> ▪ <i>diversity of seagrass</i> ▪ <i>dugong</i> ▪ <i>species of whales</i> ▪ <i>species of dolphins</i> ▪ <i>humpback whale calving</i> ▪ <i>marine turtle</i> ▪ <i>green turtle breeding</i> ▪ <i>marine turtle rookeries</i> ▪ <i>242 species of birds</i> ▪ <i>22 seabird species breeding (cays and some continental islands, globally significant breeding sites)</i> ▪ <i>plant species diversity and endemism</i> ▪ <i>coral cays</i>

26.3.2 Design refinement

Capital and more regular annual maintenance dredging of navigation channels and associated dredge material placement remain unavoidable consequences of having an operating Port in Townsville as it responds to global shipping trends (with larger ships seeking to come to port) and increasing domestic import and export markets. These uses significantly pre-date declaration of the World Heritage Area and were operating at the time of listing the World Heritage site in 1981. While the boundaries of the GBR Marine Park exclude the operating port area, channel and approved dredge material placement area (DMPA), all of these areas are within the GBRWHA which covers all coastal waters to Lowest Astronomical Tide.

In responding to submissions and emerging Government policy for beneficial reuse of dredge material on land or in reclamation, potential impacts to the OUV of the GBRWHA from the revised proposal have been reduced. As identified previously, this has been achieved principally through the placement of all dredged material into the reclamation area compared to the original PEP proposal where all of this material was proposed to be placed offshore.

While reducing the quantum of material that will be placed at sea, this placement strategy in the reclamation increases the footprint of the reclamation, resulting in the permanent loss of World Heritage Area expanding from 100 ha in the EIS to approximately 150 ha under the revised proposal.

As was the case in the EIS, it continues that a range of direct and indirect environmental offsets are proposed for this loss as outlined in Section 27.0 (Offsets) of the AEIS.

26.3.3 Supporting studies

In the context of re-assessing the potential impacts of the Project on OUV, reference has been made to the procedures and approach set out in the 2014 Referral Guidelines. Commentary is also provided in the revised assessment about the consistency of the proposal with the Strategic Assessment and 2050 Plan.

26.3.4 Revised assessment

26.3.4.1 Impact assessment

In addition to meeting each of the relevant criterion as stated above for OUV for the GBR, a natural world heritage property must also meet the conditions of Integrity. The World Heritage Convention Operational Guidelines state that “*integrity is a measure of the wholeness and intactness of the natural (and or cultural heritage) and its attributes*” and further that to examine the condition of integrity requires assessment of the extent to which the property:

- a) *Includes all elements necessary to express its Outstanding Universal Value*
- b) *Is of adequate size to ensure the complete representation of the features and processes that convey the property's significance*
- c) *Suffers from adverse effects of development and or neglect” (DOE 2014).*

The EPBC Act guidelines for OUV (OUV Guidelines) provides guidance on how to determine both the significance of likely impacts (direct, indirect and cumulative) using a series of questions about potential impacts on the listed key attributes of OUV and on the Integrity of the GBRWHA based on the Operational Guidelines.

This section uses this ‘interrogation framework’ to determine impacts to OUV by drawing from the cumulative impacts assessment results (Section 25.0 of the AEIS), along with the results from the separate discipline-specific amended assessment contained in the relevant sections. These impacts are summarised in Table 26.2 and Table 26.3 below. Table 26.2 seeks to address the requirements of the OUV Guidelines as they relate to ‘Attributes’ based on the questions posed in the Guidelines about determining a significant impact. Table 26.3 outlines how the ‘Integrity’ of OUV have been met by the Project.

This section is also consistent with the Strategic Assessment and 2050 Reef Plan.

Table 26.2 Assessment of Impacts to WHA 'Attributes'

World Heritage Criterion	Questions Posed by the EPBC Act Guidelines for Impacts on Attributes	Response
Criterion vii	Will the proposed action of itself, or in combination with other relevant impacts, result in loss or degradation of areas that are essential for maintaining the beauty of the property?	The Port has operated for a period of 150 years at its current location which has included annual maintenance dredging and industrial activities. The key sensitive ecological receptors are routinely exposed and impacted by other processes such as cyclones, bleaching and nutrients and sediments entering from catchment sources. The PEP Project will lead to short term localised changes in turbidity from dredge plumes (particularly in calm weather or following 'drier' wet seasons when background turbidity is lower) during the capital dredging campaign. Risks will be managed by not undertaking capital dredging by TSHD following extreme wet seasons, or following major cyclones or bleaching events, and through the risk management controls identified in the AEIS. Sedimentation rates and predicted mobilisation of displaced sediment during the capital dredging is not expected to result in detectable or observable changes to coastal processes including accumulation of mud or silts on Magnetic Island beaches. Overall, the marginal changes predicted from the Project are local in nature and not likely to significantly detract from the present natural beauty of the property, or the biota that maintain these values within Cleveland Bay and the greater GBR.
Criterion viii	Will the proposed action of itself, or in combination with other relevant impacts, impact on the key interrelated and interdependent elements in their natural relationships?	Unlike the middle and outer reef systems of the GBR, the inner shelf region, including Cleveland Bay is a long-standing medium to high turbidity environment and the key ecological processes are adapted to these environmental conditions. While some temporary impacts are predicted, long term changes to key physical processes (hydrodynamics, sediment transport processes, shoreline processes, waves, currents), key chemical processes (long term water quality, sediment quality) and key biological processes (breeding, recruitment, fish movement and patterns, nesting and reproductive behaviour) that control ecosystem elements are not expected.
Criterion ix	Will the proposed action of itself, or in combination with other relevant impacts, result in the loss of necessary elements that are essential for the long term conservation of the area's ecosystems and biodiversity?	<u>Direct Impacts from the Proposal – Benthic Habitat Loss or Damage</u> Benthic habitat within the area of permanent impact (reclamation) do not contain corals, seagrass, endangered, or significant inter-tidal or sub-tidal habitats, that are not well represented elsewhere in the study area (which has an abundance of soft bottom benthic habitat) and are not known critical life cycle habitat areas for key marine megafauna species (e.g. breeding sites, nesting sites, critical feeding habitat). Fauna that are known to use these areas for foraging such as inshore dolphins will have reduced habitat range from which to forage but have abundant similar habitat elsewhere in Cleveland Bay and in adjoining embayments (Halifax, Bowling Green) that could be utilised. The key findings of surveys outlined in the EIS are indicative that key species such as Snubfin dolphin are regularly observed in Cleveland Bay around the existing Port. Benthic habitats that will be subject to temporary impacts (such as dredged areas of the outer harbour and the channel widening and deepening) will start recovering almost immediately following disturbance but with full recolonization and recovery likely over medium time frames (12 – 24 months). While the resultant habitats will be modified (deeper), it has been documented and demonstrated in studies as part of the EIS that these habitats will fully recolonise over time and will continue to provide benthic primary production value following disturbance. As a result, significant impacts to Cleveland Bay's ecosystems and biodiversity are not expected. Note that as a result of the revised design in the AEIS, which no longer includes marine placement of capital dredge material at the DMPA, the area of temporary benthic habitat loss from capital dredging will be reduced by 1,140 ha (area of DMPA) compared to the EIS.

World Heritage Criterion	Questions Posed by the EPBC Act Guidelines for Impacts on Attributes	Response
		<u>Indirect Impacts from the Project – Water Quality</u> It is recognised that the Project will cause short term, localised changes to the amount of sediments in the water column at fine spatial scales (i.e. at the scale of the plume) from the dredging and from tailwater release from the placed material in reclamation. Additional assessment work has been done in the AEIS to examine the extent to which these sediments are available for re-suspension over periods of up to 12 months, looking at the cumulative volume of sediment available for re-suspension by natural processes from the TSHD dredging process (e.g. overflow of fine material). These re-suspension processes have been specifically modelled and are presented in Section 6.0 (Marine Water Quality) of the AEIS. The modelling assessment has found such changes to be small in magnitude, especially compared to background variability within the affected areas. As a result, significant impacts to Cleveland Bay's ecosystems and biodiversity are not expected; but will be monitored as part of both reactive and long term ecosystem monitoring outlined by the Project. <u>Cumulative Impacts from Other Stressors</u> External stressors such as cyclones, nutrient and sediment releases from catchments, high temperature (leading to coral bleaching), acidification, and other anthropogenic activities all play a role in the ecosystem health of marine ecological communities within Cleveland Bay and the broader study area. The cumulative impacts assessment identified that the impacts from proposed Project are likely to be small by comparison to comparable impacts from other impacting stressors. However, the timing of TSHD capital dredging needs to be cognisant of events such as floods, cyclones or bleaching events that may have occurred during the previous wet season. Based on the scale and duration of the direct and indirect impacts of the Project, the necessary elements that are essential for the long term conservation of the area's ecosystem and biodiversity can be maintained.
Criterion x	Will the proposed action of itself, or in combination with other relevant impacts, result in the loss or degradation of habitats required for maintaining the diverse fauna and flora of the region?	As outlined above, the Project will directly affect: 1. Seabed habitat within the reclamation footprint (which would be permanently removed). 2. Seabed habitat within the proposed berths of the outer harbour and designated navigation channel. The reclamation footprint, outer harbour and navigation channel, and immediate surrounds are soft sediment habitats that are: (i) well represented in the surrounding area, (ii) have generally low levels of biodiversity, and (iii) are not known to support distinct/unusual or otherwise critical ecosystem functions Based on these three factors, flow-on effects to flora and fauna at broader regional spatial scales are therefore not expected. The potential indirect impacts from changes to sediment patterns are addressed above in Criterion (ix). On the basis of the above, the proposed action is unlikely to cause loss or degradation of habitats required to maintain flora and fauna of the wider GBR region. As an added safeguard to meeting this conservation objective, an environmental offset is proposed to address the remaining residual impacts of the Project by seeking to afford greater protection (through expansion of a Fish Habitat Area under the Queensland <i>Fisheries Act 1994</i>) to similar habitat in the local region at a ratio of 8:1 (compared to the area of habitat lost through reclamation).

Table 26.3 Assessment of Impacts to WHA 'Integrity'

Criterion	Questions Posed by the EPBC Guidelines for Impacts on Integrity	Response
Wholeness	Will the proposed action of itself, or in combination with other relevant impacts, result in the loss of any elements necessary for the property to express its outstanding universal value?	The Project is not expected to result in a loss of any OUV element either individually or in combination with other projects (refer Section 25.0 of the AEIS).
	Will the proposed action of itself, or in combination with other relevant impacts, reduce the size of the property? Will the property be of adequate size to ensure the complete representation of the features and processes which convey its significance?	The Project will reduce the size of the WHA property through the reclamation by an area of 152 ha. This represents 0.0004% of the overall property. Given the overall size of the property relative to the disturbance by the Project, the fact that the Project is proposed in an existing port area and the absence of key OUV in the footprint, there will be no appreciable impact on the representation of features and processes which convey the significance of the property. The size and layout of the reclamation has been optimised to provide for the placement of dredge material (and eliminate the need for marine placement) whilst meeting the Port's operational requirements for long term operation. As outlined in the discussion of 'Attributes', the habitat area lost to reclamation are: (i) well represented in the surrounding area, (ii) have generally low levels of biodiversity, and (iii) are not known to support distinct/unusual or otherwise critical ecosystem functions. An environmental offset is also proposed to seek to afford greater protection (through expansion of a Fish Habitat Area under the Queensland <i>Fisheries Act 1994</i>) to similar habitat in the local region at a ratio of 8:1. This measure will not create or restore marine habitat but will have the effect of providing a greater level of protection and management to this habitat than its current tenure and preclude the use of the area for port or other development purposes in the future.
Intactness	Will the proposed action of itself, or in combination with other relevant impacts, result in the loss and/or degradation of the key features, processes and attributes of the property that express its outstanding universal value?	As outlined previously in the AEIS, key natural features, processes and attributes of the WHA will not be lost as a result of the proposed action except in the context of seabed areas removed by the reclamation. Temporary (sub lethal) impacts are possible based on the predictive modelling for seagrass and some coral communities on the eastern coast of Magnetic Island. Mitigation is proposed (as outlined in the Dredge Management Plan) to: ▪ imposition of a time window for the TSHD dredging that seeks to minimise impacts on ecological receptors ▪ a reactive monitoring program to validate impact assessment findings and monitor key thresholds for impacts as a trigger for corrective actions. These measures seek to ensure unacceptable impacts are fully avoided and minimised as far as practicable.
Threats	Will the proposed action of itself, or in combination with other relevant impacts, result in increased adverse effects of development, neglect or any other degrading process?	A range of stressors have affected the condition of near-shore ecosystems in the region (as described in Section 25.0, Cumulative Impacts Assessment). In particular, recent successive natural events have resulted in a reduction of seagrass meadows throughout the region and affected the condition of coral ecosystems. However, both seagrass and coral ecosystems in the study area have been observed to be recovering following more favourable climate and weather conditions. Key assessment findings from the revised assessment relevant to these sensitive receptors are as follows. ▪ Benthic habitats within soft sediments will be permanently lost through the reclamation and temporarily impacted by capital dredging with recovery times on the order of 12 – 24 months (short to medium term impacts). ▪ Turbidity and sedimentation impacts to seagrass are expected to be minor, temporary and localised as a result of the proposed dredging. ▪ Temporary (sub-lethal) impacts to coral communities are possible, based on the Worst Case scenario plumes from capital dredging of the channel particularly along the east coast of Magnetic Island. This will be a major focus of the reactive monitoring plan with the implementation of corrective mitigation measures (changed dredging practices, constrained overflow) by the dredge where ecological trigger limits are exceeded. ▪ Impacts to coral communities are not expected from sedimentation (e.g. smothering) associated with dredging.

Criterion	Questions Posed by the EPBC Guidelines for Impacts on Integrity	Response
		A range of detailed mitigation and monitoring measures are proposed in the Dredge Management Plan to seek to avoid or reduce impact to these sensitive receptors including scheduling the works to occur outside of key ecological time periods and developing and implementing a reactive monitoring program with a set of corrective actions to reduce impacts. Environmental offsets are proposed to address residual impacts from permanent impacts including measures that will contribute to building the resilience of these receptors to future impact and commitments to fund long term monitoring of key ecosystem components.
	Will the proposed action of itself, or in combination with other relevant impacts, result in an increase in processes that may cause deterioration?	As outlined above, the impacts from the capital dredging program (construction phase) are not expected to impact on the integrity of the OUV of the property. Potential operational phase impacts are outlined below: <u>Increased shipping and risks associated with spills, groundings, megafauna interaction</u> The impacts from the increase in shipping associated with port expansion have been addressed in the EIS and in other studies including the Cumulative Impact Assessment (CIA) for Abbot Point. The promulgation of the Northeast Shipping Management Plan by the Australian Maritime Safety Authority as well as other measures will seek to address the additional risk of marine traffic in and around the Great Barrier Reef. The Port of Townsville is an active participant in the implementation of these initiatives. <u>Maintenance dredging</u> The ultimate development (through construction of the eastern breakwater and subsequent shadowing of the outer harbour and channel) is estimated to result in an increase of approximately 14% to the annual maintenance dredge volume to what is currently experienced at the port for an additional 6 berths. There will likely be a period of increased maintenance volumes prior to the construction of the breakwater as a result of channel widening (an estimated 17% greater than the current annual maintenance dredge volumes). This is discussed in Section 5.0 (Coastal Processes). Further assessment of this maintenance dredging is presented in Section 6.0 (Marine Water Quality). Suitability of the material for at sea placement. A full sediment chemistry assessment will be undertaken prior to works and any material not suitable for at sea placement under the NAGD will be placed in the reclamation. This process is assured by the requirement to obtain a Sea Dumping Permit prior to the works being carried out. This process also applies to future maintenance of channels, swing basins and berths associated with port expansion.

Strategic Assessment

As outlined in the Legislation and Policy section, improving understanding and management of environmental impacts from dredging and dredged material disposal in the GBRWHA was a key recommendation of the Strategic Assessment.

In this context, the PEP design refinement is consistent with the relevant conclusions and findings of the Strategic Assessment for the following reasons.

- The design refinement no longer includes marine placement of the capital dredge material in accordance with relevant Commonwealth and State legislation.
- The numerical modelling assessment that has been undertaken for the AEIS is fully compliant with the Great Barrier Reef Marine Park Authority Hydrodynamic Modelling Guidelines (finalised following the release of the EIS). The modelling also takes into account the prospective effects of offshore currents as well as the effect of extreme weather events such as cyclones on dredged material re-suspension. The hydrodynamic model used for the assessment is fully 3D and calibrated and validated using 12 months of locally collected wave, current and water quality data. The model has been independently peer reviewed by Doug Treloar (Cardno Lawson Treloar) and also reviewed by AIMS.
- The associated water quality and ecological assessment approach employs the use of geographic 'zones of impact' based on the WA EPA (2011) environmental dredging guideline approach. This approach examines both the acute and chronic impacts from dredging and material placement using extensive baseline monitoring data (>12 months continuous data) and establishes indicative local trigger levels (to be reviewed and approved by a Technical Scientific Committee) to assess impacts to seagrass and coral habitats. As outlined elsewhere in the assessment, sensitive receptors in Cleveland Bay such as seagrass and coral reef habitats along Magnetic Island are within the 'zone of influence' and 'zone of low impact' (during the worst case scenario). 'Zones of moderate impact' and 'zones of high impact' are not expected in sensitive receptor areas. The cumulative impacts assessment presented in Section 25.0 follows the framework presented in the Strategic Assessment. The relative impacts of mitigated dredging operations are predicted to be small by comparison to impacts from other stressors operating in the region, however are proposed to be closely managed during dredging.

Reef 2050 Plan

The PEP design refinement addresses the three key actions in the 2050 Plan that are relevant to capital dredging and placement. These are:

- WQA 14 – restricting the development of new or expansion of existing port facilities to within the regulated port limits of Townsville
- WQA 18 – compliance with the legislative requirement to ban at-sea disposal of port-related capital dredge material
- WQA 19 – mandating the beneficial re-use of port related capital dredge spoil through land reclamation in port development areas.

The other actions in the 2050 Plan relevant to ports and dredging relate to future studies or strategies that are to be completed by port authorities across the Region in consultation with relevant agencies, as opposed to specific project level commitments or requirements. The proponent will continue to participate in these studies as they progress.

26.3.4.2 Mitigation measures

No additional mitigation measures are proposed specifically to address OUV, noting specific measures are proposed to protect marine habitats (seagrass, corals) and water quality through the Dredge Management Plan (Appendix B1).

26.3.5 Summary

Table 26.4 provides a summary of the risk of impacts to OUV.

Table 26.4 Summary of Risk of Impacts to OUV

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Impacts on the OUV of the GBRWHA	Construction / Operation	Moderate - High	Possible	Medium	As outlined elsewhere in this AEIS including the Dredge Management Plan	Low

26.4 Conclusion

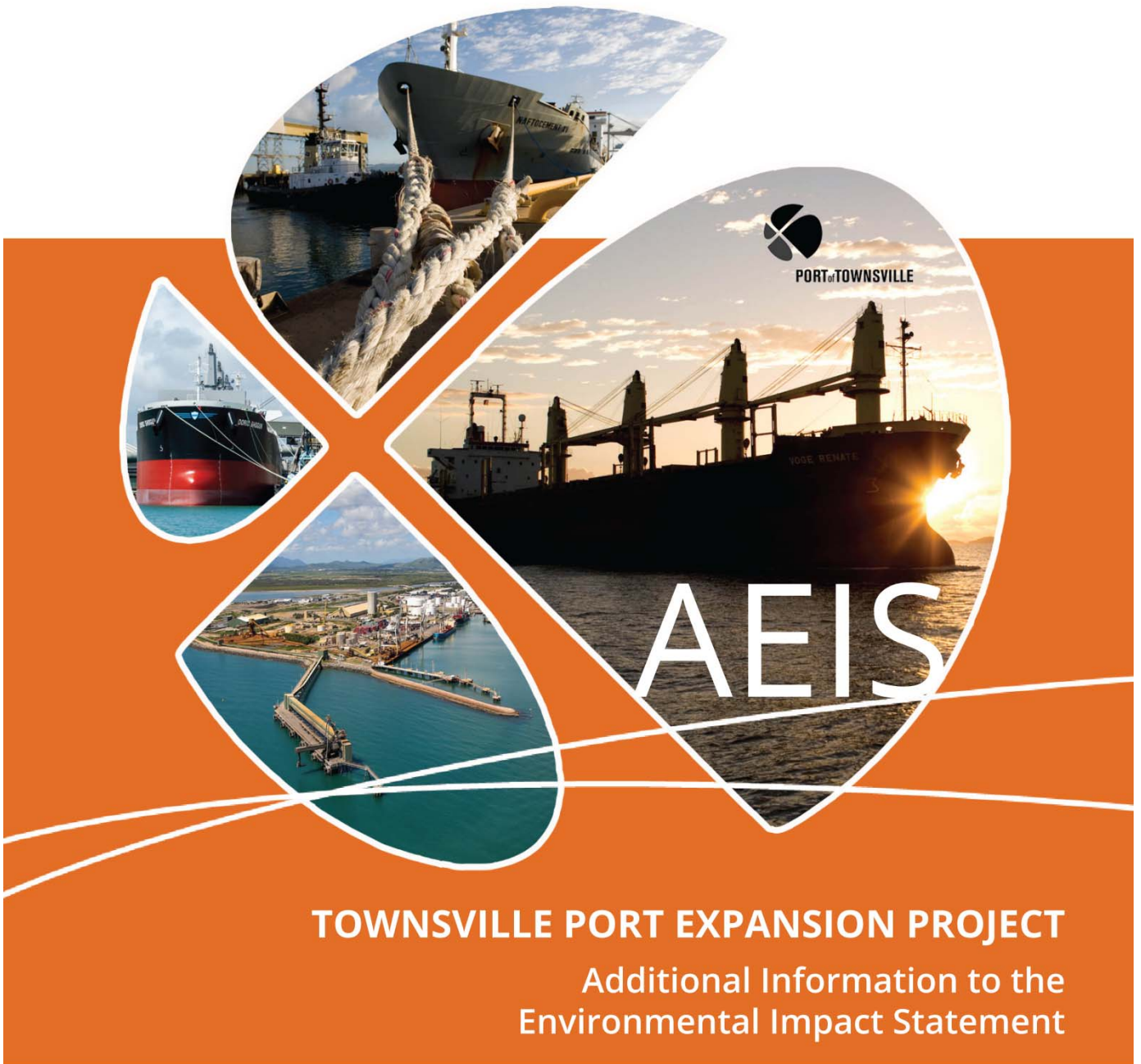
Submitters sought information on how the Project may impact OUV of the GBRWHA. This assessment has found with respect to impacts on the Attributes of the WHA that the proposed Project is:

- not likely to significantly detract from the present natural beauty of the property (Criterion vii)
- is not likely to have an adverse impact on key interrelated and interdependent elements and their natural relationships (Criterion viii)
- significant impacts to the area's ecosystems and biodiversity are not expected but there will be highly localised impacts on soft sediment habitat (permanently removed by reclamation) and temporary impacts on other key receptors through changes to water quality as a result of dredging (particularly seagrass and coral communities). These impacts on water quality will be monitored as part of both reactive and long term ecosystem monitoring outlined by the Project EIS and in accordance with mitigation and monitoring commitments set out in the Dredge Management Plan. Environmental offsets are also proposed to address residual impacts from the proposal on ecosystems and biodiversity (Criterion ix)
- the Project will not remove or have flow on effects on habitats required to maintain the diversity of fauna and flora in the WHA (Criterion x)
- While there will be permanent benthic habitat loss as a result of the reclamation area, the area of temporary benthic habitat loss from capital dredging will be reduced by 1,140 ha (area of DMPA) compared to the EIS as a result of the revised design in the AEIS (which no longer includes marine placement of capital dredge material at the DMPA) (Criterion ix).

In relation to retaining the Integrity of the WHA, the Project is:

- not expected to cause additional loss to any whole OUV element (Wholeness Criterion)
- while there will be a reduction in the size of the WHA property by 0.0004%, with the proposed mitigation and offsetting the Project is not expected to reduce the WHA's outstanding value (Intactness Criterion)
- some adverse effects are predicted, namely turbidity and sedimentation impacts to seagrass which are expected to be minor, temporary and localised as a result of the proposed dredging and temporary (sub-lethal) impacts to some coral communities on the north east coast of Magnetic Island are possible. Preventing these impacts will be a major focus of the reactive monitoring program with the implementation of corrective mitigation measures (changed dredging practices, constrained overflow) by the dredge if ecological trigger limits are reached.

Coupled with the cumulative impacts assessment findings and this section's assessment of compliance with the Strategic Assessment and the 2050 Plan, the revised PEP is considered to be consistent with policy frameworks at the Commonwealth and State level.



SECTION 27

Offsets



27.0 Offsets

27.1 Introduction

Offsets proposed to counteract potential residual impacts of the Port of Townsville Limited (POTL) Port Expansion Project (PEP) on Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES) are discussed in Chapter B.23 (Summary of Key Risks, Impacts and Mitigations) of the Environmental Impact Statement (EIS). This proposal included a range of direct and indirect measures totalling \$6.15 million and including:

- financial and management contribution to expanding the declared Cleveland Bay Fish Habitat Area to protect an additional 1,240 ha of intertidal and sub-tidal benthic habitat in Cleveland Bay under the *Fisheries Act 1994* in partnership with the Queensland Government
- recognition of improving benthic habitat values indirectly through the establishment of rock walls and breakwaters around the perimeter of the land reclamation area
- committed funding to on-ground actions and research to improve water quality entering the Great Barrier Reef lagoon in the region through the North Queensland Dry Tropics Sustainable Agriculture Program
- committed funding to the establishment and operation of a long-term ecosystem health monitoring program for Cleveland Bay and core funding for associated surveys of seagrass, corals, and megafauna.

This section provides information to address submissions received in response to the PEP EIS relevant to offsets. More specifically, key matters raised from the submission process include:

- suitability of offsets to manage residual impacts
- suitability of offsets for marine megafauna and habitat
- extent to which offsets address operational phase impacts such as maintenance dredging
- suitability of Cleveland Bay Fish Habitat Area offset proposal
- relevance of offset package in local setting
- suitability of inclusion of rock wall habitat as an offset and implication of navigational lighting on this habitat
- consideration of offsets in terrestrial fauna species management.

27.2 Response to Submissions

27.2.1 Suitability of offsets to manage residual impacts

12 submissions raised the suitability of offsets to manage residual impacts. The policy framework for environmental offsets was under review at both a Commonwealth and State Government level at the time of the release of the original EIS. A new policy framework has since been established. The offsets policy framework under the EPBC Act and Queensland *Environmental Offsets Act 2014* (Offsets Act) and its application to the revised PEP is discussed in the Section 27.3.1.

27.2.2 Suitability of offsets for marine megafauna and habitat

The Department of Environment and Heritage Protection (DEHP) highlighted the suitability of offsets for dolphin core habitat. The impacts from the revised PEP design on megafauna and the need for offsets are addressed in Section 8.0 of the AEIS. Consistent with the findings in the EIS, a significant residual impact to marine megafauna and their habitat is not predicted to occur from the revised PEP proposal and an offset for this matter is not required to be imposed.

Notwithstanding, elements of the offset proposal as set out in the EIS (expansion of the Fish Habitat Area to include the waters offshore from the Ross River mouth), research projects and long term ecosystem health monitoring will contribute to better understanding and conservation of these species, and improved long term management.

27.2.3 Extent to which offsets address operational phase impacts such as maintenance dredging

As outlined in Section 2.0 of the AEIS, the increase in annual maintenance dredging required to maintain the improved channels and berths associated with the PEP is a modest increase for the addition of 6 operational berths on existing annual maintenance dredging volumes.

In the interim development case, modelling predicts that the total quantity of siltation within all of the dredged areas in the port and the widened channel would be increased by around 17% relative to the present situation.

In the ultimate development case, the fully constructed reclamation and breakwaters act to significantly reduce suspended sediment transport into the outer and inner harbour areas. Modelling of the ultimate case indicates that the total quantity of siltation within all of the dredged areas in the port combined will be increased by about 14% relative to the present situation. This is not considered to represent a significant impact over the current impact from maintenance dredging and noting that maintenance dredging is assessed progressively over time under a range of State and Commonwealth legislation including the *Environmental Protection Act 1994*, and under the Commonwealth *Sea Dumping Act 1981*.

In terms of other operational impacts from PEP, the additional volume of shipping expected at the port is not predicted to have an significant adverse impact on any matters of National or State environmental significance. Broader planning processes including the North East Shipping Management Plan have examined the implications of additional shipping in the Great Barrier Reef (GBR) region and sought to impose additional controls to protect the World Heritage Area and its values.

On the basis of these predicted residual impacts (none of which are considered significant), an additional offset for operational phase impacts from the PEP is not considered as required.

27.2.4 Suitability of Cleveland Bay Fish Habitat Area offset proposal

Four submissions questioned the legitimacy of inclusion of the offset proposal in the EIS to extend the boundary of the Cleveland Bay Fish Habitat Area as a suitable offset on the basis that: (i) the Port does not own, lease or have management rights over the water and seabed in question, (ii) that the specific ecological values within the area of proposed additional Fish Habitat Area have not been surveyed; (iii) that the estimated value of the contribution to ecosystem services (\$142 million) from the initiative was overstated; and (iv) that the impacts from Port expansion would degrade this area, thereby cancelling out the merits of any offset.

In considering these submissions as part of the AEIS, it continues to be asserted that the expansion of the Cleveland Bay Fish Habitat Area represents a meaningful conservation outcome. The benefits of the proposal outlined on Page 829 of the EIS (Section B23) and do not change as part of the revised proposal.

Recognising that the Port is not the owner of the seabed and associated marine waters, POTL sought the concurrence of the Department of Agriculture and Fisheries (DAF) prior to making the proposal to extend the Fish Habitat Area as part of the EIS. The Department indicated strong support for the proposal at the time of the EIS. Much of the proposed offset area of 1240 ha was originally proposed to be part of the Cleveland Bay Fish Habitat Area when it was declared by the Department of Agriculture, Fisheries and Forestry. However it was removed as the Fish Habitat Area needed to take into account developments approved or being assessed at the time of establishment

Noting the need to develop a marine offset for the PEP, POTL made a decision to forego any future development rights in the area by initiating a dialogue with the Department for its inclusion as part of the offset planning process in the PEP.

Of the 1240 ha that is proposed to be converted to FHA, about 620 ha of this area occurs within the existing Port Exclusion Area of the Great Barrier Reef Coast Marine Park at the mouth of the Ross River (See Figure 27.1).

Inclusion of this 620 ha area as a Fish Habitat Area provides additional conservation planning controls over the area and precludes future dredging or other tidal works in the area.

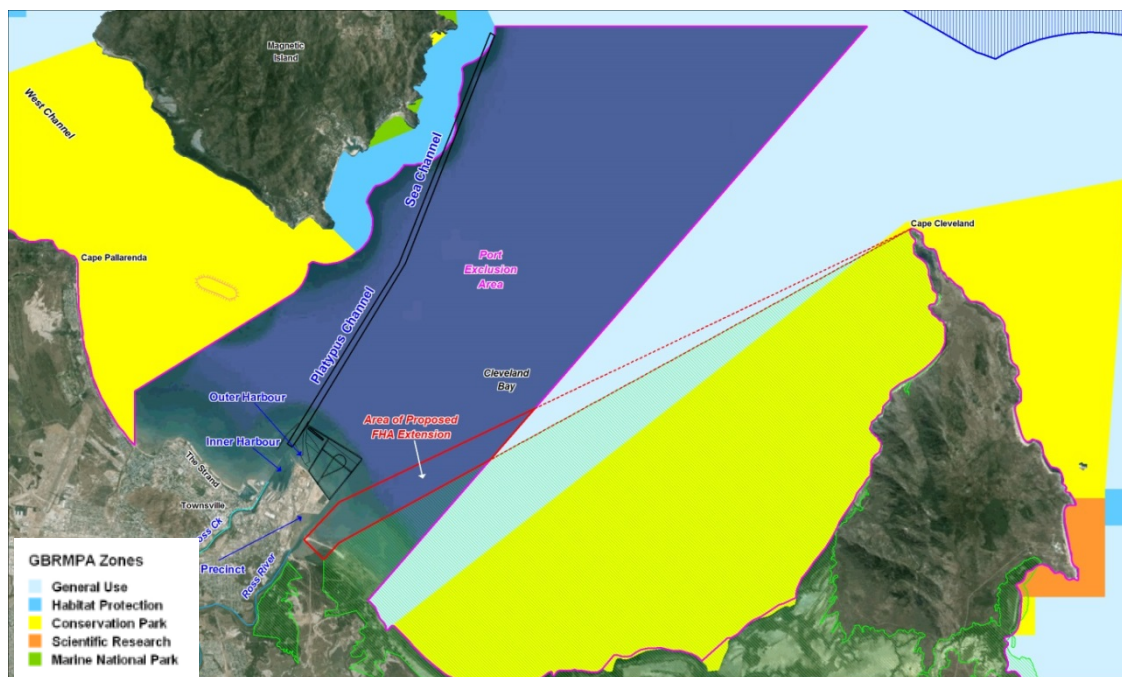


Figure 27.1 Proposed Fish Habitat Area Extension

Habitat surveys of the 1240 ha area proposed for inclusion into the Fish Habitat Area have not been undertaken as part of the EIS or AEIS on the basis that the area was considered suitable for inclusion when originally proposed by DAF. If required, additional more detailed marine ecological surveys can be carried out to the satisfaction of DAF who administer the *Fisheries Act 1994* as part of a future offset agreement. However, based on a desktop assessment, the following points support the legitimacy of the area's inclusion as a FHA.

- The intertidal areas proposed for inclusion on the eastern bank of Ross River include a mosaic of shallow sand banks, mud flats, mangroves and other marine plants that have known fish habitat value.
- The subtidal area for inclusion as part of the extended Fish Habitat Area was within the sampling area of the latest (2013) annual seagrass surveys of Cleveland Bay. Two of the monitoring sites in eastern Cleveland Bay as part of this survey showed the presence of ephemeral deepwater seagrass. Looking at the location of these monitoring sites and the location of the proposed extension area it is likely that a portion of the subtidal area for inclusion in the FHA would support deep water seagrass habitat.
- The majority of the remainder of the area would likely consist of subtidal soft bottom benthic mud environments similar to that which is being removed by the PEP reclamation or otherwise impacted by capital dredging.

As outlined elsewhere in the AEIS, the marine area being converted to FHA is also a core feeding habitat for inshore dolphin, dugong and turtle species of conservation significance (as outlined in Chapter 9.0 of the EIS) and used as feeding and resting habitat by migratory waterbirds protected under the EPBC Act. The designation of the area as a Fish Habitat Area and associated development controls will also contribute to the conservation of these species.

In terms of valuing the ecosystem services lost by the proposed Project (reclamation and dredging), and the offset provided by the expansion of the Fish Habitat Area, the monetary values identified in the EIS were based on a conservative estimate of lost or gained ecosystem services using the *Marine Fish Habitat Offset Policy FHMOP005.2* (DPIF, 2012).

Since the release of the EIS, the Queensland Government has reviewed and assimilated FHMOP005.2 into a more standardised Financial Settlement Offset Calculator for determining impacts and financial offsets under its new Environmental Offsets Act and Regulations. However, use of the Calculator to determine a financial settlement offset for the residual impacts from the revised PEP (and subsequent offset benefit from extension of the Fish Habitat Area) has limited relevance on the basis that the Calculator applies only to marine works that directly affect: (i) a protected marine park zone, (ii) a Fish Habitat Area, (iii) fish passage or (iv) damage to marine plants.

The revised PEP does not directly affect any of these prescribed areas. The reclamation and dredging will not impact on fish passage and the reclamation footprint and proposed expanded channel footprint are in areas that do not contain seagrass (based on the current sampling and previous surveys of Cleveland Bay by James Cook University).

Prevailing tide and wind in Cleveland Bay modelling does not predict any impacts on this area. On this basis, the impact of construction of the PEP and operational maintenance of the asset are not expected to affect the values of

the Fish Habitat Area and subsequently, and the risk that the offset area would be compromised in the future are considered low.

27.2.5 Relevant of offset package in local setting

Three submissions commented that the proposed offset package that was put forward in EIS needed to be more focussed and localised on the resources and values of Cleveland Bay where the impacts from the Project would be centred. Several submissions noted that the offsets should be more focussed on direct, on-ground works as opposed to financial contributions to research and monitoring.

The intent of these submissions aligns with key principles for offsets established under both the EPBC Act and under the Queensland Offset Act that favour on ground actions and strategies. However, both offset regimes recognise that practically addressing these principles in a marine context is problematic. This results from a lack of tenure or ownership over the water and seabed in the marine environment and that traditional offset mechanisms that are undertaken on land - such as rehabilitation and restoration of habitats - are much more difficult in the marine environment, have much less certainty regarding flow on effects and is challenging to achieve legislatively in the GBRWHA.

Instead, the strategic direction of marine offsets that has emerged over the past five years has been to focus on building the resilience of marine habitats to both localised anthropogenic impacts as well as broader impacts such as future climate change and extreme weather events. This is consistent with the advice of numerous papers (Bartley *et al* 2013, De'ath *et al* 2012) and reports (Strategic Assessment, 2014, Great Barrier Reef Outlook Report 2014) which have documented the links between reduced coral cover in the inshore areas of the Reef and external factors such as cyclones, ocean warming and nutrients, pesticides and sediments from catchment runoff. Likewise, Coles *et al* 2014 (in press) and Davies *et al* (2014) have noted that seagrass declines in Cleveland Bay are more closely linked to flooding, storms and cyclones as opposed to port maintenance dredging or other anthropogenic activities.

The Port of Townsville recognised the need for and difficulty in developing marine offsets associated with the PEP prior to embarking on the EIS. It engaged with key Government and non-Government stakeholders about environmental offsets and potential marine offset proposals and initiatives prior to the release of the EIS through a combination of meetings, contacts, and email exchanges.

As part of this process, all parties recognised the preference for both direct offsets as well as highly localised solutions that would be of maximum local benefit to Cleveland Bay. The process also examined and discussed what other major marine infrastructure projects had proposed in terms of offsets as well as offset packages and requirements that had been approved for similar infrastructure projects in the region and elsewhere in Australia.

The resultant offset package presented in the EIS reflects the advice and feedback obtained through this process.

The Port of Townsville has consistently indicated both as part of these pre-EIS offset discussions as well as during the public consultation process of the EIS that it would examine any proposals for potential investment as part of an offset package where such projects were considered to be directly relevant to the impacts from the PEP and therefore salient for inclusion as potential offsets. However, there was very little feedback provided in this regard from submitters, stakeholders or Agencies other than an indication that additional offsets should be investigated.

On that basis, the main elements of the offset package outlined in the EIS are proposed to be retained as commitments for consideration as part of the revised PEP, however it is recognised considerable work is currently being undertaken relating to offsetting and net benefit in the World Heritage Area. POTL will work closely with regulators to finalise the offsets package following the EIS assessment.

27.2.6 Suitability of inclusion of rock wall habitat as an offset and implication of lighting on this habitat

Three submitters raised the appropriateness of inclusion of the rock wall habitat that is created as a result of the reclamation and breakwaters as part of any offset package. A submitter also raised if this habitat and its offset values would be adversely affected by future navigational lighting.

The ecological values provided by the rock wall habitat are discussed in Chapter B.6 of the EIS. Based on the survey of existing walls at the Port, the rock walls and breakwaters built as part of the PEP will be gradually recolonised over time by a range of sessile organisms (sponges, algae), which may provide some foraging opportunities for marine megafauna such as turtles, which have been observed to graze along the existing walls of the Port from time to time. The rock walls also represent a structurally complex and locally important habitat for a range of reef-associated fish and shellfish species of direct fisheries significance. As noted in Chapter B.6 of the EIS, however, rock walls as populations of reef fish are not generally considered to be habitat limited (Sale 2006), it is unlikely that the increase in available rock wall habitat will lead to a commensurate increase in fish productivity. However, the rock wall habitats will attract fish to the port area and lead to an increase in the abundance of reef associated species at highly localised spatial scales (i.e. within the port area).

If the existing rock wall habitats at the Port are indicative, the rock wall habitat and the functions that they support are not adversely impacted by the existing light sources at the port including navigational lighting. As such, it would not be expected that required navigational lighting for new facilities would reduce the value or ecosystem services being provided by this habitat.

The inclusion of rock wall habitat within the overall package of offsets is appropriate and permissible to consider under State Government policies on fish habitat offsets and has been duly considered in other port expansion projects in the GBR region. However, it is acknowledged that this aspect of the offset proposal is not recognised under the EPBC and the Commonwealth requirements based upon agency feedback in submissions on the EIS.

27.2.7 Consideration of offsets in terrestrial fauna species management

DEHP requested additional information regarding offsets for impacts to State Significant Biodiversity Values, relevant to fauna species listed under the Queensland *Nature Conservation Act 1992* (NC Act), in accordance with the Queensland Biodiversity Offsets Policy.

The environmental offsets framework in Queensland has undergone significant changes since the preparation of the EIS. The Queensland Biodiversity Offsets Policy was replaced by the Queensland Environmental Offsets Policy in July 2014, with state significant biodiversity values revised and now referred to as MSES. Under this Policy, offset conditions apply where a prescribed activity is expected to have significant residual impact on MSES, i.e. a direct or indirect adverse impact on all or part of MSES, which remains or is likely to remain (whether temporarily or permanently), regardless of the application of mitigation measures, and is, or is likely to be, significant.

MSES include protected wildlife habitat for fauna species listed as endangered or vulnerable or special least concern under the NC Act. With recent changes to the NC Act, the existing reclamation area (adjacent to the Project area) is considered to support opportunistic habitat for one species, Beach Stone-curlew (*Esacus magnirostris*), considered a MSES i.e. listed as vulnerable under the NC Act.

The extent of MSES species populations utilising or preferred habitat present within the Project area is discussed in Chapter 9.0 of the AEIS. One pair of Beach Stone-curlew were observed, on one occasion only, roosting at high tide, in the marine precinct within the existing reclamation area (adjacent to the Project area). A larger population (up to 320 individuals per count) was recorded foraging and roosting, outside and to the south of the Project area on the Ross River sand spit.

The Beach Stone-curlew is not solely restricted to the existing reclamation area nor does this artificial area support preferred habitat for this species due to its constructed and operational nature. Beach Stone-curlews may utilise the marine precinct and revetments opportunistically for foraging or roosting purposes however, the area does not form part of any habitat area considered essential or critical to the long-term viability of this species. With the presence of more preferred, less disturbed habitat in the vicinity (in the form of the Ross River sand spit and other intertidal areas of Cleveland Bay and Magnetic Island) and existing disturbed nature of the Project area, the impact to Beach Stone-curlews as a result of the PEP is considered to be low.

With the implementation of mitigation measures outlined in the Construction and Operational Environmental Management Plans, the PEP is not expected to have a significant residual impact on this species, or other MSES, and therefore, an offset is not deemed to be required. POTL however, have committed to implementing a range of offset initiatives outlined in 27.3.4 if the Project is approved on the basis of the PEP delivering positive conservation outcomes and a net environmental benefit. This will include consideration of the additional rock wall habitat as a result of the revised design.

27.3 Revised Environmental Impact Assessment

27.3.1 Legislation and policy

Environmental offsets for the Project are governed by the following documents:

- Commonwealth EPBC Act Environmental Offset Policy (October, 2012)
- Queensland Environmental Offsets Policy - Version 1.0 (July, 2014) and associated *Environmental Offsets Act 2014* and Regulations.

As outlined in these documents, environmental offsets become applicable when the residual impacts from a development or action on a relevant Matter of National or State Environmental Significance are significant and cannot be fully avoided or minimised and where all other Government standards are met.

Offset principles from the two documents concur that suitable offsets must:

1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by environment law and affected by the proposed action
2. be built around direct offsets but may include other compensatory measures
3. be in proportion to the level of statutory protection that applies to the protected matter

4. be of a size and scale proportionate to the residual impacts on the protected matter
5. effectively account for and manage the risks of the offset not succeeding
6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs
7. be efficient, effective, timely, transparent, scientifically robust and reasonable
8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

It is important to note that offsets are not required for all approvals under the EPBC Act or under the Queensland *State Development and Public Works Organisation Act 1971*. Offsets requirements can be imposed by the approving authorities where the residual impacts (e.g. after the application of reasonable and practicable mitigation) of a proposed action are predicted or likely to be 'significant' and relevant to prescribed matters of National or State Environmental Significance.

Guidance about determining the significance of impacts to matters of National and State significance are outlined in the following documents:

- Department of the Environment (2013) Matters of National Environmental Significance: Significant impact guidelines 1.1
- Department of the Environment (2014) EPBC Act referral guidelines for the Outstanding Universal Value of the Great Barrier Reef World Heritage Area
- Queensland Government (2014) Significant Residual Impact Guideline. Prepared under the Queensland Environmental Offsets Policy.

Offset packages under these documents can comprise a combination of 'direct' offsets and 'other compensatory measures'. Other compensatory measures are those actions that do not directly offset the impacts on the protected matter, but are anticipated to lead to benefits for the impacted protected matter, for example funding for research or educational programs.

In general, offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a net conservation gain.

Given the difficulty and complexity of implementing direct offsets in the marine environment, compensatory measures tend to be an important component of offsets for marine works.

As outlined in the section previous, under the new Queensland offset policy framework, a financial settlement for marine areas can also be determined based on a financial settlement offset calculator. The calculator provides prospective financial offsets based on spatial impact (ha) to prescribed marine areas including fish habitat areas, protected marine park zones, fish passage areas and marine plants. However, the PEP is not having a direct impact on any of these prescribed MSES.

27.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. The PEP footprint of works will no longer occur directly within the boundaries of the Great Barrier Reef Marine Park or Commonwealth Marine Area.

The Project will reduce the size of the WHA property through the reclamation by an area of 152 ha. This represents 0.0004% of the overall property. Given the overall size of the property relative to the disturbance by the Project, the fact that the Project is proposed in an existing port area and the absence of sensitive receptor values in the development footprints, the assessment conclusion is that this impact from the Project is not having a significant impact to any matters of National or State significance. The temporary impacts of the PEP on water quality and marine ecology is expected to be reduced with the revised staging of the Project, use of alternative plant (that generates less turbidity) and the avoidance of at marine placement of dredge material.

27.3.3 Supporting studies

Additional field studies of the marine environment (benthic communities) were undertaken and are discussed in Section 8.0 of the AEIS.

27.3.4 Revised assessment

Impacts associated with the design refinement are expected to be less than that identified in EIS and are discussed in further detail in Sections 6.0, 8.0 and 9.0 of the AEIS.

Mitigation measures to manage MNES and MSES are summarised in Sections 8.0-9.0 and Appendix A1 and A7 of the AEIS. With the application of these mitigation measures, the PEP is not expected to have a significant residual impact on any MNES or MSES.

In this circumstance, environmental offsets proposed for the PEP are not strictly required to be implemented within the meaning and scope of Commonwealth and Queensland offset policies. POTL however, have committed to implementing the offset initiatives outlined in this Section if the Project is approved on the basis that:

- 1) The offset proposal will contribute to the PEP delivering positive conservation outcomes and a net environmental benefit, recognising the current condition and low resilience of the GBRWHA.
- 2) This forms part of a contingency offsets plan. That is offsets that are to be implemented as a contingency measure if unexpected impacts occur during Project construction or operational phases. In this context, the proactive implementation of offsets under the PEP as outlined in the EIS and this chapter of the AEIS provides a 'banked' offset for future use should it ever be required and improved understanding and resilience for Cleveland Bay.

Based on the response to submissions, the key offset initiative from the EIS that are proposed to be carried forward in the AEIS for consideration as part of the Final EIS as follows.

- In partnership with DAF, instigating and supporting a proposal to provide additional legislative protection to an area of 1,240 ha of intertidal and subtidal benthic habitat in Cleveland Bay through a proposed amendment to the Cleveland Bay Fish Habitat Area under the *Fisheries Act 1994* (including over 620 ha of habitat outside of the marine park in the Port Exclusion Area).
- Contribution of a one off administrative grant to the Queensland Government to accommodate the expansion of the FHA as well as funding for the management and enforcement of the expanded FHA (with a total funding commitment of \$150,000).
- Committing funding to on-ground actions and research to improve water quality entering the GBR lagoon in the region (through the NQ Dry Tropics Sustainable Agriculture Program and other projects that are recognised under the Reef Water Quality Protection Plan 2013).
- Committing funding to the establishment and operation of a long term ecosystem health monitoring program for Cleveland Bay and core funding for associated surveys of seagrass, corals, and megafauna.

As outlined in the EIS, the offset funding commitments for the above actions remains at a total of \$6.15 million.

If the Project is approved, it is expected the Port will discuss with regulators, confirm the offsets package or modify accordingly to achieve best outcomes and develop a legally binding offset agreement with the relevant regulatory agencies to clarify the offset commitments set out above as well as develop a timetable and implementation plan for delivery.

This will include consideration of appropriate staging of offset commitments given the long term focus of the proposed Project over a 20+ year horizon. This may include the 'banking' of offset investment made in the short term to ensure such actions and activities are included for consideration as part of future stages of the work.

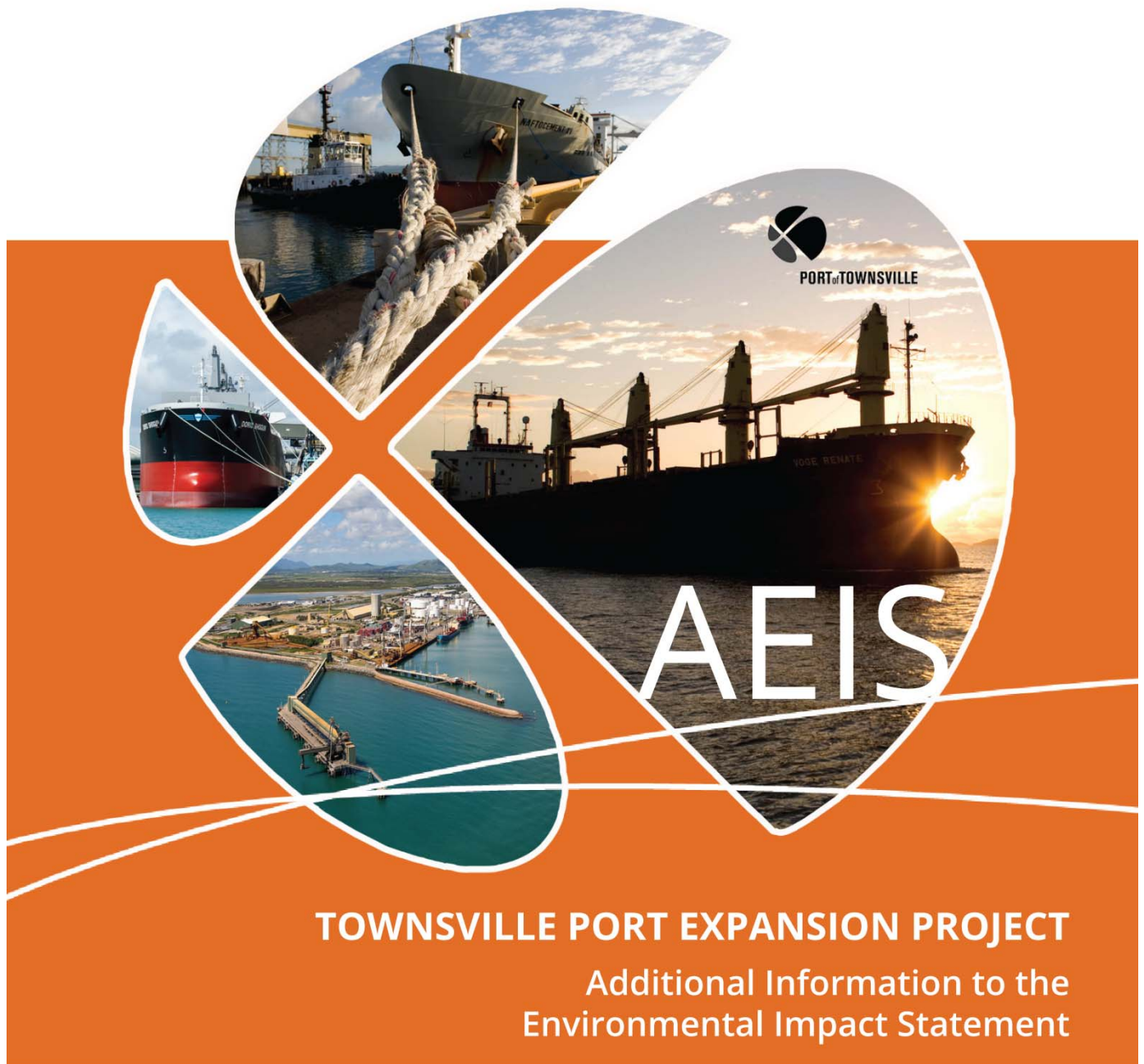
Where required, the offset agreement will also include any additional requirements or commitments imposed as part of any conditions of approval for the Project.

27.4 Conclusion

The key elements of the offset proposal outlined in the Chapter 23.3 of the EIS continue to be relevant to the impacts of the revised PEP proposal. The measures described in the EIS and summarised above serve to provide additional environmental safeguards to offset the unavoidable impacts from the Project and seek to achieve a net environmental benefit.

These initiatives are carried forward and submitted for consideration by the duly delegated authorities under the Queensland *State Development and Public Works Organisation Act 1971* and EPBC Act.

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SECTION 28

Environment Management Strategies



28.0 Environmental Management Strategies

28.1 Introduction

Part C1 of the Environmental Impact Statement (EIS) provides an overview of the environmental management framework to manage the risks and impacts of the Port Expansion Project (PEP) on the environment and maritime operations. Where possible and practicable, unacceptable environmental risks and effects have been mitigated through design considerations; including most notably the design refinement process following receipt of stakeholder submissions (described in Section 1.0-2.0). Port of Townsville Limited (POTL) will implement a number of plans and controls to manage all stages of the PEP project. Plans to be implemented include the following:

- Construction Environmental Management Plan
- Operational Environmental Management Plan
- Dredge Management Plan
- Maritime Operations Management Plan
- Vessel Traffic Management Plan.

A number of submissions received in response to the EIS related to environmental and operational management of the PEP. The key matters raised in the submission process relating to the respective plans are summarised below and addressed in the following sections. Responses to a number of the key matters identified below are also addressed in other sections of the Additional Information to the Environmental Impact Statement (AEIS). Although nominated under separate management plans, matters relating to both the Construction Environmental Management Plan and the Operational Environmental Management Plans are provided together to avoid repetition in the AEIS. Key matters raised under these plans include the following.

- Dredge Management Plan:
 - limiting dredge overflow, control of dredge plumes and cessation of dredging (Section 28.2.1)
 - expert panel for Reactive Monitoring Program design, implementation and review (Section 28.2.2)
 - dredging time window (Section 28.2.3)
 - marine animal stranding response (Section 28.2.4)
 - marine placement, monitoring and re-suspension processes (Section 28.2.5)
 - tailwater management (Section 28.2.6).
- Construction and Operational Environmental Management Plans:
 - adequacy of weed and animal pest management measures (Section 28.2.7)
 - adequacy of fire hazard management measures (Section 28.2.8)
 - consultation with service providers (Section 28.2.9)
 - adequacy of cyclone management measures (Section 28.2.10)
 - impact to non-PEP vessel movements and interactions (Section 20.2.5 of the AEIS)
 - adequacy of detail on compliance provisions and penalties (Section 28.2.11)
 - adequacy of water and air quality monitoring measures (Section 28.2.12).
- Vessel Traffic Management Plan:
 - adequacy of the Vessel Traffic Management Plan – Construction (Section 28.2.13 and Section 20.2.6 of the AEIS).
- Maritime Operations Management Plan:
 - adequacy of emergency response capabilities for shipping incidents (Section 28.2.14)
 - adequacy of monitoring of benthic impacts from anchorage and waste discharge (Section 28.2.16)
 - adequacy of spill management measures (Section 28.2.15 and Section 20.2.7 of the AEIS)
 - safety hazards for construction workers due to excess wash from vessels (Section 28.2.17).

Amendments to the plans are documented and provided as revised management plans found in Appendix B of the AEIS.

28.2 Response to Submissions

28.2.1 Limiting Dredge Overflow, Control of Dredge Plumes and Cessation of Dredging

A 14 submitters indicated the need for greater environmental controls on dredging; specifically the need for increased overflow reduction during channel dredging to protect adjacent sensitive receptors at Magnetic Island. Related matters that were raised included further definition of the overflow regime that will be adopted for the dredging campaign and greater clarity around the intended dredge operation to reduce plumes (including visual plumes). Items raised are addressed below.

Overflow

The PEP design in the EIS originally included marine placement of dredge material at the Dredge Material Placement Area (DMPA) and dredging using a medium-sized Trailer Suction Hopper Dredge (TSHD). Subsequent to receiving submissions on the EIS, and legislative change, considerable additional assessment work was undertaken to examine how overflow reduction during each Stage of the PEP capital dredging can improve water quality outcomes and subsequent adverse impacts on sensitive receptors. This assessment looked at not only the immediate plumes generated by overflow dredging but also the resuspension of spilled dredged material during and following the dredge campaign that may be mobilised by natural coastal processes.

The revised AEIS design now involves dredging using a backhoe dredger and a small TSHD, with placement of dredge material in the reclamation area instead of the marine DMPA. As a result, the dredge plumes are predicted to be greatly reduced in frequency and magnitude due to the lower production rates of the dredging equipment.

With the revised project design, Section 6.0 (Marine Water Quality) concluded that during the Expected Case scenario there will be no zones of impact in areas of sensitive ecological receptors. During the Worst Case scenario, zones of low impact are predicted to extend from the dredge area to waters adjacent to the north-eastern coast of Magnetic Island, where sensitive ecological receptors are known to occur. It is predicted that these zones of impact can be mitigated through the implementation of a range of standard mitigation measures, along with additional mitigation measures such as:

- undertaking capital dredging of the channel (TSHD during Stage 1 and Stage 3) during the most appropriate environmental window to avoid coral spawning, seagrass recruitment, turtle breeding and extreme weather events
- develop and implement a Reactive Monitoring Program (RMP) with appropriate triggers and corrective actions.

With the refined project design including a revised dredge methodology (predominantly mechanical dredge with some TSHD), the predicted impacts are significantly reduced compared to the EIS. As such, restrictions on overflow are deemed to be no longer warranted with the revised design, however restrictions on overflow may be implemented as a corrective action resulting from exceedance of triggers in the RMP, if deemed appropriate.

Visual Plumes

One submitter requested that consideration be given to corrective actions for visual plumes that could affect the Magnetic Island coast and associated tourism and recreational activities where such plumes are clearly attributed to the dredging activity (e.g. while the dredge is operating).

The ability for an operating dredge to reduce visual plumes is limited noting dredge plumes can be visible over long distances despite low actual concentrations of total suspended solids and turbidity in the water column.

The principal mitigation for visual plumes is the requirement for the contracted dredge vessel to have a 'green valve' which reduces visual plumes at the surface of the water by directing dredge overflow underkeel of the vessel. This commitment is already within the Dredge Management Plan (DMP). Further detail on 'green valves' is provided in Section 6.2.6 of the AEIS.

The revised design using a backhoe mechanical dredger and smaller TSHD will greatly assist in reducing dredge plumes generated during operations particularly in the Sea Channel where dredging operations are closest to the Magnetic Island coast and embayments.

Cessation of Dredging

Submissions noted that the Dredge Management Plan, Figure C.2.1.2 in particular, did not provide for the suspension or cessation of dredging as a corrective action.

The DMP in section (C2.1) 5.5 does identify suspension of the dredging as a corrective action option when other mitigations have been ineffective, for consistency, Figure C.2.1.2 has been amended in the revised DMP to reflect this pre-existing commitment.

28.2.2 Expert panel for Reactive Monitoring Program design, implementation and review

Seven submissions made comment about the Reactive Monitoring Program (RMP) as proposed in the DMP. There was general support in the submissions for the program and the formation of an expert Technical Advisory Committee (TAC) to oversee the RMP design, setting associated trigger levels and to oversee the implementation of the program during dredging.

Several submissions criticised the RMP and in particular Figure C.2.1.2 on the basis that it infers it will allow excessive light reduction to key receptors (such as seagrass and corals) before corrective actions are triggered. This is not the intent of the DMP or diagram in Figure C.2.1.2, noting the overarching performance objective underpinning the RMP is to avoid any mortality and to minimise as far as practicable any sub-lethal impacts (such as coral bleaching).

The text of the DMP in section C2.1 (3.4.2.4) sets out the process for establishing water quality and ecological triggers which has been revised further as part of amended DMP in Appendix B1. 'Interim' triggers have been identified in the revised documentation following the collection of a full 12 months of water quality data from sensitive receptor sites (and subsequent statistical analysis), further coral surveys around Magnetic Island and further seagrass surveys throughout Cleveland Bay all of which have been undertaken following the release of the EIS and to respond to submissions and/or delivery of prior commitments by POTL.

These triggers are expressed as 'interim' only on the basis that they are intended to be reviewed and finalised by the TAC which will be made up of recognised government and non-government scientists from local academic institutions. The TAC process will provide an additional safeguard to ensure the most appropriate and robust values for ecological triggers are used in the RMP including, where required, through the collection of additional data.

The submissions included a range of recommendations for consideration in the design of the RMP and the operation of the TAC. The majority of these recommendations are constructive and will be provided to the TAC for consideration and incorporation as part of the TAC review process if the PEP is approved and implemented. The recommendations include the following.

- Where possible monitoring points should be in the bays rather than at the tip of headlands as close as possible to areas with greater coral cover and where sedimentation rates may be greater.
- The trigger levels need to look at both acute and chronic (longer term) light deprivation to coral species.
- The trigger levels should be transparent including the rationale for how they have been derived.
- Control and impact sites of the RMP need to be carefully selected and all aspects (i.e. all coasts of Magnetic Island) need to be considered noting the tracer study and modelling shows the influence of dredge material can be felt over great distances.
- Further articulation of the process for how 'control' monitoring sites will be compared with 'impact' monitoring sites to determine if impacts are attributable to dredging is needed.
- The control sites need to be sufficiently representative of the impact sites for meaningful comparison.
- The RMP should include the west coast of Magnetic Island and Cockle Bay as important receptors for seagrass and associated green turtles feeding habitat.
- Outcomes of the RMP should be used in an adaptive management framework to inform future stages of dredging for the Project.
- There has to be independent representation on the expert advisory committee.

Further refinement of the governance structure and implementation of the RMP has also been identified in the revised DMP in Appendix B1 which clarifies the role of:

- 1) A regulatory 'Oversight Committee' made up of the key approving agencies for the Project that would review and approve subsequent plans and strategies as well as oversee compliance with the RMP during dredging/construction.
- 2) A 'Technical Advisory Committee' of both government and non-government scientific experts to review and advise on the technical aspects of the RMP including the location of control and impact sites, ecological thresholds, monitoring design and triggers for corrective action as well as oversight of the RMP during operation.
- 3) A 'Dredging Implementation Committee' made up of the proponent, its dredging consultant/contractor and the Regional Harbour Master which will oversee the dredge campaign and interact where necessary with the other committees with respect to operational and logistical issues.

As discussed in the revised DMP in Appendix B1, the Interim RMP design, monitoring locations and trigger values will need to be approved by the Technical Advisory Committee prior to the commencement of dredging.

28.2.3 Dredging Time Window

Four submitters raised the timeframe for dredging activities. The justification behind the dredging time window was articulated in the DMP in Section C2.1 (3.4.1). The preferred window for capital dredging of the channels stated in the EIS (e.g. in winter months between April and October) was based on assessment of the preferred ecological timing for several marine receptors that could be affected including corals, seagrass, marine megafauna and fisheries. It was apparent early on in this assessment that the constraints and opportunities for these receptors do not perfectly align and consideration also was given to ambient water quality and hydrodynamic conditions which vary considerably between seasons. Consultation on a preferred ecological window for dredging was undertaken with regulatory agencies as part of several briefings, with the opportunity to provide alternative views of a more suitable window. Feedback from these processes was incorporated into the eventual commitment.

Notwithstanding this, based on the advice of local scientific experts, three of these submitters have identified that the first coral spawning period for local Magnetic Island coral communities occurs after the full moon in October and on this basis, this month should also be excluded from the time window for dredging by the TSHD. This recommendation is supported and is addressed in the revised Dredge Management Plan contained in Appendix B1.

28.2.4 Marine animal stranding response

The Department of National Parks, Recreation, Sport and Racing (DNPRSR) raised the suitability of the marine animal stranding response process outlined in the DMP element for Marine megafauna.

In particular, the DNPRSR is seeking more measurable performance criteria and targets in the marine megafauna management plan (e.g. no entanglement occurs over the course of the dredging), the need for clearer protocols for response with Queensland Parks and Wildlife Service, corrective actions following an incident and more transparent accountability for actions between the dredge contractor and POTL.

In responding to this submission, it should be recognised that the DMP within the EIS is a framework document that is intended to inform and guide more detailed plans that will be required to be developed for the approval of regulatory agencies if the Project is approved. POTL will continue to work closely with relevant agencies (the Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Service in particular) to ensure the operational plans for marine megafauna protection developed for the EIS address the matters raised by the submitter, including a robust response plan for marine strandings.

28.2.5 Marine Placement, Monitoring and Resuspension Process

The Queensland Tourism Industry Council highlighted the marine placement of dredge spoil. As discussed throughout this AEIS, a key component of the design refinement process has been that all of the dredge material that was proposed to be placed at sea under the EIS design will instead be placed in the reclamation area under the revised design. Therefore, there will be no marine placement and subsequent resuspension of dredge material from the DMPA.

28.2.6 Tailwater management

The Department of Environment and Heritage Protection provided some specific comments to include corrective actions for tailwater management. These measures have been incorporated into the revised Dredge Management Plan.

28.2.7 Adequacy of weed and animal pest management measures

The Queensland Health submission recommended strategies for pest and vermin monitoring and prevention be included in the relevant Environmental Management Plans and a commitment made ensuring the provisions of the *Public Health Act 2005* and Division 3 of the *Public Health Regulation 2005* are adhered to. The management of weeds and animal pests in common areas within the Port is the responsibility of POTL. Tenants are responsible for the implementation of these measures within their leased areas in accordance with POTL requirements. The Construction Environmental Management Plan (refer Appendix B2 of the AEIS) and Operational Environmental Management Plan (refer Appendix B3 of the AEIS) have been revised to extend the weed and pest animal management measures proposed in the EIS to include monitoring and the application of control to manage risks to public safety (refer Section 9.2.4 of the AEIS; Appendix B2 (Section 1.8.6); Appendix B3 (Section 5.5)).

28.2.8 Adequacy of fire hazard management measures

The Queensland Fire and Rescue Service submission recommended actions for fire management during construction and operation of the PEP. Changes to current emergency plans and response strategies to deal with relevant incidents will be distributed to relevant stakeholders through the POTL Emergency Management Committee and Local Disaster Management Group (refer Section 24.0 of the AEIS) prior to construction.

All hazardous materials will be used, handled, stored on site and disposed of in accordance with regulatory requirements (refer Section 14.2.2 of the AEIS).

28.2.9 Consultation with service providers

The Powerlink submission recommending consultation where construction and operational works associated with the PEP have the potential to impact upon nearby services infrastructure. POTL will consult Powerlink in the event PEP works will impact or have the potential to impact upon adjacent services infrastructure in accordance with the Management of Easement Co-Use Guideline (Powerlink, 2014) and relevant existing POTL Procedures.

28.2.10 Adequacy of cyclone management measures

The DNPRSR and Maritime Safety Queensland (MSQ) submissions requested additional information on cyclone mooring requirements during construction works. The DNPRSR also requested information on cyclone mooring requirements with respect to the Great Barrier Reef Marine Park. Management of safety and environmental risks associated with shipping and vessel activity within the Great Barrier Reef Marine Park are the responsibility of individual vessel masters (refer Section 20.2.2 of the AEIS for further information on the vessel management responsibilities). Mooring requirements and contingencies for cyclones will be developed by individual construction contractors and implemented through their own Vessel Traffic Management Plan. Vessel Traffic Management Plans will be prepared in accordance with the Port Procedures, Maritime Safety Queensland and regulatory requirements to ensure the safety of vessels and personnel.

Chapter C.2.3 of the EIS provides a template for the Vessel Traffic Management Plan for contractors to use in the development of their own Vessel Traffic Management Plans. Vessel Traffic Management Plans will be developed specific to contractor operations and will be submitted to POTL and the Regional Harbour Master for approval.

28.2.11 Adequacy of detail on compliance provisions and penalties

The North Queensland Dry Tropics submission proposed the need for compliance penalties associated with non-performance to be built into Environmental Management Plans, as well as the need for accounting for changes in environmental protection requirements over the duration of the project.

The environmental management plans developed as part of the PEP make provision for adaptive management over the duration of the Project construction and will account for changes in environmental protection requirements.

A performance based approach to environmental management is proposed as it allows flexibility to adopt new or improved technologies as they become available over the duration of the project, as well as allowing incorporation of current conditions.

The environmental performance during the construction phase will be overseen by a transparent governance structure which will include State and Commonwealth agencies, and independent scientific specialists to support and guide the Project environmental performance. These aspects are documented in the updated Dredge Management Plan (Appendix B1) and the Construction Environmental Management Plan (Appendix B2). The compliance with environmental management plans is also usually a condition enforceable by State and Commonwealth agencies.

28.2.12 Adequacy of water and air quality monitoring measures

Two submissions requested further information on the adequacy of air and water quality monitoring associated with the PEP. Air and water quality management is addressed in Section 11.0 and 6.0 of the AEIS. Air and water quality monitoring will be undertaken as part of the PEP in accordance with regulatory requirements. Monitoring and other mitigation measures to manage air and water quality associated with the PEP will be implemented through the Construction Environmental Management Plan and Operational Environmental Management Plans (included as Appendices B2 and B3 of the AEIS, respectively).

28.2.13 Adequacy of the Vessel Traffic Management Plan - Construction

Two submissions were received regarding the adequacy of the Vessel Traffic Management Plan - Construction. A Vessel Traffic Management Plan - Construction is provided in Part C, Section C2.3 of the EIS. This plan will act as a template for individual contractors to develop their own Vessel Traffic Management Plans specific to their operations. All Vessel Traffic Management Plans will be developed in accordance with the *Port Procedures, Information for Shipping* and the draft *Standard for Marine Construction Activities* (if made publically available by MSQ). The Vessel Traffic Management Plan will be required to be submitted to POTL and the Regional Harbour Master for approval three months prior to commencement of work. Vessel Traffic Management Plans will outline performance objectives as well as navigation hazard management and reporting requirements. The following sections of the AEIS address related submissions:

- adequacy of cyclone management measures (refer Section 28.2.10)
- requirements of the Vessel Traffic Management Plan (refer Section 20.2.6)
- impact to non-PEP vessel movements and interactions (refer Section 20.2.5).

28.2.14 Adequacy of emergency response capabilities for shipping incidents

Two submissions raised the adequacy of available resources to respond to shipping incidents within or that have the potential to impact upon the Great Barrier Reef in regards to the Maritime Operations Management Plan (refer Section C2.4 of the EIS). POTL is responsible for the management of operational shipping activities under their control and shipping activities that utilise their facilities. The management of safety and environmental risks associated shipping and vessel activity within the Great Barrier Reef Management Park are the responsibility of individual vessel masters. However POTL would respond to an emergency in the area if required.

Currently a POTL Oil Spill Contingency Plan, Queensland Coastal Contingency Action Plan and National Plan is in place to guide oil spill response. In addition emergency response measures have been identified and are to be implemented through the Maritime Operations Management Plan (Part C of the EIS). This plan has been developed and will be updated prior to commencement of operations. This plan has been developed in accordance with regulatory requirements and is to be implemented upon approval by Maritime Safety Queensland. POTL is considered to be capable of adequately responding to shipping incidents involving their facilities and / operational shipping activities under their control through the implementation of this plan.

POTL will develop a Vessel Traffic Management Plan for each stage of construction in consultation with MSQ. Vessel masters need to comply with these Vessel Traffic Management Plans in accordance with MSQ requirements. These plans will outline measures for vessel interactions and emergency response. With the implementation of these plans, vessels outside of POTL's authority are expected to comply with their obligations for emergency response management relevant to the Great Barrier Reef.

28.2.15 Adequacy of spill management measures

MSQ raised the adequacy of the current spill management measures in the Maritime Operations Management Plan (Section C2.4 of the EIS). Existing POTL spill management measures are considered adequate to manage spills associated with the PEP and will be applied to the construction and operational phases of the Project. Spill management measures will be reviewed and discussed with the Regional Harbour Master prior to Stages B and C where berths are increased to ensure their adequacy.

This includes first strike response measures. First strike response measures will be developed with consideration for the POTL Oil Spill Contingency Plan, Queensland Coastal Contingency Action Plan and National Plan. Any changes or updates to spill management actions and procedures will be appropriately reflected in the revision of the Construction Environmental Management Plan and Operational Environmental Management Plan and the Maritime Operations Management Plan prior to commencement of operations.

28.2.16 Adequacy of monitoring of benthic impacts from anchorage and waste discharge

MSQ raised the adequacy of monitoring of benthic impacts from anchoring and discharge of pollutants and / or waste materials. The discharge of pollutants and / or waste materials is heavily regulated and all vessels within Australia, Queensland and the Great Barrier Reef Marine Park are required to comply. The Australian Maritime Safety Authority, Great Barrier Reef Marine Park Authority and Maritime Safety Queensland are responsible for compliance monitoring and penalty enforcement relevant to waste management and discharge.

The PEP proposes to utilise the existing anchorage area for the Port of Townsville and as such, no additional benthic sampling has been undertaken. Measures to manage ship anchorage under POTL's control are outlined in Part C2.4 of the EIS (Maritime Operations Management Plan). Measures to manage ship anchorage outside of POTL control will be developed in accordance with Maritime Safety Queensland by individual vessel masters as part of their Vessel Traffic Management Plans.

MSQ suggested that managing the number of ships at anchor could be used as a performance criterion. The number of ships at anchor is outside the control of POTL and is dependent on trade demand. It is therefore not considered an accurate criterion for monitoring impacts to the benthic environment. In this instance, ongoing water quality monitoring is considered more appropriate to assess the potential impact to the benthic environment. Water quality monitoring in the vicinity of the Port will continue to be undertaken and relevant indicators used as performance criteria for assessing the impact of port operations on the marine environment.

28.2.17 Safety hazards for construction workers due to excess wash from vessels

MSQ enquired if excess wash from vessel movement during construction of the outer harbour would be expected to create safety hazards for construction workers, with reference to this being a potential risk during previous construction works in the inner harbour. The PEP (including the new outer harbour) is a new expansion to the port, and as a result most of the vessel movement during Stage 1, with the exception of Berth 11, will be related to construction. Operational vessel movements will increase incrementally as new berths are developed during Stages 2 and 3. The consecutive berths construction starting from Berth 12 to Berth 18 will provide a natural segregation of operation and construction activities. Whilst these factors provide for a lower risk of excess wash from vessel movements compared to works within the active inner harbour, the construction contractors will be responsible for the development of robust Safety Management Plans in compliance with POTL requirements, and these will be required to consider construction safety within an operating port environment.

28.3 Revised Environmental Management Strategies

28.3.1 Overview

Since the preparation of the EIS and subsequent submissions process, the project design has been refined as described in Section 2.0 of the AEIS. The revision focusses on amendments to the extent of dredging and reclamation works and staging of construction works and to that extent, affect the content of the relevant environmental management plans.

Numerous technical investigations have been undertaken based on the revised design and the revised impact assessments documented in Sections 3.0 to 27.0 of the AEIS. Mitigation and management measures identified in the EIS have also been reviewed and revised where appropriate to address identified risks accordingly.

28.3.2 PEP environmental risk management approach

An environmental risk management approach underpins the Project to apply an environmental safety net. This approach ensures that environmental risks are able to be effectively managed throughout the construction and operation of the PEP.

The first Tier of risk management focuses on the impact assessment investigations. This includes collecting relevant baseline data, and configuring and applying a set of numerical or computer models in order to estimate the potential impacts and environmental risks. The risks identified as requiring management became the focus of a set of mitigation (or environmental safety) actions which are documented in the EIS.

A design refinement process was subsequently undertaken in response to submissions and changes to Commonwealth and State policy, and to further reduce the potential environmental risks related to impacts to the Great Barrier Reef Marine Park and World Heritage Area. This resulted in revising the proposed dredge methodology and increasing the proposed reclamation area to capture all dredge material, thereby avoiding placement of capital dredge material at sea.

Further impact assessment studies were undertaken to consider the design refinement, and reconsider Tier 1 mitigation measures. The residual project risks were then assessed by evaluating the potential impacts following the application of these Tier 1 mitigation actions. The scale of residual risks determines the requirement for Commonwealth or State environmental offsets. No significant residual impacts were predicted for Matters of National Environmental Significance, or Matters of State Environmental Significance.

The condition of sensitive ecological receptors in the marine environment generally wax and wane over time primarily as a result of regional and global drivers such as extreme wet seasons, cyclones, and disease outbreaks, or bleaching events. Recognising the long lead-times for implementing large infrastructure projects, knowledge of ecological processes is anticipated to continue to develop over time. Further detailed information will also become available as a result of geotechnical investigation and as the detailed design progresses.

In order to manage the risk posed by changing environmental conditions and stakeholder expectations, a second Tier or environmental risk management measures have been proposed. This involves a re-assessment of the environmental risks immediately prior to major dredging operations, a reactive monitoring program to monitor impacts during the dredging operation, and an oversight governance arrangement, including an Oversight Committee, Technical Advisory Committee, and a Dredging Implementation Committee. These management measures are described in the Dredge Management Plan.

The Construction Environmental Management Plan and Operational Environmental Management Plan similarly manage key environmental risks associated with the non-marine related impacts.

This tiered approach to environmental safety represents current best-practice environmental management and provides a high level of certainty that the environmental risks can continue to be identified and appropriately managed.

28.3.3 Revised management plans

The project design has been revised as described in Section 2.0 of the AEIS. The following management plans have been revised to address matters raised in the submissions on the EIS, changes to Commonwealth and State policy and accommodate the outcome of the design refinement process:

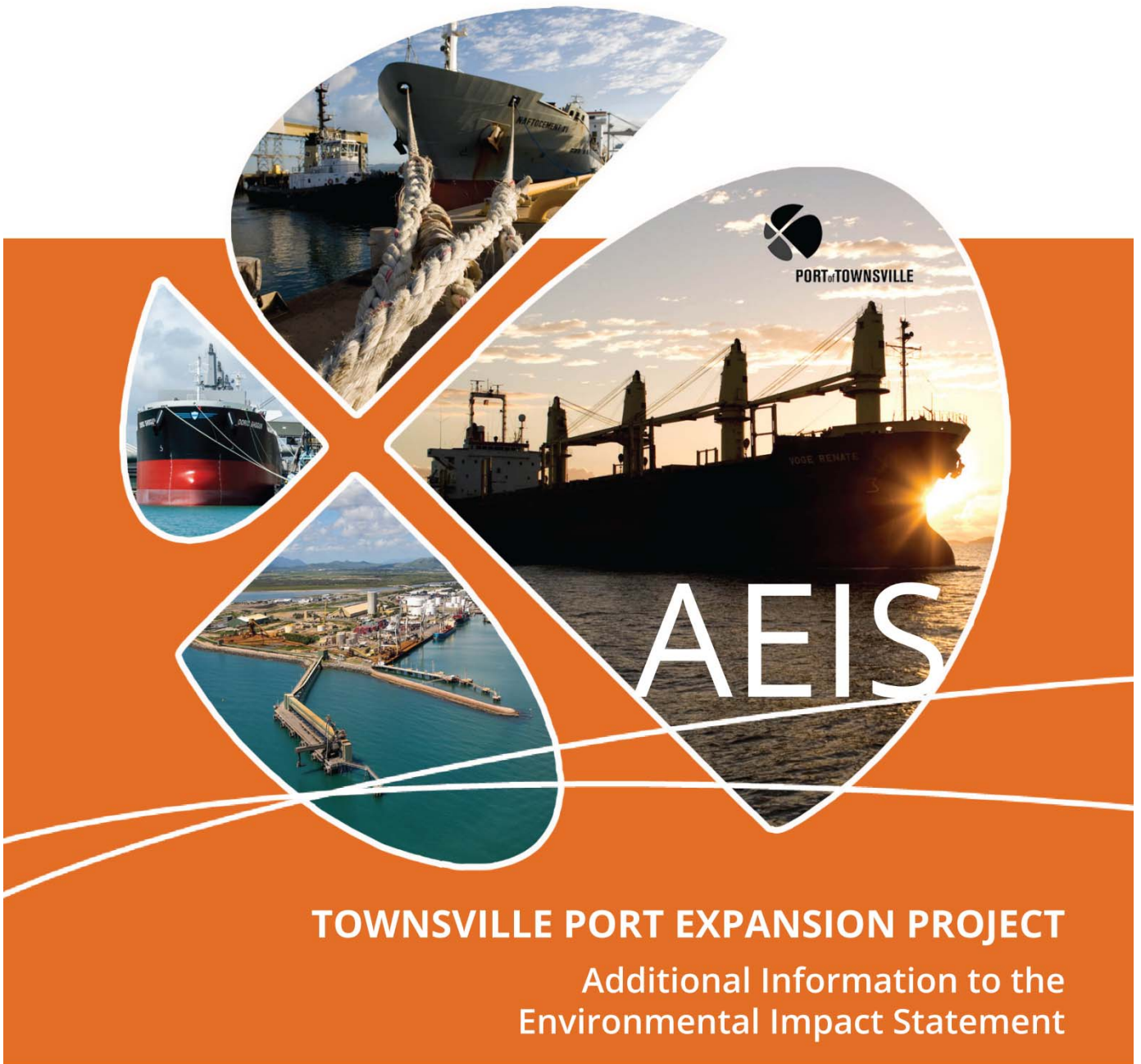
- Dredge Management Plan
- Construction Environmental Management Plan
- Operational Environmental Management Plan.

The Environmental Management Plan (Overview), Vessel Traffic Management Plan Construction and the Maritime Operations Management Plan have not been revised and are provided in Part C of the EIS. Individual vessel masters will be required to develop and implement specific Vessel Traffic Management Plans for the work that they are proposing to undertake.

The revised plans are contained in Appendix B of the AEIS. In assessing the final EIS, these documents replace the previous plans that were presented in the EIS documentation.

28.4 Conclusion

With the application of the proposed environmental risk based approach and implementation of the mitigation measures outlined in the aforementioned management plans, the potential impacts associated with the construction and operation of the PEP will be appropriately managed.



SECTION 29

Summary



29.0 Summary

29.1 Introduction

The Port of Townsville is a long-established seaport that is significant to both the history and development of Townsville and wider North Queensland region. The Port was established in 1864 and is also recognised by the Queensland Government as one of the four Priority Port Development Areas along Queensland's coastline under the *Sustainable Ports Development Act 2015*.

The Port Expansion Project (PEP) was originally conceived through a Master Planning process, which was completed in 2007. The Master Planning process recognised the driver for the Expansion Project being the predicted steady increase in trade over the coming decades, necessitating an increase in port capacity. Since that time, the Project has undergone an comprehensive engineering design review process that has considered environmental, social and economic factors (including historic dredge campaigns) to culminate in the harbour and channel designs described in the Environmental Impact Statement (EIS) that was approved for release by the Coordinator-General in May 2013 for public submissions (hereafter referred to as the "PEP EIS design").

The PEP EIS design sought to achieve additional port capacity through the deepening of the channel to a navigational design depth of -13.7m LAT (which necessitated some capital works extending into the boundaries of the Great Barrier Reef Marine Park), the construction of six additional berths and the reclamation of approximately 100 ha of adjoining port land.

It was recognised in the design that the dredging of the channel was required independently of the construction of any additional berths or land reclamation as it will itself provide a capacity increase for the Port to accommodate larger and wider ships (with a deeper draft). The land reclamation area for the PEP design was made intentionally larger than what was required for Port operations to reduce the volume of capital dredge material that needed to be placed at sea in the approved Dredge Material Placement Area (DMPA) in Cleveland Bay..

The PEP EIS was informed by the technical studies undertaken in accordance with the Queensland State Government Terms of Reference and the Australian Commonwealth Government Guidelines, as well as the Port's extensive experience in undertaking dredge campaigns since its establishment in 1864.

Following public consultation of the EIS for the Project undertaken in May 2013, a total of 435 submissions were received by the Commonwealth and State governments. These submissions comprised 23 from government departments, 39 from non-government organisations, 157 from private submitters and 216 online-facilitated submissions, either fully or partially based on a form letter. 40 submissions were duplicates submitted to both State and Commonwealth Governments by the same respondent.

The key issues identified across these submissions included the following:

- Project need
- Project options and alternatives including the dredger methodology and dredged material disposal options
- Environmental and socio-economic impacts from the Project including:
 - impacts to local ecosystems and the resilience of marine habitats in the GBR World Heritage Area (WHA) including cumulative impacts to the Great Barrier Reef;
 - impacts to amenity of Townsville and Magnetic Island and associated tourism activities; and
 - the adequacy of environmental offsets proposed.

The Additional Information to the Environmental Impact Statement (AEIS) (this report) has been prepared in response to the Coordinator-General's request to provide further clarification of specific issues raised in submissions received following the public notification period of the EIS, as well as also responding to significant changes in Commonwealth and State Policy and Legislation.

This AEIS provides a summary of the submissions, the proponent's response, and an outline of amendments to the submitted EIS in response to the submissions and legislative change. The AEIS forms part of the overall environmental impact assessment documentation for the Project that will need to be considered by the Coordinator General under the State Development Act, however it does not seek to duplicate or replace the EIS but rather to complement the existing assessment.

Unlike a traditional supplementary report to an EIS, this AEIS describes how the design of the PEP has been refined in response to Government policies on dredging and material disposal in the Great Barrier Reef World Heritage Area as well as responding to the submissions received on the EIS. As outlined later in this summary, this included additional fieldwork, data collection and re-analysis of the environmental and socio-economic impacts of the Project. It also includes updated management plans for consideration in the final decision on the Project by the State and Commonwealth decision makers.

29.2 Design refinement

A comprehensive assessment of project alternatives was undertaken during the development of the Master Plan and brought forward into the PEP. The PEP EIS design was found to provide the best balance of environmental impacts, economic efficiency and safety. Alternative design options assessed tended to fragment and duplicate port facilities being disconnected from existing land and sea access infrastructure, and required a major new approach channel to be dredged, in addition to the existing port channel. Also, these options did not provide opportunities for beneficial re-use of the capital dredge material produced from the excavation of the harbour basin and berths.

Following the development of the EIS, significant changes were made to environmental legislation and Government policy as it pertained to the Great Barrier Reef World Heritage Area. The drivers for these changes are broadly summarised below.

- A visit to Australia by a United Nations Educational, Scientific and Cultural Organization (UNESCO) committee and preparation of a report expressing concern about the health of the Great Barrier Reef World Heritage Area.
- A review of environmental factors affecting the Great Barrier Reef World Heritage Area and preparation of a Strategic Assessment by the Commonwealth and Queensland Governments.
- Release of the Great Barrier Reef Outlook Report 2014.
- Release of the Queensland Ports Strategy by the Queensland Government as a blueprint for managing and improving the efficiency and environmental management of the State's port network over the next 10 years. The strategy includes a commitment to concentrate port development to selected long-established major port areas (including the Port of Townsville) within or adjoining the Great Barrier Reef World Heritage Area.
- The Commonwealth Minister for the Environment created regulations under the Great Barrier Reef Marine Park Act to put an end to the sea disposal of capital dredge material in the Great Barrier Reef Marine Park.
- Release of complimentary Queensland legislation in late 2015 with the *Sustainable Ports Development Act 2015*. The act prohibits the sea-based disposal of capital dredge material into the Great Barrier Reef World Heritage Area and mandates the beneficial reuse of port-related capital dredge material such as for land reclamation, or placement on land where it is environmentally safe to do so.

The *Sustainable Ports Development Act 2015* also prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Project meets both of these criteria in that the Port of Townsville is identified as a priority port under the Act and the PEP is the subject of an eligible EIS process.

The Project has undergone a design refinement process in direct response to the changes that have occurred in government policy and legislation since the EIS was completed and has also sought to respond to the submissions received during the consultation period. This design refinement process resulted in following key design outcomes:

- Avoiding sea disposal by relocating all capital dredge material within the PEP reclamation area for beneficial re-use, noting this has resulted in an expanded reclamation footprint from that proposed in the PEP EIS Design.
- Avoiding direct impact on the Great Barrier Reef Marine Park (General Use Zone) by widening the channel design and only partially deepening the channel.
- Modifying the dredging methodology to reduce the bulking factor of the dredged material which will reduce the size of the reclamation area needed to handle material during dewatering and consolidation. This methodology will also reduce water quality impacts during capital dredging by using mechanical dredge plant that does not overflow the dredge material during operation

Berth 12 is an outer harbour berth at the Port that was approved under Commonwealth and State legislation in (2011 and 2012) but is not yet constructed. The design refinement process for PEP has incorporated Berth 12 as it forms a critical component of the outer harbour swing basin. Previously, the EIS had assumed that the approved Berth 12 project will be constructed ahead of the PEP, however the introduction of the *Sustainable Ports Development Act 2015* has affected the Berth 12 approval (by precluding placement of capital dredge material at sea) leading to its inclusion in the revised design.

The design refinement process also included examination of in situ volumes of dredged material for each stage of the works considering different dredging and reclamation methodologies. Other critical elements included optimising the ultimate location of the rail loop within the PEP AEIS footprint, and locating any temporary breakwaters or revetments as footings to minimise the cost of installing this infrastructure when it is required.

A summary of the updates to the PEP EIS design as a result of the design refinement process is provided in Table 29.1 below. The AEIS design addresses key matters raised by respondents and is consistent with Commonwealth and State Government policy and legislation changes since the EIS. Specific consideration and response to EIS submissions are provided in the relevant sections of this AEIS.

Table 29.1 Key outcomes of the AEIS design refinement process

Project Aspect	EIS Design	AEIS Design Refinement	Outcome
Reclamation size	100 ha	152 ha	Increased by 52 ha to accommodate all capital material onshore
Capital dredge material placement at sea	5.6 million m ³	No placement of capital dredge material at sea	Reduced by 5.6 million m ³
Dredge Material Placement Area	Area 1,140 ha	No placement of capital dredge material at sea	No impact from placement of capital dredged material in the Dredge Material Placement Area
GBRMP*	Dredging in Stage D extending into the GBRMP* General Use Zone (extension of channel)	No dredging required within the GBRMP* General Use Zone	No direct impacts to benthic environments in the GBRMP* General Use Zone
Beneficial reuse volume (reclamation)	4.3 million m ³	11.4 million m ³	Increased by 7.1 million m ³ to accommodate all capital dredge material onshore
Dredging duration	Approximately 4 years	Approximately 10.5 years	Increased by 6.5 years, change in dredging methodology to minimise the reclamation footprint size
Channel length	16.6 km	14.9 km	Channel length reduced by approximately 1.7 km
Channel width	92 m (including some minor strategic widening)	Platypus Channel - tapers from 180 to 135 m Sea Channel - tapers from 135 to 120 m	Increased channel width to accommodate longer and beamier vessels and improvement to vessel navigational safety
Channel navigation design depth	-13.7 m LAT	-12.8 m LAT	Reduced channel navigation design depth by 0.9 m to minimise impact in the GBRMP* General Use Zone
Number of berths for PEP	6	6	No change in number, locations have been refined
Harbour basin area	56.1 ha	51.4 ha	Reduced by approximately 4.7 ha to minimise the reclamation footprint size
Revetment wall (excluding breakwaters)	3.5 km	4.0 km	Increased by approximately 0.5 km to accommodate the reclamation increase
Project Impacts	Expanded reclamation footprint at an increased project cost. Reduction of total number of berths in the proposed outer harbour to seven. Shallower channel. Berth infrastructure program delayed. Modified dredge methodology and increased dredge duration. Further investigations required and undertaken as part of the AEIS.		

*Great Barrier Reef Marine Park

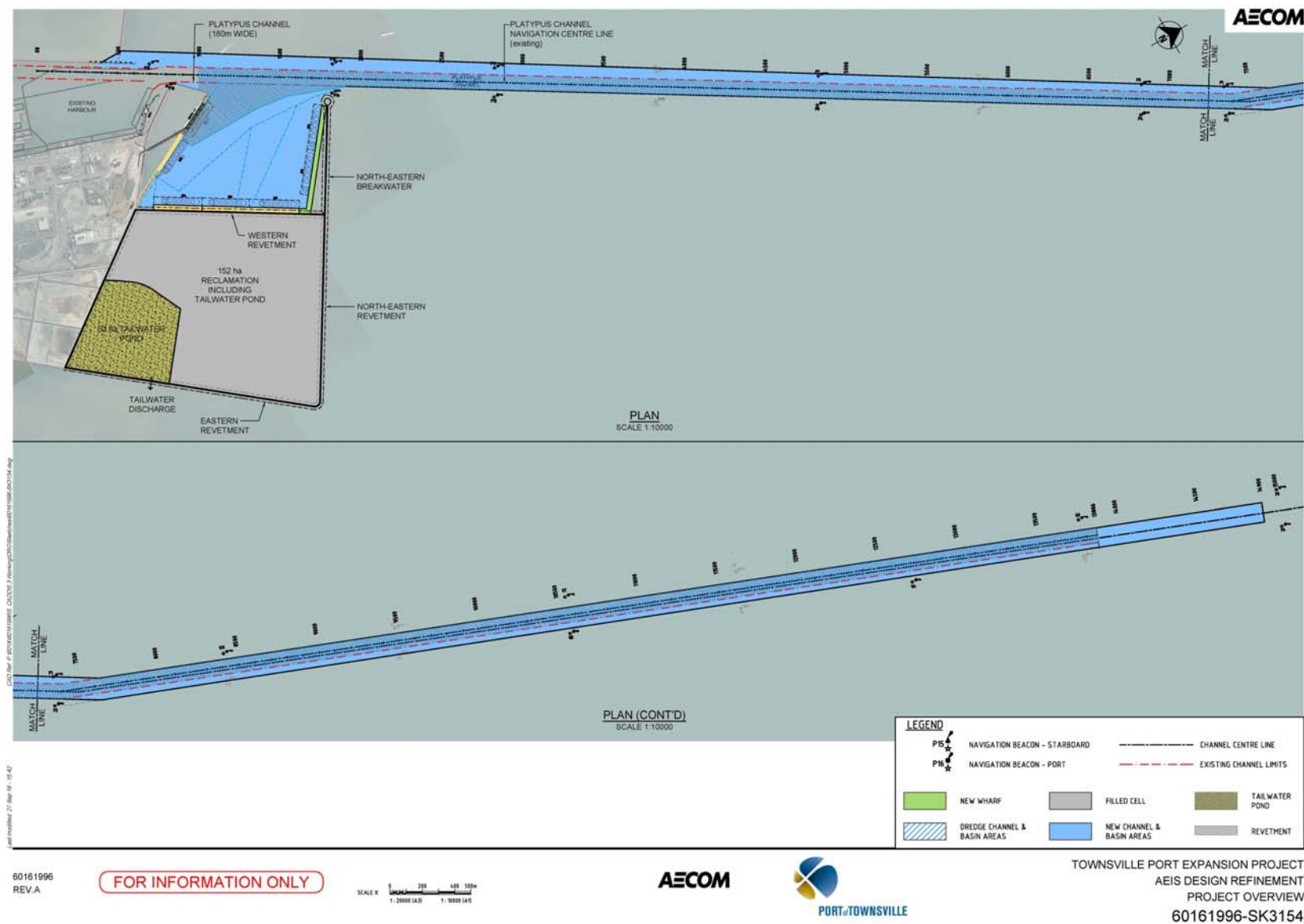


Figure 29.1 Port Expansion Project – AEIS Design Refinement Project Overview

29.3 Additional Environmental Impact Statement Studies

A range of additional studies, data collection activities and assessments have been undertaken as part of the AEIS. The following summarises the findings of the revised impact assessments in terms of the marine, land, socio-economic and other environments.

29.3.1 Marine environment

The following section summarises the findings of the revised impacts assessments in terms of coastal processes, sediment quality, water quality and marine ecology sections of the AEIS.

29.3.1.1 Coastal Processes

The expanded footprint of the reclamation area will not cause significant additional impacts beyond those identified in the EIS. The changes to hydrodynamics and sediment transport caused by the construction of the reclamation and breakwaters are minor and there may be slight benefits at The Strand due to a potential reduction in siltation.

The proposed widening of the channel is not expected to cause additional coastal processes impacts because it will not have a significant impact on wave transmission or reflection. The reduction in the proposed depth of the final channel design has reduced the length of the required channel and therefore reduced impacts at the northern end of the Sea Channel and avoids direct impacts on the Great Barrier Reef Marine Park – General Use Zone. Due to the widened channel, maintenance dredging volumes are predicted to increase by 17% over the existing case for the Interim development stage (e.g. Stage 1) and by 14% over the existing case for the Ultimate development (e.g. Stage 2 once the breakwater and full reclamation is in place which will act to shield a part of the Platypus channel from longshore sedimentation).

The likely changes in the longshore sand transport regime at The Strand are not changed by the revised PEP. There will be increased sheltering of the Ross River mouth from northerly waves due to the expanded reclamation, however exposure to prevailing north easterly waves will not be significantly changed. The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case, including avifauna habitat areas.

The revised assessment presented in this AEIS addresses the EIS submissions and finds that the design refinement does not represent a significant increase in impacts to coastal processes and hydrodynamics compared with the EIS.

29.3.1.2 Marine sediment quality

Maintenance dredging of port areas has been undertaken in Cleveland Bay for over 100 years in order to maintain navigable shipping channels, berths and vessel swing basins. Capital dredging works have also been required from time to time as a result of expansion to Port of Townsville infrastructure. Therefore, marine sediments in Cleveland Bay, particularly in the vicinity of port infrastructure and the main shipping channel have a long history of regular disturbance from dredging activities.

All sediment quality testing to date (including additional samples obtained as part of the AEIS) has indicated that the dredged material is very likely to be suitable for placement in the confined subtidal reclamation proposed for the revised design.

Consistent with the commitments made in the EIS, further more detailed testing of sediments will be undertaken at a later stage of the Project to inform design and detailed sediment management measures. Any contaminated sediments that are identified through this sampling process will be treated appropriately in accordance with relevant regulations and guidelines.

As such, the revised PEP is not expected to significantly impact upon marine sediment quality values on site or within the surrounding area and with the implementation of mitigation measures the overall impact to marine sediment quality is considered low.

29.3.1.3 Marine water quality

Marine water quality is an important environmental asset in the Study Area and surrounds due to the presence of a number of ecological receptors that are sensitive to altered water quality conditions. These sensitive receptors include seagrass meadows, which are located throughout Cleveland Bay, as well as reef communities (including coral) at Middle Reef and Magnetic Island.

A number of submissions were received in response to the EIS that are relevant to marine water quality. The design refinement has focused on avoiding sea disposal of dredged material with anticipated benefits to marine water quality in Cleveland Bay. To assess the potential impacts to marine water quality and ecologically sensitive areas from the revised design dredging works, 'zones of impact' were developed. The 'zones of impact' were established using both outputs of the hydrodynamic and water quality numerical models and through the development and application of site-specific threshold values.

The site specific threshold values were derived using a 12 month continuous water quality data set that was collected from various locations in Cleveland Bay in 2014 in conjunction with documented tolerance limits and standards for

seagrass and corals published in scientific literature (including those used in the 1993 POTL capital dredging reactive monitoring program (which was developed by a consortium of consultants and university scientists)).

The zones of impact approach, which are recommended in the GBRMPA Modelling Guidelines and are generally based on environmental assessment guidelines for dredging produced by the WA EPA (2011) include the following:

- Zone of Influence - extent of detectable plume, but no predicted ecological impacts.
- Zone of Low Impact - water quality may be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors with a nominal recovery time of approximately 6 months.
- Zone of Moderate Impact - water quality likely to be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors and/or mortality with a nominal recovery time up to 24 months.
- Zone of High Impact - water quality would most likely be pushed beyond natural variation (excluding extreme weather events) potentially resulting in mortality of ecological receptors with recovery greater than 24 months.

It is very important to note that the recovery times outlined for the various zones should be considered as indicative only, noting that recovery timeframes for particular marine ecosystems are dependent on a range of site specific factors that are problematic to accurately predict. Instead, the zones and their 'recovery timeframe's represent a means for comparing the likelihood that significant, detectable impact to sensitive receptors could occur, and are based on the assumption that recovery timeframes are dependent on the magnitude of impact.

The revised numerical modelling assessment that has been undertaken to generate the zones of impact provides a more sophisticated and robust assessment than is required by the State Government Terms of Reference and complies with the recommended approach in the GBRMPA Hydrodynamic Modelling Guidelines. The modelling also takes into account the prospective effects of offshore currents as well as the effect of extreme weather events such as cyclones on dredged material resuspension. The hydrodynamic model used for the assessment is fully 3D and calibrated and validated using the 12 months of locally collected wave, current and water quality data. The model has previously been peer reviewed by AIMS as well as an independent peer review as part of the EIS. As such, it addresses concerns about the suitability of past modelling approaches.

Similar to the findings of the EIS, the main impacting process from the Project will be from the capital dredging of the Platypus and Sea Channels proposed during Stage 1 (channel widening) and Stage 3 (channel deepening) of the PEP by a small-sized trailer suction hopper dredge (TSHD). While a mechanical dredger is likely to be used for a large component of the dredging, the TSHD contributes a greater proportion of turbid plumes due to the nature of its operation which involves overflowing dredge sediments from its hopper and associated turbidity generated from the operation of the dredge head at the seabed and propeller wash.

It is predicted that during channel widening and deepening under a Worst Case scenario, zones of moderate impact are predicted to remain localised near to the channel bend where the Platypus Channel and the Sea Channel connect. Under this Worst Case scenario zones of low impact would extend to waters adjacent to the north-eastern coast of Magnetic Island, where sensitive ecological receptors are known to occur.

However, during the Expected Case scenario, all zones of impact would be limited to the channels and adjacent areas where sensitive ecological receptors are not known to occur.

While the unmitigated risk rating is low, these zones of impact can be further mitigated through a range of mitigation measures, including the implementation of a Reactive Monitoring Program (RMP) to monitor key impact thresholds as a trigger for corrective actions. These management measures seek to minimise impacts to marine water quality as far as practicable, and will be implemented through the revised Dredge Management Plan.

29.3.1.4 Marine ecology

Despite significant changes to Townsville's coastal zone as a result of urban and port development, Cleveland Bay continues to support a broad range of significant marine ecological values and functions.

A number of submissions were received in response to the EIS relevant to marine ecology, relating to a variety of matters including the adequacy of reef surveys at Cockle Bay, and marine ecology baseline surveys as well as the potential impacts on the Outstanding Universal Value (OUV) of the GBRWHA, turtles and megafauna. The resilience of marine ecosystems and their ability to recover from expected impacts associated with the Project was also raised in submissions.

Further field surveys were undertaken as part of the AEIS to address submissions, and to support a revised impact assessment which considered the design refinement.

Key findings from the revised impact assessment with respect to marine ecology are as follows:

- The revised design in the outer harbour will not create additional impacting processes to those reported in the EIS. While the reclamation area for the revised design is larger than reported in the EIS, the impact risk levels remain the same as reported previously and do not introduce additional risks to important marine habitat areas such as seagrass.

- The revised dredge plume modelling simulated that under a Worst Case scenario, zones of low impact would extend to waters adjacent to the north-eastern coast of Magnetic Island and potentially impact upon coastal environments which support sensitive ecological receptors (corals and seagrass meadows). However, these effects are considered to present a low residual risk to these receptors along Magnetic Island and elsewhere in Cleveland Bay.
- Additional or cumulative risks to marine megafauna reported in the EIS do not increase or otherwise change materially under the revised design, noting a range of mitigation measures are proposed to limit impacts on marine megafauna including exclusion zones during pile driving, turtle exclusion devices on the dredge and similar measures.

Additional mitigation measures that will be applied to the dredging and placement activities include:

- Avoidance of late spring and summer months for TSHD dredging
- Development and implementation of a Reactive Monitoring Program.

Commitments to environmental offsets in the EIS for the unavoidable loss of marine habitat associated with the PEP reclamation (World Heritage listing as well as providing feeding habitat for coastal dolphins) are maintained in the AEIS.

29.3.2 Land and freshwater environment

The following section summarises the findings of the revised impacts assessments in terms of land and land use, terrestrial ecology and water resources sections of the AEIS.

29.3.2.1 Land management and land use

Policy and legislative reforms that have come into place since the preparation of the EIS have strengthened the Port's position as an important strategic land use asset and as a preferred location for port expansion works. The revised design is considered to be consistent with legislative and policy changes since the EIS assessment.

In response to a number of submissions and based on the revised design, volumes of potential acid sulfate soils (PASS) were recalculated and the potential impact and management reconsidered. POTL has managed and treated PASS during a number of dredge campaigns and has a high degree of experience in management of PASS within reclamation areas to minimise potential environmental impacts. In this context, placement in reclamation represents a better environmental outcome for the management of highly saline and/or acidic soils compared to alternatives to place dredge material on land above high water mark.

With the implementation of appropriate mitigation measures described in the Construction Environmental Management Plan, and the Operational Environmental Management Plan the overall impact to land, including PASS, is considered to remain low.

29.3.2.2 Terrestrial ecology

The existing port provides opportunistic habitat for a number of shorebirds, with various species observed breeding on the existing artificial revetments, during operation of the port industries. Better quality, largely undisturbed habitat is present to the south and outside of the Project area in the form of the Ross River sandspit and mouth, which was the subject of a number of submissions.

The Project will result in the temporary partial loss of opportunistic (revetment) habitat as the existing revetment is removed and reclamation area extended; however, this extension will include the construction of a longer revetment area, which may be utilised by frequenting species in the future.

Construction activities are limited to the area to the north of the existing reclamation area so that the marine precinct and surrounding area will remain unchanged. The coastal processes assessment has illustrated that the shoreline progradation at the Ross River mouth will be maintained under the developed case, thereby continuing to provide habitat opportunities for avifauna.

The PEP is not expected to significantly impact upon terrestrial ecological values on the Project site or in surrounding areas. With the implementation of proposed mitigation measures, the overall impact to terrestrial ecology is considered to remain low.

29.3.2.3 Water resources

The Project area lies in marine waters offshore from the existing reclamation area near the vicinity of the mouth of Ross River and Ross Creek. Existing groundwater monitoring on the constructed eastern reclamation area adjacent to the Project area indicates water levels are tidal influenced and the quality is saline. Water discharges from the PEP such as tail water during construction and stormwater during operation are therefore predominantly limited to the marine environment.

In response to submissions and based on the revised design, an update of the flood modelling was undertaken using the revised Developed Case Model to consider the potential impact of the PEP on flooding, including the scenario of a developed Townsville State Development Area.

The resultant impact of the PEP on the extent and intensity of storm surges is consistent with that identified in the EIS. There is no measurable change in the impact of the PEP on the extent or duration of a 50 year or 100 year flood event on the Townsville region as a result of the revised design, nor does it change the expected impact of the PEP on the 100 year surge event.

The PEP is expected to have a low impact on surface water and groundwater resources on site or within the surrounding area. Whilst the PEP reclamation footprint has been revised through the design refinement process, this has not altered the outcome of the assessment presented in the EIS. With the implementation of mitigation measures, the potential for impact to water resources associated with the PEP will be able to be managed.

29.3.3 Socio-economic environment

The following section summarises the findings of the revised impacts assessments in terms of the socio-economic environment comprising the social environment, air quality, noise and vibration, waste, cultural heritage, economic development, scenic amenity, and transport and infrastructure sections of the AEIS.

29.3.4 Social environment

The PEP represents a major expansion of port land area and infrastructure adjacent to the CBD of Townsville. The port has played a significant role in the economic development of Townsville and has influenced its social characteristics in the process, both adjacent to the immediate port area and more broadly across the city as a whole. Social values relevant to the Project area and surrounds are discussed in EIS.

A number of socio-economic factors were considered in the AEIS, in response to submissions and changes to Commonwealth and State policy and legislation and to consider the design refinement. The PEP is not expected to result in significant adverse social impacts during its construction or operation. The social values that characterise the Local, District and Regional Study Areas are not expected to materially change as a result of the revised design.

Whilst temporary impacts are predicted through changes in water quality as a result of the dredging campaign, and air and noise quality from land reclamation activities, these are expected to comply with relevant standards. Although the land reclamation generates visual impacts that are considered to be 'high' for the adjacent local areas, this would be considered low at broader scales and consistent with its immediate surroundings, that is, the port environs. The EIS also identified the potential for temporary impacts on amenity values, mostly related to the construction phase of the project. This has been reflected in a number of the submissions received through the EIS process and addressed in the AEIS.

The PEP will continue to provide a range of positive social benefits at a regional, district and local level. The positive economic impacts of the PEP are expected to provide a number of secondary benefits to the community, including Magnetic Island. In the short term the PEP will provide opportunities for new trades to utilise the Port, including larger cruise ships which are currently restricted from visiting Townsville. In the longer term the Project continues to support the development of Northern Australia as one of Queensland's priority ports.

Mitigation measures proposed in the EIS remain appropriate, as well as relevant, to current environmental protection requirements and the revised design. The Port is committed to ongoing community engagement with Townville and Magnetic Island residents and businesses to facilitate a mutual understanding, and to proactively identify any social impacts as a result of the PEP, should they arise.

29.3.4.1 Air Quality

The Port of Townsville is bounded by Cleveland Bay to the north and east and a combination of commercial and residential land immediately to the south and west. The nearest residences are located adjacent to the port's southern boundary, along Archer Street, South Townsville. The potential air quality impacts associated with the construction of the PEP were assessed with predicted concentrations of particulates at indicative sensitive receptor locations estimated using the CALPUFF model.

The magnitude of dust emissions from the revised PEP construction activities was considered to have been reduced compared to the original design assessed in Chapter B9 of the EIS. Better project definition regarding timing of construction activities means that some activities that were modelled in the EIS as concurrent, no longer occur concurrently, thereby resulting in a reduction in total dust emissions during the construction stage. It was also confirmed by DEHP (March 2014) that impacts from future port tenant operational activities would be dealt with in future development applications for those specific activities.

Concentrations of PM₁₀ and TSP predicted to fall below criteria for all averaging periods, at all indicative sensitive receptors. Dust deposition rates also predicted to fall below the relevant criterion for dustfall, at all indicative sensitive receptors. While dust impacts during construction are temporary, under the unmitigated scenario the risk of increased dust emissions leading to degradation of air quality amenity at sensitive receptors is considered

'moderate'. With the implementation of the proposed reactive monitoring programme and management plan the risk is able to be reduced to 'low'.

Concentrations of NO₂, SO₂, CO, and PM_{2.5} from shipping emissions were also considered in the AEIS and predicted to be below the relevant criteria for both the short and long-term averaging periods, at all indicative sensitive receptors. The overall risk to health and well-being from shipping emissions is considered low.

Key mitigation recommended in the Construction Environmental Management Plan for air quality includes:

- All activities being undertaken with the objective of preventing visible emissions of dust beyond the site boundary.
- Implementation of a Conceptual Reactive Monitoring Program based on a set of air quality triggers for corrective action.

The mitigation measures, including the reactive monitoring program, outlined in the AEIS are considered appropriate to effectively manage air quality impacts. Trigger levels for the reactive monitoring programme were not provided in the EIS, however, draft dust monitoring trigger values have since been developed and are provided in the AEIS.

29.3.4.2 Noise and vibration

The Project area supports the existing port facilities with the nearest sensitive receptor being identified approximately 1.4 km from the Project boundary. The existing ambient environment at the Project boundary is characterised by traffic and port activity noise.

The revised modelling undertaken as part of the AEIS predicts that the changes made as part of the design refinement are not envisaged to substantially alter the outcome of the Noise and Vibration assessment in the EIS.

The mitigation measures outlined in the EIS are considered adequate to effectively manage noise impacts. These measures include application of POTL's established complaints handling procedure which will be updated to accommodate the PEP. Information regarding noise issues and enquiries will be made available on the POTL website.

29.3.4.3 Waste

The construction and operation of the PEP will generate a variety of waste that requires appropriate storage, handling and disposal management to reduce impact to the environment, community and port users.

POTL manages waste in the common areas of the Port under its existing Environmental Management System. Future port tenants are required to implement appropriate waste measures for their operations, including negotiating individual trade waste agreements with licenced contractors, arranging the removal of regulated waste to a licensed receiving facility and for adhering to the relevant regulatory requirements regarding the disposal of quarantine wastes. Port tenants and ship operators must also adhere to existing POTL procedures, which require the collection of shipping waste to be organised by the shipping agent and handled in accordance with the Australian Maritime Safety Authority regulations.

The types of hazardous materials that will be used during the construction of the PEP will be typical of a large infrastructure project. Whilst detailed information on hazardous materials is not available at the current project stage, all hazardous materials to be used during construction of the PEP will be identified prior to commencement, and appropriate storage facilities will be established (where required) in accordance with regulatory requirements.

Ballast water discharge from vessels is managed by individual ship operators under the controls of the Commonwealth Department of Agriculture and Water Resources. All international vessels operating in Australian waters, including the Great Barrier Reef Marine Park, must manage their ballast water in accordance with commonwealth requirements. These vessels must exchange ballast water for clean water from the deep ocean prior to entering Australian waters. All discharge activities at berth must be undertaken in accordance with commonwealth requirements and regulations.

With the implementation of these and other measures, as outlined in the Section 14 of the AEIS and management plans in Appendix B of the AEIS, the potential impact to the environment from waste are able to be appropriately managed and the mitigated risk considered low.

29.3.4.4 Cultural heritage

The mitigation measures outlined in the AEIS, including those specified in POTL's registered Cultural Heritage Management Plan (CHMP), are considered adequate to effectively manage the potential for discovering items of Indigenous cultural heritage values and would maintain the unmitigated risks during construction works and operations at low.

The PEP is expected to also have a negligible impact upon non-Indigenous cultural heritage values on site or within the surrounding area. With the implementation of similar discovery control measures, the potential for discovering items of heritage values during construction works will also be appropriately managed through the Construction Environmental Management Plan.

29.3.4.5 Economic environment

The port has played a significant role in the economic development of Townsville and North Queensland since its establishment in 1864 and is recognised by the Queensland Government as one of the four Priority Port Development Areas along Queensland's coastline.

The proposed expansion to the Port of Townsville is required to accommodate medium and long-term future growth in trade volume over a planning horizon to 2040 and beyond, and also to ensure that the port remains attractive to shippers as the global fleet increases in size. Additional berths, land reclamation and modifications to improve accessibility for vessels will allow for increased shipping movements and remove the current constraints on growth.

While a summary review of the berth utilisation figures may indicate that the port has plenty of capacity available, this is not the case. Optimum berth utilisation for any particular berth depends upon a number of factors. It is expected that multi-cargo ports such as Townsville are not able to achieve utilisations as high as those achieved in contemporary single cargo ports and in many instances over the last five years some berths at the port have been over their optimum capacity.

An economic disruption model that describes the impacts of channel restrictions on economic activity was developed to simulate the potential impacts of the channel being restricted. By implication, economic impacts of restricting future trades can be estimated. In summary, economic impact of three short-term vessel disruption or access restriction scenarios ranged from \$779M to \$1,429M. This result suggests that future trades that may be foregone as a result of a lack of sufficient capacity in the port land-based and channel infrastructure could be at least of this magnitude.

In response to the matters raised in submissions about the need to avoid dredging in the Marine Park the design refinement has investigated alternatives to the proposed deepening of the channels, which would provide an equivalent increase in channel capacity. In lieu of deepening the existing channels to a navigational design depth of -13.7 m LAT as proposed in the EIS, the design refinement of a widened channel will allow the Post Panamax vessels with a 43m beam access to Townsville. It is anticipated that Post Panamax vessels up to 100,000 DWT will have access to Townsville under the revised design. This compares favourably against the typical Panamax vessels which currently visit Townsville Port being in the 60,000 to 70,000 DWT size range. This avoids directly impacting on the Great Barrier Reef Marine Park – General Use Zone.

To assess the potential impacts that the PEP could have on tourism operators on Magnetic Island, an assessment was carried out focusing on the tourism operators who utilise the foreshore and fringing reefs as the basis of their operations. The assessment of the TSHD utilised similar international studies to assign an approximate economic impact to the 16.5-week TSHD dredging campaign in Stage 1 (potentially impacting 1,328 dives). It was conservatively found that a total monetised impact to tourism operators was approximately \$26,559.

In relation to the potential greater economic impacts of the PEP on the Great Barrier Reef OUV, the expected direct and cumulative impacts are described in the marine ecology and cumulative impacts sections. Of relevance, the long term impacts are expected to be loss of soft sediment sub-tidal habitat at the site of the expanded reclamation, and changes to visual amenity. Both of these whilst being permanent impacts, are highly localised in scale and therefore by definition do not impact the wider Great Barrier Reef World Heritage Area economic values.

Overall, assuming that the proposed mitigation and reactive monitoring measures discussed in Section 6 of the AEIS are implemented, broad scale impacts to the greater Great Barrier Reef OUV are assessed to be negligible (refer section 25.0 and 26.0 of the AEIS). This result is consistent with the observed impacts from the previous major capital dredging campaign in 1993 that also featured a defensible and intense short and long term environmental monitoring program.

29.3.4.6 Scenic amenity

The Project will affect the views of several near and distant receptors in the Townsville/Magnetic Island locality. The AEIS confirmed that impacts of moderate significance would continue to be generated at the local level. Scenic amenity impacts on the wider GBRWHA are of lesser significance due to visual containment. These impacts arise principally as a result of cumulative and perceptual aspects.

The implementation of mitigation measures to manage impacts on visual values as identified in the EIS would assist in integrating the port infrastructure into its landscape context at a local level but would not change the overall risk level.

29.3.4.7 Transport and infrastructure

The PEP will result in an increase in traffic associated with the transportation of plant, equipment, products, wastes, personnel and rock armour and core material from local quarries during construction. The design refinement has resulted in revised staging for the PEP, impacting a number of transport and traffic assumptions/details that were based on the original EIS staging.

The design refinement expands the reclamation area by approximately 50 ha to the north-east to avoid sea disposal of dredged material. Transportation of materials to the site has increased from those presented in the EIS by approximately 17% due to construction of a larger reclamation area.

The types of impacts associated with the revised refinement are expected to be consistent with those originally identified in the EIS, however the number and rate of vehicle movements has increased as a result of the larger reclamation. Average numbers of heavy vehicles hauling armour rock from quarry sources has increased during Stage 1 and Stage 2, for a limited period during placement of revetments and the breakwater. Whilst the average number of traffic movement is higher at these times (by 4-6 vehicle movements per hour), the duration that material is being hauled at this intensity has reduced since the EIS. During the remainder of the Project construction, average heavy vehicle movements are either similar or less than predicted in the EIS.

Haulage routes have been refined since the EIS. The EIS utilised data that was captured prior to the completion of the Townsville Port Access Road and a number of route options were still being considered to haul armour rock. With the Townsville Port Access Road now functional it is proposed that heavy vehicle construction traffic will avoid the use of Boundary Street for bulk materials haulage where possible. This will significantly decrease the potential traffic impact on Boundary Street compared to the EIS.

Mitigation measures to further reduce the impact of the PEP, in regards to transport and infrastructure, are contained with the AEIS and outlined in the updated Construction Environmental Management Plan and Operational Environmental Management Plan updated through the AEIS.

29.3.5 Operational port requirements

The primary function of POTL, under the *Transport Infrastructure Act 1994*, is to establish, manage and operate effective and efficient facilities and services within the port relating to port infrastructure, while maintaining appropriate levels of safety and security at the Port of Townsville.

The Regional Harbour Master (Townsville) has jurisdiction over the safe movement of all shipping within the pilotage area under the *Transport Operations (Marine Safety) Act 1994*. Collectively, POTL and the Regional Harbour Master have responsibility for managing the safe and efficient operation of the port. All vessel movements are coordinated through Townsville Vessel Traffic Service (VTS) and the Port Procedures Information for Shipping – Townsville must be complied with by all ship owners, ship masters, ships, other persons or matters in the Port of Townsville.

The following section summarises the findings of the revised impacts assessments in the AEIS in terms of port operations comprising port operations, health and safety and security, property and infrastructure, and emergency management sections of the AEIS.

29.3.5.1 Port operations

The progressive development of the PEP will occur in response to trade demand. POTL, as the port authority, will be responsible for the development of the PEP in terms of the dredging and land reclamation activities. The Australian Maritime Safety Authority (AMSA), GBRMPA and Maritime Safety Queensland are responsible for determining permitted shipping activities within the GBRMP, compliance monitoring and enforcement of penalties for non-compliance with regards to environmental and safety management. Other modifications to the Project include dredging activities, such as staging and timing.

The impacts on vessel safety and operational efficiency of the port identified in the EIS remain relevant and the mitigation measures still apply. Prior to the development of each stage of the Project, navigation arrangements, lighting and illumination requirements will be reviewed and revised by POTL in consultation with the Regional Harbour Master as necessary to maintain efficiency and safety for shipping and port operations.

Port tenants will be responsible for the management of their own infrastructure and handling facilities. Associated approvals will be independently undertaken by port tenants at the appropriate time.

The incremental development of the PEP over several decades is not expected to significantly impact upon port operations and with the implementation of mitigation measures as described in the Construction Environmental Management Plan, Operational Environmental Management Plan, Maritime Operation Management Plan, Vessel Management Plan and Dredge Management Plan, the overall impact to port operations is considered low.

29.3.5.2 Health and safety

The design, construction and operation of the PEP will be undertaken in accordance with regulatory requirements at the time of each stage to minimise health and safety risks to personnel, property and the broader community. Measures to manage the Project's health and safety risks during construction and operations are covered by an extensive regulatory framework extending beyond the health and safety legislation.

Tenants and port operators are responsible for developing and implementing safety management plans to manage their own operations, including spills, within their tenancies, in accordance with regulatory requirements and POTL management systems. POTL have developed procedures and guidelines for safety management at the port,

including for the management of spills and POTL undertakes regular reviews of their own operations to ensure compliance. This includes safe handling, storage, use and disposal of hazardous materials and response to spills.

POTL has undertaken a number of reclamation projects in the past and is well placed to manage health and safety associated with the Project. POTL currently manages health and safety risks through their management systems. With the implementation of mitigation measures through these mechanisms, the Construction Environmental Management Plan and the Operational Environmental Management Plan, the PEP is not expected to significantly impact upon existing procedures and framework or responses to safety issues.

29.3.5.3 Security, property and infrastructure

The Port of Townsville is recognised as essential infrastructure which, if destroyed, degraded or rendered unavailable for a short or extended period, would significantly impact on social and economic values. The nature of maritime business and infrastructure associated with the port falls within statutory requirements that provide safeguards against unlawful interference with maritime transport and establishes security levels for the Port of Townsville and its projects and infrastructure.

POTL currently manages security risks associated with essential infrastructure through its maritime security and emergency management plans in accordance with regulatory requirements. Security risks associated with the PEP will be appropriately managed through the implementation of mitigation measures and the incorporation of the Project into existing plans.

29.3.5.4 Emergency management

Emergency management and response requirements associated with the PEP include extreme climatic events, natural hazards and hazards resulting from human actions.

Emergency management planning for the PEP is consistent with current POTL procedures and plans and adheres to relevant regulatory requirements. Emergency management for all current and future POTL operations is delivered through the POTL Emergency Response Procedures, Safety Management System, Environmental Management Systems, POTL's Security Plan and through the management of critical infrastructure and in support of the POTL Emergency Management Committee and Local Disaster Management Group.

With the implementation of mitigation measures through these mechanisms, the PEP is not expected to significantly impact upon existing procedures and framework and emergency response services locally or regionally.

29.3.6 Climate change and natural disaster

Tropical cyclones occur in Townsville leading to flooding events and beach erosion. Storm surges often occur during the passing of cyclones causing flooding to low-lying coastal and the potential for severe wave action acting on coastal structures.

A number of submissions questioned whether the potential impacts of climate change were adequately considered in planning the design and operational capacity of the PEP, specifically in terms of flood levels and management of natural disasters.

The PEP design refinement has considered all relevant legislation, policies and design guidelines relating to climate change and natural disaster. Climate change resilience will continue to form a key design consideration during the detailed design. The Port of Townsville has successfully operated for over 150 years and is experienced in managing construction and operation of a port in tropical North Queensland.

The project flood model has been revised in response to the design refinement process and has considered future development of the Townsville State Development Area. The study adheres to the same methodology as the EIS and confirmed that the PEP will not result in any significant change in the extent and / or severity of upstream catchment flooding given the project is effectively located offshore from the mouth of the Ross River and Ross Creek.

Through continued consideration of climate change and natural disaster risks during the PEP detailed design phase and by implementing mitigation measures and contingency plans, the PEP is expected to be able to achieve and maintain an appropriate level of climate change protection and infrastructure resilience.

29.3.7 Greenhouse gas

Emissions generated by the PEP will contribute to existing concentrations of greenhouse gases in the atmosphere such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). This has secondary consequences through its contribution to climate change impacts.

The design refinement has resulted in revised greenhouse gas of approximately 290,500t/CO₂-e, which is a 22% increase greenhouse gas emissions since the EIS. This is due to all dredge material being placed on land requiring more trips by onsite machinery to deliver dredged material to the reclamation area.

Onsite machinery has increased substantially by 137% due to increases in land reclamation from 100 ha to approximately 150 ha. Capital dredging emissions have increased by approximately 9% as capital dredging works are taking place over a longer period of time, requiring more energy consumption from dredgers.

Project emissions from embodied energy now comprise 5% less than the EIS, and emissions from transportation of material now comprises 17% less of the total compared with the EIS; primarily as the material quantities remained mostly the same whilst other emissions increased thereby changing the proportion of emission sources.

A number of actions to reduce greenhouse gas emissions associated with the PEP are contained within the Construction EMP.

29.4 Cumulative Impacts

A number of submitters sought more information on how project impacts would compare to impacts on Outstanding Universal Value (OUV) resulting from other stressors (such as cyclones, bleaching, and catchment runoff) impacting the study area and Great Barrier Reef in general, and what consideration should be given to the timing of the project with respect to other stressors impacting sensitive ecological receptors.

In response to submissions, the cumulative impact assessment was revised to be consistent with the GBRMPA *Framework for Understanding Cumulative Impacts Supporting Environmental Decisions and Informing Resilience-Based Management of the Great Barrier Reef World Heritage Area*.

The cumulative impacts assessment has identified the key other stressors acting on sensitive ecological receptors, assessed their relative roles and impacts and investigated the relative timing of different stressors.

The key results from this revised Cumulative Impact Assessment are as follows:

- Research suggests that the near-shore environment of the GBR, including Cleveland Bay has featured relatively high turbidity over geological timescales (pre European settlement). The availability of large relic sediment stores in the study area resulting in frequent periods of elevated turbidity as local winds and tidal currents routinely re-suspend these 'old' sediments.
- Post European settlement has seen significant development of the GBR catchment. This has resulted in increased loads of fine sediments entering the GBR lagoon. The majority of these sediments are thought to fall out of the water column and be deposited near river mouths. Ongoing sediment transport can transport some of these away from river mouths although these volumes are thought to be small by comparison to the existing sediment stores.
- The near-shore environment of the GBR, including the sensitive ecological receptors in the study area, are routinely impacted by stressors, including cyclones, CoTS outbreaks and bleaching events.
- The impacts predicted by the PEP are generally considerably less than impacts occurring from other stressors.
- The timing of capital dredging using a TSHD should consider major events such as bleaching or cyclones that impact the study area and occurred over the previous wet seasons.

The main recommendation from this revised Cumulative Impact Assessment is consideration should be given to the state (and relative resilience) of sensitive ecological receptors in the study area prior to capital dredging being undertaken. The risk management actions outlined in the Dredge Management Plan (Appendix B1) should be undertaken prior to capital dredging being undertaken. In particular trigger levels for managing the impacts of dredging need to be cognisant of the bio-condition of sensitive ecological receptors at the time of dredging activities.

29.5 Outstanding Universal Values

The GBR was declared a World Heritage Area in 1981, internationally recognised by the World Heritage Committee for its Outstanding Universal Values (OUV). It is listed for all four natural criteria (vii), (viii), (ix) and (x) as follows:

- Criterion vii - Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
- Criterion viii - Be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features
- Criterion ix - Be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals
- Criterion x - Contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

UNESCO undertook a reactive monitoring mission in 2012 at the request of the World Heritage Committee at its 35th session in Paris. The mission assessed the state of conservation of the GBRWHA and the resulting report concluded that while the overall OUV has likely been maintained, the environmental quality of parts of the Great Barrier Reef ecosystem have declined since the time of inscription in 1981.

In response to the UNESCO mission, a comprehensive Strategic Assessment of the GBR WHA and adjacent coastal zone was undertaken by the Australian and Queensland Governments between 2012 and 2014. The assessments were carried out under Part 10 of the EPBC Act and form part of the Australian Government's response to the World Heritage Committee's concerns about development impacts on the Great Barrier Reef World Heritage Area.

In response to the threats posed to the Great Barrier Reef World Heritage Area, the Australian Government and Queensland State Government have drafted the *Reef 2050 Long-Term Sustainability Plan*. The Plan outlines measures for identifying, protecting, conserving, presenting and transmitting of the Reef's OUV for future generations.

Since the EIS was released there has been substantial further guidance provided about the OUV of the Great Barrier Reef including finalisation of EPBC Act referral guidelines published by the Australian Government, Department of the Environment. These guidelines have been used in the re-assessment of the Project and in responding to submitters' issues and concerns.

Submitters sought information on how the Project may impact OUV of the GBRWHA. This assessment has found with respect to impacts on the Attributes of the WHA that the proposed project is:

- not likely to significantly detract from the present natural beauty of the property (Criterion vii)
- is not likely to have an adverse impact on key interrelated and interdependent elements and their natural relationships (Criterion viii)
- significant impacts to the area's ecosystems and biodiversity are not expected but there will be highly localised impacts on soft sediment habitat (permanently removed by reclamation) and temporary impacts on other key receptors through changes to water quality as a result of dredging (particularly seagrass and coral communities). These impacts on water quality will be monitored as part of both reactive and long term ecosystem monitoring outlined by the Project EIS and in accordance with mitigation and monitoring commitments set out in the Dredge Management Plan. Environmental offsets are also proposed to address residual impacts from the proposal on ecosystems and biodiversity. (Criterion ix)
- the Project will not remove or have flow on effects on habitats required to maintain the diversity of fauna and flora in the WHA (Criterion x).
- While there will be permanent benthic habitat loss as a result of the reclamation area, the area of temporary benthic habitat loss from capital dredging will be reduced by 1,140 ha (area of DMPA) compared to the EIS as a result of the revised design in the AEIS (which no longer includes marine placement of capital dredge material at the DMPA) (Criterion ix).

In relation to retaining the Integrity of the WHA, the project is:

- not expected to cause additional loss to any whole OUV element (Wholeness Criterion)
- while there will be a reduction in the size of the WHA property by 0.0004%, with the proposed mitigation and offsetting the Project is not expected to reduce the WHA's outstanding value (Intactness Criterion)
- some adverse effects are predicted, namely turbidity and sedimentation impacts to seagrass which are expected to be minor, temporary and localised as a result of the proposed dredging and temporary (sub-lethal) impacts to some coral communities on the north east coast of Magnetic Island are possible. Preventing these impacts will be a major focus of the reactive monitoring program with the implementation of corrective mitigation measures by the dredge if ecological trigger limits are reached.

Coupled with the cumulative impacts assessment findings and this section's assessment of compliance with the Strategic Assessment and the 2050 Plan, the revised PEP is considered to be consistent with policy frameworks at the Commonwealth and State level, most notably the Project:

- is in a priority port development area (Actions WQA6 and EBA10).
- has taken into account national and international requirements and guidelines for the disposal of dredged material and has maximised the placement of material in the reclamation, removing the need for sea placement and therefore removing the impact of re-suspension of placed material (WQA7).
- includes a dredge management strategy that prioritises beneficial re-use of dredged material and includes a range of measures (reactive monitoring program, timing of the works) to minimise impacts on Reef water quality and ecosystem health (Action WQA8).
- includes commitments to environmental research, monitoring and on ground actions as part of the environmental offset proposal that support protection, restoration and management of coastal ecosystems that contribute to reef health and resilience (Action EHA3).

29.6 Offsets

Offsets proposed in the EIS to counteract potential residual impacts of the PEP on Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES) were re-assessed in the AEIS to consider additional field studies and baseline information, the design refinement and legislation and policy changes.

The AEIS found that impacts associated with the design refinement are expected to be less than identified in the EIS and with the implementation of proposed mitigation measures that the PEP is not expected to have a significant residual impact on any MNES or MSES.

In this circumstance, environmental offsets proposed for the PEP are not strictly required to be implemented within the meaning and scope of Commonwealth and Queensland offset policies. POTL however, have committed to implementing the offset initiatives outlined in AEIS if the Project is approved on the basis that:

- 1) The offset proposal will contribute to the PEP delivering positive conservation outcomes and a net environmental benefit, recognising the current condition and low resilience of the GBRWHA;
- 2) This forms part of a contingency offsets plan. That is offsets that are to be implemented as a contingency measure if unexpected impacts occur during project construction or operational phases. In this context, the proactive implementation of offsets under the PEP as outlined in the EIS and this chapter of the AEIS provides a 'banked' offset for future use should it ever be required and improved understanding and resilience for Cleveland Bay.

Based on the response to submissions, the key offset initiative from the EIS that are proposed to be carried forward in the AEIS for consideration as part of the Final EIS as follows:

- In partnership with the Queensland Department of Agriculture, Fisheries, Forestry (DAFF), instigating and supporting a proposal to provide additional legislative protection to an area of 1,240 ha of intertidal and subtidal benthic habitat in Cleveland Bay through a proposed amendment to the Cleveland Bay Fish Habitat Area under the *Fisheries Act 1994* (including over 620 ha of habitat outside of the marine park in the Port Exclusion Area).
- Contribution of a one off administrative grant to the Queensland Government to accommodate the expansion of the FHA as well as funding for the management and enforcement of the expanded FHA (with a total funding commitment of \$150,000).
- Committing funding to on-ground actions and research to improve water quality entering the GBR lagoon in the region (through the NQ Dry Tropics Sustainable Agriculture Program and other projects that are recognised under the Reef Water Quality Protection Plan 2013).
- Committing funding to the establishment and operation of a long term ecosystem health monitoring program for Cleveland Bay and core funding for associated surveys of seagrass, corals, and megafauna.

As outlined in the EIS, the offset funding commitments for the above actions remains at a total of \$6.15 million.

If the Project is approved, it is expected the Port will discuss with regulators, confirm the offsets package or modify accordingly to achieve best outcomes and develop a legally binding offset agreement with the relevant regulatory agencies to clarify the offset commitments set out above as well as develop a timetable and implementation plan for delivery.

This will include consideration of appropriate staging of offset commitments given the long term focus of the proposed Project over a 20+ year horizon. This may include the 'banking' of offset investment made in the short term to ensure such actions and activities are included for consideration as part of future stages of the work.

Where required, the offset agreement will also include any additional requirements or commitments imposed as part of any conditions of approval for the Project.

29.7 Environmental Management Plans and Strategies

Numerous technical investigations have been undertaken based on the revised design and the revised impact assessments documented in Sections 3.0 to 27.0 of the AEIS. Mitigation and management measures identified in the EIS have also been reviewed and revised where appropriate to address identified risks accordingly.

An environmental risk management approach underpins the Project to apply an environmental safety net. This approach ensures that environmental risks are able to be effectively managed throughout the construction and operation of the PEP.

The first tier of risk management (Tier 1) focuses on the impact assessment investigations. This includes collecting relevant baseline data, and configuring and applying a set of numerical or computer models in order to estimate the potential impacts and environmental risks. The risks identified as requiring management became the focus of a set of mitigation (or environmental safety) actions which are documented in the EIS.

A design refinement process was subsequently undertaken in response to submissions and changes to Commonwealth and State policy and legislation, and to further reduce the potential environmental risks related to impacts to the Great Barrier Reef Marine Park and World Heritage Area. This resulted in revising the proposed dredge methodology and increasing the proposed reclamation area to capture all dredge material, thereby avoiding placement of capital dredge material at sea.

Further impact assessment studies were undertaken to consider the design refinement, and reconsider Tier 1 mitigation measures. The residual project risks were then assessed by evaluating the potential impacts following the application of these Tier 1 mitigation actions. The scale of residual risks determines the requirement for Commonwealth or State environmental offsets. No significant residual impacts were predicted for Matters of National Environmental Significance, or Matters of State Environmental Significance.

The condition of sensitive ecological receptors in the marine environment generally wax and wane over time primarily as a result of regional and global drivers such as extreme wet seasons, cyclones, and disease outbreaks, or bleaching events. Recognising the long lead-times for implementing large infrastructure projects, knowledge of ecological processes is anticipated to continue to develop over time. Further detailed information will also become available as a result of geotechnical investigation and as the detailed design progresses.

In order to manage the risk posed by changing environmental conditions and stakeholder expectations, a second Tier or environmental risk management measures has been proposed. This involves a re-assessment of the environmental risks immediately prior to major dredging operations, a reactive monitoring program to monitor impacts during the dredging operation, and an oversight governance arrangement, including an Oversight Committee, Technical Advisory Committee, and a Dredging Implementation Committee. These management measures are described in the Dredge Management Plan.

The Construction Environmental Management Plan and Operational Environmental Management Plan similarly manage key environmental risks associated with the non-marine related impacts.

This tiered approach to environmental safety represents current best-practice environmental management and provides a high level of certainty that the environmental risks can continue to be identified and appropriately managed.

The revised PEP management plans include:

- Dredge Management Plan.
- Construction Environmental Management Plan
- Operational Environmental Management Plan

The Environmental Management Plan (Overview), Vessel Traffic Management Plan Construction and the Maritime Operations Management Plan have not been revised and are provided in Part C of the EIS. Vessel masters will be required to meet specific Vessel Traffic Management Plans for each stage of the Project.

The revised plans are contained in Appendix B of the AEIS. In assessing the final EIS, these documents replace the previous plans that were presented in the EIS documentation.

29.8 Conclusion

The Port of Townsville is a long-established seaport that is significant to the history and development of Townsville and the wider North Queensland region. The Port was established in 1864 and is also recognised by the Queensland Government as one of the four Priority Port Development Areas along Queensland's coastline.

In order for the Port to continue to service its customers effectively, the Port must remain internationally competitive and able to accommodate expected medium to long term changes to vessel sizes and shipping requirements. To accommodate larger and wider vessels, there is a requirement to enlarge the existing channel.

The PEP EIS design (as part of the EIS released for comment in 2013) proposed to achieve future expansion through the deepening of the existing channel which would have resulted in the existing channel extending into the Great Barrier Reef Marine Park - General Use Zone, and included disposal of capital dredge material offshore, as well as partial reuse of dredge material in the reclamation.

A design refinement process initiated as part of the AEIS process has considered submissions received during the consultation period as well as significant changes that have occurred in government policy and legislation since the EIS was completed, prohibiting capital dredge material placement offshore.

The potential impacts from the Project have been assessed in this AEIS.

The key findings of the revised impact assessment in the AEIS are that the impacts associated with the Project are expected to be similar to or less than that identified in EIS. This has been achieved through:

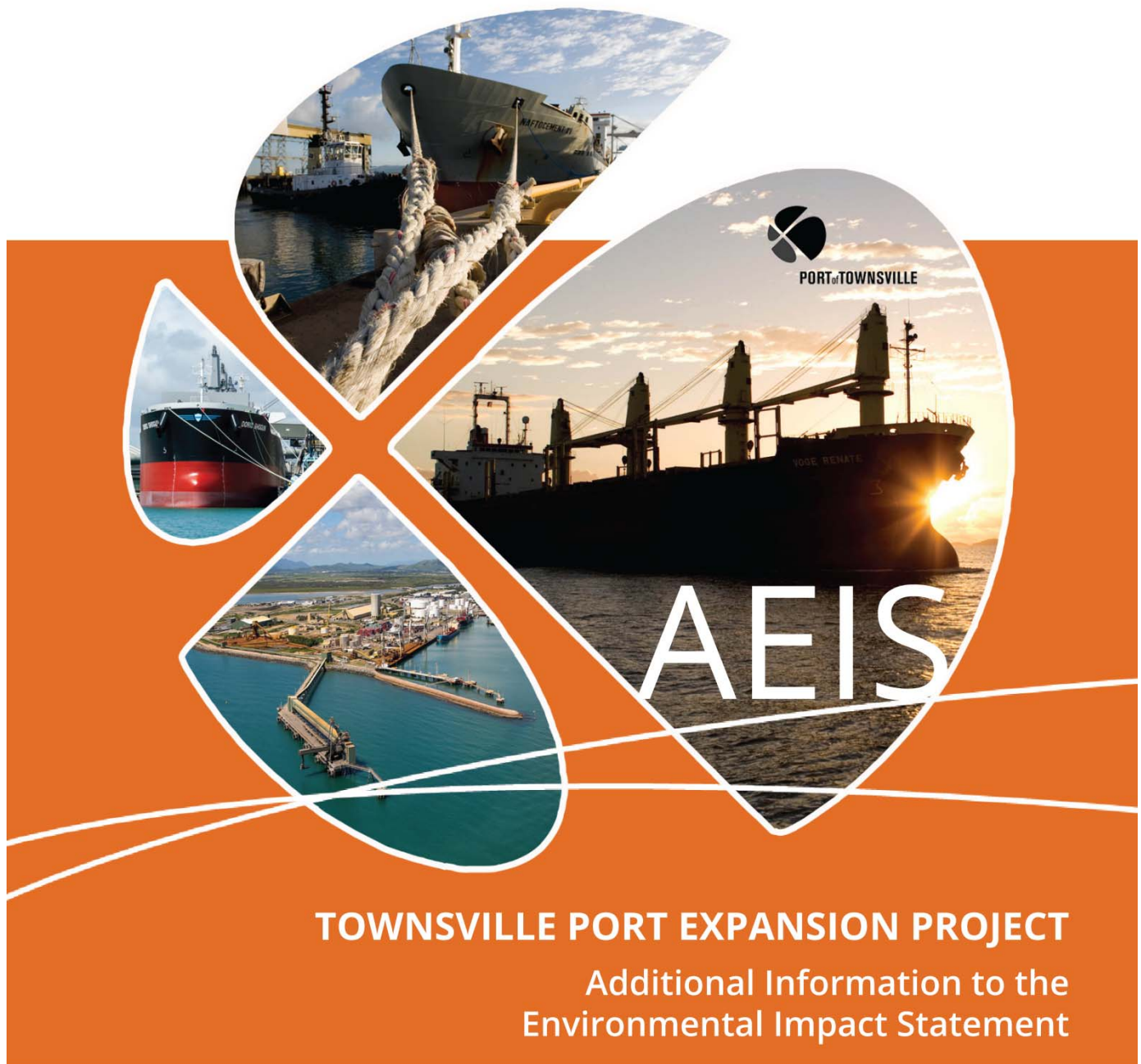
- Avoiding at-sea disposal of dredge material by relocating all capital dredge material within the reclamation for beneficial re-use.. This change to the design also avoids temporary impacts from capital dredge placement on approximately 1,140 ha of benthic environment within the offshore Dredge Material Placement Area but will result in an expanded outer harbour reclamation footprint
- Avoiding direct impact on the seabed within the Great Barrier Reef Marine Park - General Use Zone by widening the channel design and only partially deepening the channel.
- Modifying the dredging methodology to reduce the bulking factor for dredged material in order to reduce the size of the reclamation area required to manage material during dewatering and consolidation. This change to the dredge methodology will also help to minimise turbidity impacts during capital dredging and during the release of dredge tailwater from the reclamation.
- Developing additional mitigation measures to manage Matters of National Environmental Significance and Matters of State Environmental Significance as outlined in the revised environmental management plans including:
 - Implementation of a reactive monitoring program that will trigger corrective actions by the dredge if water quality trigger points are exceeded.
 - Timing of the capital dredging using TSHD within preferred ecological windows including, taking into account periods of low resilience.

The AEIS found that impacts associated with the design refinement to MNES or MSES are expected to be less than identified in the EIS and with the implementation of proposed mitigation measures that the PEP is not expected to have a significant residual impact on any MNES or MSES.

While significant residual impacts are not expected, POTL remain committed to implementing the environment offset initiatives outlined in AEIS if the Project is approved. The offset proposal will contribute to the PEP delivering positive conservation outcomes and a net environmental benefit, recognising the current condition and low resilience of the GBRWHA.

With the application of the proposed environmental risk based approach and effective implementation of the proposed mitigation measures, it is considered that the potential impacts associated with the construction and operation of the PEP can be appropriately managed.

Taken together, the EIS and the AEIS comprehensively describe the baseline conditions and potential impacts from the project as well as documenting the refinement to the design to achieve consistency with Government policy and legislation as it pertains to the Great Barrier Reef World Heritage Area. If approved, the Project will play an important role in facilitating economic development and greater regional prosperity in a manner that is consistent with the Sustainable Ports Development Act.



APPENDIX A1

Additional Field Studies for Townsville Port Expansion Project





Additional Field Studies for Townsville Port Expansion Project AEIS

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	Project Manager:	Brad Grant
	Author:	Brad Grant, Conor Jones
	Client:	AECOM
	Client Contact:	Rouven Lau
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Introduction

1 Introduction

1.1 Background

The Port of Townsville Port Expansion Project (PEP) involves dredging of the sea bed to provide for larger shipping vessel access, manoeuvring and berthing. It is proposed that dredge material will be placed in a near shore reclamation area to provide land requirements for operation of the port expansion.

The Environmental Impact Statement (EIS) for the PEP was submitted in late 2012. The EIS committed to undertaking further marine environmental data collection programs to develop an improved understanding of existing (baseline) conditions within Cleveland Bay. Submissions received on the EIS also highlighted the need for further data to address data gaps, particularly with respect to reef benthic communities.

Subsequent to the EIS, the project design was revised in an effort to reduce the potential for adverse impacts to sensitive ecological receptors, namely seagrass and corals. The design refinement included widening of the channel, and a larger reclamation to accept all dredge material on land. As a result of this design refinement, additional field studies were required to investigate areas previously not included in the design footprint.

1.2 Aims and Objectives

The aim of this study is to characterise baseline conditions in marine water quality, reef benthic communities and benthic habitats within and adjacent to areas potentially affected by the proposed PEP. This information is intended to inform the PEP Additional Environmental Impact Statement (AEIS) and planning of the PEP.

The specific objectives of this study are to:

- Describe water quality conditions at representative sensitive ecological receptors sites in Cleveland Bay over a 12 month period.
- Based on these data, develop revised water quality threshold values to assess impacts from the revised project design in the AEIS.
- Describe benthic communities on reefs along the southern and eastern coasts of Magnetic Island, to document short term temporal changes in communities, and increase spatial resolution of data along the south eastern coast of Magnetic Island.
- Describe and characterise benthic habitats in areas not previously surveyed in the EIS and which now form the PEP development footprint following the design refinement.

2 Water Quality

2.1 Water Quality Data Presented in the EIS

Cleveland Bay has been subject to numerous water quality monitoring studies, which are summarised in the PEP EIS. These water quality monitoring studies have different aims and objectives, and the underpinning data varies among studies in terms of parameters measured (and measurement techniques), data currency, spatial and temporal resolution of data, and data quality. The description of baseline water quality conditions presented in the EIS was based on the most applicable data available at the time of report production.

Numerical modelling was undertaken in the EIS to predict the characteristic of sediment plumes generated by dredging. The existing water quality data provided a basis for determining the degree to which dredge-related sediment plumes (predicted by modelling) varied from 'background' conditions.

The EIS acknowledged that additional water quality data were required to understand patterns in temporal variability of water quality conditions at sensitive ecological receptor sites. Consequently, a commitment to collect a further 12 months of continuous water quality data at sensitive receptor sites was included in the EIS. It is intended that these data will be used to devise locally specific water quality threshold values, based on statistical metrics describe 'natural variability' in water quality conditions at different time intervals.

The water quality threshold values were originally intended for use in a future reactive water quality monitoring program for the PEP. The water quality thresholds will also be used to assess the degree to which dredge-related sediment plumes from the revised project design (predicted by modelling) vary from 'background' conditions, as documented in the Additional Environmental Impact Statement (AEIS).

Details of the additional water quality data collected are included in the following sections.

2.2 Additional Data Collected

2.2.1 Monitoring Stations

Water quality monitoring was carried out at five stations containing benthic primary producer habitats (seagrass and/or corals) and in areas most likely to be affected by dredge plumes. Two stations were located in nearshore areas close to the mainland (the Strand and Virago Shoal), and three locations were located in offshore waters on the east coast of Magnetic Island (Geoffrey Bay, Florence Bay and Picnic Bay) (Table 2-1 and Figure 2-1).

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Table 2-1 Monitoring stations

Station	Location	Longitude	Latitude	Water Depth (m LAT)
The Strand	Nearshore	146.82343	-19.241371	-3 m
Virago Shoal	Nearshore	146.791949	-19.213799	-3 m
Geoffrey Bay	Magnetic Island	146.869291	-19.155137	-4 m
Florence Bay	Magnetic Island	146.883527	-19.123141	-5 m
Picnic Bay	Magnetic Island	146.848674	-19.181414	-7 m



Figure 2-1 Location of Water Quality Monitoring Instruments

2.2.2 Water Quality Instruments

Physical and chemical water quality parameter measurements were collected at each station using Yellow Spring Instruments (YSI) 6600 multi-parameter automated data loggers, also known as sondes. The sondes were equipped with self-cleaning optical sensors, anti-fouling wipers, optimal power management, and a built-in battery compartment which improve reliability and maintain high data accuracy during extended deployments. The sondes house multiple probes that simultaneously measured temperature, electrical conductivity, dissolved oxygen (percent saturation), depth, pH and turbidity. Other parameters are not measured directly but calculated by the sonde, namely: salinity, which is calculated using specific conductivity and temperature; and dissolved oxygen which is calculated using temperature, salinity and dissolved oxygen percent

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saturation. The sondes were mounted on secure frames placed on the sea bed, thereby measuring water quality at the location of benthic primary producer habitats (i.e. seagrass and coral).

A terrestrial PAR sensor was installed on the roof of the Yongala Lodge Motel during April 2012. An additional terrestrial PAR sensor was installed on the roof of the Magnetic Island Police Station in July 2012. Data from these sensors will be used to represent PAR levels at the water surface. This allows a correction to be made for decreased light levels due to cloud cover.

Following retrieval, the instruments and sensors were thoroughly inspected and any significant fouling or damage was noted in order to compare with reported values. Raw data were downloaded from the sonde to a lap-top computer. Raw data were saved in an Excel data file that was named after the station and time period.

2.2.3 Duration and Frequency of Monitoring

Data were collected at 10 minute intervals between March 2012 and July 2013 to collect 12 months of baseline water quality data.

The monitoring period for each instrument was as follows:

- Strand: March 2012 – May 2013.
- Virago Shoal: March 2012 – May 2013.
- Picnic Bay: July 2012 – July 2013.
- Geoffrey Bay: July 2012 – July 2013.
- Florence Bay: July 2012 – July 2013.

2.3 Data Quality

2.3.1 Field Quality Assurance (QA) Procedures

The following QA procedures were in place prior to instrument deployment:

- All instruments were calibrated as recommended by the manufacturer using standard solutions prepared from National Institute of Standards and Technology (NIST) traceable reagents.
- Accuracy and precision checks were undertaken in accordance with manufacturer instructions. Re-calibration of instruments was undertaken if accuracy and precision tests failed to meet data quality objectives shown in Table 2-2.
- New Energizer 'ProCell' batteries were used throughout the campaign.
- A checklist was followed for programming instruments. The checklist prescribed:
 - Download data file from instrument to PC.
 - Verify data file is complete and without error. Reattempt download if data file is incomplete.
 - Download calibration file to PC.
 - Delete all files from instrument.

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- Synchronise instrument time to 'real' time (obtainable from PC connected to internet).
- Check sensor wiping is on and set to correct interval.
- Check correct sensors are enabled.
- Check correct reporting fields are selected.
- Set start time and date. Ensure logging date is correct and period is set to '365' days.
- Ensure battery voltage is >12.0 volts.
- Ensure battery life and free memory exceed the expected duration of sampling.
- Commence logging.
- Verify instrument is logging in 'Status' screen.
- Verify instrument is logging just prior to deployment by observing wiper on optical sensor.

Table 2-2 Data quality objectives

Parameter	Resolution (and Range)	YSI Accuracy (±)	Data Quality Accuracy (±)	Precision Criteria (Relative Percent Difference)
Temperature (°C)	0.01 (-5 to 45)	0.15	0.3°C in the range of 0 to 45°C	≥95% (≤5% RPD) as determined from duplicate recordings at the same time and space
Depth (m)	0.001 (0 to 61)	0.12	0.12	
Conductivity (mS/cm)	0.001 (0 to 100)	0.5% of standard (+0.001)	2% of standard	
Dissolved oxygen (mg/l)	0.01 (0 to 50)	0.2 or 2% of standard	5% of standard	
Turbidity (NTU)	0.1 (0 to 1000)	2.0 or 5% of standard	2.0 or 5% of standard	

2.3.2 Instrumentation Calibration and Frequency

Sondes were calibrated and deployed for four-six week periods. At the end of the deployment period, the sondes were retrieved and replaced with recently calibrated sondes.

2.3.3 Data Quality Control (QC) Procedures

Data were plotted as a time series and visually scanned for outliers and evidence of failed probes. Obvious issues were noted in the spreadsheet. Potential outliers were highlighted and questionable data were re-examined following the calibration. With the exception of debris blocking turbidity optics, most outliers are caused by probe failure and were therefore flagged during post-deployment calibration.

Erroneous turbidity and PAR measurements can occur as a result of fouling of the optical sensors. Some turbidity and PAR data outliers are readily identifiable and others are measurements that could occur naturally without clear indication that these marginal values should be censored.

Debris covering the turbidity sensor produces a high turbidity reading (>200 NTU). If a single reading or block of readings in that high range occurred with typical 'base' turbidity (i.e. mean

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values) on either side of the measurement or block of measurements, this outlier was quarantined from the final data worksheet.

Random spikes (over 100 NTU) are more difficult to identify. Suspected outliers were investigated with the following process:

- Fouling/interference of the optical equipment was suspected where turbidity spikes (>50 NTU) exceeded either (i) >50% of the values either side of the spikes; or (ii) were greater than three standard deviations from the seasonal mean.
- Data were then examined with consideration to the meteorological conditions at the time (with data from the Bureau of Meteorology) to determine whether rainfall or wind conditions may have affected the measurements in question. If high rainfall or strong winds did not accompany dips in EC or spikes in turbidity, the data were considered potentially erroneous and subjected to further scrutiny.
- The suspect data were compared with trends in data from other instruments known to experience similar conditions. If other instruments did not show similar patterns, the data were considered potentially erroneous.
- Finally, recalibration of the equipment for subsequent deployments identified whether an individual sensor, or entire sonde, could be responsible for erroneous readings (for example, a turbidity wiper inoperable, or a pH probe out of specification).

Data were also quarantined during periods of capital and maintenance dredging in Cleveland Bay.

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2.4 Baseline Assessment

As the key parameter of concern for dredging, turbidity was the focus of the analysis of the 12 month monitoring data set. Summary statistics were calculated for the wet season (November to April - Table 2-3) and the dry season (March to October - Table 2-4).

Findings from the data analysis indicate the following:

- Nearshore sites had higher turbidity compared to offshore sites along Magnetic Island.
- There was little difference in median (50th percentile) turbidity values between the wet season and dry season, however there was greater variability in the data during the wet season as indicated by the higher mean values and standard deviation values. Based on rainfall records from Townsville Aero, the wet season of 2012/2013 was slightly drier (especially Nov/Dec) than the long term average wet season rainfall.
- Peaks in turbidity (represented by 80th and 95th percentile values) were higher during the wet season than the dry season, most likely due to wet weather riverine inflows into the Bay.

Table 2-3 Summary of Wet Season (Nov-Apr) Turbidity Data (excluding dredging periods)

Monitoring Site	Summary of Turbidity Data (NTU)					
	Mean	Standard Deviation	20 th Percentile	50 th Percentile	80 th Percentile	95 th Percentile
Near-shore Sites						
The Strand	80	172	11	18	43	424
Virago Shoal	31	58	6.6	17	38	105
Magnetic Island Sites						
Florence Bay	4.3	7.2	0.5	2.3	5.4	17
Geoffrey Bay	3.3	4.2	1.0	2.0	4.8	10
Picnic Bay	3.9	6.6	0.9	2.1	5.0	15

Table 2-4 Summary of Dry Season (Mar-Oct) Turbidity Data (excluding dredging periods)

Monitoring Site	Summary of Turbidity Data (NTU)					
	Mean	Standard Deviation	20 th Percentile	50 th Percentile	80 th Percentile	95 th Percentile
Near-shore Sites						
The Strand	33	76	6.3	15	38	104
Virago Shoal	21	32	4.3	11	29	74
Magnetic Island Sites						
Florence Bay	2.4	1.5	1.4	2.0	3.3	5.6
Geoffrey Bay	2.8	1.7	1.7	2.8	3.3	5.1
Picnic Bay	2.8	1.7	1.7	2.3	3.5	5.9

Water Quality

Other parameters, including electrical conductivity (EC), salinity, pH and dissolved oxygen (DO), were also recorded during the 12 month monitoring program. Percentile values were calculated and are presented in Table 2-5.

Table 2-5 Summary Statistics of other Water Quality Parameters (March 2012- July 2013)

Monitoring Site	Summary Statistic	EC (mS/cm)	Salinity (ppt)	pH	DO (% sat)
Strand	20th percentile	46.99	30.47	7.91	94.5
	Median	52.08	34.20	8.10	98.2
	80th percentile	54.86	36.39	8.17	102.9
	95th percentile	57.09	37.88	8.20	107.5
Virago Shoal	20th percentile	46.58	30.20	7.98	94.5
	Median	53.42	35.14	8.09	97.9
	80th percentile	55.67	36.86	8.23	102.8
	95th percentile	57.43	38.21	8.26	108.4
Florence Bay	20th percentile	53.24	35.08	7.96	93.7
	Median	54.71	36.27	8.05	97.4
	80th percentile	55.80	36.99	8.18	103.8
	95th percentile	56.71	37.62	8.21	110.6
Geoffrey Bay	20th percentile	52.75	34.71	7.54	91.6
	Median	54.15	35.86	8.01	96.1
	80th percentile	56.14	37.24	8.14	101.7
	95th percentile	56.98	37.81	8.20	110.9
Picnic Bay	20th percentile	52.60	34.56	7.94	85.3
	Median	54.23	35.91	8.06	94.2
	80th percentile	56.20	37.27	8.16	103.0
	95th percentile	57.35	38.09	8.20	113.4

2.4.1 Time Series Data

2.4.1.1 Turbidity

Time series of the 'cleaned' turbidity data (refer to Section 2.3) are presented in Figure 2-2 to Figure 2-4 for the three monitoring locations along the east coast of Magnetic Island. Figure 2-5 and Figure 2-6 present the time series turbidity data for the two nearshore sites (refer to Figure 2-1 for locations). These figures show the entire monitoring period, along with periods when capital and maintenance dredging occurred. Data collected during these periods of dredging were quarantined from the data set and are therefore not shown in the time series.

Water Quality

To compensate for data periods required to be quarantined from the 12 month dataset, the revised water quality impact assessment in the AEIS makes use of previous monitoring data from 2008/2009 to enhance the 2012/2013 dataset.

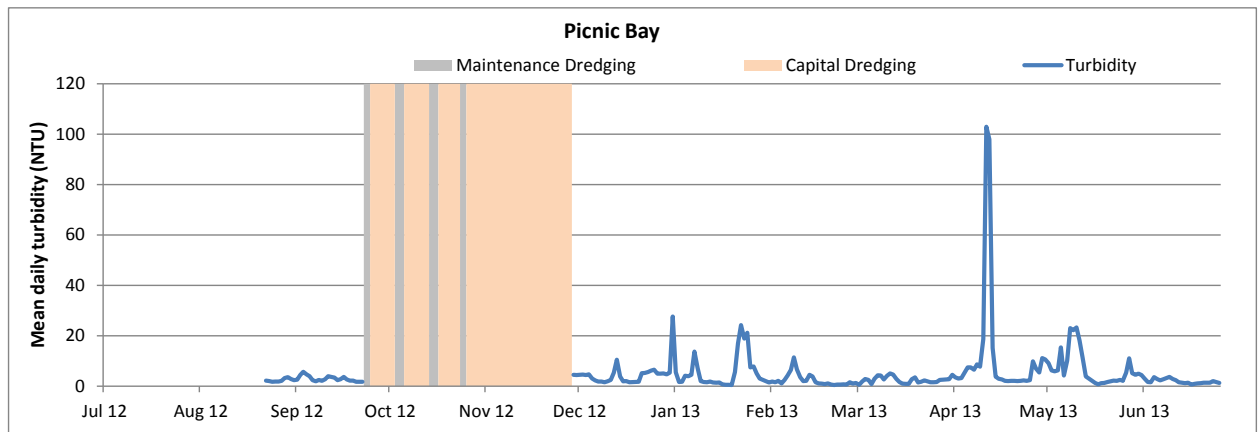


Figure 2-2 Picnic Bay Turbidity

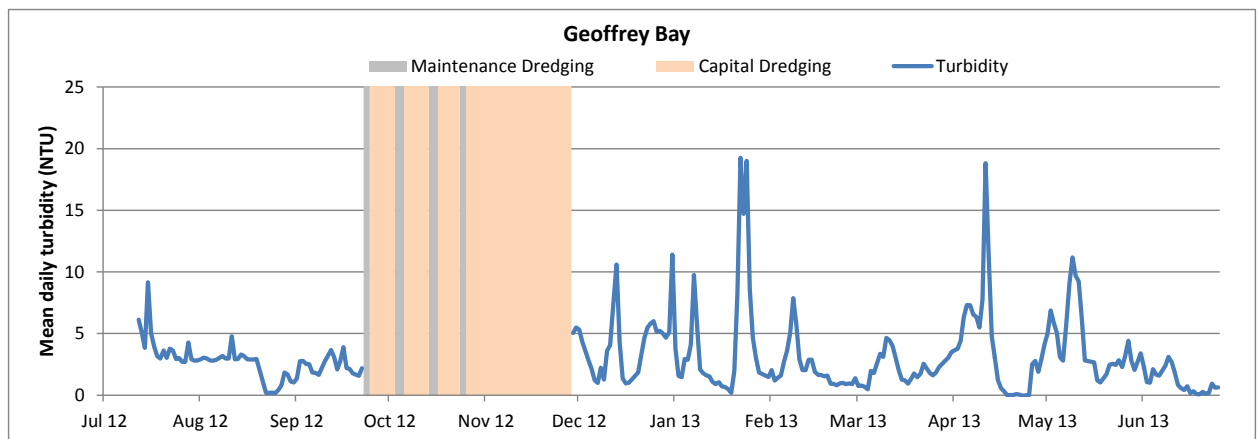


Figure 2-3 Geoffrey Bay Turbidity

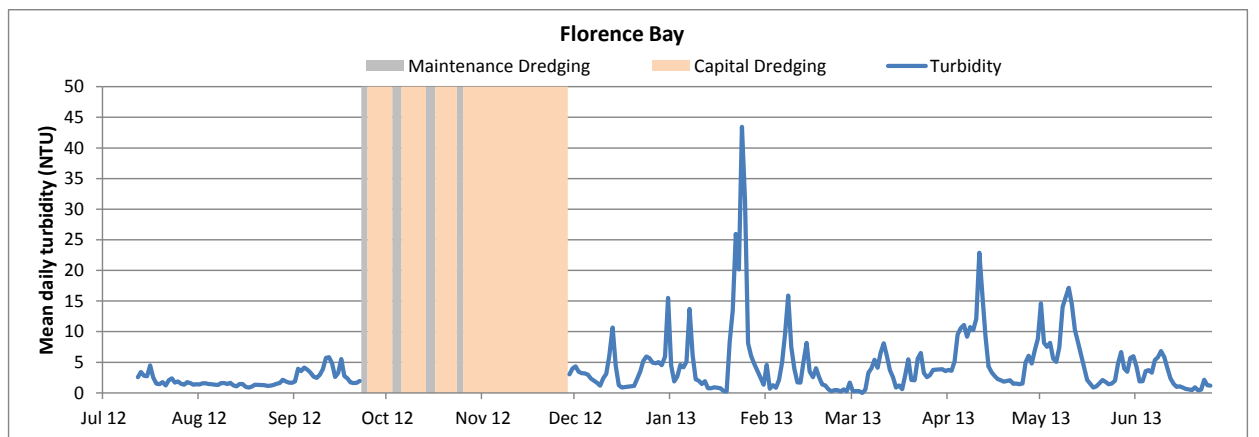


Figure 2-4 Florence Bay Turbidity

Water Quality

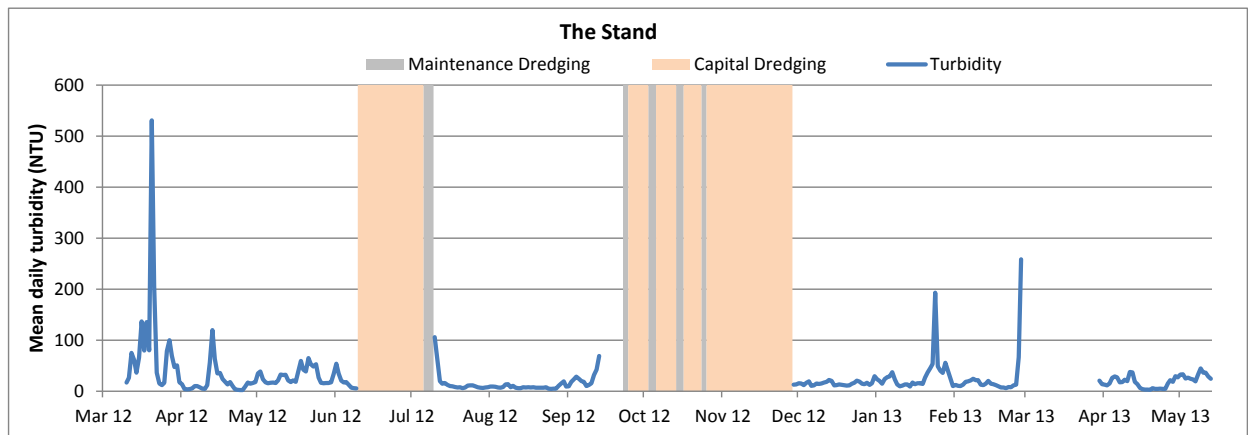


Figure 2-5 Strand Turbidity

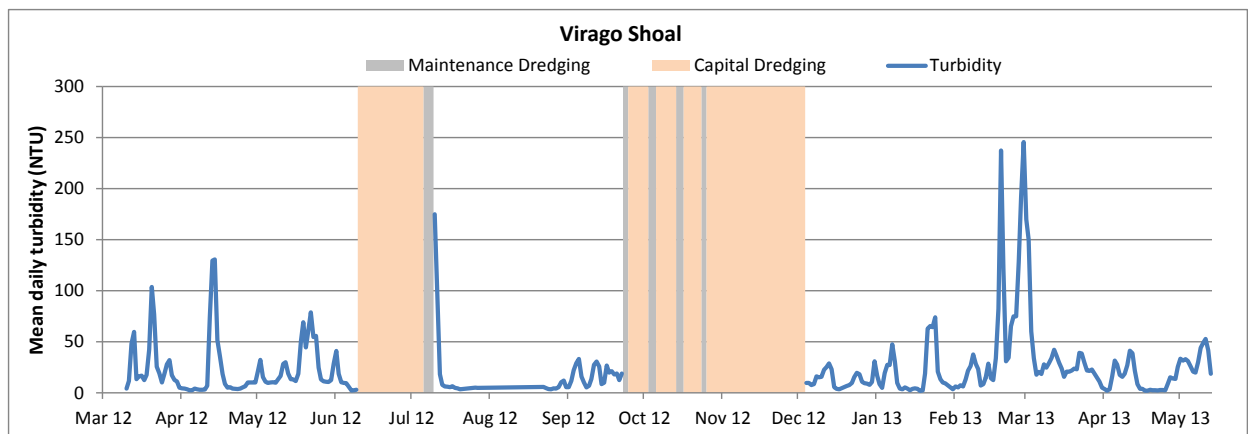


Figure 2-6 Virago Shoal Turbidity

2.4.1.2 Benthic PAR

The benthic PAR time series data (which provides a measure of light levels reaching the seabed) was analysed and total daily benthic PAR at each site calculated. The data are presented as a two week rolling average in the figures below. A two week running average was chosen as recent studies in Gladstone for the key intertidal seagrass *Zostera muelleri* (capricorni) found that a two week average of daily light was a critical time window to support seagrass growth (Chartrand et al. 2012).

Figure 2-7 to Figure 2-9 present the time series total daily benthic PAR data for the three monitoring locations along the east coast of Magnetic Island, while Figure 2-10 and Figure 2-11 present the time series total daily benthic PAR data for the two nearshore sites (near the mainland).

These figures show the monitoring period for each site where good quality data was recorded. Data collected during capital and maintenance dredging were quarantined from the data set and are

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therefore not shown in the time series. Note that for all monitoring sites, there are substantial data gaps in PAR due to equipment failure and bio-fouling.

The time series of total daily benthic PAR indicate the following:

- Total daily benthic PAR (2 week rolling average) for sites along Magnetic Island ranged from 10 to 20 mol/m²/day at Picnic Bay, 5 to 8 mol/m²/day at Geoffrey Bay, and 5 to 20 mol/m²/day at Florence Bay. It should be noted that benthic PAR is influenced by the depth of water at each instrument.
- Total daily benthic PAR (2 week rolling average) for nearshore sites ranged from 2 to 12 mol/m²/day at the Strand and 2 to 14 mol/m²/day at Virago Shoal.

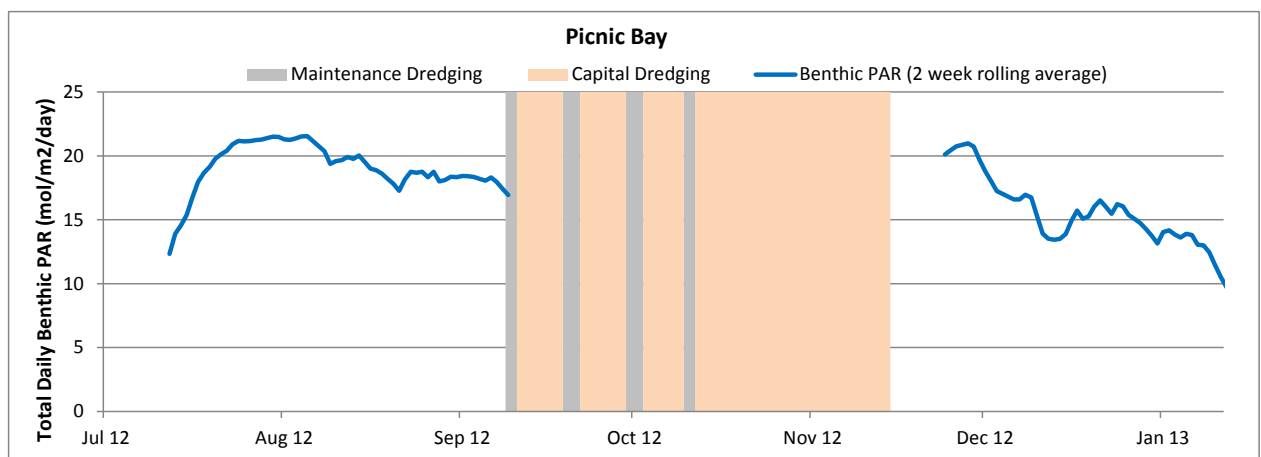


Figure 2-7 Picnic Bay Total Daily Benthic PAR (mol/m²/day) (2 week rolling average)

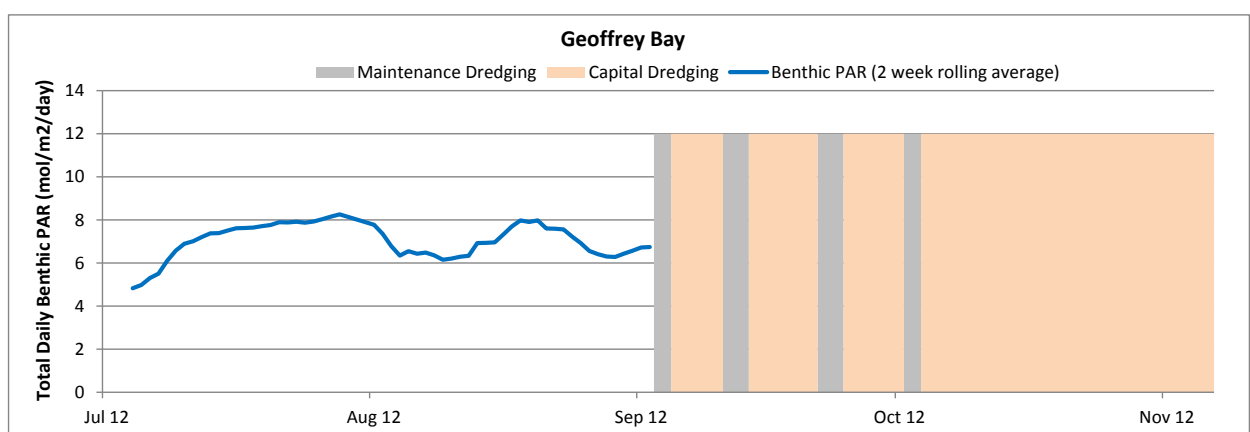


Figure 2-8 Geoffrey Bay Total Daily Benthic PAR (mol/m²/day) (2 week rolling average)

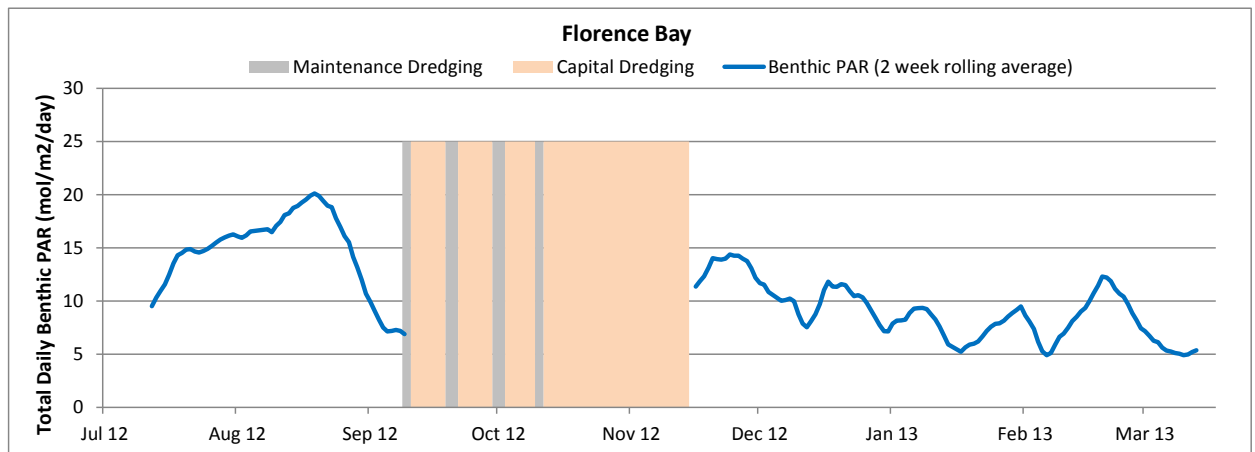


Figure 2-9 Florence Bay Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

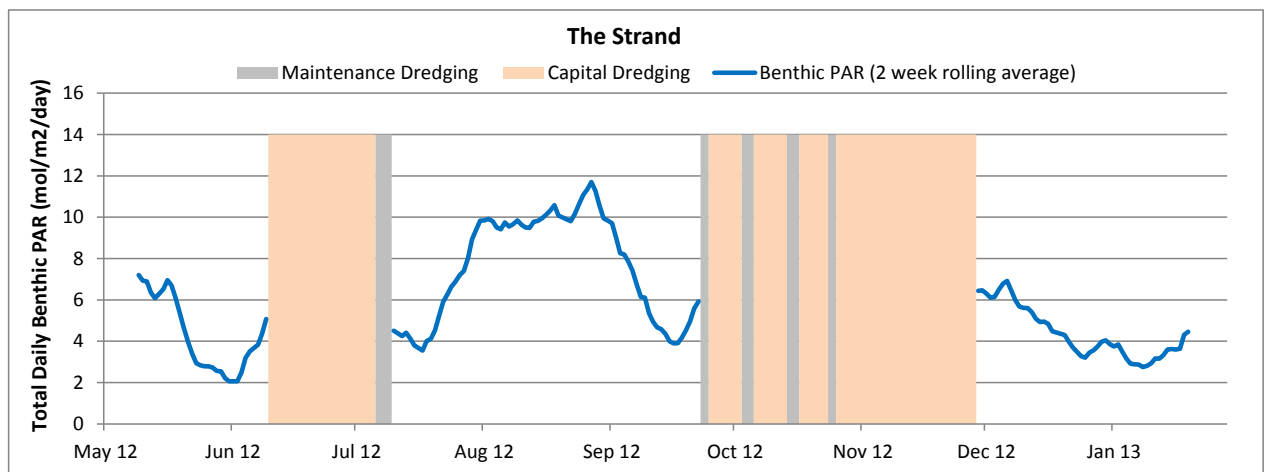


Figure 2-10 Strand Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

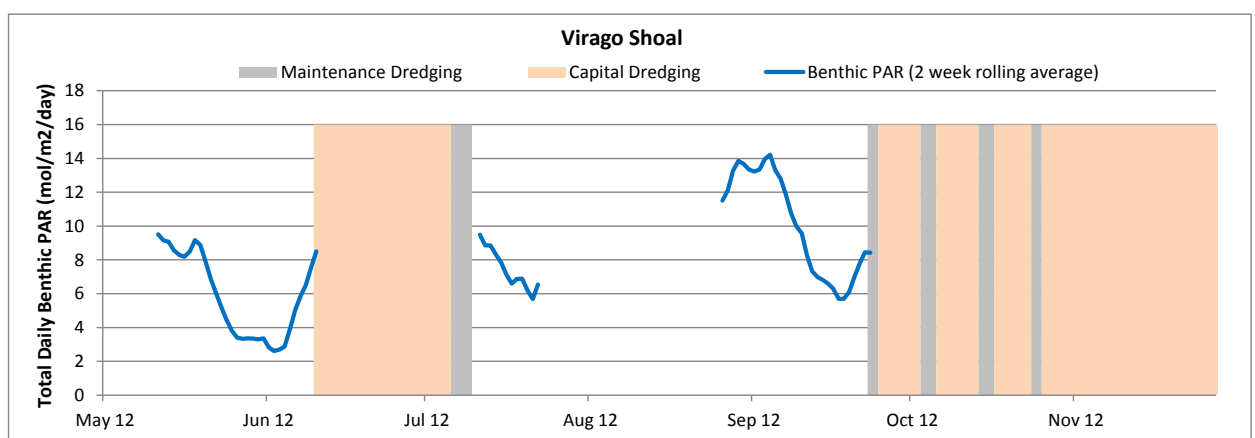


Figure 2-11 Virago Shoal Total Daily Benthic PAR (mol/m2/day) (2 week rolling average)

Water Quality

2.4.2 Relationship between PAR and NTU

Daily light requirements for several species of seagrass have been developed in Townsville (Collier *et al.* 2012a; 2012b) and Gladstone (Chartrand *et al.* 2012). In order to compare changes in turbidity (NTU) and PAR, and subsequent light-based impacts of turbidity, the relationships between mean daily PAR and NTU was estimated using data from the Virago Shoal and the Strand (Figure 2-12). The Virago Shoal relationship was used to examine putative impacts because the instrument was situated within an existing *Halophila* meadow, it is relatively distant from the influence of the Ross Creek and Ross River (for better comparison with modelled data), and was situated in water depths consistent with the presence of *Halophila* sp. (2.2- 6.17 m below the water surface, mean = 4.01 m). Mean daily PAR was calculated for ease of comparison with established daily light requirement values for seagrass. Fitted relationships were similar at the two locations.

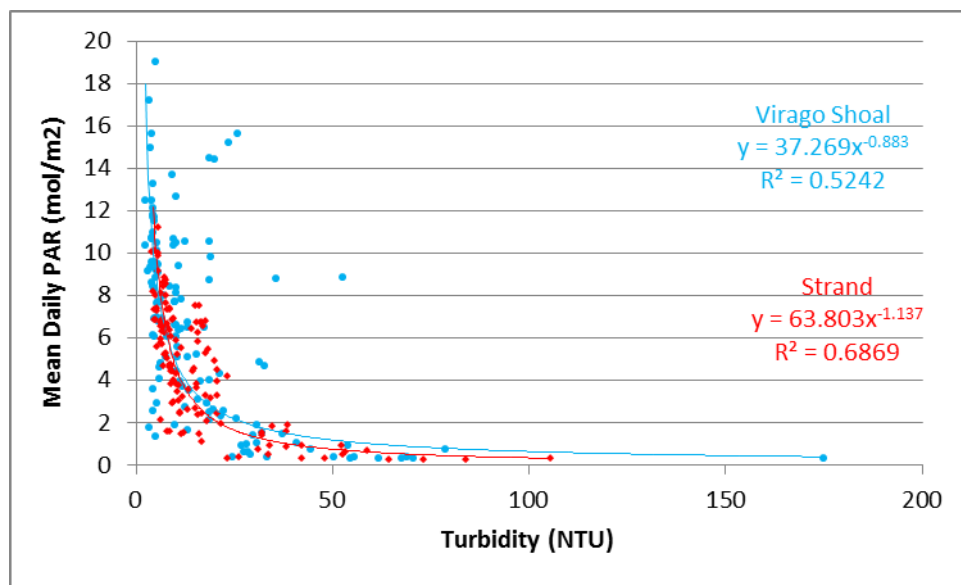


Figure 2-12 Relationship between Mean Daily PAR and Turbidity at Virago Shoal

3 Reef Habitat Surveys

3.1 Additional Data

Reef surveys were undertaken in response to a number of submissions on the EIS, regarding:

- Limited sampling effort at Cockle Bay (southern coast of Magnetic Island).
- No discussion on the stromatolites purported to exist in Geoffrey Bay.

The adopted sampling methods are described below.

3.1.1 Cockle Bay Reef Habitat and Community Surveys

Reef habitat and community surveys were undertaken at Cockle Bay Reef from 24 to 28 September 2014, inclusive. The methodology was consistent with that employed in 2012 and consisted of: (i) qualitative habitat mapping and, (ii) quantitative reef community surveys in reef slope and reef crest habitats. The locations of transects sampled in the present study and in the 2012 (EIS) survey are shown in Figure 3-1.

Habitat Survey

A preliminary habitat map was developed by digitising the boundaries of distinct mapping units (based on texture, colour, tone) from geo-rectified digital satellite imagery (Google Earth Pro imagery, 3 October 2009). Each map unit/polygon was assigned a preliminary map unit code prior to field survey and re-evaluated and attributed following field survey, analysis and classification of field data.

The field survey was undertaken by divers (on snorkel) swimming the length of transects extending from the near the low tide mark to the reef edge. The divers recorded major changes in benthic habitats with a hand-held GPS. Reef habitat categories adopted for this survey are shown in Table 3-1, and were mapped using the MapInfo GIS package.

Table 3-1 Reef habitat categories

Category	Description
Unconsolidated sediment (sand)	Bare sand substrate - sparse to no cover of seagrass or algae in places
Unconsolidated sediment (mud)	Bare mud substrate - sparse to no cover of seagrass or algae in places
Reef flat with macroalgae	Reef flat with >5% cover of macroalgae +/- soft coral
Seagrass meadow	Seagrass with >2% cover - may occur on other habitats
Lagoon (scattered micro-atolls)	Lagoonal habitat within the reef flat
Reef crest	Low gradient, distal edge of reef flat
Reef slope/edge	High gradient, distal edge of reef flat
Occasional bombores & scattered rubble	Soft sediment habitat at distal margin of reefs with occasional bombores and scattered rubble

Reef Habitat Surveys

Quantitative reef community surveys were carried out in reef slope and reef crest habitats. At each site, three 30 m transects were positioned along a depth contour at approximately 1-3 m below mean sea level (MSL). Each transect start position was marked using a hand-held GPS tethered to the diver's surface float. Transect imagery was collected using paired high-definition submersible cameras with dual 1800 lumen video lights to maximise image quality. Imagery was collected from 20-30 cm above the seafloor, providing a 0.5-1 m wide swath of imagery. One camera collected still imagery every two seconds while the other filmed continuously. This approach allowed for objective selection of still imagery because stills were collected randomly, and a video recording to aid in identification if necessary. Each photo covered approximately 1 m² so that each transect provided a 30m² belt transect.

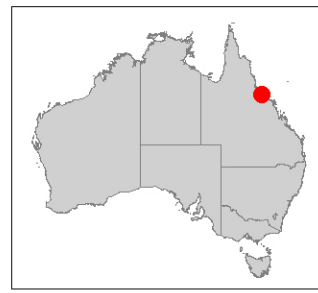
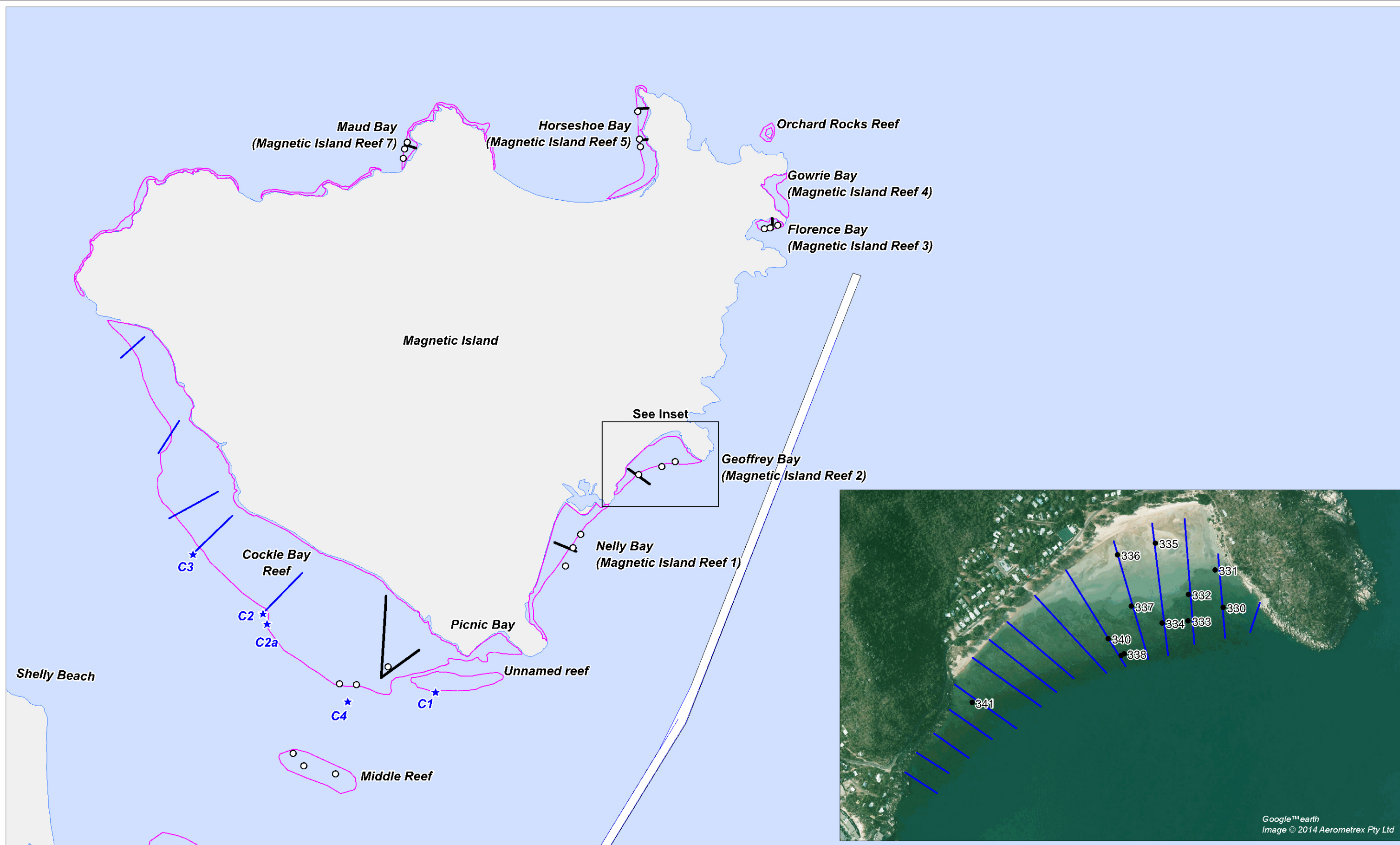
Coral Point Count (Kohler and Gill 2006) was used to quantify benthic cover. Using CPCe 4.1, a 300 pixel setback was used to ensure point identifications were made in the brightest, clearest part of the photo, and also to reduce the chances of non-independence between partially overlapping photos. Twenty points were identified from each photo, giving 600 point IDs per transect.

At the most westerly quantitative site on Cockle Bay Reef (site C3) the reef edge was highly simplified and lacking major changes in bed elevation that could be described as a crest or slope, so one transect collected here and was considered the reef edge. Similarly, only the reef edge was sampled at site C2A.

3.1.2 Geoffrey Bay Stromatolite Survey

At Geoffrey Bay, 15 transects (separated by a distance of 70 m) were surveyed by divers on snorkel, covering a total distance of 5 km. The position of transects is shown in Figure 3-1 (see inset). Any features (outcrops of rock or coral) bearing any similarity to stromatolites or microbial mats were photographed, and GPS points were taken using a submersible GPS tethered to a surface float.

Dr Jane Mellors from James Cook University (JCU) was also consulted regarding the status of stromatolites at Geoffrey Bay. Dr Mellors provided information and several photos of structures that are currently the subject of research by JCU researchers.



LEGEND			
	Transects 2012		Quantitative 30m Transects 2012
	Transects 2014		Quantitative 30m Transects 2014
	Coral Reefs (GBRMPA Gazetteer)		Quantitative 30m Transects 2014
	Channel Area		

Title: **Locations of snorkel and photo transects surrounding Magnetic Island and Middle Reef**

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Approx. Scale

Figure **3-1**

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Reef Habitat Surveys

3.2 Cockle Bay

3.2.1 Reef Habitats

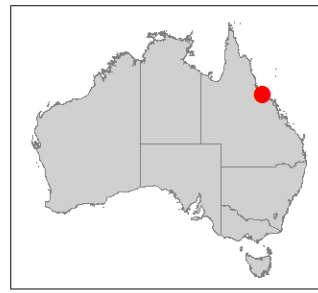
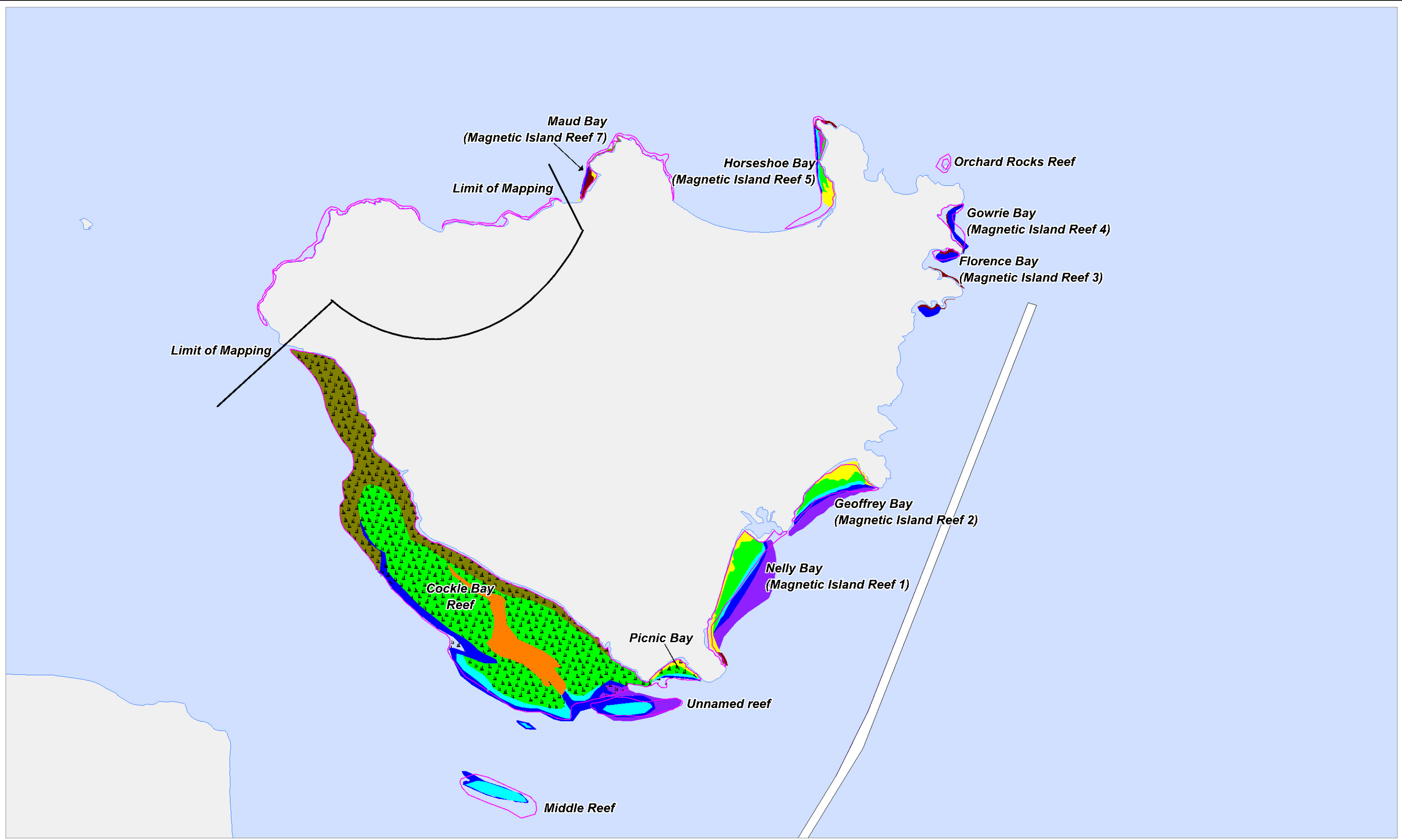
Figure 3-2 shows the distribution of different reef habitat types on Cockle Bay Reef.

The shoreline fringing the mangroves at Cockle Bay and most of the northern reef flat was composed of unconsolidated sandy mud. Sediments fringing the mangroves had a sparse cover of *Halophila ovalis* while other seagrass species (*Zostera*, *Halodule* and *Cymodocea*) were more common on unconsolidated sediments in slightly deeper waters.

Reef flat with macroalgae was the largest habitat type represented on Cockle Bay Reef. This habitat type was comprised of low to high cover of macroalgae on sand, mud and/or rubble fragments, with occasionally dense patches of seagrass (primarily *Cymodocea*, *Halodule* and *Halophila*). *Porites latistella* was also common over the reef flat, and soft corals (e.g. *Sarcophyton*) were present in places.

A shallow lagoon (shaded orange in Figure 3-2) was located in the centre of the reef flat, and contained microatolls and occasional coral outcrops. The substrate in this lagoon was composed of sandy mud and seagrass was present in places. The lagoon area appeared to include natural deeper areas as well as deeper sections that may have created or exacerbated by human disturbances such as historic dredging, or altered hydrodynamics associated with the pipeline alignment between Cape Pallarenda and Magnetic Island.

The reef crest at Cockle Bay Reef was structurally similar to that of the reef edge/slope, and often had highly simplified habitat structure. The reef edge had the densest cover of living hard coral, which progressively became less prominent with distance in a north-westerly direction, towards Cape Pallarenda and Rattlesnake Island. There was no distinct reef edge habitat north-west of site C3; instead a low gradient reef flat (with occasional seagrass patches) gradually merged with the seabed. This characteristic is not reflected in the GBRMPA Gazetteer layer for Cockle Bay, but it is identified on the Australian Navigation Chart 256.

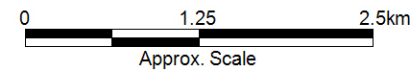


LEGEND

- | | |
|--|--|
|  New Channel Extent |  Unconsolidated Reef Flat (Sand) |
|  Coral Reefs (GBRMPA Gazetteer) |  Reef Flat with Macroalgae |
|  Reef Flat with Soft Coral and Algae |  Scattered Micro-atolls |
|  Unconsolidated Mud |  "Reef Crest" |
|  Granite Boulders With Occasional Coral and Algae |  Reef Slope/Edge |
|  Seagrass Meadow |  Occasional Bomboras and Scattered Rubble |

Title:
Reef community types around eastern Magnetic Island and Middle Reef

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Figure 3-2	Rev: A
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3.2.2 Reef Communities

Reef communities on the reef crest and slope showed great variability in community structure (Figure 3-3). In terms of coral cover:

- Site C1 had the highest living coral cover of any of the sites investigated through the entire EIS process, and was dominated by acroporids (namely *Montipora*) and dendrophylliids (*Turbinaria* spp.). As discussed in Section 3.2.1, living coral cover declined with increasing distance to the north-west away from site C1.
- Site C2A was located in a recessed section of the reef edge that formed a protected pocket of coral with mud and seagrass patches (*Halophila spinulosa*) between coral colonies. Site C2A had the next highest living coral cover, and unlike other sites, was composed primarily of large bombores of *Pavona cactus* (Agariciidae).
- Site C2 had low living coral cover and was not dominated by any particular taxa.
- Site C3 was almost devoid of living hard coral cover apart from occasional small colonies of *Goniastrea* and *Favites* (Faviidae).
- Site C4 had approximately 10% coral cover, which was comparable with cover observed at Maud, Florence, and Nelly Bays. Coral cover at Site C4 was dominated by *Montipora* and *Acropora* with occasional *Porites* and *Lobophyllia* (Mussidae) colonies.

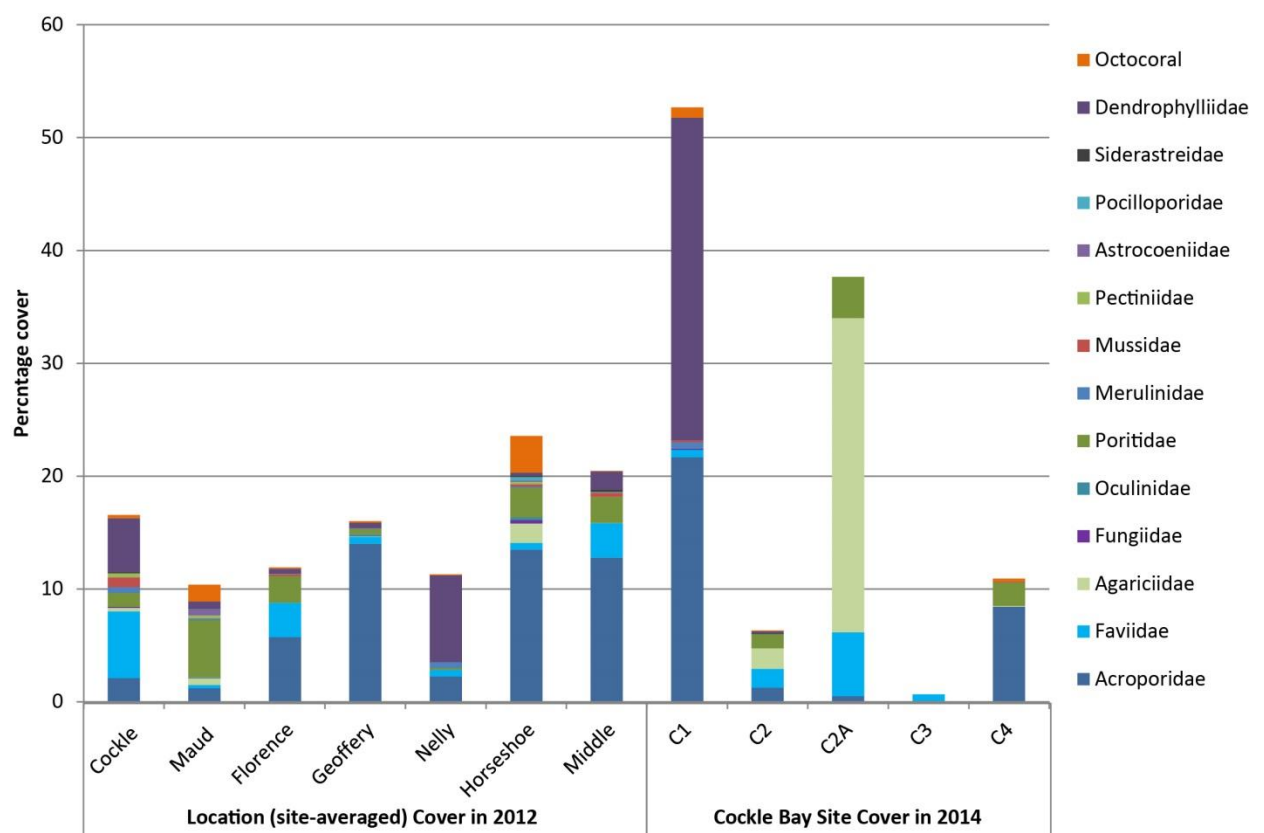


Figure 3-3 Percent cover of living coral at Cockle Bay Reef Sites (C1-C4) and sites visited previously

Reef Habitat Surveys

Macroalgal communities differed between the previously surveyed sites and the additional sites at Cockle Bay Reef (Figure 3-5). The additional Cockle Bay Reef sites had a higher percentage cover of *Acanthophora* and *Caulerpa* than the sites surveyed previously. *Asparagopsis* was also observed at site C3, which had not been observed previously. *Sargassum* was the dominant macroalgae at most sites, the exception being C3 which lacked suitable hard substrate for holdfast attachment. Otherwise, the additional Cockle Bay Reef sites had *Sargassum* cover that was similar to that observed elsewhere around Magnetic Island.

Differences in macroalgal species present between the two surveys may be related to spatial or temporal differences that have occurred between survey events. Geographical differences in communities may have been the result of a greater influence of catchment runoff at Cockle Bay Reef, alternatively some of the differences in macroalgal communities may simply be explained by broad-scale temporal changes that have occurred since 2012.

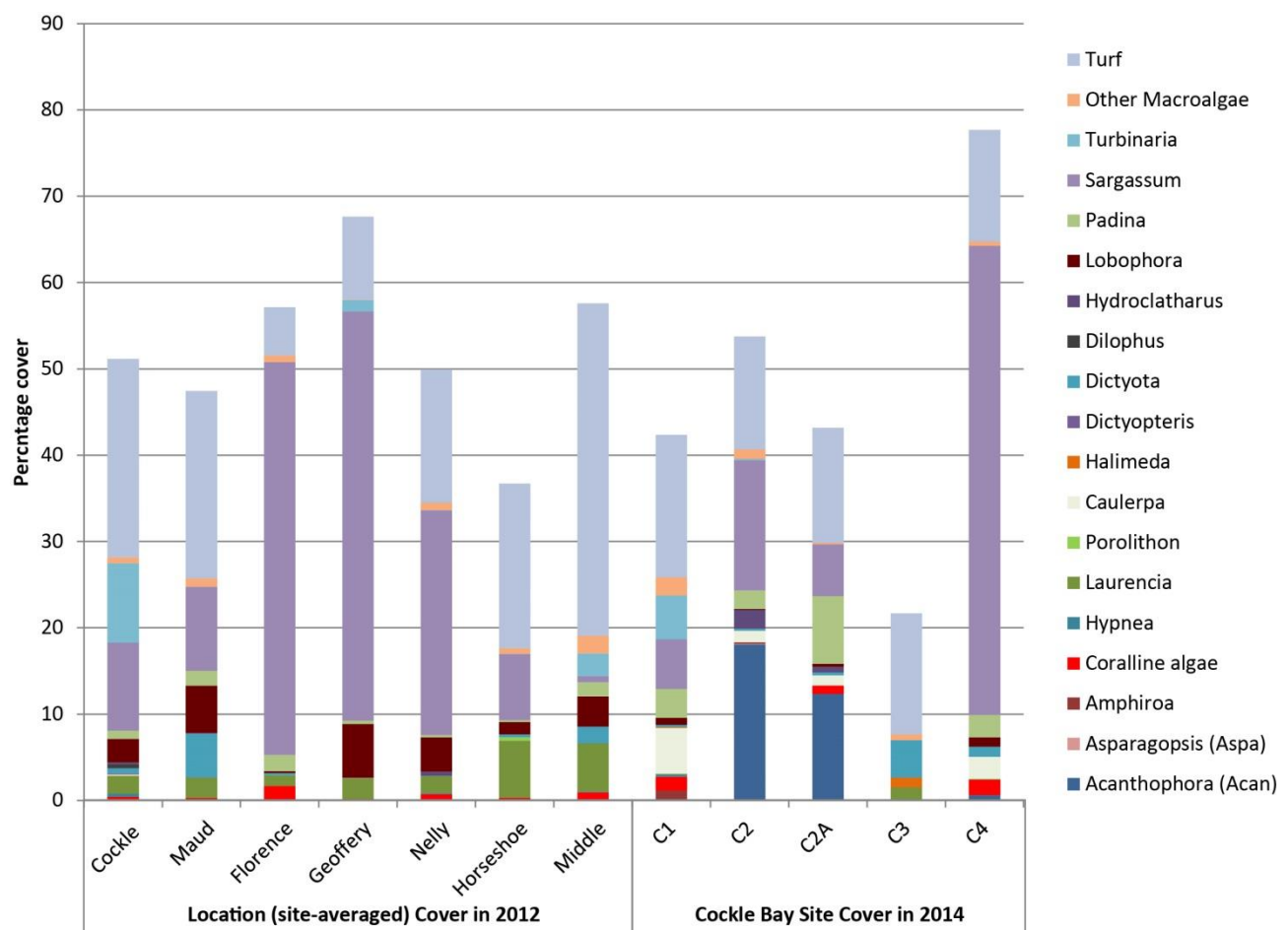


Figure 3-4 Percent cover of macroalgal forms at Cockle Bay Reef Sites (C1-C4) and sites visited previously

Other benthic classes (Figure 3-5) also differed between Cockle Bay Reef sites and other sites surveyed in 2012. Seagrass was abundant at sites C2, C2A and C3 (13-27%), but was uncommon at other reef sites. Sand was a dominant form of cover at Site C3, while macroalgal cover much

Reef Habitat Surveys

lower compared to other sites, reflecting the lack of a clear reef edge and available hard substrates in this area. Unlike the 2012 survey, no coral bleaching was observed at the additional Cockle Bay sites sampled in 2014. This was not unexpected given the difference in season (and water temperature) between the two events; the 2012 survey was conducted in summer while the 2014 survey occurred in spring.

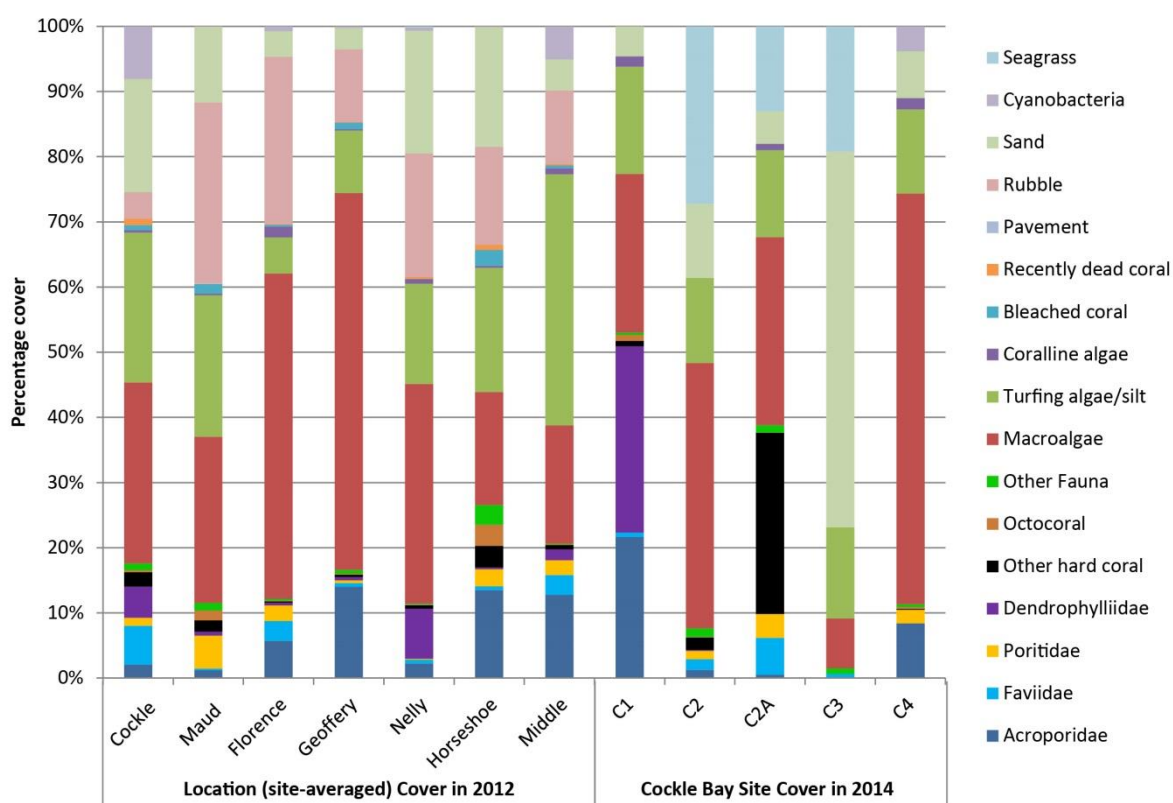


Figure 3-5 Percent cover of major cover types at Cockle Bay Reef Sites (C1-C4) and sites visited previously

3.3 Geoffrey Bay Stromatolite Assessment

3.3.1 Habitat and Ecology

Modern stromatolites are the ancestors of bacteria that began to appear on earth 350 million years ago, and formed the earliest known reefs. They are presently rare on earth and it is hypothesised that predation from early grazers, and competition from macroalgae caused a massive reduction in stromatolite abundance once multi-cellular life evolved (Awramik 1971).

Stromatolites are built by cyanobacteria as a refuge from ultra-violet radiation. Stromatolites grow when sediment particles adhere to the mucus coating the microbial mat. The cyanobacteria then migrate up towards the surface of the accreted sediments and the previous layer of sediment becomes calcified. This cycle repeats, leading to layers of calcified sedimentation, or lamina.

Present day stromatolites generally exist in extreme environments where competitors and grazers cannot live, such as pools that are hypersaline or too warm to support grazing molluscs or

Reef Habitat Surveys

competing macroalgae. Hamelin Pool in Shark Bay is one of the best known examples of such a habitat.

The shallow surface waters, particularly of tide pools, surrounding Magnetic Island can exceed 30°C during calm, sunny weather in summer, and excessive evaporation can lead to higher than usual salinity during low tides. However, these extreme conditions only occur at certain times of the year when low tides co-occur with hot, calm, sunny weather.

3.3.2 Survey Findings

Eight points of interest were recorded on transects at Geoffrey Bay intersected (Figure 3-6). Lithified (rocky) structures at points 331, 332, 337, 338, and 341 appeared to be dead coral fragments with microbial/ algal coverings, and those at points 335 and 336 resembled photos supplied by Dr Jane Mellors of potential stromatolites (Figure 3-7). While the structures at points 335 and 336 were covered in a thick microbial mat, they differed greatly in morphology to the dome-shaped structures of Shark Bay in Western Australia. Whether these mounds have been created by microbes (true stromatolites), or if they are microbial coverings on dead coral skeletons could not be ascertained during the field trip (by visual survey alone, without destructive sampling).

Information supplied by Jane Mellors suggests that these structures may be low-profile stromatolite mounds, as personally communicated by John Talent (Emeritus Professor of Geology, Macquarie University) in Farabegoli *et al.* (2007). While there is nothing in the primary literature to suggest that the structures are stromatolites, Macquarie University lecture notes by John Talent refer to them, as do interpretive signs located in Cairns (Figure 3-7J).

Research grants to David Vardeh (PhD candidate at the University of New South Wales) included a provision for analysis of microbial communities from stromatolites at Magnetic Island; however, none of this research has been published to date. Interestingly, research by Shiba *et al.* (1991) examined surface bacterial communities from a range of substrates including stromatolites, coral, sponges, algae, sand, and rocky surfaces across the east and west coasts of Australia. Sites included a range of locations in Shark Bay, including Hamelin Pool in Western Australia, as well as Arcadia, Horseshoe and Radical Bays at Magnetic Island. Shiba *et al.* (1991) did not examine any stromatolite structures from Magnetic Island, but found concentrations of 6.7-20% aerobic bacteriochlorophyll containing bacteria (ABB; a type of bacteria that can form stromatolites) in intertidal algal mats from Magnetic Island (exact location unspecified). ABB can live on non-stromatolite surfaces such as rock, algae and other marine plants, but Shiba *et al.* (1991) recorded their highest concentrations in Shark Bay in Western Australia.

Based on the above information, the presence of stromatolites at Geoffrey Bay is possible but inconclusive. The structures could be either low-profile microbial mounds created by cyanobacteria as suggested by John Talent, or they could be weathered coral microatolls covered in turfing algae and cyanobacteria. Sectioning of rock sample and identification of bacterial lamina would be required in this regard. The structures bear little physical resemblance to stromatolites from Shark Bay or the Caribbean, but have been likened to fossilised structures from the Tethys Sea in modern day Italy (John Talent pers. com. in Farabegoli *et al.* 2007).

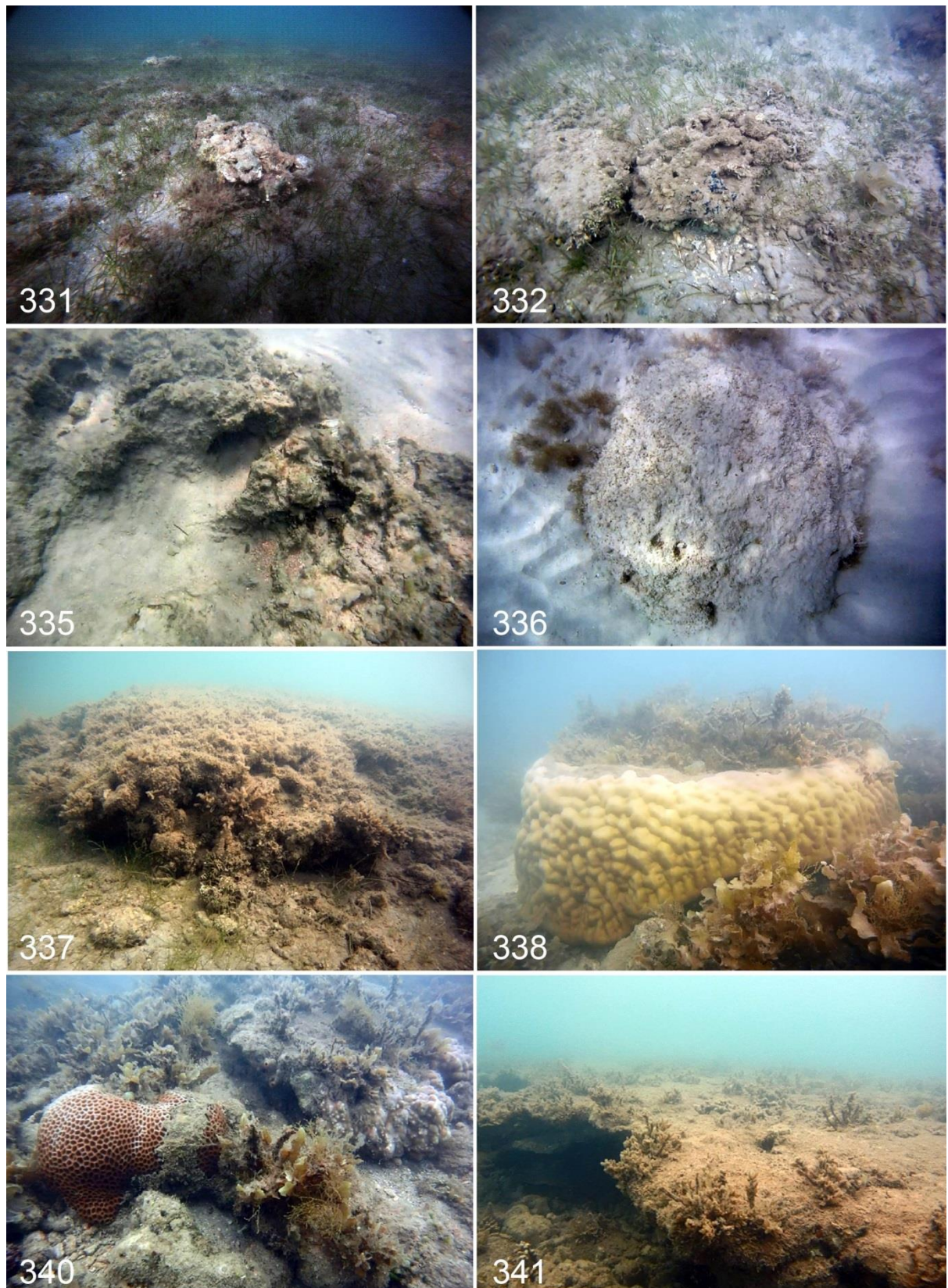


Figure 3-6 Potential stromatolites and microbial mats observed at Geoffrey Bay (see Figure 3-1 for photo locations)

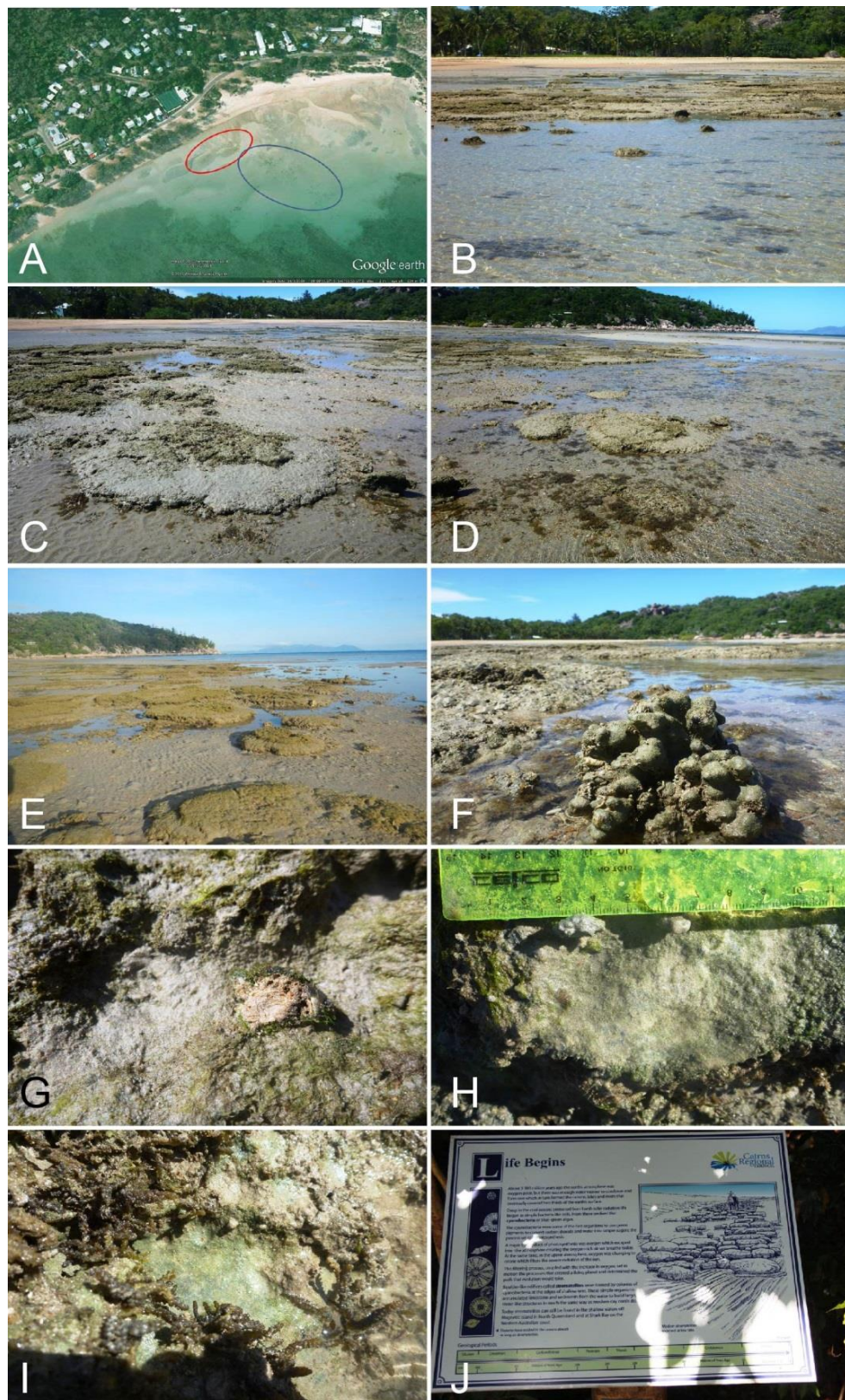


Figure 3-7 Photos of potential stromatolites supplied by Jane Mellors; photo locations (A); structures at low tide (B-E); close-ups (F-I); interpretive signage located in Cairns referencing Magnetic Island stromatolites

4 Benthic Habitat Assessment

In response to submissions on the EIS, the PEP project design was revised as follows:

- The size of the reclamation was increased to accommodate all dredge material (i.e. no unconfined placement of dredge material at sea).
- The channel will be widened (previous design included deepening only).

As such, additional benthic habitat surveys were undertaken at the channel widening areas and the increased reclamation footprint. These benthic habitat surveys included:

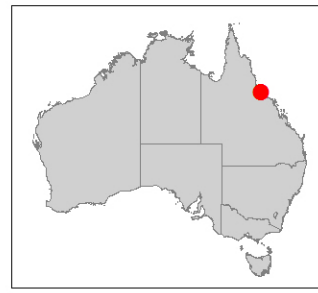
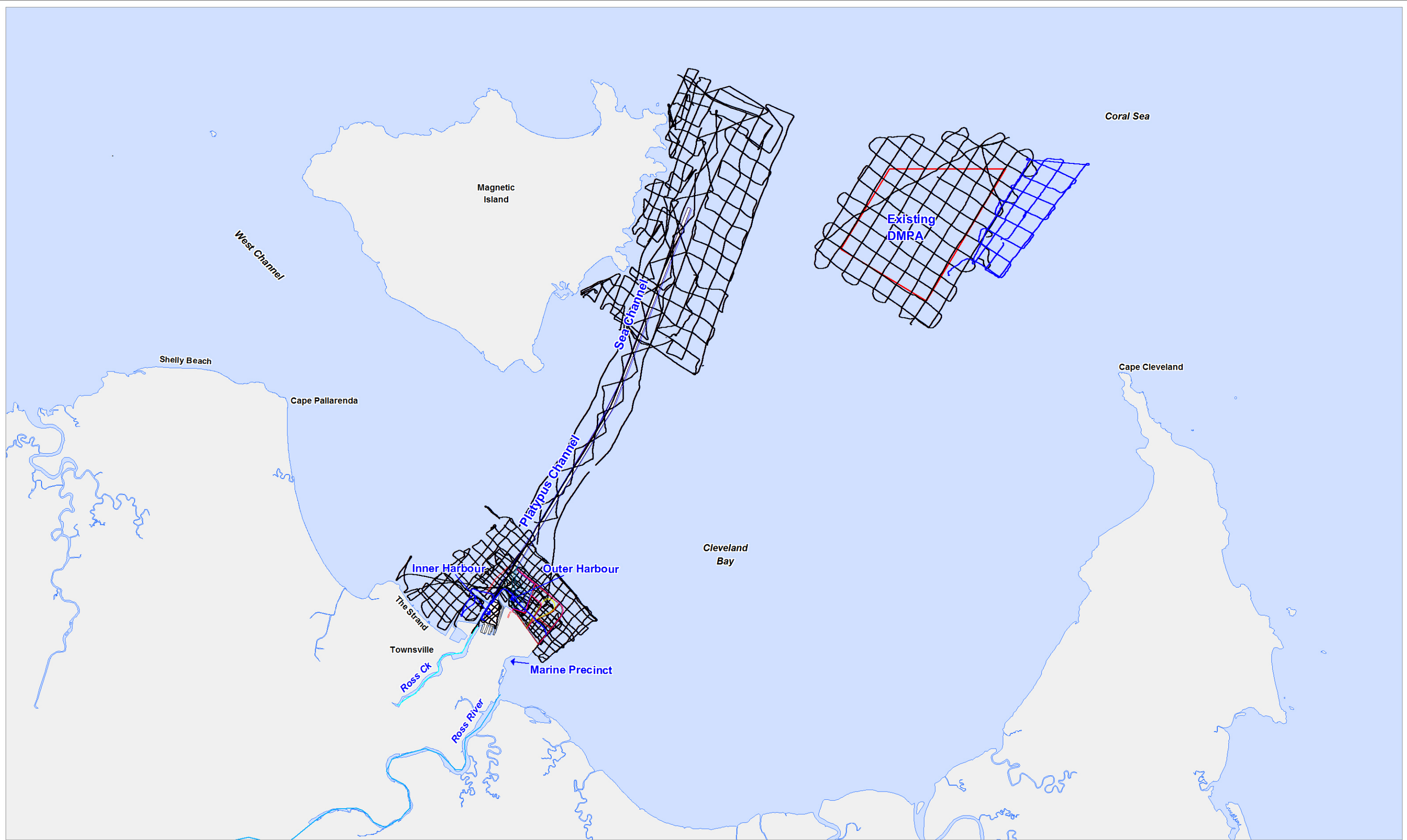
- Acoustic habitat mapping.
- Underwater video survey.
- Benthic grab samples.

4.1 Data Collection

Data were collected with the same methodologies used in the EIS. Acoustic records were collected on September 27th, 2014, and were analysed with the QTC software suite as previously described.

Of the 15,271 acoustic records collected, 12,995 had cluster confidences >95% and these were retained. Data collection parameters were set to those used in 2011 and 2012. Lines for additional data collection are shown in Figure 4-1. Some new data was collected over the previous line work to better facilitate comparison between the two datasets.

Benthic community data were collected using a combination of grab-sampling (0.028m² van Veen, $n=4$ per site) and drop camera observations as per the methods used in the EIS. The locations of benthic infaunal sites, PSD sites and drop camera (epifauna) investigation sites collected during the EIS process and during the present additional studies are shown in Figure 4-2.



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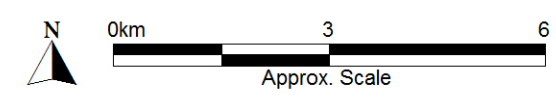
- Existing DMPA
- Reclamation Area
- Channel Extents

Acoustic Transects

- Data Points 2010-12
- Data Points 2014

Title:
Locations of acoustic transects from 2010 to 2014

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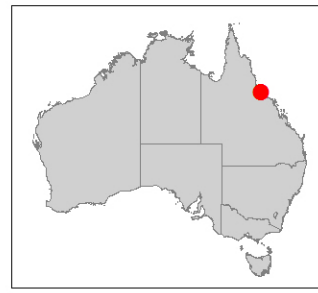
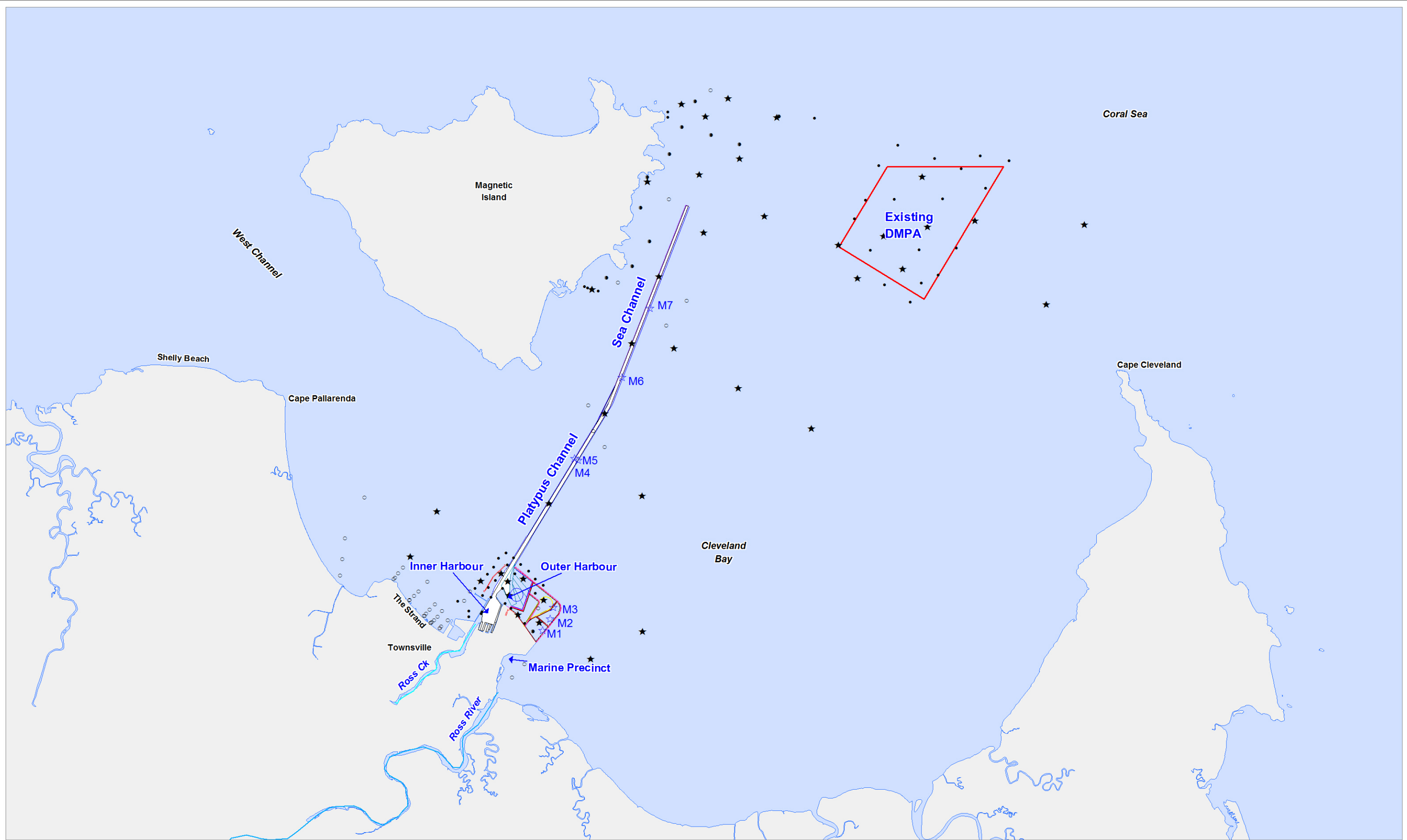


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Figure
4-1

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B





LEGEND

-  Existing DMPA
-  Reclamation Area
-  Channel Extents

- Benthic Sites**
- Video Sites 2012
 - PSD Sites 2012
 - ★ Infauna, PSD, and Video Sites 2012
 - ☆ Infauna Sites 2014

Title:
Locations of video transects, epifauna and infauna sampling sites (2012-2014)

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Figure
4-2

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4.2 Acoustic Habitat Mapping

The 2014 acoustic data showed strong agreement with the 2010 dataset (Figure 4-3) - the original 2010 survey collected data in the region shown in Figure 4-1.

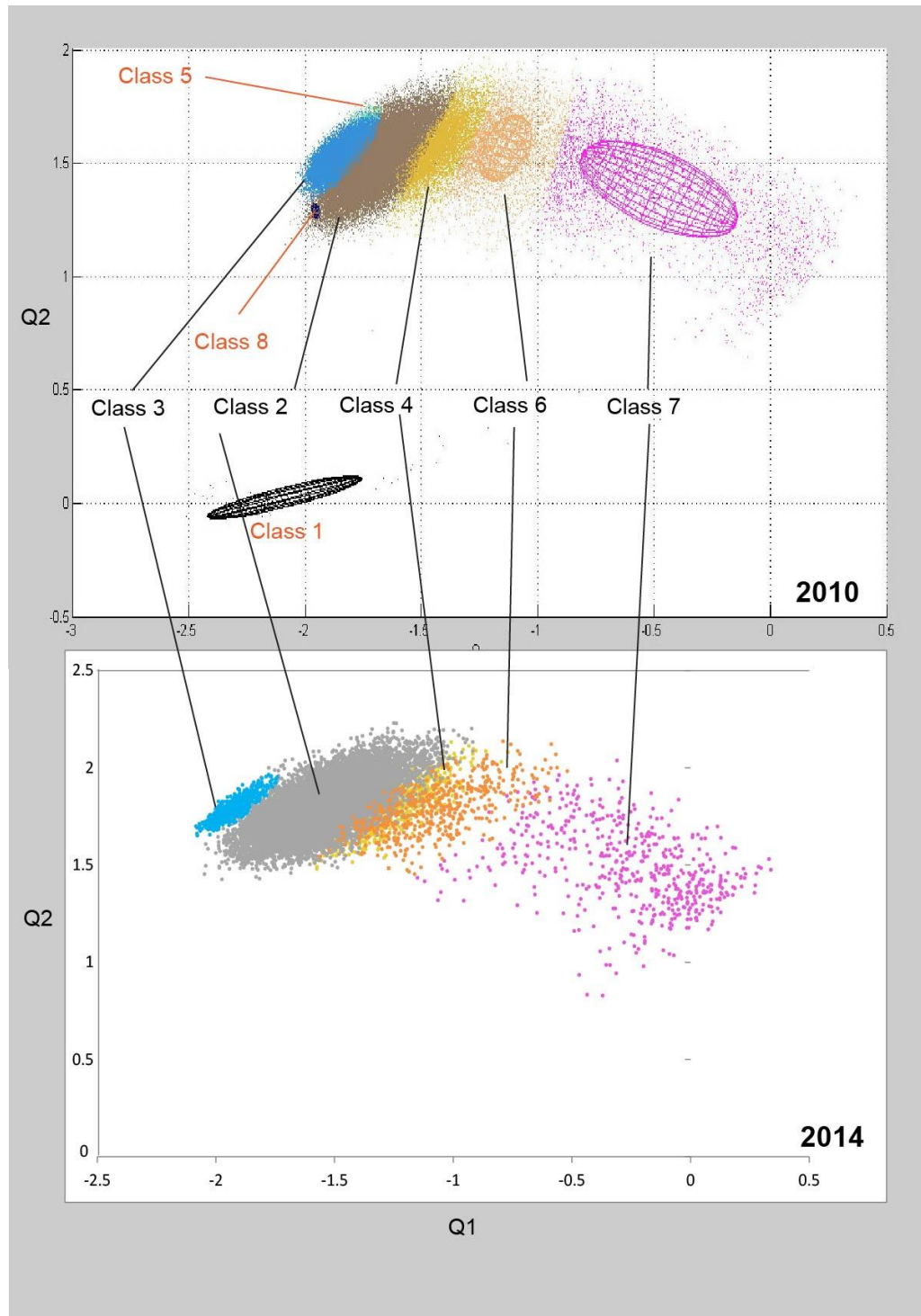


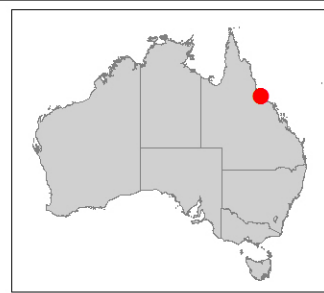
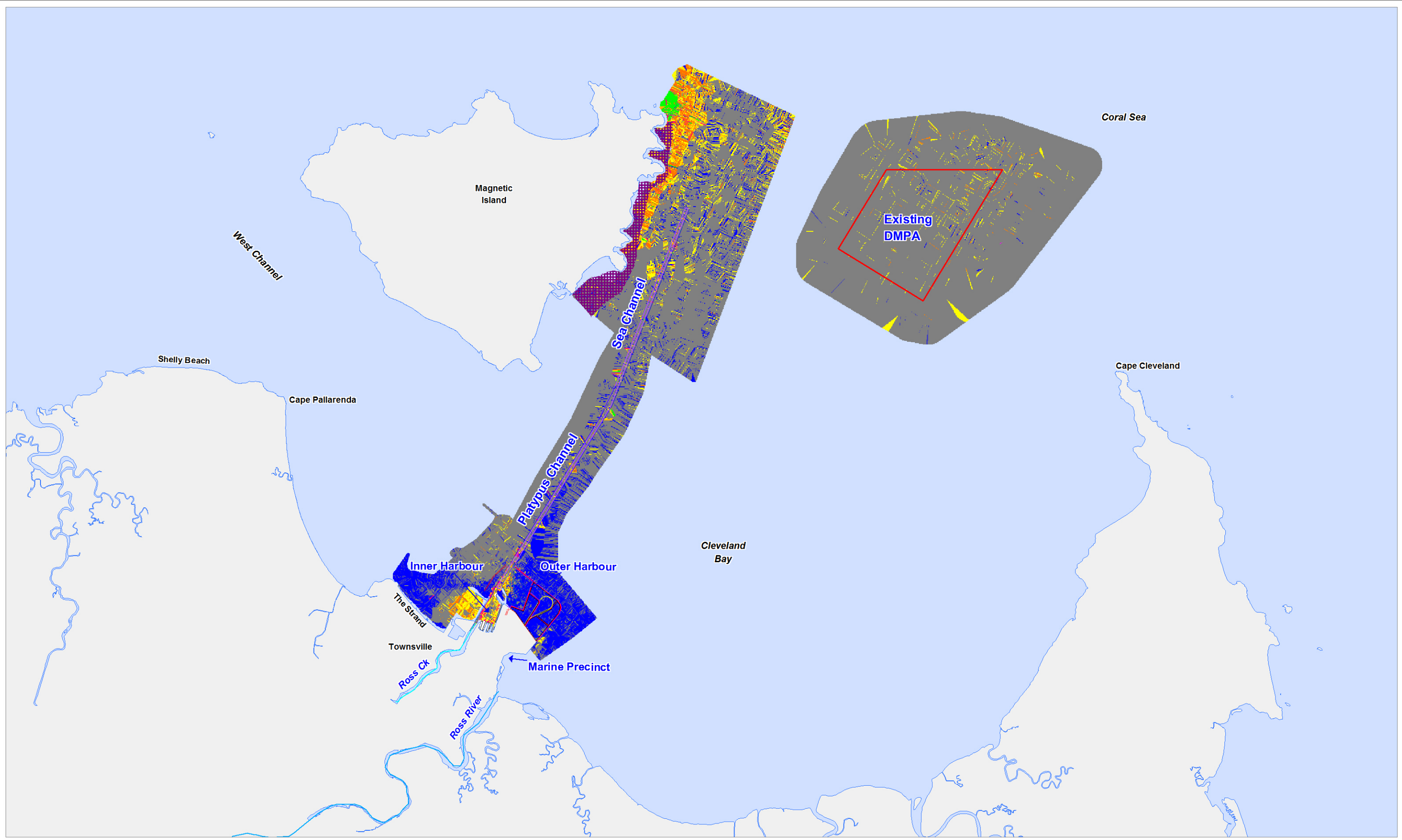
Figure 4-3 Clustering of the 2010 and 2014 datasets showing the five significant acoustic classes common to both sampling events

Benthic Habitat Assessment

As shown in Figure 4-4, acoustic habitat classes in the channel widening areas were composed primarily of class 2 and 3 sediments, with occasional class 4 and 6 sediments. This corresponded to a primarily silty mud substrate with occasional sandier patches, generally with high plasticity and occasional larger gravel-sized pieces.

The acoustic habitat class in the reclamation footprint area was relatively uniform across the area, composed primarily of class 3 sediments. This corresponded to primarily silty substrate.

There were no areas of reef or harder substrate, such as gravel beds or sand ridges, located in or adjacent to the channel widening areas or the reclamation footprint.



LEGEND

- Existing DMPA
- Reclamation Area
- High Calcium Carbonate

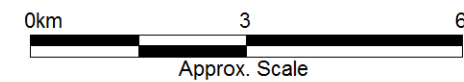
Acoustic Classes

- 2
- 3
- 4
- 6
- 7
- 9

Title:

Interpolated distribution of acoustically derived sediment classes

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Figure

4-4

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B



4.3 Epibenthic Communities

Sites adjacent to the existing channel area, within the channel widening footprint (M4-M7) had sparse epifaunal communities (Figure 4-5). While visibility was low, conditions were sufficient to determine that sessile epifaunal communities (such as corals and sponges) were absent, with small to medium sized burrows (most likely goby burrows) occasionally observed. These results were similar to that of the EIS, which depicted similar sparse communities over the existing DMPA and channel extension areas.

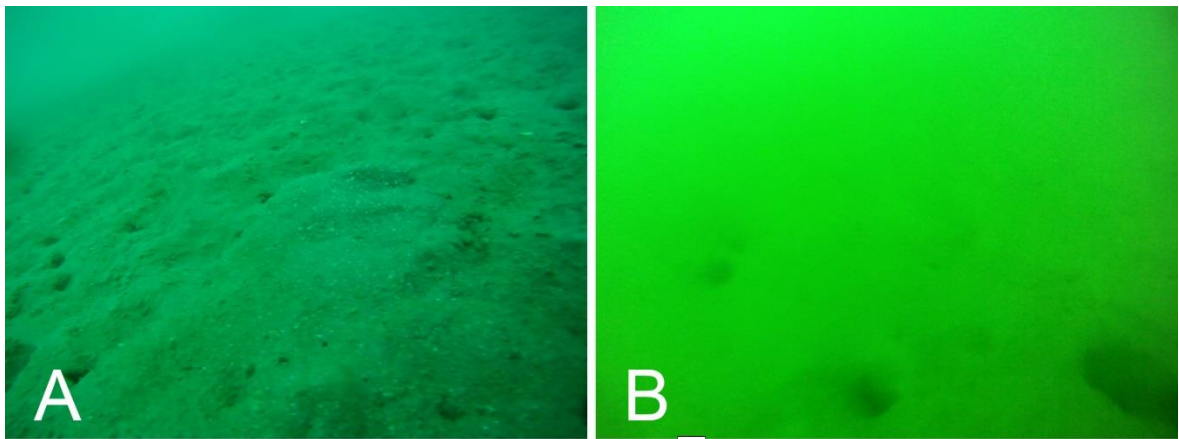


Figure 4-5 Screen captures from the channel widening area: bioturbation with slight surface dimpling at site M7 (A); poor visibility and burrows at site M6 (B).

4.4 Infaunal Communities

Infaunal communities collected during the EIS and in September 2014 had similar compositions of major taxonomic groups with polychaetes and crustaceans generally numerically dominating samples (Figure 4-6). There were substantially more “other” fauna collected during the EIS, and these consisted of peanut worms, sipunculids, blind gobies, and branchiostomids (lancelets).

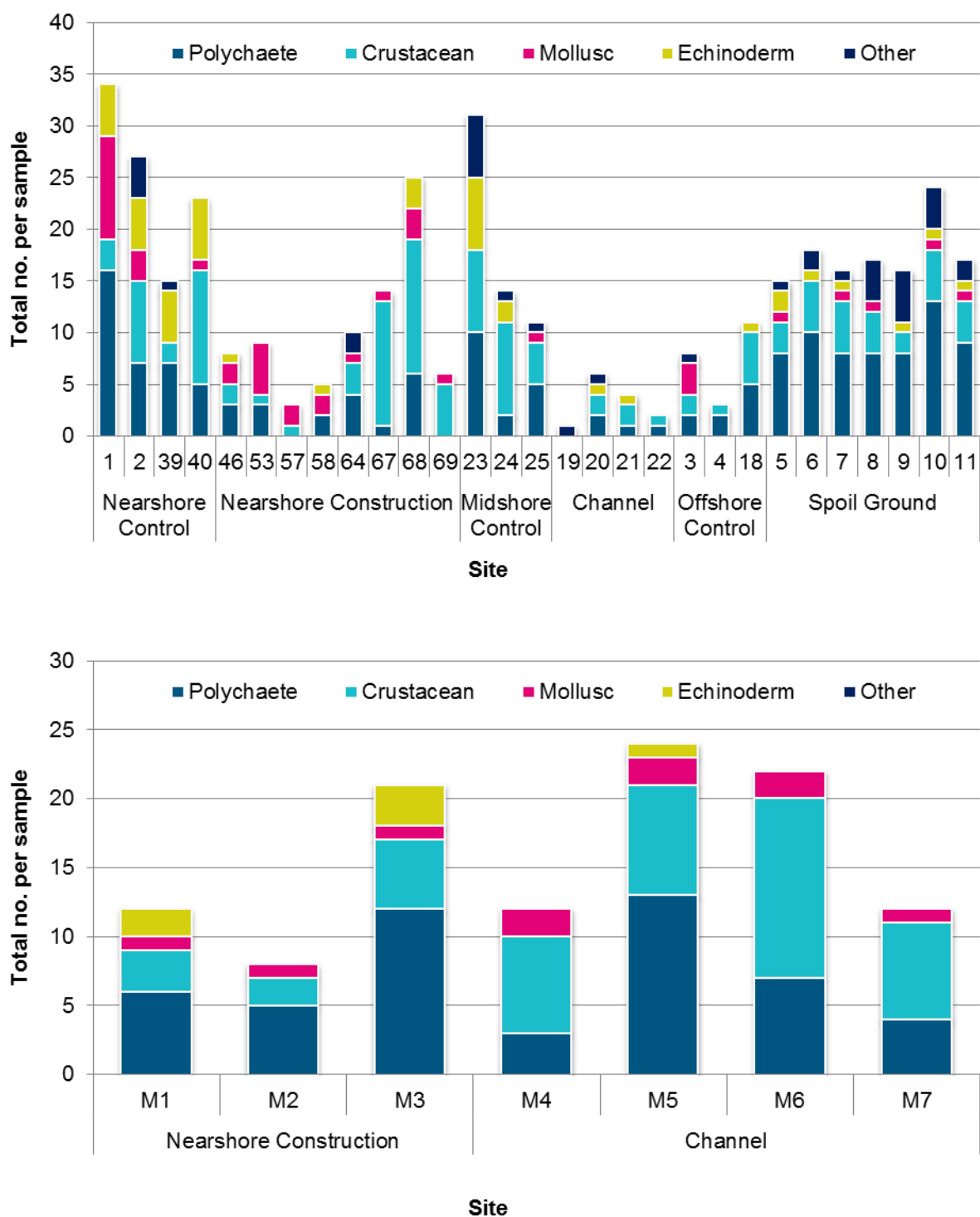


Figure 4-6 Composition of infaunal communities collected in 2012 (above) and in 2014 (below)

While there were fewer minor phyla observed in the 2014 survey, taxonomic richness was generally similar between the two events, within representative areas (Figure 4-7). The nearshore

Benthic Habitat Assessment

construction area had an average of between 2-3 taxa per site in the EIS while taxonomic richness ranged between about 2-4 individuals in 2014. Taxonomic richness was higher in the channel widening area in 2014 than it was in the channel area during the EIS; however, it should be noted that the channel widening area represents a relatively undisturbed habitat compared to the channel area which undergoes maintenance dredging.

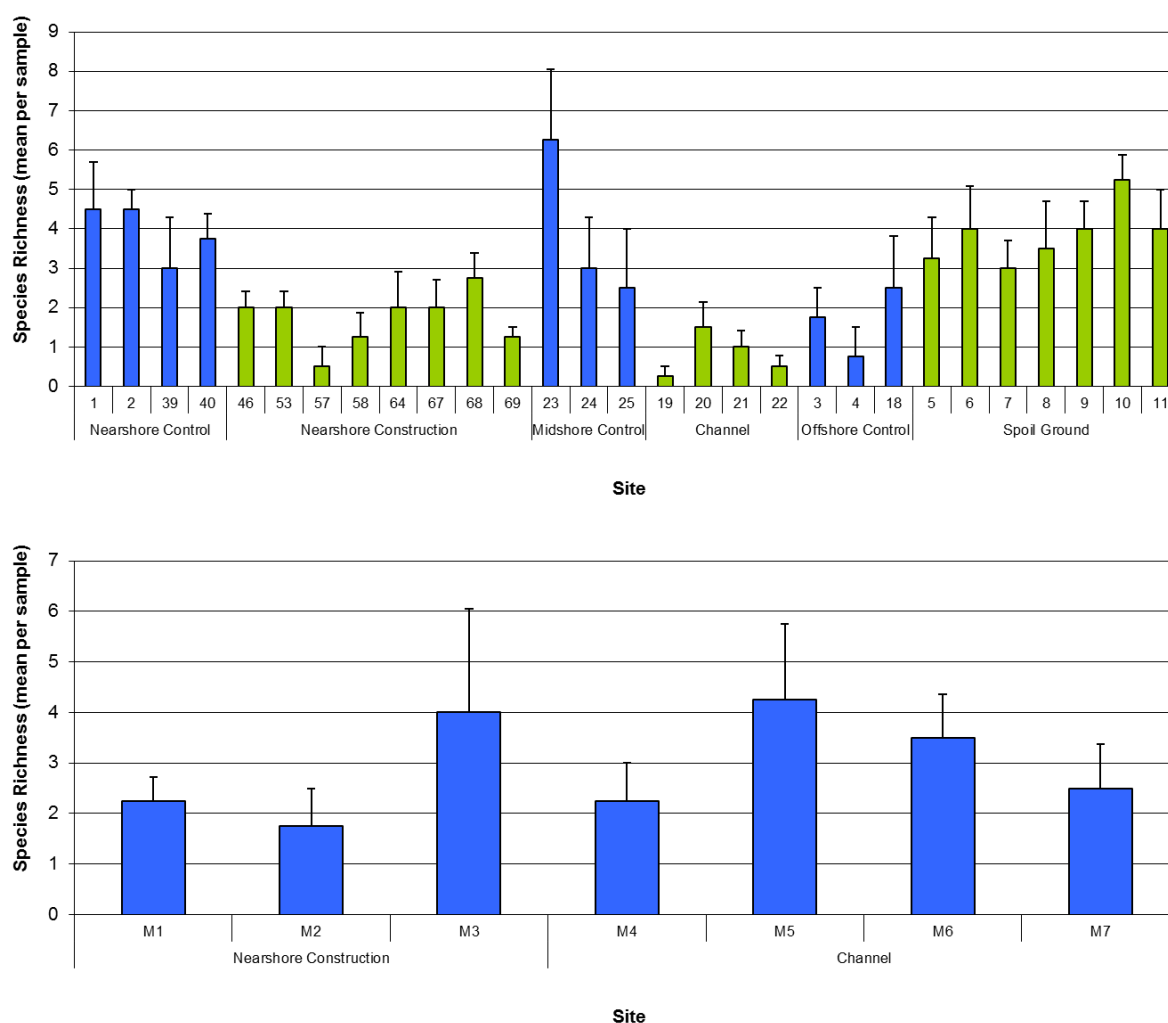


Figure 4-7 Mean ($\pm$ SE) species richness of infaunal communities collected in 2012 (above) and in 2014 (below)

Patterns in taxonomic richness among representative areas and sampling events were very similar to those observed for overall abundance, with the nearshore construction area having the lowest abundance, followed by the channel widening area, and the DMPA had the most abundant communities (Figure 4-8).

It should be noted that some of the differences among the new sampling locations and those sampled during the EIS are likely due to temporal variation between events, and between the time of year that samples were collected. Despite this variability, the patterns in abundance, richness, and high-level community composition were relatively similar between the two sampling periods.

Benthic Habitat Assessment

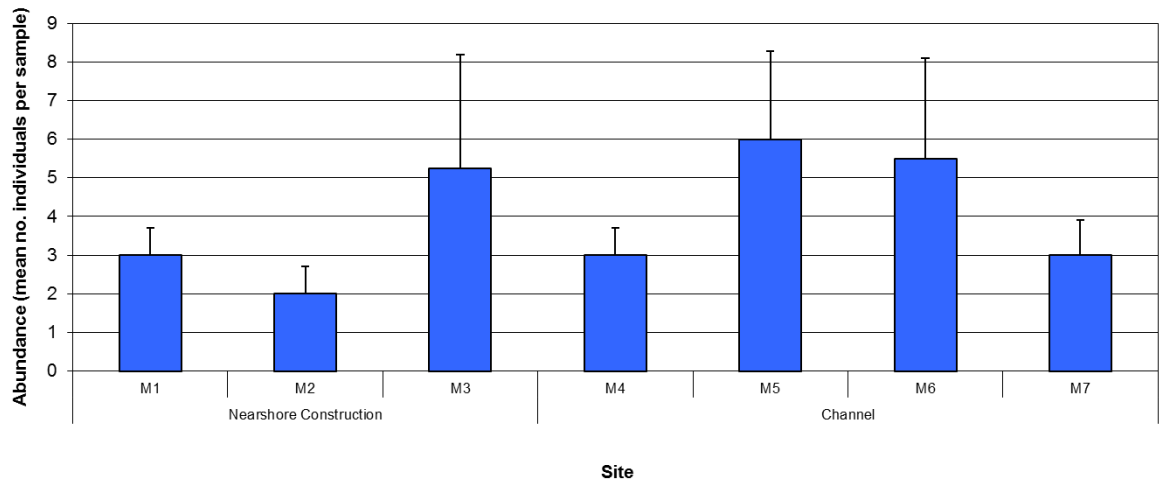
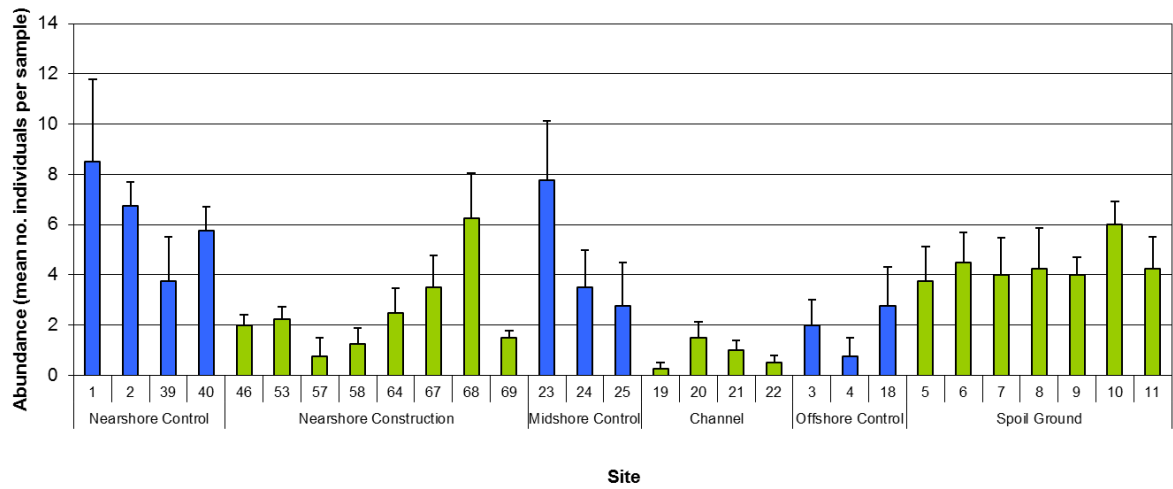


Figure 4-8 Mean ($\pm$ SE) abundance of infaunal communities collected in 2012 (above) and in 2014 (below)

References

5 References

- Awramik SM (1971) Precambrian columnar stromatolite diversity: Reflection of Metazoan Appearance. *Science* 174: 825-827. [DOI:10.1126/science.174.4011.825].
- Chartrand KM, R. P. (2012). Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program. Cairns: State of Queensland (Department of Agriculture, Forestry and Fisheries).
- Collier C.J., Waycott M., Ospina A.G. (2012a) Responses of four indo-west pacific seagrass species to shading. *Marine Pollution Bulletin* 65:342-354.
- Collier C.J., Waycott M., McKenzie L. (2012b) Light thresholds derived from seagrass loss in the coastal zone of the northern great barrier reef, Australia. *Ecological Indicators* 23:211-219.
- Farabegoli E, Perri MC, Posenato R (2007) Environmental and biotic changes across the Permian–Triassic boundary in western Tethys: The Bulla parastratotype, Italy. *Global and Planetary Change*, 55: 109-135.
- Kohler, KE, Gill, SM (2006) Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. *Computers and Geosciences*, 32: 1259–126.
- Shiba T, Shioi Y, Takamiya K-I, Sutton DC, Wilkinson CR. (1991) Distribution and Physiology of Aerobic Bacteria Containing Bacteriochlorophyll a on the East and West Coasts of Australia. *Applied and Environmental Microbiology* 1991;57: 295-300.

Appendix A Particle Size Distribution Data

CERTIFICATE OF ANALYSIS

Work Order	: EB1444213	Page	: 1 of 2
Client	: BMT WBM GROUP LTD	Laboratory	: Environmental Division Brisbane
Contact	: MR BRAD GRANT	Contact	: Customer Services EB
Address	: PO BOX 203 SPRING HILL BRISBANE QLD 4004	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: brad.grant@bmtwbm.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 07 3831 6744	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3832 3627	Facsimile	: +61-7-3243 7218
Project	: B21057	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 13-Oct-2014 12:45
C-O-C number	: ----	Date Analysis Commenced	: 17-Oct-2014
Sampler	: CONOR JONES	Issue Date	: 22-Oct-2014 18:27
Site	: ----		
Quote number	: ----	No. of samples received	: 4
		No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Hamish Murray	Supervisor - Soils	Newcastle - Inorganics



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

Analytical Results

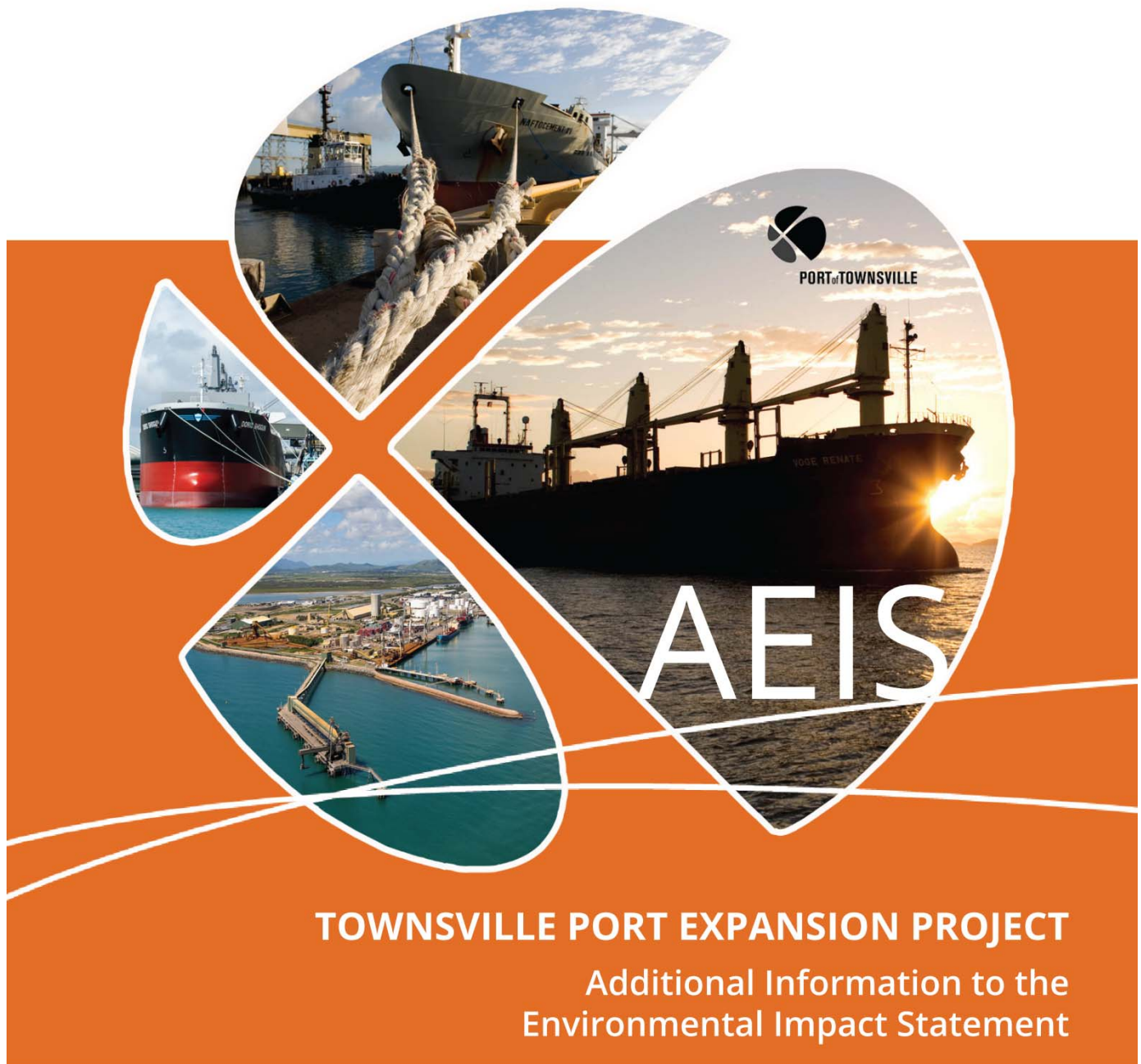
Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				M8	M9	M10	M11	----
Client sampling date / time				[13-Oct-2014]	[13-Oct-2014]	[13-Oct-2014]	[13-Oct-2014]	----
Compound	CAS Number	LOR	Unit	EB1444213-001	EB1444213-002	EB1444213-003	EB1444213-004	-----
				Result	Result	Result	Result	Result
EA150: Particle Sizing								
+75µm	----	1	%	66	66	69	70	----
+150µm	----	1	%	54	52	54	55	----
+300µm	----	1	%	22	17	16	20	----
+425µm	----	1	%	10	9	8	11	----
+600µm	----	1	%	5	5	4	6	----
+1180µm	----	1	%	2	2	2	2	----
+2.36mm	----	1	%	<1	1	<1	<1	----
+4.75mm	----	1	%	<1	<1	<1	<1	----
+9.5mm	----	1	%	<1	<1	<1	<1	----
+19.0mm	----	1	%	<1	<1	<1	<1	----
+37.5mm	----	1	%	<1	<1	<1	<1	----
+75.0mm	----	1	%	<1	<1	<1	<1	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	34	34	31	30	----
Sand (>75 µm)	----	1	%	66	65	68	70	----
Gravel (>2mm)	----	1	%	<1	1	1	1	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	----



BMT WBM Bangalow	6/20 Byron Street, Bangalow 2479 Tel +61 2 6687 0466 Fax +61 2 66870422 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Brisbane	Level 8, 200 Creek Street, Brisbane 4000 PO Box 203, Spring Hill QLD 4004 Tel +61 7 3831 6744 Fax +61 7 3832 3627 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Denver	8200 S. Akron Street, #B120 Centennial, Denver Colorado 80112 USA Tel +1 303 792 9814 Fax +1 303 792 9742 Email denver@bmtwbm.com Web www.bmtwbm.com
BMT WBM London	International House, 1st Floor St Katharine's Way, London E1W 1AY Email london@bmtwbm.co.uk Web www.bmtwbm.com
BMT WBM Mackay	PO Box 4447, Mackay QLD 4740 Tel +61 7 4953 5144 Fax +61 7 4953 5132 Email mackay@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Melbourne	Level 5, 99 King Street, Melbourne 3000 PO Box 604, Collins Street West VIC 8007 Tel +61 3 8620 6100 Fax +61 3 8620 6105 Email melbourne@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Newcastle	126 Belford Street, Broadmeadow 2292 PO Box 266, Broadmeadow NSW 2292 Tel +61 2 4940 8882 Fax +61 2 4940 8887 Email newcastle@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Perth	Level 3, 20 Parkland Road, Osborne, WA 6017 PO Box 1027, Innaloo WA 6918 Tel +61 8 9328 2029 Fax +61 8 9486 7588 Email perth@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Sydney	Level 1, 256-258 Norton Street, Leichhardt 2040 PO Box 194, Leichhardt NSW 2040 Tel +61 2 8987 2900 Fax +61 2 8987 2999 Email sydney@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Vancouver	Suite 401, 611 Alexander Street Vancouver British Columbia V6A 1E1 Canada Tel +1 604 683 5777 Fax +1 604 608 3232 Email vancouver@bmtwbm.com Web www.bmtwbm.com



APPENDIX A2

Townsville Port Expansion AEIS Hydrodynamic and Advection – Dispersion Modelling Technical Report





Appendix: Townsville Port Expansion AEIS Hydrodynamic and Advection-Dispersion Modelling Technical Report

Reference: R.B21057.003.03.AEIS_Modelling.docx

Date: March 2016

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Document Control Sheet

BMT WBM Pty Ltd Level 8, 200 Creek Street Brisbane Qld 4000 Australia PO Box 203, Spring Hill 4004 Tel: +61 7 3831 6744 Fax: + 61 7 3832 3627 ABN 54 010 830 421 www.bmtwbm.com.au	Document:	R.B21057.003.03.AEIS_Modelling.docx
	Title:	Appendix: Townsville Port Expansion AEIS Hydrodynamic and Advection- Dispersion Modelling Technical Report
	Project Manager:	Greg Fisk
	Author:	Dr Paul Guard, Toby Devlin, Dr Ian Teakle
	Client:	AECOM
	Client Contact:	Rouven Lau
	Client Reference:	
Synopsis: This technical appendix outlines and summarises hydrodynamic modelling undertaken to assess hydrodynamic and water quality impacts of the proposed Port of Townsville expansion project as part of the Additional Information for the Environmental Impact Statement.		

REVISION/CHECKING HISTORY

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DISTRIBUTION

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1 Introduction

1.1 Background

Evaluation of the impact of the proposed port expansion at the Port of Townsville (POT) requires a thorough understanding of the hydrodynamic and coastal processes operating within Cleveland Bay, as well as appropriate tools to support assessment of these processes. This information is necessary to optimise the port and channel design configuration from an operational and ongoing maintenance perspective as well as for consideration of construction techniques and potential adverse impacts. Wind, waves, water levels, currents and sediment transport are all interrelated and can influence the design, and positioning of the project in a number of ways.

There has been extensive data collection carried out in Cleveland Bay over many years as well as numerous studies and numerical modelling of the hydrodynamic and coastal processes.

BMT WBM (WBM) was responsible for and is in possession of the extensive oceanographic data collected in 1992 – 1993 for the modelling and monitoring of the Platypus Channel deepening and extension works at that time. WBM also undertook data collection and modelling of Cleveland and Halifax Bays associated with a proposed Nickel Ore import facility in the 1990s. This included modelling and assessment of dredging and siltation of Platypus Channel.

Other important reports reviewed as part of the current study include:

- JCU/AIMS report, "Water Circulation and Fate of Dredge Spoil, Cleveland Bay, Townsville" (1991). This study by JCU and AIMS involved oceanographic data collection and modelling of water circulation in Cleveland Bay to investigate the fate of dumped dredge material.
- GHD report, "Outer Harbour Hydrodynamic Modelling Report and Appendices" (2004). This report provides an investigation of hydrodynamic processes in the Outer Harbour and outputs of the Delft 3D model used by GHD. It also provides an overview and summary of historical data and investigations of hydrodynamic behaviour in Cleveland Bay and in the Outer Harbour area and provides a basis for assumptions about sediment transport patterns and their relationship to wind and wave processes.

As part of the Preliminary Engineering and Environmental Study (PEES) for the port expansion which was undertaken in 2008/2009 (BMT WBM, 2009), WBM was engaged to develop and employ a suite of numerical modelling tools to assess the range of potential hydrodynamic, water quality and coastal process impacts from future port expansion. WBM has continued to develop this suite of modelling tools as part of this EIS, and has assessed the potential impact of the proposed port expansion, principally using the hydrodynamic model TUFLOW FV. This technical appendix describes the model development and validation process and the results of the impact assessments.

1.2 Objectives and Purpose

Key objectives of the hydrodynamic modelling assessment of the port expansion are:

- Development of a suite of numerical modelling tools capable of simulating the hydrodynamic, wave and sedimentation processes of Cleveland Bay, in particular around Townsville Harbour;

- Assessment of the implications of the specific design configuration with respect to currents, coastal processes and sedimentation for assessment of impacts;
- Assessment of turbid plume dispersion associated with dredging for consideration of potential environmental impacts;
- Identification of any further data collection and model validation requirements necessary for detailed design and impact assessment purposes; and
- Documentation of the modelling and findings.

The modelling work presented in this technical appendix was independently peer reviewed. A letter confirming the outcomes of the peer review process is included as Appendix H2 of the EIS.

1.3 Proposed Port Configurations for Assessment

For the purposes of hydrodynamic impact assessment, the geometric configurations of the Port during the various stages of the Project have been consolidated into three scenarios as described in Table 1-1. The scenarios are described in more detail in Section 4.2. The proposed staging of the expansion and associated geometry is shown in Figure 1-1 and Figure 1-2.

Table 1-1 Hydrodynamic Impact Assessment Geometric Configurations

Label	Geometry
BASE CASE	EXISTING GEOMETRY PLUS • WIDENED WESTERN SIDE OF PLATYPUS CHANNEL CH 600 TO CH 1900.
INTERIM CASE (POST STAGE 1)	BASE CASE PLUS • WIDENED CHANNEL • INTERIM RECLAMATION AND BERTH 12
ULTIMATE CASE (POST STAGE 2 AND STAGE 3)	INTERIM CASE PLUS • DEEPENED CHANNEL (WITH EXTENSION TO THE NORTH) • FINAL RECLAMATION AND BERTHS 14, 15, 16, 17, 18

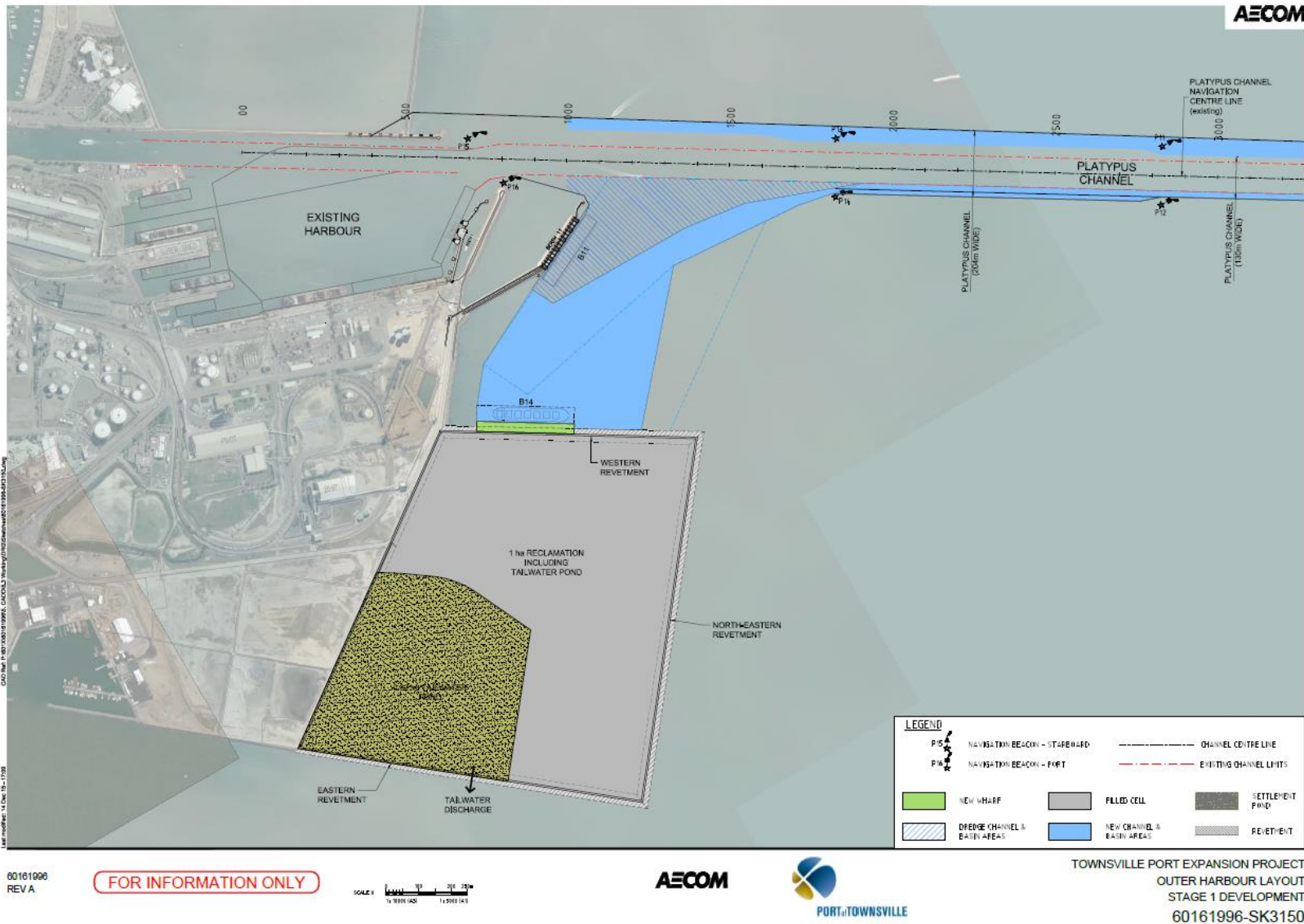


Figure 1-1 Port Expansion Staging and Geometry – Stage 1



Figure 1-2 Port Expansion Staging and Geometry – Stages 2 and 3

2 Methodology and Model Development

2.1 Approach

The methodology for evaluation of hydrodynamic (HD) and advection-dispersion (AD) processes was based on three-dimensional numerical modelling. The package that was used was TUFLOW FV, which is a 3D flexible mesh hydrodynamic model that handles both hydrodynamic and advection-dispersion components. A baroclinic model configuration with density coupling from both temperature and salinity has been applied in order to represent stratification processes that occur within the Great Barrier Reef lagoon. Details of the TUFLOW FV numerical model are provided in Attachment A of this appendix.

A spectral wave model (SWAN) was also developed for assessing changes to the wave climate.

These models have been used by BMT WBM on several other major studies including:

- Gladstone Western Basin Dredging and Disposal Project (coastal studies);
- Murray River Mouth, Coorong & Lower Lakes Environmental & Morphological Modelling; and
- MetOcean and Sedimentation Study for LNG Import Terminal, Pipavav Port, India.

The modelling framework offers the ability to simulate hydrodynamics, sediment resuspension, transport and deposition and dissolved pollutant transport, and is well suited to the needs of this study.

One advantage of employing a flexible mesh model is its ability to adjust the spatial resolution of the computational network, and in particular, to increase resolution in areas of specific interest to the study. In the current study, these areas include the proposed works sites, and the existing infrastructure in the immediate vicinity, such as breakwaters and berths. The flexible mesh has been constructed to resolve these structures, with resolution also being commensurately reduced in areas where it was not needed, such as outside Cleveland Bay. As such, simulation times and efficiencies were not constrained by the highest resolution required.

Formal calibration of the numerical modelling was also undertaken as part of the study. Data used for calibration included Acoustic Doppler Current Profiler (ADCP) velocity and water level measurements from the Preliminary Engineering and Environmental Study (PEES) undertaken for the port expansion in 2008/2009 and two ADCP deployments in Cleveland Bay undertaken as part of this study.

2.2 Hydrodynamic Model Extent and Mesh Definition

The base hydrodynamic model network extends over an area of some 28,400 km², incorporating the Port of Townsville, Cleveland Bay, Halifax Bay and Bowling Green Bay. The modelled area represents a reach length of approximately 350km, extending from Abbott Point at the south-eastern extent to Lucinda in the north-west. The model extent includes the whole of the Great Barrier Reef lagoon between these points, and extends through reef passes into the Coral Sea.

There are a number of tidal waterways adjacent to the Port including the Ross River at Townsville, which are incorporated into the model. The modelling of the Ross River and Ross Creek focuses

on representation of the tidal storage and exchange within the system as well as the delivery of fluvial (freshwater) flows into the model domain. Other waterways such as Crocodile Creek and Black River flow into the ocean along the modelled reach, but have not been included in the model as they are far from the area of interest. The model domain also extends south of the Burdekin River, which is a major ongoing source of fluvial discharge and suspended sediment to the Great Barrier Reef lagoon. The model is therefore capable of simulating freshwater plumes due to runoff from the Burdekin River catchment and the associated delivery of additional sediment and lagoon stratification.

The developed model mesh for the study area is shown in Figure 2-1. In developing the model mesh, particular focus was given to a number of key areas to ensure a suitable model representation of ambient conditions. Where appropriate, the resolution of the model mesh was increased to provide a more accurate representation of local conditions. Some key areas are discussed below:

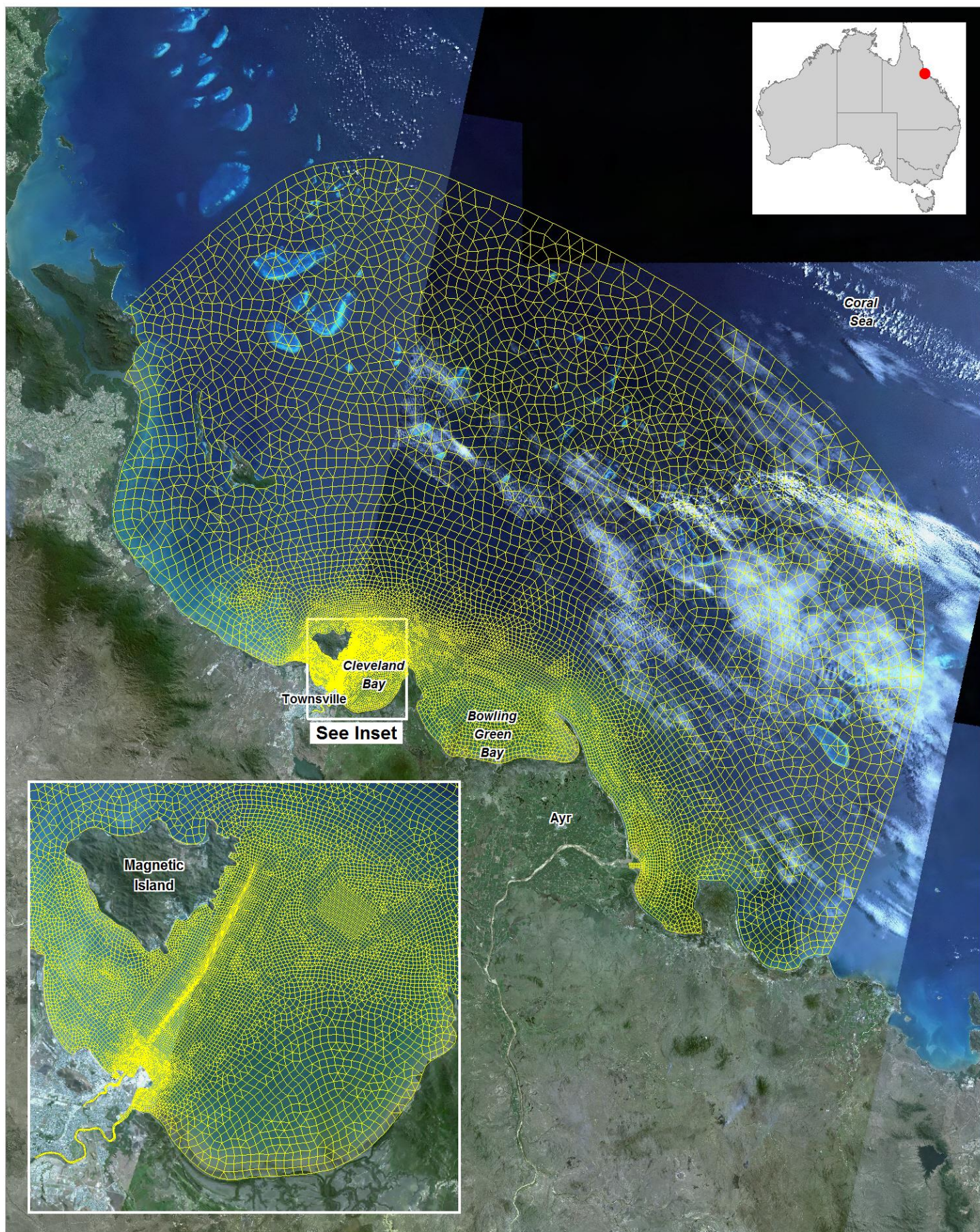
- There are numerous islands within the study area (e.g. Magnetic Is., Herald Is., Great Palm Is.), which can have an influence on flow distribution. Local adjustment of the mesh resolution has been undertaken to define the land boundaries, and the adjacent flow channels around the islands, which are typically characterised by rapid changes in bed elevation.
- Ross Creek flows into the Port of Townsville harbour. The model has been extended for approximately 3.5 km upstream of the Port in order to adequately define the tidal storage and simulate the tidal flux through the harbour.
- The Ross River is a major waterway which discharges into Cleveland Bay immediately to the south-east of the Port of Townsville facilities. The model has been extended for approximately 10 km upstream of the river mouth. This provides the opportunity to adequately define the tidal storage within the river system and simulate the tidal flux.
- The resolution of the mesh has been adapted to represent in detail the Platypus Channel out from Townsville to the sea, as well as the Port in the immediate vicinity of the Ross River confluence in order to enhance the representation of local (potentially complex) hydraulic conditions.
- The domain coverage extends well beyond Cleveland Bay into the Great Barrier Reef lagoon and includes the Burdekin River, which is the major fluvial source into the study area. The Burdekin is an important driver of hydrodynamics through the introduction fresh water and of regional morphology through its supply of 'new' sediments into the nearshore region.
- The existing Townsville Port Dredge Material Placement Area (DMPA) has been refined to a typical mesh dimension of approximately 100 metres to allow for accurate modelling of maintenance dredging activity.

2.3 Advection Dispersion Modelling

A system for modelling the advection and dispersion of a sediment plume produced during dredging has been developed as part of this study using the cohesive sediment module of TUFLOW FV coupled with the 3D hydrodynamic model.

Methodology and Model Development

To accurately capture advection and dispersion, the model requires input of dispersion coefficients and sediment characteristics. These inputs determine the resultant spread of fluid and suspended matter throughout the model domain. The choice of dredge plume source terms, dispersion coefficients, particle size distributions and settling velocities is discussed in Section 3.



Title:
Port of Townsville TUFLOW FV Model Mesh

Figure:
2-1

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0 5 10km
Scale - Inset
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Scale - Main Map



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2.4 SWAN Wave Models

A spectral wave model for Cleveland Bay was established to assess the wave climate in the context of the proposed development and for coupling with the hydrodynamic model.

The SWAN (Delft University of Technology, 2006) numerical model was used for this purpose. SWAN is a third-generation spectral wave model, which is capable of simulating the generation of waves by wind, dissipation by whitecapping, depth-induced wave breaking, bottom friction and wave-wave interactions in both deep and shallow water. SWAN simulates wave/swell propagation in two-dimensions, including shoaling and refraction due to spatial variations in bathymetry and currents. This is a global industry standard modelling package that has been applied with reliable results to many such investigations worldwide.

A regional model covering a large section of the Great Barrier Reef lagoon and Coral Sea was established and wind boundary conditions were extracted from global NCEP model reanalyses. Wave propagation to the immediate vicinity of the Port has been assessed by establishing a nested sub-model over the section of the TUFLOW FV model within the Great Barrier Reef lagoon. The wind boundary conditions for the nested model were the same as those developed for the TUFLOW FV hydrodynamic model, as described in Section 2.7.

The SWAN model domains are shown in Figure 2-2.

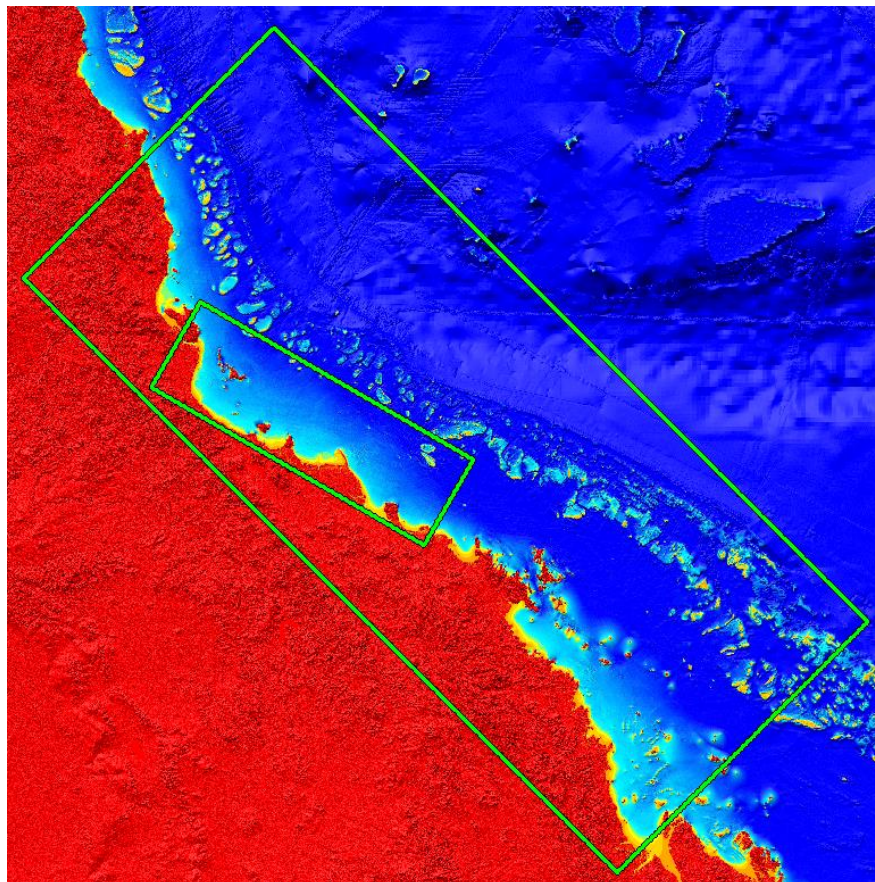


Figure 2-2 Regional and Nested SWAN Domains

2.5 Bathymetry

Hydrographic (bathymetric) data for both the hydrodynamic and wave models was sourced from the following:

- Local hydrographic survey data supplied by Port of Townsville;
- Bathymetric data of Cleveland Bay and the Great Barrier Reef Lagoon from external sources;
- Navigation charts (AUS 256) covering Cleveland Bay, Ross River and Ross Creek;
- Geoscience Australia Australian Waters Digital Elevation Model (250m grid); and
- Project 3DGBR: a high-resolution depth model for the Great Barrier Reef and Coral Sea (Reef and Rainforest Research Centre, 2010).

All these were converted to metres above Australian Height Datum (mAHD).

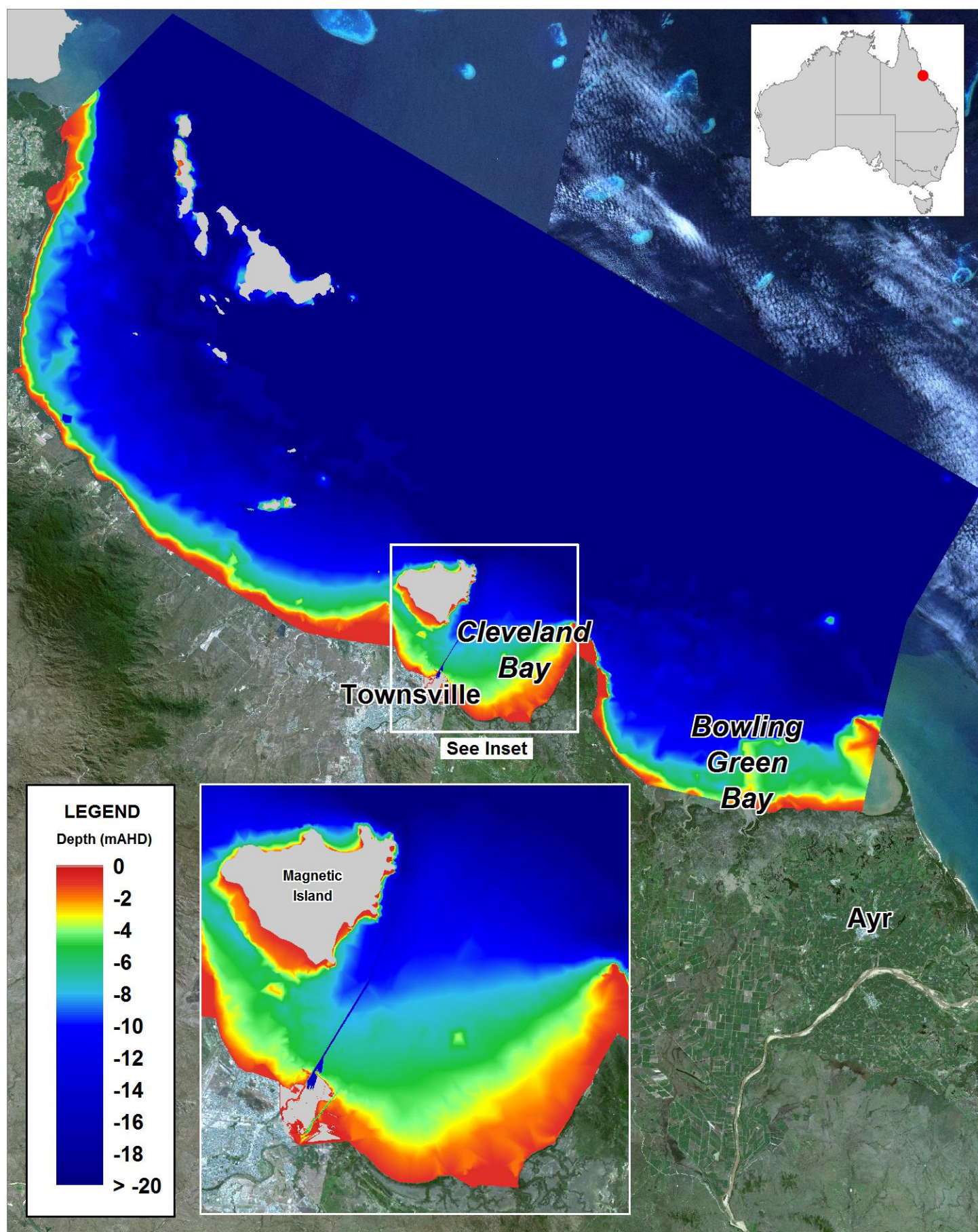
The digital elevation model of the study area as derived from the various survey components is shown in Figure 2-3.

In developing the hydrodynamic model, consideration was given to the underlying bathymetry in defining the mesh configuration. For example, model resolution was enhanced at locations of rapidly varying bathymetry or expected high velocity/flow regions based on main channel definition.

A point inspection of the DEM was used to define the bed level at the model mesh nodes located at the vertices of the individual elements of the mesh.

2.6 Tidal Boundary Conditions

The developed model extent included an open boundary that required temporal definition of water surface elevations. This boundary is shown in Figure 2-1. Due to the large extent of the model domain, tidal elevations vary spatially and temporally along the length of the boundary. Tidal data along these boundaries was extracted from a BMT WBM calibrated tide model of the Great Barrier Reef lagoon and Coral Sea, the spatial extent of which is shown in Figure 2-4. The regional tide model boundary conditions were forced by tidal constituents supplied by the Bureau of Meteorology, National Tide Centre.



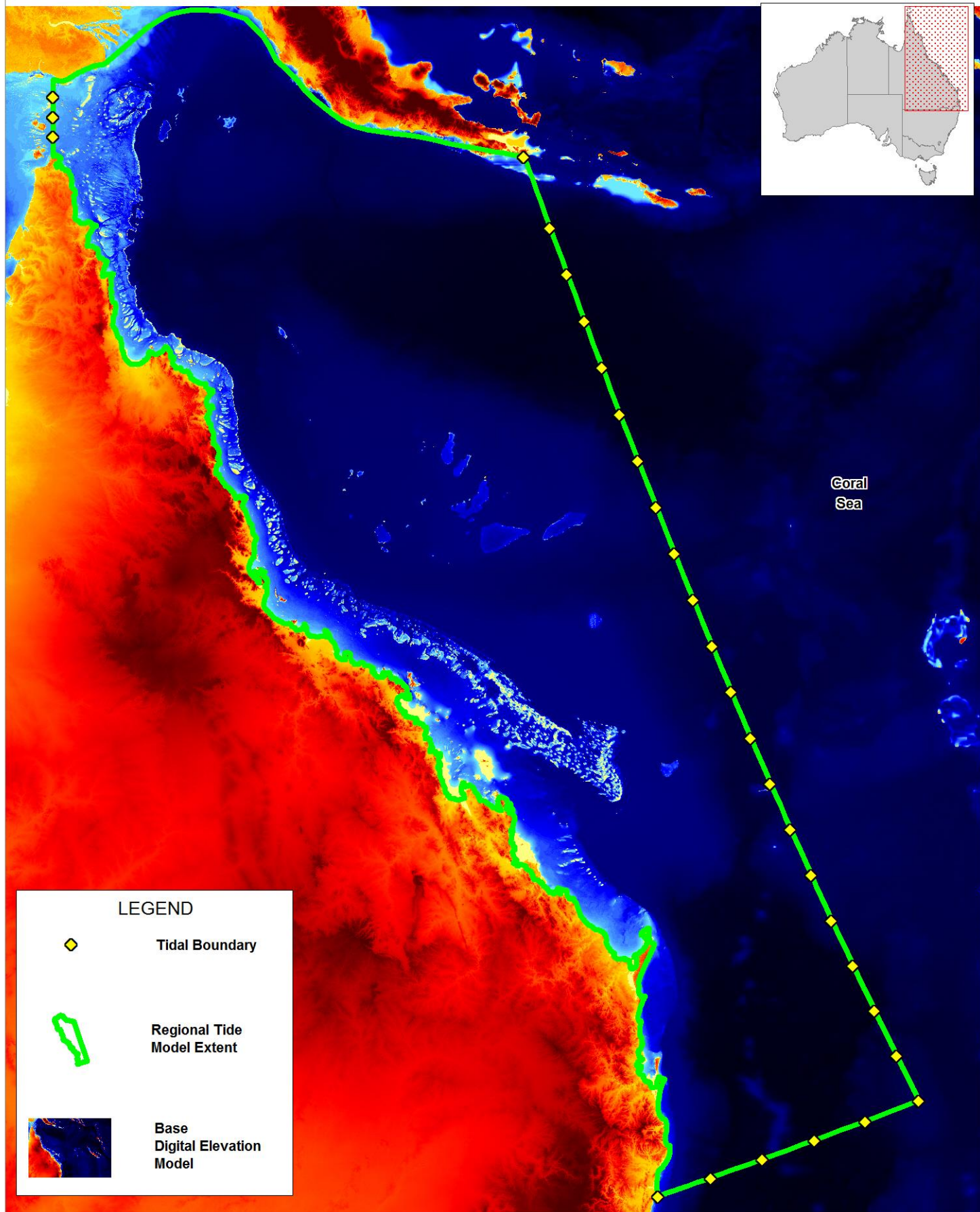
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Bathymetry of Model Area

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2-3

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Title:
Regional Tide Model Extent

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2-4

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2.7 Salinity and Temperature Boundary Conditions

The model calibration process confirmed that 3D temperature and salinity stratification effects were significant to vertical velocity structures and hence overall circulation with Cleveland Bay. The model was therefore provided with temperature and salinity profiles at all external boundaries. These were derived from the ocean general circulation model, HYCOM (<http://hycom.org/>) and varied both in space (longitude, latitude and elevation) and time.

The General Ocean Turbulence Model (GOTM) was coupled with the 3D TUFLOW FV hydrodynamic model in order to simulate the vertical mixing processes in the presence of density stratification (<http://www.gotm.net/>).

Atmospheric heat fluxes and water column heat dynamics were simulated internally within TUFLOW FV. Boundary condition data including air temperature, long and short wave radiation, precipitation and relative humidity were obtained from global NCEP model reanalyses (NOAA, 2012). These model input fields were spatially uniform but varied in time in order to represent both seasonal and higher-frequency variations (e.g. diurnal).

The model was warmed up for a minimum period of 6 weeks prior to all calibration and impact assessments, in order to develop the internal salinity and temperature distributions contributing to density stratification.

2.8 Ocean Current Forcing

The model was provided with regional current forcing (residual water level, current magnitude and direction) at the open boundary. These were derived from the ocean general circulation model HYCOM (<http://hycom.org/>) and varied both in space (longitude, latitude and elevation) and time.

2.9 Wind Boundary Conditions

The Port of Townsville provided wind data (speed and direction) at ten minute intervals at the entrance to the Port (P14) for the period 2006 to 2011. A spatially interpolated wind field was constructed using additional data from the Townsville Airport, Lucinda Point and Alva Beach stations of the Bureau of Meteorology (BOM) and data from Australian Institute of Marine Science (AIMS) stations as shown in Figure 2-5. A three hour moving average of each dataset was obtained and spatially interpolated to develop a consistent and continuous dataset over the periods used for calibration and impact assessment purposes.



Figure 2-5 Wind Stations Used for the Spatially Interpolated Wind Field

2.10 Fluvial Discharge Boundary Conditions

Daily-average freshwater flows and suspended sediment loads in Ross River and Ross Creek were derived from existing catchment models developed by BMT WBM (2010).

Freshwater flows in the Burdekin River were obtained from the Department of Natural Resources and Mines via their online data delivery service (<https://water-monitoring.information.qld.gov.au>). The paper by Bainbridge et al (2012) which describes field measurements of the 2010-11 wet season Burdekin River plume was used to develop an approximate relationship for sediment load from the Burdekin River as a function of instantaneous flow rate as shown in Figure 2-6.

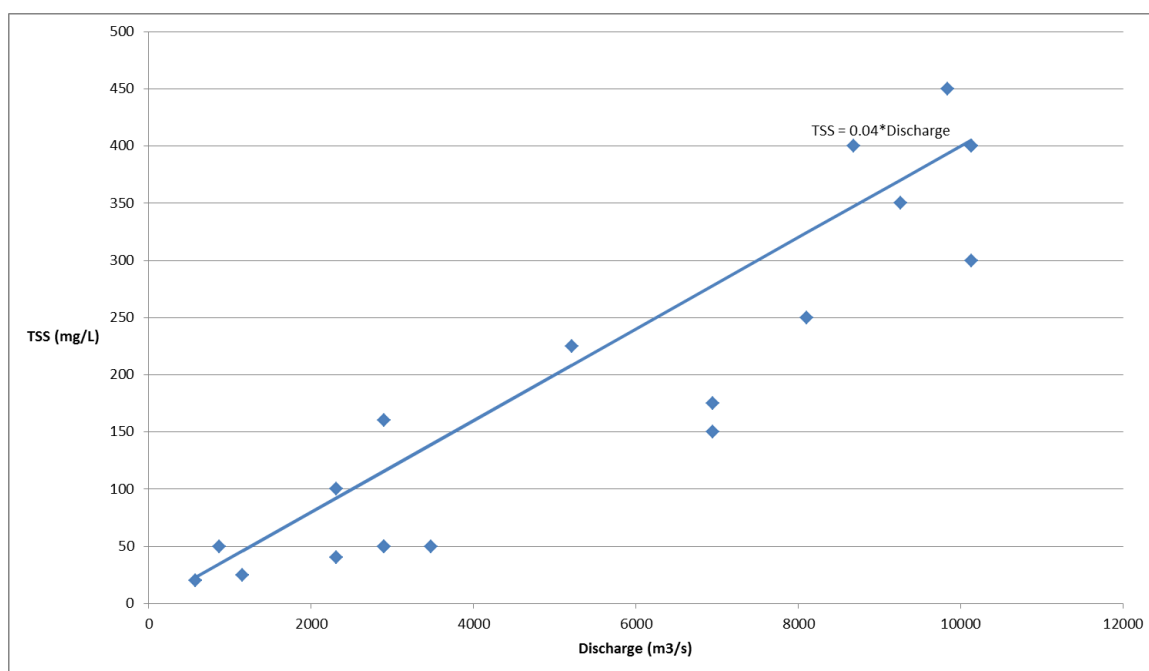


Figure 2-6 Burdekin River Sediment Rating Derived from Bainbridge et al. (2012)

Catchment inflow boundary conditions were applied as time-varying inputs extracted for the selected simulation periods and represent best-estimates of actual catchment flows at particular times rather than generalised or averaged inflows.

2.11 Material Properties

Within the TUFLOW FV model, various hydraulic properties, for example hydraulic roughness, can be assigned to groupings of model elements. This involves the specification of a spatial distribution of various material types with common properties. For example all model elements representing mangrove areas can be given a material type classification, from which it is possible to prescribe a common Nikuradse " k_s " roughness coefficient. A representation of this material classification adopted for the model is shown in Figure 2-7. This distribution was based on the bathymetry of the model, with three main areas defined as follows:

- Deep water: $k_s = 0.05\text{m}$;
- Reef: $k_s = 1\text{m}$ (to represent very low conveyance across under-resolved reef structures); and
- Rocky coast: $k_s = 0.5\text{m}$.

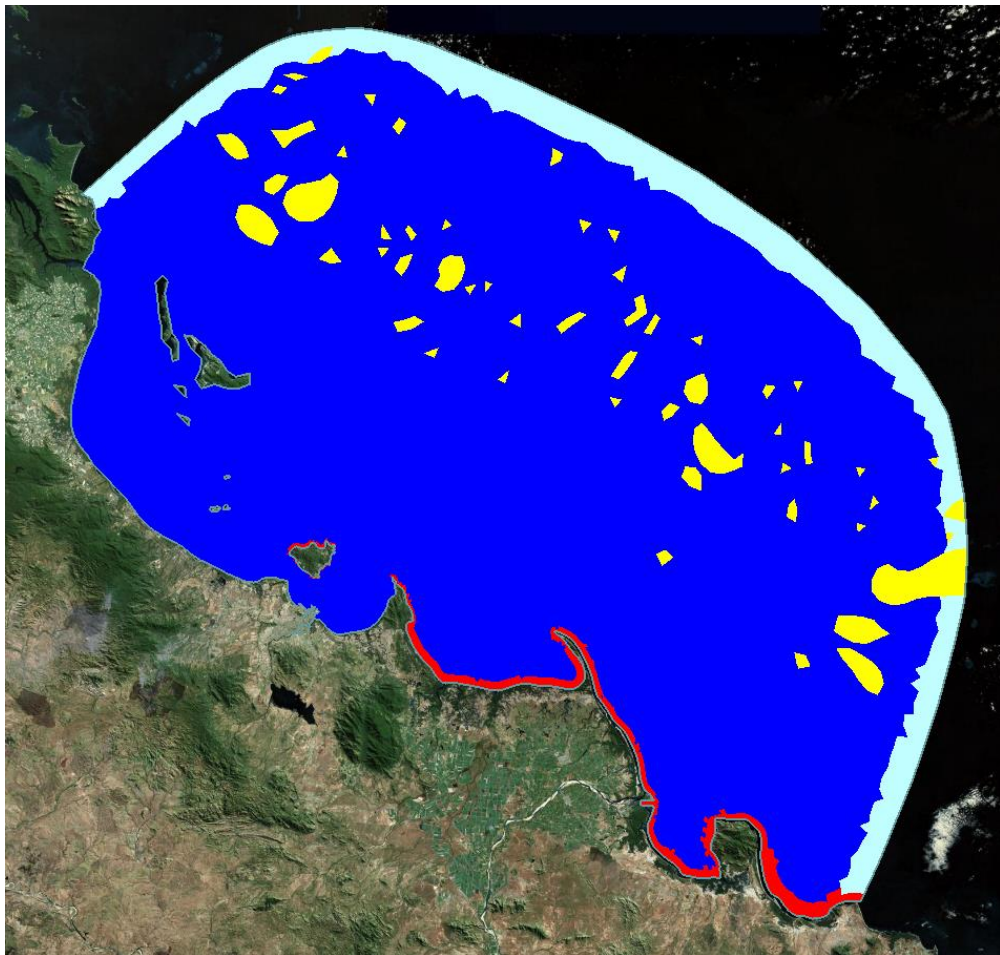


Figure 2-7 Material Distribution
Deep Water (Dark Blue), Reef (Yellow), and Rocky Coast (Red)
(Light Blue Areas Represent Boundary Regions)

2.12 Comparison of Modelling Methodology with EIS

A number of changes have been made to the numerical modelling methodology in the AEIS. Some of the changes are in order to satisfy requirements of the GBRMPA Guidelines (GBRMPA, 2012), while others have been implemented in response to feedback from EIS submissions. The most significant changes include:

- Ocean current forcing is now included on the open boundaries (Section 2.8).
- All dredge plume modelling was undertaken with both dredged and ambient sediment explicitly included. This allows for mixing of ambient and dredged sediment in the model and improves the accuracy of resuspension dynamics.
- The impact assessment methodology for dredging plumes is substantially different, and now includes a 'moving window' analysis of the change in turbidity and deposition rate percentiles due to dredging (Section 6.2.5). The collection of 12 months of ambient turbidity data has allowed impact thresholds to be derived (see the Water Quality and Ecology EIS Chapters for details).
- The model has been recalibrated for ambient sediment resuspension using the full 12 month set of water quality measurements (Section 3.4).
- A full 12 months of resuspension of dredged sediment has been analysed, rather than one month. This allows for a wider range of hydrodynamic conditions and provides a fuller description of the long term fate of dredged sediment.
- Maintenance dredging is now explicitly included in the modelling assessment and the cumulative impacts of capital and maintenance dredging are assessed.
- The modelling of the dredging program is now much more detailed with respect to the volumes of each type of material to be dredged. The available geotechnical information was used to estimate the volume of each type of material in each segment of the channel, and the source rate and particle size distribution of the dredging plume varied according to the type of material being dredged.

2.13 GBRMPA Guidelines Cross-Check

Table 2-1 provides a cross-check of the modelling approach applied in the PEP AEIS with the GBRMPA hydrodynamic modelling guidelines (GBRMPA, 2012).

Table 2-1 GBRMPA Guidelines Cross-Check Summary

Guideline Reference/s	Guideline Requirement	How Addressed	Report Section/s
2, 5	3D Hydrodynamic Model	All AEIS modelling assessments undertaken using 3D TUFLOW FV HD Model.	2.2
5	3D Sediment Plume Modelling	All AEIS plume modelling assessments undertaken using 3D TUFLOW FV ST Model.	2.1

Guideline Reference/s	Guideline Requirement	How Addressed	Report Section/s
6	Tidal forcing	Model uses spatially varying tidal forcing.	2.6
6	Wind forcing	Spatially and temporally varying wind field.	2.9
6	Wave forcing	SWAN wave model coupled with HD and ST models.	2.4
6	Ocean Current Forcing	Model simulates ocean currents. Uses HYCOM forcing at open boundaries.	2.8
6	Stratification represented	GOTM turbulence model with salinity/temperature density coupling, Burdekin River flows.	2.7
7	Hydrodynamic Calibration	HD model calibration undertaken. Independent validation undertaken.	3.1.3
7	Sediment Plume Calibration	ST model calibrated against long-term ambient turbidity datasets. Model validation performed against 2011 maintenance dredging monitoring data.	3.4 3.3
8	Wave-Current induced bed shear stress	Represented using Soulsby (1997).	3.4
8	Wave-induced mud fluidization	Wave induced resuspension mechanism included. Model calibrated/validated to suspended sediment measurements over multiple wave events.	3.4
10, 11, 12	Baseline Data	6-12 month baseline hydrodynamic datasets. 12 month baseline water quality dataset.	3.1.1
13a-c	Sediment Transport Modelling of multiple particle sizes	3 ambient sediment size fractions represented.	3.4
13d	Sediment size of material to be dredged	Additional 3 dredge sediment size fractions represented.	3.3
13e	Accurately represent ambient conditions	Model calibration/validation shows acceptable performance over a range of ambient conditions.	3.4
13e	Representative impact assessment periods.	Consideration of representativeness of impact assessment period in context of long-term climate.	4.1
13f	Represent dredging sediment sources	Source rates based on plume monitoring, advice from dredging consultant and industry experience.	6.2.3
13g	Duration of simulations	Simulations were conducted for the	6.3

Guideline Reference/s	Guideline Requirement	How Addressed	Report Section/s
		entire PEP dredging program.	
14c	Model horizontal resolution	Flexible mesh model (TUFLOW FV) with sufficiently high resolution in key areas of interest. Sufficiently large domain to consider long term and far field fate of sediment.	2.2
14a-b	Model vertical scheme/resolution	Hybrid z-coordinate scheme with sigma surface layers. Up to 34 layers depending on depth.	3.1.2
15	Range of impact levels assessed	Range of physical impacts assessed in modelling report. Water Quality and Marine Ecology impacts derived from model outputs as described in those respective AEIS chapters.	4 5 6
2, 3, 4, 16	Spatially based impact assessments	Model output used to derive spatial contours of change to turbidity and sedimentation rate percentiles as a result of dredging activities. Spatial Zone of Influence also derived from model output.	6.3
16	Extent, severity & Duration of impacts assessed	30 day percentiles analysis of the model output was used to derive the extent, severity and duration of turbidity impacts in the context of ambient turbidity statistics derived from baseline data. See also the Water Quality and Marine Ecology chapters.	6.2.5
9	Impact zoning scheme	Model outputs used to inform an impact zoning scheme as described in the Water Quality and Marine Ecology chapters.	AEIS Chapters
16	"Best Case" and "Worst Case" Scenarios	Expected Case and Worst Case Scenarios assessed through an ensemble modelling approach.	6.3 6.4 6.5
17	Impact thresholds	Impact thresholds derived from site specific baseline water quality data and biological criteria derived from literature. These are detailed in the Water Quality chapter.	AEIS Chapters
18	Sensitive receptors	Impact zones have been overlaid on sensitive habitat maps in the Marine Ecology chapter.	AEIS Chapters
19	Map output	Impact zone maps will be made available to GBRMPA in a suitable GIS format.	NA
20	Mid-depth and near sea	Turbidity impact maps have been	6.3

Guideline Reference/s	Guideline Requirement	How Addressed	Report Section/s
	floor turbidity impacts assessed	prepared for depth-average and nearbed.	6.4 6.5
20	Sedimentation assessed	Sedimentation rate increases due to dredging and total sedimentation attributable to dredging have been derived.	6.3 6.4 6.5
20	Timeseries outputs	Timeseries outputs of turbidity at key locations.	6.3 6.4 6.5
21	Units consistency	Water Quality modelling assessments output in turbidity units (consistent with baseline datasets). Sedimentation assessments output in rate units of mg/cm ² /day.	6.3 6.4 6.5
23	Independent peer review	Independent peer review completed by Doug Treloar	NA

3 Model Calibration and Validation

3.1 Hydrodynamic Model Calibration and Validation

3.1.1 Calibration and Validation Data

During PEES a bottom-mounted ADCP was deployed in Cleveland Bay in the vicinity of Platypus Channel, from the 4th September 2008 to the 11th February, 2009. The deployment location was chosen to provide representative current and wave conditions in central Cleveland Bay at a water depth of approximately 5m. This deployment provided a range of tide, wind and wave conditions during typical (but different) spring and summer periods.

In addition, the model has been validated against ADCP data collected at two other locations between October 2010 and February 2011. One ADCP was deployed near the eastern shore of Magnetic Island, and the other was deployed at the existing DMPA location. These ADCP deployment sites are shown in Figure 3-2. The data retrieved has been processed and analysed to provide the appropriate parameters necessary for model calibration and validation purposes.

Simultaneous regional data has also been collated from other sources including:

- Offshore wave data from the Waverider buoy maintained by the Department of Science, Information Technology and Innovation (DSITI); and
- Tide level data from regional tide gauges.

This data has also been used as part of the model calibration and validation process where needed.

With respect to waves, the Townsville Waverider buoy (DSITI) is located about 25 km east of the port, 5 km north of Cape Cleveland where the water depth is approximately 15m. Therefore it does not provide a direct indication of the wave climate within Cleveland Bay or at the study site. Therefore, in addition to collecting current data, the ADCPs deployed in this study also measured local wave conditions.

3.1.2 Model Parameterisation

The TUFLOW FV model was run in 3D hydrodynamic mode using a z-coordinate scheme with layer thicknesses of less than 1 m down to an elevation of -13 m AHD and 2 m or less down to an elevation of -25 m AHD. A maximum of 30 layers were resolved in the deeper sections of the model domain, with the bottom layer thickness varying according to the local depth below -25 m AHD. This high degree of vertical resolution in the top 25 m of the water column was necessary in order to simulate vertical stratification within the water column. This also allowed for detailed representation of the vertical distribution of dredge plume suspended sediment.

Salinity and temperature were simulated within the model as density-coupled scalar constituents in order to incorporate baroclinic density gradient forcing and more-importantly the effect of vertical density stratification on the water-column turbulence.

The General Ocean Turbulence Model was coupled with the hydrodynamic model for the purposes of deriving vertical turbulent mixing parameters. A 2-equation k-omega model was adopted with default parameters.

3.1.3 Hydrodynamic Model Calibration Results

The model was run in 3D baroclinic mode over two calibration periods from 1st October 2008 to 1st November 2008 and from 1st December 2010 to 1st February 2011. These periods incorporated representative spring and neap tide conditions and a range of meteorological conditions. This enabled assessment of the ability of the model to adequately represent a range of conditions and its suitability for use in impact assessments.

The calibration and validation results in terms of comparison of simulated water levels and velocities against observed data are presented in the following sections.

3.1.3.1 Water Levels

Validation plots of observed versus simulated water levels are shown in Figure 3-1 for the Townsville storm tide gauge (marked as 'Townsville Gauge' in Figure 3-2), for representative spring and neap tide conditions. Both figures show that the modelled water levels are consistent with measurements in terms of phasing and amplitude.

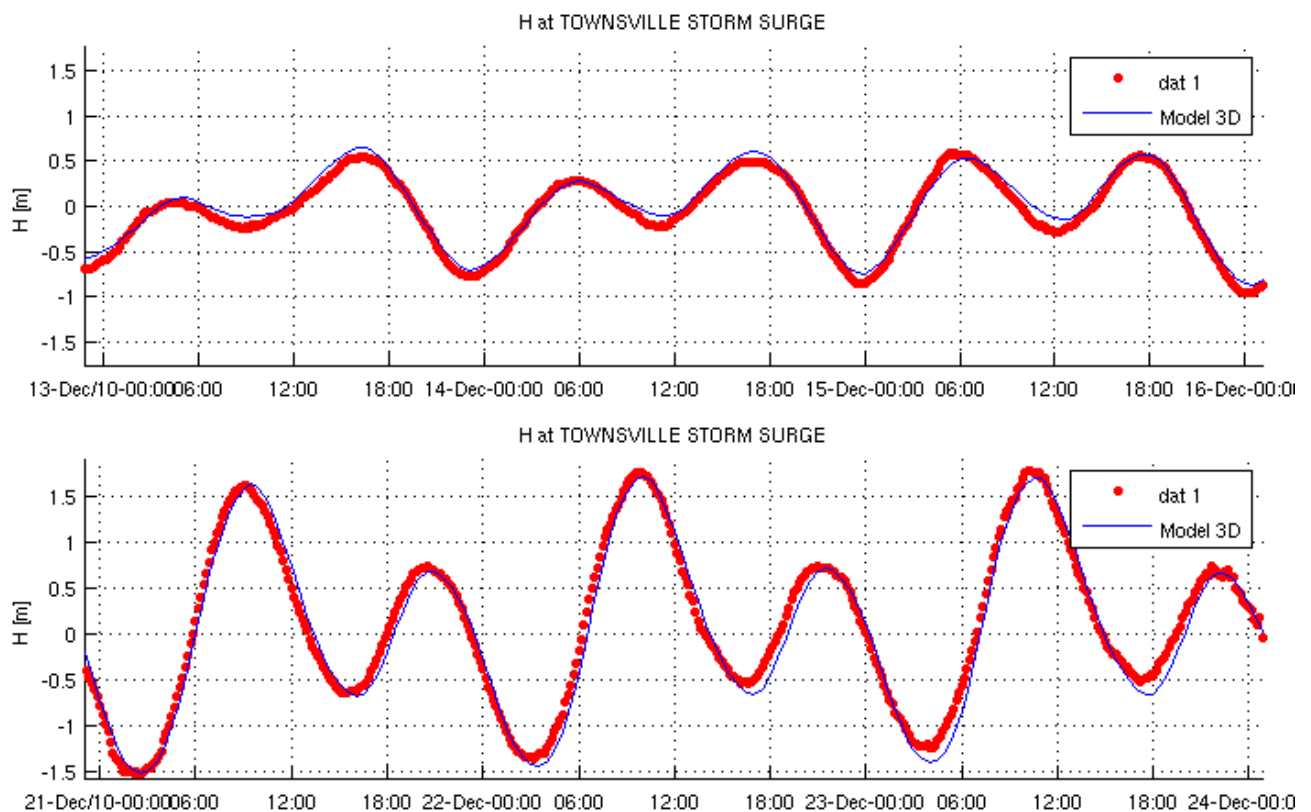


Figure 3-1 Water Level Validation – Townsville Storm Surge Gauge (2010)

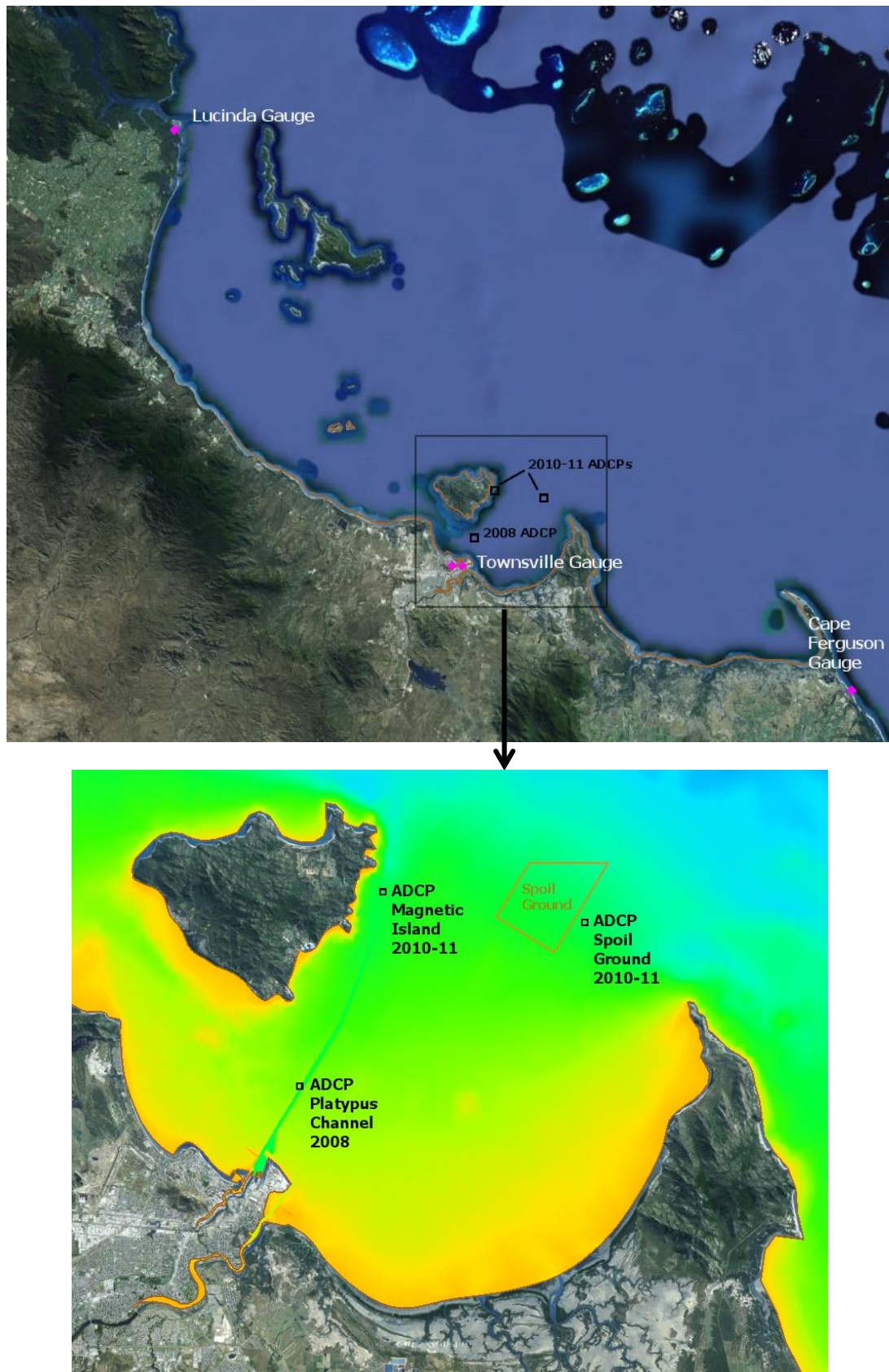


Figure 3-2 Location of Model Calibration Points

3.1.3.2 Water Temperature

A comparison of modelled temperature from the summer 2010/11 validation period with measurements from the AIMS Cape Cleveland station is shown below. Following an initial over-prediction in temperature the model can be seen to be in reasonable agreement with the measurements.

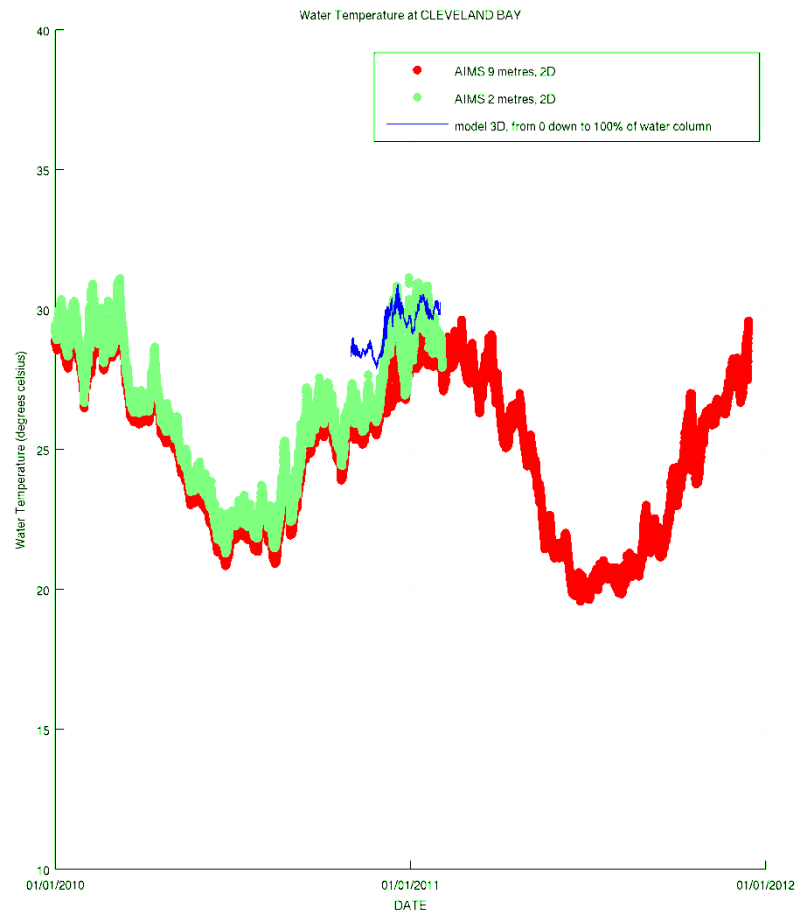


Figure 3-3 Temperature Validation – AIMS Cape Cleveland Station

3.1.3.3 Salinity

The summer of 2010/11 was one of the wettest on record for the study area and resulted in significant flood flows from the major Burdekin River catchment which discharges into the Great Barrier Reef lagoon approximately 100km south-east from Townsville. Bainbridge et al. (2012) have described a campaign of measurements focussed on the Burdekin River plume during this period, and include comparisons with a series of MODIS satellite images of the plume.

Figure 3-4 shows a surface salinity plot from the TUFLOW FV model for the 4th of January 2011 together with the MODIS satellite image from the same date (<http://oceancolor.gsfc.nasa.gov/>). These model results show reasonably good qualitative agreement with the plume spatial distributions which are discernible from the MODIS satellite images. The remaining surface salinity snapshots for comparison with the Bainbridge et al. Figure 3 are provided in Attachment B of this appendix.

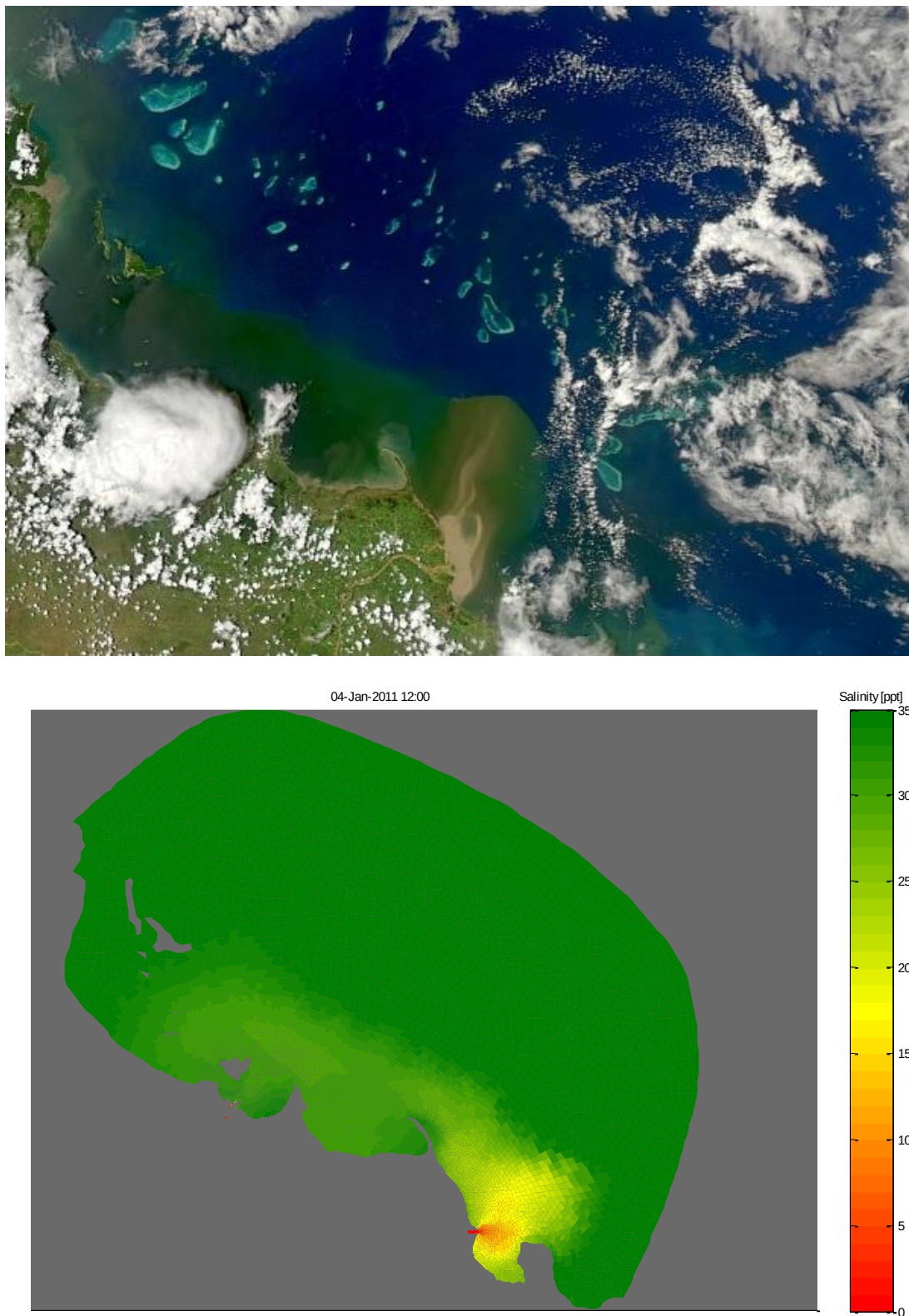


Figure 3-4 Modelled Surface Salinity on the 4th January 2011 (bottom) and the MODIS Satellite Image for the Same Date (top).

3.1.3.4 Current Velocities

Model outputs were compared against the ADCP current velocity magnitude and direction measurements (see Figure 3-2 for ADCP locations). The ADCP data was post processed to provide time series averages of the velocities in the top 50% and bottom 50% of the profile, to allow comparison with the three dimensional output of the model.

Vertical variations in current speed and direction that were indicative of stratification within the water column were sometimes observed in the measured ADCP data, particularly from the 2010-11 summer/wet season deployments. An example velocity profile measured at the DMPA ADCP is shown in Figure 3-5, and can be seen to illustrate the degree of vertical current profile variation that occurred during the significant catchment runoff events in January 2011. Also shown in this figure are the model predictions which demonstrate that the turbulence scheme is able to successfully capture these processes.

The time series model versus data comparisons are shown in Figure 3-6 to Figure 3-11. It can be seen that the velocity magnitude predicted by the TUFLOW FV model is generally within the bounds of the accuracy of the recorded data. In particular, spring tide conditions are reproduced accurately in terms of both timing and amplitude at all three ADCP locations.

Velocity directions are generally well reproduced by the model, except for the 2010 Magnetic Island data where the model sometimes misses the full rotation of the velocity vectors. Overall the model predicts the general hydrodynamic characteristics within the region of interest with sufficient detail for the purposes of this study.

During the 2010 monitoring campaign it is understood that the salinity influence from the Burdekin River flood plume may have begun to influence the DMPA and Magnetic Island monitoring sites from around the 9th December. At this time, the surface currents at the DMPA site are seen in both the data and the model predictions to “decouple” from the near-bed currents. While the agreement at the DMPA site is good the model skill at predicting the Magnetic Island ADCP current behaviour is not as good as for the preceding period.

Current roses for the top and bottom 50% of the profile at the ADCP deployment locations are presented in Figure 3-12 to Figure 3-17. The top panel is the model output, and the bottom panel is the measured ADCP data.

Agreement between the model and data for both directions and magnitudes is excellent for the 2008 data collected near the Platypus Channel.

Compared to the data at the Magnetic Island location in 2010, the model does a good job of estimating current magnitudes, but tends to overestimate the directional spread in the bottom 50% of the water column and underestimate the spread in the top 50% of the water column.

At the DMPA location, the model underestimates the directional spread in the bottom 50% of the water column and slightly underestimates velocity magnitudes in some directions. In the top 50% of the water column at the DMPA, velocity magnitudes for currents travelling towards the West are somewhat underestimated, and the predominant direction is biased slightly to the south with respect to the data.

Overall, the model performance is considered to be acceptable for the purposes of the present study.

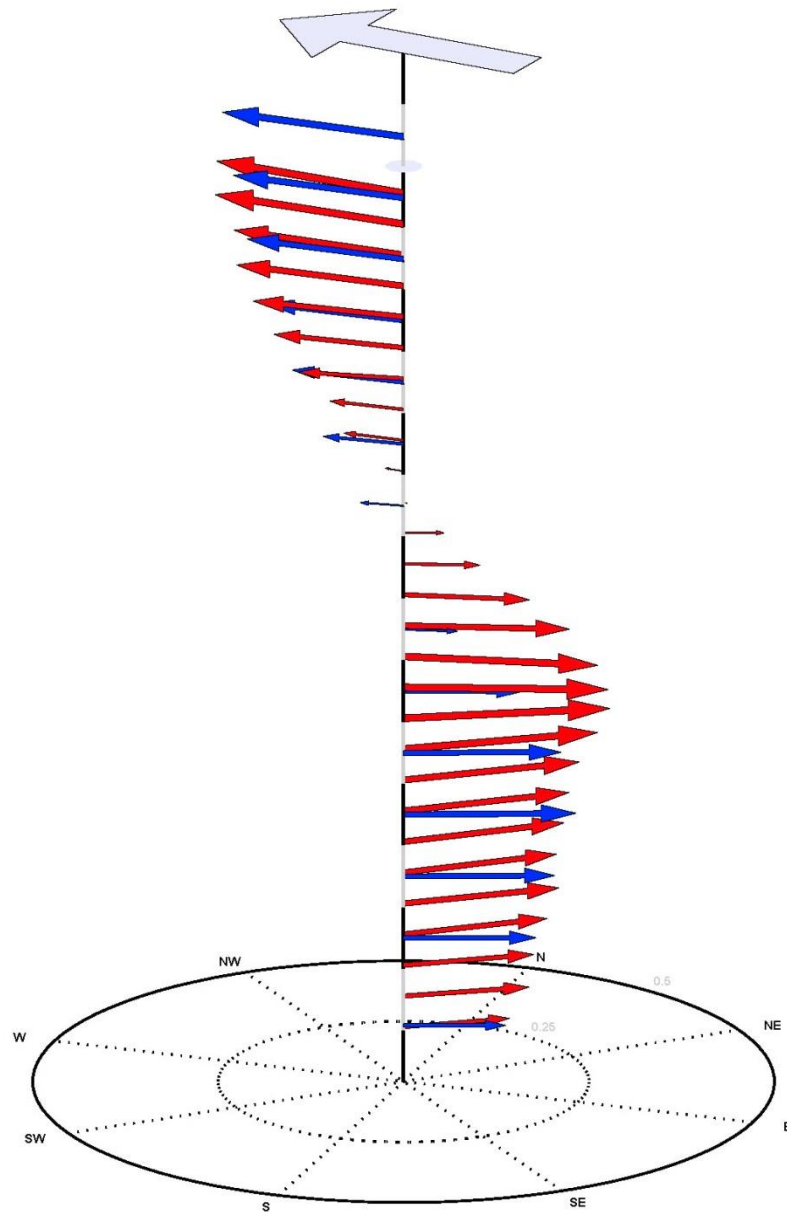


Figure 3-5 Velocity Profile at the DMPA ADCP
Blue Arrows – Model; Red Arrows – Data
The Grey Arrow at the Top of the Profile Indicates the Wind Direction

Model Calibration and Validation

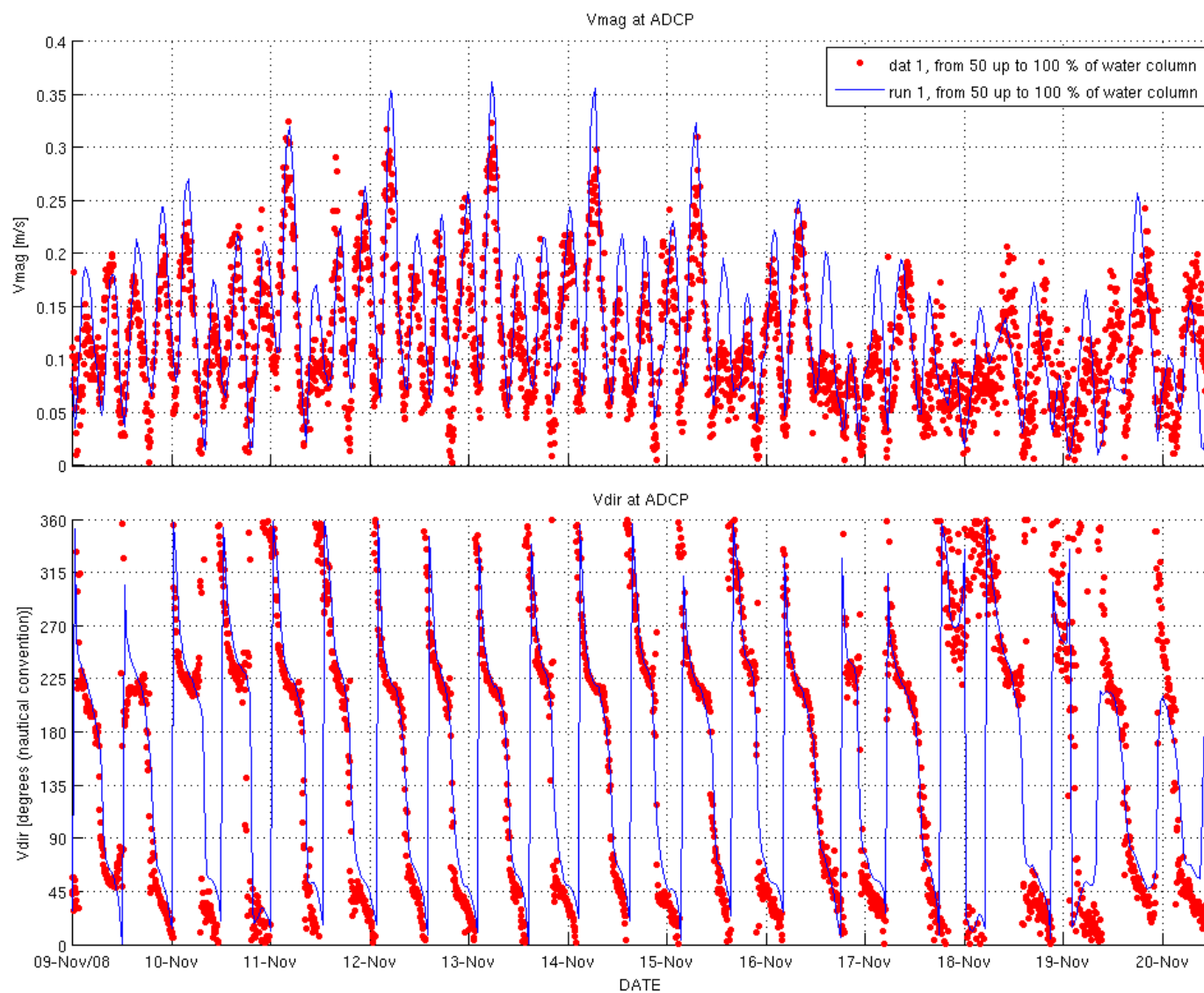


Figure 3-6 Velocity Magnitude Validation Time Series – 2008 PEES ADCP Data – Top 50%

Model Calibration and Validation

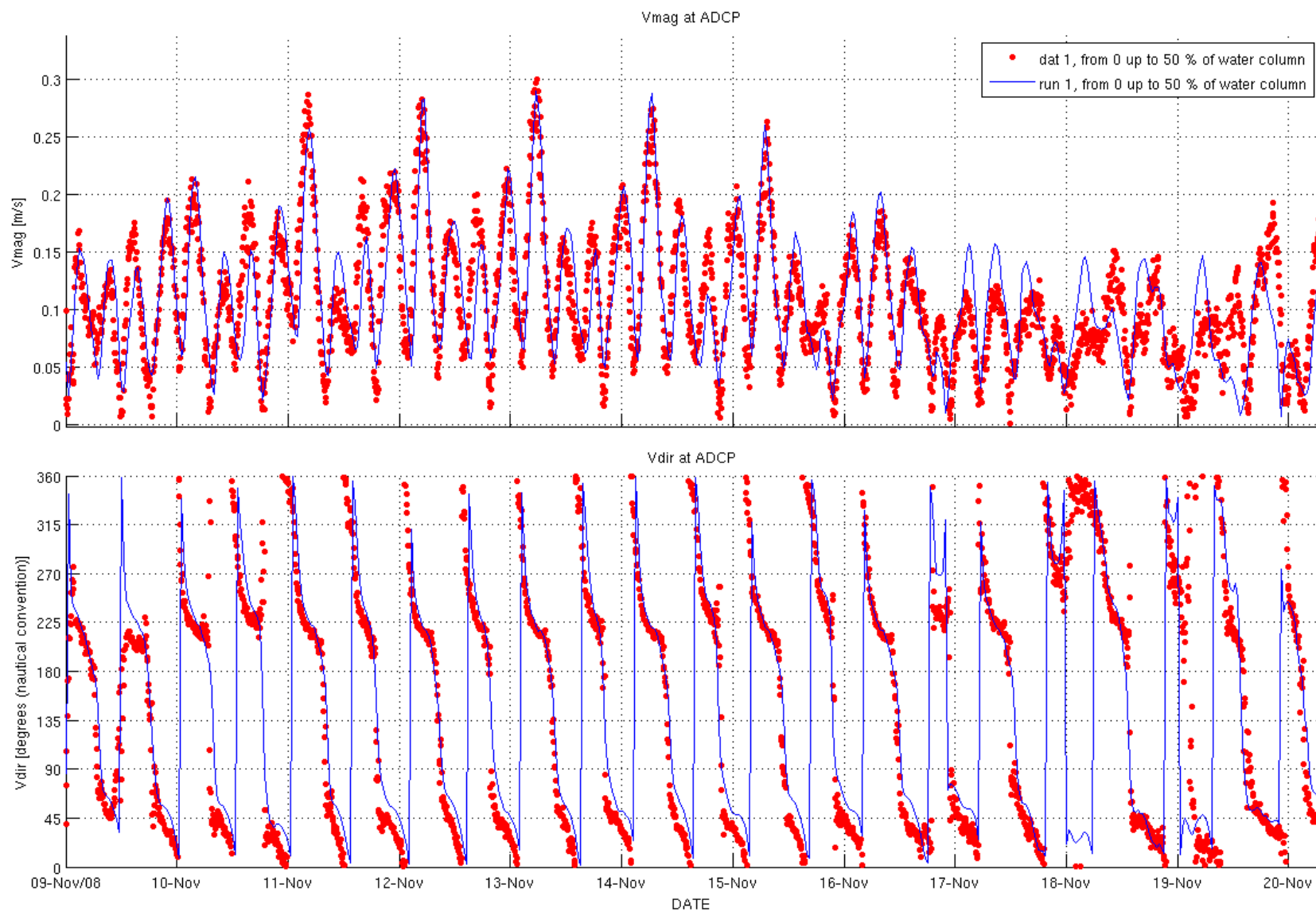


Figure 3-7 Velocity Direction Validation Time Series – 2008 PEES ADCP Data – Bottom 50%

Model Calibration and Validation

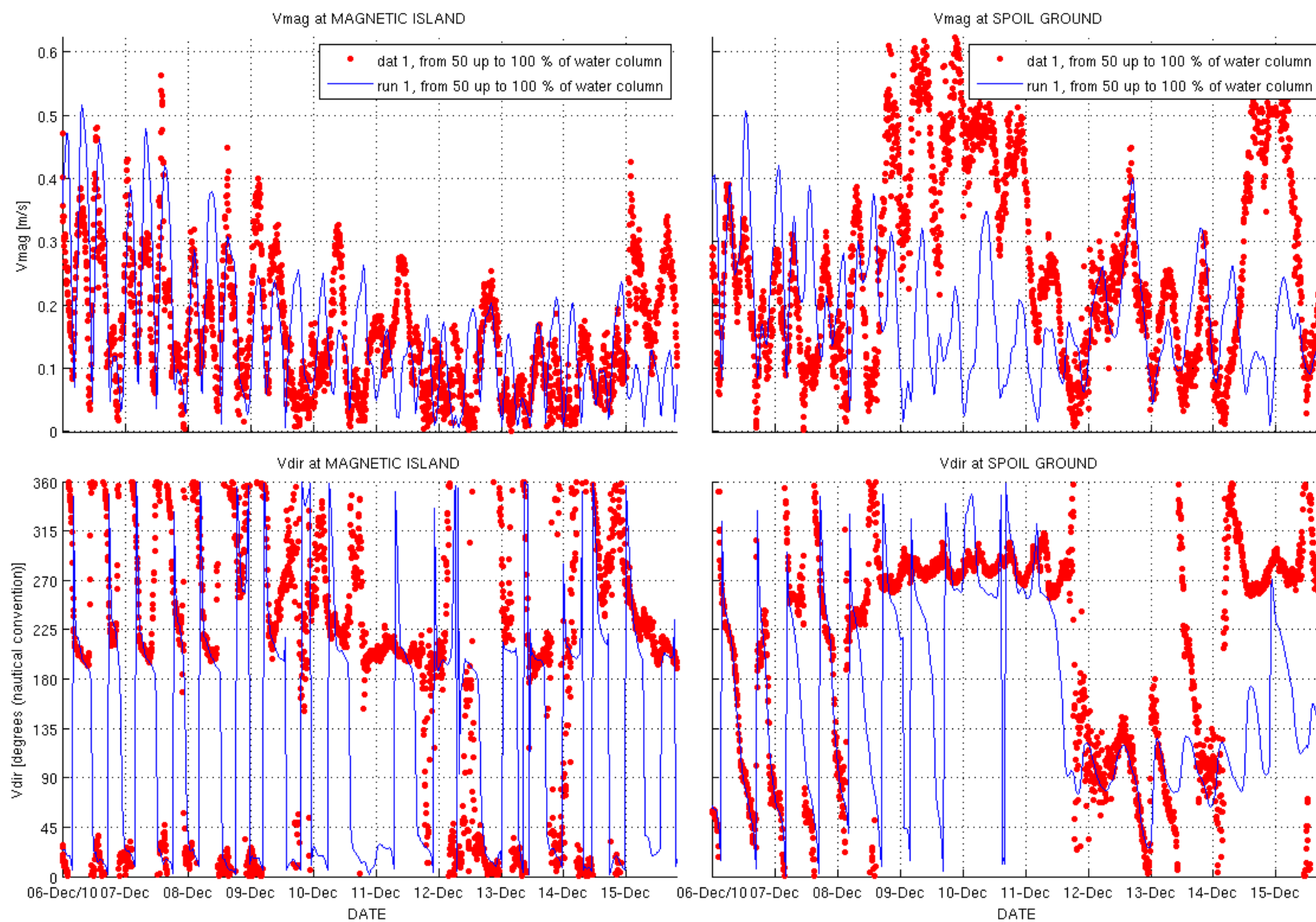


Figure 3-8 Velocity Validation Time Series – 2010 ADCP Data Top 50%, 6-16 December – Magnetic Island (Left) and DMPA (Right)

Model Calibration and Validation

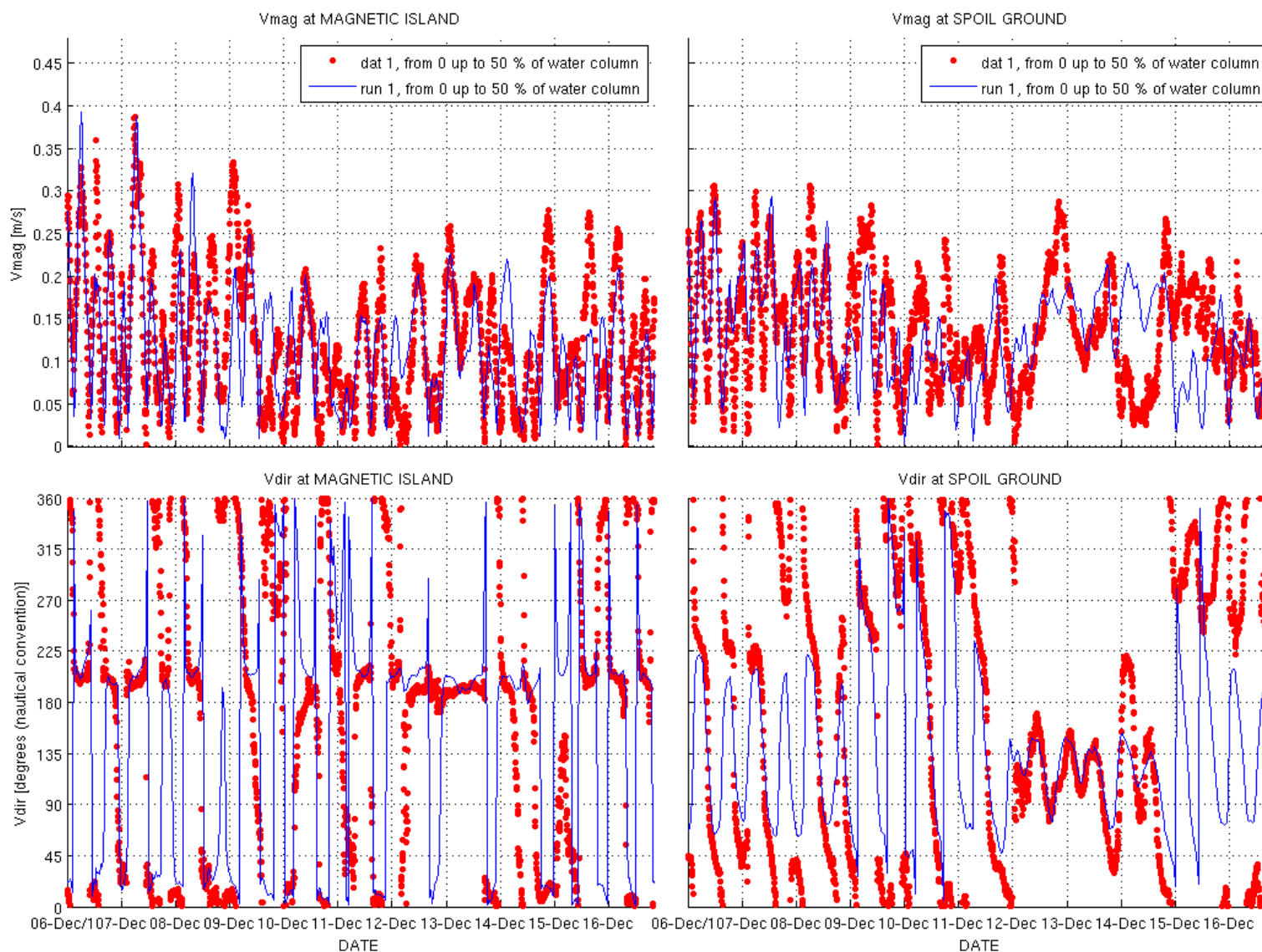


Figure 3-9 Velocity Validation Time Series – 2010 ADCP Data, Bottom 50%, 6-16 December – Magnetic Island (Left) and DMPA (Right)

Model Calibration and Validation

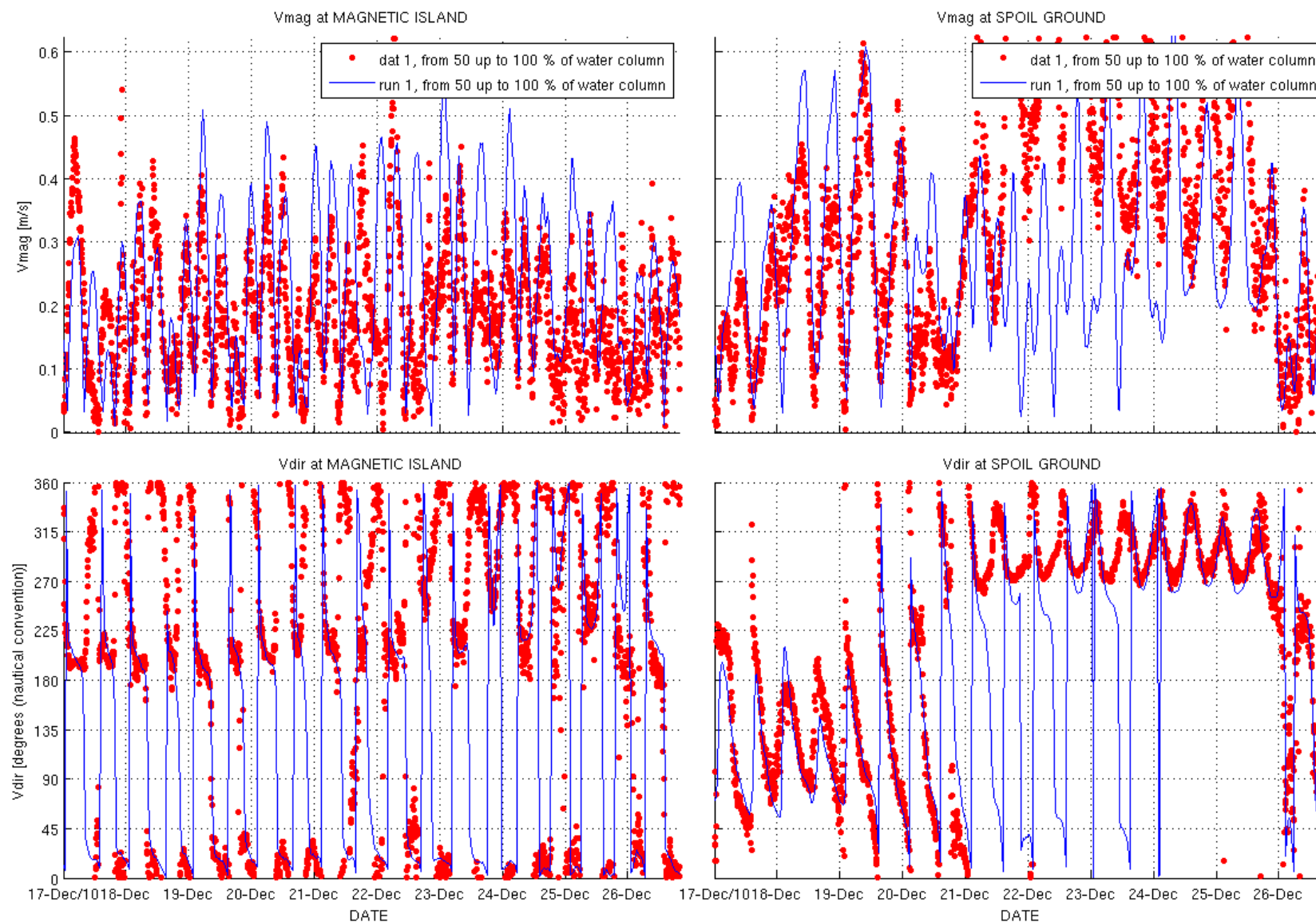


Figure 3-10 Velocity Validation Time Series – 2010 ADCP Data, Top 50%, 17-28 December – Magnetic Island (Left) and DMPA (Right)

Model Calibration and Validation

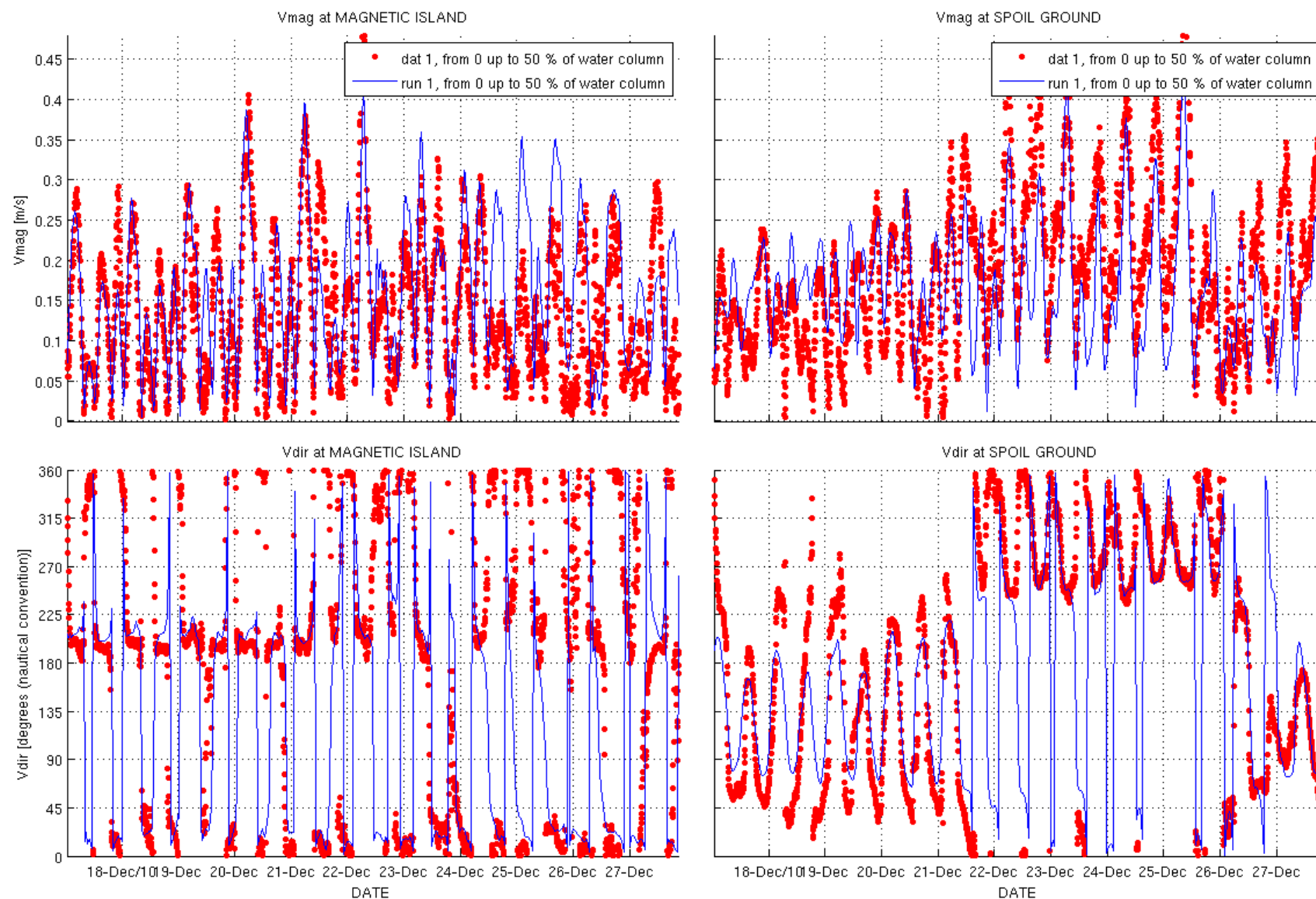


Figure 3-11 Velocity Validation Time Series – 2010 ADCP Data, Bottom 50%, 17-28 December – Magnetic Island (Left) and DMPA (Right)

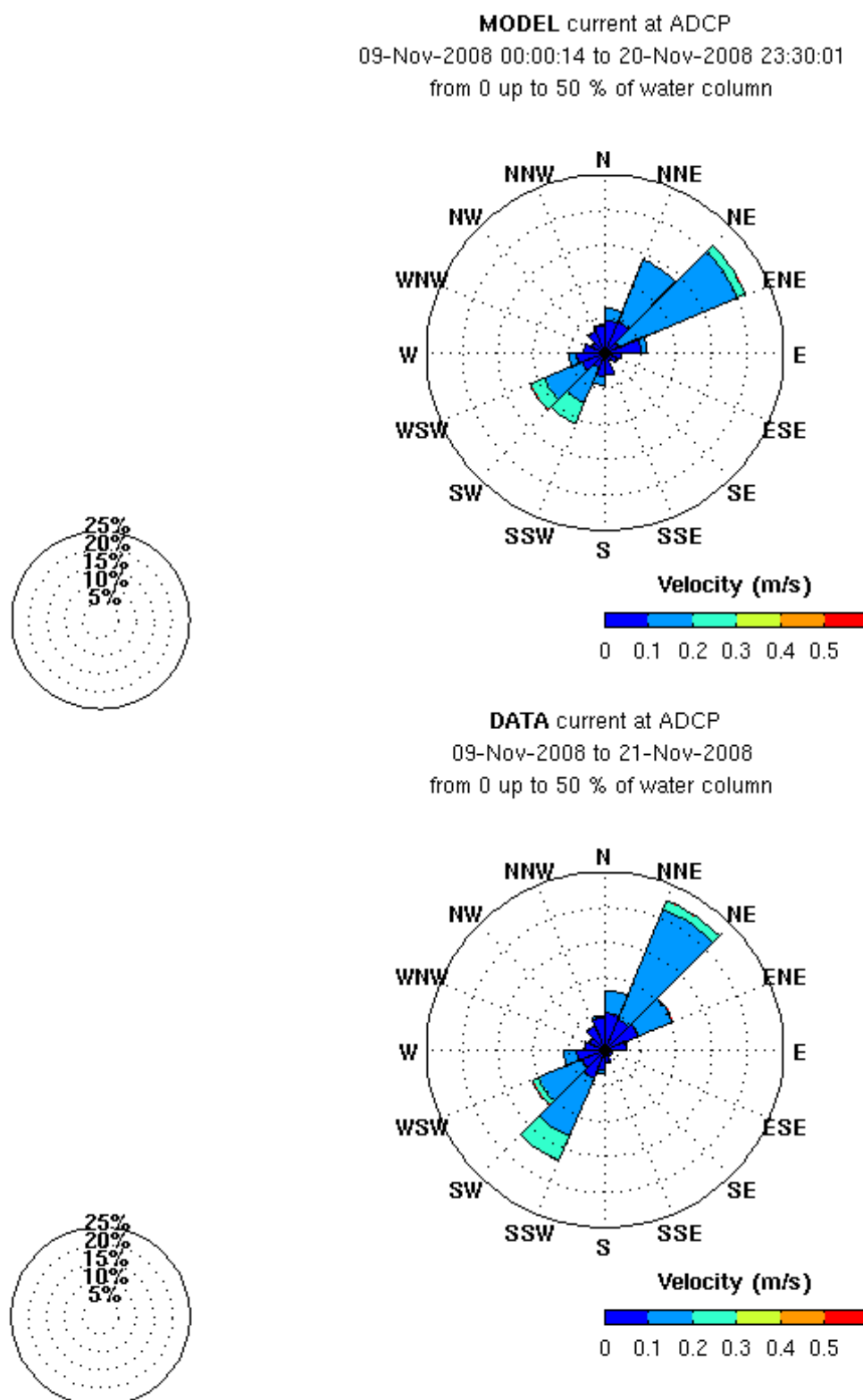


Figure 3-12 Velocity Validation Rose Plot – 2008 Platypus Channel ADCP Data – Bottom 50% Top – Model, Bottom – Data

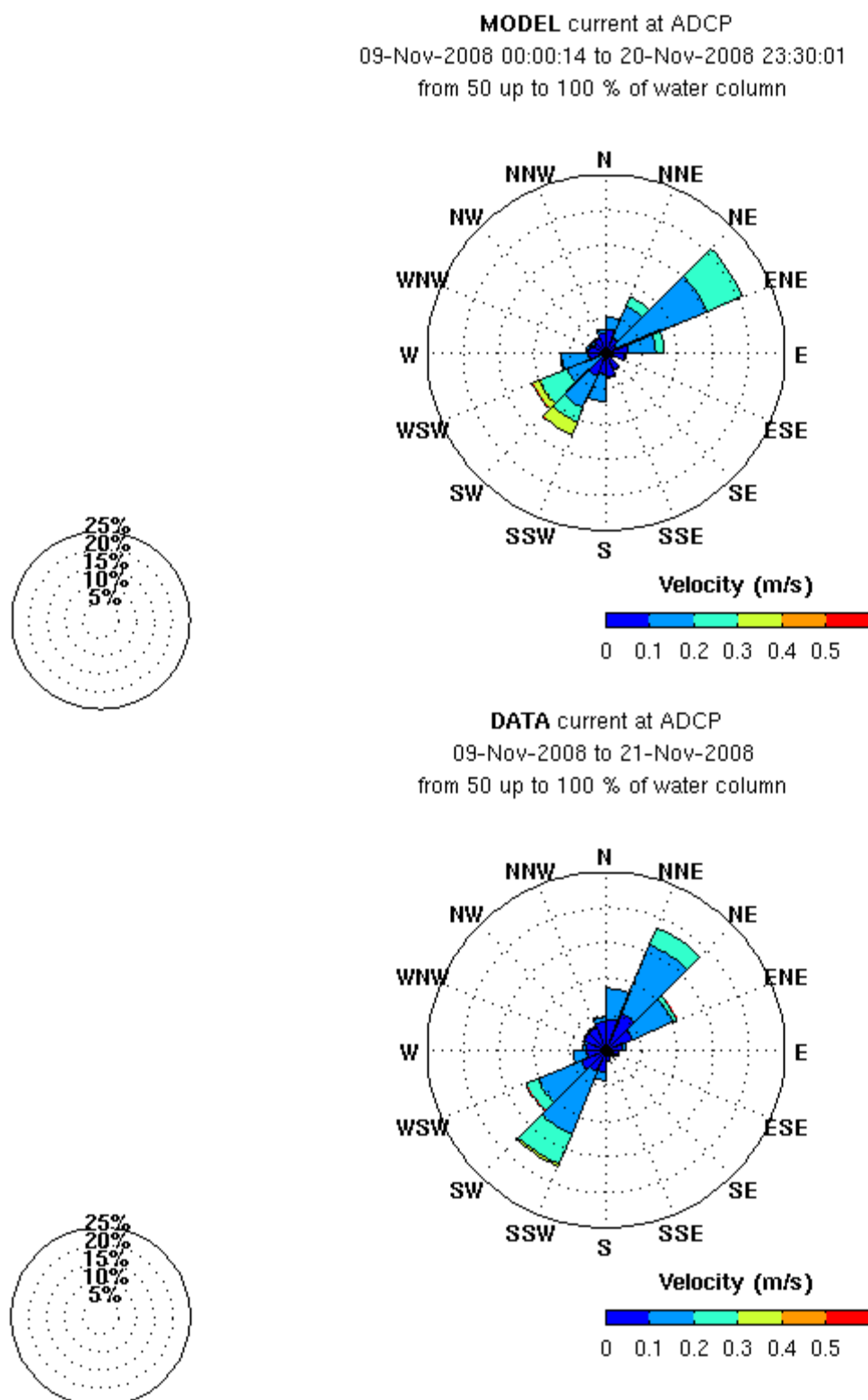
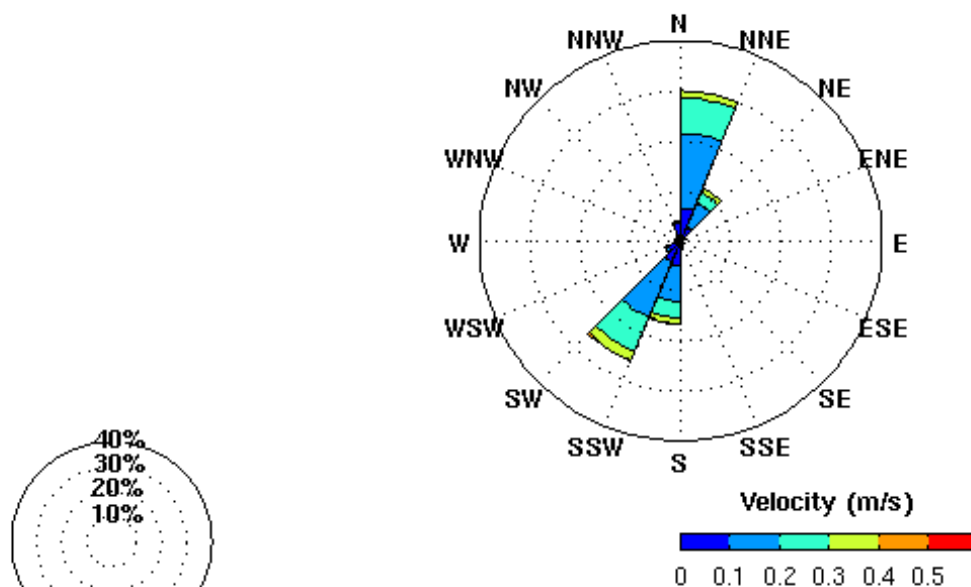


Figure 3-13 Velocity Validation Rose Plot – 2008 Platypus Channel ADCP Data – Top 50% Top – Model, Bottom – Data

MODEL current at MAGNETIC ISLAND
01-Dec-2010 00:00:08 to 31-Dec-2010 23:30:01
from 0 up to 50 % of water column



DATA current at MAGNETIC ISLAND
01-Dec-2010 00:00:01 to 31-Dec-2010 23:58:56
from 0 up to 50 % of water column

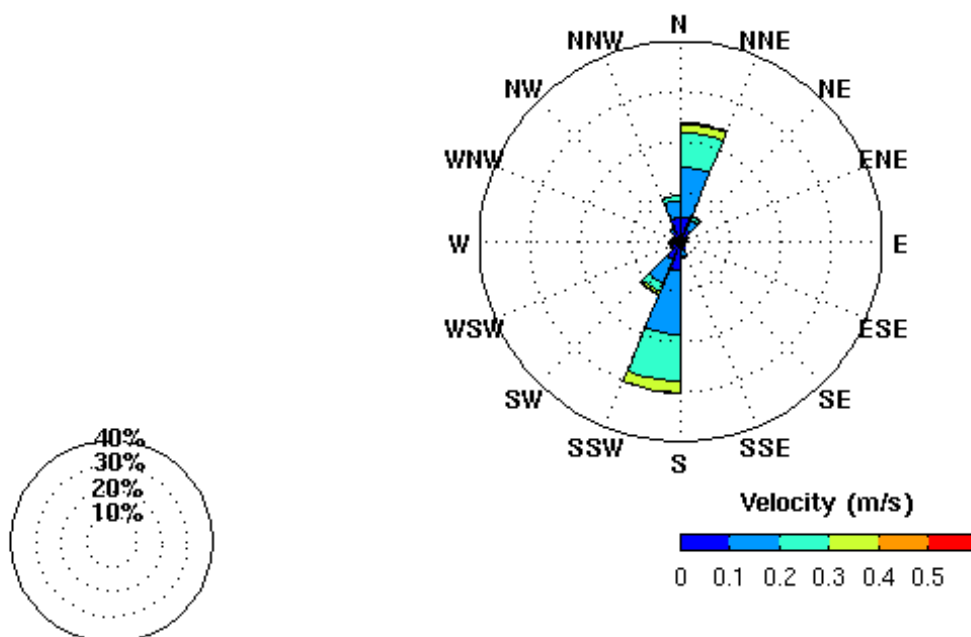
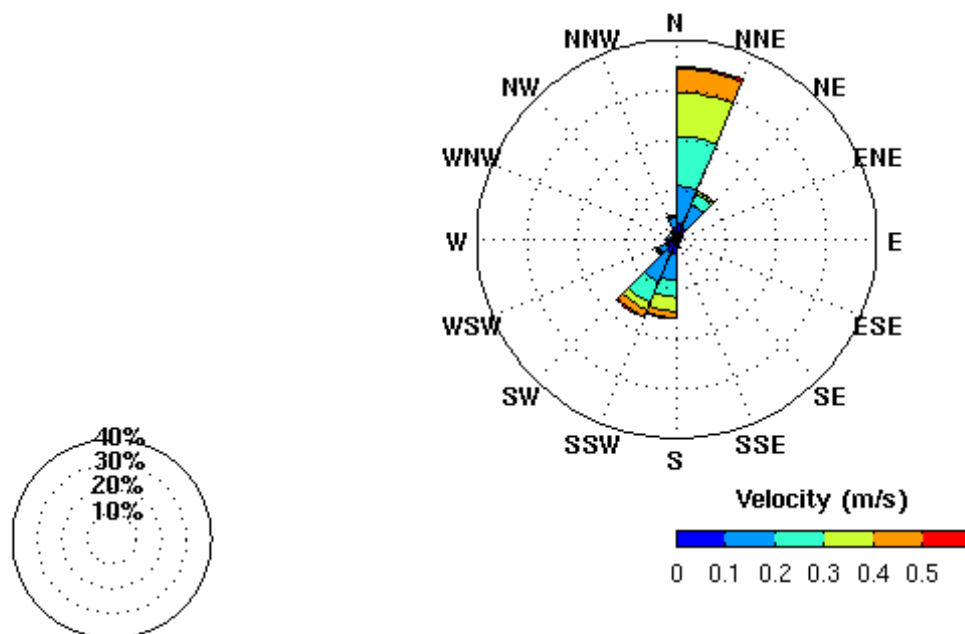


Figure 3-14 Velocity Validation Rose Plot – 2010 Magnetic Island ADCP Data – Bottom 50% Top – Model, Bottom – Data

MODEL current at MAGNETIC ISLAND
01-Dec-2010 00:00:08 to 31-Dec-2010 23:30:01
from 50 up to 100 % of water column



DATA current at MAGNETIC ISLAND
01-Dec-2010 00:00:01 to 31-Dec-2010 23:58:56
from 50 up to 100 % of water column

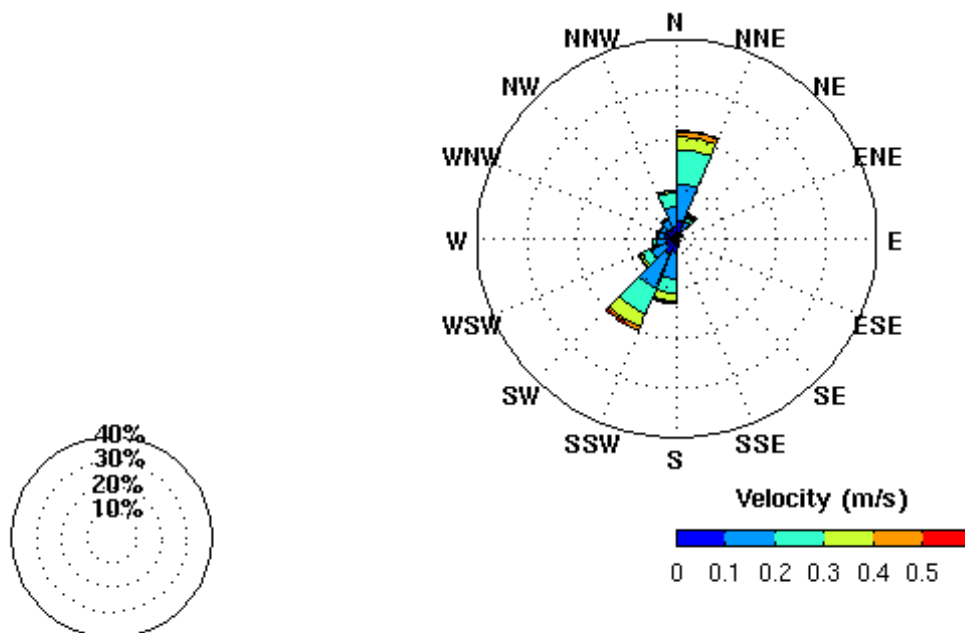


Figure 3-15 Velocity Validation Rose Plot – 2010 Magnetic Island ADCP Data – Top 50% Top – Model, Bottom – Data

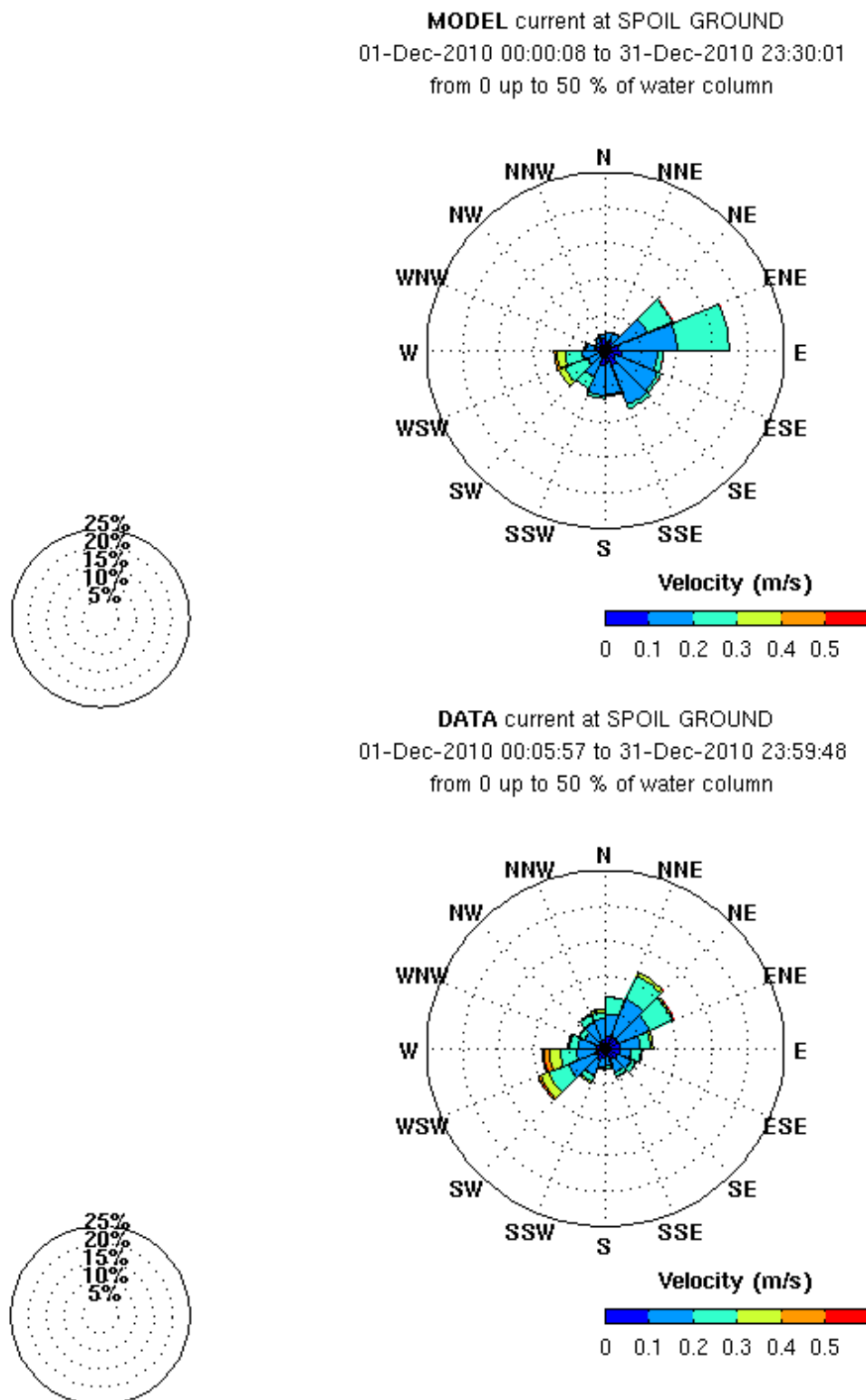
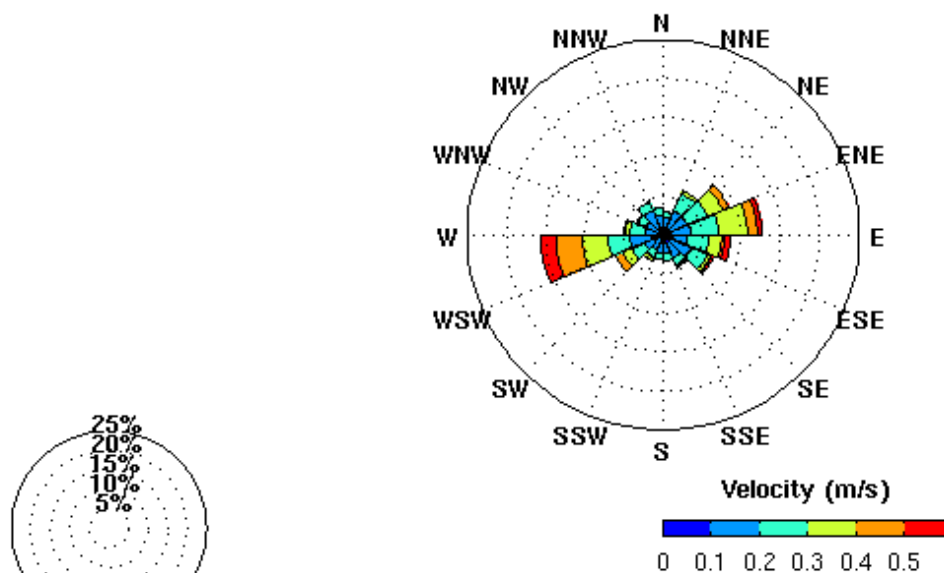


Figure 3-16 Velocity Validation Rose Plot – 2010 DMPA ADCP Data – Bottom 50% Top – Model, Bottom – Data

MODEL current at SPOIL GROUND
01-Dec-2010 00:00:08 to 31-Dec-2010 23:30:01
from 50 up to 100 % of water column



DATA current at SPOIL GROUND
01-Dec-2010 00:05:57 to 31-Dec-2010 23:59:48
from 50 up to 100 % of water column

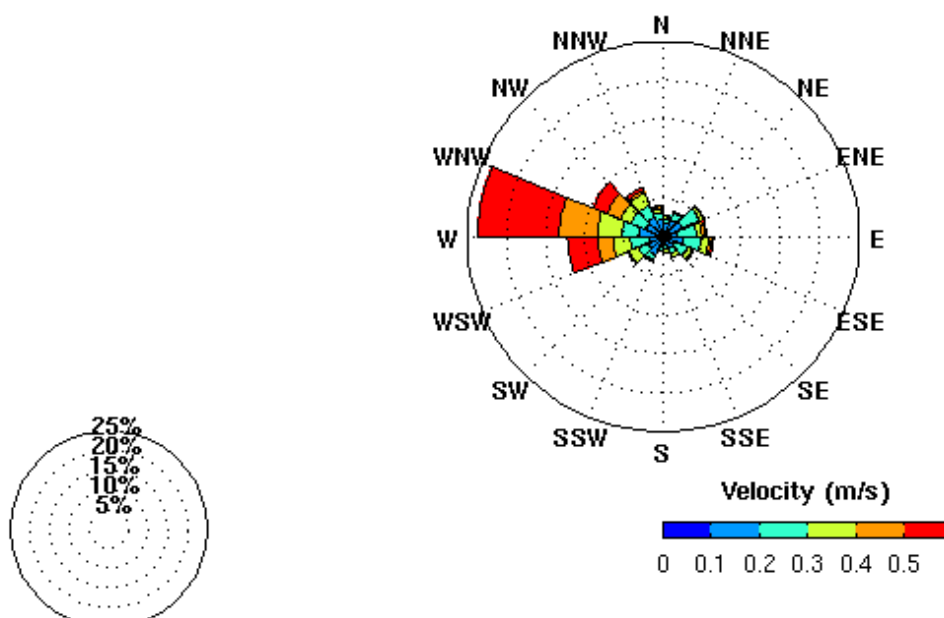


Figure 3-17 Velocity Validation Rose Plot – 2010 DMPA ADCP Data – Top 50% Top – Model, Bottom – Data

3.2 SWAN Wave Model Calibration Results

Measured wave data from the two ADCPs deployed in 2010 and from the DSITI Waverider Buoy were used to calibrate and validate the SWAN wave models (for deployment locations see Figure 3-2).

The results of the nested wave model calibration are shown in Figure 3-18, Figure 3-19 and Figure 3-20. Agreement between the measured and modelled wave heights, directions and peak periods is generally good, particularly with the DSITI wave buoy and the Magnetic Island ADCP. Some under-prediction bias is evident relative to the DMPA ADCP significant wave height measurements; however it is unclear why this would be significantly different from the DSITI wave buoy which was located within a relatively short distance of the DMPA. Some under-prediction bias is probably attributable to the non-stationary assumptions made in the wave model predictions.

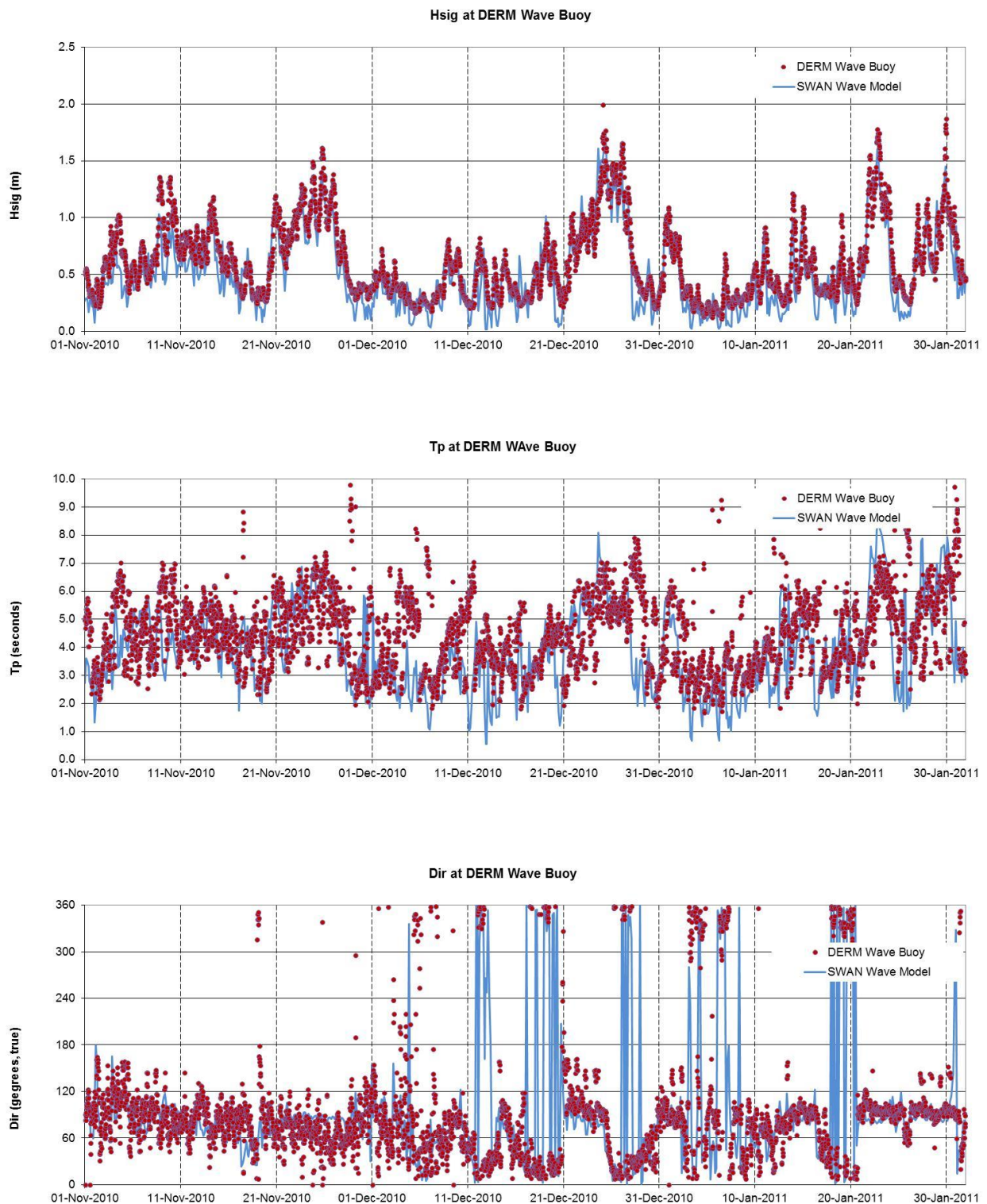


Figure 3-18 Wave Model Calibration – DSITI Waverider Buoy

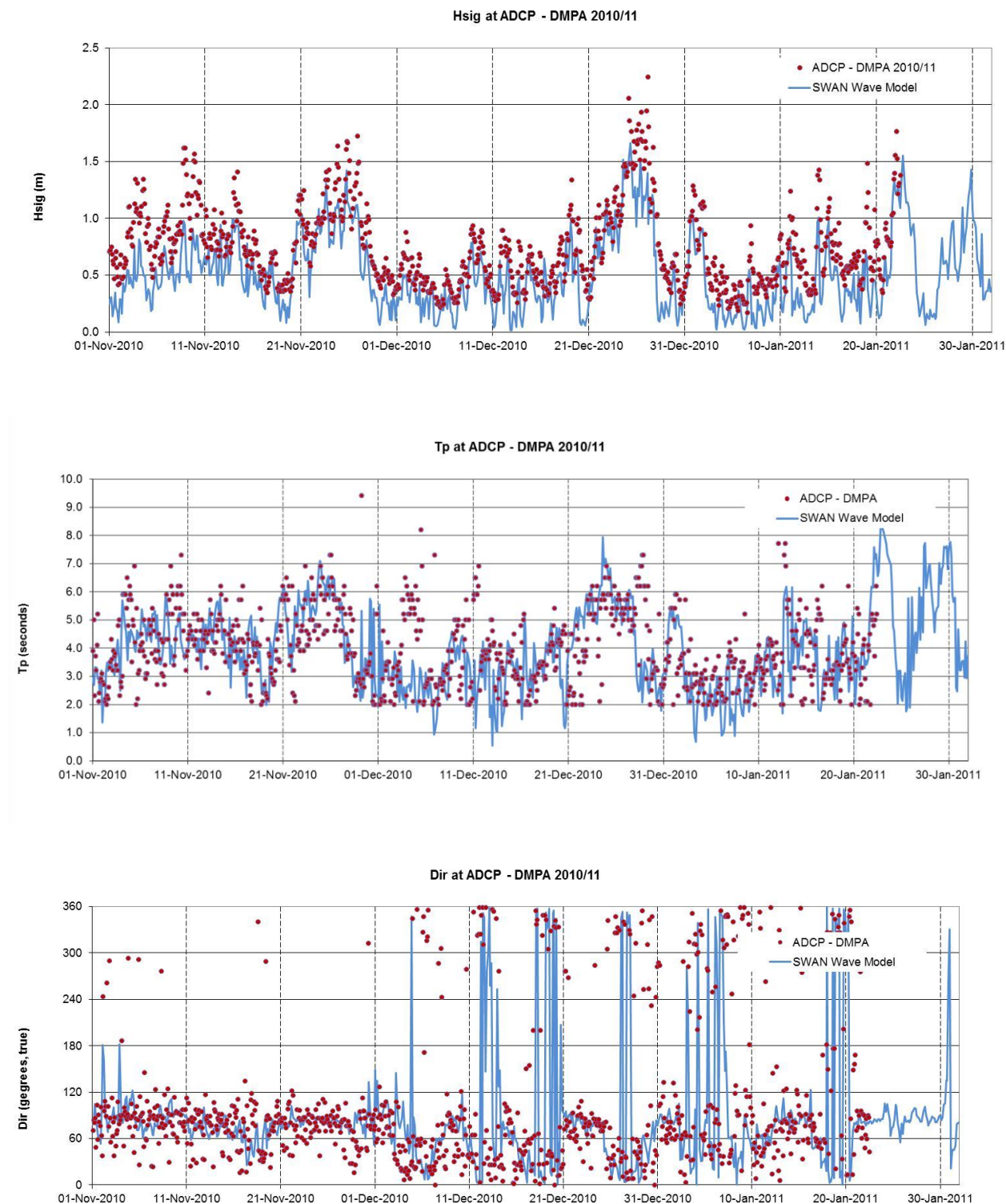


Figure 3-19 Wave Model Calibration – DMPA ADCP

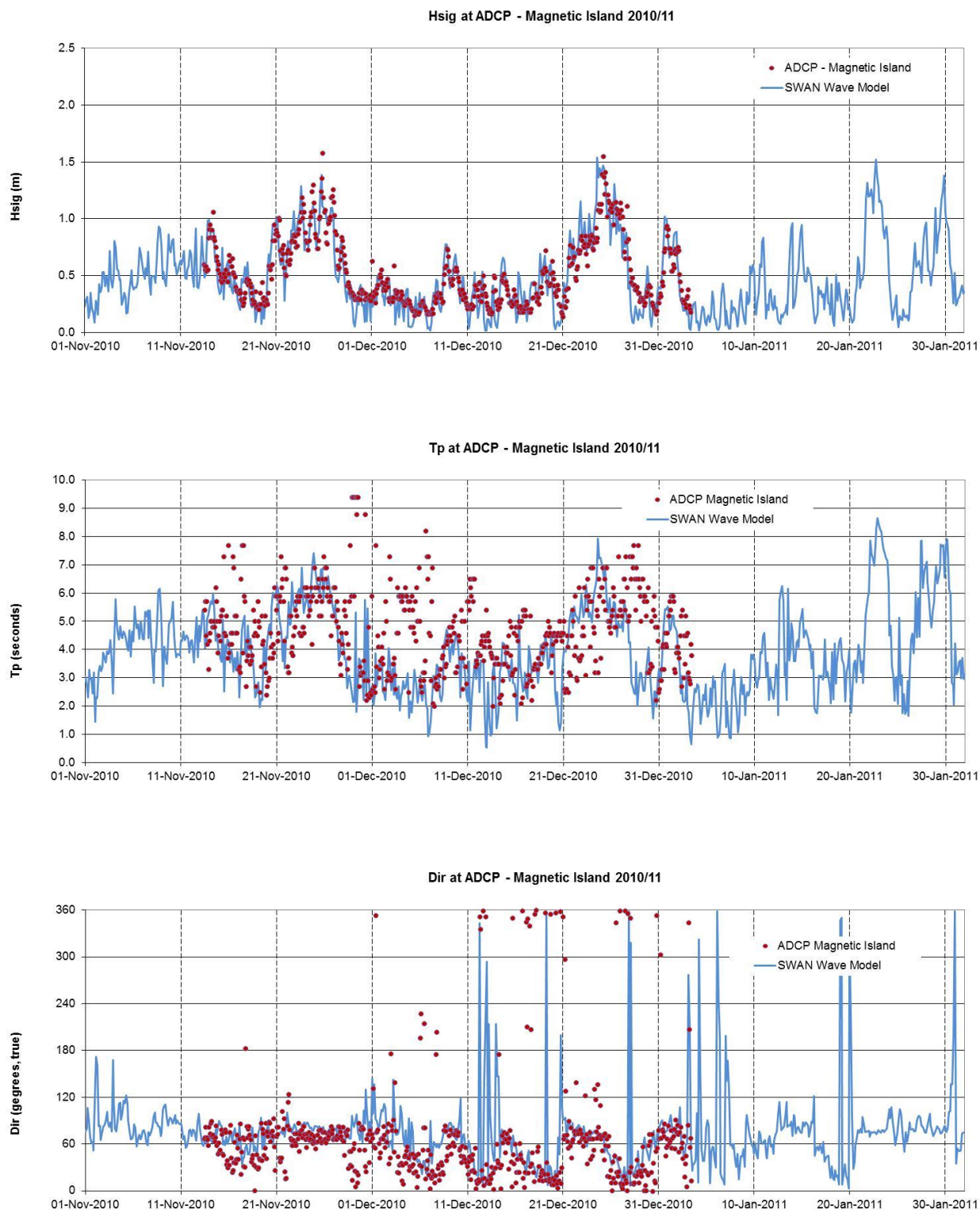


Figure 3-20 Wave Model Calibration – Magnetic Island ADCP

3.3 Advection-Dispersion Plume Modelling Validation

3.3.1 Data Collection

Dredge plume monitoring was conducted by BMT WBM in the nearshore and offshore areas of the Port of Townsville from 2nd - 5th January 2011. These measurements were used to assist in the validation of the advection-dispersion model and to guide the adoption of specific sediment loading rates for the proposed dredging activities.

The BMT WBM vessel “Resolution II” was used to undertake the field work. Weather conditions were relatively mild throughout the monitoring campaign. The vessel was equipped with an Acoustic Doppler Current Profiler (ADCP) which was configured in backscatter echo intensity mode to show in real time a surrogate of the suspended particle concentrations within the water column below the vessel. The ADCP was configured with real time navigation data from a differential GPS system as well as the ADCP’s own inertial navigation system so that recorded backscatter intensities were time tagged and spatially located in real earth coordinates. Simultaneous measurements (water column profiles, water sample collection and backscatter echo intensities) were conducted on a series of transects through the dredge plume at each monitoring location.

3.3.2 Data Processing

Measurements of turbidity in Nephelometric Turbidity Units (NTU) and Total Suspended Solids (TSS) results from the laboratory were compared in order to establish the TSS – NTU relationship shown in Figure 3-21. The turbidity measurements (converted into TSS) and the water sample TSS results were then used as the basis for converting the ADCP backscatter measurements to TSS concentrations. Plume water samples were also analysed for suspended sediment Particle Size Distribution (PSD), with the results shown in Figure 3-22.

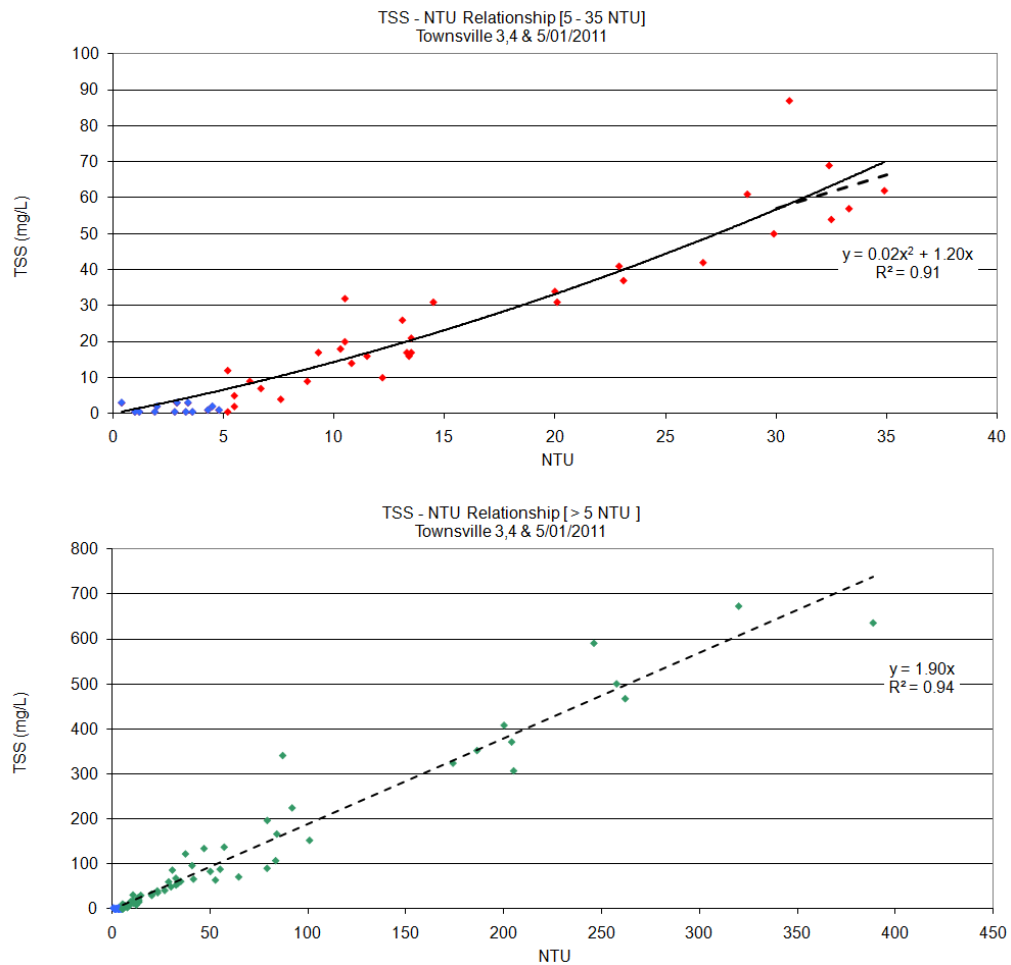


Figure 3-21 TSS – NTU Relationship for Maintenance Dredging Plume Material

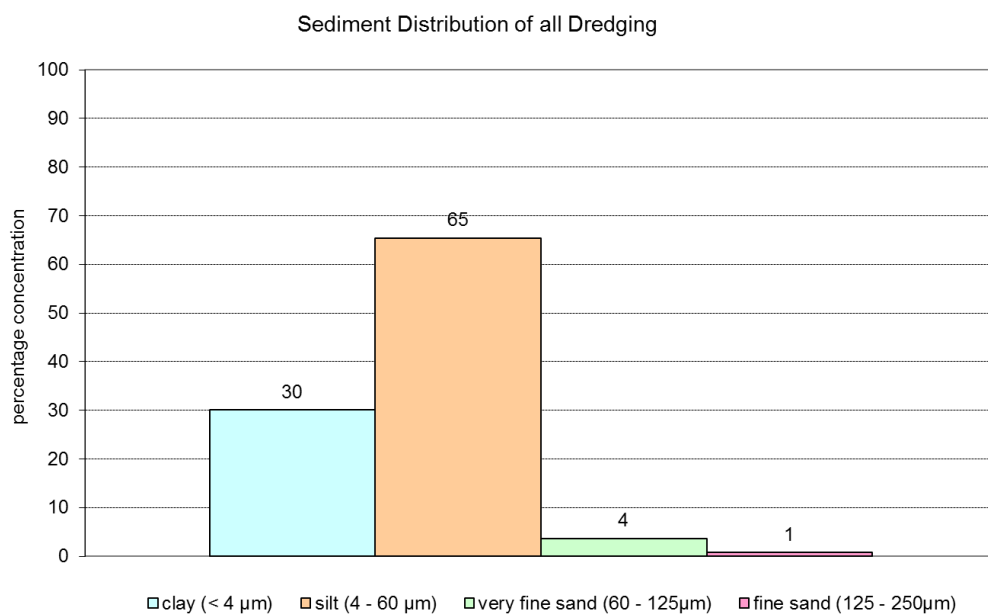


Figure 3-22 Dredge Plume Particle Size Distribution

3.3.3 Model Parameters

Dredging works cause the generation of plumes of suspended sediment through a number of potential sources/mechanisms. The major sources considered for the modelling of the Trailing Suction Hopper Dredge (TSHD) Brisbane were:

- Sediment entrainment at the draghead during dredging;
- Overflow of sediment from the hopper; and
- Placement of material at the Dredge Material Placement Area (DMPA) by hopper release.

The measured 3D TSS concentrations from the January 2011 ADCP transects were compared to simulations of plume dispersion using the 3D TUFLOW FV coupled advection-dispersion and hydrodynamic model in order to calibrate the model parameters.

The dredging logs were obtained and used to locate the dredge and also to determine the mode of operation (i.e. dredging, dredging with overflow or placement).

Prediction of dredge plume impacts involves a number of components, namely:

- Source rate definition, i.e., mass load and characteristics of sediment entrained by the dredging activities;
- Prediction of plume advection/dispersion; and
- Prediction of plume settling.

The first of these is the most variable, and depends intimately on the type of dredging activities (e.g., type and size of dredge) as well as the material being excavated. As such, this component of the dredge plume modelling is also the most subject to variation. Initially, the source parameters were chosen based on engineering judgement, experience on similar projects and literature values. These parameters were then modified during the calibration process on the basis of comparisons with the measured data. The source terms adopted after model calibration are summarised below:

TSHD “BRISBANE”

- Total source while overflow dredging in the channel: 250kg/s.
- Total source while overflow dredging in the outer harbour: 50kg/s.
- Source during placement: 200kg/s.

A higher rate of sediment release was adopted during channel dredging than during outer harbour dredging in order to more closely match the measured plume concentrations. The dredge travelled at a higher speed during channel dredging and did not have the manoeuvring constraints found in the outer harbour, and therefore tended to release more sediment.

The material released during the maintenance dredging activity was assumed to be composed of 30% clay, 65% silt and 5% fine sand (based on the particle size distribution of sampled sediment - Figure 3-22), with assumed settling velocities of 1×10^{-4} m/s, 5×10^{-4} m/s and 1×10^{-2} m/s respectively.

The dredge plume boundary condition was applied as a depth-averaged source into the model as there was no consistent indication in the near-field ADCP data that the source was particularly concentrated in any one part of the water column during either dredging or placement.

The General Ocean Turbulence Model (<http://www.gotm.net/>) was used to control vertical mixing of both momentum and sediment. A Smagorinsky model was used for the estimation of the horizontal eddy viscosity and diffusivity coefficients.

Examples of the results of the plume model validation exercise are illustrated in Figure 3-23 and Figure 3-24. The full collection of plume model validation plots are presented in Attachment C of this appendix. The upper panels in each figure show transects through the dredge plume, with contour plots of TSS measured by the ADCP (on the left) and modelled (on the right). The lower panels show a plan view of depth-averaged TSS, with the model results in the background and the ADCP-measured TSS shown as a black-bordered line along the transect. A red cross marks the start point of the transect (0m chainage in the upper panel).

The plume model validation results generally indicate that the model is accurately reproducing the pattern of suspended sediment distribution associated with dredge plumes. The magnitude of the suspended sediment concentration is overestimated in some cases, especially during dredging in the outer harbour. The accuracy of the ADCP data in the near field is sometimes uncertain due to bubbles and turbulence generated by the dredge propwash. Given the complexity of the modelling task, and the highly three-dimensional nature of plumes and temporal variation in dredge discharge, the model performance is considered to be good.

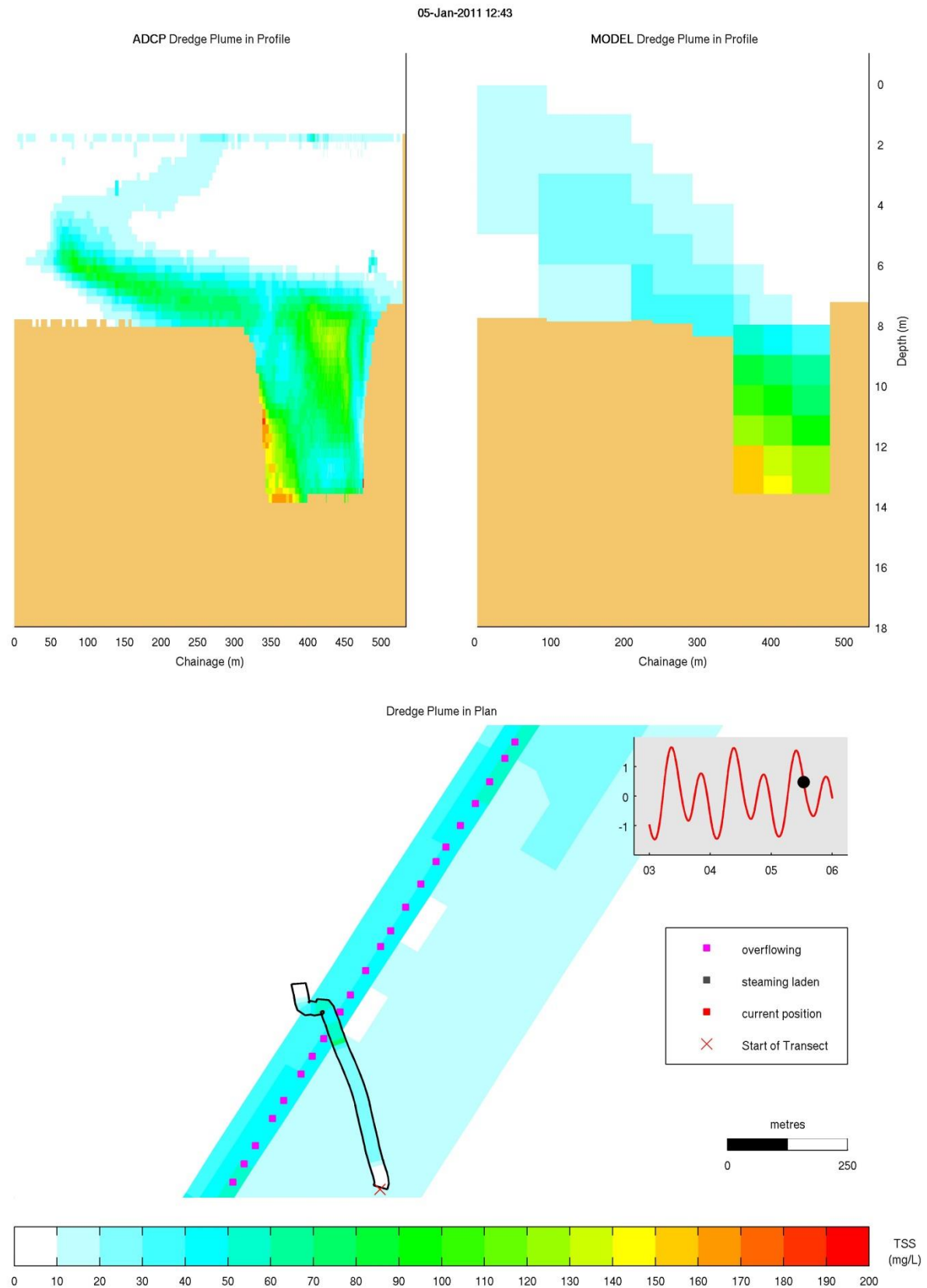


Figure 3-23 Dredge Plume Model Validation – Platypus Channel – 5/1/2011 ADCP Data

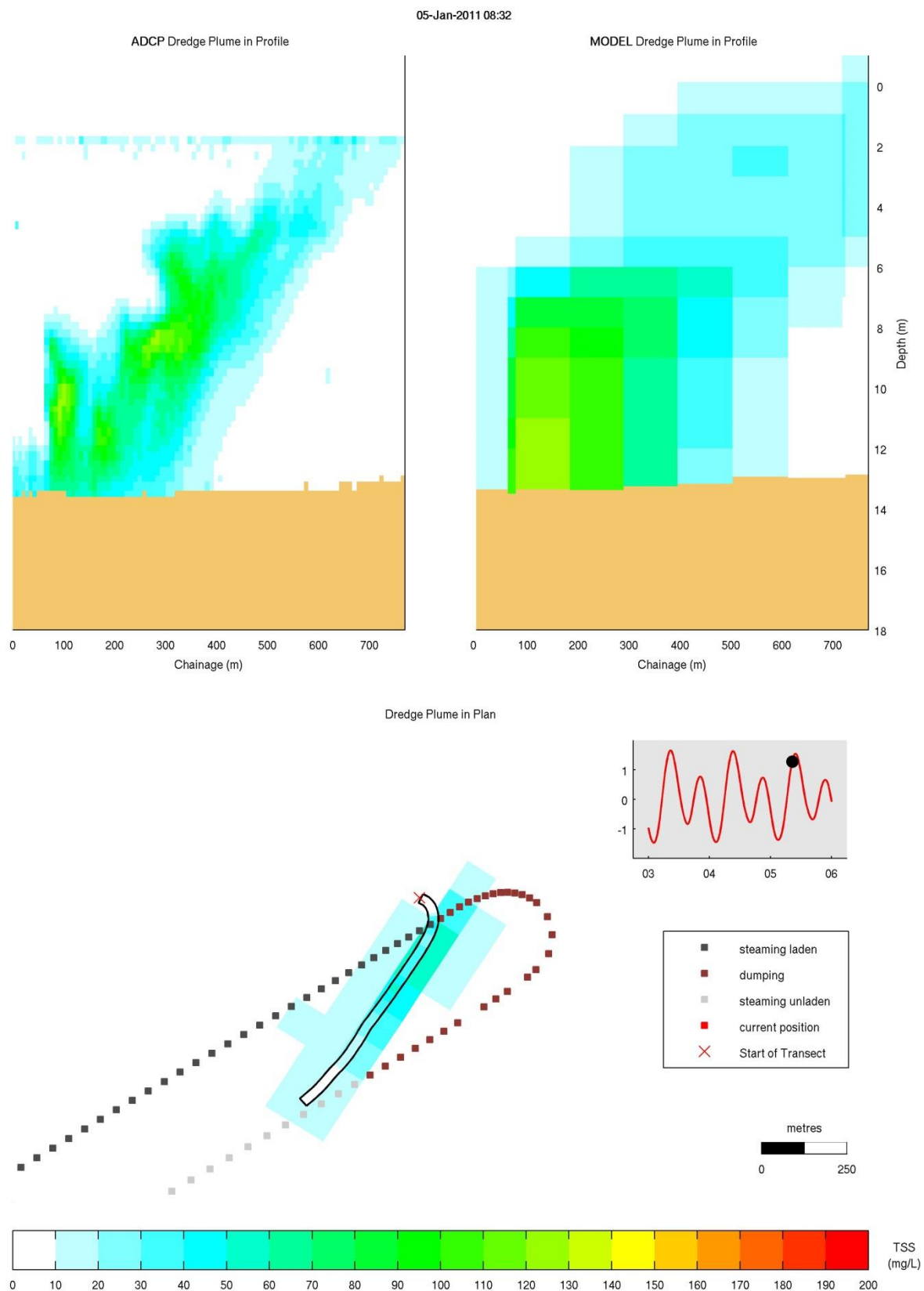


Figure 3-24 Dredge Plume Model Validation – DMPA – 5/1/2011 ADCP Data

3.4 Resuspension Model Calibration

In order to use the TUFLOW FV model to estimate the natural sediment resuspension dynamics in the study area, the model was calibrated using available measurements of ambient turbidity.

The cohesive sediment module of TUFLOW FV simulates the exchange of sediments between the bed and the water column. The effective clear water sediment settling velocity of each sediment fraction, w_s , is directly specified and is assumed to have no dependence on either suspended sediment concentration (e.g. flocculation or hindered settling). The modelled rate of sediment deposition (in g/m²/s) is a function of the near-bed sediment concentration (TSS), the still-water fall velocity (w_s) and the bed shear stress (τ_b), according to the relationship:

$$Q_d = w_s.TSS.\max\left(0, 1 - \frac{\tau_b}{\tau_{cd}}\right) \quad \text{units [g/m}^2\text{/s]}$$

where τ_{cd} is a model parameter defining the critical shear stress for deposition. As such, sediment settling is reduced below its still water value by the action of bed shear stress and associated vertical mixing in the water column. The rate of erosion is calculated according to:

$$Q_e = E.\max\left(0, \frac{\tau_b}{\tau_{ce}} - 1\right) \quad \text{units [g/m}^2\text{/s]}$$

where Q_e is the erosion rate, E is the erosion rate constant and τ_{ce} is the critical bed shear stress for erosion.

The General Ocean Turbulence Model was used to control vertical mixing of both momentum and sediment. A Smagorinsky model was used for the estimation of the horizontal eddy viscosity and diffusivity coefficients.

The calibration process led to the adoption of the following model parameters:

- Critical shear stress for erosion $\tau_{ce} = 0.2$ Pa;
- Critical shear stress for deposition $\tau_{cd} = 0.1$ Pa; and
- Erosion rate constant $E = 0.005$ g/m²/s.

The initial model bed was composed of 25% clay, 50% silt and 25% fine sand, with assumed settling velocities of 1×10^{-4} m/s, 5×10^{-4} m/s and 1×10^{-2} m/s respectively. The model was run for an initial “warm up” period to allow the sediment types to redistribute within the model. This process allowed the bed composition in each area to evolve towards an initial condition which was likely to reflect the actual local natural bed composition.

YSI 6600 water quality instruments were deployed in Cleveland Bay in March and July 2012 to collect 12 months of baseline water quality data. These baseline data were used to develop trigger levels for use in proposed capital dredging projects, and were also used to review existing programs and dredging practices as part of POTL’s commitment to continual improvement.

The YSI water quality instruments were deployed at two locations close to the mainland (the Strand and Virago Shoal) and three locations near the east coast of Magnetic Island (Geoffrey Bay, Florence Bay and Picnic Bay) (Figure 3-25).



Figure 3-25 Locations Used for Model Calibration

These instruments logged data for a range of parameters, including turbidity, dissolved oxygen (DO), pH and conductivity, once every 10 minutes. The instruments also recorded photosynthetically active radiation (PAR) data, which is an indicator of light available to sensitive receptors (e.g. seagrass and corals). Terrestrial PAR sensors on Magnetic Island and the mainland also allowed light attenuation through the water column (due to turbidity) to be calculated.

The instruments were mounted on secure frames placed on the sea bed, thereby measuring water quality at the location of benthic ecosystems (i.e. seagrass and coral). The instruments were deployed in the following approximate water depths:

- The Strand: -3 m LAT.
- Virago Shoal: -3 m LAT.
- Picnic Bay: -4 m LAT.
- Geoffrey Bay: -5 m LAT.
- Florence Bay: -7 m LAT.

Comparisons between measured and modelled turbidity are presented in Figure 3-26, Figure 3-27 and Figure 3-28. The ambient TSS time series is plotted as a blue line, while measured TSS is shown as red dots. The model did capture the overall suspended sediment dynamics reasonably well, including the overall magnitude of suspended sediment concentrations during several resuspension events. There was a significant discrepancy between measured and modelled turbidity during early March 2013 at The Strand and late February 2013 at Virago Shoal, however it is uncertain whether the data recorded during this period, especially at The Strand, is reliable (wave conditions during this period were not energetic). It is possible that freshwater inflows from Ross Creek and Ross River in late February / early March 2013 may have caused the increased turbidity at these nearshore locations and the model is not adequately representing these inflows (though they are included in the model). Note that the ambient turbidity predictions are inherently less accurate than the dredging-related turbidity simulations due to the greater uncertainty in the assumptions associated with modelling ambient sediment dynamics. The validation results indicate that the model is able to adequately reproduce natural variations in ambient turbidity in the study area.

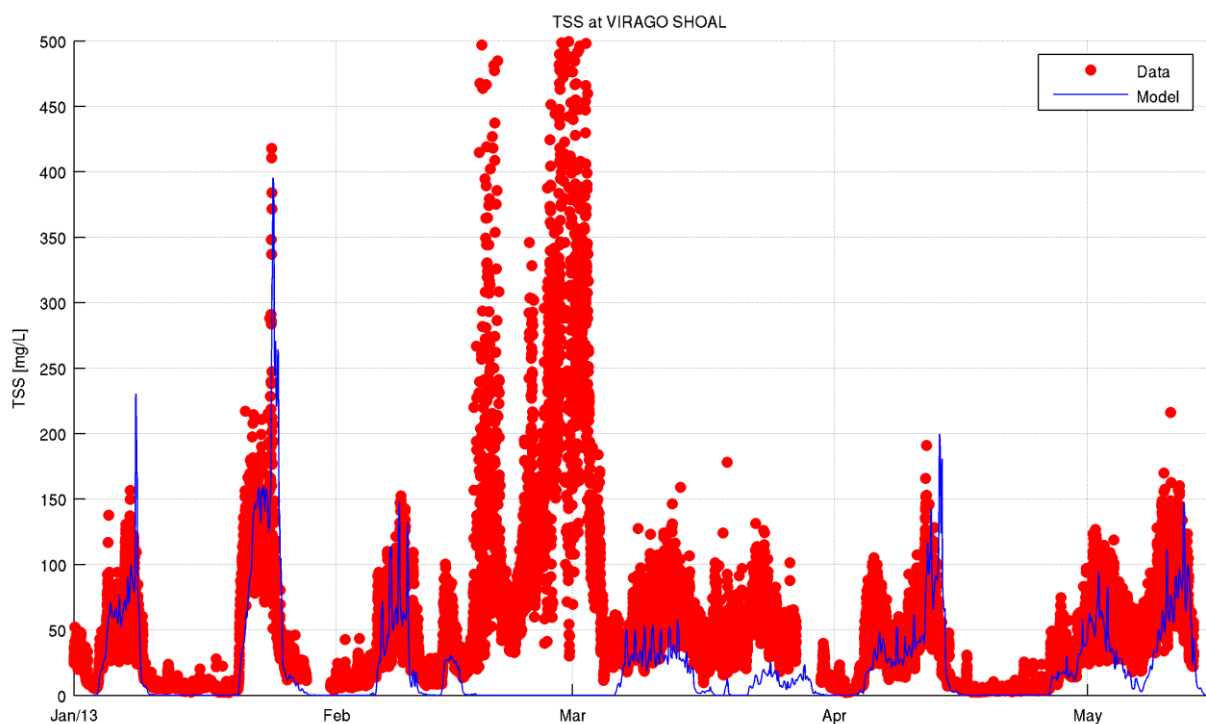


Figure 3-26 Measured and Modelled Suspended Sediment Concentrations at Virago Shoal

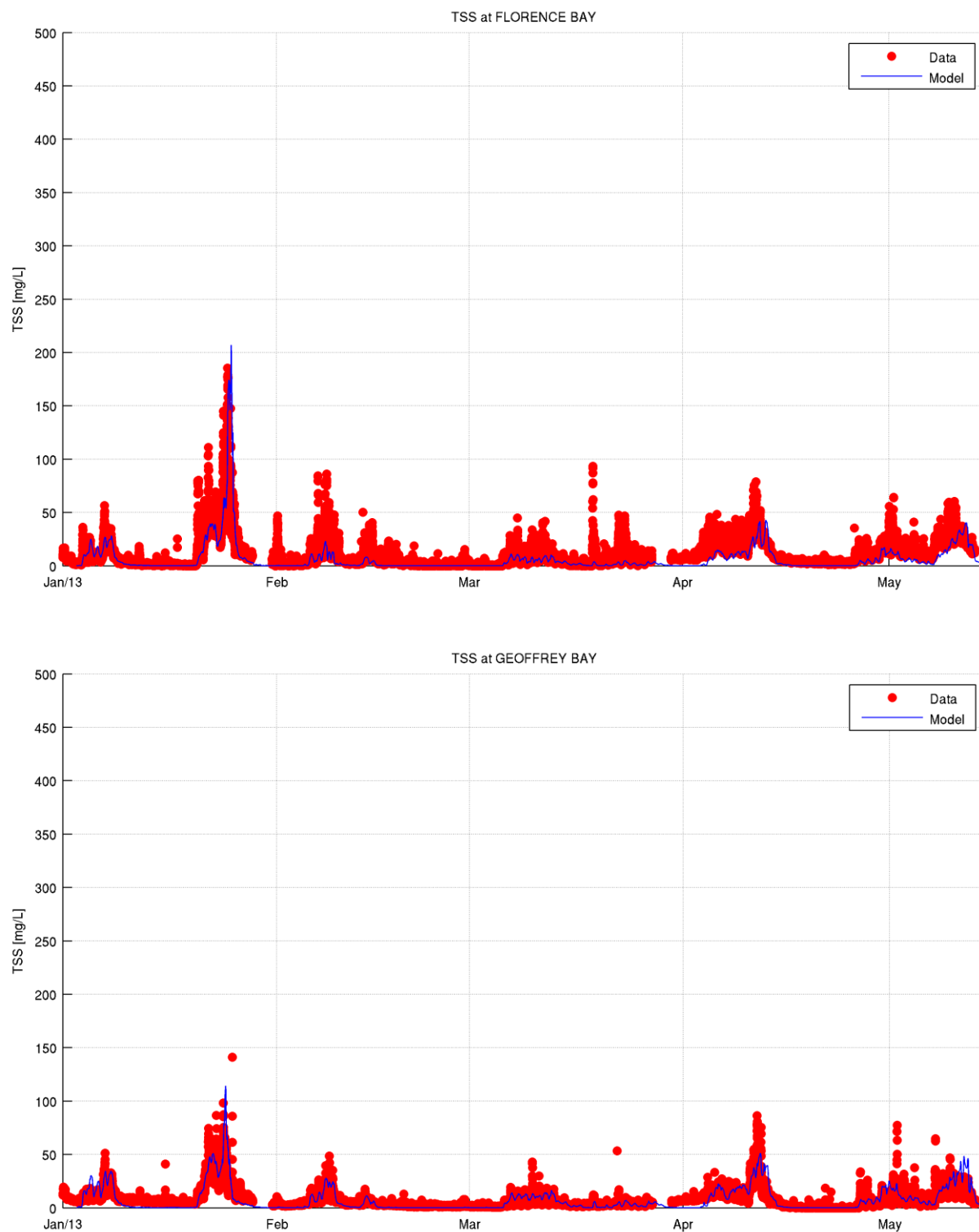


Figure 3-27 Measured and Modelled Suspended Sediment Concentrations at Florence Bay (Top) and Geoffrey Bay (Bottom)

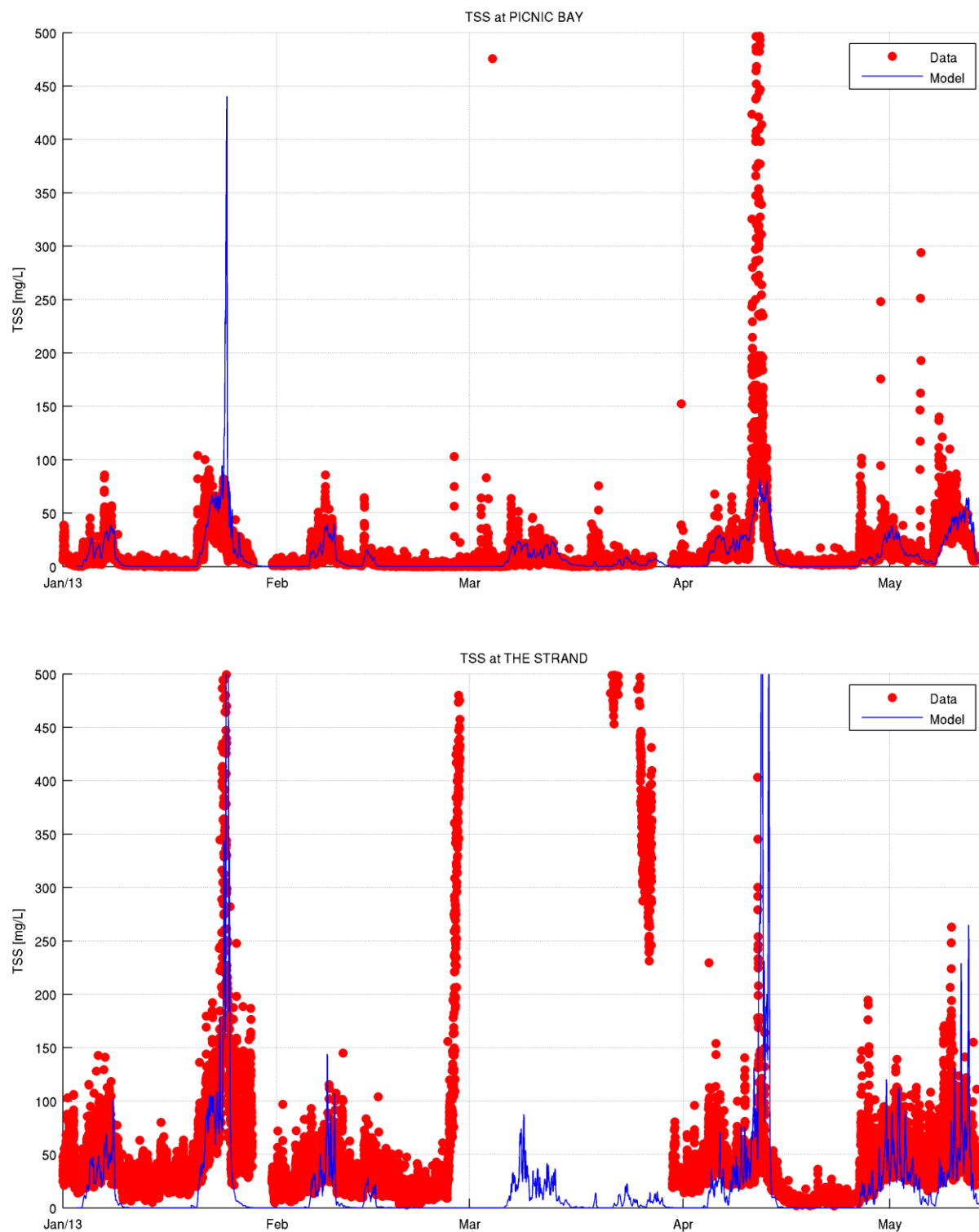


Figure 3-28 Measured and Modelled Suspended Sediment Concentrations at Picnic Bay (Top) and The Strand (Bottom)

4 Hydrodynamic Impact Assessments

Following setup, calibration and validation of both the hydrodynamic and advection dispersion models, a series of hydrodynamic scenarios were executed and interrogated. The general intent of these scenarios was to provide direct information on design conditions and potential hydrodynamic impacts. These scenarios are described below.

4.1 Existing Hydrodynamics

The validated hydrodynamic model was firstly used to illustrate the existing patterns of hydrodynamics within the study area.

For this purpose the model was run from 1/11/2010 to 1/12/2010, a period which included a period of the prevailing strong SE winds. The wind magnitude and direction for the period in the vicinity of the Port is shown in Figure 4-1. The wind rose measured at the Cleveland Bay gauge (for location refer Figure 2-5) and the wave rose measured at the DSITI Waverider buoy for this period are shown in Figure 4-2. The wave and wind roses for the same locations during the period 2008-2011 are shown in Figure 4-3. Comparison of these figures indicates that the modelled period is broadly representative of the average conditions, though with a slightly higher percentage of SE winds.

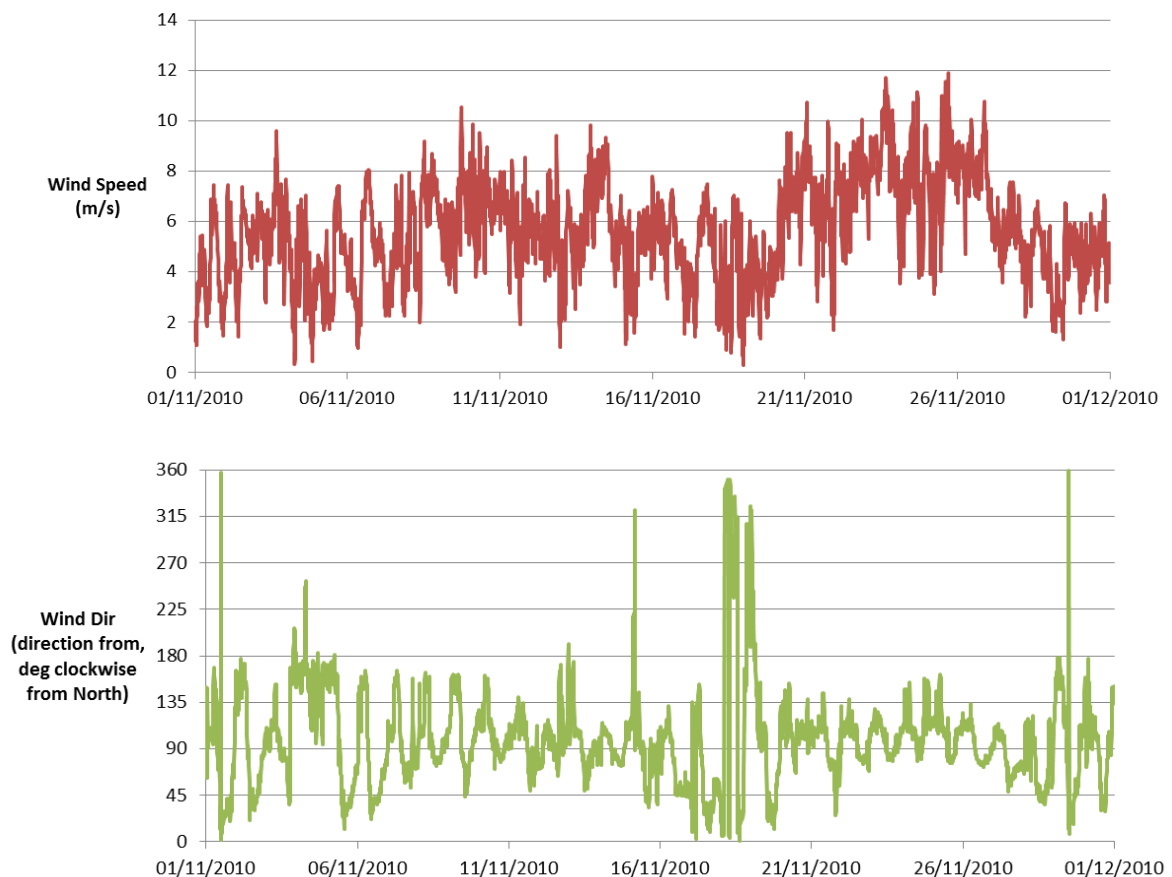


Figure 4-1 Wind Speed and Direction at the Port of Townsville During the Modelling Period (10 minute averages measured at 10 metres elevation)

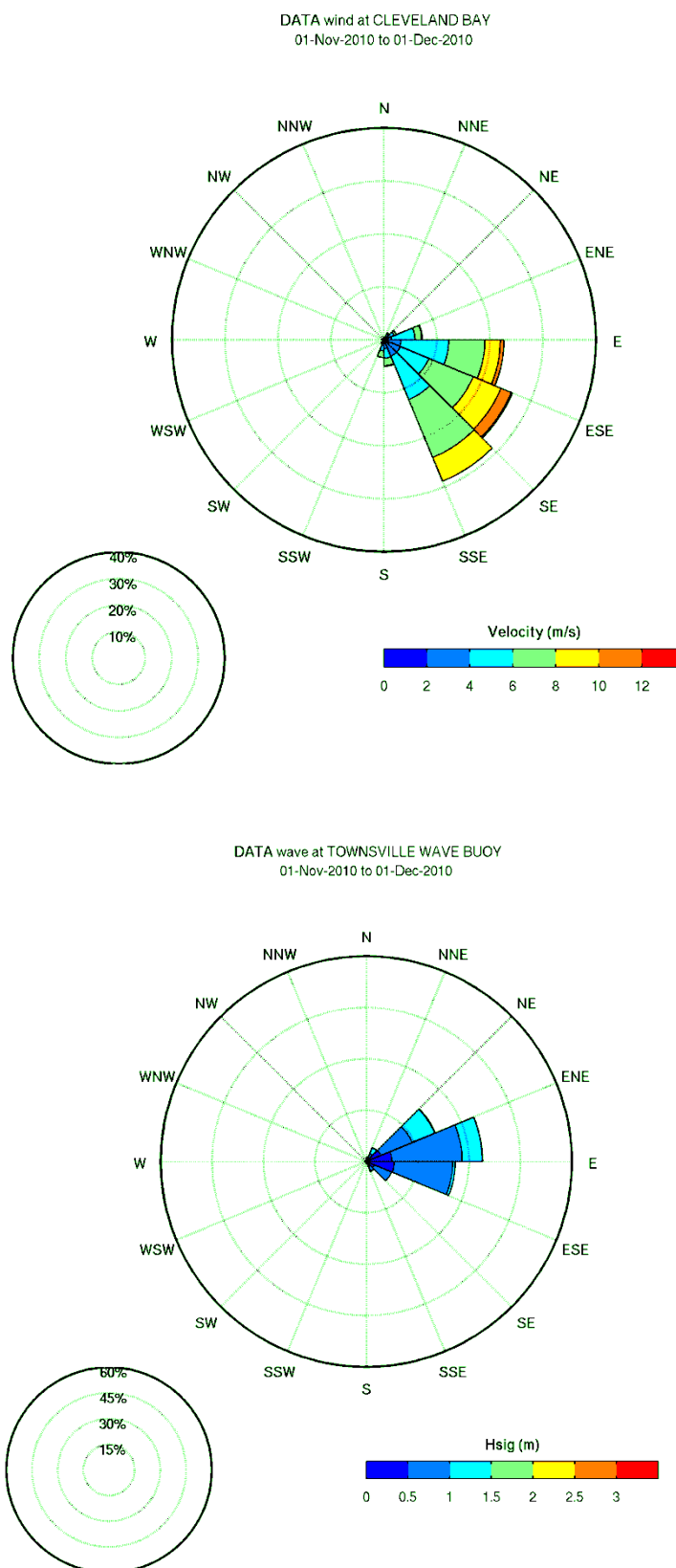


Figure 4-2 Wind (top) and Wave (bottom) Roses for the Modelling Period

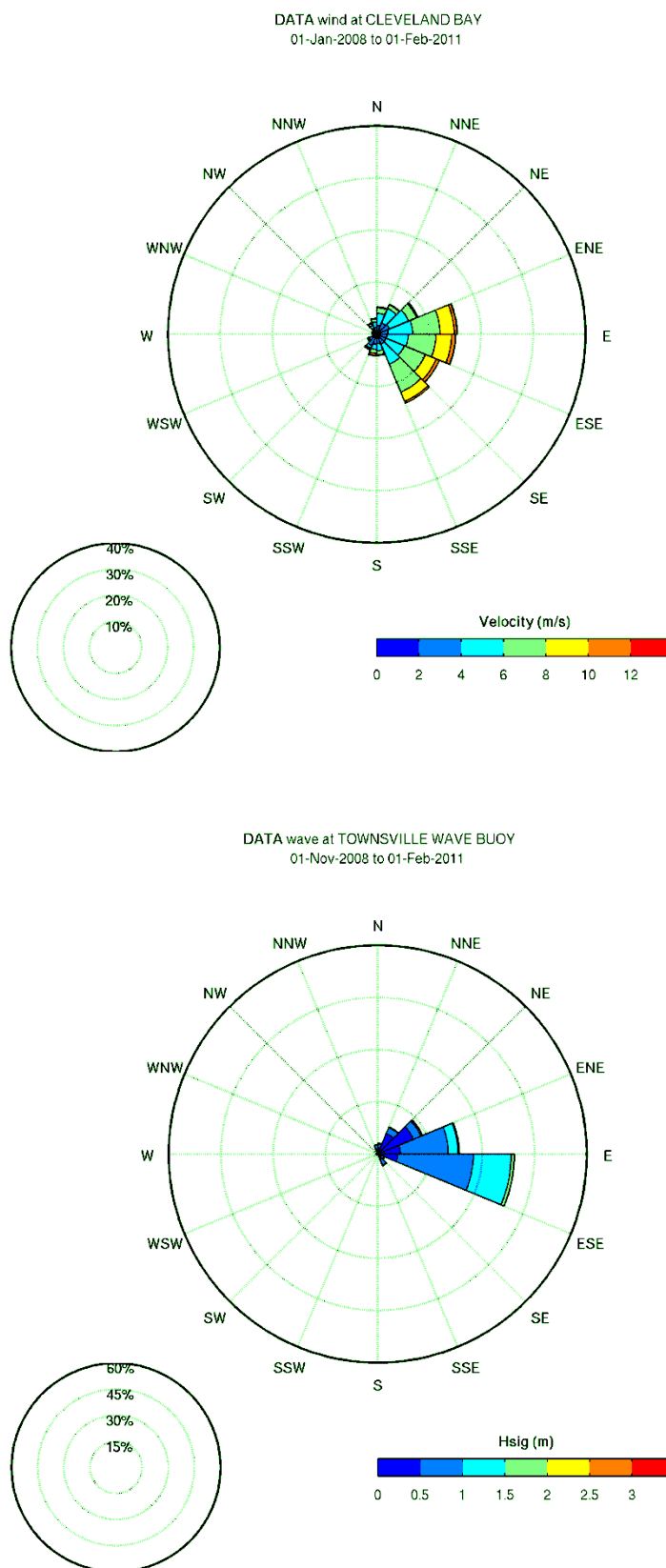


Figure 4-3 Wind (top) and Wave (bottom) Roses for the Period 2008-2011

Figure 4-4 shows the typical tidal current pattern in Cleveland Bay during low-wind spring tidal conditions. The flow can be seen to be predominantly in a south-west (flooding) to north-east (ebbing) direction.

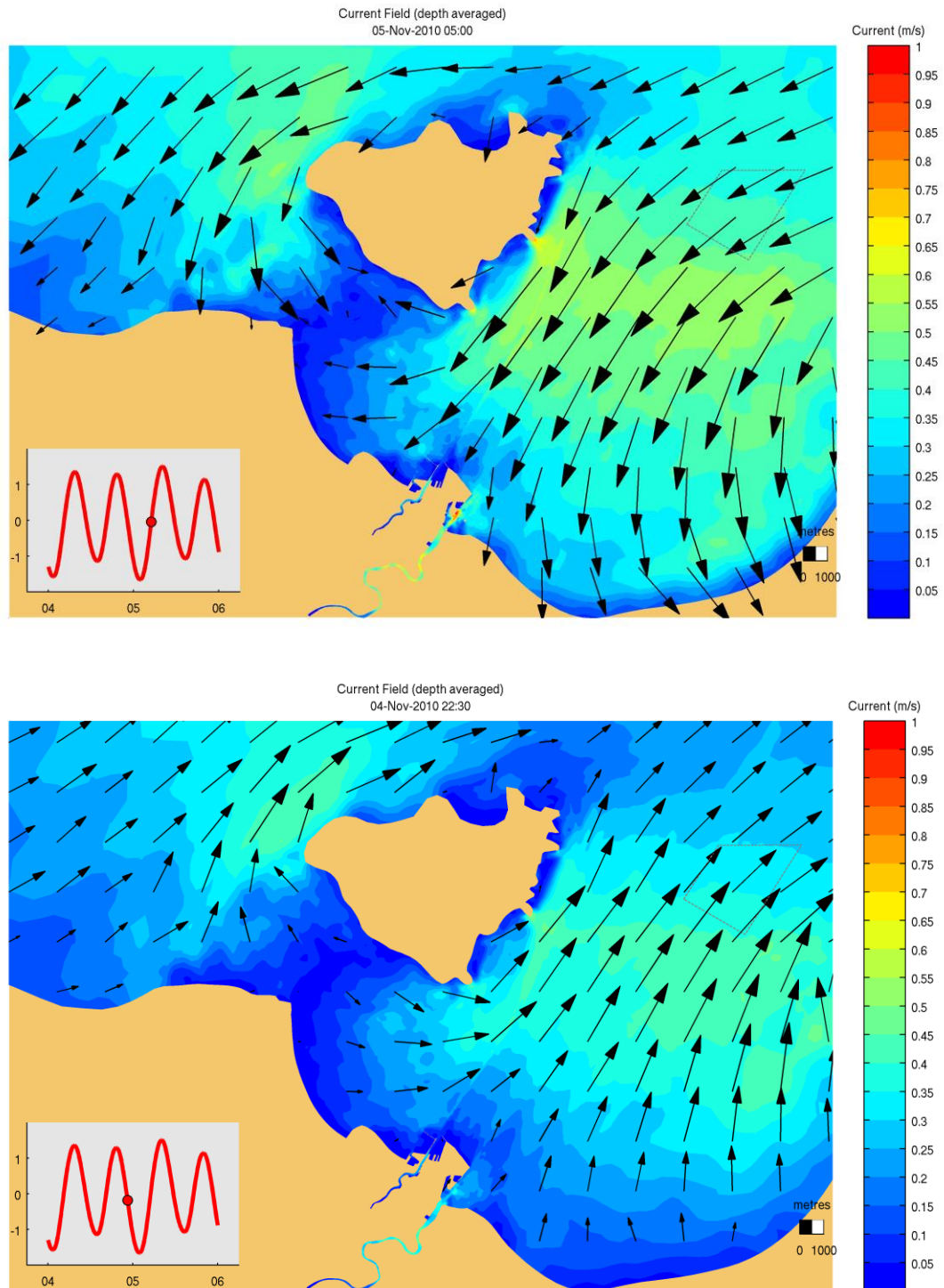


Figure 4-4 Typical Tidal Current Flow Pattern in Cleveland Bay: Flood Tide (top) and Ebb Tide (bottom)

Figure 4-5 shows the effects of relatively strong south-east wind conditions on the flood and ebb tide current patterns. The major difference from the no-wind pattern is the relatively strong ebb tide flow driven to the north-west between Cape Pallarenda and Magnetic Island.

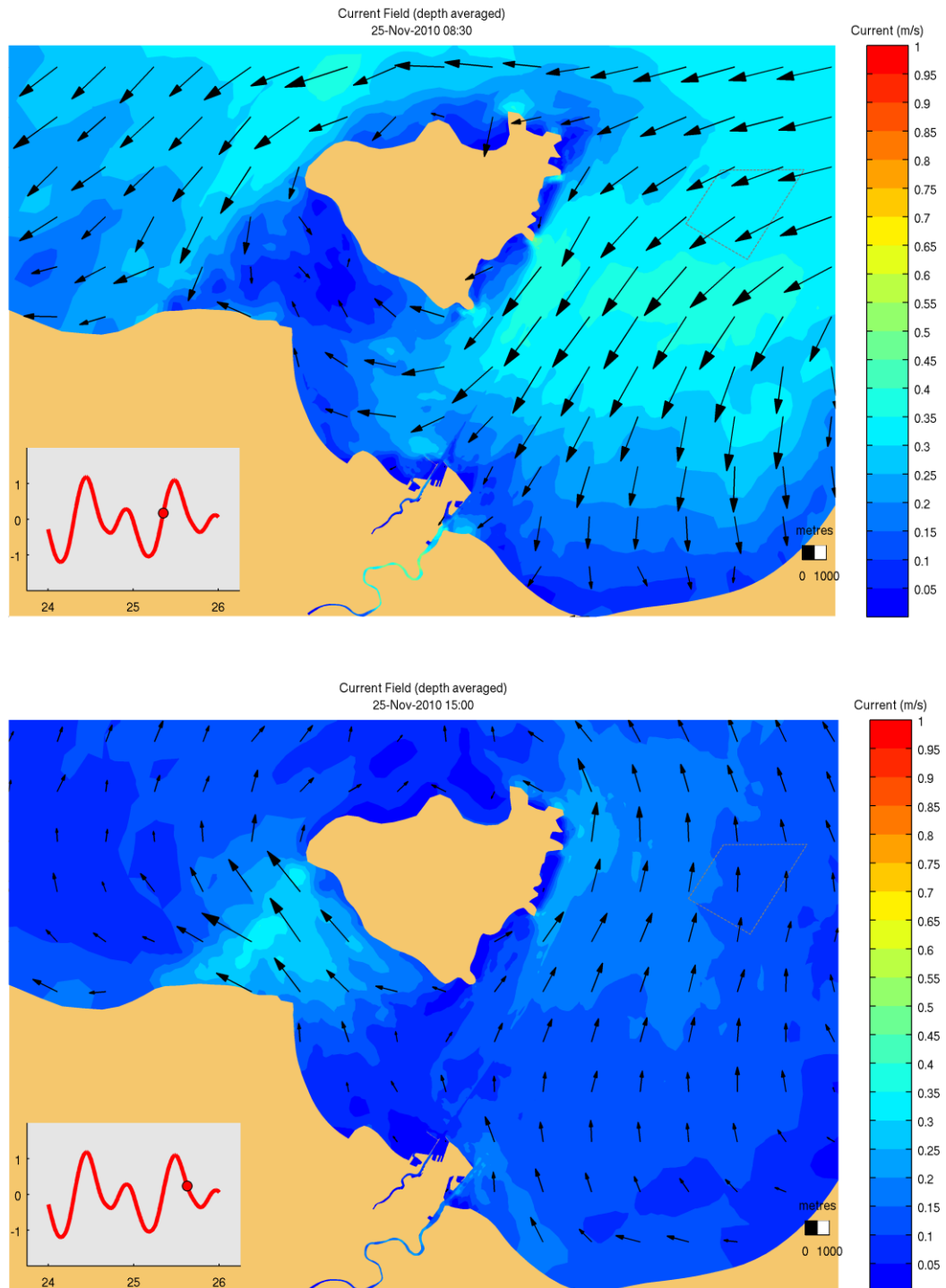


Figure 4-5 Influence of Prevailing Wind Forcing on Current Patterns: Flood Tide (left) and Ebb Tide (right)

The residual depth-averaged currents for the simulated period are shown below in Figure 4-6 which again shows the net effect of the ebb-tide flow to the north-west at Cape Pallarenda. The wind-driven net north-west drift in the Great Barrier Reef lagoon offshore of Cleveland Bay can also be seen.

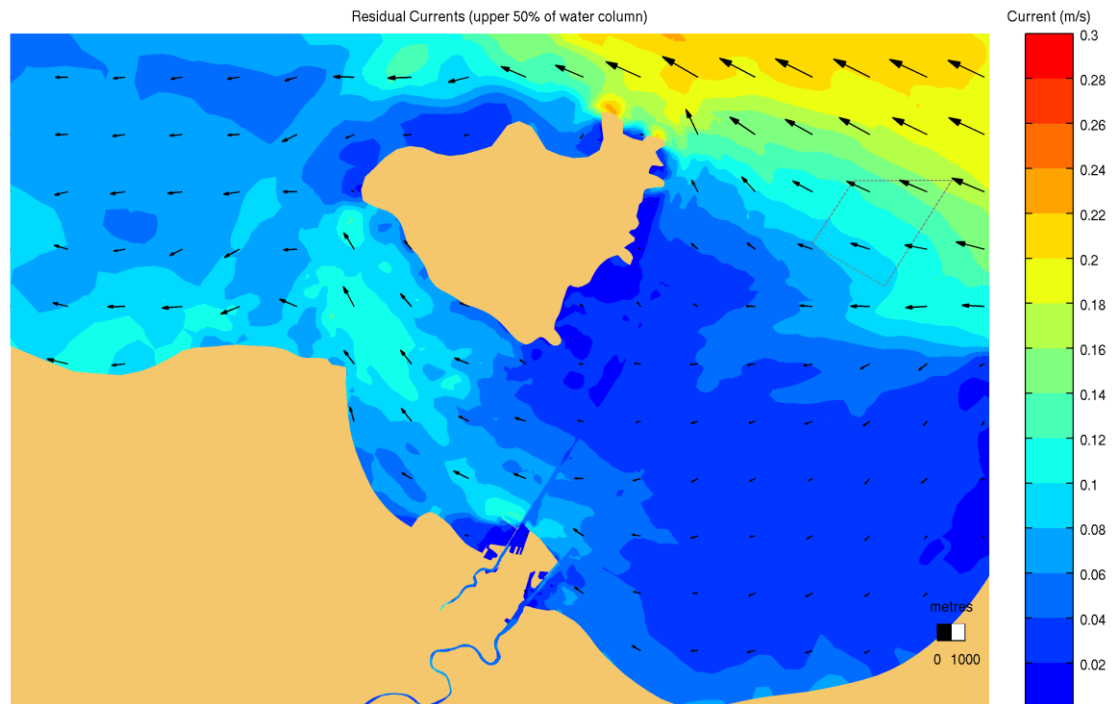


Figure 4-6 Typical Residual Depth-Averaged Current through Cleveland Bay due to Prevailing Winds from the Southeast

4.2 Hydrodynamic Impact Scenarios

Various bathymetric configurations and reclamation phases were considered in the hydrodynamic modelling scenarios based on the proposed staging of the development. The three scenarios assessed included a Base Case (representative of conditions prior to commencement of the port expansion), an Interim Case (at the conclusion of Stage 1 development), and an Ultimate Case (at the conclusion of Stage 2 and 3 development), as described here:

- (1) Base Case. This included all dredging and reclamation associated with the Marine Precinct;
- (2) Interim Case. This included the widened channel, the dredging of Berth 12, and the interim reclamation area proposed as part of Stage 1; and
- (3) Ultimate Case. This included full dredging of the constructed harbour, the final reclamation configuration and deepening of the approach channel to -13.5mLAT (-15.4mMSL).

Model layouts for these scenarios are shown in Figure 4-7 to Figure 4-9.

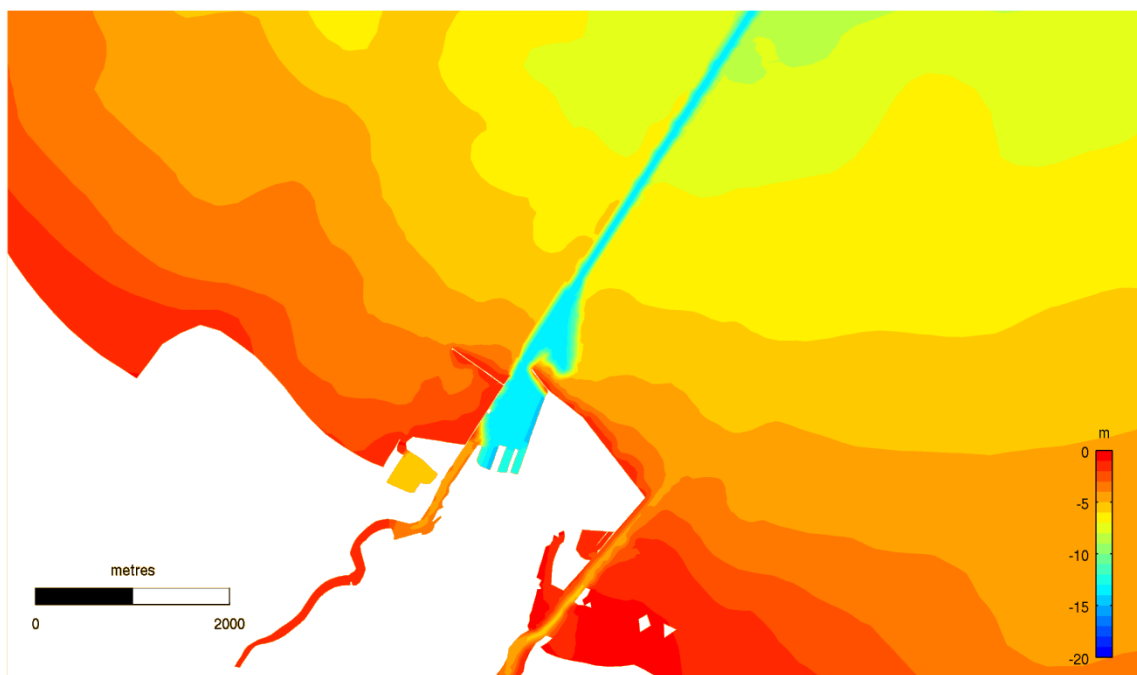


Figure 4-7 Base Case Model Bathymetry

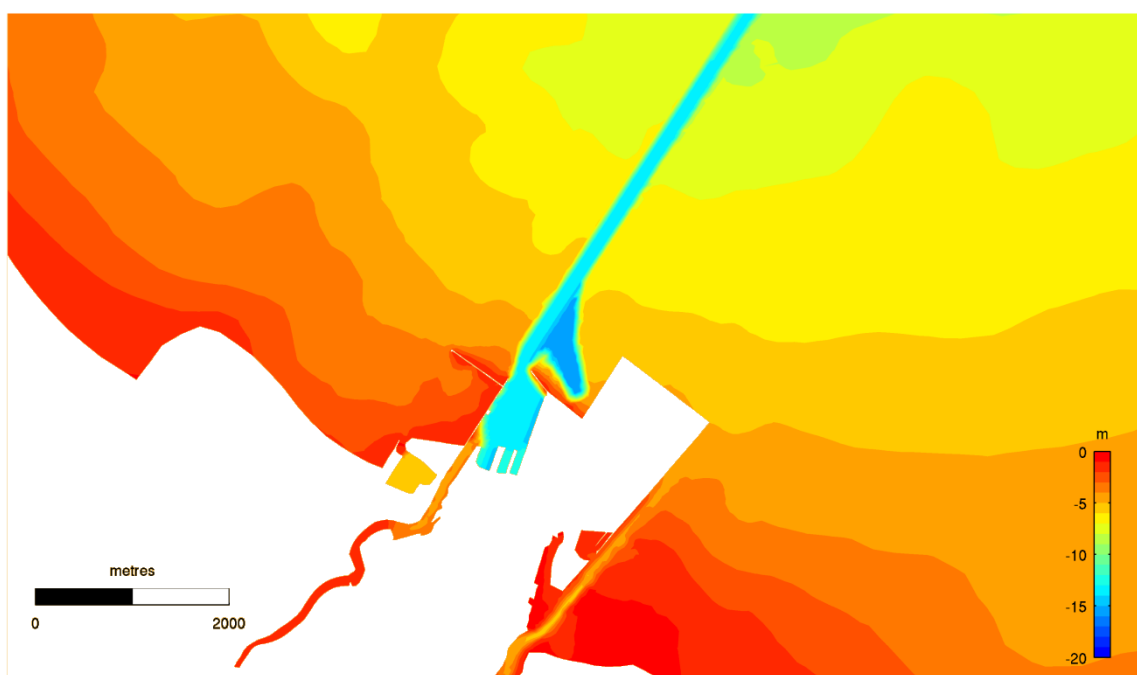


Figure 4-8 Interim Case Model Bathymetry

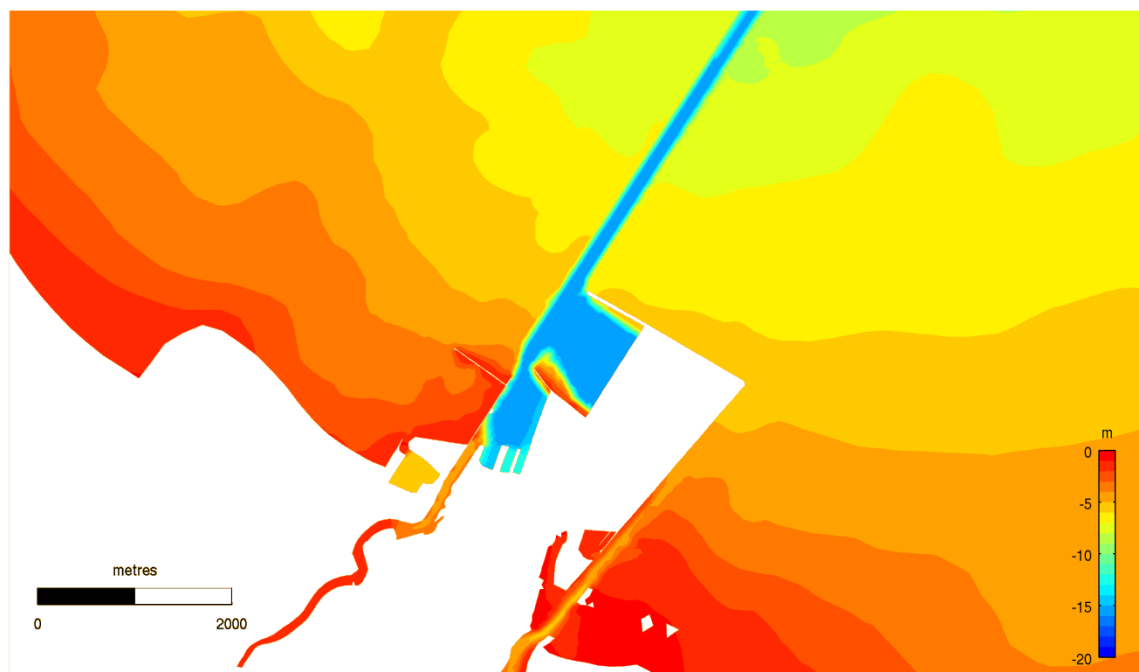


Figure 4-9 Ultimate Case Model Bathymetry

For impact assessment purposes the model was run from 1/01/2013 to 1/02/2013, a period which included predominantly easterly winds and a period of significantly large spring tides. Hydrodynamic impacts were assessed by comparing the Interim Case and Ultimate Case with the Base Case.

4.3 Hydrodynamic Modelling Results and Discussion

Results are presented below in term of hydrodynamic impact at specific times between the Base Case and Interim configuration, and the Base Case and Ultimate configuration. Figure 4-10 illustrates the tide level near the port for the simulation and the times at which the typical current patterns and impacts have been extracted. These tidal conditions correspond to peak ebb and flood flows during a period with a large spring tidal range.

Spatial plots of the changes in velocity magnitudes between the Base Case and Interim Case are shown in Figure 4-11 and Figure 4-12, and between the Base Case and Ultimate Case in Figure 4-13 and Figure 4-14. Spatial water level impact plots are not shown due to the negligible magnitude of the changes.

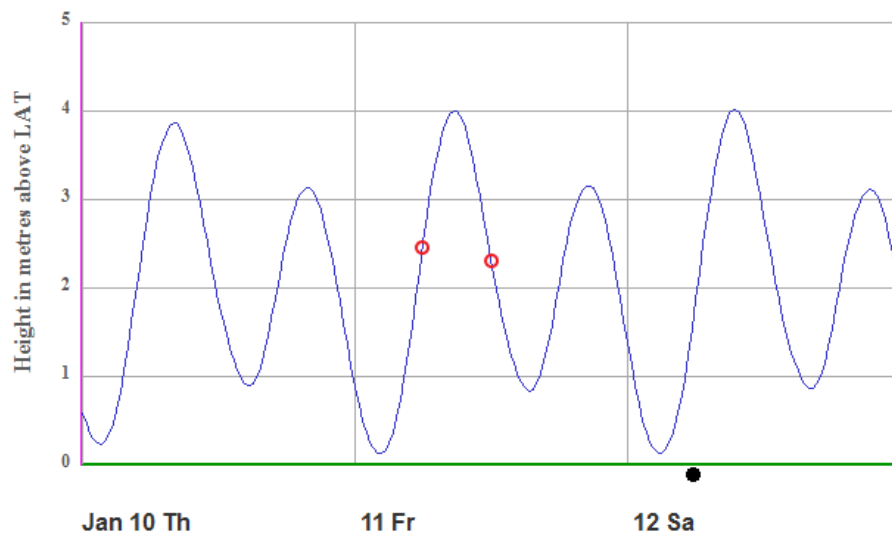


Figure 4-10 Hydrodynamic Impact Assessment Tide Levels
 Flood: 06:00 11/01/2013 Ebb: 12:00 11/01/2013

Figure 4-11 illustrates the difference in velocity in the Interim Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north, west and south of the interim reclamation area are reduced by up to 0.15 m/s. There are increases in velocity of up to 0.2 m/s relative to the Base Case to the east of the interim reclamation area due to the diversion of tidal flows around the reclamation area. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Marine Precinct.

Figure 4-12 illustrates the difference in velocity in the Interim Case compared to the Base Case during an ebb tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the interim reclamation are up to 0.07 m/s lower in the Interim Case than in the Base Case. There are increases in velocity of up to 0.03 m/s relative to the Base Case to the east of the proposed interim reclamation due to the diversion of tidal flows around the reclamation area.

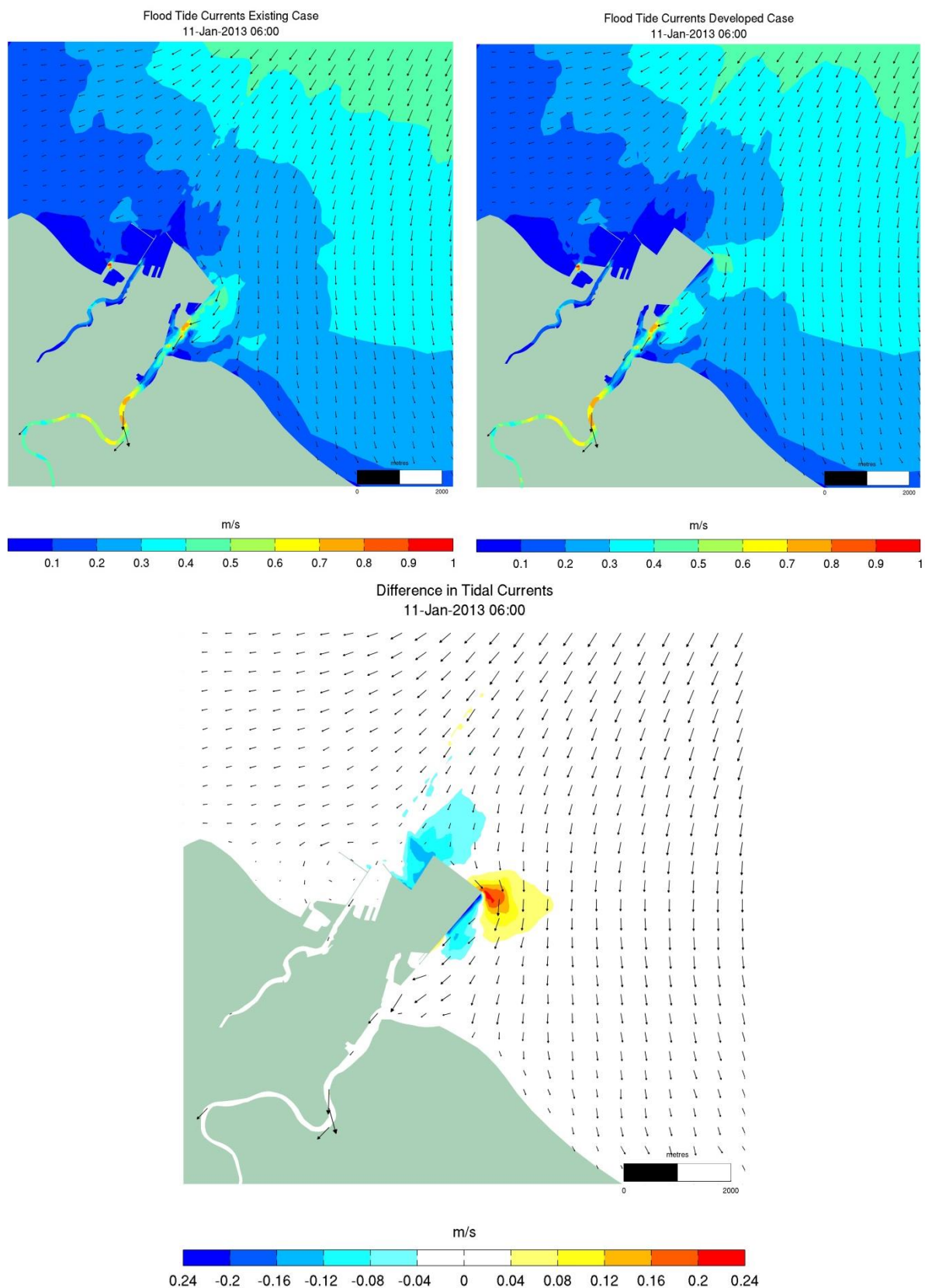


Figure 4-11 Flood Tide Velocity – Base Case (Top Left), Interim Case (Top Right) and Difference (Bottom)

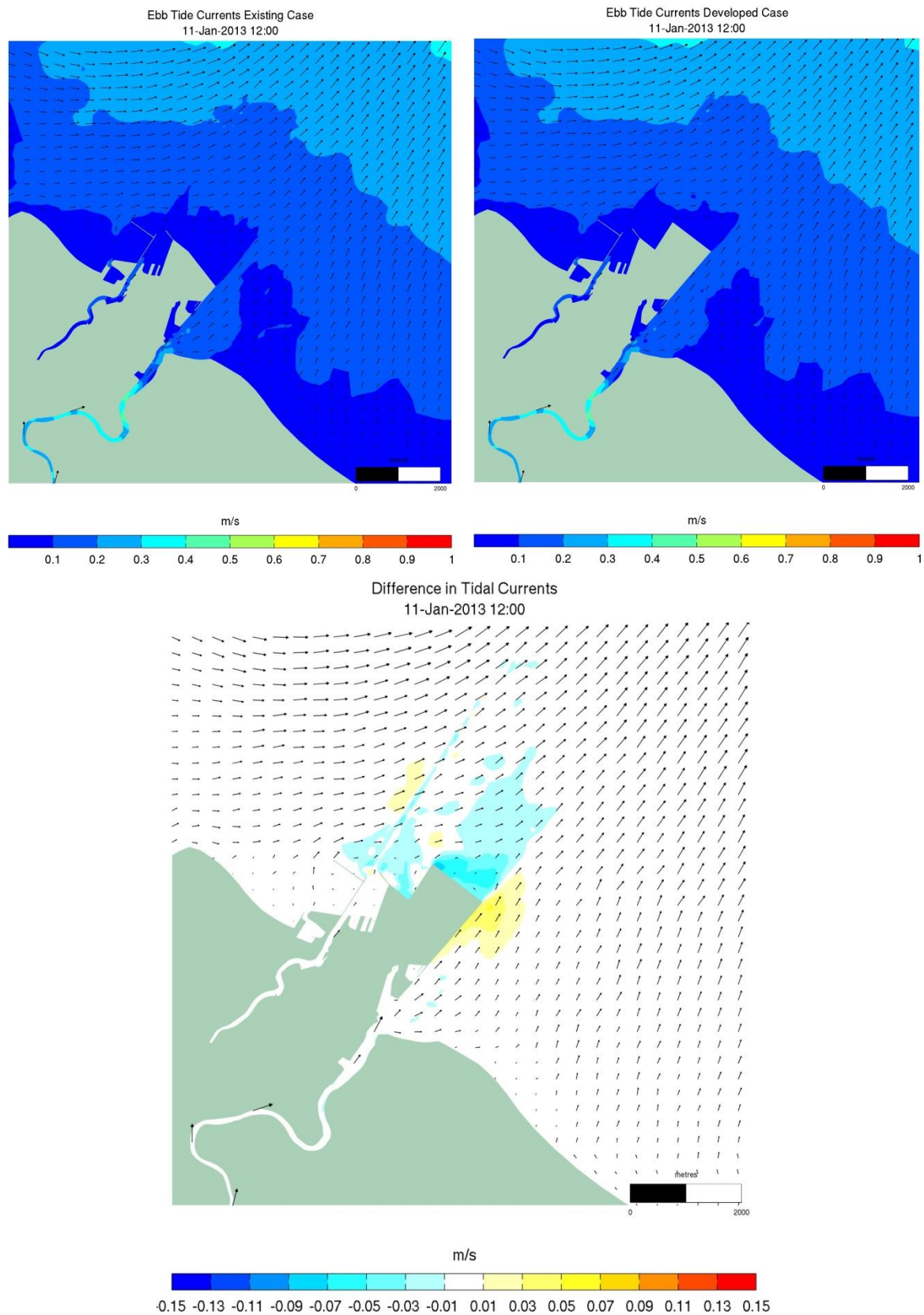


Figure 4-12 Ebb Tide Velocity – Base Case (Top Left), Interim Case (Top Right) and Difference (Bottom)

Figure 4-13 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-eastern revetment are reduced by up to 0.15 m/s. Velocities within the new port expansion harbour area are up to 0.2m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.25 m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area. The Ross River approach channel will continue to experience flood tide cross-currents at the tip of the reclamation, which will be shifted further offshore under the Ultimate Case but will remain of a similar magnitude to the Base Case. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Marine Precinct.

Figure 4-14 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during an ebb spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-east breakwater are up to 0.07 m/s lower in the Ultimate Case than in the Base Case. Velocities within the new port expansion harbour area are up to 0.1 m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.05m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area.

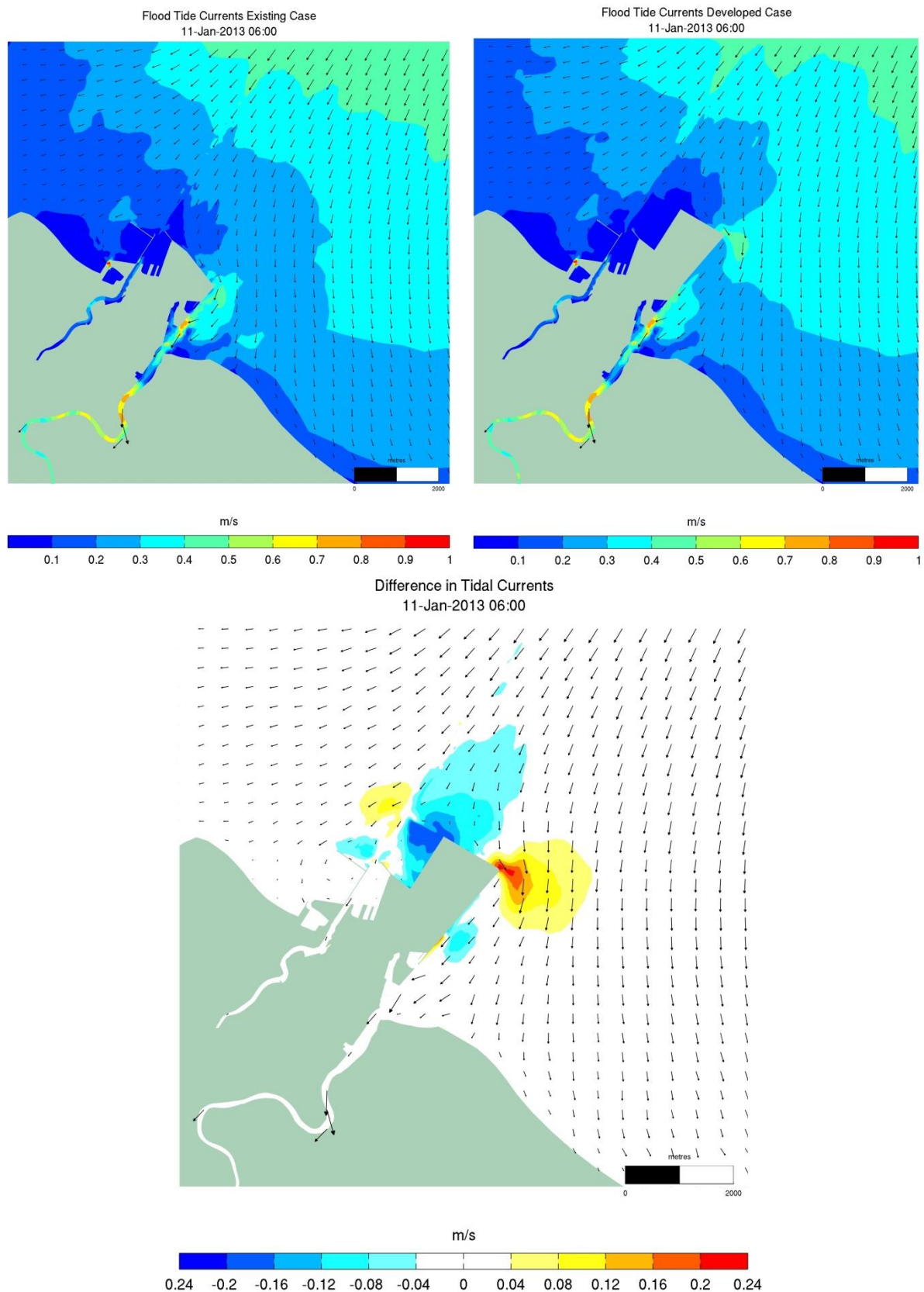


Figure 4-13 Flood Tide Velocity – Base Case (Top Left), Ultimate Case (Top Right) and Difference (Bottom)

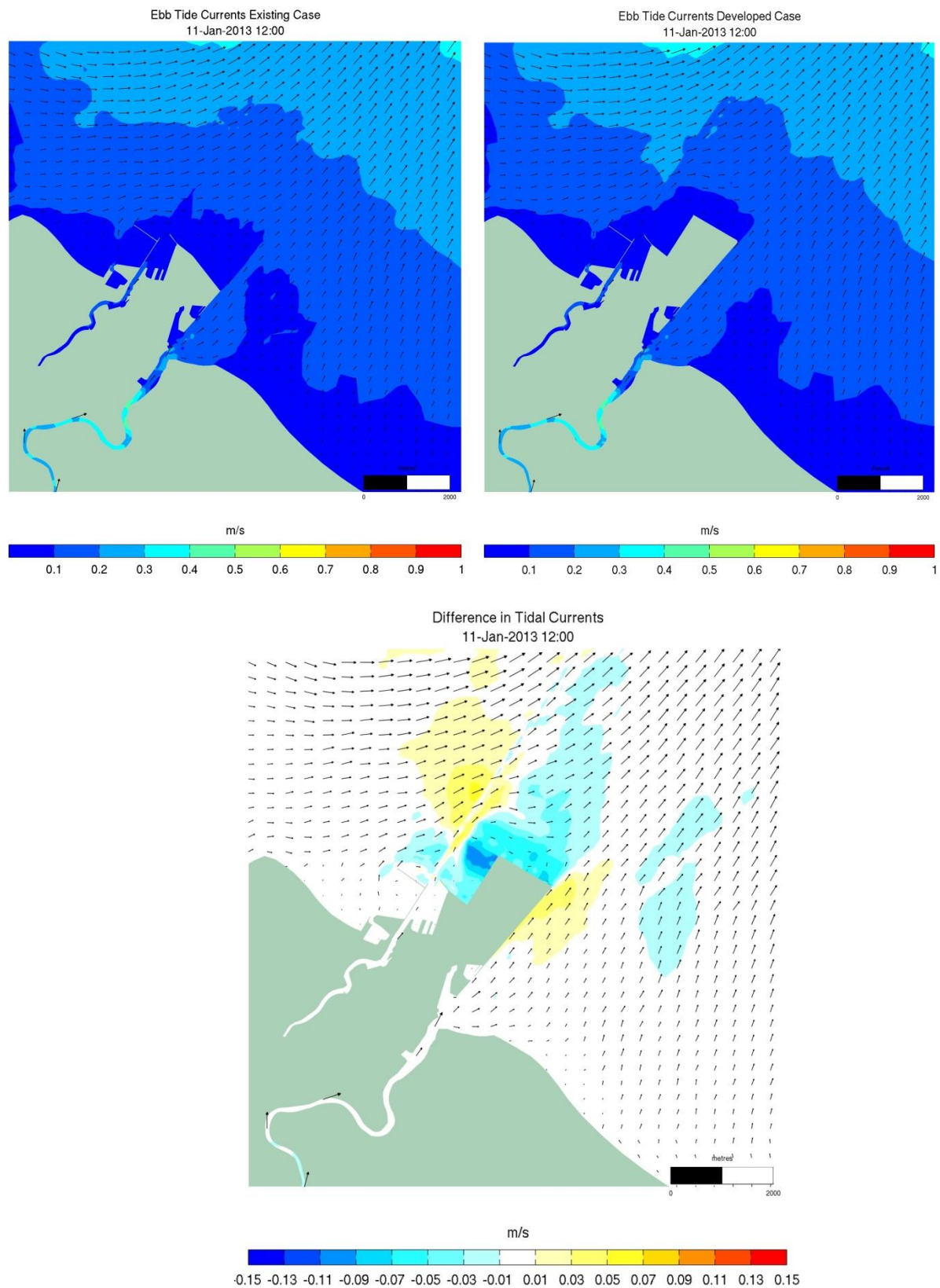


Figure 4-14 Ebb Tide Velocity – Base Case (Top Left), Ultimate Case (Top Right) and Difference (Bottom)

Water level percentiles derived from the model at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case are shown in Figure 4-15. No change in water levels is predicted for the ultimate port expansion development case relative to the Base Case. The model results indicate that no water level impacts will occur at any location due to the port expansion development.

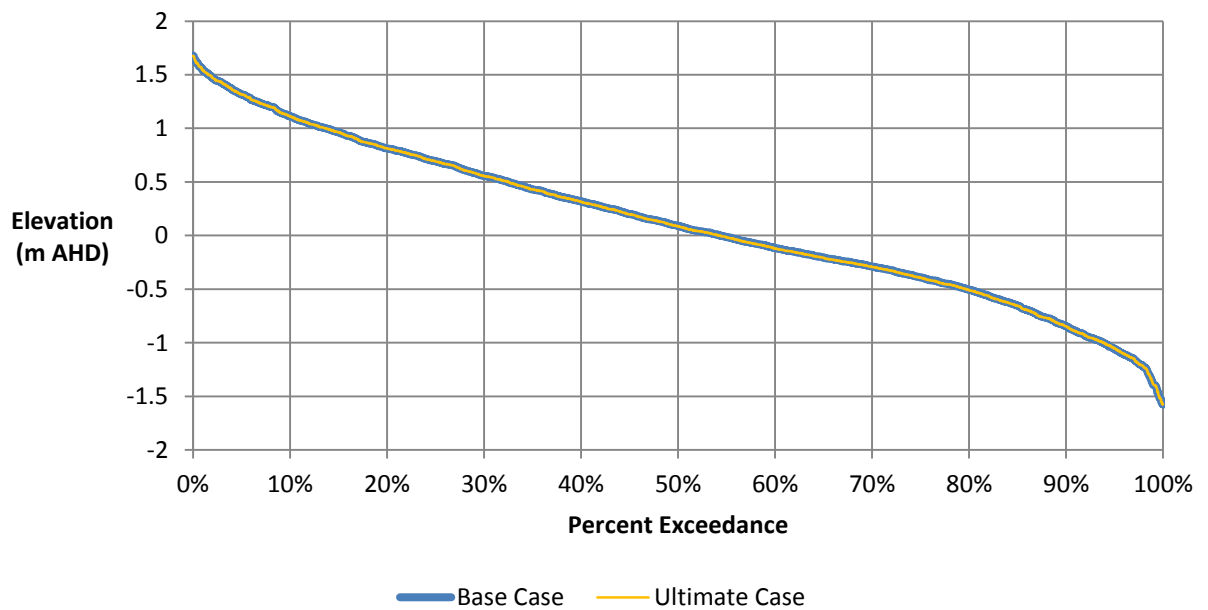


Figure 4-15 Water Level Exceedance Plot at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case

Figure 4-16 illustrates the change in velocity magnitude adjacent to the port reclamation area for the Ultimate Case compared to the Base Case. The two locations that are compared are shown as Point 1 and Point 2 in the top panel of Figure 4-16. This provides a direct comparison between the expected currents adjacent to the existing and future breakwaters. It is noted that a significant increase in spring tide velocities is expected in the Ultimate Case compared to velocities adjacent to the existing breakwater. Morphological impacts driven by these velocity changes are considered in Section 5. In general the current velocity changes are unlikely to create any additional problems for ship navigation.

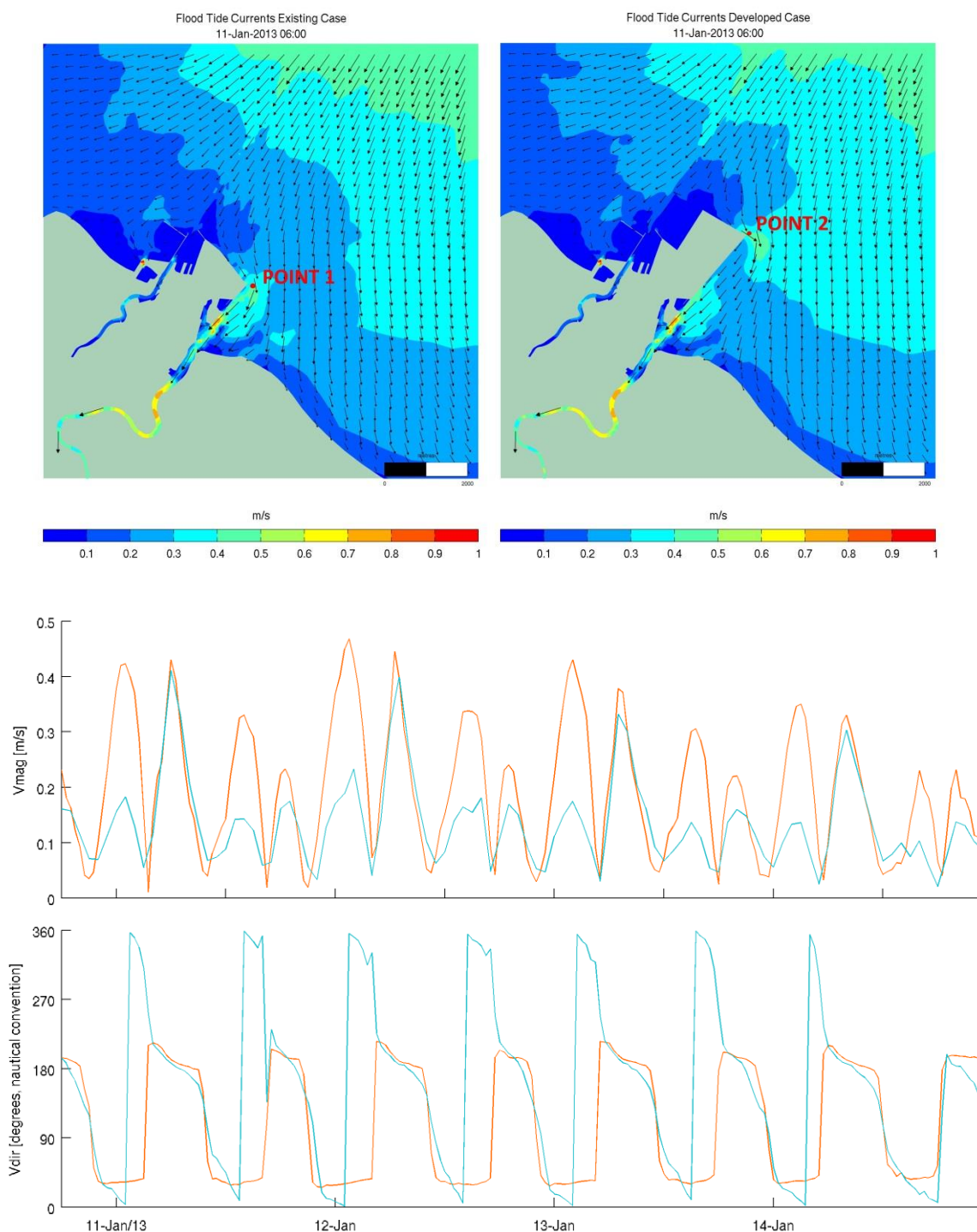


Figure 4-16 Velocity Magnitude Time Series at Point 1 in the Base Case and Point 2 in the Ultimate Case (Base Case in Blue, Ultimate Case in Red)

4.5 Summary of Hydrodynamics Results

The hydrodynamic impacts of the proposed port expansion are not large in magnitude or extent, being confined to changes in velocity magnitude in the immediate vicinity of the proposed breakwaters and reclamation area. Water levels at all locations in the vicinity of the proposed works will not change as a result of the Project.

Velocity magnitudes decrease by up to 0.25 m/s adjacent to the new breakwater structures and within the port expansion harbour area on both the flood and ebb tides in the Ultimate Case. There are increases in velocities of up to 0.3 m/s in the Ultimate Case in some areas as shown in Figure 4-13 and Figure 4-14. No significant change in tidal current velocities is predicted in the existing Inner Harbour in the Ultimate Case port expansion scenarios considered in these assessments.

5 Cleveland Bay Morphology and Sedimentation

5.1 General Effects

The proposed PEP will alter the bathymetry and hydrodynamics in some parts of Cleveland Bay in the vicinity of the Port such that the local sedimentation processes will be altered to a significant extent. Impacts on sedimentation processes and the marine seabed morphology relate predominantly to:

- Effects that the reclamation and breakwater structures will have on both waves and currents and associated sediment re-suspension, transport and deposition;
- Effects that deepening and widening the channels will have on sediment deposition in those dredged areas of the marine seabed; and
- Effects that alterations of the harbour basin configuration and depths have on hydrodynamics and deposition there.

This section considers impacts of the PEP on siltation processes associated with the harbour and channels and at adjoining nearshore seabed areas (e.g. The Strand).

5.2 Sediment Transport

In the context of determining impacts on sedimentation processes, including siltation rates in the harbour and shipping channels, the TUFLOW FV model was used to simulate the re-suspension of fine material due to the action of waves and currents for the Base Case and Ultimate Case to determine the potential impact of the project on bed morphology and siltation rates. The model was run for the period 01/01/2013 to 01/06/2013 for the purposes of the impact assessment.

Residual sediment transport rates were calculated by averaging results over a period of approximately 1 month, ensuring that the start and end points both coincided with similar high tide levels. It is acknowledged that the long-term residual may differ from the values derived over this limited time period, however the selected period was adopted based on being reasonably representative of prevailing climatic conditions and should not therefore be grossly different from the longer term residual. In the longer term, cyclones also have a significant influence on the distribution of sediments.

The Base Case residual suspended sediment transport patterns are shown in Figure 5-1, which indicates a net transport in the north-west direction with highest transport rates in the shallower inshore parts of Cleveland Bay. A concentrated region of higher transport is shown immediately offshore of the existing port and the partial interception of the suspended sediment flux by the dredged approach channel can be inferred by the evident reduction in transport from updrift to downdrift of this feature.

The Ultimate Case residual sediment transport and corresponding impact (difference from Base Case) are shown in Figure 5-2 and Figure 5-3 respectively. It can be seen that Outer Harbour extension will redirect the residual suspended sediment drift around the reclamation. A small net reduction in fine sediment drift from east to west of the port may

occur due to the combined interception effect of the outer harbour extension and the wider and deeper Platypus channel.

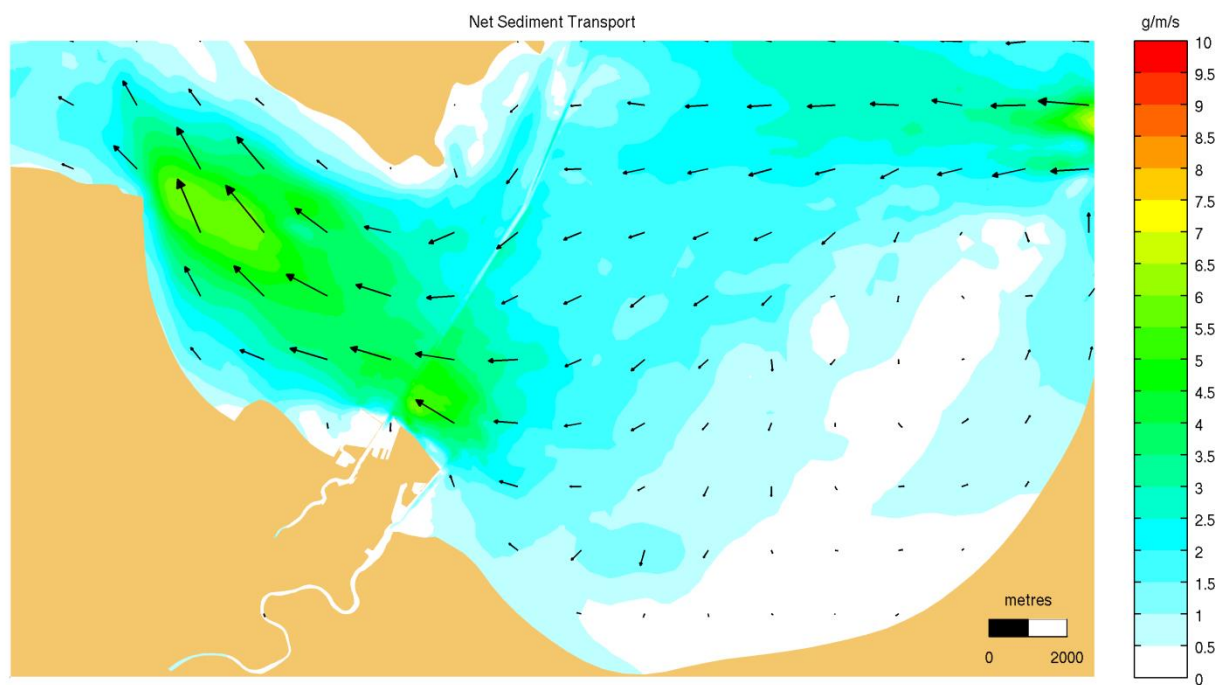


Figure 5-1 Modelled Base Case Residual Suspended Sediment Transport

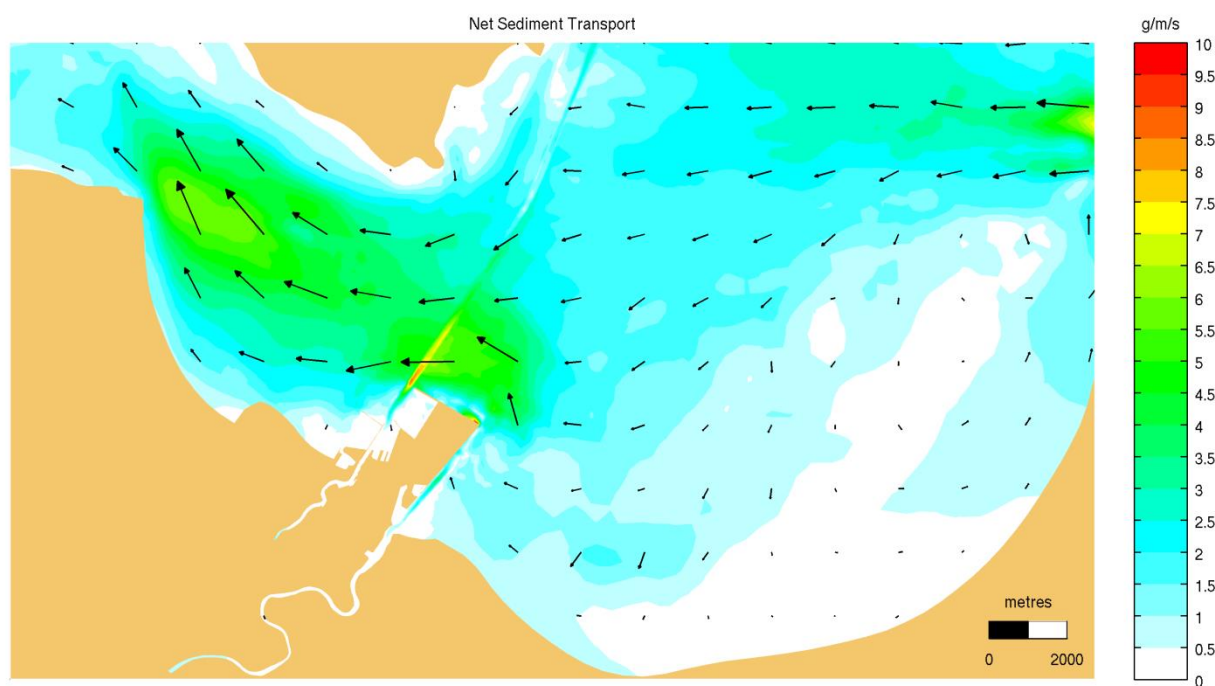


Figure 5-2 Modelled Ultimate Case Residual Suspended Sediment Transport

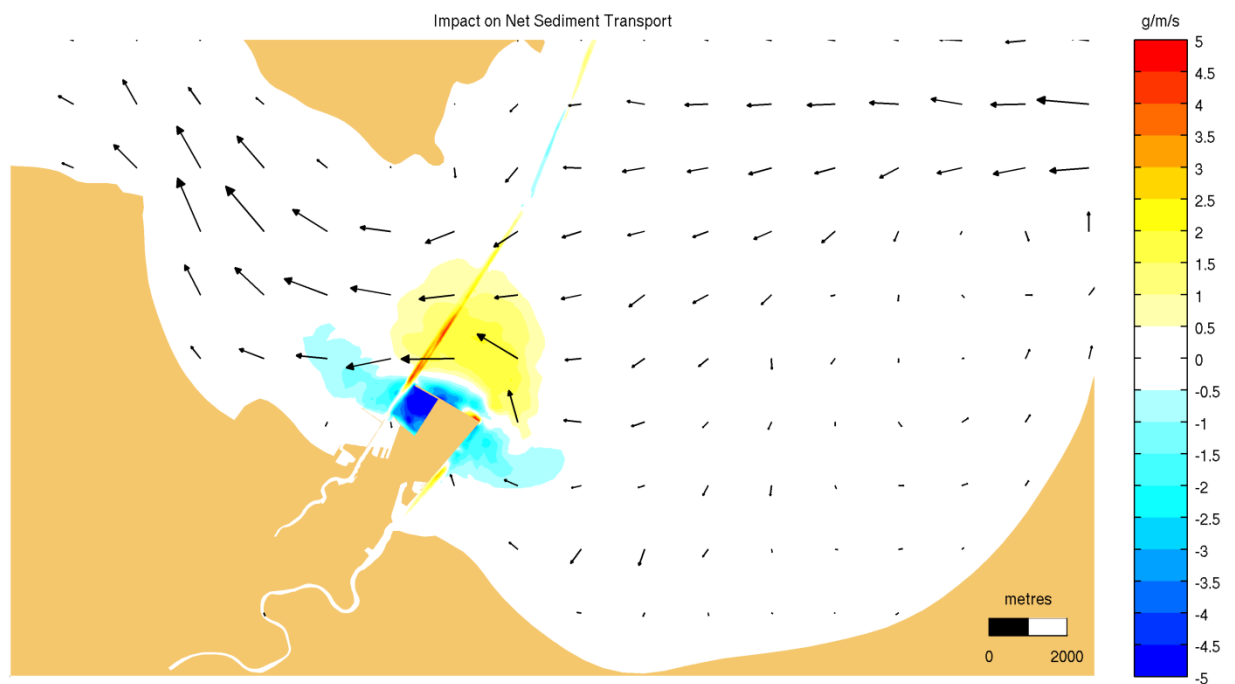


Figure 5-3 Ultimate Case Residual Suspended Sediment Transport Impacts

5.3 Channel Siltation

The modelled Base Case siltation rate in terms of bed level change in metres per year is shown in Figure 5-4 and the modelled annual siltation volumes are summarised in Table 5-1 for the regions shown in Figure 5-5. The modelled base case sedimentation rates were found to be in reasonable agreement with annual average historic dredging volumes for the existing dredged areas (POTL, 2013).



Figure 5-4 Modelled Base Case Siltation Rate (m/year)

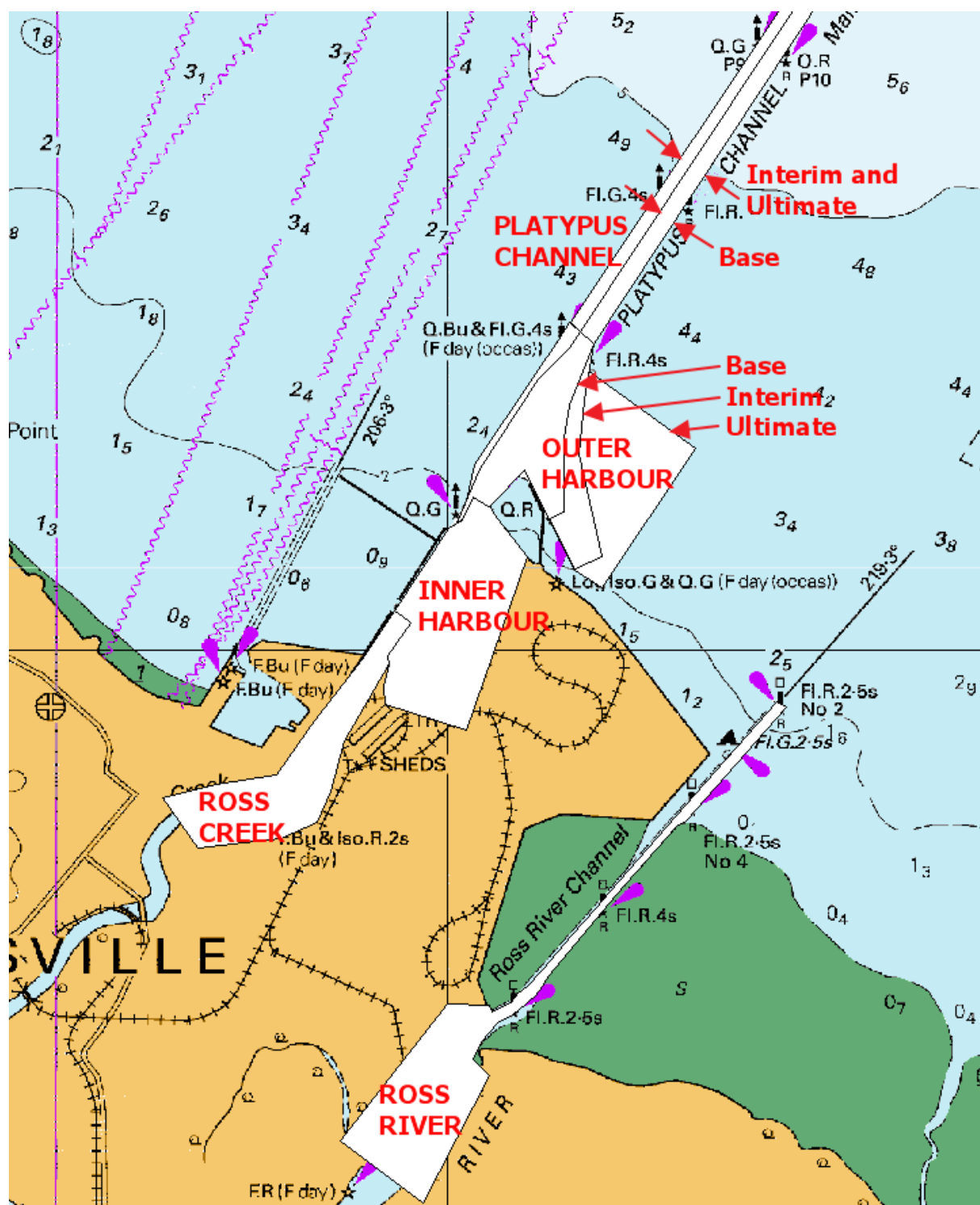


Figure 5-5 TUFLOW FV Sedimentation Model Regions

5.3.1 Interim Case

The distribution of modelled Interim Case siltation rate is shown in Figure 5-6 and the modelled annual siltation volumes for the Interim Case are summarised in Table 5-1. The changes to siltation rates due to the port expansion are shown in Figure 5-7. The model indicates a reduction in siltation rates within the inner harbour, and an increase in newly dredged areas. The model indicates an increase in siltation in most of the Platypus and Sea Channels.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 36%. The Interim Case reclamation acts to partly reduce the magnitude of suspended sediment transport into the inner harbour dredged areas.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 20%, and by 13% in the Sea Channel. This is mainly due to the increased channel width. Sedimentation volumes within the outer harbour are predicted to increase by around 20% relative to the Base Case, primarily due to the Berth 12 dredging.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined may be increased by around 70,000m³ per year (about 17% relative to the present situation). This is primarily due to the widening of the Platypus and Sea Channels.

Table 5-1 Modelled Annual Sedimentation Volumes – Interim Case (m³)

Dredge Area	Base Case	Interim Case	Percentage Change
Dredge Area	Base Case	Interim	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	18,000	- 36%
Platypus Channel	163,000	195,000	+ 20%
Sea Channel	40,000	45,000	+ 13%
Outer Harbour	128,000	153,000	+ 20%
Ross River	33,000	50,000	+ 52%
Total (modelled)	396,000	465,000	+ 17%

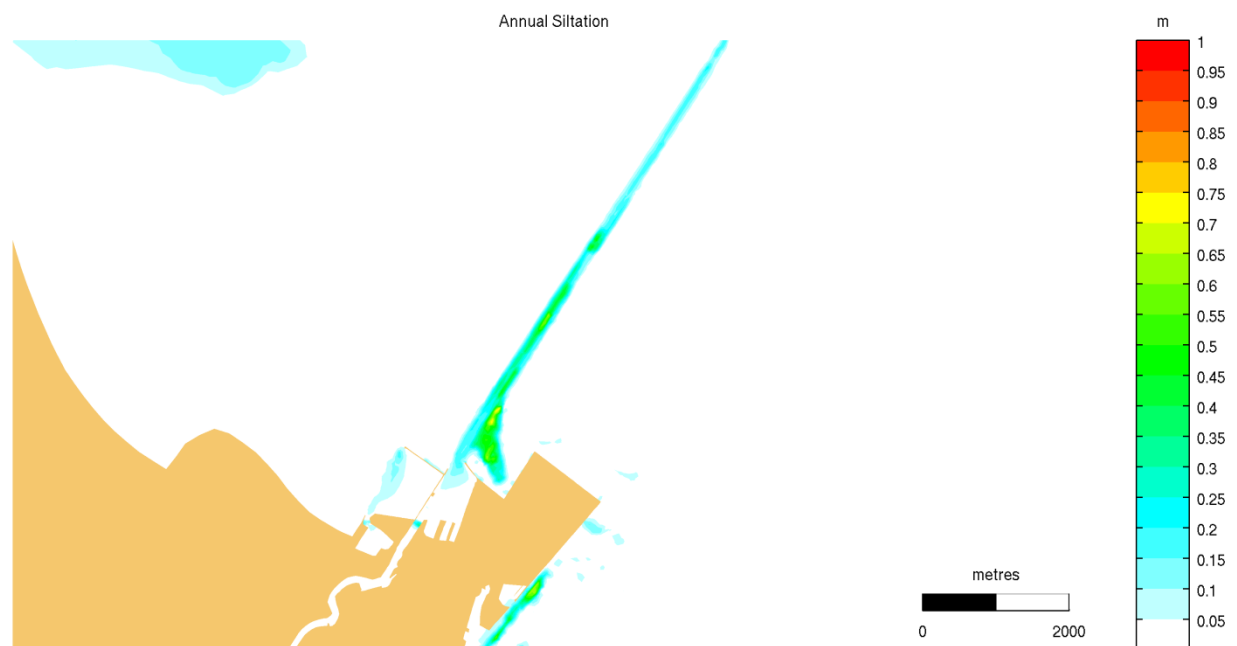


Figure 5-6 Modelled Interim Case Siltation Rate (m/year)

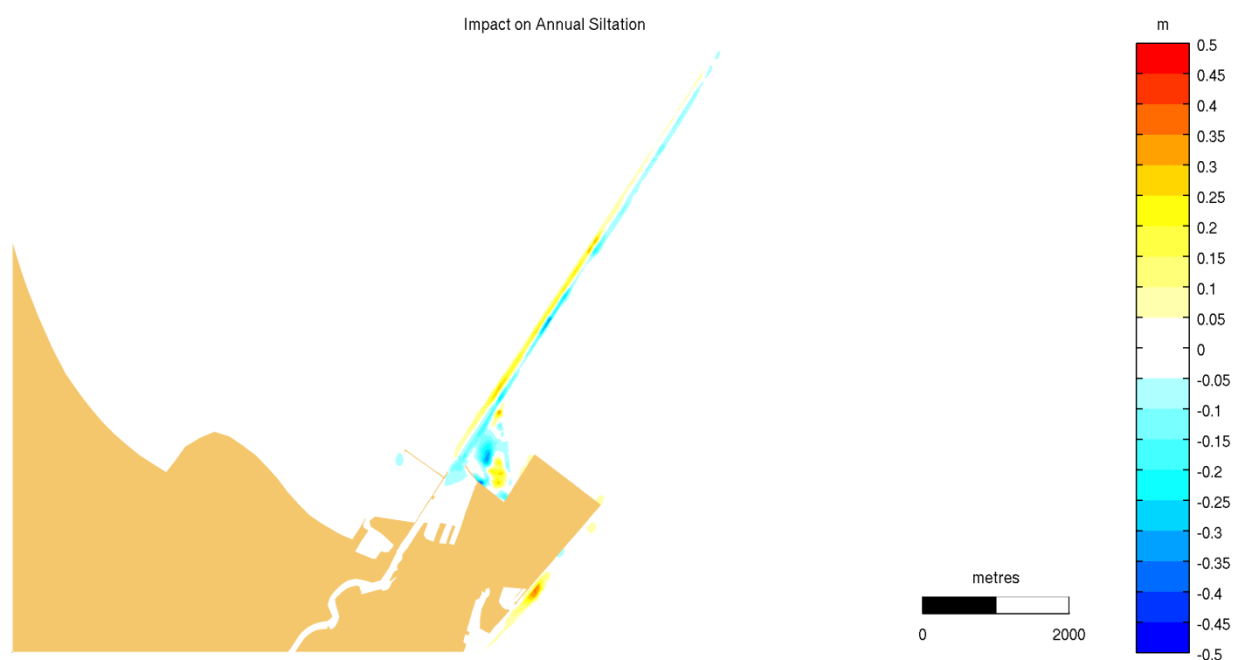


Figure 5-7 Difference in Siltation Rate between the Interim Case and Base Case (m/year)

5.3.2 Ultimate Case

The distribution of modelled Ultimate Case siltation depths is shown in Figure 5-8 and the modelled annual siltation volumes for the Ultimate Case are summarised in Table 5-2. The change in siltation rates due to the port expansion are shown in Figure 5-9. The model results indicate a reduction in siltation rates within the new enclosed outer harbour area, and an increase in siltation in the Platypus Channel and Sea Channel.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 21% and sedimentation volumes within the outer harbour are predicted to decrease by around 15% relative to the Base Case. The Ultimate Case reclamation and breakwaters act to significantly reduce the efficiency of suspended sediment transport into the outer and inner harbour dredged areas. It should be noted that the Ultimate Case assessments have been undertaken without a western breakwater in place. A modest decrease in predicted sedimentation would most likely occur with the addition of a western breakwater.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 26%, and within the Sea Channel it is predicted to increase by around 65%. This is due to the increased channel width and depth as part of the ultimate development.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined will increase by around 14% relative to the present situation. Although there will be a reduced suspended sediment net transport flux around the expanded port, this is more than offset by increased siltation in the widened and deepened channel. The material depositing in the new enclosed outer harbour area will be entirely very fine silts without the minor component of coarser silt/sand that deposits in the existing dredged basin and berth areas exposed at the present time.

Table 5-2 Modelled Annual Sedimentation Volumes – Ultimate Case (m³)

Dredge Area	Base Case	Ultimate Case	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	22,000	- 21%
Platypus Channel	163,000	205,000	+ 26%
Sea Channel	40,000	66,000	+ 65%
Outer Harbour	128,000	109,000	- 15%
Ross River	33,000	46,000	+ 39%
Total (modelled)	396,000	452,000	+ 14%

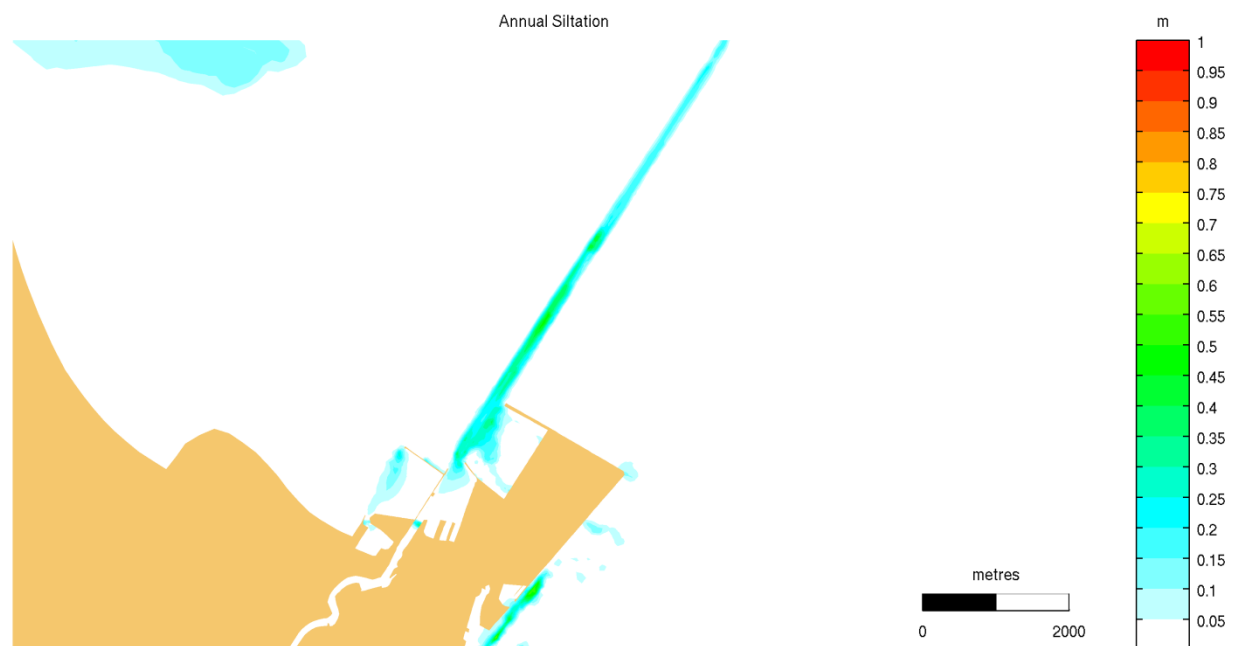


Figure 5-8 Modelled Ultimate Case Siltation Rate (m/year)

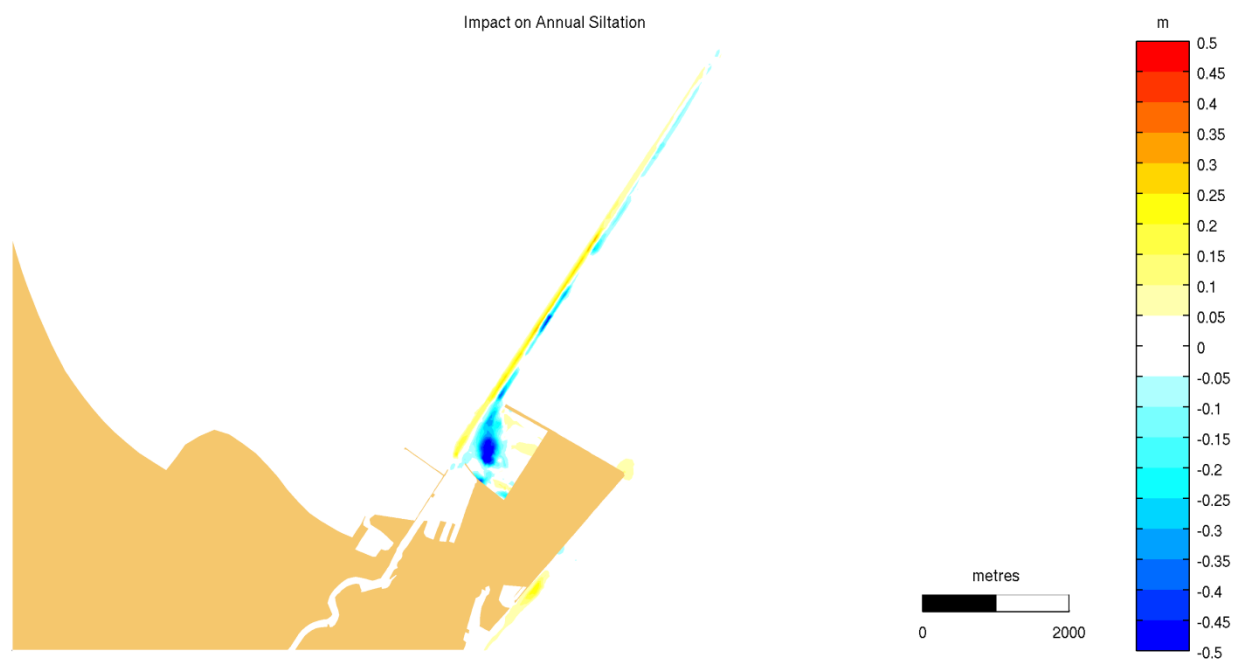


Figure 5-9 Difference in Siltation Rate between the Ultimate Case and Base Case (m/year)

5.4 Fine Fluvial Sediments from Ross River

To assess the potential for changes to siltation patterns supplied by fluvial sediment from Ross River, the TUFLOW FV model was used to investigate the fate of sediment discharged from the river in the Ultimate Case compared to the Base Case. Catchment modelling was undertaken as part of another BMT WBM study (BMT WBM, 2010) for a period of 30 years (1/4/1978 to 31/3/2008). A major inflow event in January 1998 was used for the impact assessment. The 1% exceedance level suspended sediment concentrations due to the fluvial discharge for the Ultimate Case configuration are shown in Figure 5-11. These may be compared with those for the Base Case configuration in Figure 5-10. The difference between the Ultimate and Base cases is shown in Figure 5-12.

The model results indicate that nearshore areas near The Strand are more sheltered from these suspended sediment discharges in this case and the PEP may help to reduce the amount of fine Ross River sediment that reaches and deposits in that area. There is a corresponding slight increase in the Ross River flood plume concentrations to the immediate east of the Port development.

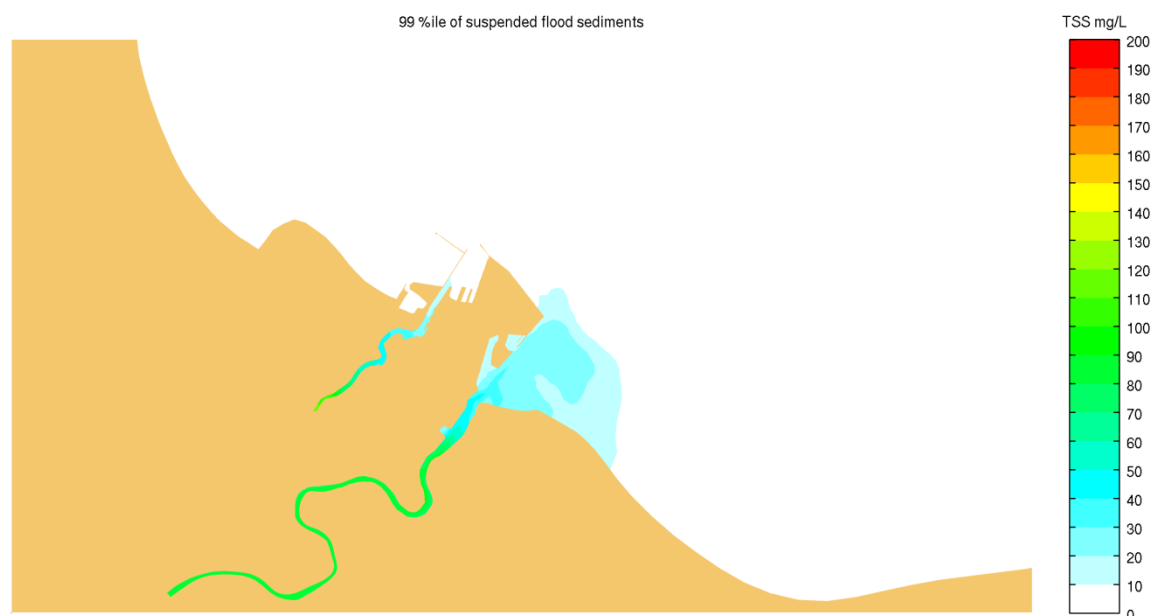


Figure 5-10 Depth-Averaged TSS Exceeded for 1% of the Simulation Period due to Ross River and Ross Creek Sediment Discharge in the Base Case

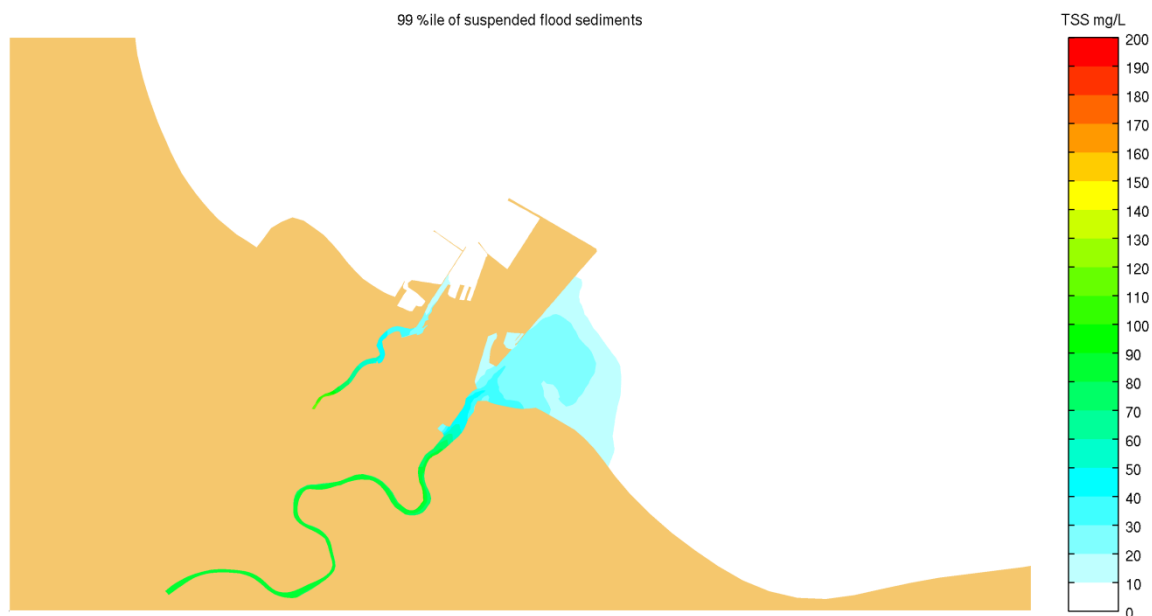


Figure 5-11 Depth-Averaged TSS Exceeded for 1% of the Simulation Period due to Ross River and Ross Creek Sediment Discharge in the Ultimate Case



Figure 5-12 Difference in Depth-Averaged TSS Exceeded for 1% of the Simulation Period due to Ross River and Ross Creek Sediment Discharge (Ultimate Case Minus Base Case)

6 Dredge Plume Assessment

6.1 Introduction

The following section describes the methodology and results of the numerical modelling assessment of the revised PEP capital dredging and reclamation programme. The revised programme involves disposal of all capital dredging material in an expanded reclamation area (no disposal of capital dredging material at sea). The dredge plume modelling methodology is described in detail followed by the presentation of model results for the following impact assessments:

- Capital program dredging assessments, including:
 - Model scenarios for Stage 1 to 3 of the revised PEP program;
 - Backhoe dredging of the berths and channel (80% of total volume);
 - TSHD channel dredging (20% of total volume);
 - Ensemble modelling scenarios for the critical (TSHD) dredging operations;
 - ‘Expected’ Case impacts derived as the ensemble average;
 - ‘Worst Case’ impacts derived as the ensemble maximum.
- Maintenance dredging assessments (for assessment of cumulative impacts).

The modelling outcomes provide a detailed and site specific assessment of possible dredge plume dispersion which was used as the basis for ecological impact assessments.

6.2 Methodology

6.2.1 Modelled Sediment Fractions

The current assessment simulated the re-suspension of “ambient” surficial seabed material as well as the “dredged” material that is released to the water column during dredging.

As summarised in Table 6-1, seven sediment fractions were simulated as part of the dredging impact assessments in order to track both the ambient and dredge material. Physical properties and model parameters were identical for corresponding size fractions of the ambient and dredge material.

The inclusion of both ambient and dredged material within the dredge plume and dispersion modelling assessment allows for the process of mixing and assimilation of the dredged material with the ambient material through the processes of re-suspension, suspended sediment transport and deposition. The ambient sediment bed was “warmed up” as described in Section 3.4. Throughout the dredge plume and dispersion assessment simulation the surface seabed sediment layer experienced re-suspension and deposition of all of the modelled sediment classes, with the relative proportions within the surface layer being dependent on the relative quantities being deposited. In this way the surface sediment layer subsequently available for re-suspension was made up of a representative mix of ambient and dredged sediments.

Table 6-1 Characteristics of Simulated Sediment Classes

Modelled Sediment Class	Still Water Fall Velocity, w_s (m/s)	Critical Shear Stress Erosion, τ_{ce} (Pa)	Critical Shear Stress Deposition, τ_{cd} (Pa)	Erosion Rate Constant, E (g/m ² /s)
Ambient Clay	1×10^{-4}	0.2	0.18	0.005
Ambient Silt	1×10^{-3}	0.2	0.18	0.005
Ambient Siliceous Sand	1×10^{-2}	0.2	N/A	0.05
Ambient Carbonaceous Sand	5×10^{-3}	0.2	N/A	0.05
Dredged Material Clay	1×10^{-4}	0.2	0.18	0.005
Dredged Material Silt	1×10^{-3}	0.2	0.18	0.005
Dredged Material Fine Sand	3×10^{-2}	0.2	N/A	0.05

6.2.2 Dredging Activities

The revised dredging programme involves the use of a small TSHD (similar in size to the TSHD Brisbane), and a backhoe dredge (1600kW power assumed). Approximately 20% of the total volume of dredging is anticipated to be undertaken by the TSHD, with the remaining 80% by the backhoe dredge. All material will be transported to the expanded reclamation area adjacent to the outer harbour.

The small TSHD will be used to dredge materials that can be pumped ashore from the hopper – these include soft marine sediments and dense clayey sands. The backhoe will be used to dredge the remaining material which is composed of stiff sandy clays.

6.2.3 Dredging Parameterisation

Table 6-2 presents the particle size distributions adopted for each material class, based on analysis of borehole data.

Table 6-2 Assumed Particle Size Distributions for each Dredged Material Class

	Soft marine sediments	Medium dense clayey sand	Stiff sandy clays	Tailwater discharge
Clay	40%	55%	88%	30%
Silt	50%	15%	0%	67%
Sand	10%	30%	12%	3%

Source terms for the passive plume associated with working with a TSHD are:

- The drag-head, which disturbs the bed and might re-suspend material locally;
- The propeller wash, which causes re-suspension of fines settled on or near the bed, especially when the keel clearance is limited; and
- The overflow during loading, which forms a dynamic plume from which parts are released to the surrounding waters.

The plume source terms for the TSHD were adopted as:

- Drag-head and propeller wash: 2% of the amount of fines within the dredged materials
- During overflow 80% of the fines entering the hopper disappear through the overflow. Of this 80%, approximately 85% forms a dynamic plume on the seabed in the dredging area, which will be re-cycled and 15% goes in the water column as a passive plume outside the dredging area. It is the passive plume (12% of the fines entering the hopper) which is represented in the numerical model.

The plume generation source term for a backhoe dredger is 3% of the fines within the material dredged. The production rate of the backhoe is expected to be lower during the channel deepening operation due to the thinner layer of sediment to be removed as well as the requirement to move clear of the channel for shipping movements.

The release of sediment to the water column during dredging was calculated as a percentage of the production rate, varying according to whether the dredge was operating with or without overflow. A uniform vertical distribution was assumed for all plume sources. Key parameters adopted for the dredging program are presented in Table 6-3 and Table 6-4.

Table 6-3 Key Assumptions for Plume Release Rates – Small TSHD (Equivalent Size to TSHD Brisbane)

Dredge Type	Small TSHD	
Material Class	Soft Marine Sediments	Medium Dense Clayey Sand
Assumed in-situ dry density [kg/m ³]	1450	1950
Production/trip [in-situ m ³]	1580	1800
Hopper volume [m ³]	2900	2900
Release rate of sediment to the water column due to draghead and propwash (2% of the fines dredged) [kg/s]	38	24
Release rate of sediment to the water column due to overflow (12% of fines entering the hopper) [kg/s]	228	147
Assumed vertical release distribution	Uniform for all plume sources	
Dredging time before overflow [mins]	15	15
Overflow time [mins]	11	42
Speed of dredge during dredging [m/s]	0.7	0.7
Cycle time [h]	2.42	3.37

Table 6-4 Key Assumptions for Plume Release Rates - Backhoe

Dredge Type	Large BHD	
	Channel Widening	Channel Deepening
Production during dredging (m ³ /h)	250	210
Dry density (kg/m ³)	2000	2000
Plume source during dredging (kg/s)	3.67	3.08
Operating hours per week	100	70

6.2.4 Meteorological and Hydrodynamic Conditions

In order to assess the impacts of the proposed dredging operations, the most significant dredging operations were simulated for five different months within the 2009-2010 period. These periods include a variety of different wind conditions including strong south-easterlies and some periods of northerlies. The 'long term' wind rose is provided in Figure 6-1 and the wind roses for the assessment months are shown in Figure 6-2.

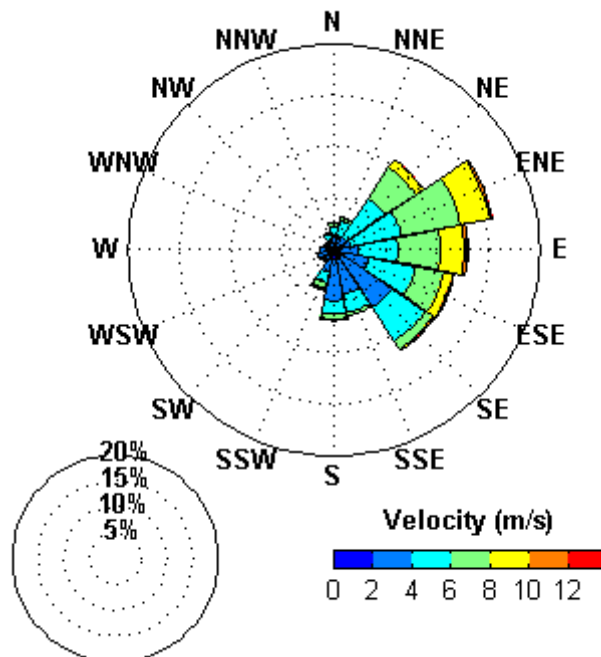


Figure 6-1 Long Term (1995-2011) Wind Rose – Townsville Aero

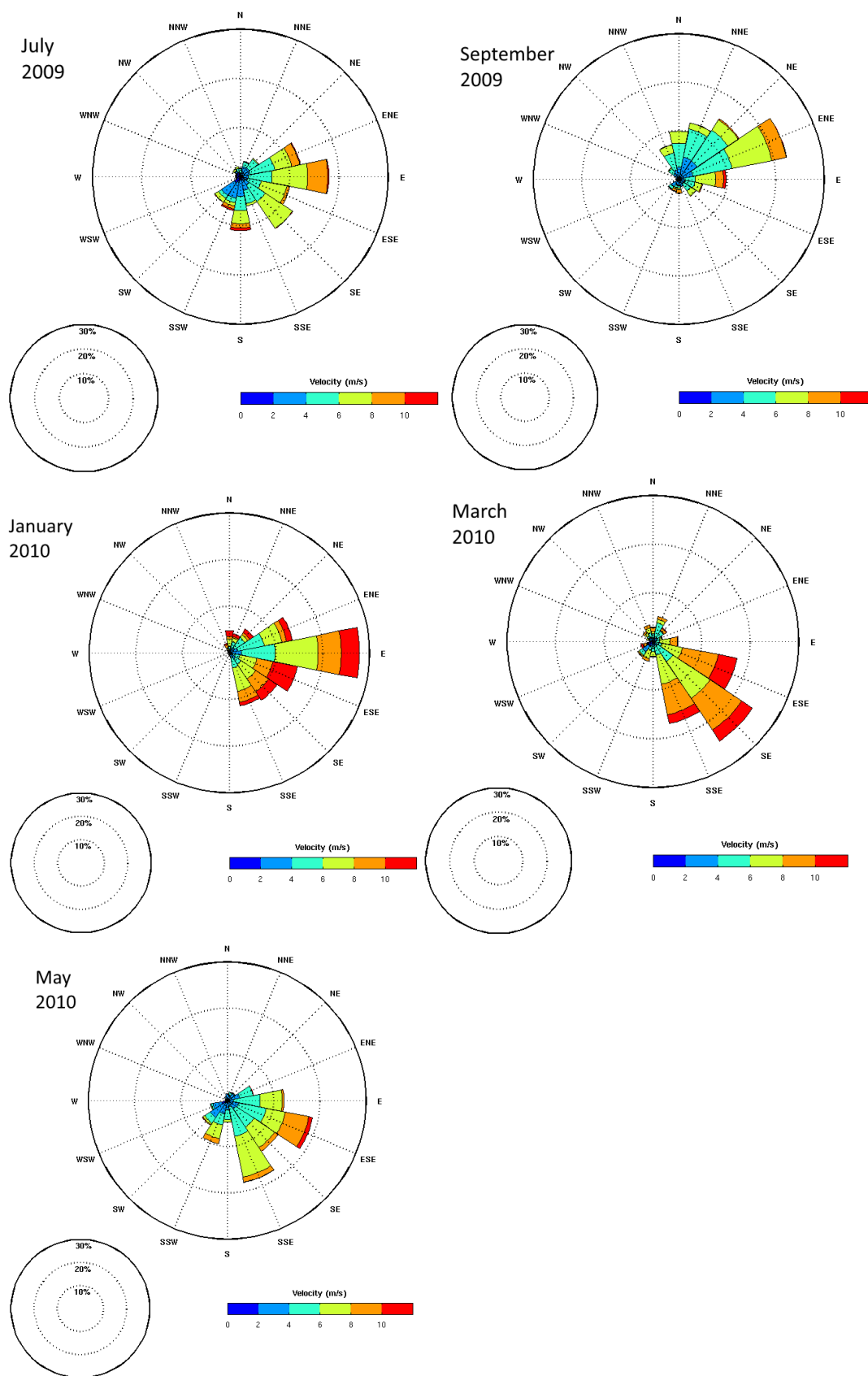


Figure 6-2 Impact Assessment Months – Wind Roses – Townsville Aero

6.2.5 Impact Assessment Methodology

The effects of dredging were assessed based on modelled increases in suspended sediment concentration and sedimentation above natural or ambient levels. Both ambient and dredge related signals have been resolved in the predictive model, which allows for an understanding of how significant the dredge contribution is in relation to ambient conditions.

The water column turbidity impacts associated with dredging-related suspended sediment were derived by converting the modelled Total Suspended Solids (TSS) levels into an equivalent turbidity value using the relationship developed in Section 3.3.3. Depth-averaged turbidity values are presented here since they are most relevant to assessing ecological impacts due to the reduction in seabed Photosynthetically Active Radiation (PAR). Nearbed turbidity is also presented in order to indicate the maximum concentrations within the water column. Sedimentation impacts were derived from the daily rate of change in bed sediment mass associated with the dredge fractions. The adopted sedimentation rate units are $\text{mg}/\text{cm}^2/\text{day}$.

The anticipated effects of dredging have been assessed using two different presentation techniques:

- Time series at sensitive receptor sites; and
- Spatial plots based on percentile analysis.

6.2.5.1 Time Series Analysis

Time series provide a simple way to present turbidity increases due to dredging at predetermined points of interest. Having simulated both dredging and ambient sediment, the time series show both these contributions to the total signal and in doing so provide important information on the relative magnitude of the dredging related signal.

The time series plots of turbidity and sediment deposition for the small TSHD dredging dense clayey sand material during Stage 3 channel deepening are presented in Attachment D (since this activity produced the most significant suspended sediment plumes). The locations used for model time series outputs are shown in Figure 6-3. Results are presented at Sites 4, 5, 6 and 22 are presented for three of the simulated 30-day periods – July 2009, September 2009 and March 2010 – to represent a range of possible seasonal conditions.

6.2.5.2 Percentile Analysis

Each dredging activity was simulated over a 30 day period. Spatial representations of the dredging impacts were based on percentile exceedance analysis of the model results. The 30 day window period is somewhat arbitrary but in a physical hydrodynamic context represents the approximate duration of two (2) consecutive spring-neap tidal cycles, while in an ecological context it is a meaningful timescale for assessing impacts to some key sensitive receptors in the area (e.g. dominant seagrass *Halophila ovalis*).

The percentile impact plots correspond to the predicted increase in turbidity/sedimentation statistics over ambient conditions that are attributable to the dredging. It is important to note

that the presented turbidity percentile plots do not represent the plume extent at any one particular instant in time.

Percentile values considered in this report are 95th and 50th, which correspond to exceedance durations of 36hrs (5%) and 15 days (50%) respectively for the 30 day simulation. The highest percentiles correspond to relatively acute and short-lived increases in turbidity/sedimentation while the lower percentiles correspond to more chronic longer-term increases.

The spatial percentile exceedance dredging impact plots are presented in tandem with the equivalent modelled ambient percentile statistics, calculated as the average over all five of the 30 day modelling periods. This allows the increases in turbidity/sedimentation due to dredging to be seen relative to the modelled ambient conditions.

Key features of the dredging impact analysis methodology include:

- Consideration of a range of impact durations from acute to chronic.
- Can account for the influence of a variety of meteorological conditions.
- A similar analysis applied to the baseline data can quantify the ambient conditions including natural variability across different periods. This can be used to derive meaningful thresholds for the impacts.

For the most significant dredging activities (i.e. TSHD), the simulation was carried out for an ensemble of five different 30 day periods during different seasons and the results were aggregated to determine the likely range of potential impacts. The 'Expected Case' impacts were determined on the basis of the ensemble average turbidity and deposition percentiles. The 'Worst Case' impacts were determined on the basis of the ensemble maximum turbidity and deposition percentiles.

Twelve months of baseline turbidity monitoring was undertaken as part of the project which has allowed for the derivation of contour limits for the presentation of the percentile impact plots that are meaningful at specific sites. It should be noted that different thresholds (and therefore different contour limits) are appropriate for the different percentiles.



Figure 6-3 Sites for Time Series Outputs

6.3 'Expected Case' Dredging Impacts

6.3.1 PEP Stage 1

The PEP Stage 1 consists of three main dredging operations.

- The removal of soft sediments under retaining wall structures along the perimeter of the proposed interim reclamation area. This will be carried out by backhoe.
- Widening the Platypus Channel on its western side (a new width of 180m at the Outer Harbour, tapering to 135m at its northern end), and widening the Sea Channel on its eastern side (for 135m at the southern end to 120m at its northern end). The soft marine sediments and dense clayey sands will be dredged by TSHD (20% of the total volume). The stiff, very stiff and hard clays will be dredged by backhoe (80% of the total volume).
- The dredging of Berth 12 to an elevation of -13.5mLAT by backhoe.

The geometry assumed for the channel dredging simulations in this stage corresponds to the existing bed elevations for the channel and adjacent areas, with the interim reclamation in place. The plume sources for the channel widening are released into model cells adjacent to the existing channel. The plumes generated during Berth 12 dredging were not modelled because they would have a smaller influence than the plumes generated during the removal of soft surface sediments under reclamation wall structures.

6.3.1.1 *Removal of soft sediments under reclamation wall structures*

This initial dredging activity involves the removal of soft surface sediments along the footprint of the proposed reclamation bunds using a backhoe dredge. The modelled impact of the dredging operation is shown in Figure 6-4 to Figure 6-8. The 30 day modelling period shows the dredge working in a single location. The extent of the influence of the suspended sediment plumes will be similar for other locations along the perimeter of the reclamation bunds. The influence of suspended sediment plumes and deposited sediment is restricted to the immediate vicinity of the dredging operation.

Impact of dredging on the 95th %ile of turbidity

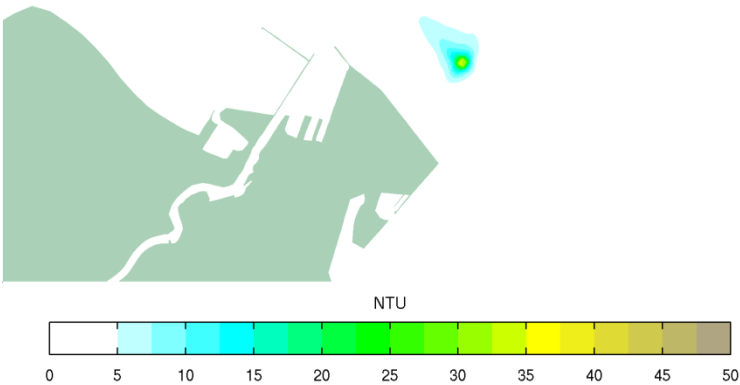


Figure 6-4 Stage 1 – Soft Sediments – 95th Percentile Depth Average Turbidity: Impact of Dredging

Impact of dredging on the 95th %ile of turbidity

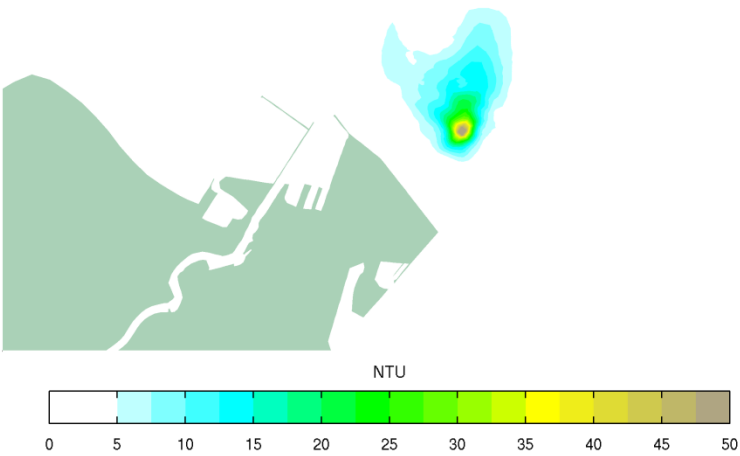


Figure 6-5 Stage 1 – Soft Sediments – 95th Percentile Bottom 1m Turbidity: Impact of Dredging

Impact of dredging on the 50th %ile of turbidity

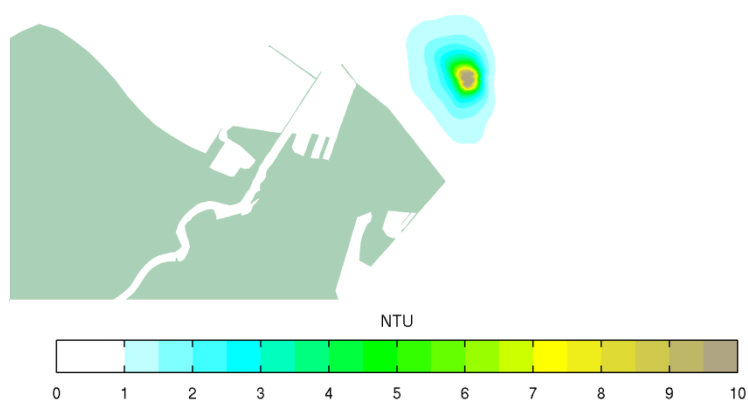


Figure 6-6 Stage 1 – Soft Sediments – 50th Percentile Depth Average Turbidity: Impact of Dredging

Impact of dredging on the 50th %ile of turbidity

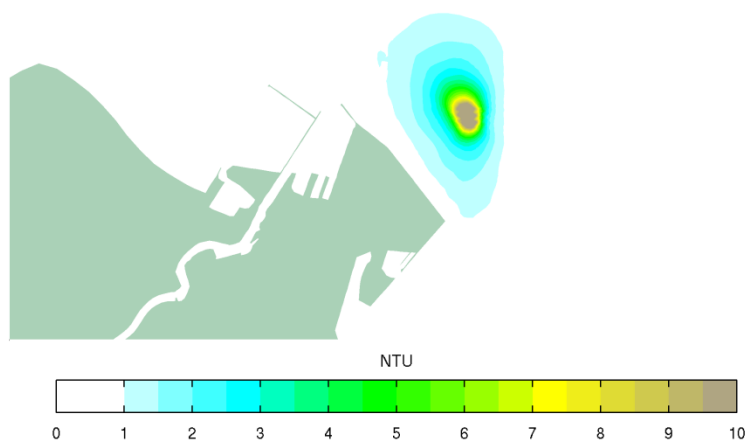
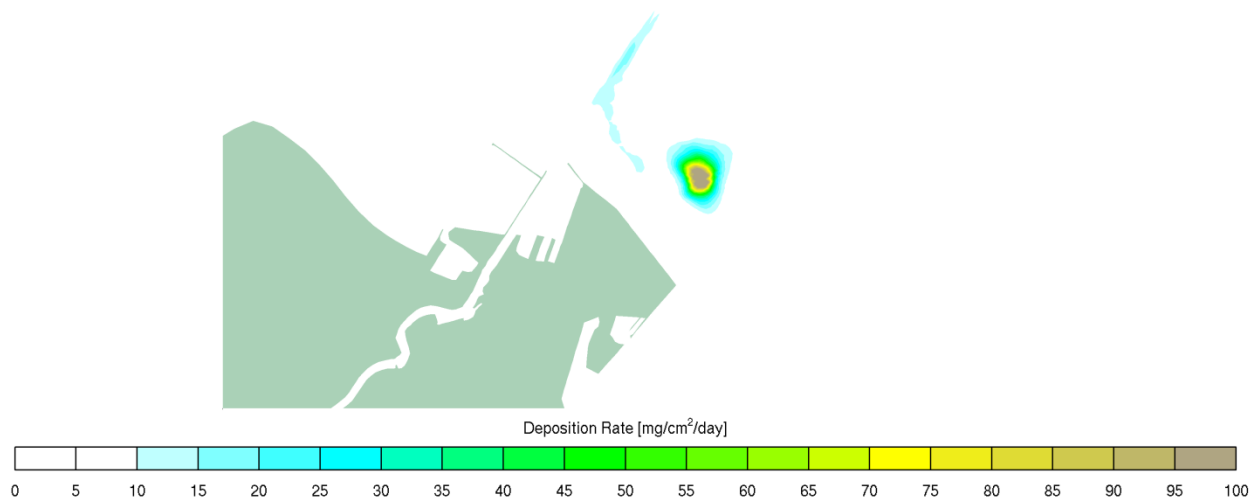


Figure 6-7 Stage 1 – Soft Sediments – 50th Percentile Bottom 1m Turbidity: Impact of Dredging

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

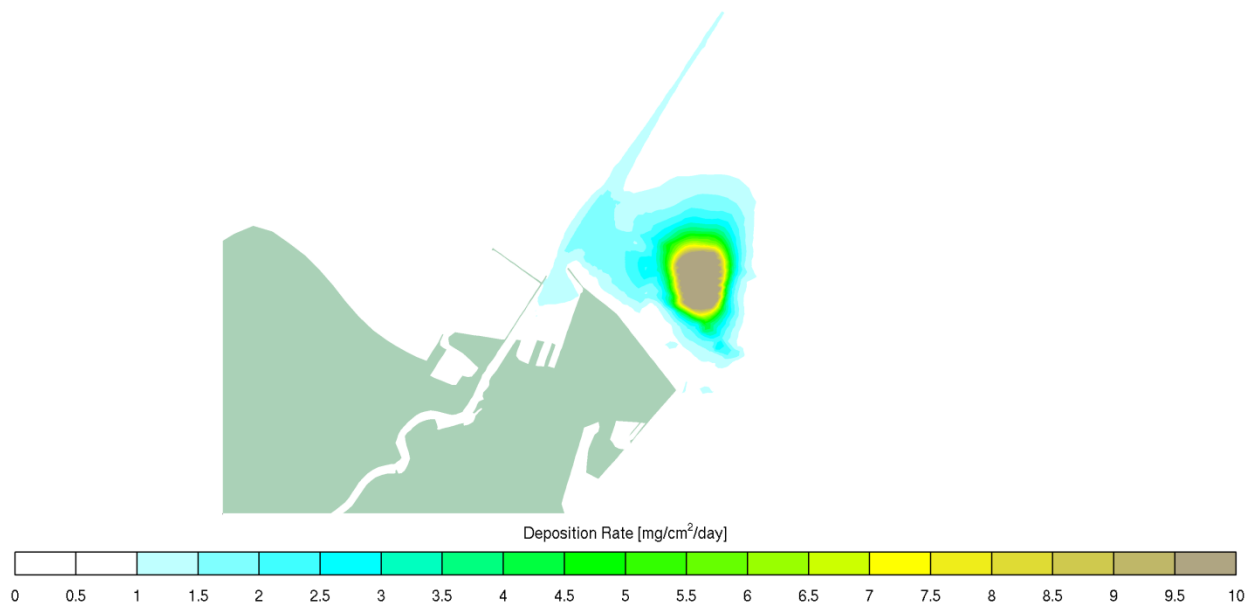


Figure 6-8 Stage 1 – Soft Sediments – Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

6.3.1.2 *Widening of Platypus and Sea Channels by Small TSHD*

The modelled impact of dredging during the widening of the Platypus and Sea Channels by a small TSHD is shown in Figure 6-9 to Figure 6-14. The impacts shown are representative of the TSHD working in dense clayey sand material (since this generates more extensive plumes than working in soft material). The total campaign duration for the TSHD for this stage of the programme is 16.5 weeks, approximately one third of which will involve working in dense clayey sands.

Figure 6-9 shows the change in the 95th percentile depth-averaged turbidity due to dredging, averaged over the five different 30-day periods that were modelled. Figure 6-10 shows the change in the 95th percentile turbidity in the bottom 1m layer of the model due to dredging (again, averaged over the five 30-day periods that were modelled). These figures indicate the likely acute (short term) influence of suspended sediment plumes generated by the TSHD.

Figure 6-11 shows the change in the 50th percentile depth-averaged turbidity due to dredging and Figure 6-12 shows the change in the 50th percentile turbidity in the bottom 1m layer of the model due to dredging. These figures indicate the likely chronic (persistent) influence of suspended sediment plumes generated by the TSHD.

Figure 6-13 shows the change in the 95th and 50th percentile deposition rate due to dredging, while Figure 6-14 shows the total amount of dredged material deposited in a 30 day simulation (the average of the five months that were modelled). Overall, the modelled turbidity and deposition impacts are limited to the immediate vicinity of the channel.

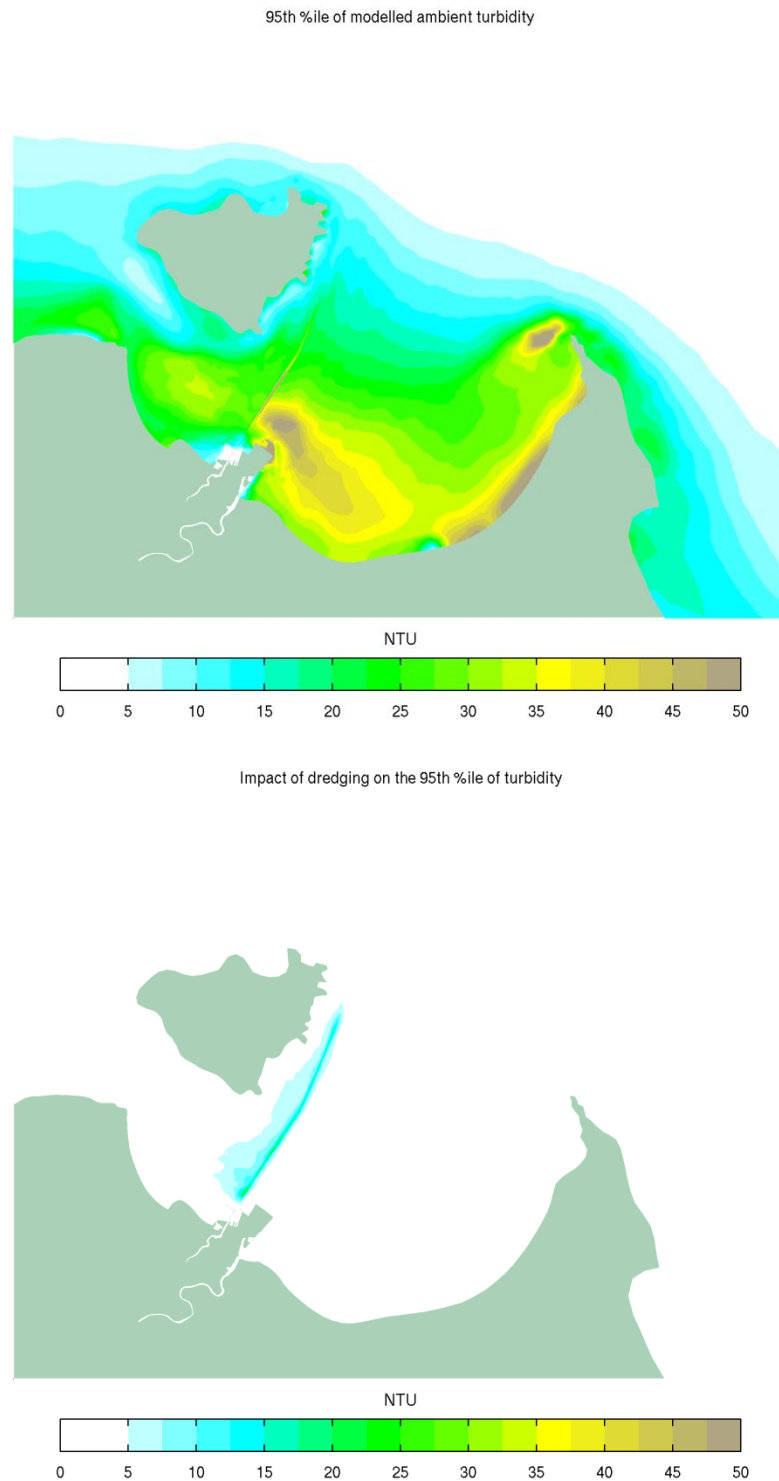
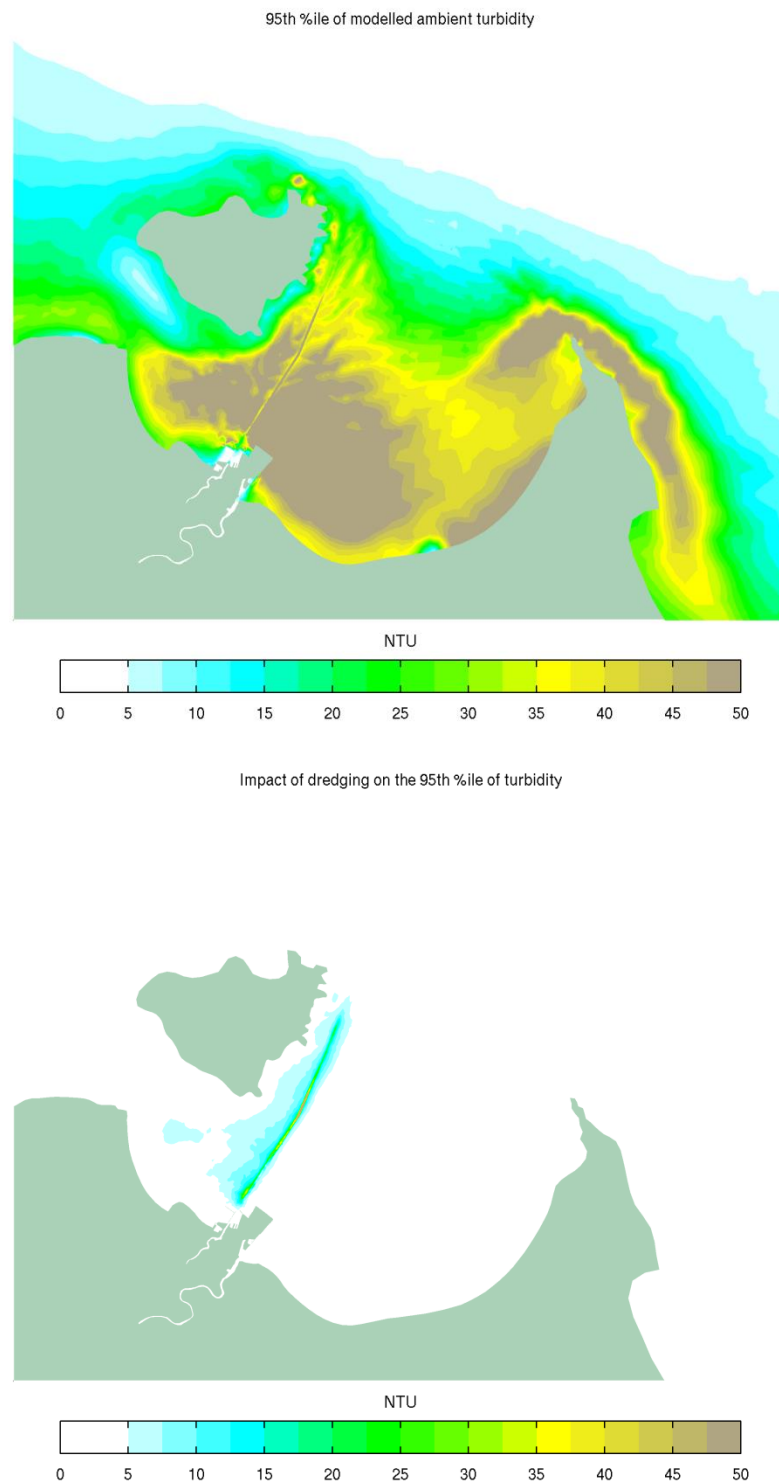


Figure 6-9 Widening of Platypus and Sea Channels by Small TSHD - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)



**Figure 6-10 Widening of Platypus and Sea Channels by Small TSHD - 95th Percentile
Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)**

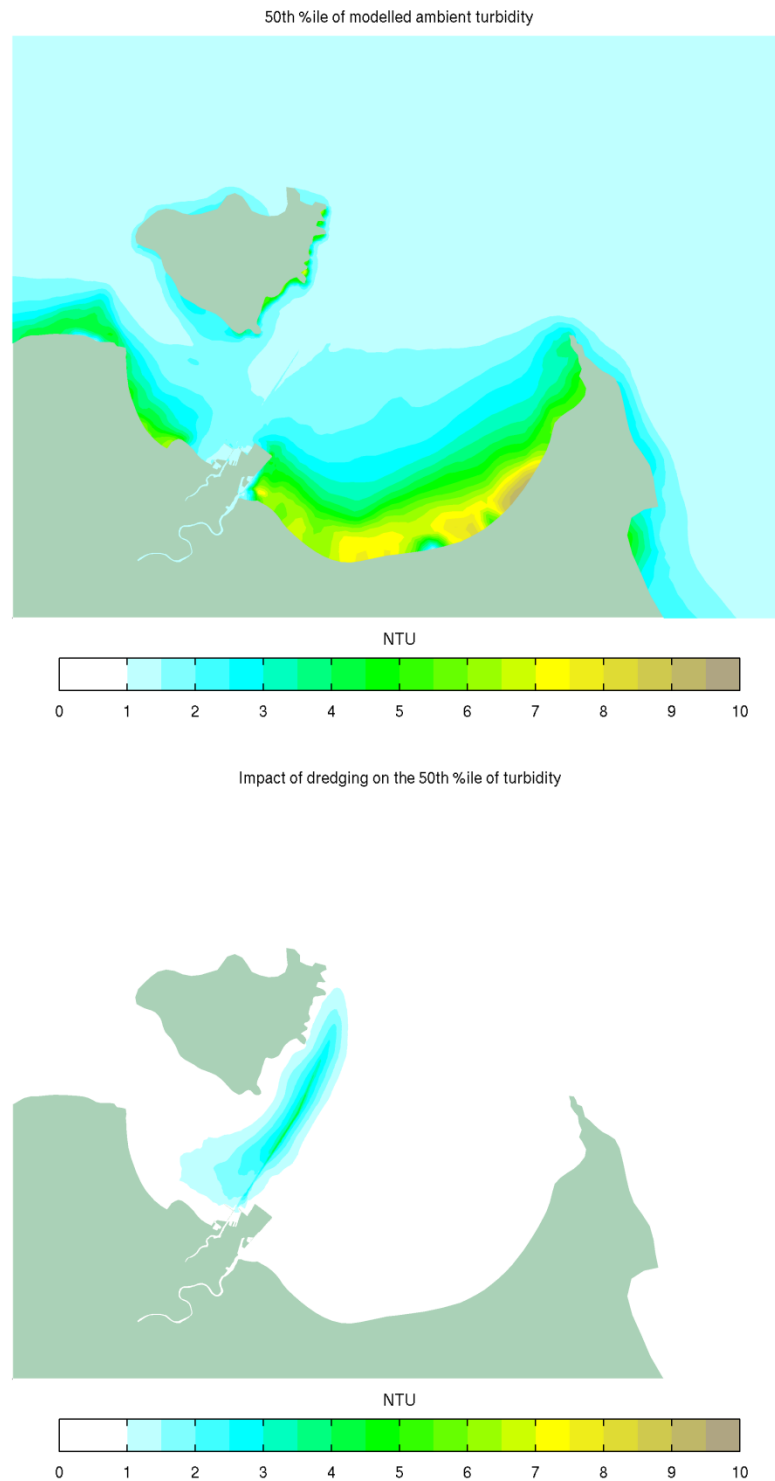


Figure 6-11 Widening of Platypus and Sea Channels by Small TSHD - 50th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

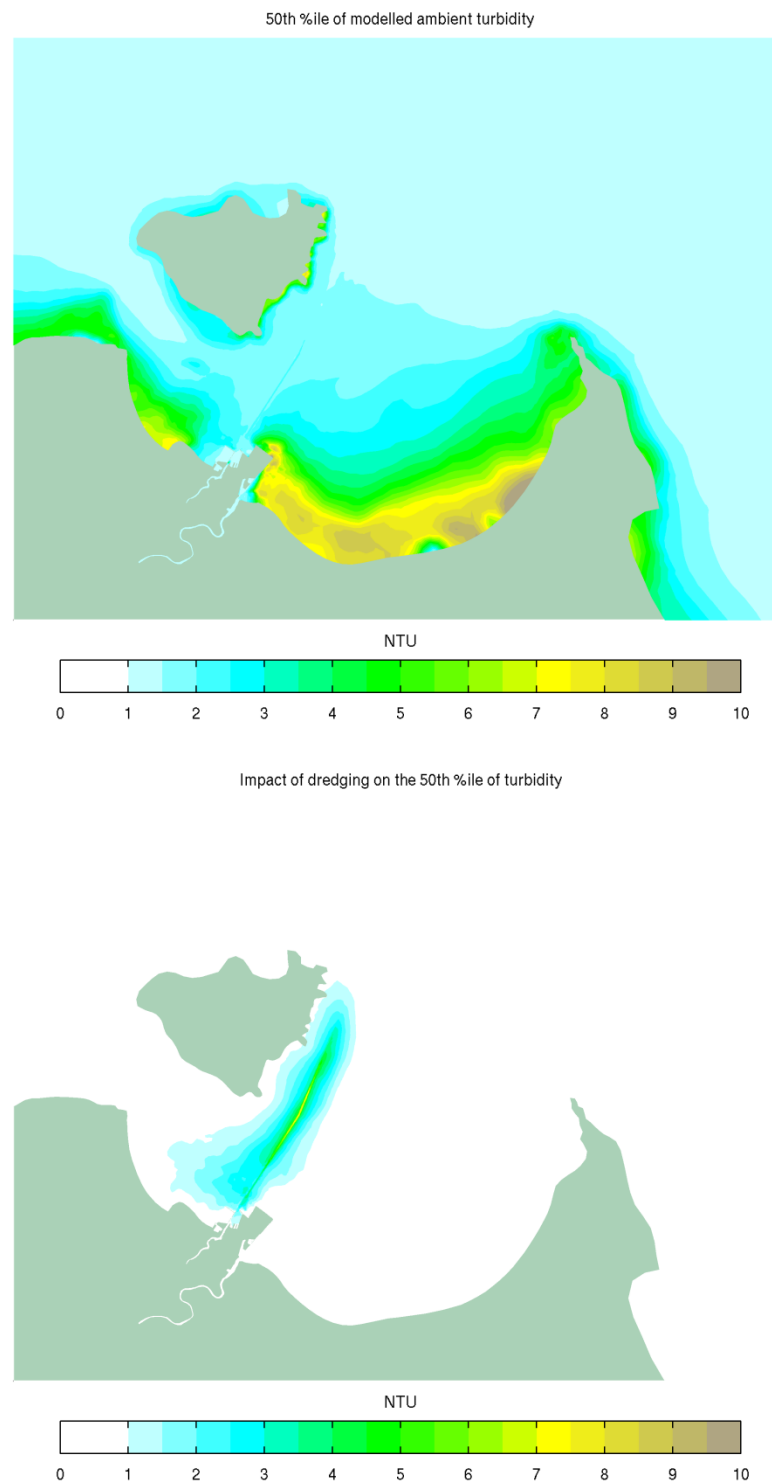
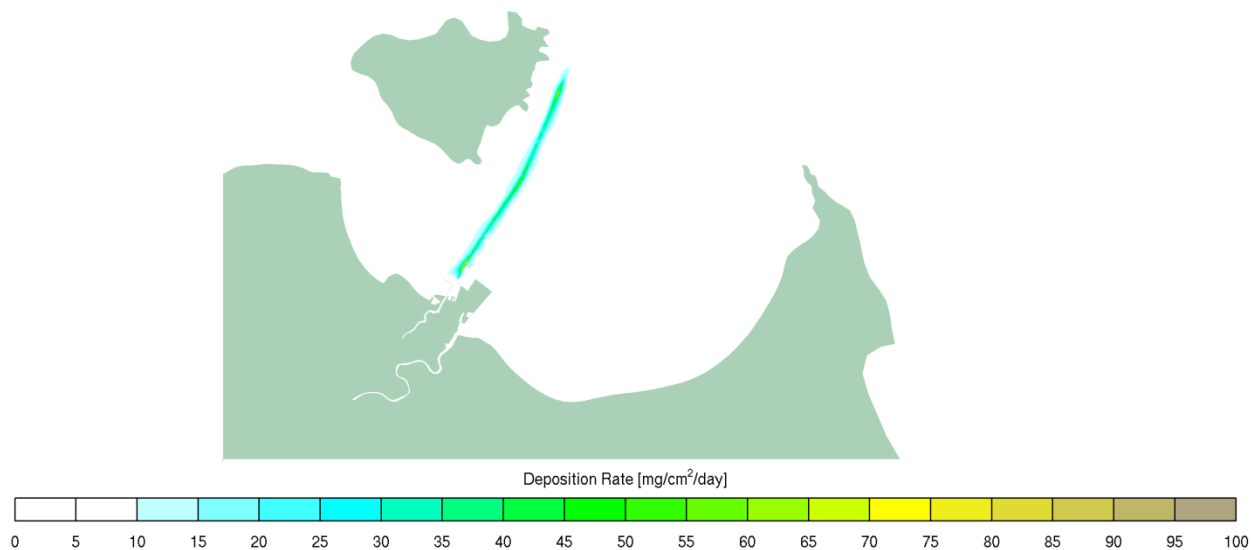


Figure 6-12 Widening of Platypus and Sea Channels by Small TSHD - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

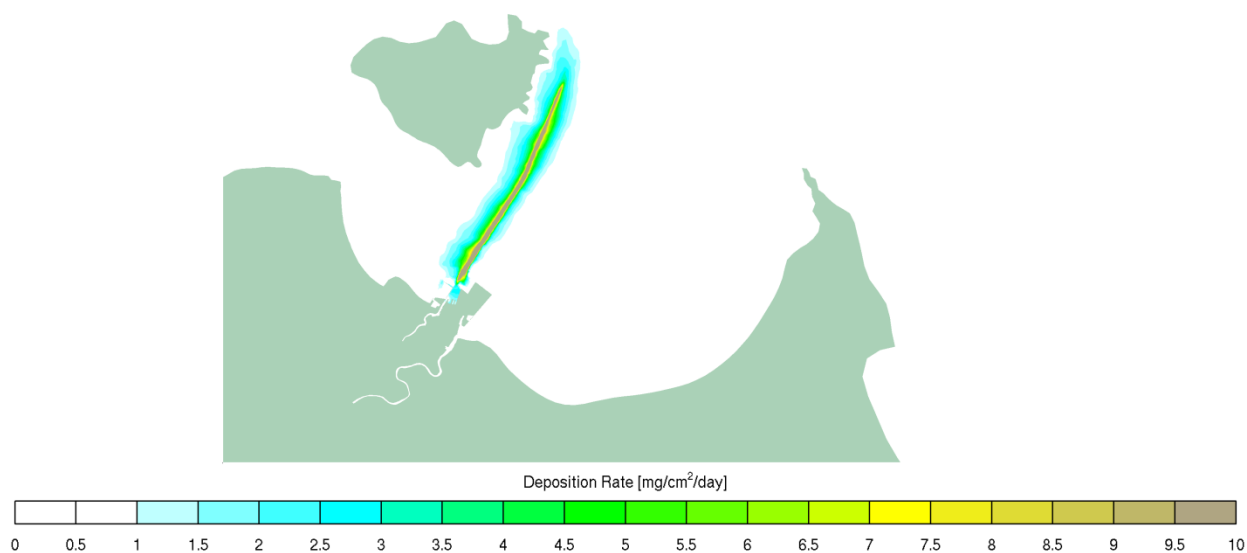


Figure 6-13 Widening of Platypus and Sea Channels by Small TSHD - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

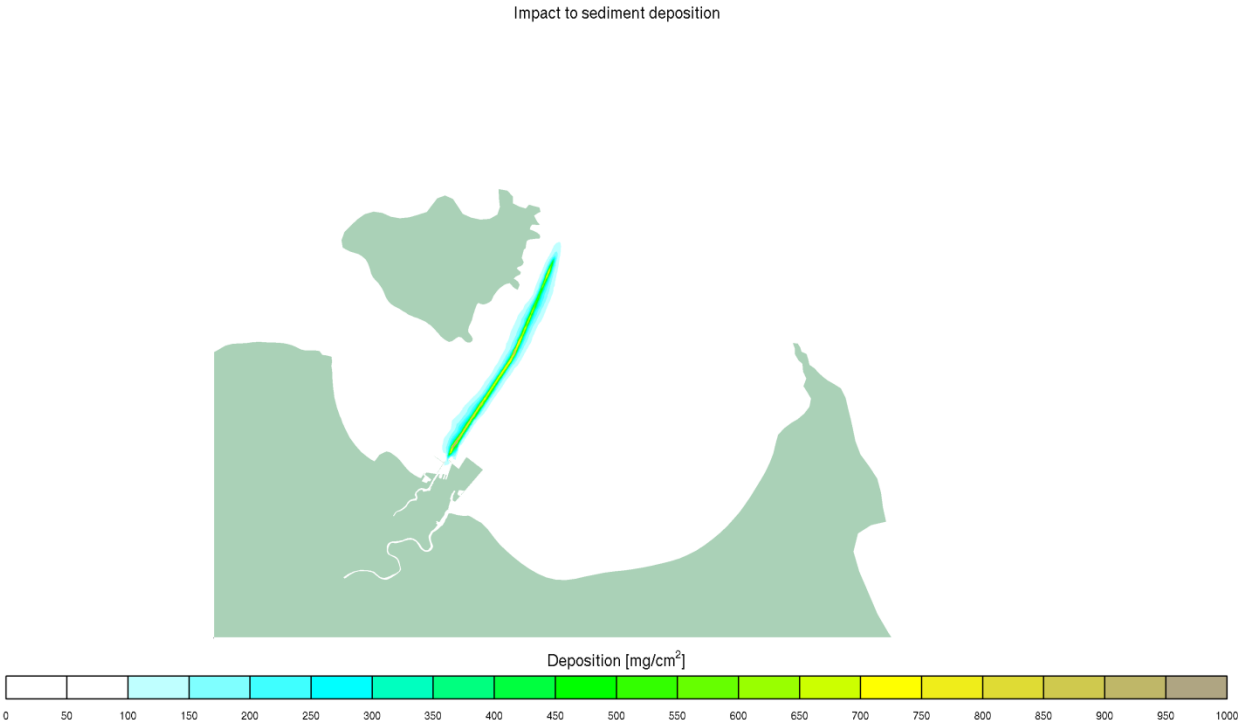
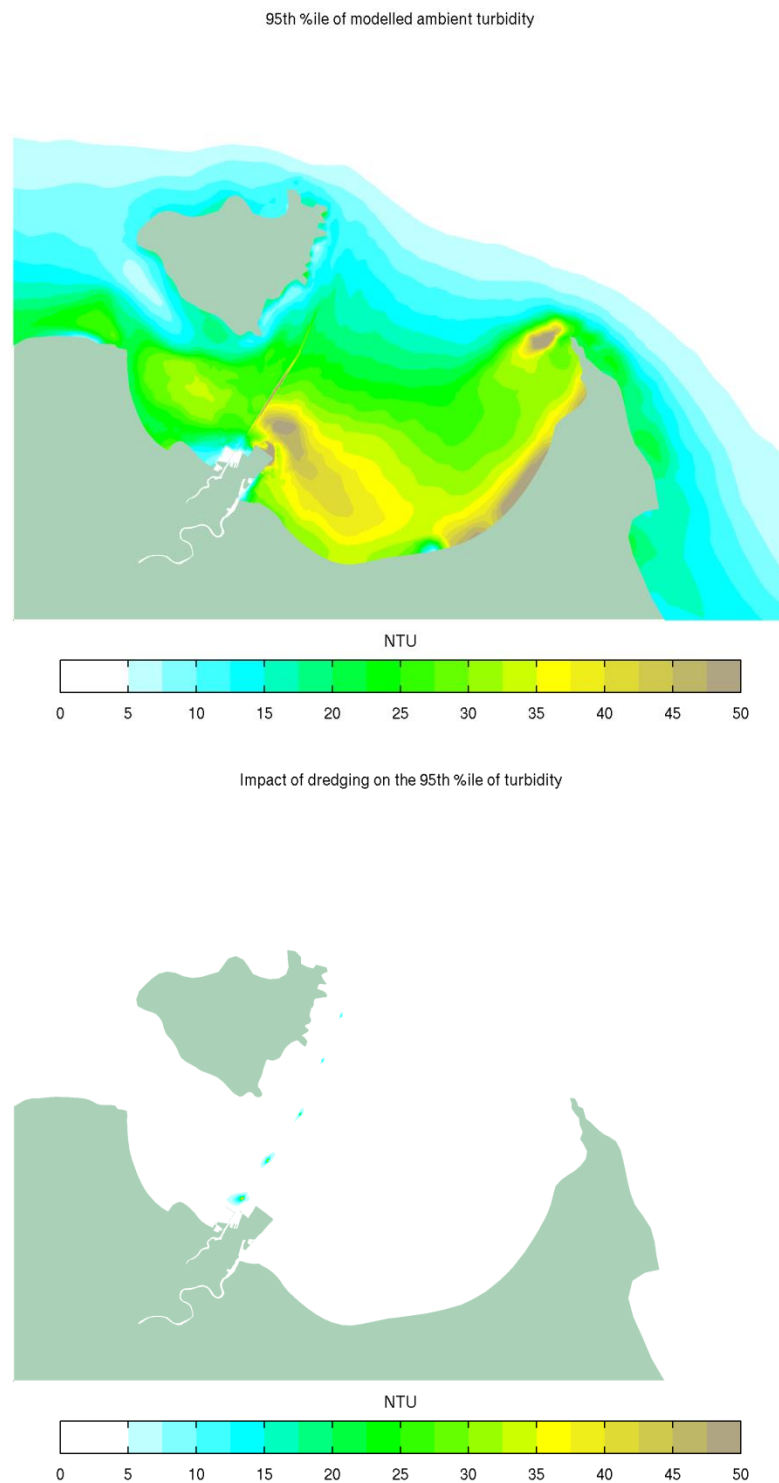


Figure 6-14 Widening of Platypus and Sea Channels by Small TSHD - Deposition of Dredged Sediment After 30 Days

6.3.1.3 *Widening of Platypus and Sea Channels by Backhoe*

The modelled impact of dredging during the widening of the Platypus and Sea Channels by a backhoe is shown in Figure 6-15 to Figure 6-20. Note that the impact plots presented here show the superposition (addition) of the impacts of a backhoe dredge working at five different locations along the shipping channel. The impacts shown are representative of a typical 30 day period of backhoe dredging at each location. The influence of dredging plumes generated by the backhoe at intermediate locations along the channel can be estimated by interpreting the plots. It can be seen that the acute and chronic impacts of the backhoe dredging operation are restricted to the immediate vicinity of the dredging location. The backhoe dredging campaign for this stage of the project is expected to take approximately two years.



**Figure 6-15 Widening of Platypus and Sea Channels by Backhoe - 95th Percentile Depth
Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)**

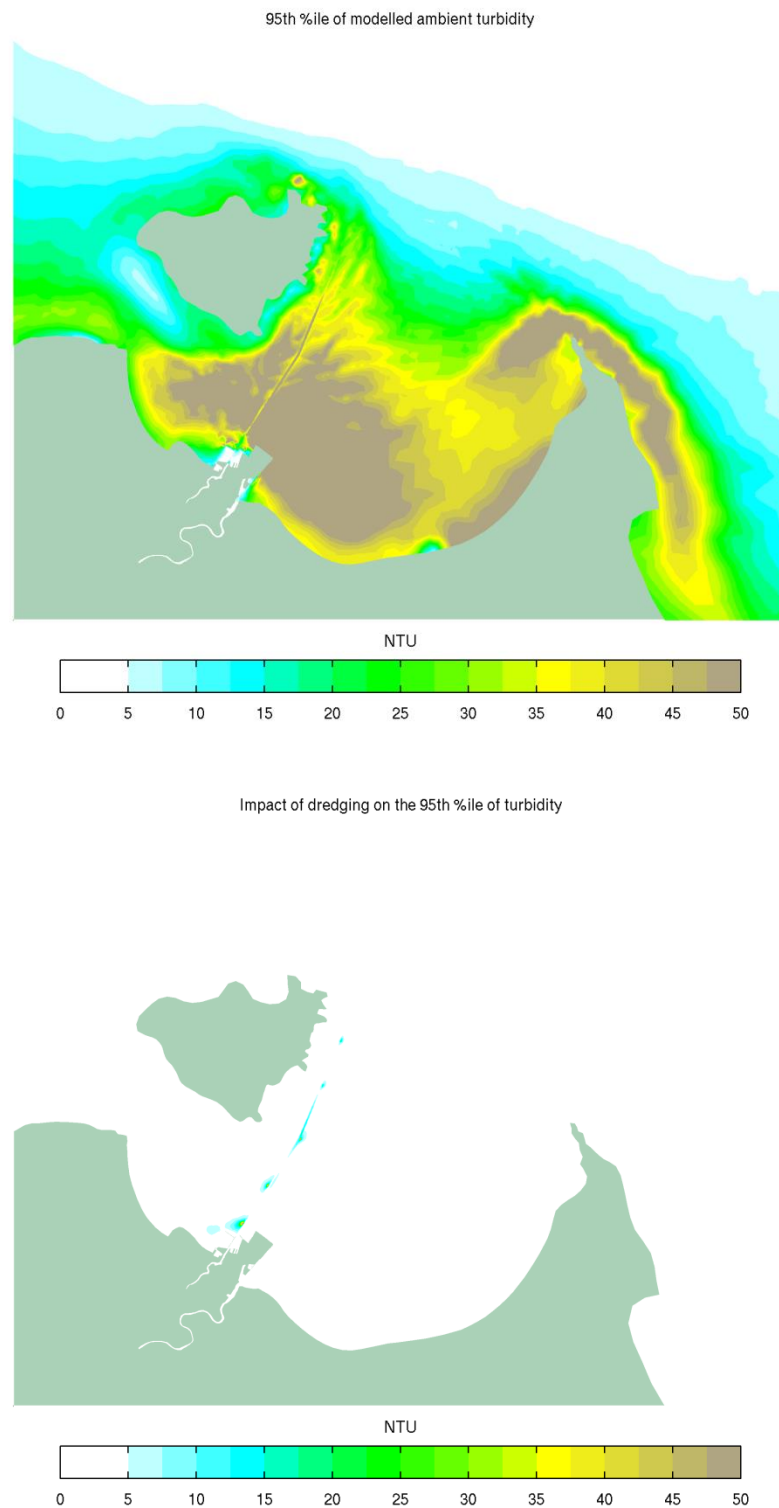
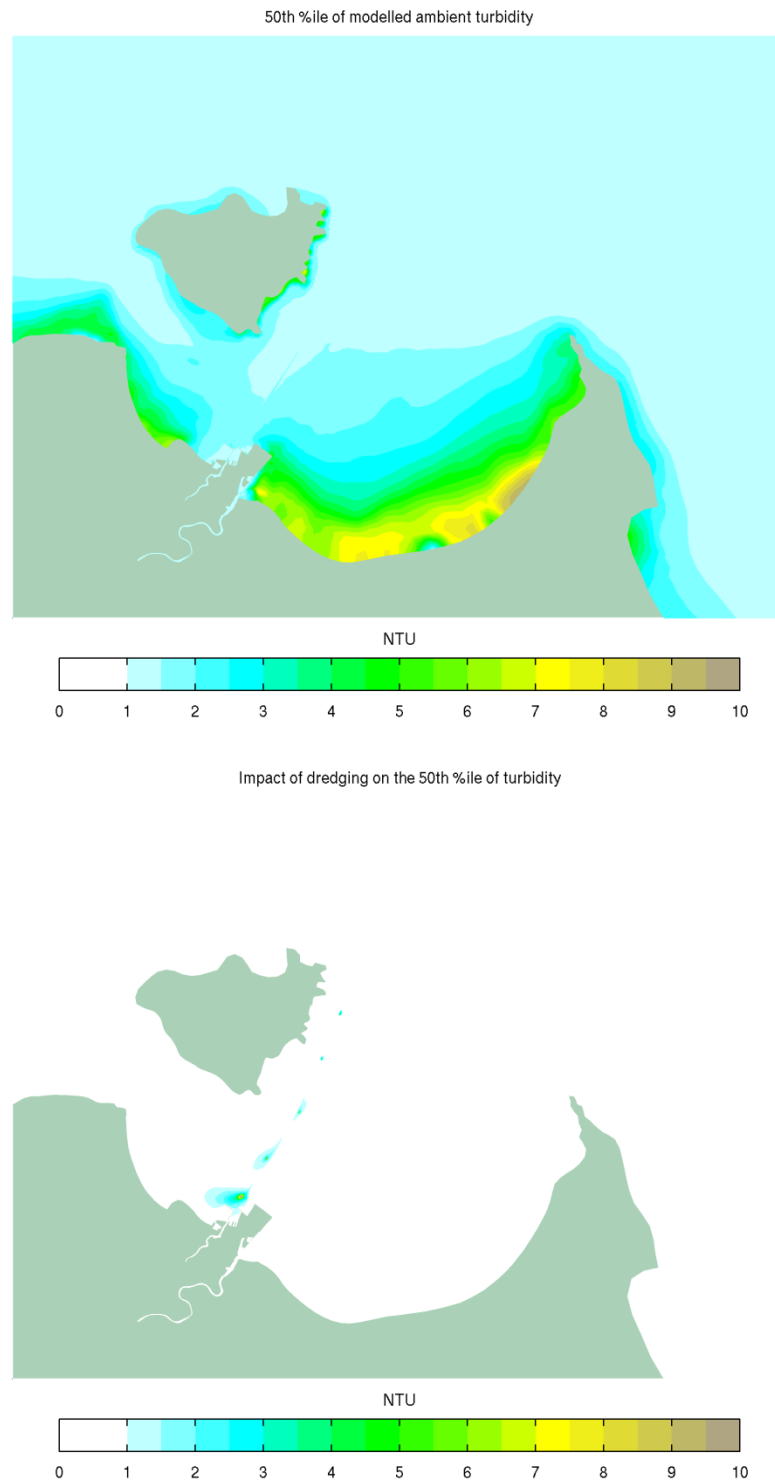


Figure 6-16 Widening of Platypus and Sea Channels by Backhoe - 95th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)



**Figure 6-17 Widening of Platypus and Sea Channels by Backhoe - 50th Percentile Depth
Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)**

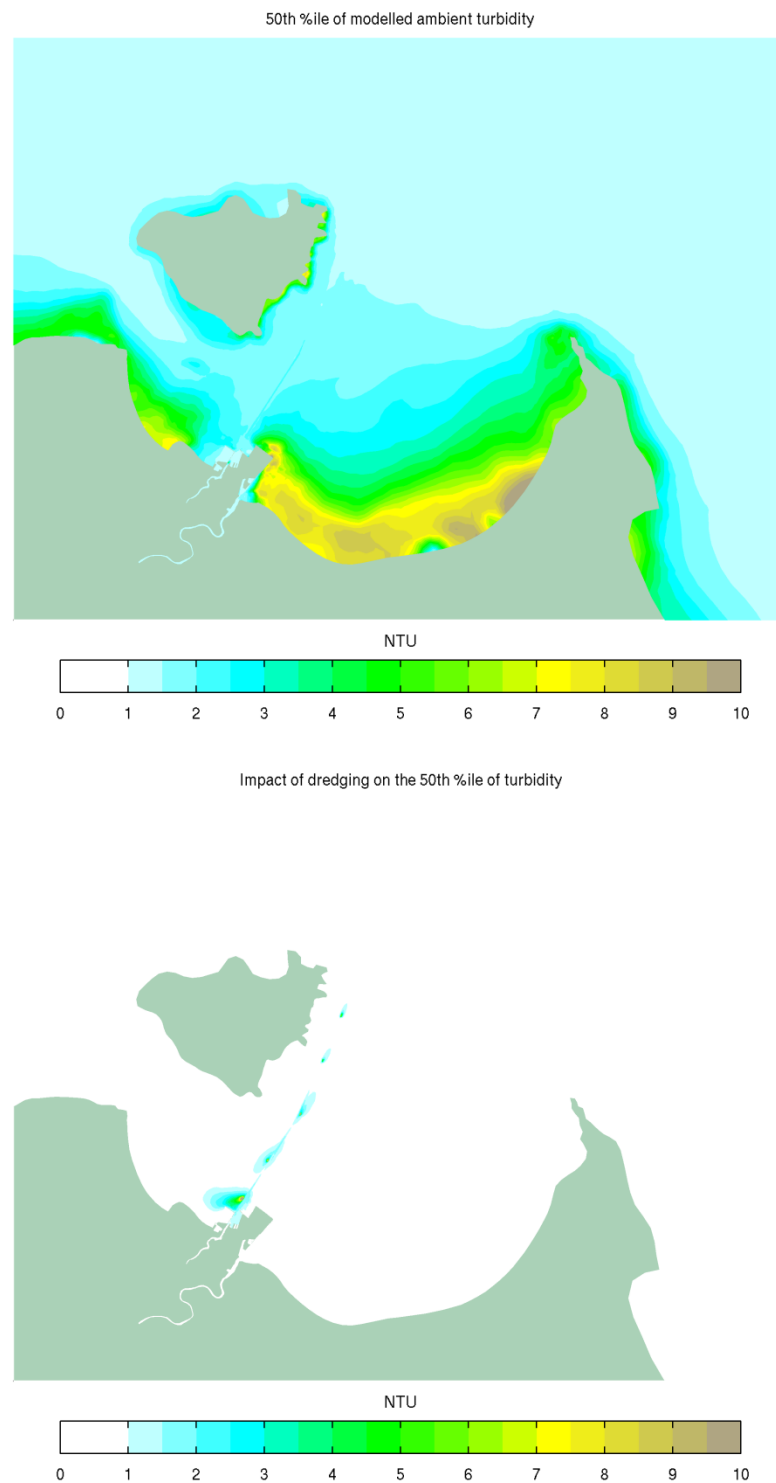
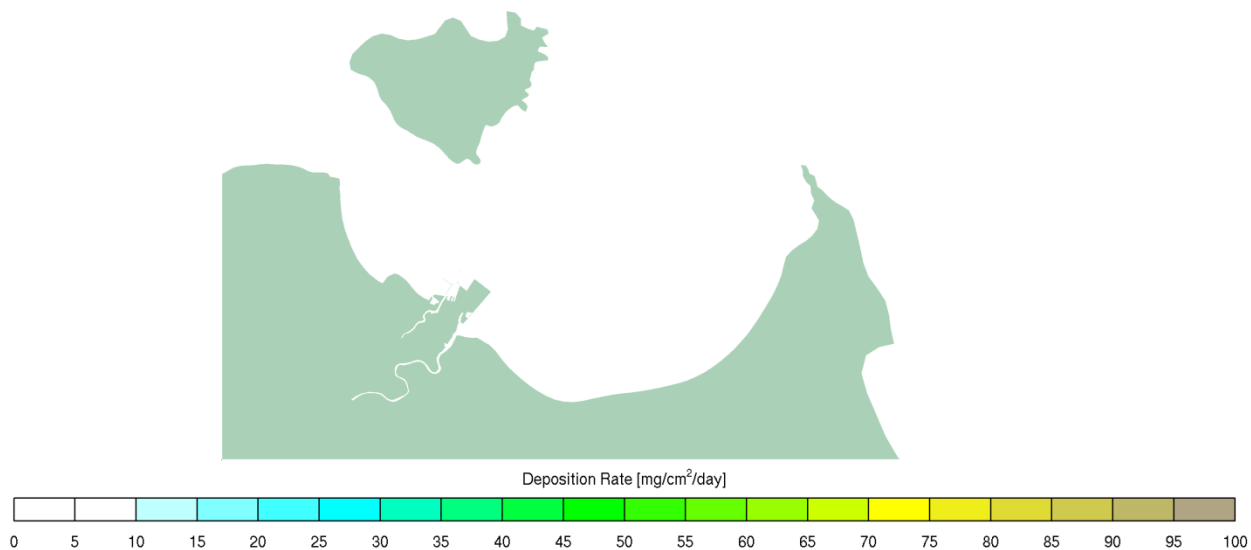


Figure 6-18 Widening of Platypus and Sea Channels by Backhoe - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

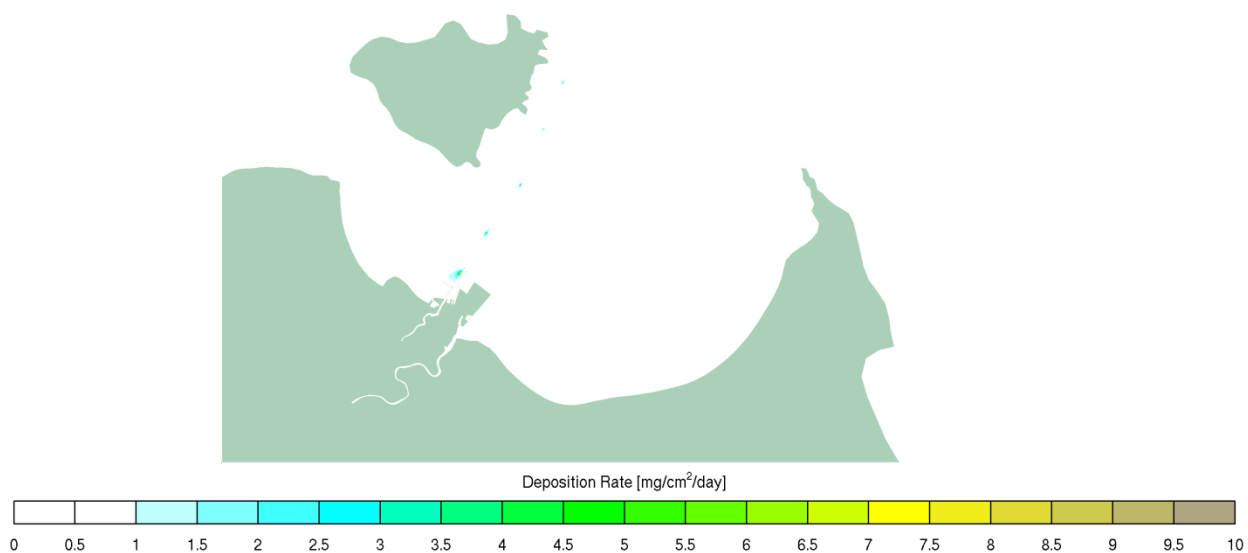


Figure 6-19 Widening of Platypus and Sea Channels by Backhoe - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

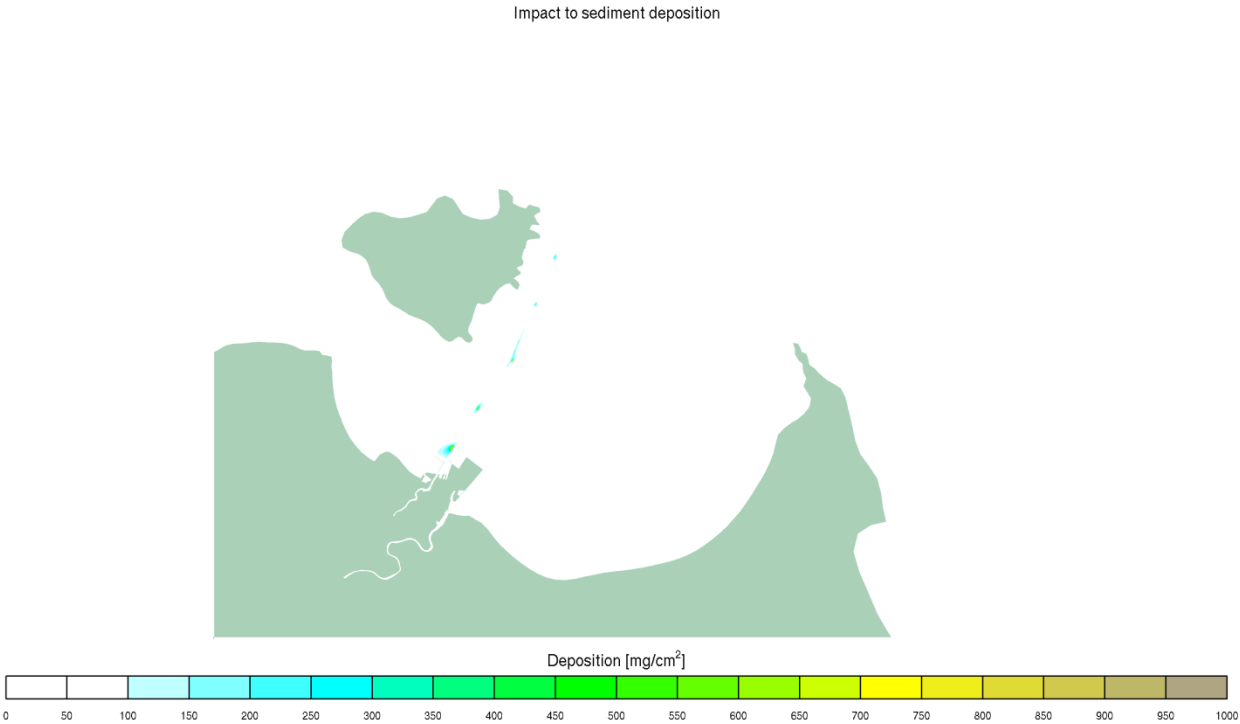


Figure 6-20 Widening of Platypus and Sea Channels by Backhoe - Final Deposition of Dredged Sediment After 30 Days (Five Locations)

6.3.2 PEP Stage 2

The PEP Stage 2 involves dredging berths 14, 15 and 16 in the Outer Harbour, as well as soft sediments under the footprint of the final reclamation bunds and breakwater. This will be carried out by backhoe dredging.

The impacts of Stage 2 dredging are shown in Figure 6-21 to Figure 6-25. The model was run for five different backhoe locations within the berthing areas, and the highest impacts for any of the five simulations are shown for each location in the model domain. Turbidity and deposition impacts are confined to the immediate vicinity of the dredging operation.

Impact of dredging on the 95th %ile of turbidity

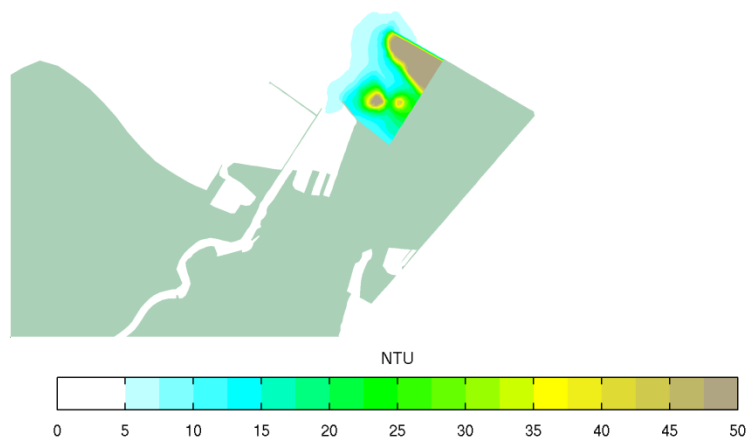


Figure 6-21 Stage 2 – Berths 14, 15 and 16 – 95th Percentile Depth Average Turbidity: Impact of Dredging

Impact of dredging on the 95th %ile of turbidity

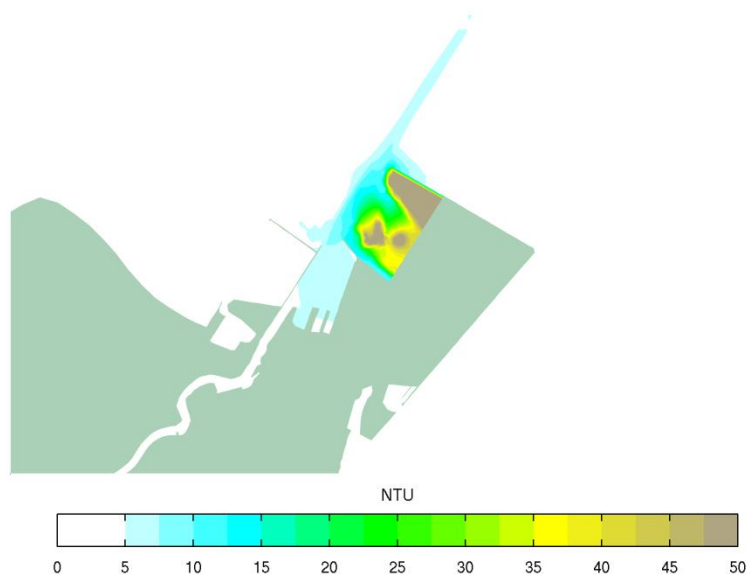


Figure 6-22 Stage 2 – Berths 14, 15 and 16 – 95th Percentile Bottom 1m Turbidity: Impact of Dredging

Impact of dredging on the 50th %ile of turbidity

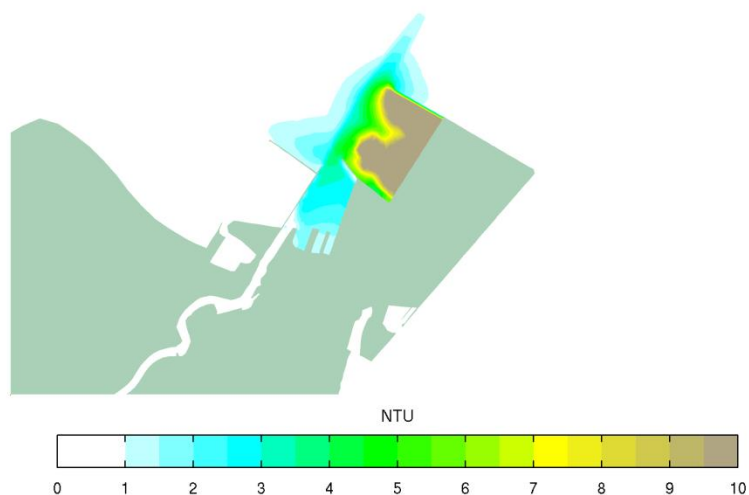


Figure 6-23 Stage 2 – Berths 14, 15 and 16 – 50th Percentile Depth Average Turbidity: Impact of Dredging

Impact of dredging on the 50th %ile of turbidity

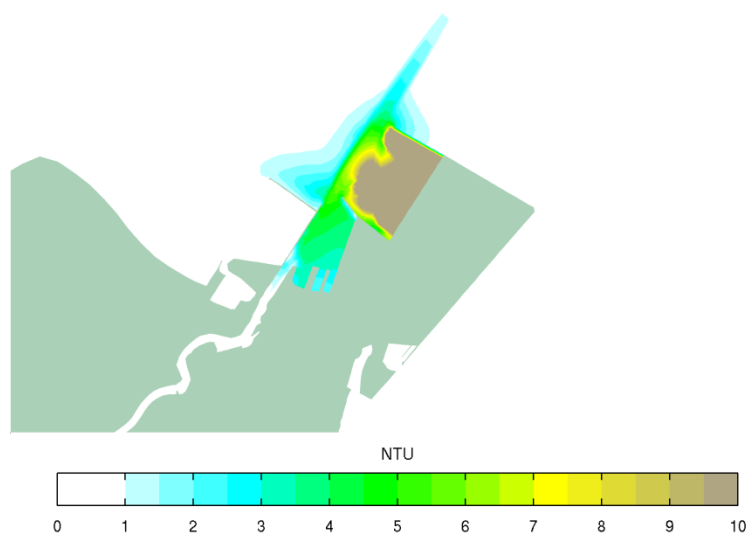
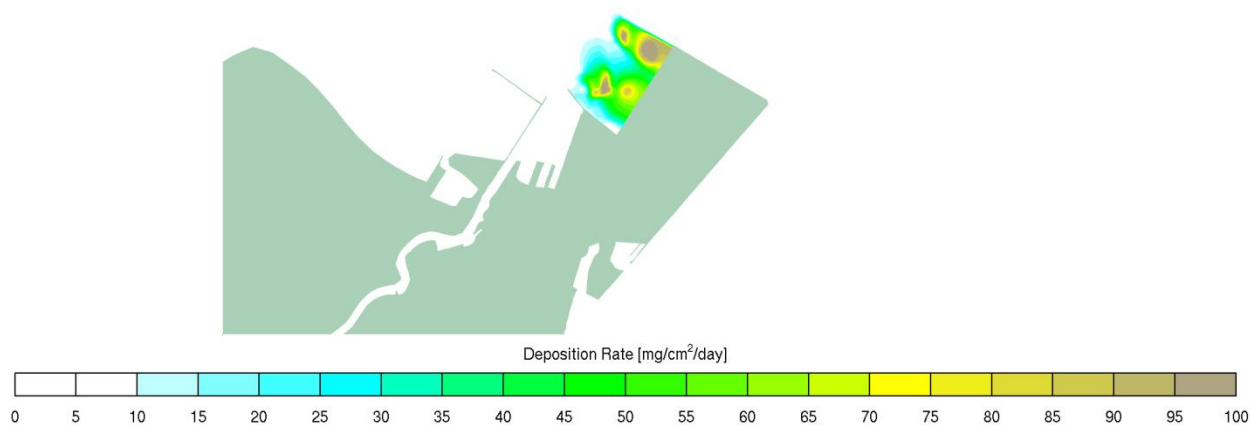


Figure 6-24 Stage 2 – Berths 14, 15 and 16 – 50th Percentile Bottom 1m Turbidity: Impact of Dredging

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

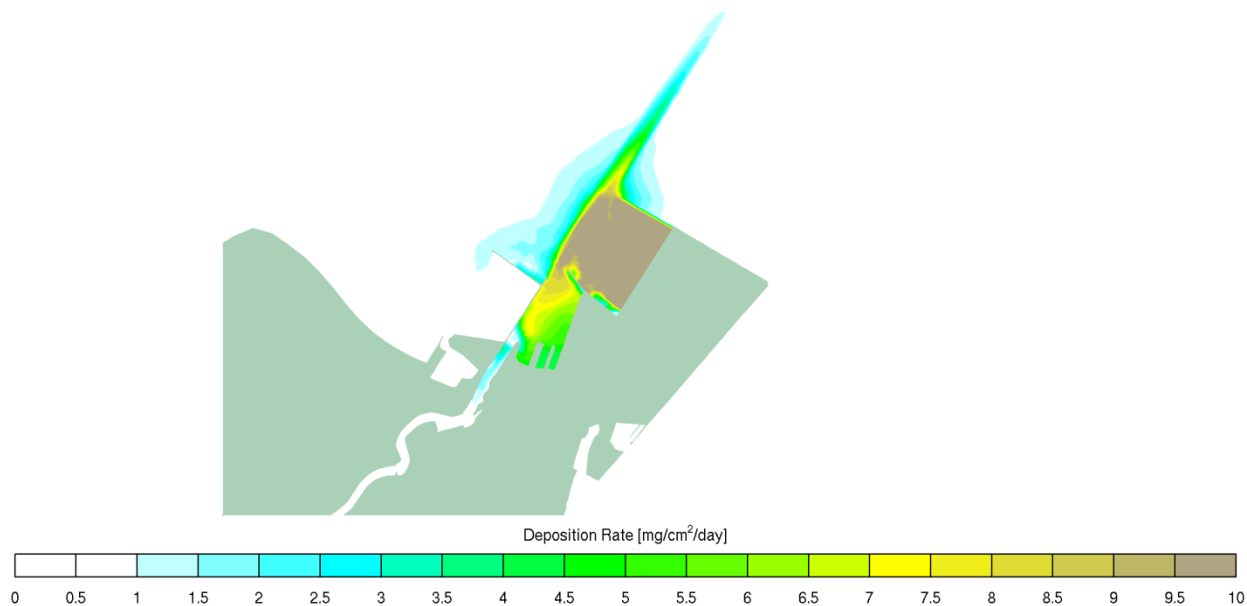


Figure 6-25 Stage 2 – Berths 14, 15 and 16 - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

6.3.3 PEP Stage 3

The PEP Stage 3 consists of two main dredging operations.

- Deepening of the Platypus Channel and the Sea Channel to a bed elevation of -13.5 mLAT (-15.4 mAHD) inclusive of overdredging allowance. The soft marine sediments and dense clayey sands will be dredged by TSHD (20% of the total volume). The stiff, very stiff and hard clays will be dredged by backhoe (80% of the total volume).
- The dredging of the berth pockets for Berths 17 and 18 by backhoe. The impacts for this activity are similar to those of Stage 2 dredging.

The geometry assumed for the channel dredging simulations in this stage corresponds to the post-widening bed elevations for the channel, with the ultimate reclamation in place.

6.3.3.1 Deepening of Platypus Channel and Sea Channel by Small TSHD

The modelled impact of dredging during the deepening of the Platypus Channel by a small TSHD is shown in Figure 6-26 to Figure 6-31. The impacts shown are representative of the TSHD working in dense clayey sand material (since this generates more extensive plumes than working in soft material). The total campaign duration for the TSHD for this stage of the programme is 8 weeks, approximately one third of which will involve working in dense clayey sands.

Figure 6-26 shows the change in the 95th percentile depth-averaged turbidity due to dredging, averaged over the five different 30-day periods that were modelled. Figure 6-27 shows the change in the 95th percentile turbidity in the bottom 1m layer of the model due to dredging (again, averaged over the five 30-day periods that were modelled). These figures indicate the likely acute (short term) influence of suspended sediment plumes generated by the TSHD.

Figure 6-28 shows the change in the 50th percentile depth-averaged turbidity due to dredging and Figure 6-29 shows the change in the 50th percentile turbidity in the bottom 1m layer of the model due to dredging. These figures indicate the likely chronic (persistent) influence of suspended sediment plumes generated by the TSHD.

Figure 6-30 shows the change in the 95th and 50th percentile deposition rate due to dredging, while Figure 6-31 shows the total amount of dredged material deposited in a 30 day simulation (the average of the five months that were modelled). Overall, the modelled turbidity and deposition impacts are limited to the immediate vicinity of the channel.

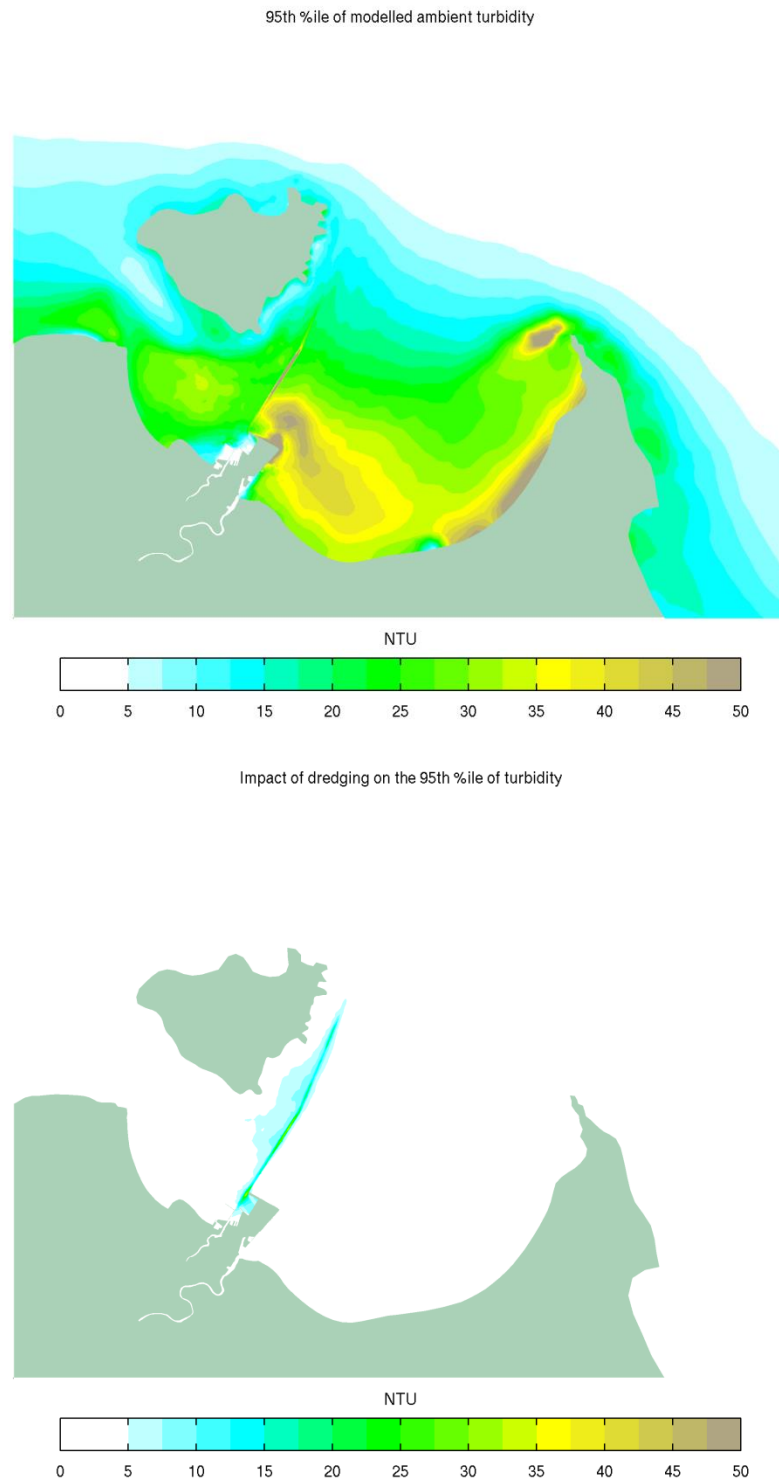


Figure 6-26 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

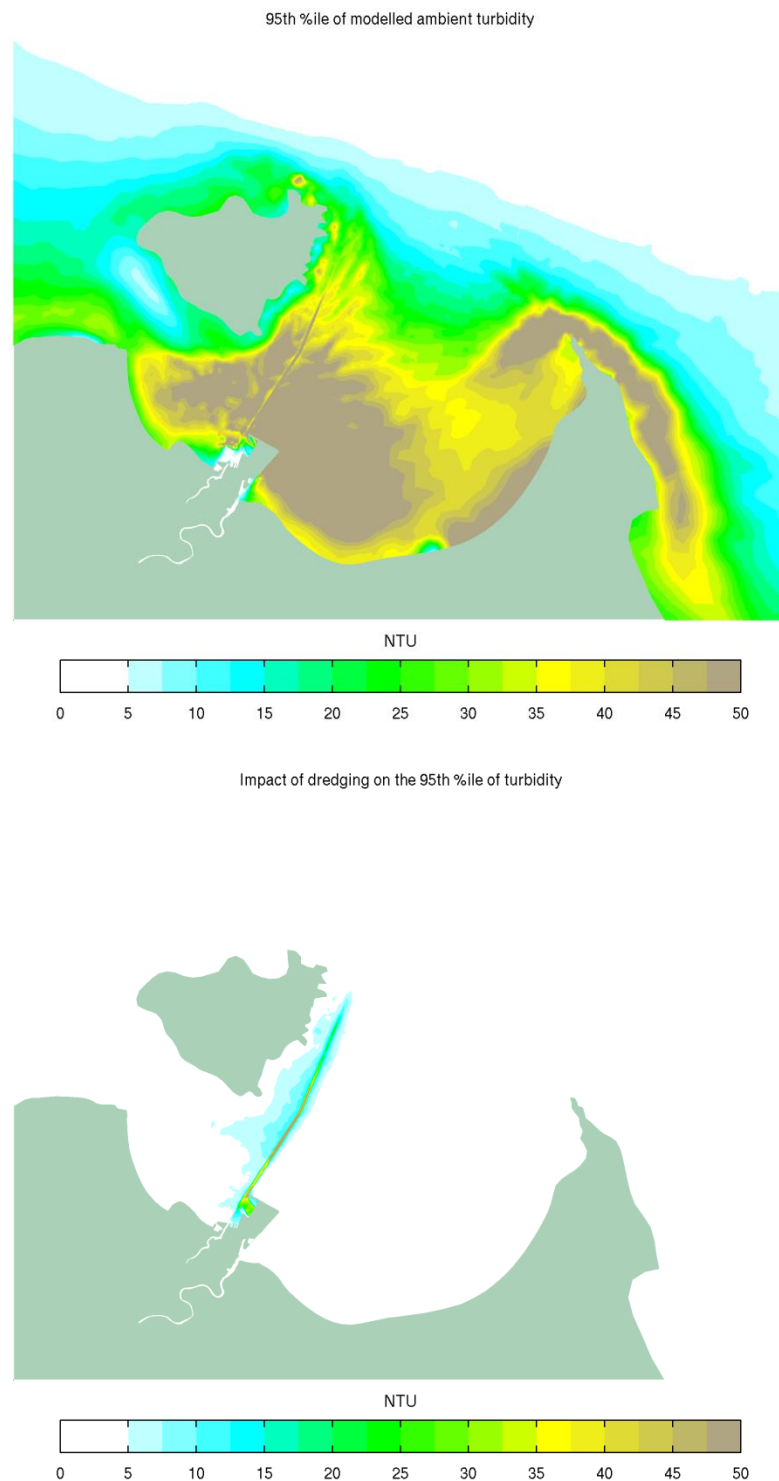


Figure 6-27 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD - 95th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

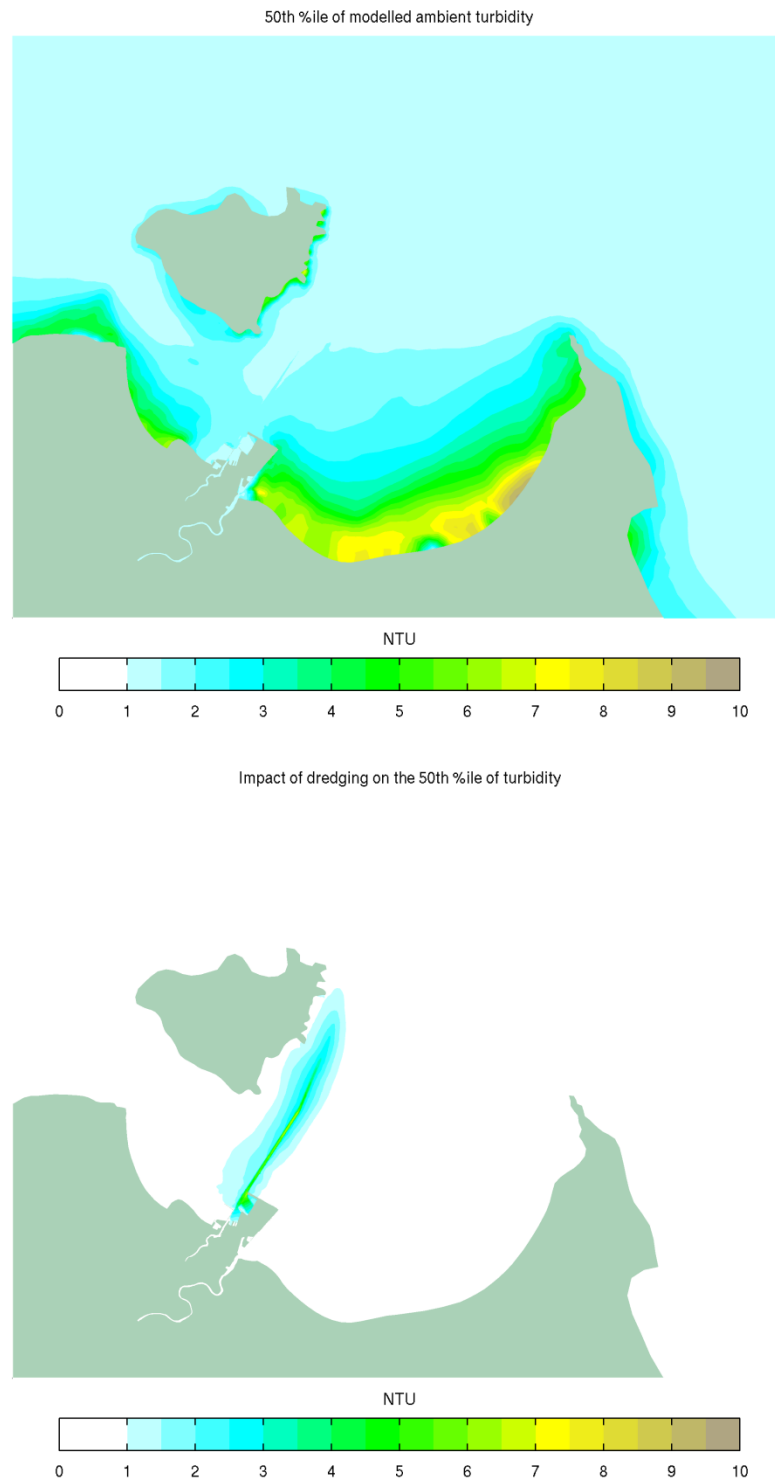


Figure 6-28 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD - 50th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

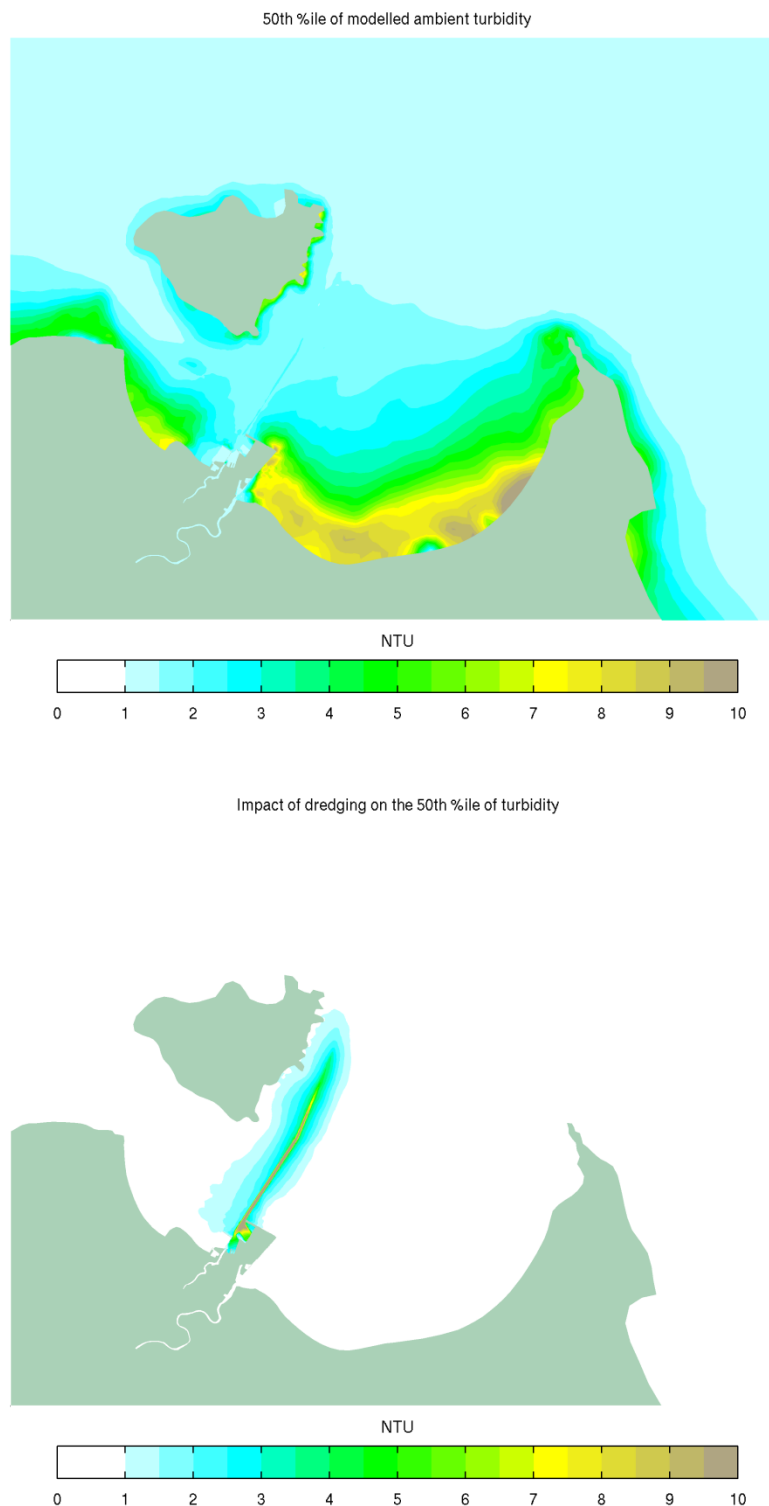
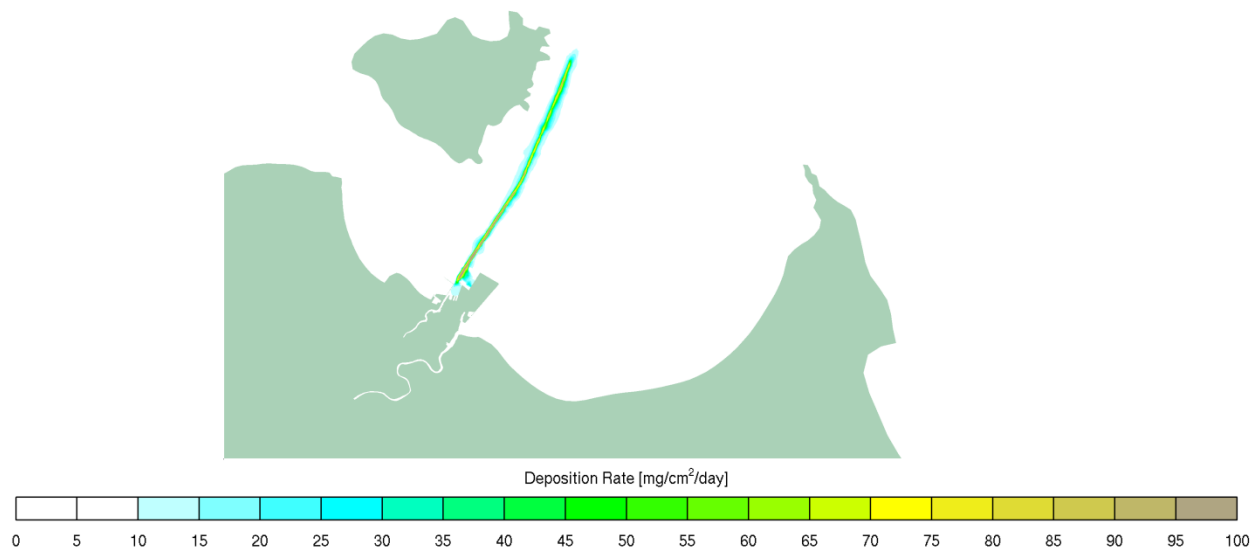


Figure 6-29 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

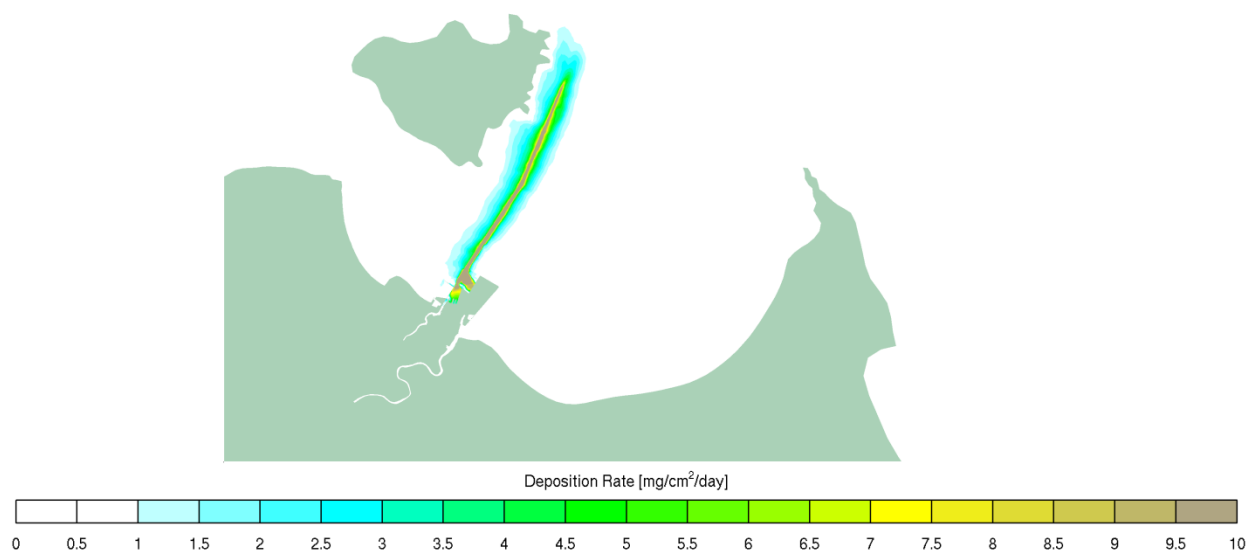
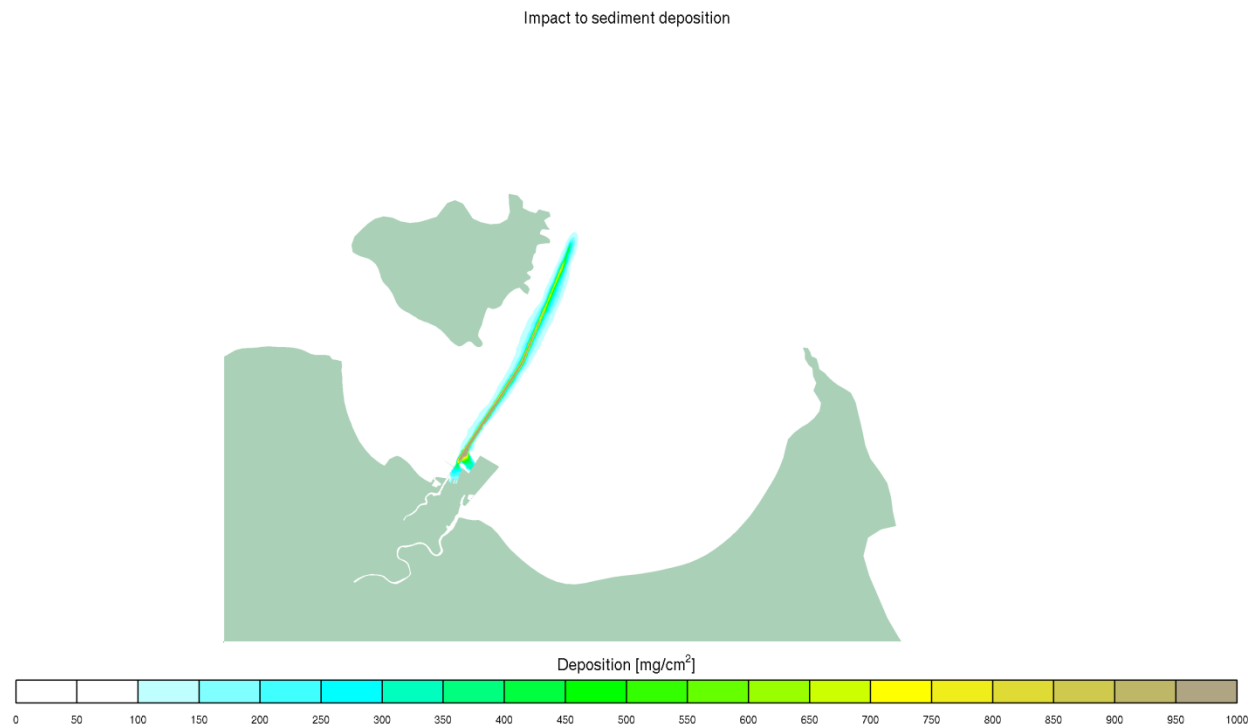


Figure 6-30 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)



**Figure 6-31 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Small TSHD -
Final Deposition of Dredged Sediment After 30 Days**

6.3.3.2 *Deepening of Platypus and Sea Channels by Backhoe*

The impacts to turbidity and deposition percentiles during Stage 3 channel deepening using a backhoe are shown in Figure 6-32 to Figure 6-37. Note that the impact plots presented here show the superposition (addition) of the impacts of a backhoe dredge working at five different locations along the shipping channel. The impacts shown are representative of a typical 30 day period of backhoe dredging at each location. The influence of dredging plumes generated by the backhoe at intermediate locations along the channel can be estimated by interpreting the plots. It can be seen that the acute and chronic impacts of the backhoe dredging operation are restricted to the immediate vicinity of the dredging location. The backhoe dredging campaign for this stage of the project is expected to take approximately two years.

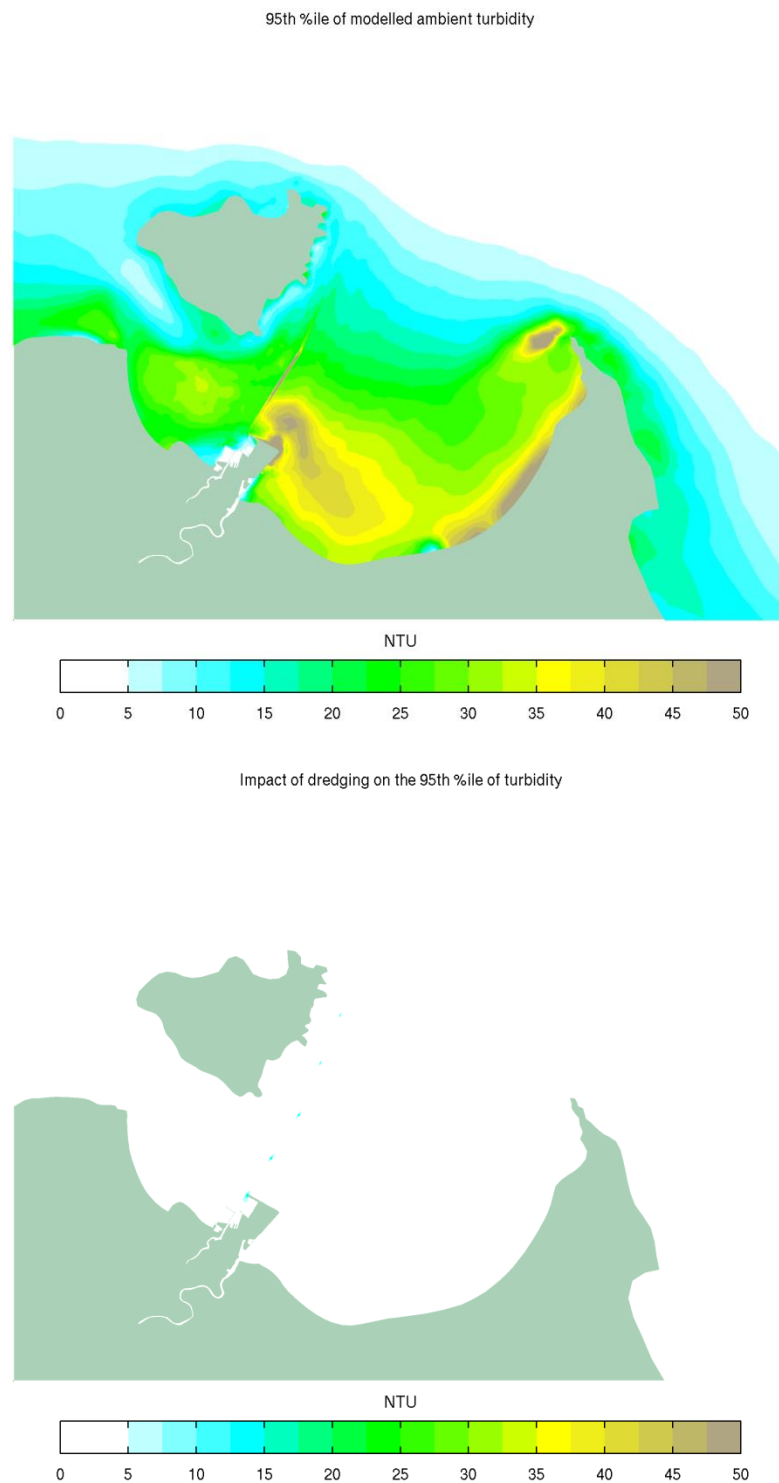


Figure 6-32 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

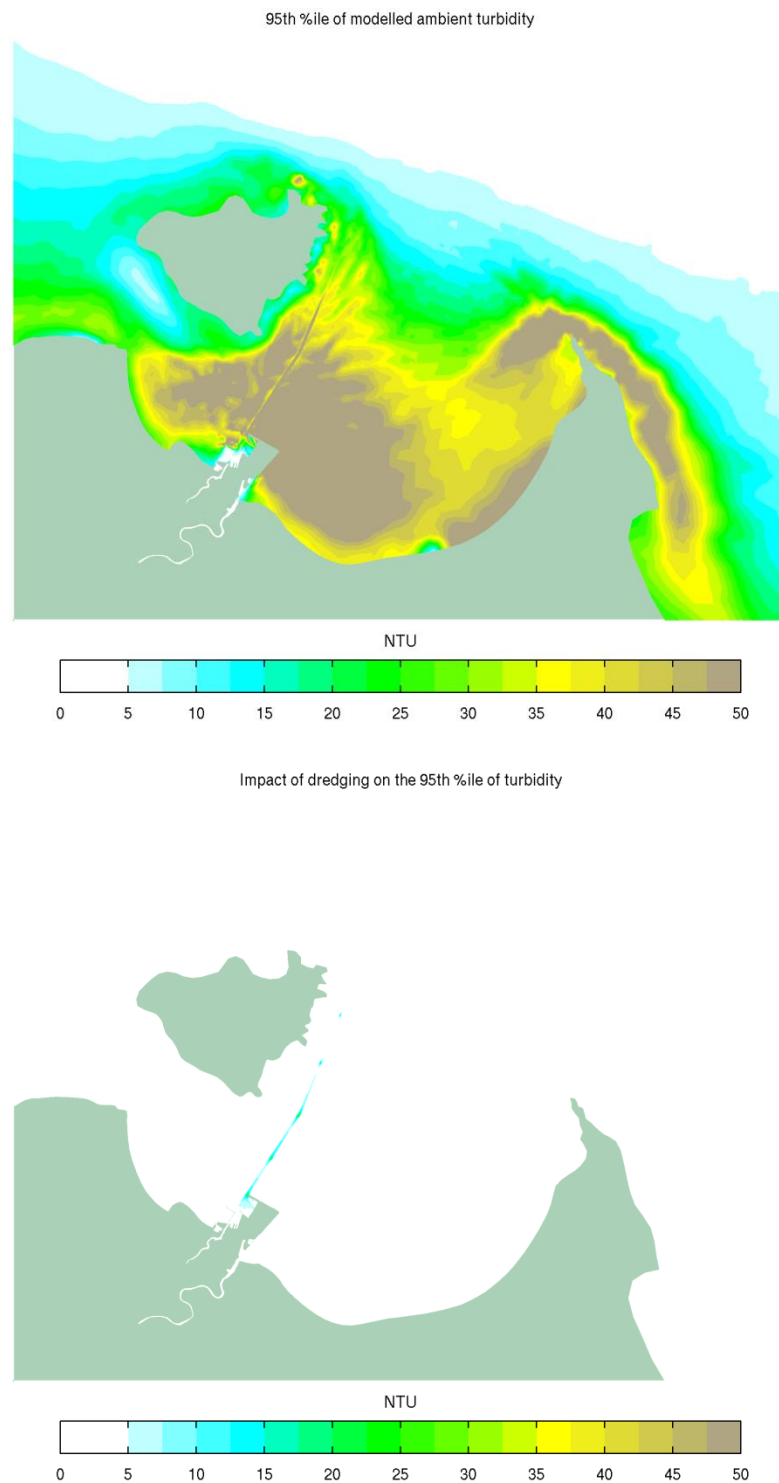


Figure 6-33 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe - 95th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

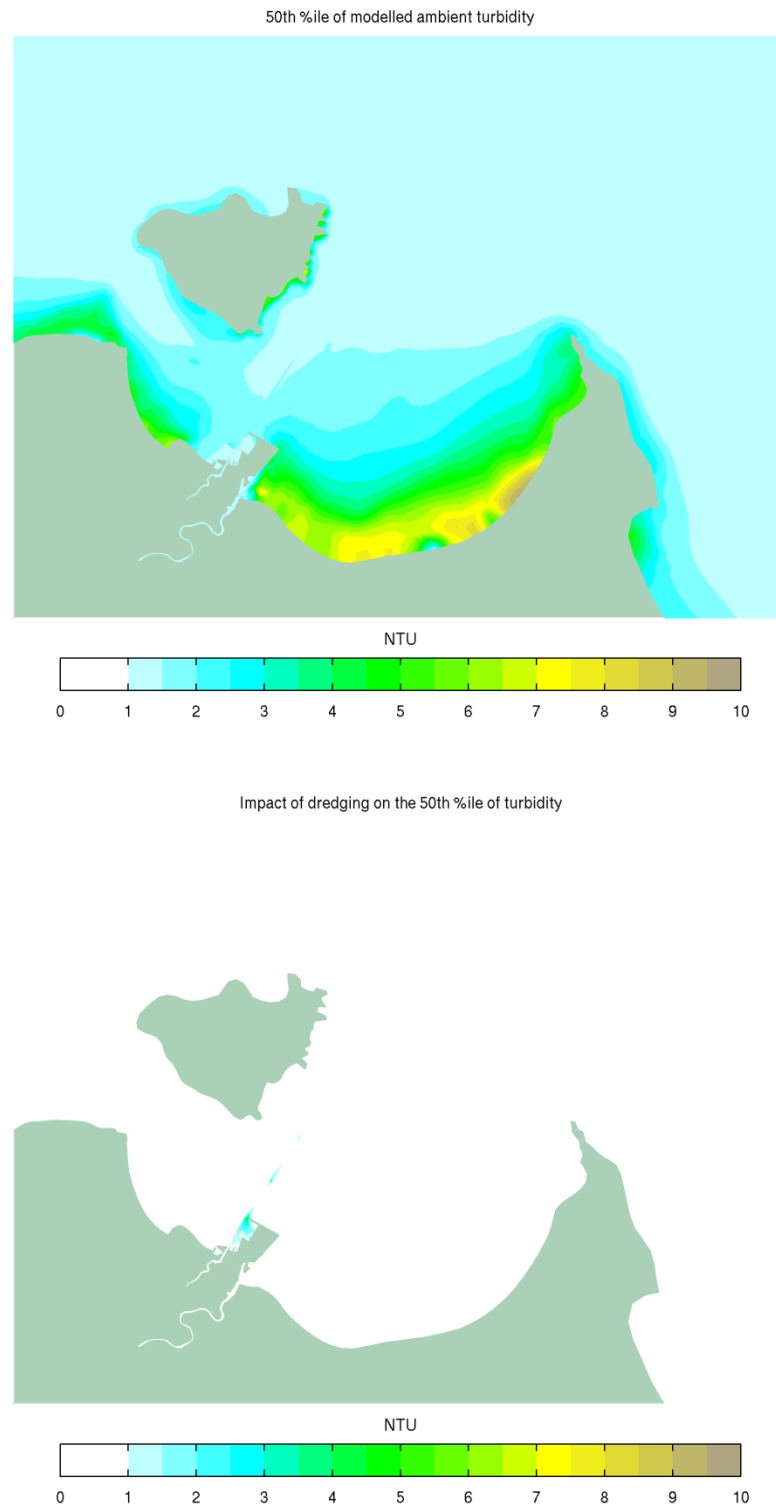


Figure 6-34 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe - 50th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

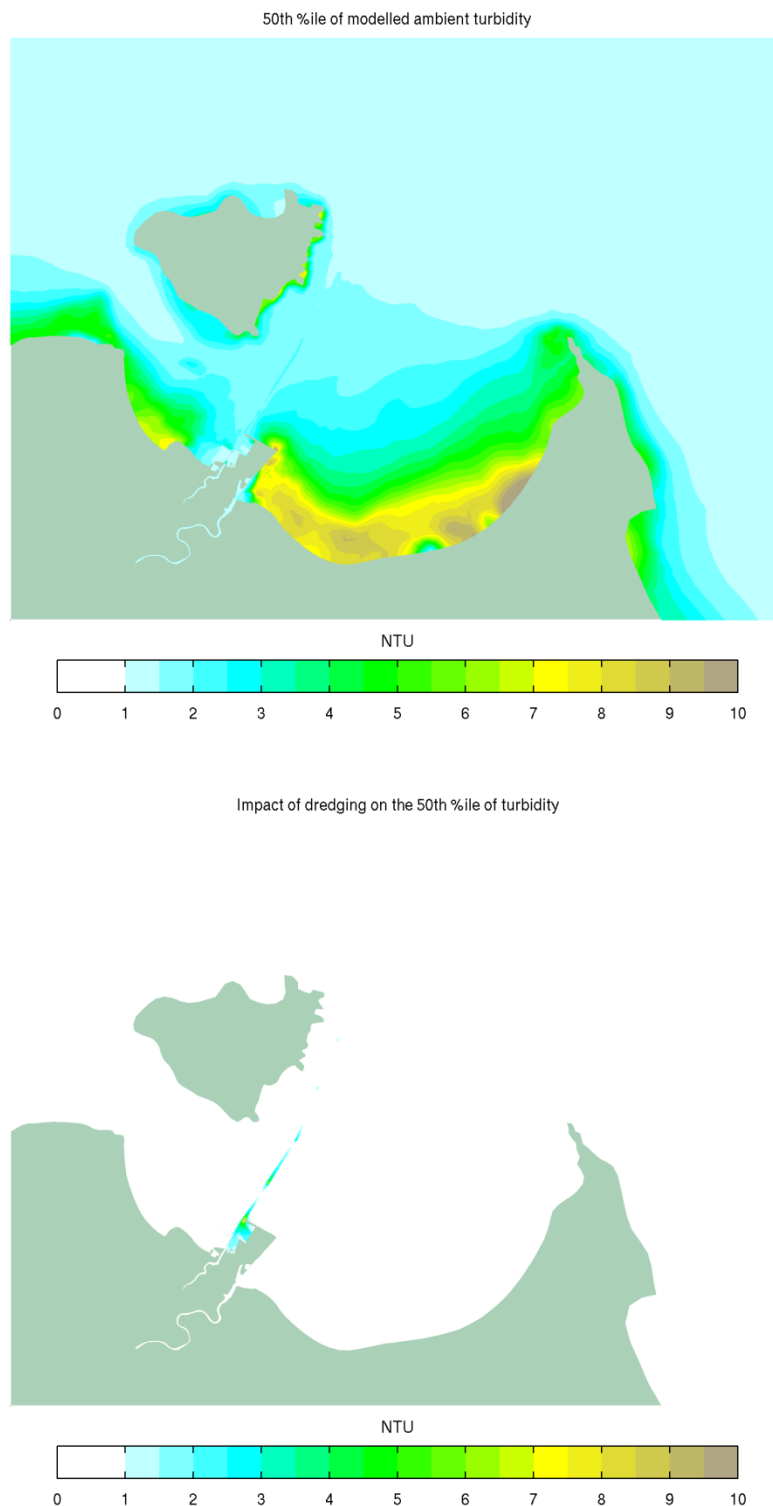


Figure 6-35 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

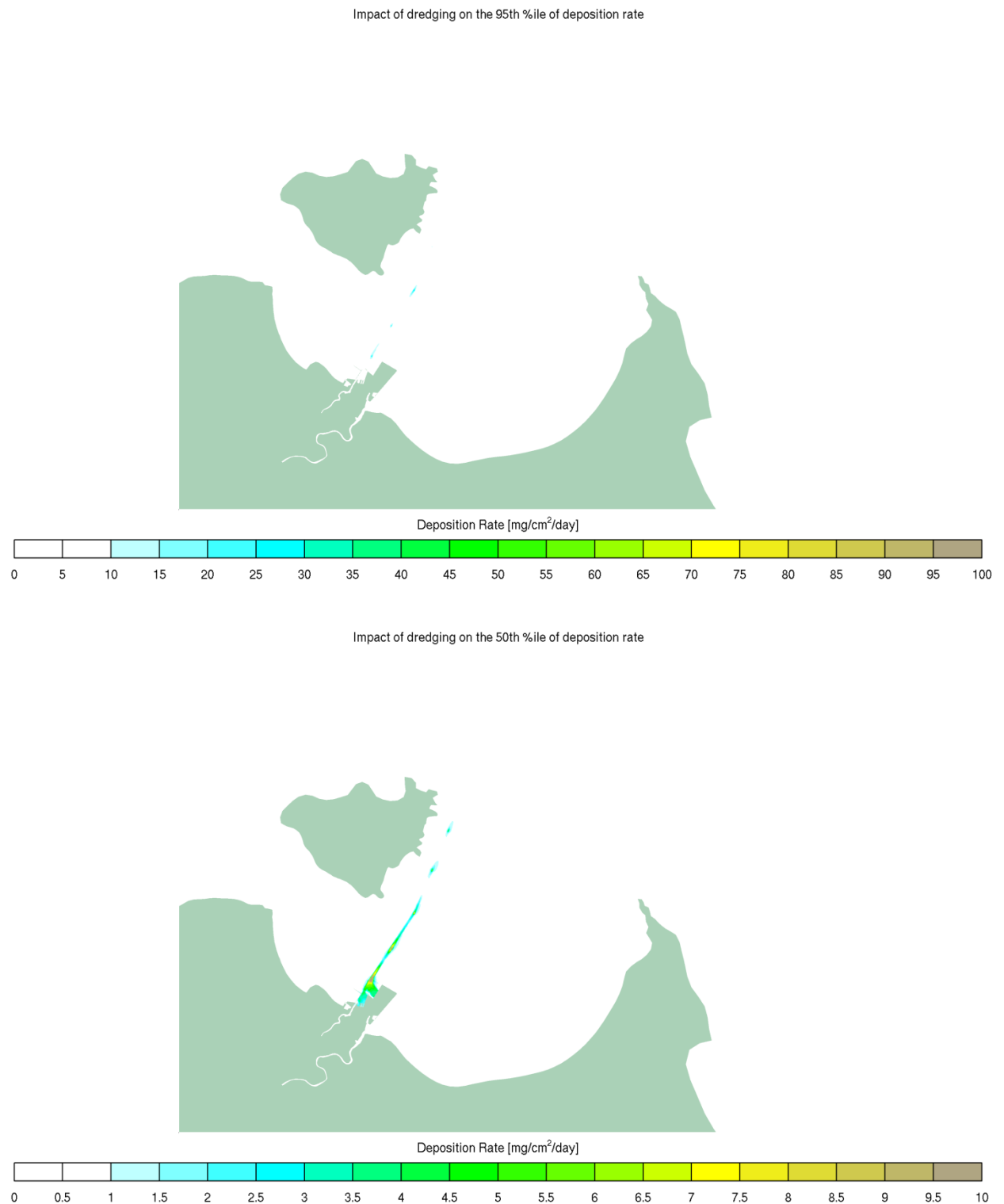
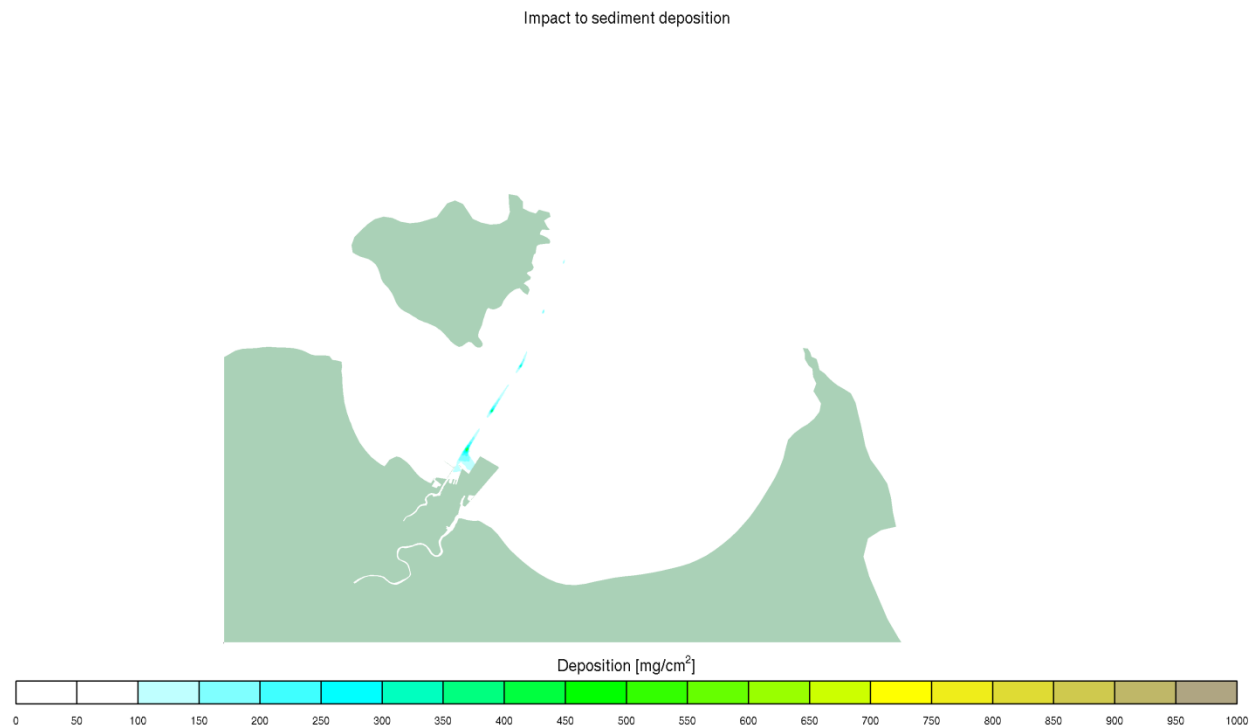


Figure 6-36 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)



**Figure 6-37 Stage 3 Dredging – Deepening of Platypus and Sea Channels by Backhoe -
Final Deposition of Dredged Sediment After 30 Days (Five Locations)**

6.4 'Worst Case' Dredging Impacts

The 'Worst Case' dredging impacts were obtained by taking the ensemble maximum of the predicted impacts to the turbidity and deposition rates over the five 30 day TSHD dredging simulations. This means that the 'Worst Case' impacts represent the highest intensity impacts that are possible in a given location if adverse weather conditions occur.

6.4.1 Stage 1 – Channel Widening by TSHD

The potential impacts to the turbidity percentiles are a function of both the dredging activity and the ambient meteorological and hydrodynamic conditions. Examples of the impacts to the 95th percentile turbidity for each of the five 30 day modelling periods are provided in Figure 6-38. The corresponding wind roses for each modelling period are provided in Figure 6-2. The months with the strongest winds (January 2010 and March 2010) show a lower overall level of impact (due to higher ambient turbidity) but a larger spatial extent (due to stronger wind-driven currents).

Figure 6-39 shows the maximum change in the 95th percentile depth-averaged turbidity due to dredging throughout the modelling domain over the five different 30-day modelling periods. Figure 6-40 shows the change in the 95th percentile turbidity in the bottom 1m layer of the model due to dredging (again, the maximum of the five 30-day periods that were modelled). These figures indicate the possible variability of acute (short term) influence of suspended sediment plumes generated by the TSHD depending on the ambient meteorological conditions.

Figure 6-41 shows the change in the 50th percentile depth-averaged turbidity due to dredging and Figure 6-42 shows the change in the 50th percentile turbidity in the bottom 1m layer of the model due to dredging (the maximum out of the five modelling periods). These figures indicate the possible chronic (persistent) influence of suspended sediment plumes generated by the TSHD depending on the ambient meteorological conditions.

Figure 6-43 shows the change in the 95th and 50th percentile deposition rate due to dredging, while Figure 6-44 shows the total amount of dredged material deposited in a 30 day simulation (the maximum of the five modelling periods).

Overall, the modelled turbidity and deposition impacts are generally limited to the immediate vicinity of the channel, although there is the potential for some sensitive receptors along the coastline of Magnetic Island to be influenced by plumes during strong easterly or southerly wind conditions.

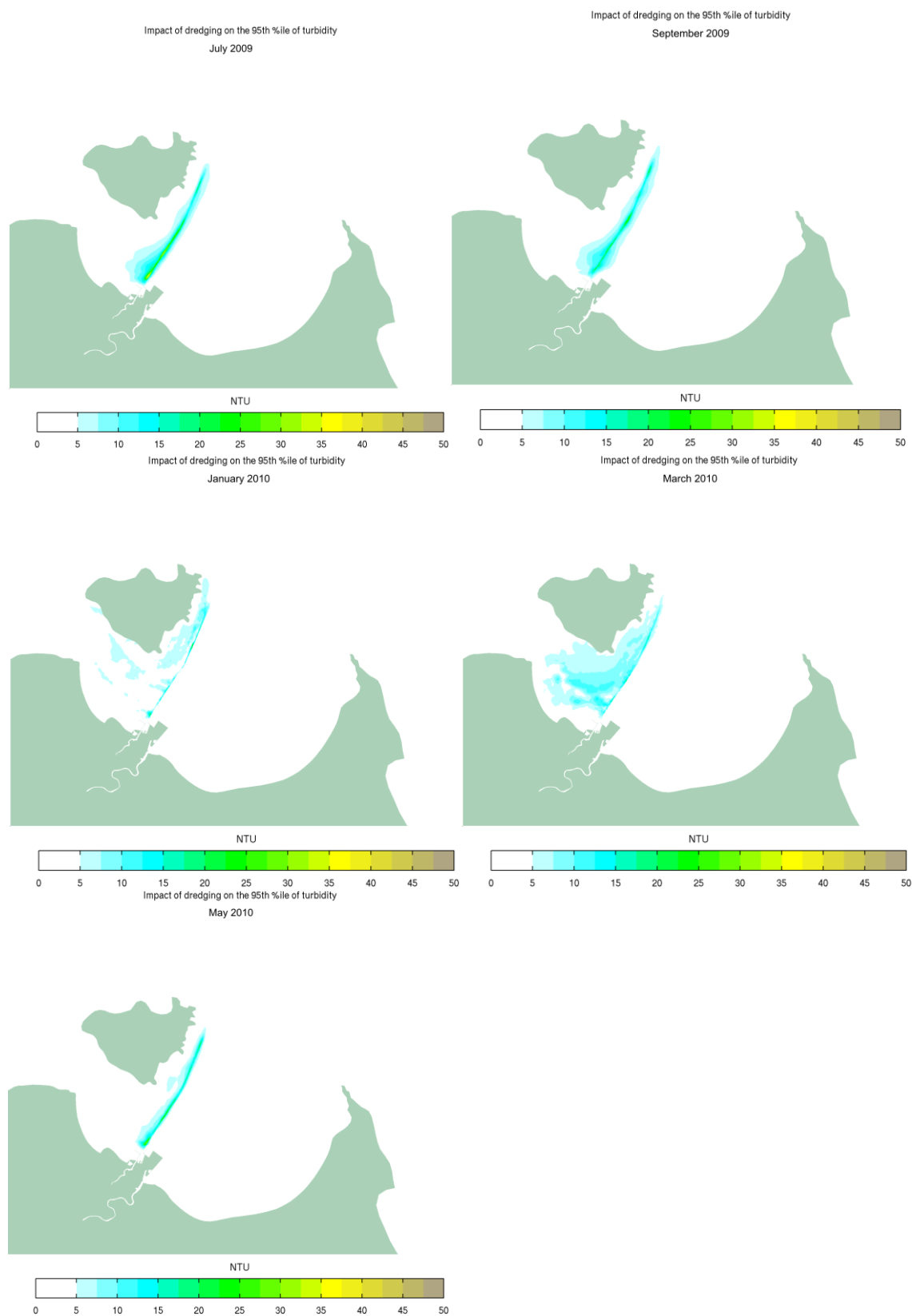


Figure 6-38 Dredging Impacts to the 95th Percentile Turbidity for each Modelling Period

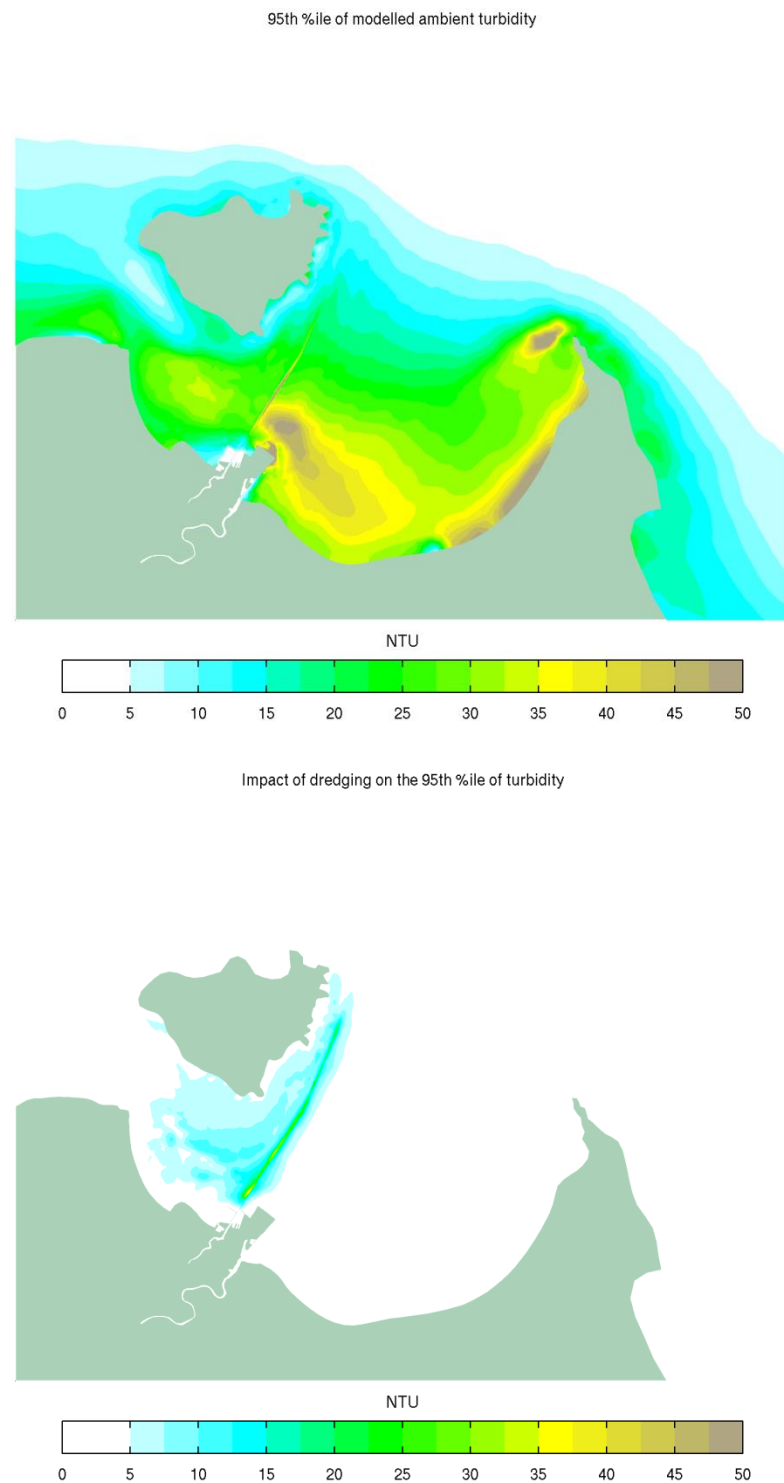


Figure 6-39 Stage 1 – ‘Worst Case’ - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

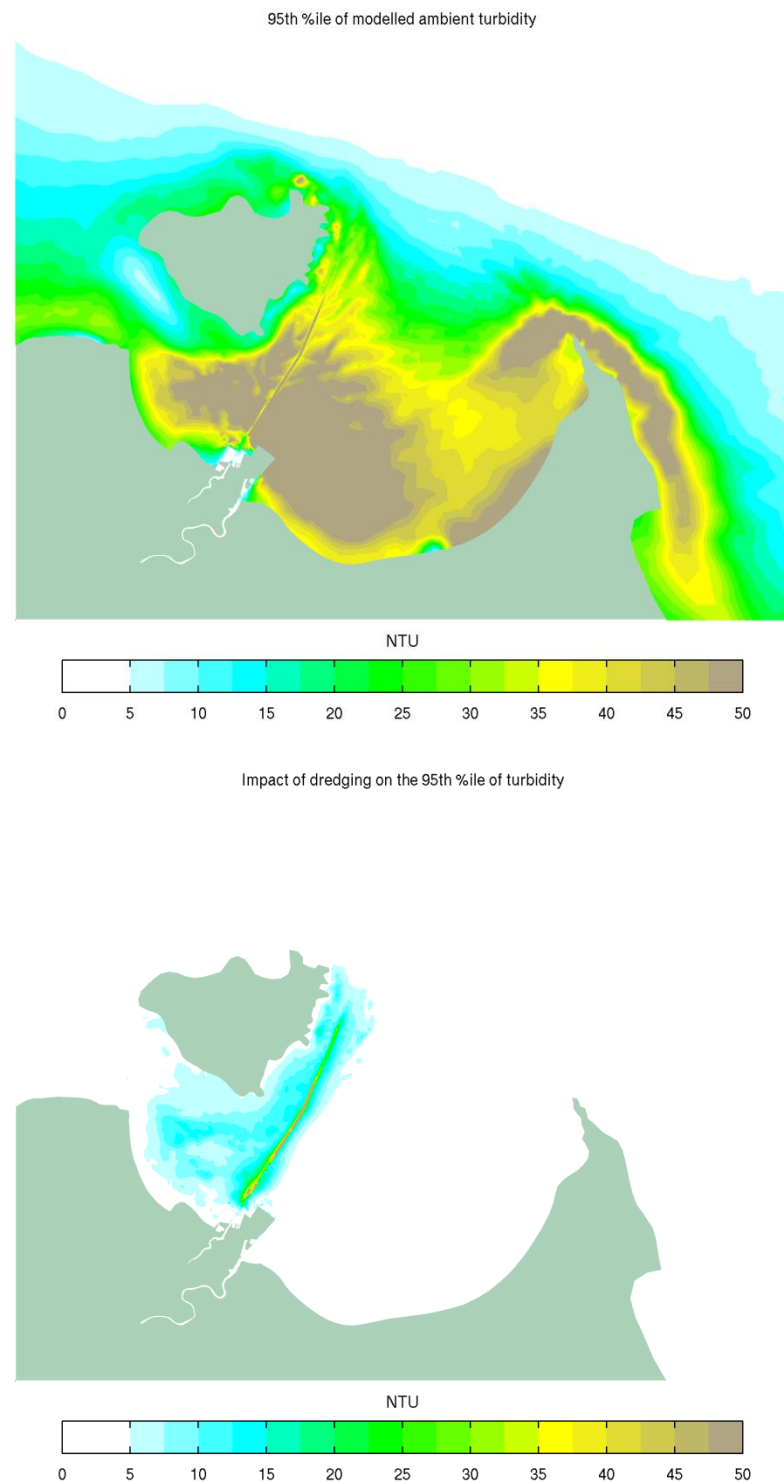


Figure 6-40 Stage 1 – ‘Worst Case’ - 95th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

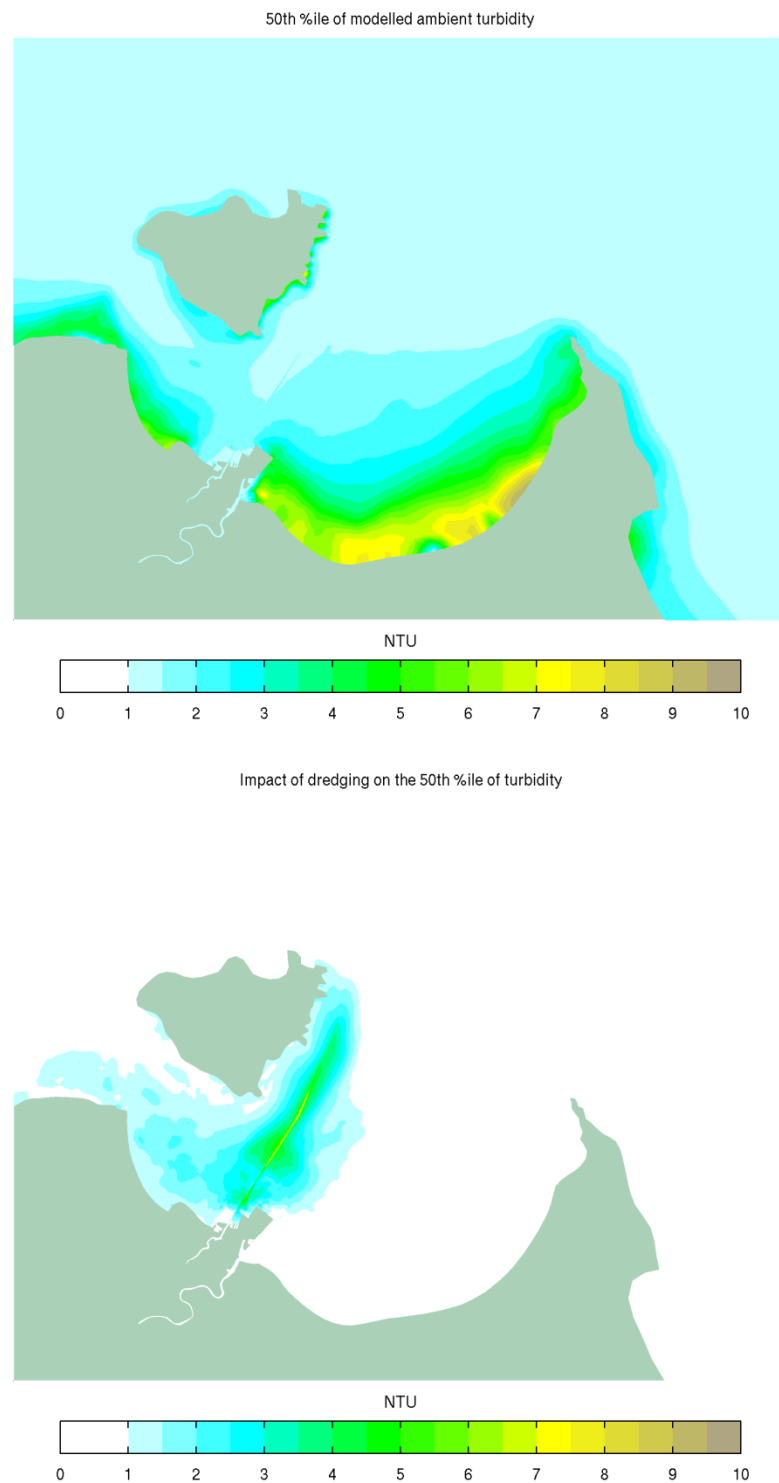


Figure 6-41 Stage 1 - 'Worst Case' - 50th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

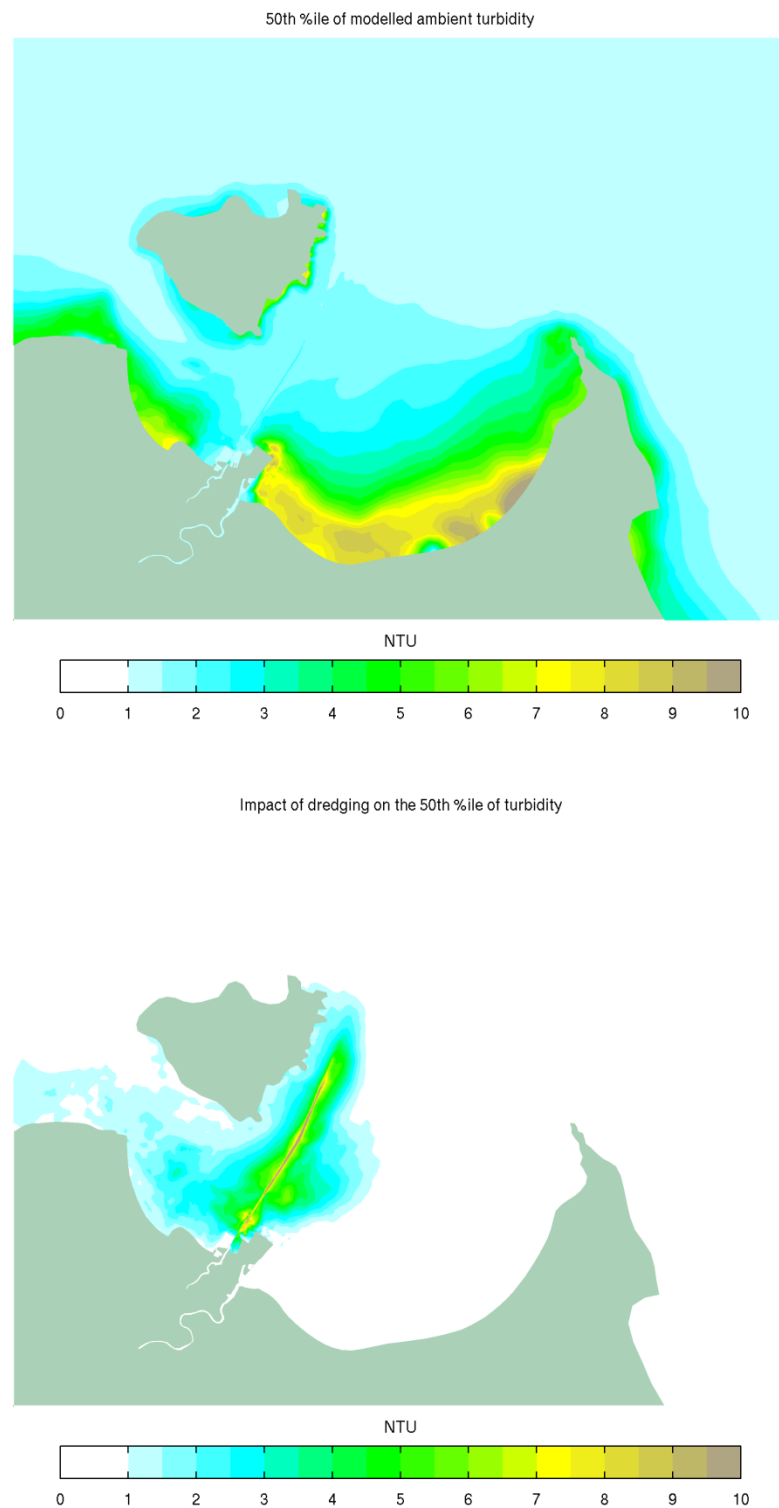
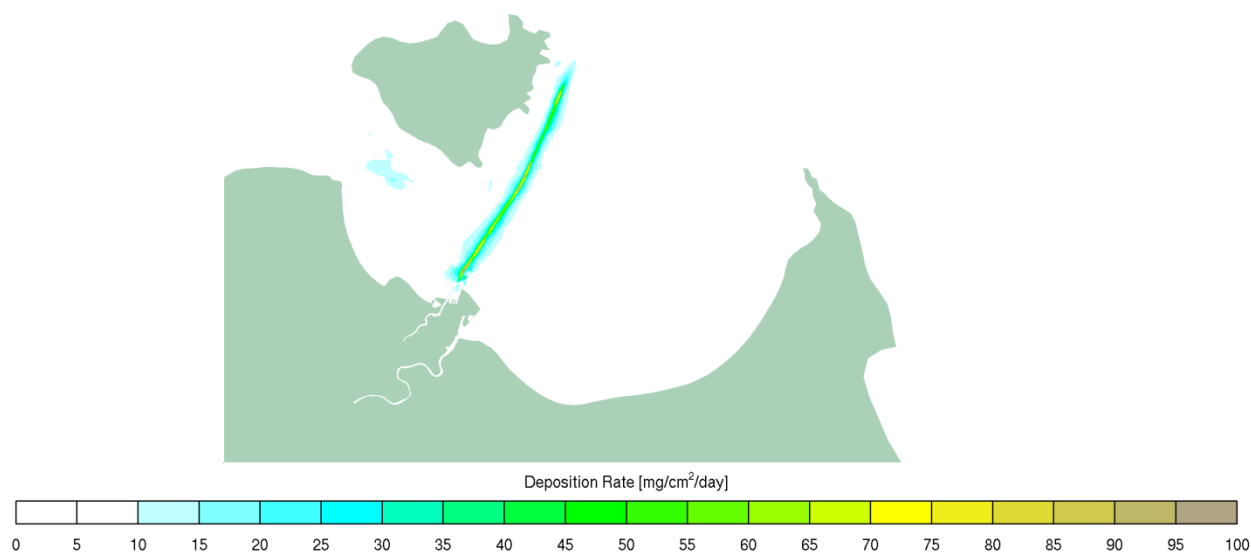


Figure 6-42 Stage 1 - 'Worst Case' - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

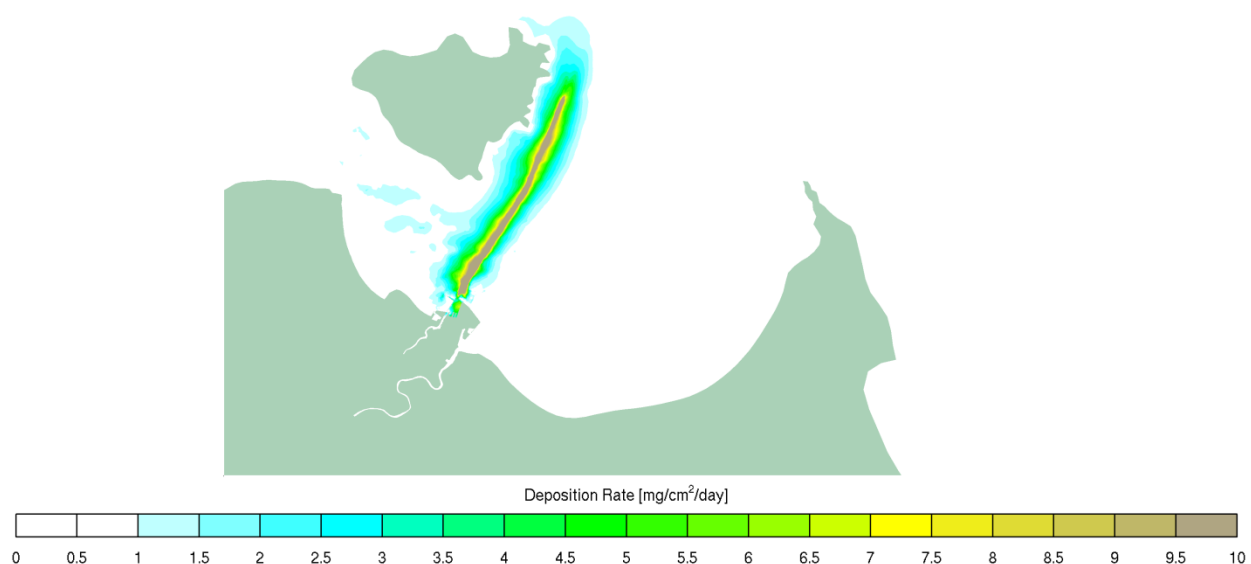


Figure 6-43 Stage 1 - 'Worst Case' - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

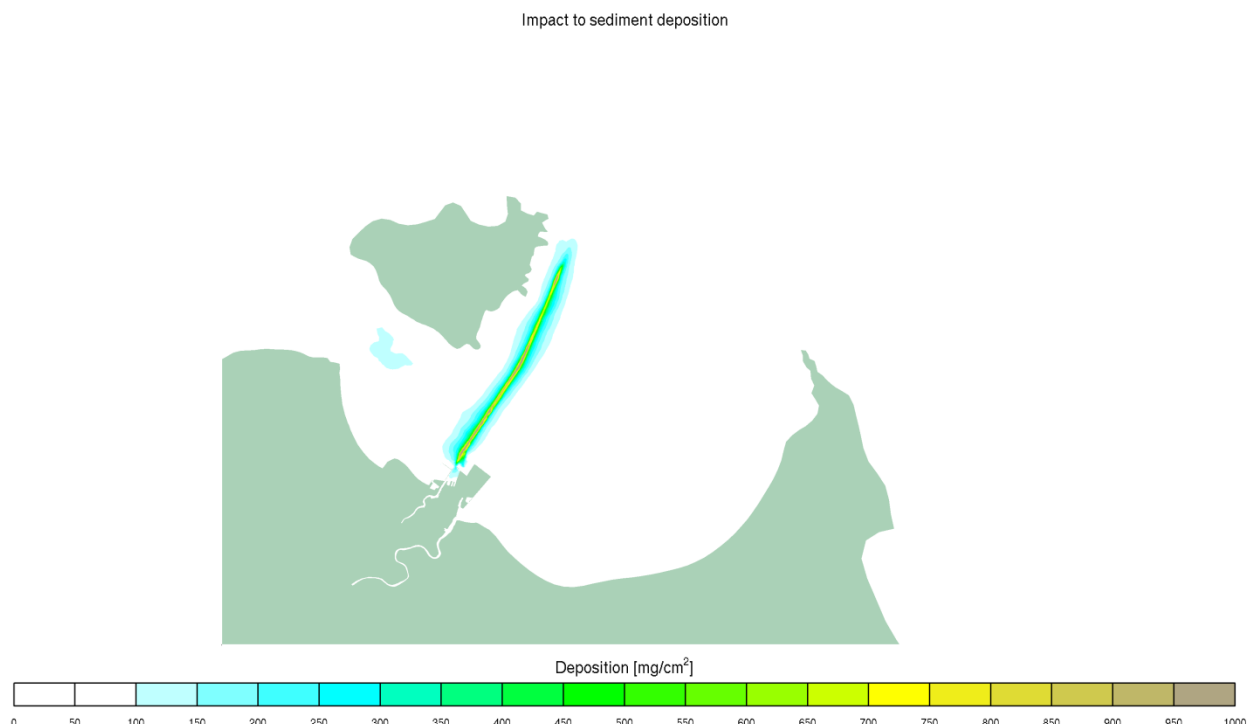


Figure 6-44 Stage 1 - 'Worst Case' - Final Deposition of Dredged Sediment

6.4.2 Stage 3 – Channel Deepening by TSHD

Figure 6-45 the maximum change in the 95th percentile depth-averaged turbidity due to dredging throughout the modelling domain over the five different 30-day modelling periods for the deepening of the channel by TSHD. Figure 6-46 shows the change in the 95th percentile turbidity in the bottom 1m layer of the model due to dredging (again, the maximum of the five 30-day periods that were modelled). These figures indicate the possible acute (short term) influence of suspended sediment plumes generated by the TSHD depending on the ambient meteorological conditions.

Figure 6-47 shows the change in the 50th percentile depth-averaged turbidity due to dredging and Figure 6-48 shows the change in the 50th percentile turbidity in the bottom 1m layer of the model due to dredging (the maximum out of the five modelling periods). These figures indicate the possible chronic (persistent) influence of suspended sediment plumes generated by the TSHD depending on the ambient meteorological conditions.

Figure 6-49 shows the change in the 95th and 50th percentile deposition rate due to dredging, while Figure 6-50 shows the total amount of dredged material deposited in a 30 day simulation (the maximum of the five modelling periods).

Overall, the modelled turbidity and deposition impacts are generally limited to the immediate vicinity of the channel, although there is the potential for some sensitive receptors along the coastline of Magnetic Island to be influenced by plumes during strong easterly or southerly wind conditions.

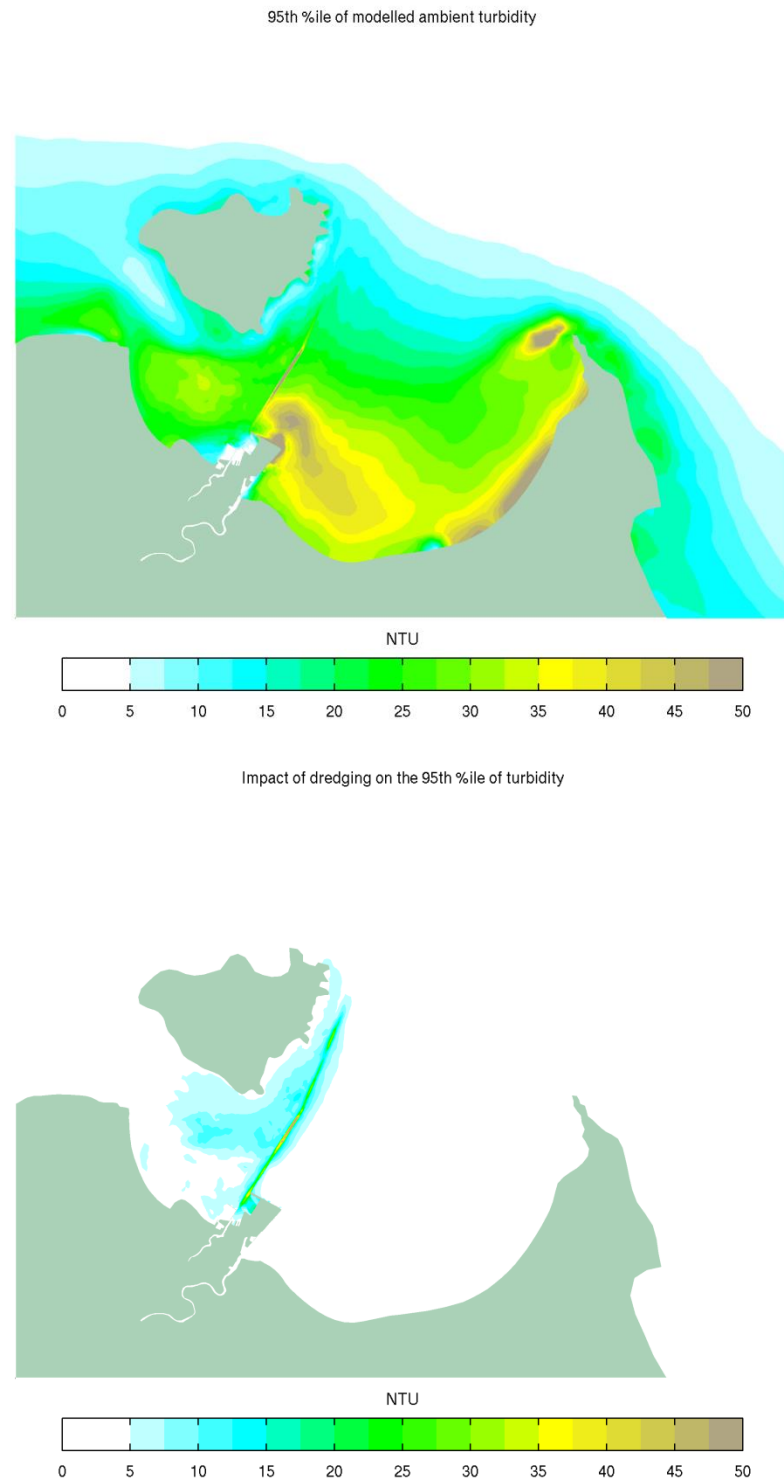


Figure 6-45 Stage 3 – ‘Worst Case’ - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

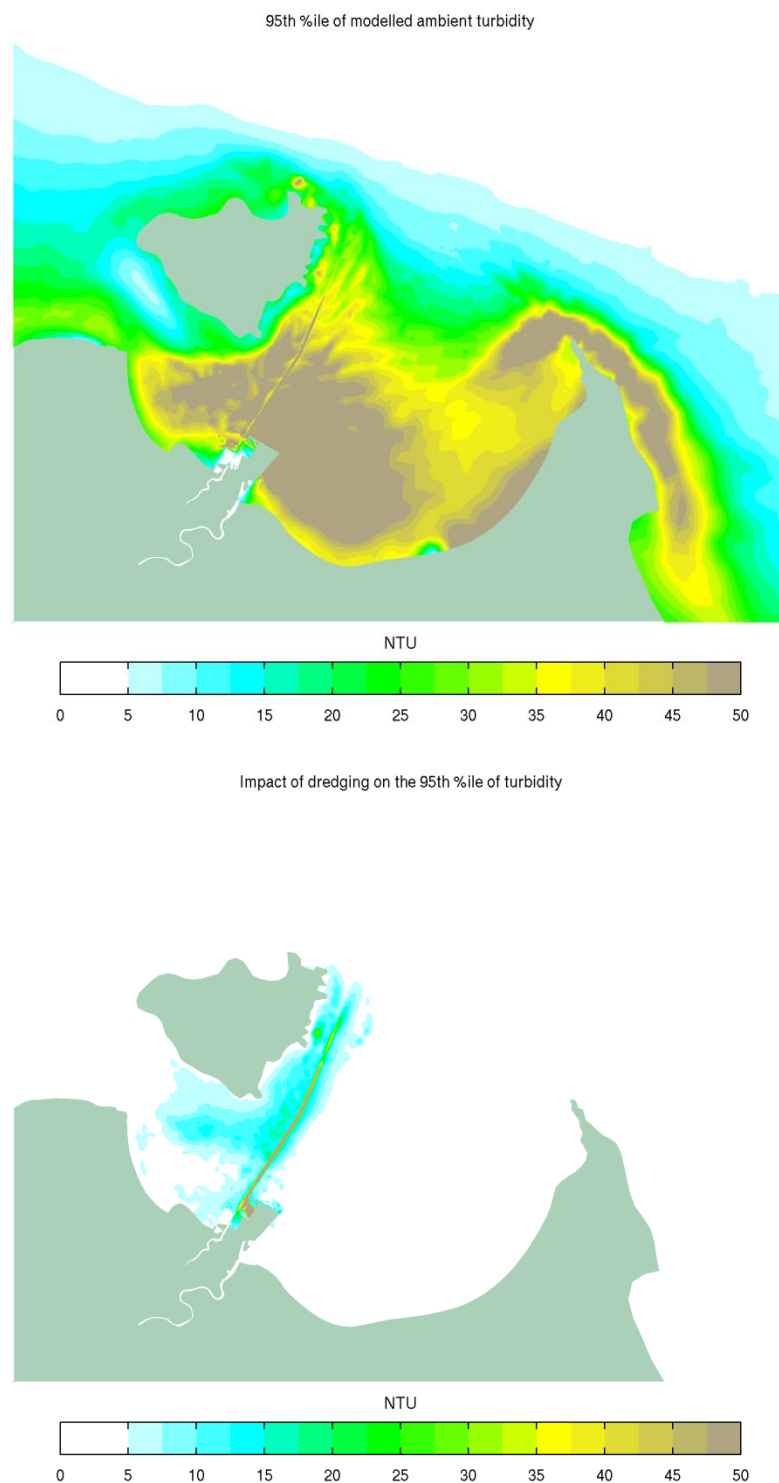


Figure 6-46 Stage 3 – ‘Worst Case’ - 95th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

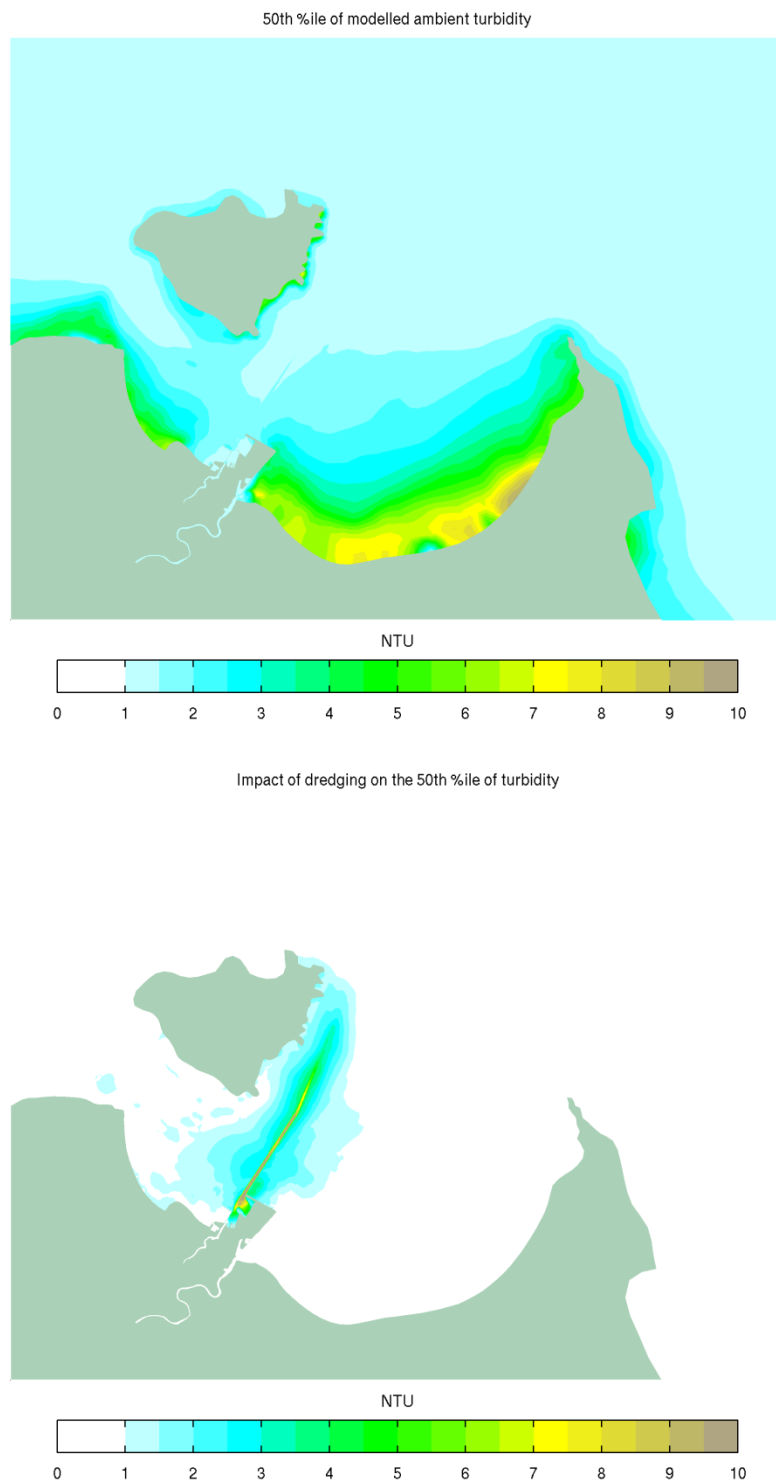


Figure 6-47 Stage 3 – ‘Worst Case’ - 50th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

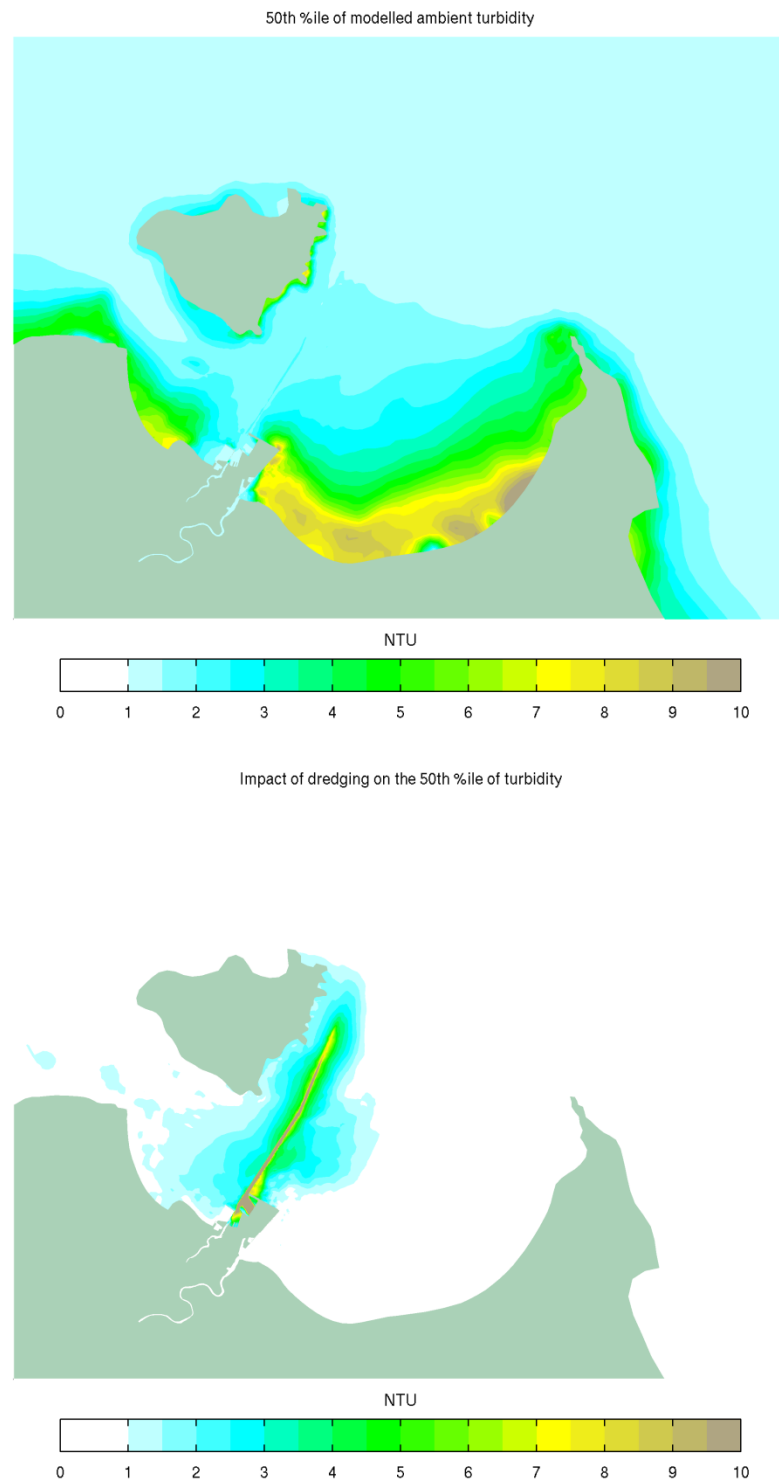
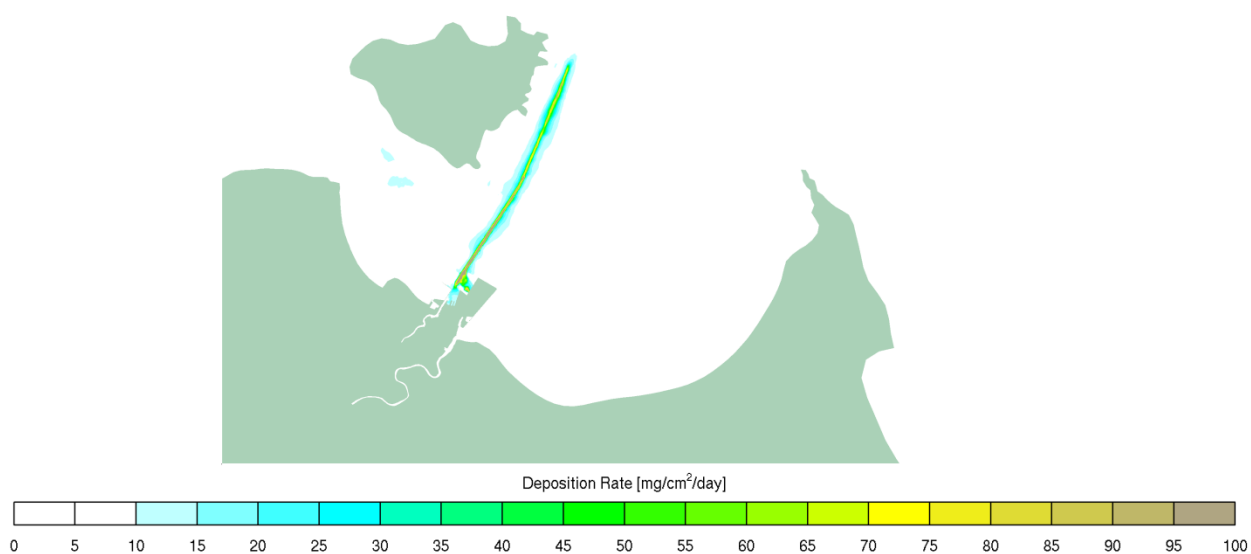


Figure 6-48 Stage 3 – ‘Worst Case’ - 50th Percentile Bottom 1m Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)

Impact of dredging on the 95th %ile of deposition rate



Impact of dredging on the 50th %ile of deposition rate

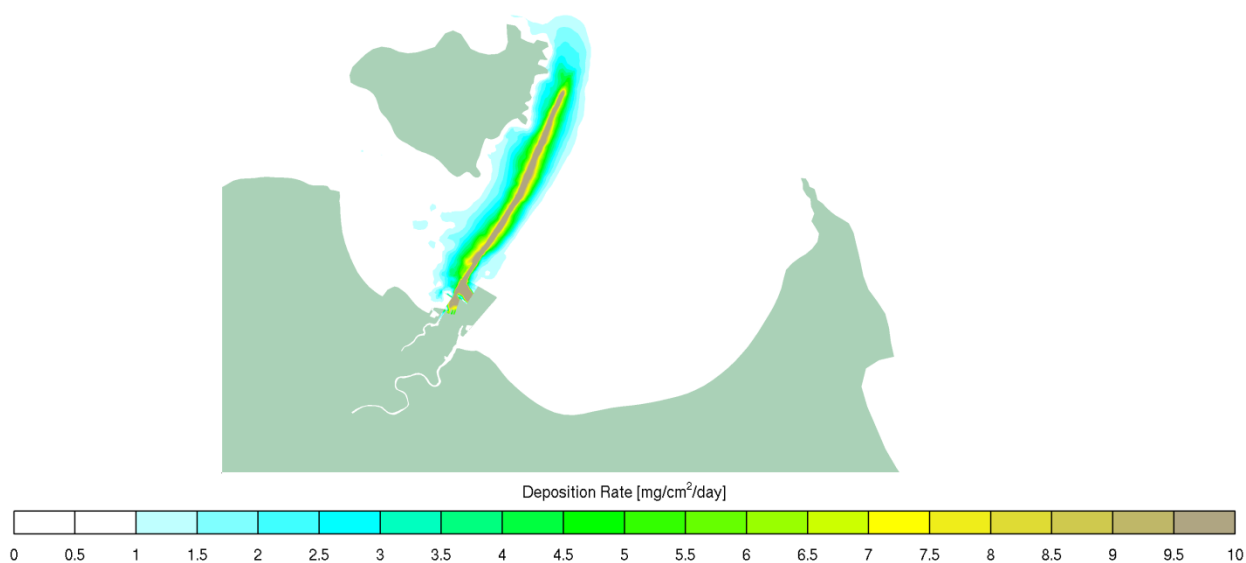


Figure 6-49 Stage 3 – ‘Worst Case’ - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

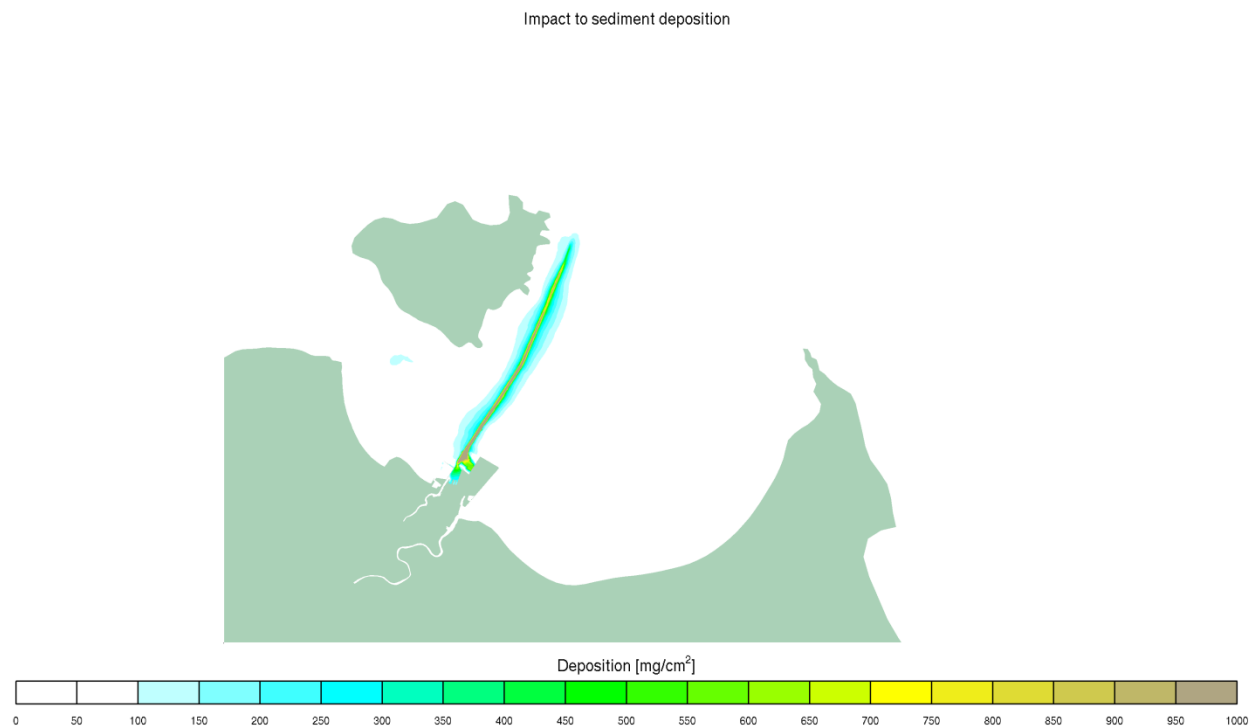


Figure 6-50 Stage 3 – ‘Worst Case’ - Final Deposition of Dredged Sediment After 30 Days

6.5 Maintenance Dredging Program

The modelled impact of maintenance dredging of the Platypus and Sea Channel for the Ultimate Case development is shown in Figure 6-51 to Figure 6-54. Turbidity and deposition impacts are generally limited to the immediate vicinity of the channel and the DMPA site.

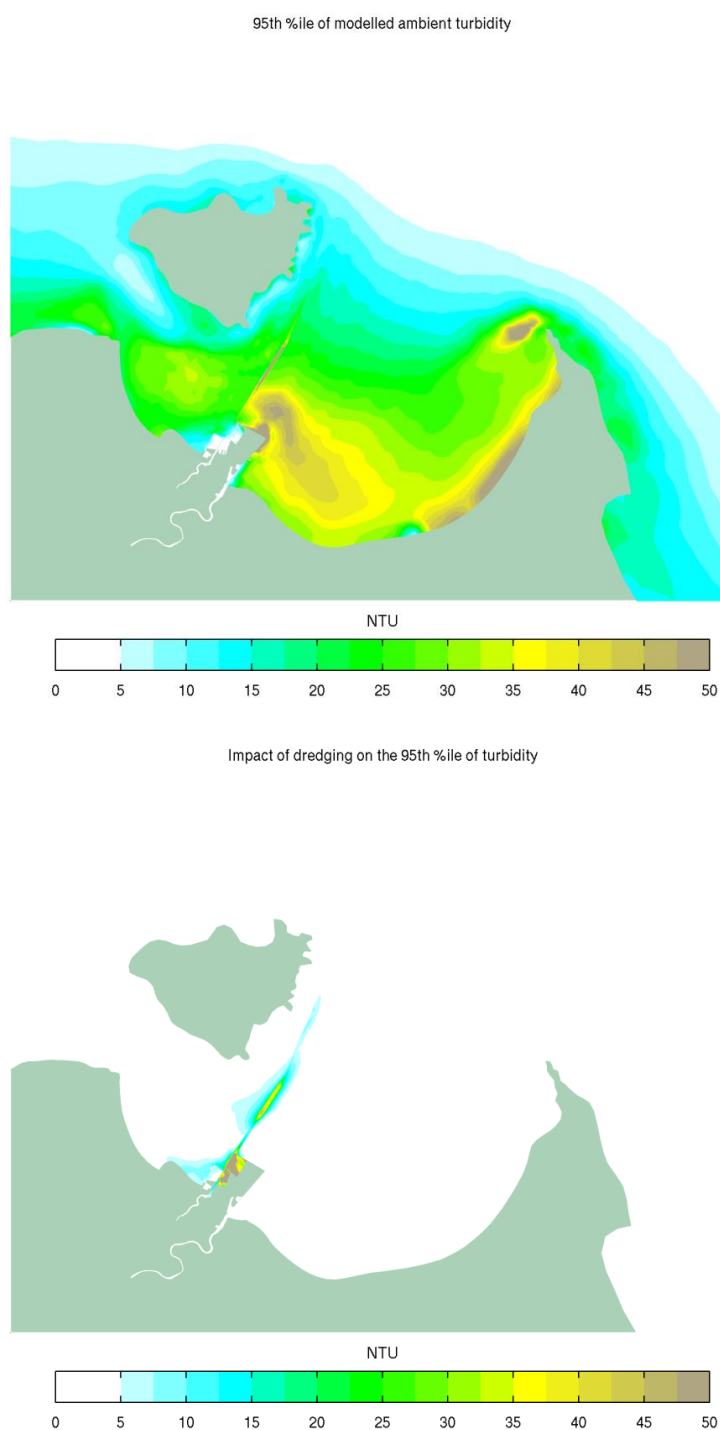
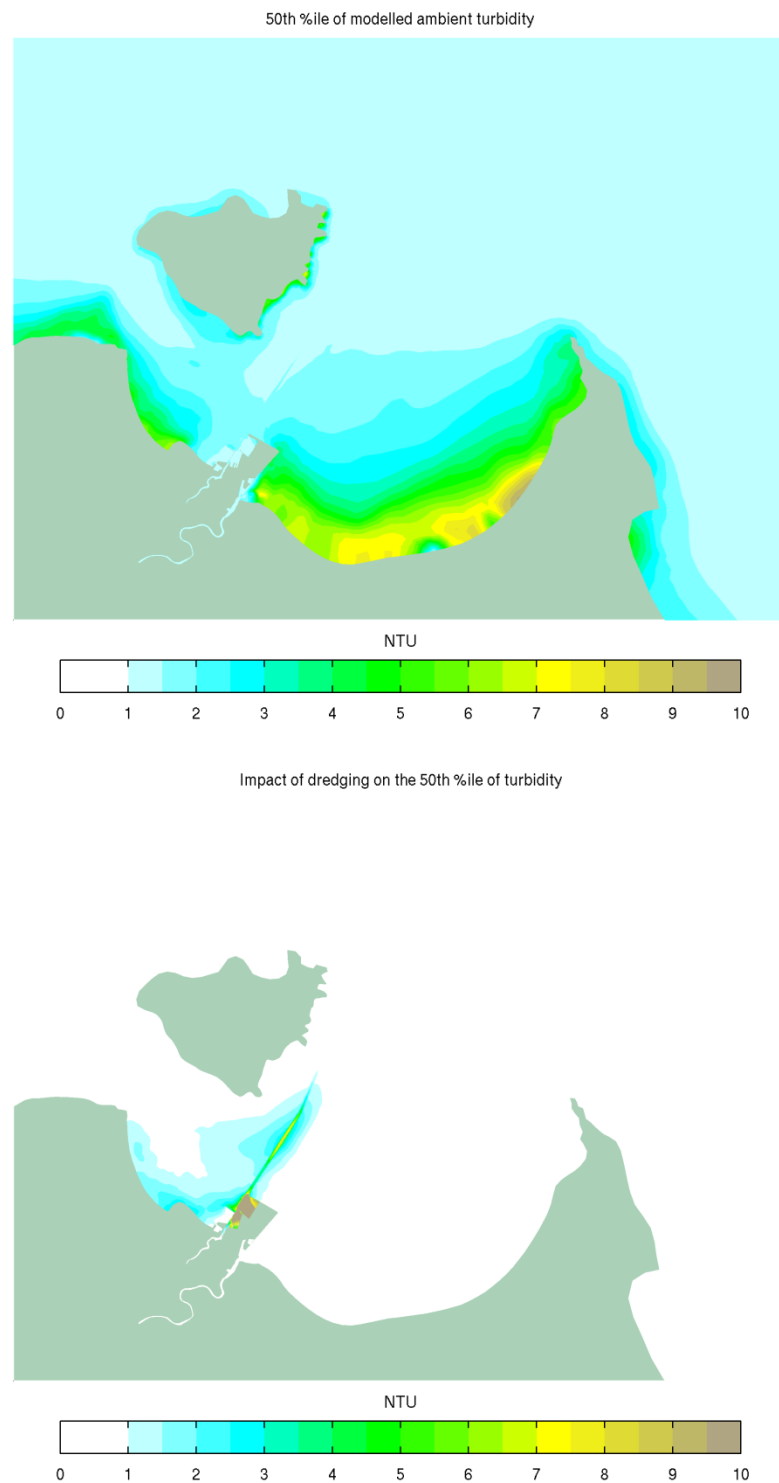


Figure 6-51 Maintenance Campaign by Small TSHD - 95th Percentile Depth Average Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)



**Figure 6-52 Maintenance Campaign by Small TSHD - 50th Percentile Depth Average
Turbidity: Average Ambient Turbidity (top), Impact of Dredging (bottom)**

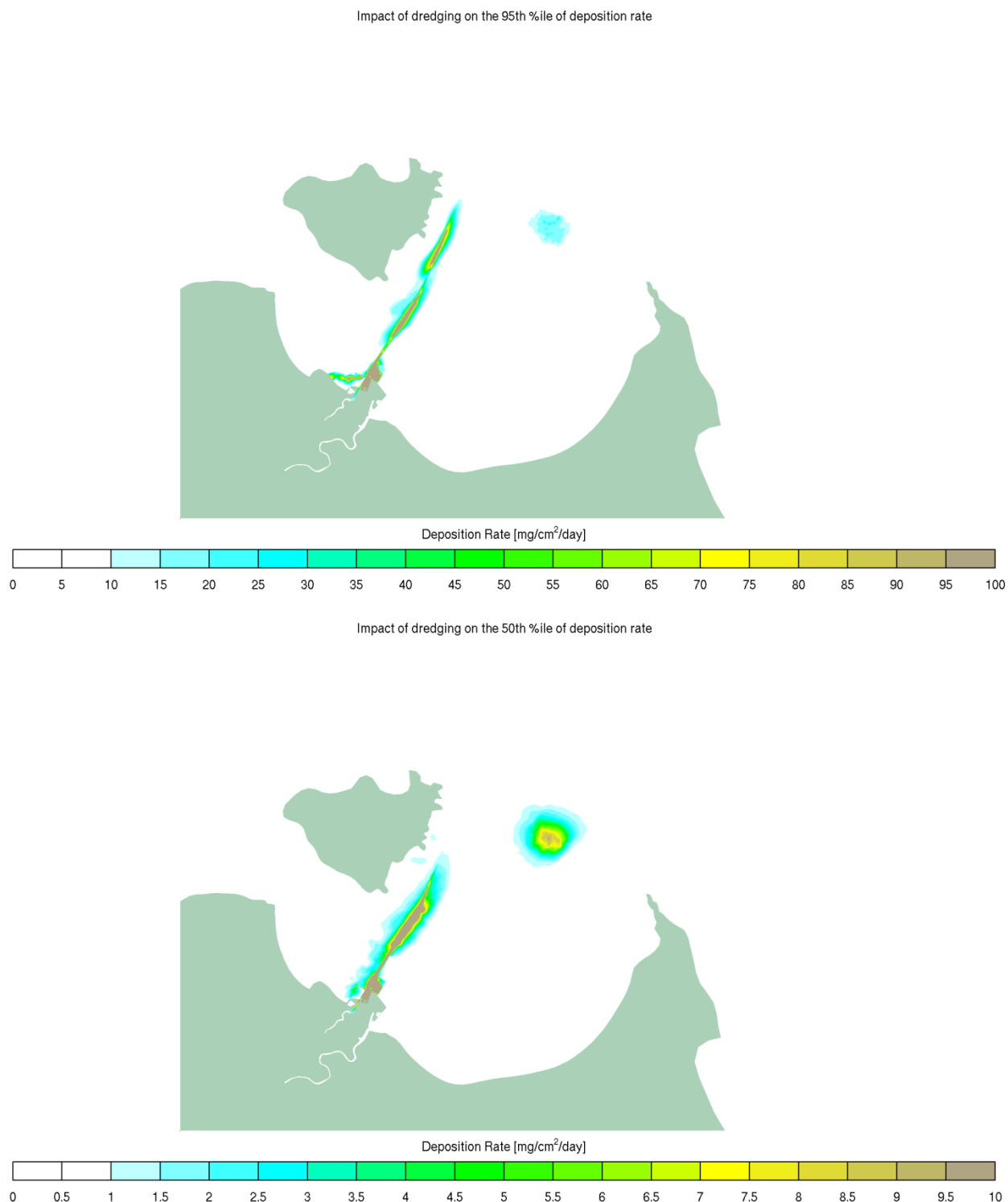


Figure 6-53 Maintenance Campaign by Small TSHD - Impact of Dredging on 95th Percentile Deposition Rate (top), Impact of Dredging on 50th Percentile Deposition Rate (bottom)

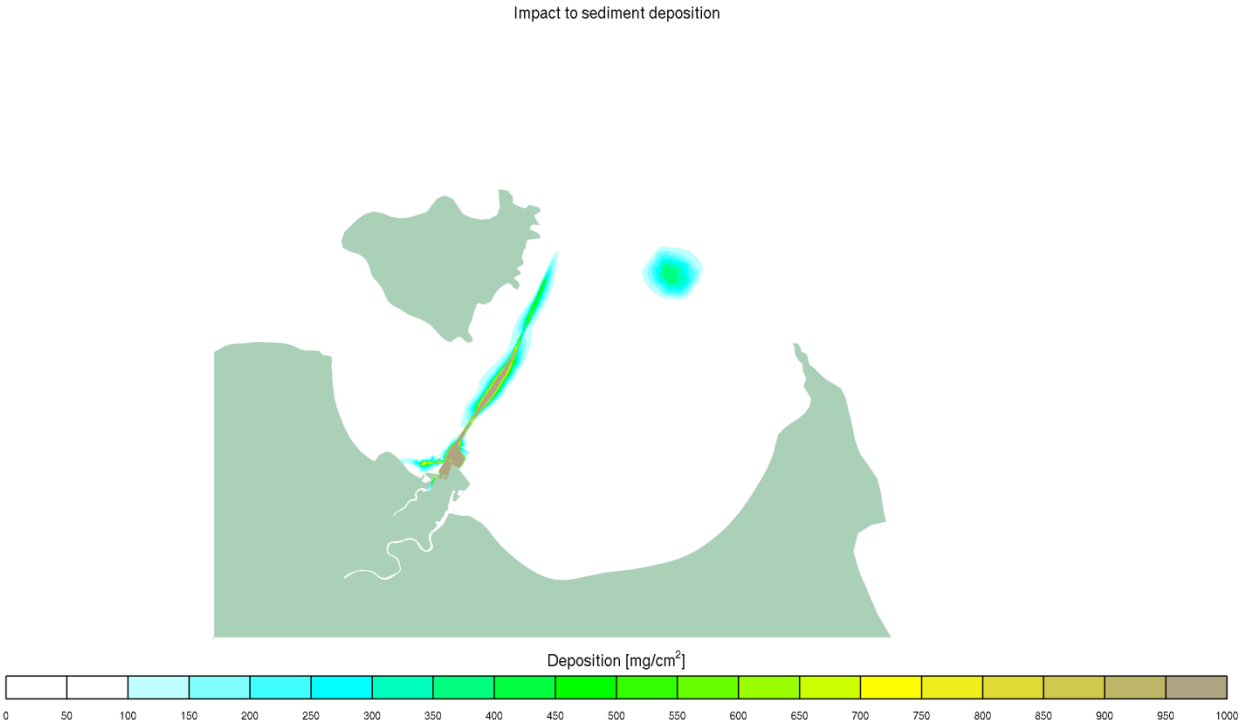


Figure 6-54 Maintenance Campaign by Small TSHD - Final Deposition of Dredged Sediment

6.6 Summary of Plume Dispersion Results

The dredge plume modelling results were used to inform the assessment of water quality and ecological impacts as discussed in the Water Quality and Marine Ecology sections of the AEIS. A full discussion of the impact of dredging plumes on water quality and marine flora and fauna can be found in those sections.

In general terms the largest impact from dredging operations is predicted to occur during the widening (Stage 1) and deepening (Stage 3) of the Platypus and Sea Channels. The entrainment of sediment by overflow of the TSHD hopper and propeller wash produces plumes which can under certain conditions influence sensitive receptor sites along the periphery of Magnetic Island.

The plumes caused by dredging in the outer harbour and caused by tailwater discharge are predicted to cause an impact at the local level but do not disperse over a wide area. The increase in suspended sediment concentrations at sensitive receptor sites from dredge plumes produced at these locations is negligible.

7 References

- Anthony, K.R.N. and Fabricius, K.E. (2000) Shifting roles of heterotrophy and autotrophy in coral energetics under varying turbidity. *Journal of Experimental Marine Biology and Ecology* 252: 221-253.
- Anthony, K.R.N., Ridd, P.V., Orpin, A.R., Larcombe, P., Lough, J. (2004) Temporal variation of light availability in coastal benthic habitats: Effects of clouds, turbidity, and tides. *Limnology and Oceanography* 49(6): 2201-2211.
- Anthony, K.R.N. (2006) Enhanced energy status of corals on coastal, high-turbidity reefs. *Marine Ecology Progress Series* 319: 111-116.
- Bainbridge, Z.T., Wolanski, E., Álvarez-Romero, J.G., Lewis, S.E., Brodie, J.E. (2012). Fine sediment and nutrient dynamics related to particle size and floc formation in a Burdekin River flood plume, Australia. *Marine Pollution Bulletin* 65: 236-248. doi:10.1016/j.marpolbul.2012.01.043
- Beach Protection Authority (1995). Rows Bay / Pallarenda Foreshore Management Study. Draft report of the Rows Bay / Pallarenda Working Group, February 1995.
- Benson, LJ, Goldworthy, PM, Butler IR, and Oliver J, editors. (1994) Townsville Port Authority Capital Dredging Works 1993: Environmental Monitoring Program. Townsville Port Authority: 237 pp.
- BMT WBM (2009). Townsville Port Expansion Preliminary Engineering and Environment Study - Oceanographic Data Collection. Report prepared for Maunsell Australia, July 2009.
- BMT WBM (2010). Black and Ross River Water Quality Improvement Plan Catchment and Water Quality Modelling. Report prepared for Townsville City Council, December 2010.
- Coastal Engineering Solutions (1998). Coastal processes and Beach Management Studies for The Strand and Rows Bay. Final Report, prepared for Townsville City Council, July 1998.
- Cooper, T.F., Ridd, P.V., Ulstrup, K.E., Humphrey, C., Slivkoff, M., Fabricius, K.E. (2008) Temporal dynamics in coral bioindicators for water quality on coastal reefs of the Great Barrier Reef. *Marine and Freshwater Research* 59: 703-716.
- ETS Worldwide (2012). Sediment Dynamics Assessment, Port of Townsville and Cleveland Bay: Assessment of Sediment Plume(s) Generated during Dredging and Disposal. Report prepared for Port of Townsville Ltd.
- Fabricius, K.E. (2005) Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. *Marine Pollution Bulletin* 50: 125-146.
- GBRMPA (2012). The use of Hydrodynamic Numerical Modelling for Dredging Projects in the Great Barrier Reef Marine Park, August 2012.
- GHD (2004) Hydrodynamic Modelling of the Outer Harbour. Report prepared for the Townsville Port Authority, August 2004.
- Gilmour, J. (1999) Experimental investigation into the effects of suspended sediment on fertilisation, larval survival and settlement in a scleractinian coral. *Marine Biology* 135: 451-462.

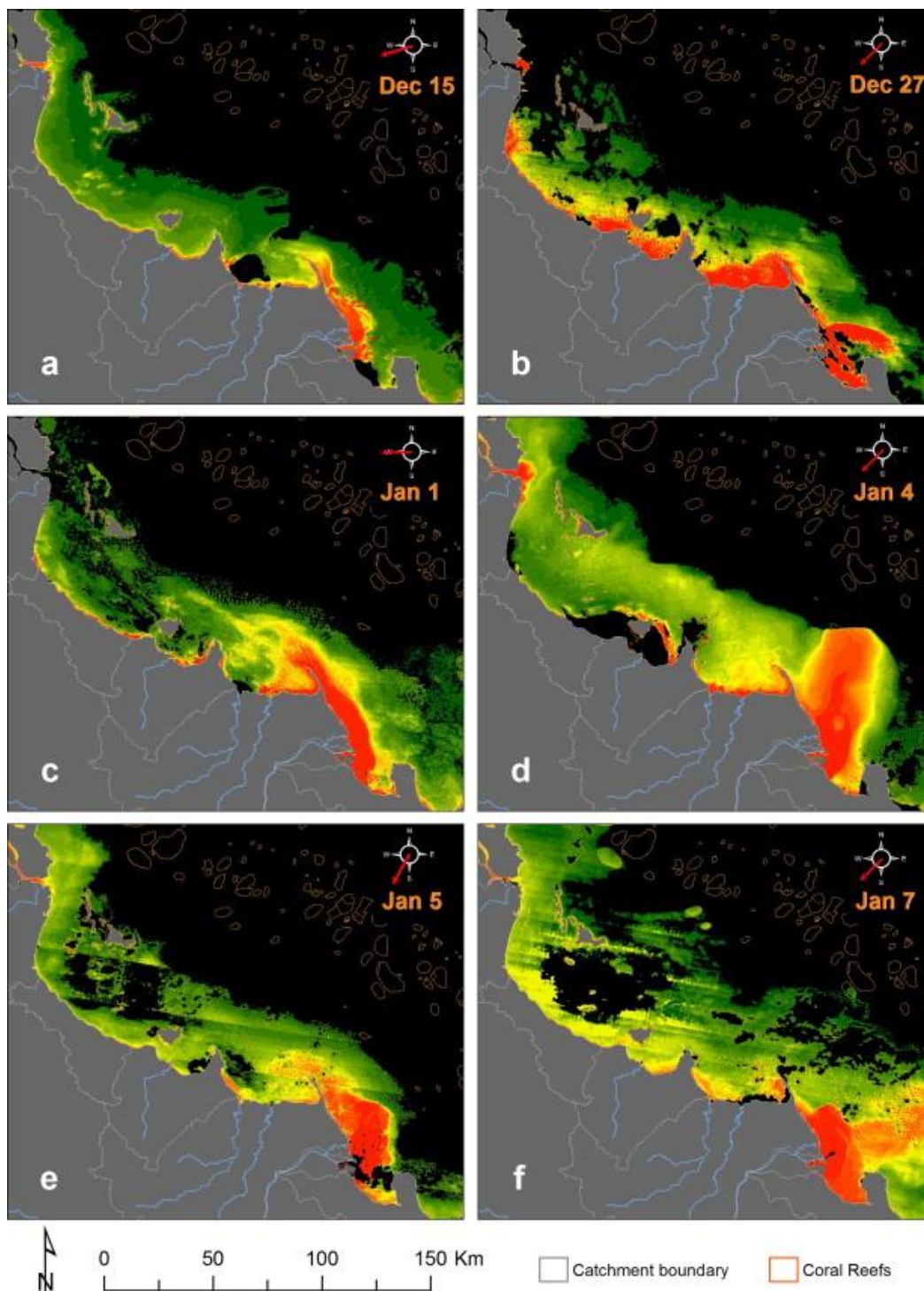
References

- Hardy T.A. (1991). Impact on Townsville's Beaches of Proposed Extensions to the Port of Townsville. Report to Sinclair Knight & Partners for Townsville Port Authority, September 1991.
- Humphrey, C., Weber, M., Lott, C., Cooper, T., Fabricius, K.E. (2008) Effects of suspended sediments, dissolved inorganic nutrients and salinity on fertilisation and embryo development in the coral *Acropora millepora* (Ehrenberg, 1834). *Coral Reefs* 27: 837-850.
- JCU/AIMS (1991) Water Circulation and Fate of Dredge Spoil, Cleveland Bay, Townsville. Report to the Townsville Port Authority, March 1991.
- Kaly, U.L., Mapstone, B.D., Ayling, A.M., Choat, J.H. (1994) Coral communities. In 'Townsville Port Authority Capital Dredging Works 1993: Environmental Monitoring Program' (Eds Benson L.J., Goldsworthy, P.M., Butler, I.R., Oliver, J.) Townsville Port Authority, Townsville Australia.
- Kettle B., Dalla Pozza R. & Collins J. (2001). New Directions, A Review of the Impacts of Dredging in Cleveland Bay and Research Priorities for the Next Decade. Report for Townsville Port Authority Dredge Spoil Disposal TACC, 2001.
- Mabin M. (1996). Beach Changes 1982 – 1995, Strand Beach, Townsville. Prepared for Townsville City Council.
- NOAA, (2012). NOMADS - NOAA Operational Model Archive and Distribution System <http://www.ncep.noaa.gov/>. Retrieved 28/05/2012.
- POTL (2013) Long Term Dredging and Disposal Management Plan for Port of Townsville: Final Report.
- Pringle, A.W. (1989) The History of Dredging in Cleveland Bay, Queensland and Its Effect on Sediment Movement and on the Growth of Mangroves, Corals and Seagrass. Prepared by the Great Barrier Reef Marine Park Authority for the Townsville Port Authority.
- Rasheed, M.A. & Taylor, H.A. (2008) Port of Townsville seagrass baseline survey report, 2007-2008. Queensland Government Department of Primary Industries and Fisheries, Publication PR08-4014, Cairns.
- Reef and Rainforest Research Centre, 2010. Project 3DGBR: a high-resolution depth model for the Great Barrier Reef and Coral Sea. Marine and Tropical Sciences Research Facility Final Report.
- Riedel & Byrne Pty Ltd (1983). Preliminary Design of Breakwaters for the 105ha Benwell Road Reclamation. Report to Townsville Harbour Board.
- Sinclair Knight Merz (1996). Beach Erosion Issues. Prepared for the Townsville Port Authority.
- Sofonia, J.J., Anthony, K.R.N. (2008) High-sediment tolerance in the reef coral *Turbinaria mesenterina* from the inner Great Barrier Reef lagoon (Australia). *Estuarine, Coastal and Shelf Science* 78: 748-752.
- Weber, M., Lott, C., Fabricius, K.E. (2006) Sedimentation stress in a scleractinian coral exposed to terrestrial and marine sediments with contrasting physical, organic and geochemical properties. *Journal of Experimental Marine Biology and Ecology* 336: 18-32.

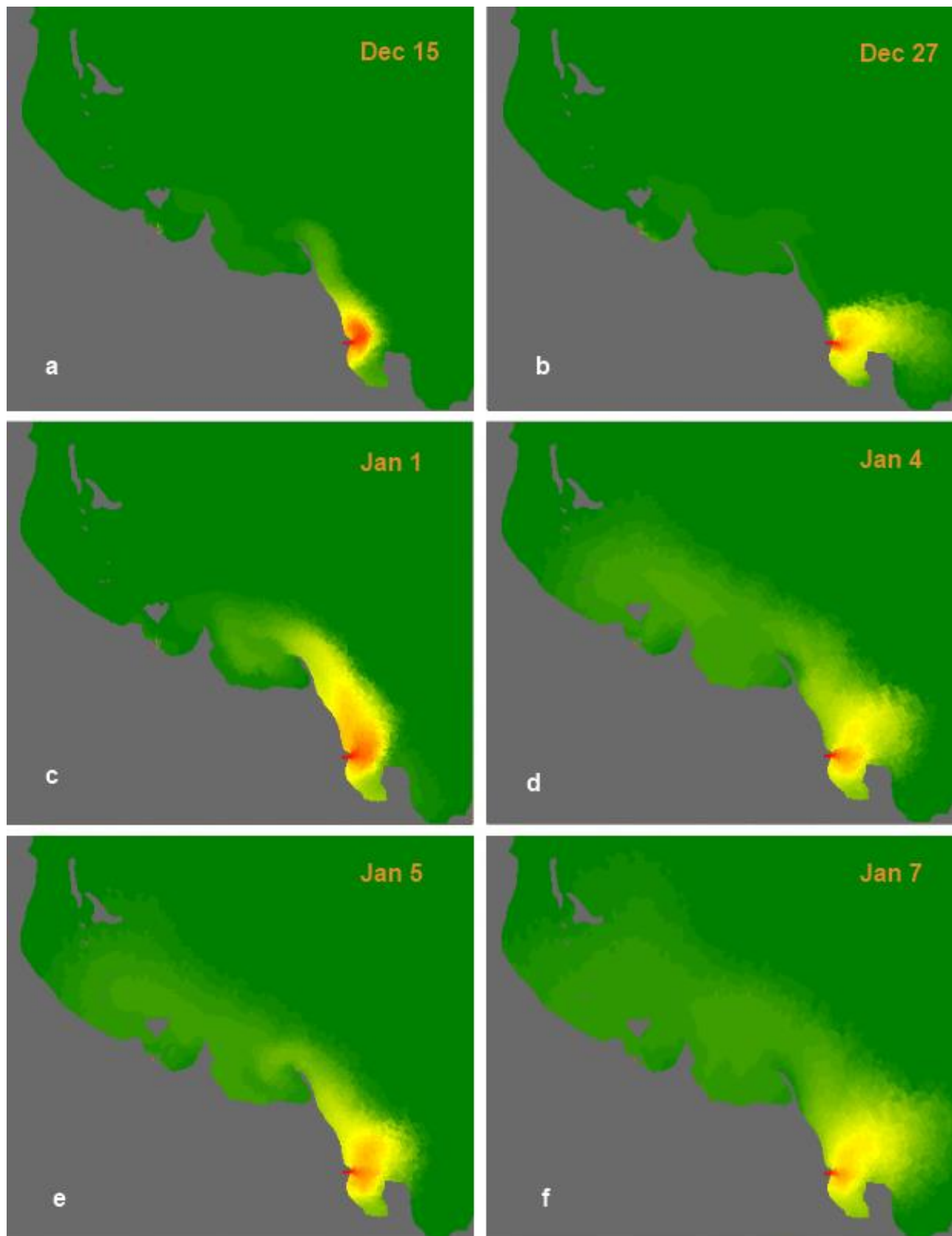
Appendix A TUFLOW FV Description

Appendix B Summer 2010/11 River Plumes

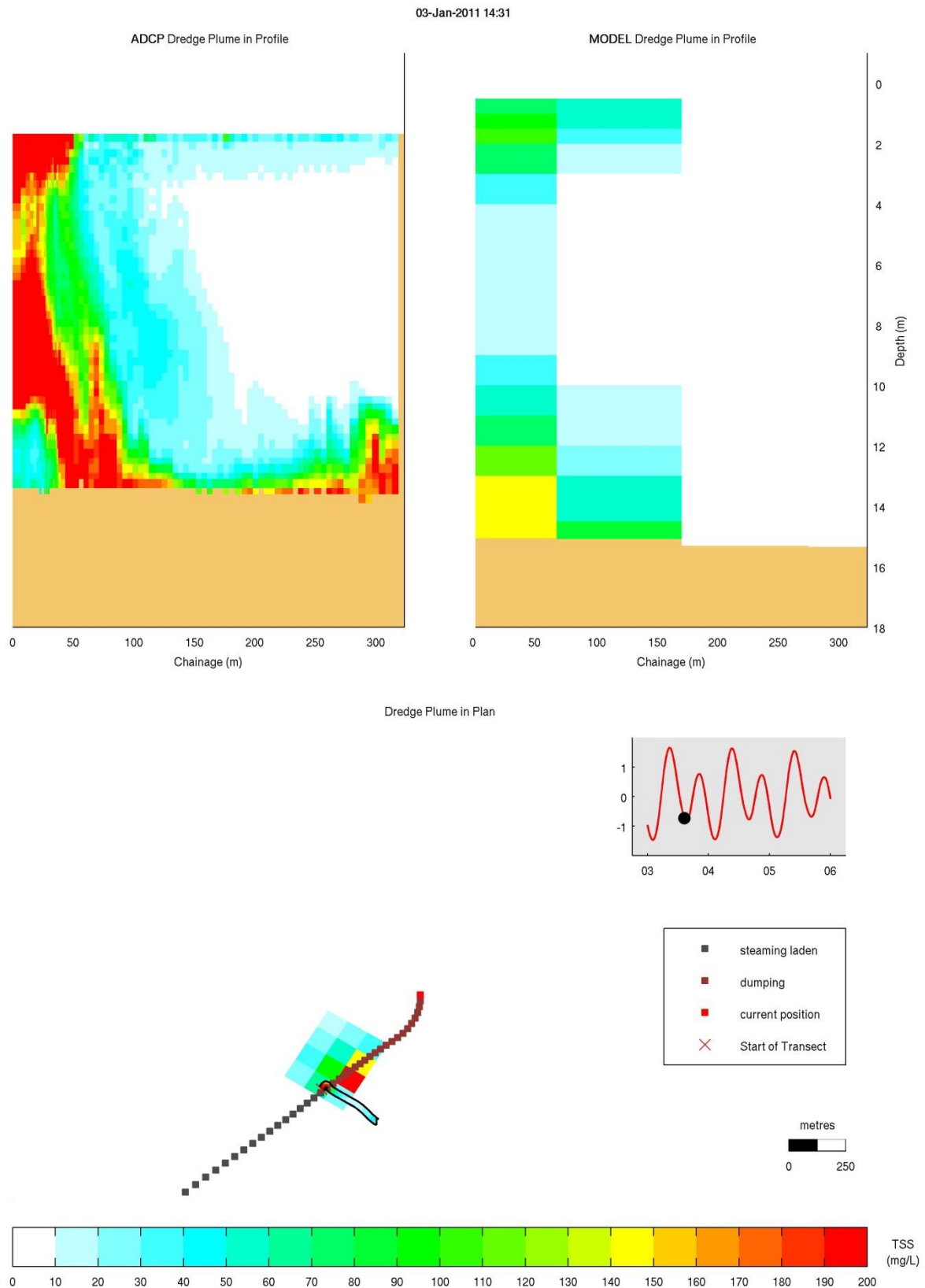
MODIS satellite images reproduced from Figure 3 of Bainbridge et al. (2012) show the evolution of the Burdekin River flood plume from the 15/12/10 to 07/01/11.



Model snapshots of surface salinity at equivalent times (showing the extent of the river plume) are provided on the following page for comparison purposes.

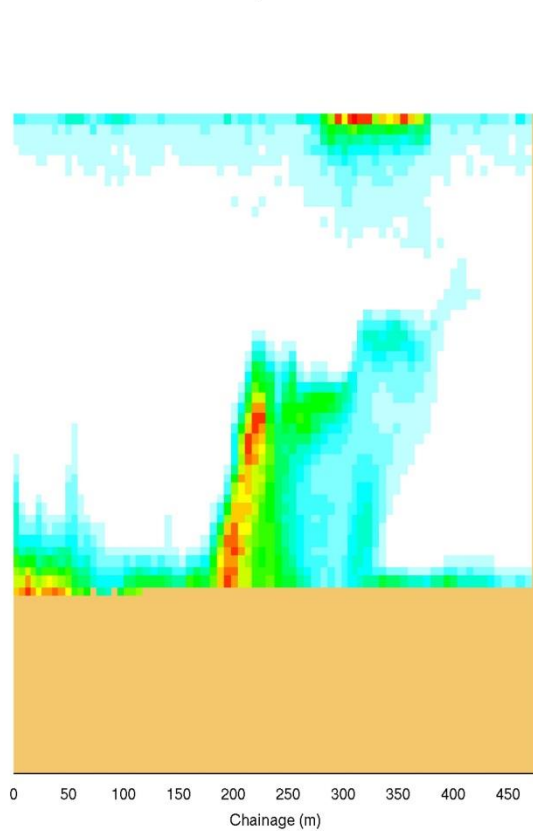


Appendix C Dredge Plume Model Calibration Plots

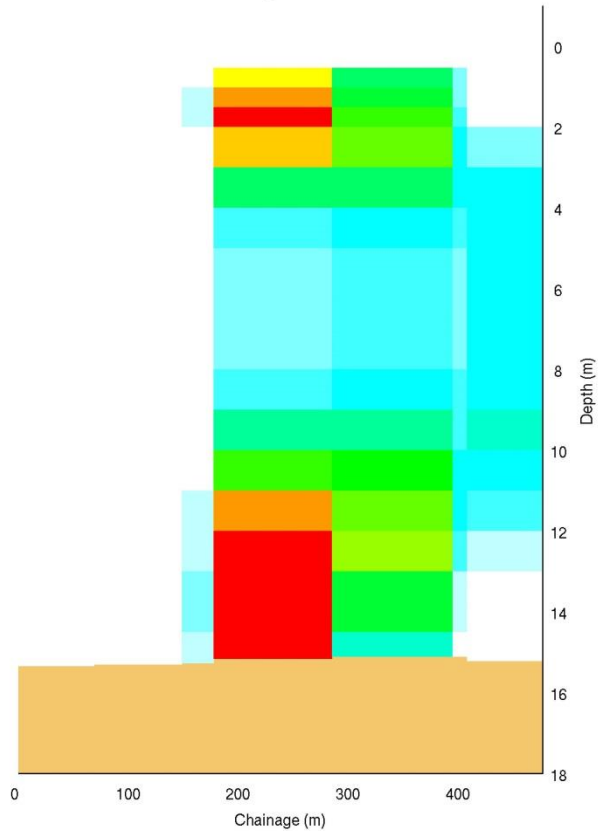


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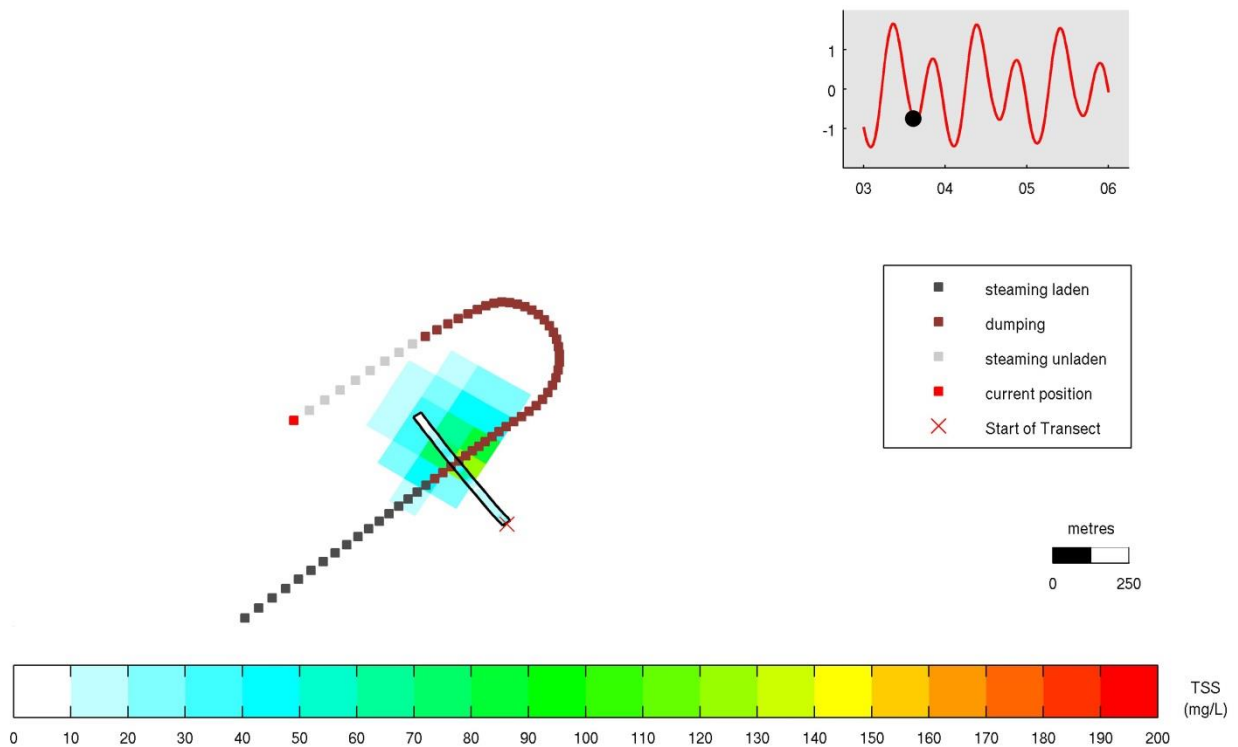
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile

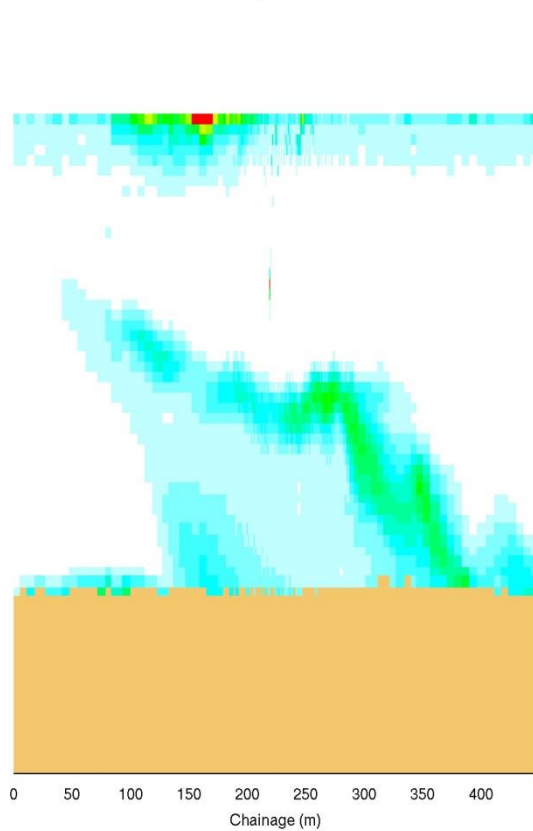


Dredge Plume in Plan

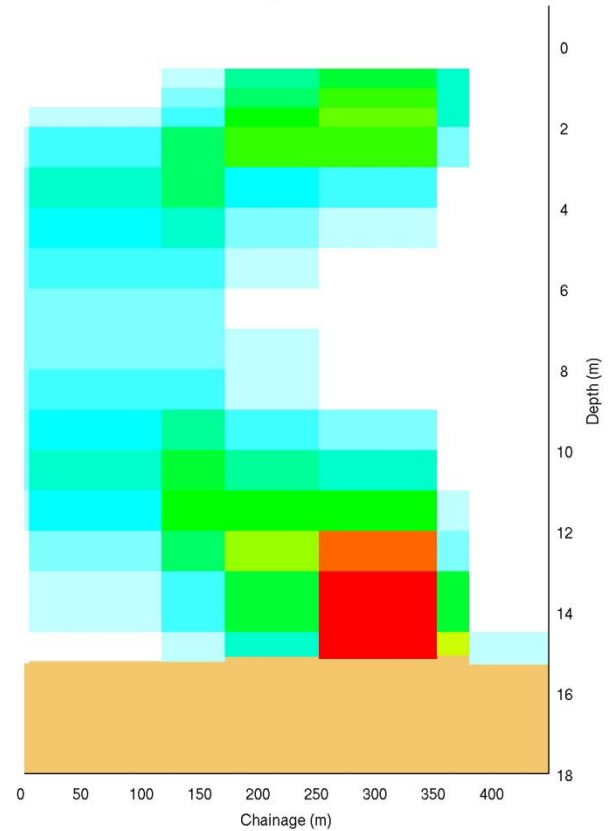


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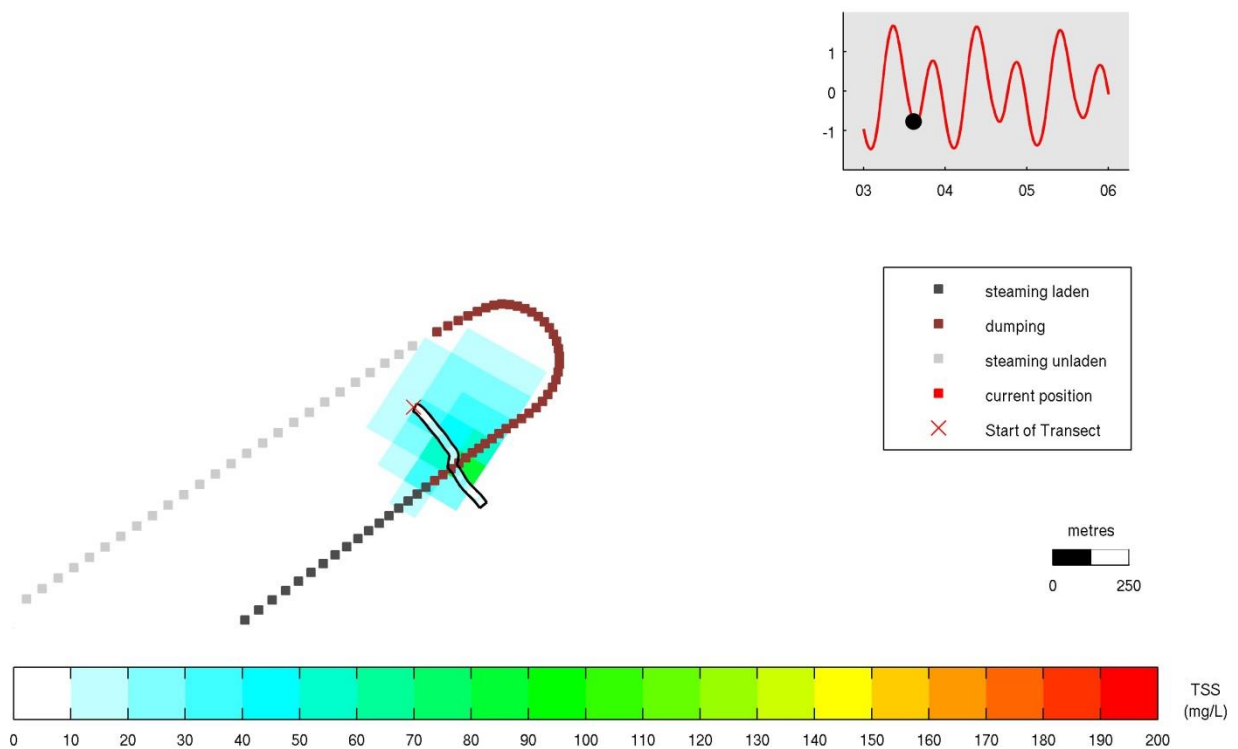
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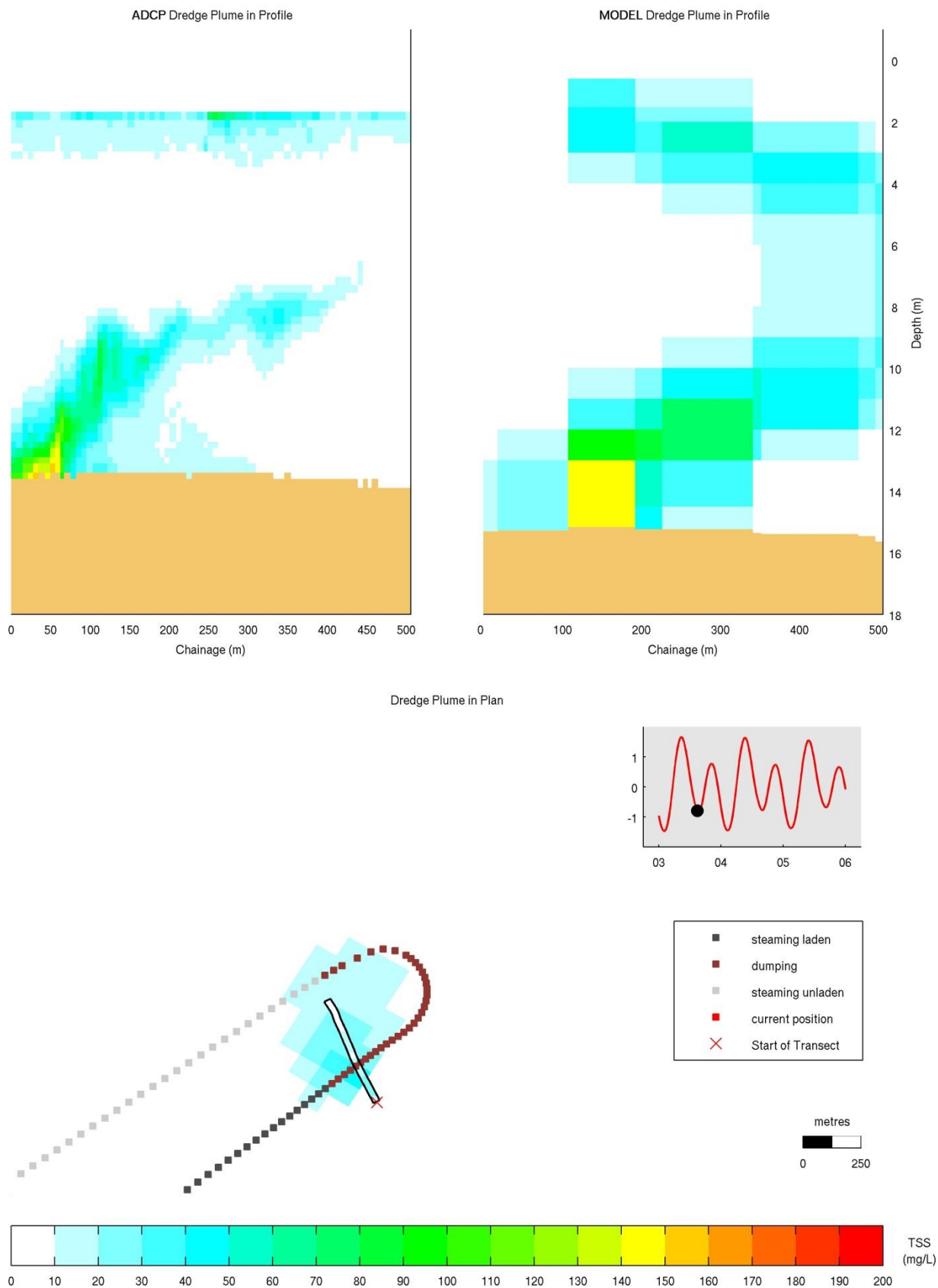
MODEL Dredge Plume in Profile



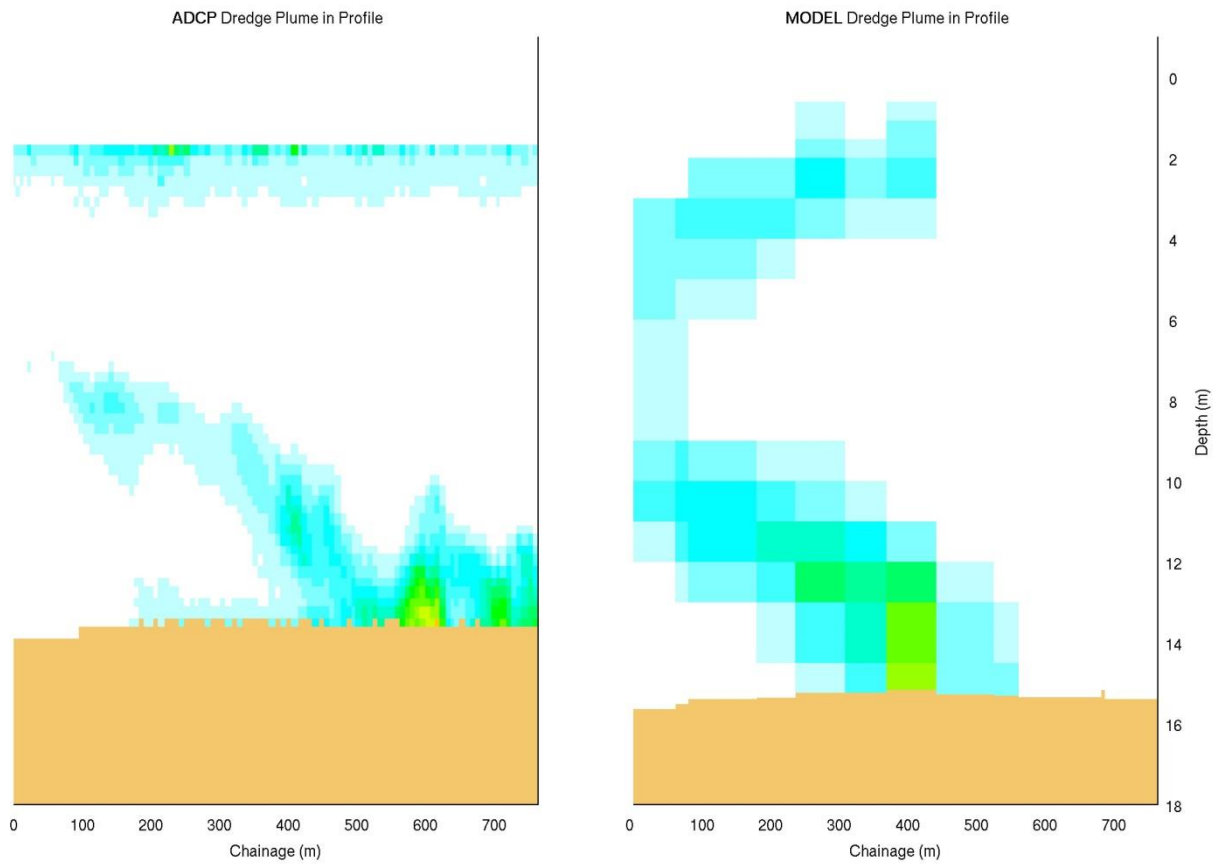
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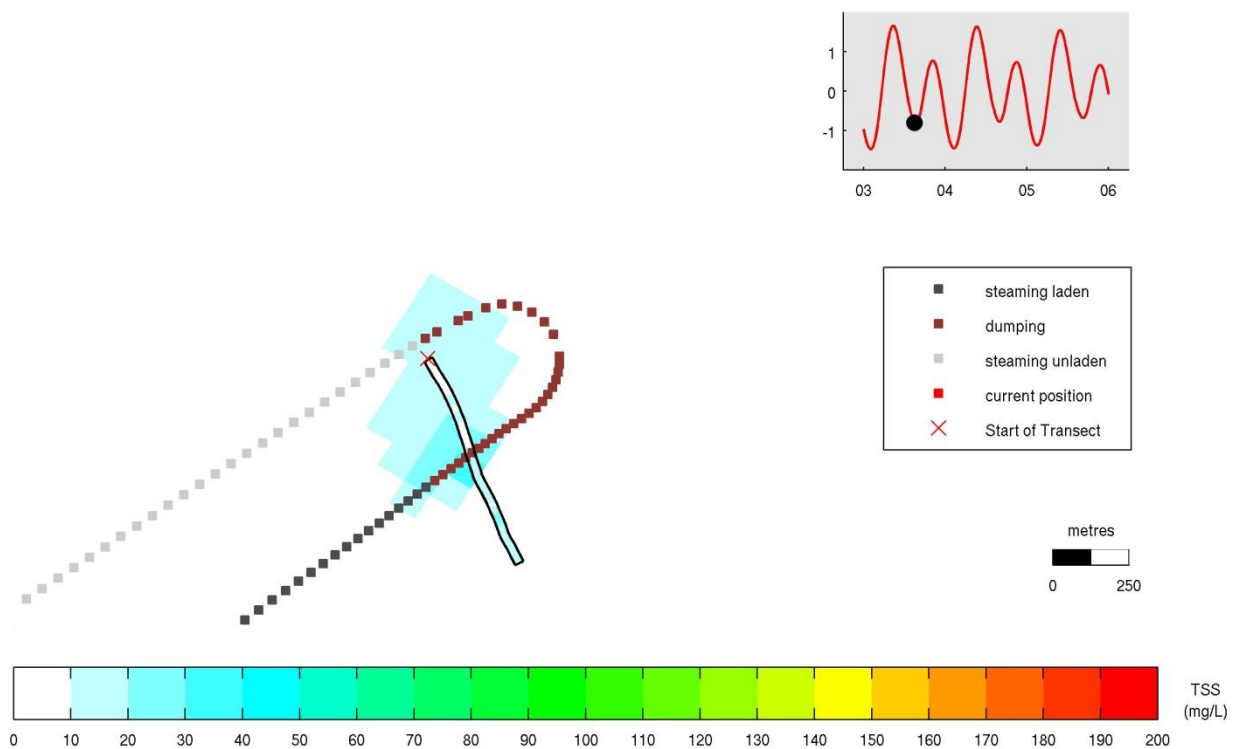
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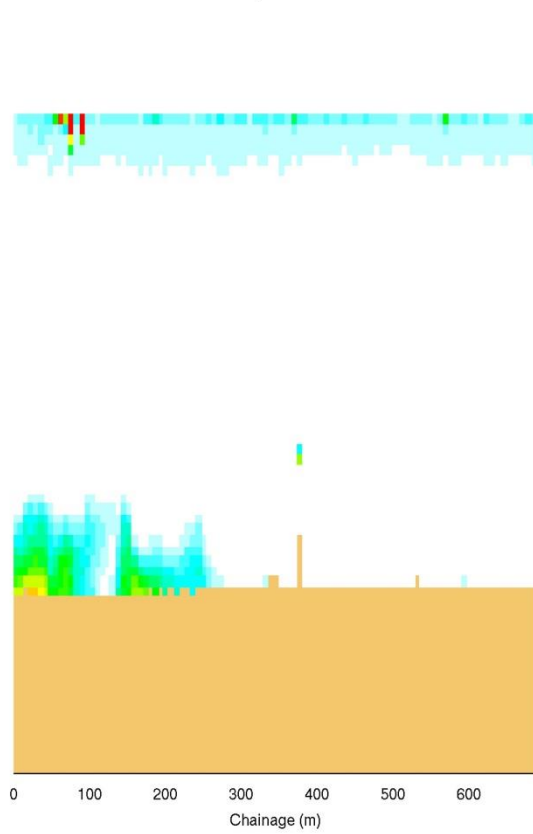


Dredge Plume in Plan

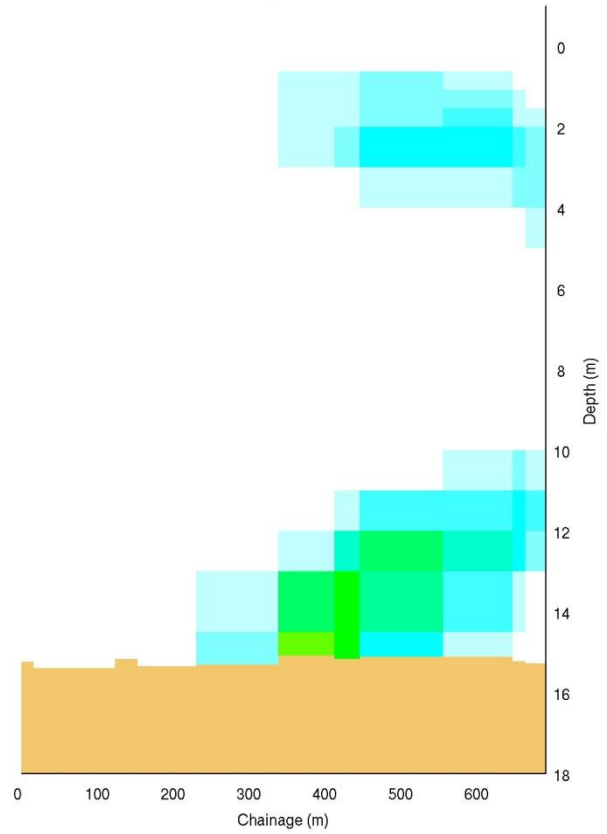


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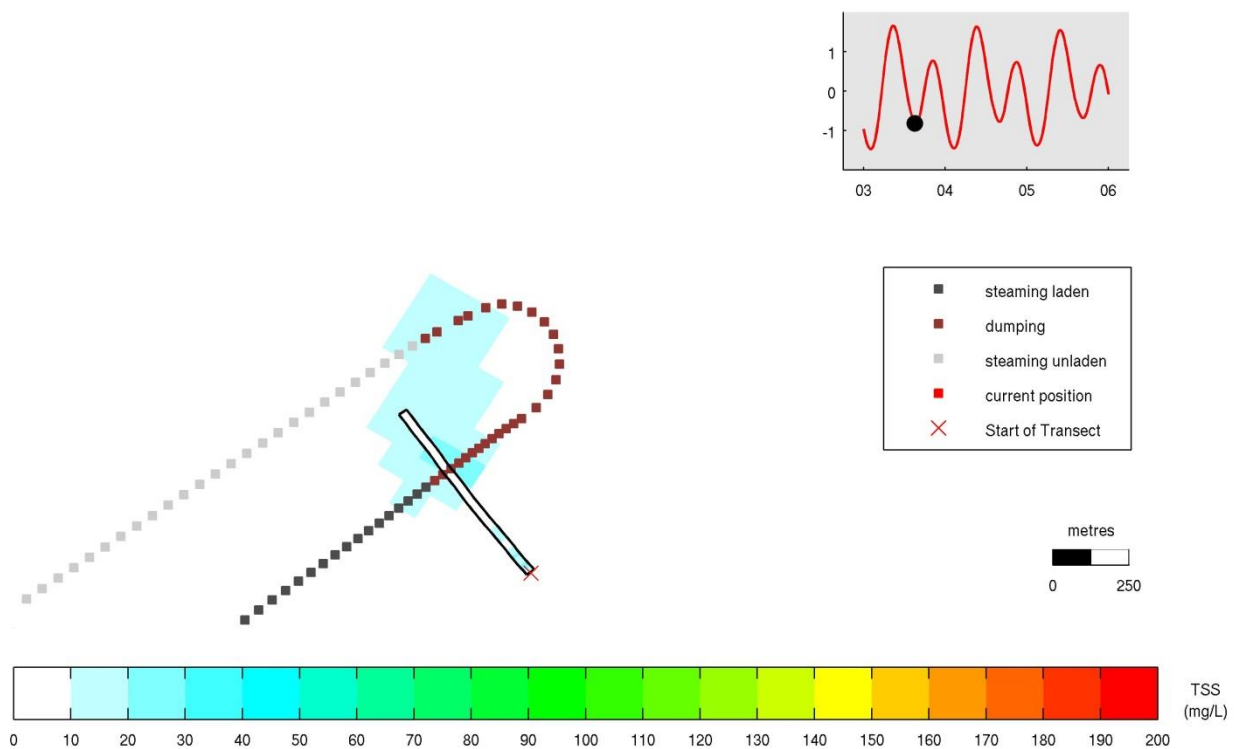
ADCP Dredge Plume in Profile



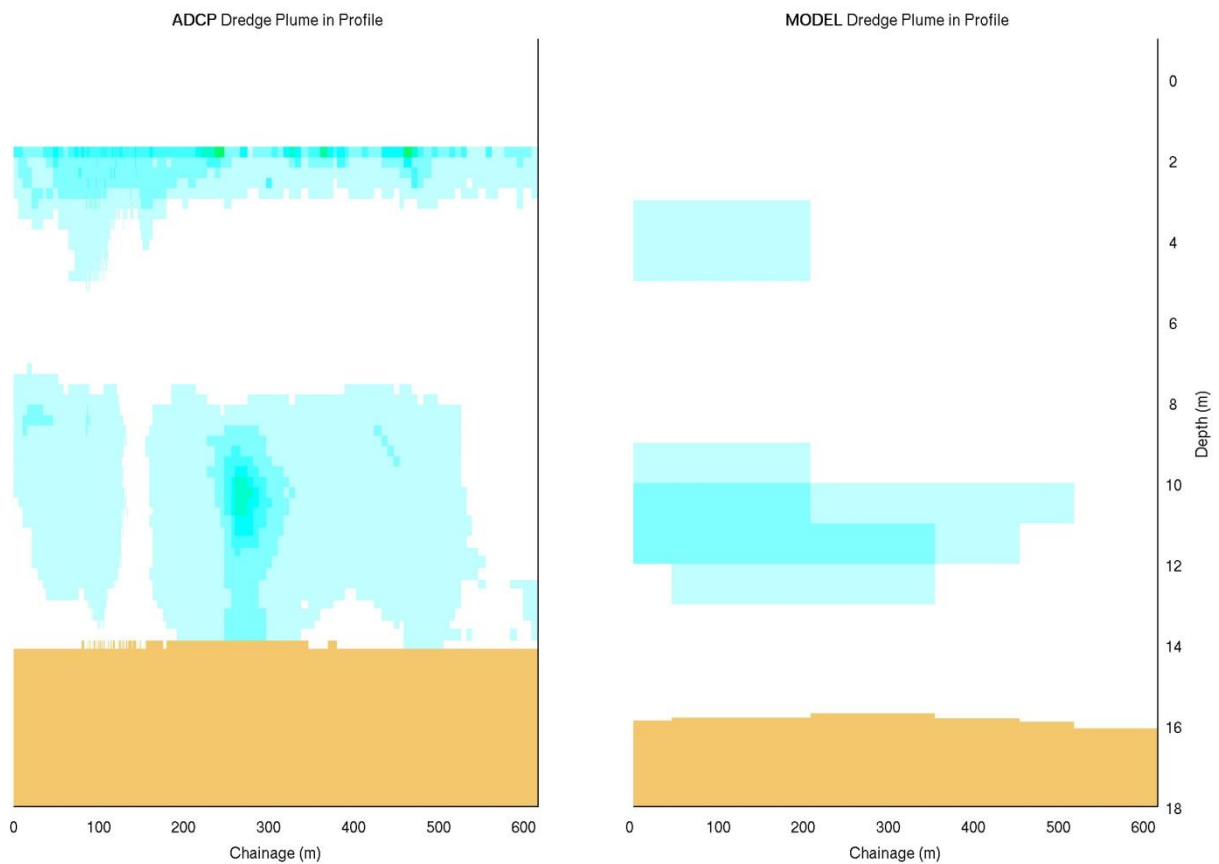
MODEL Dredge Plume in Profile



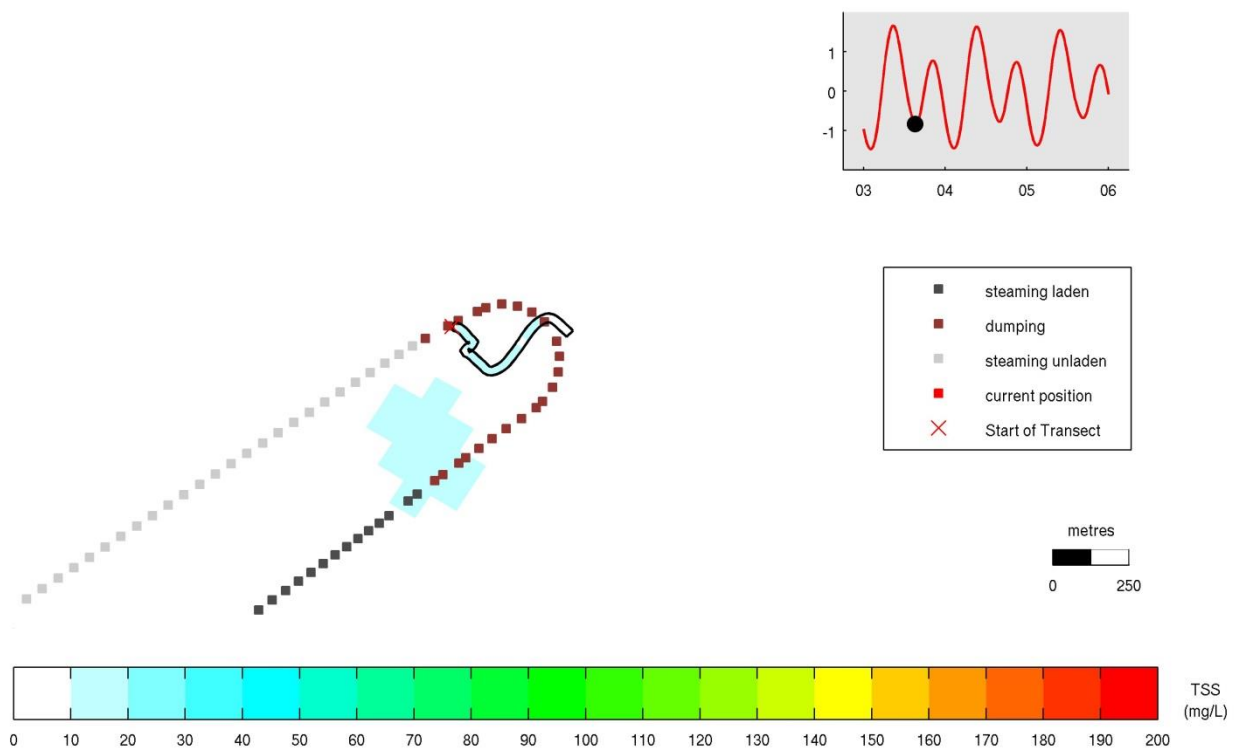
Dredge Plume in Plan



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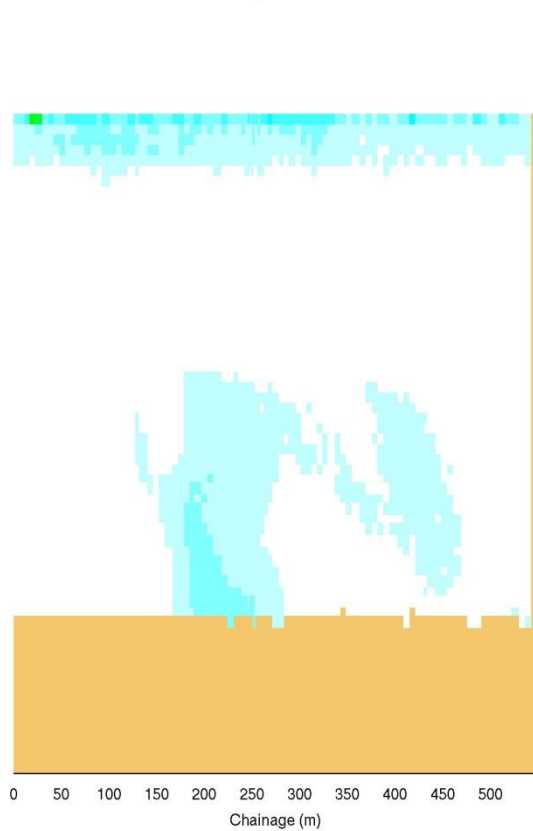


Dredge Plume in Plan

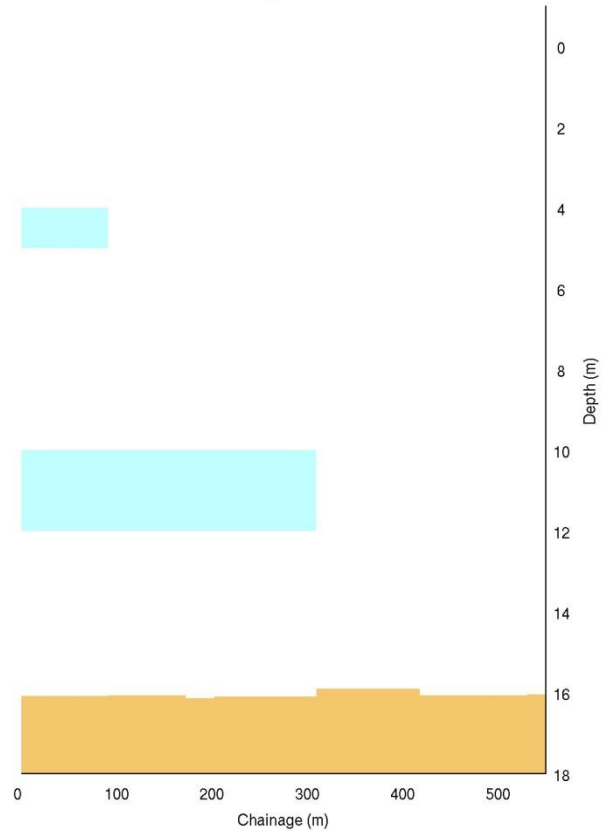


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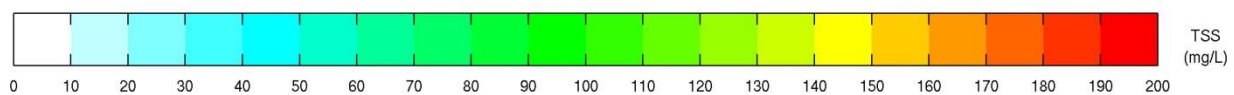
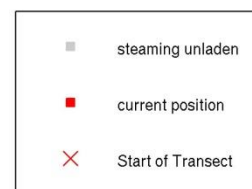
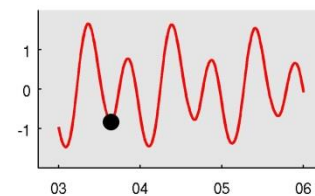
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile



Dredge Plume in Plan

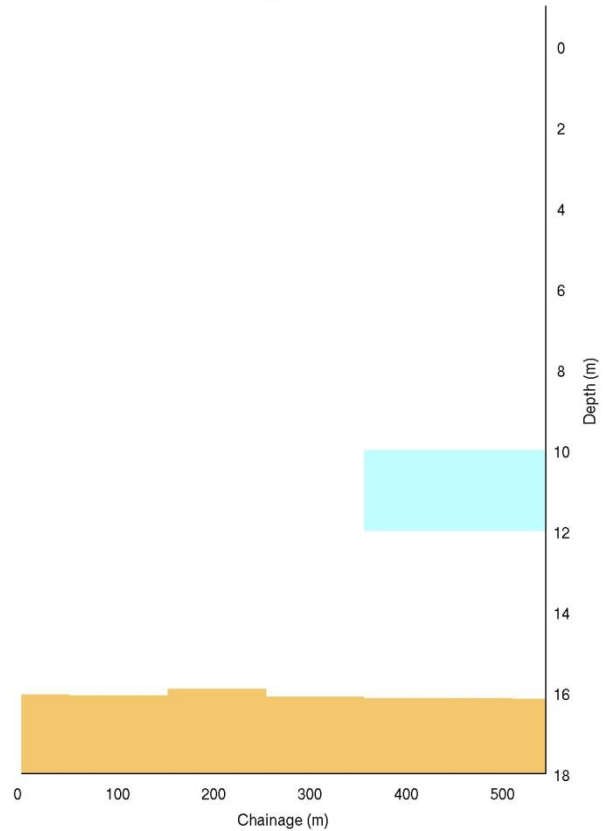


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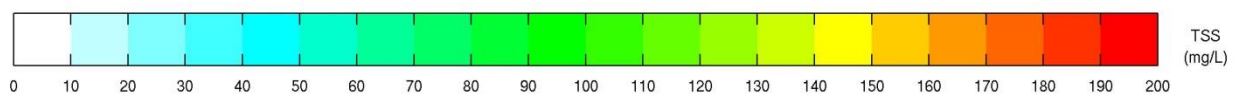
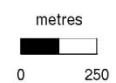
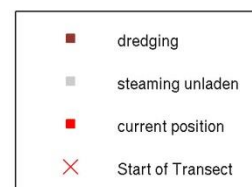
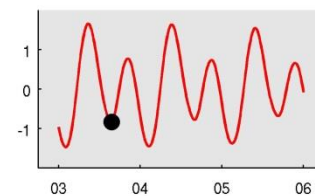
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile



Dredge Plume in Plan

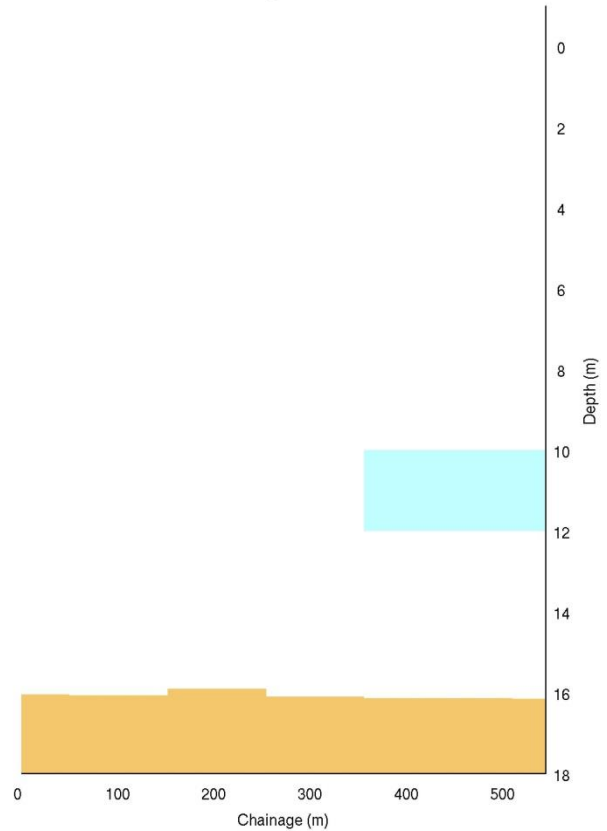


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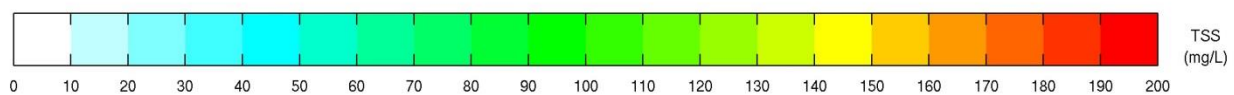
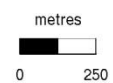
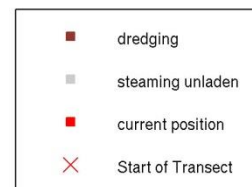
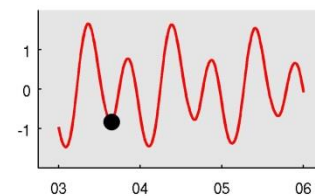
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile



Dredge Plume in Plan

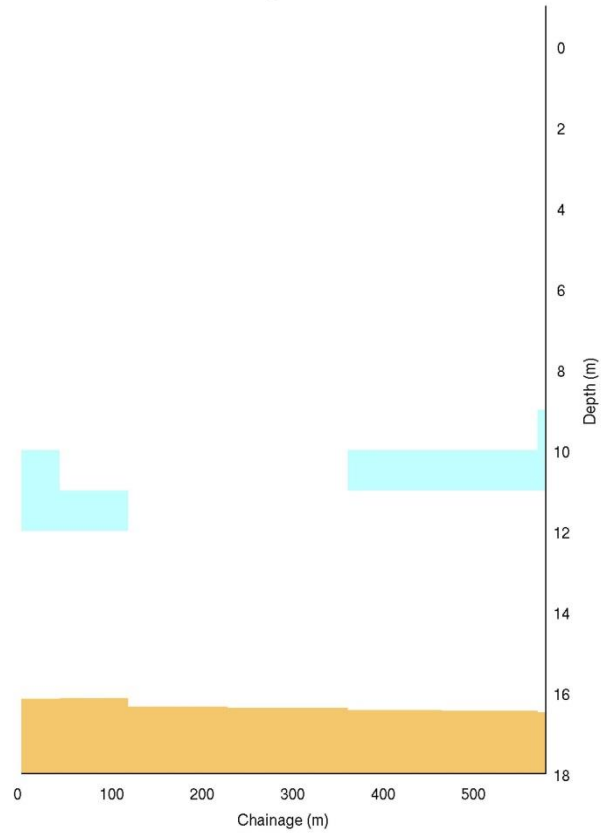


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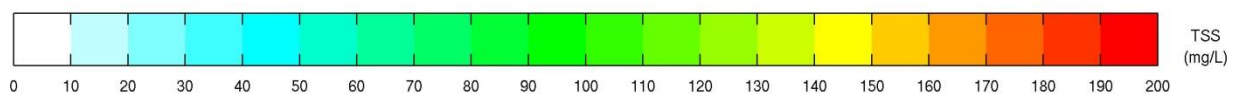
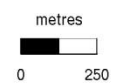
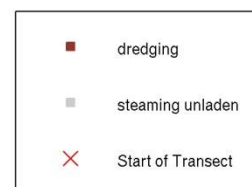
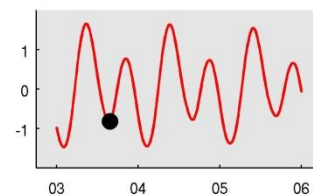
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile

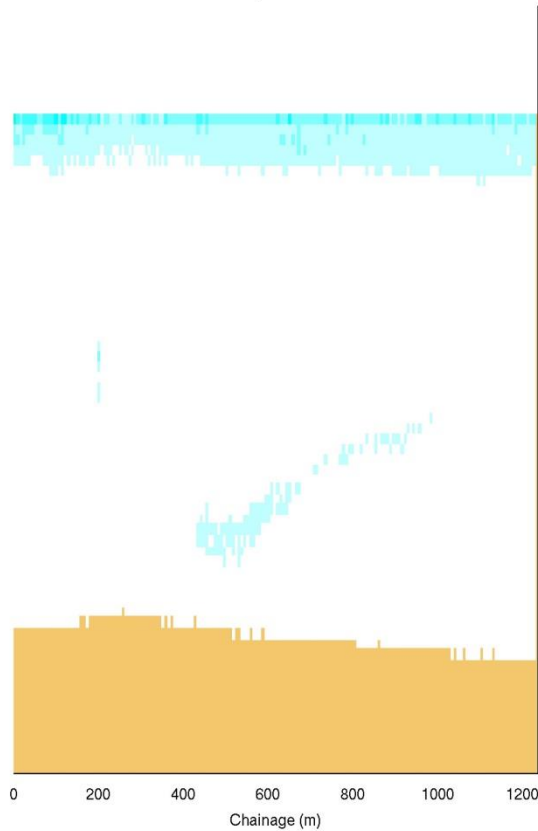


Dredge Plume in Plan

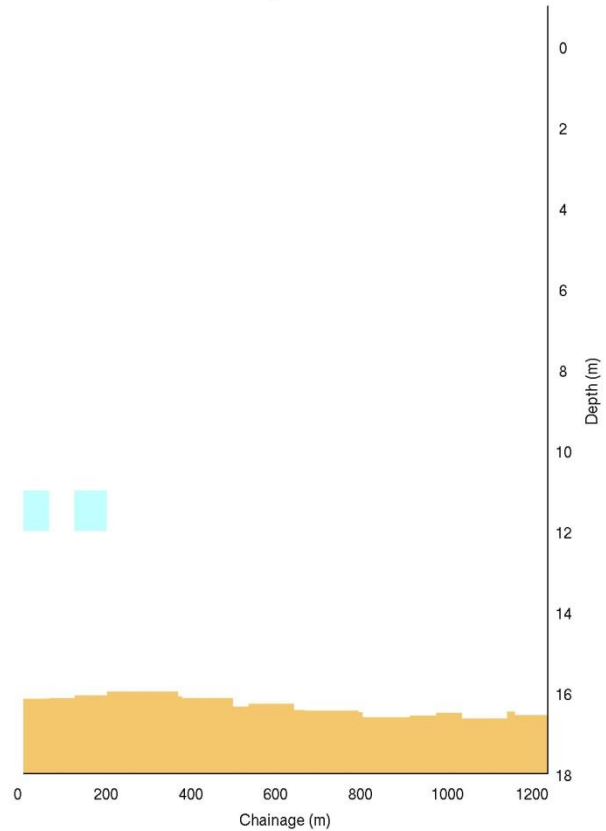


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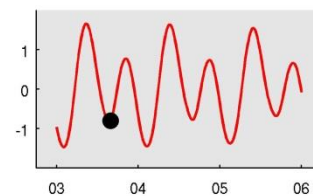
ADCP Dredge Plume in Profile



MODEL Dredge Plume in Profile

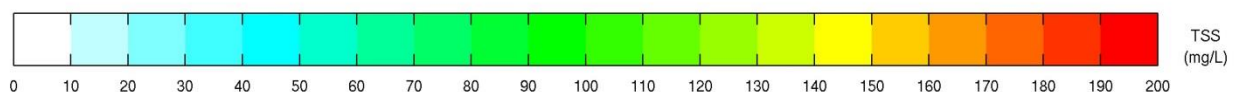


Dredge Plume in Plan

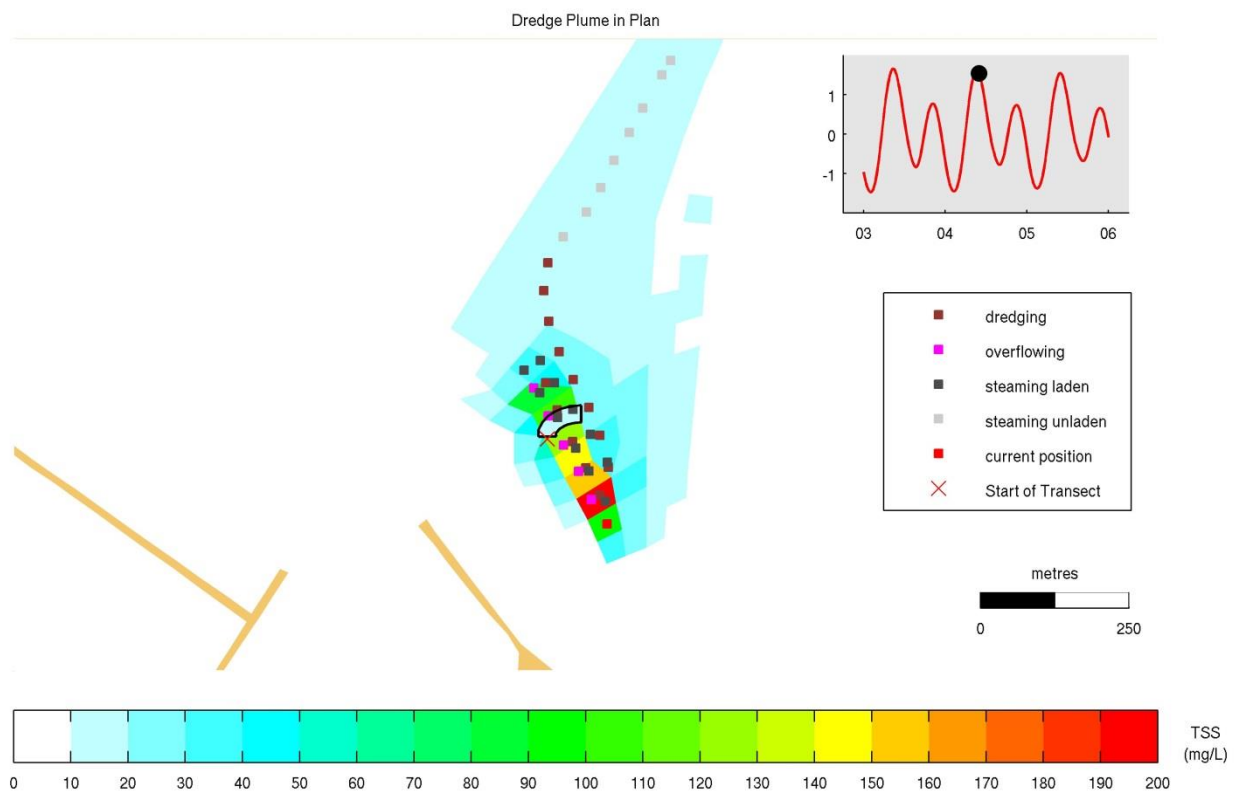
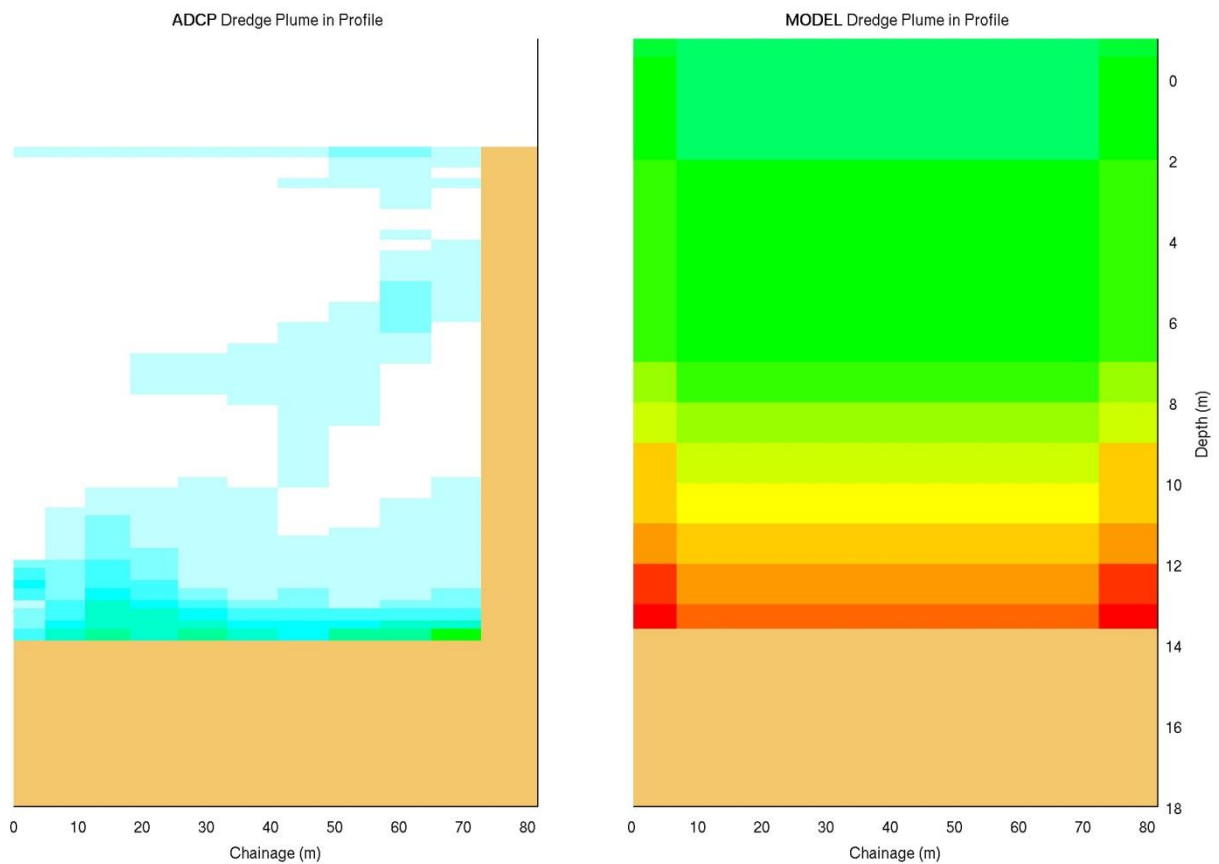


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- steaming laden
- steaming unladen
- current position
- × Start of Transect

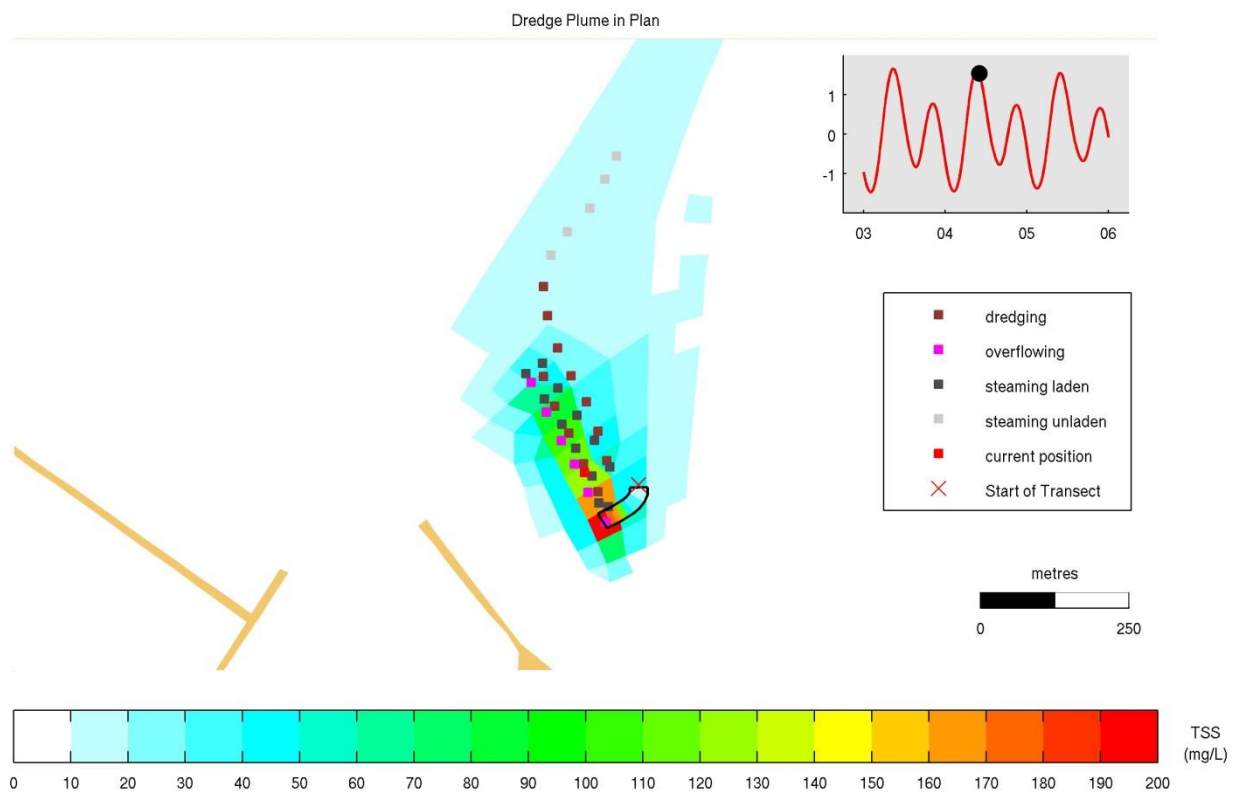
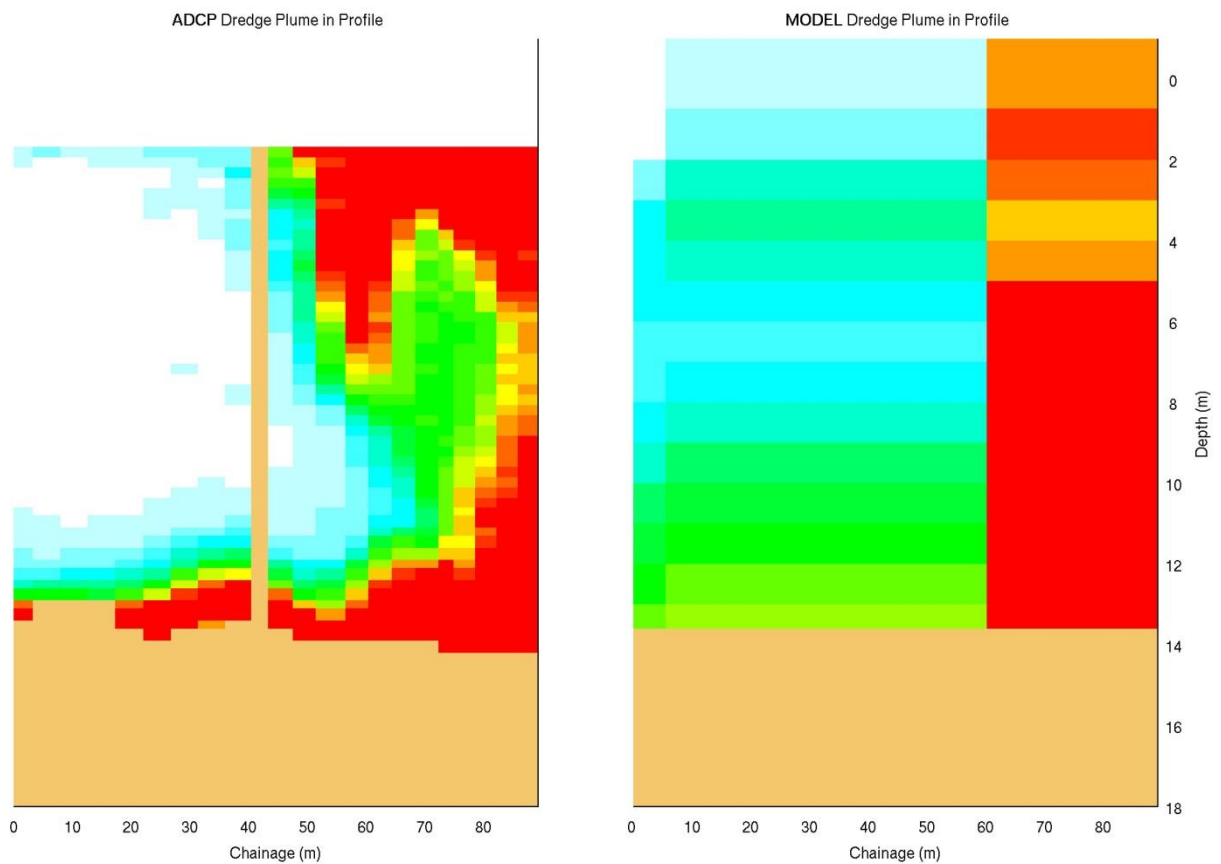
metres
0 250



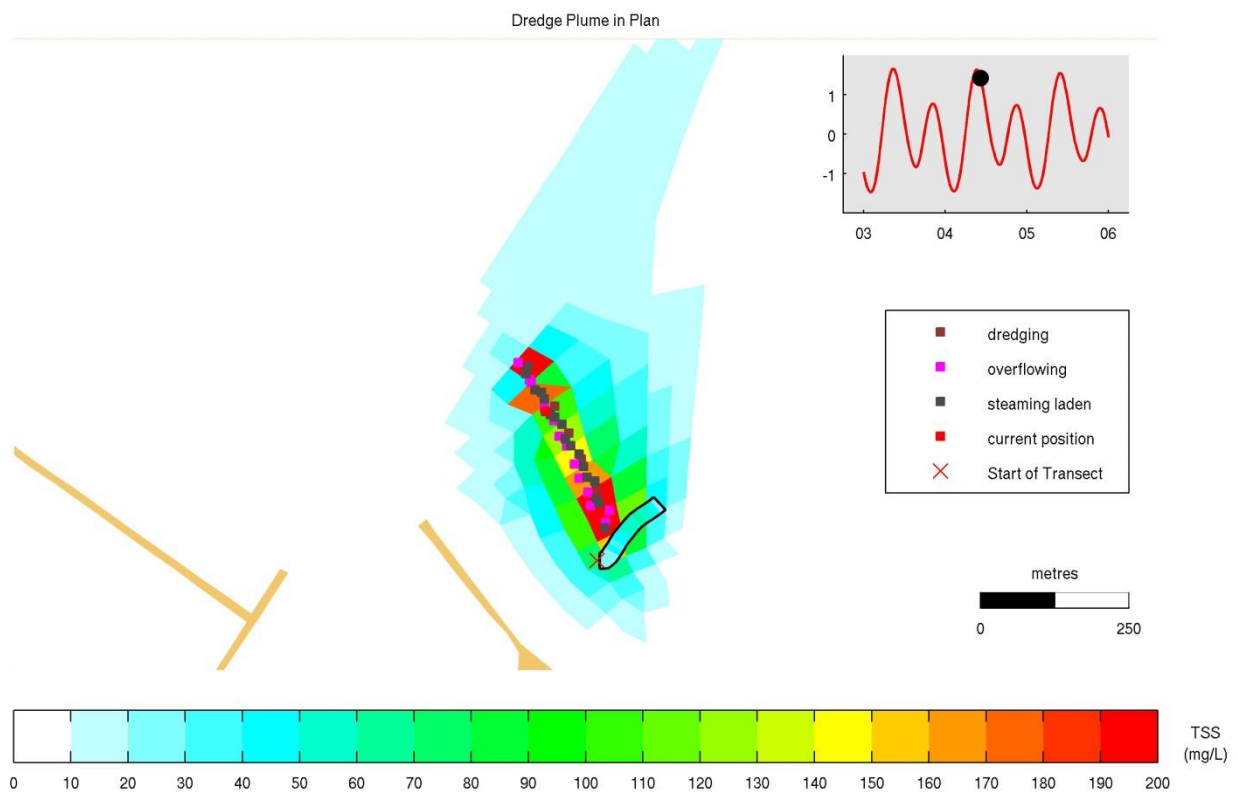
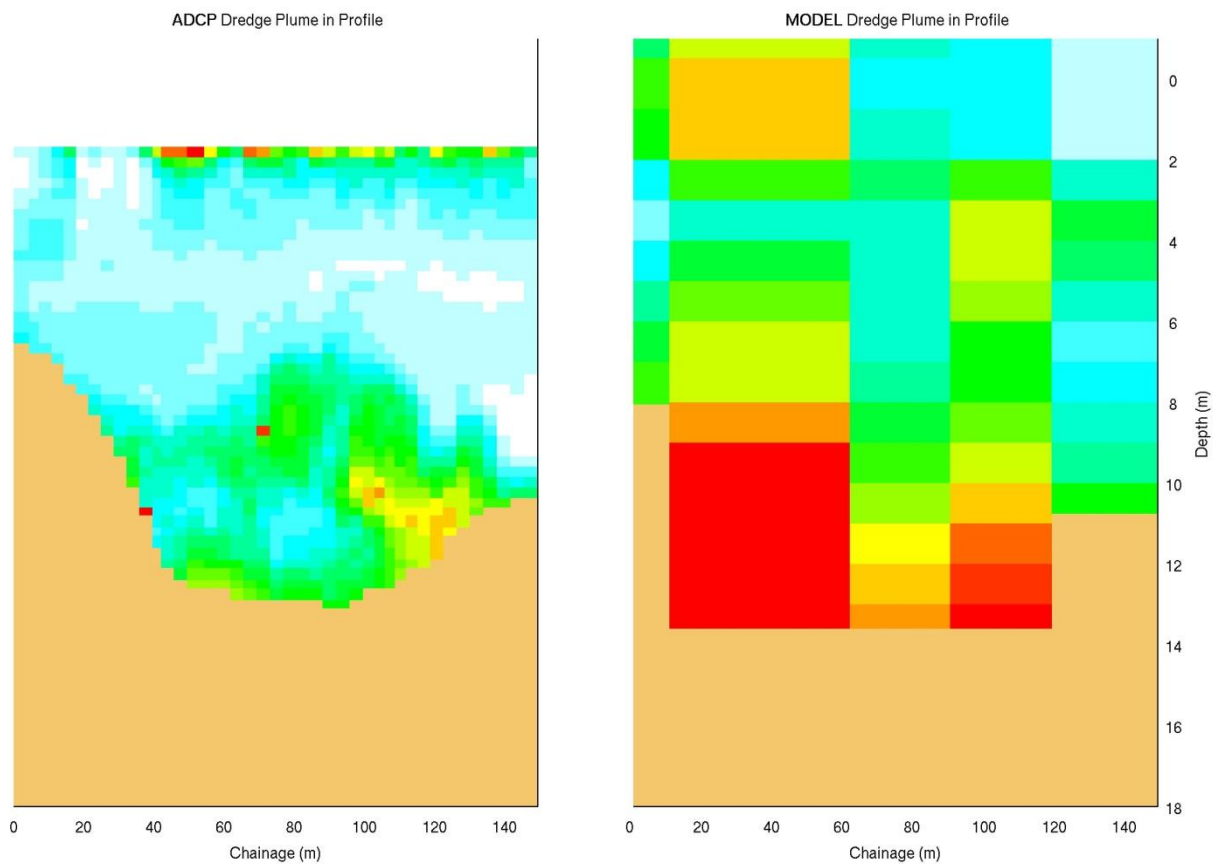
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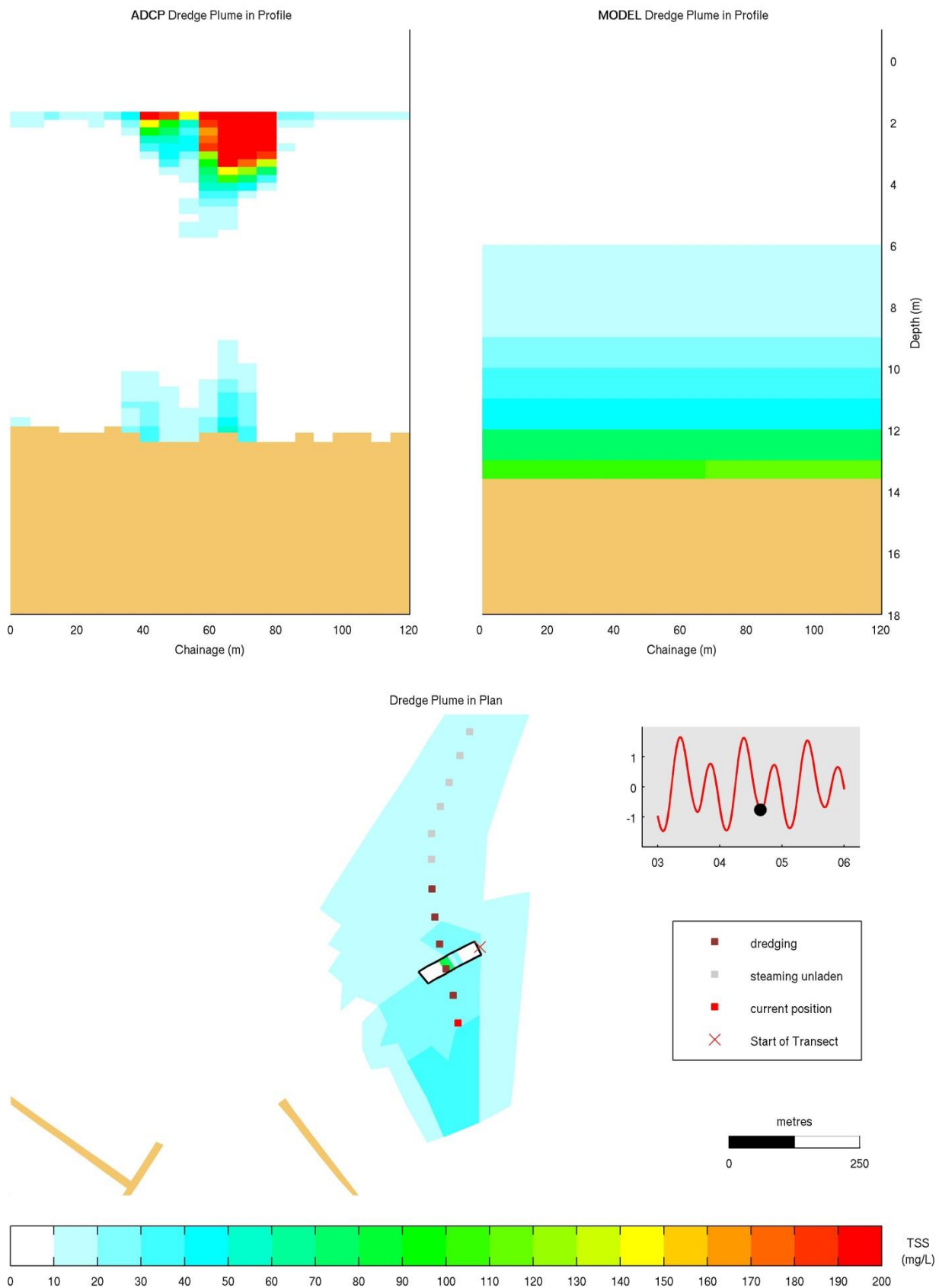
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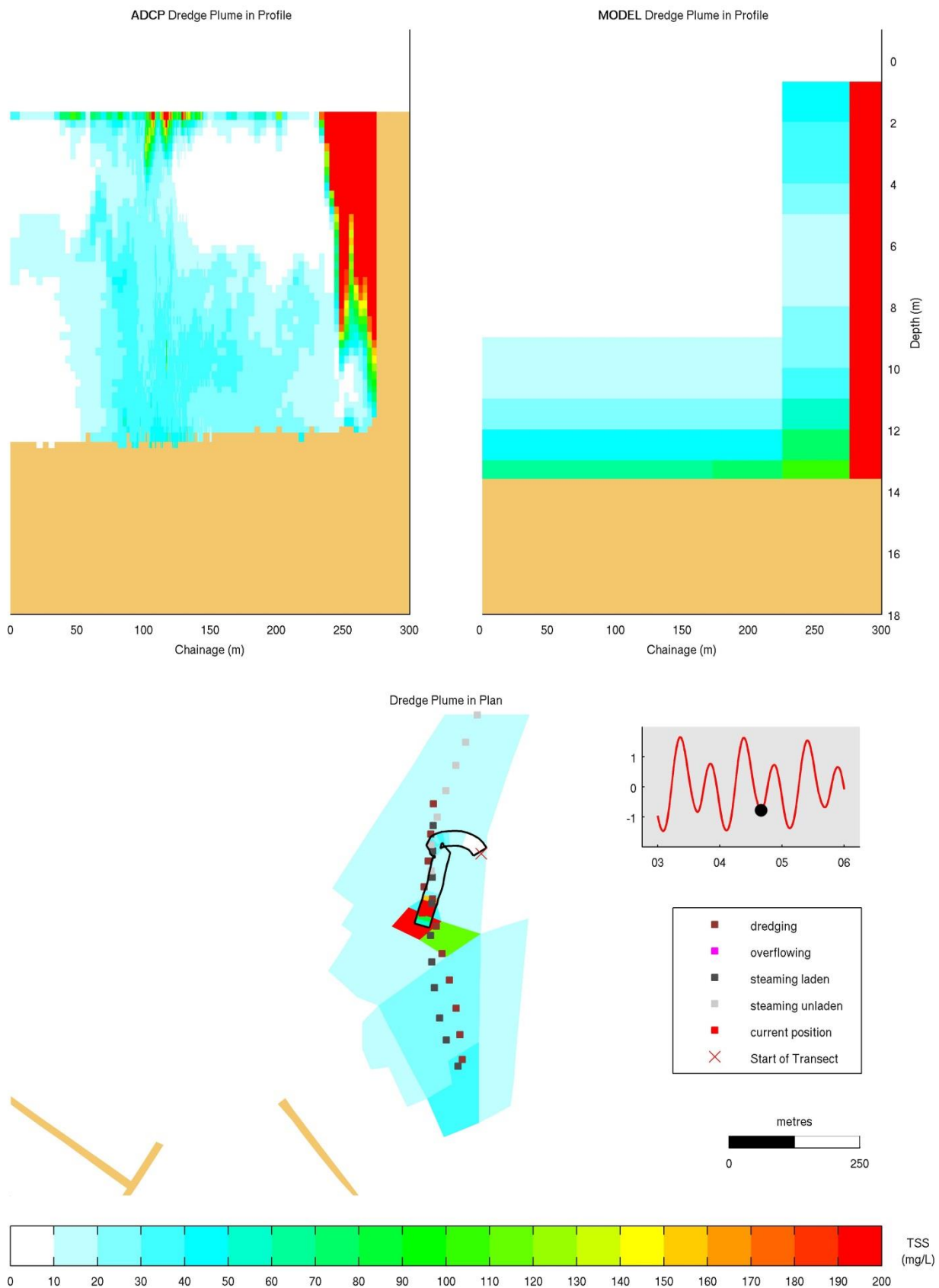
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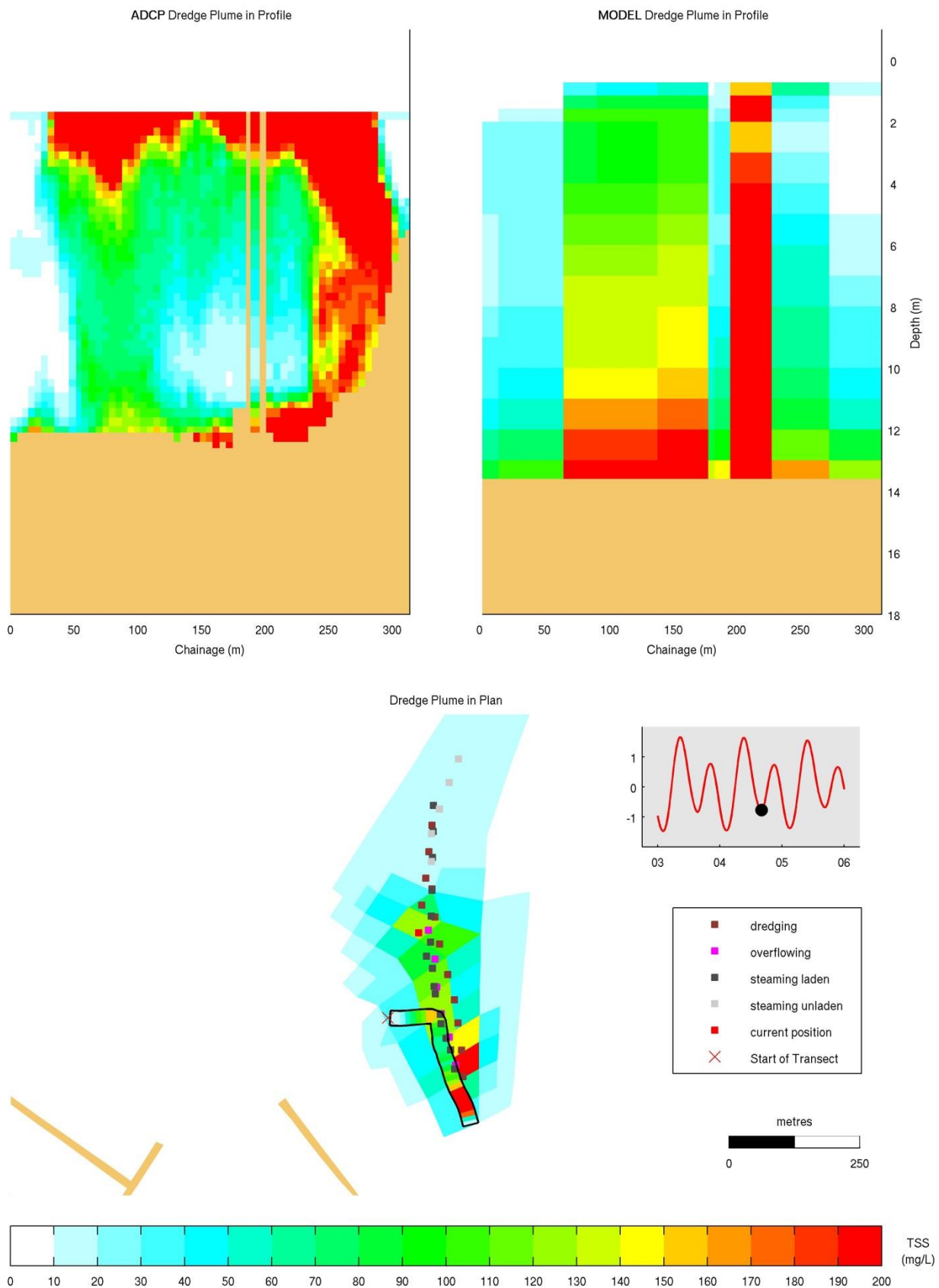
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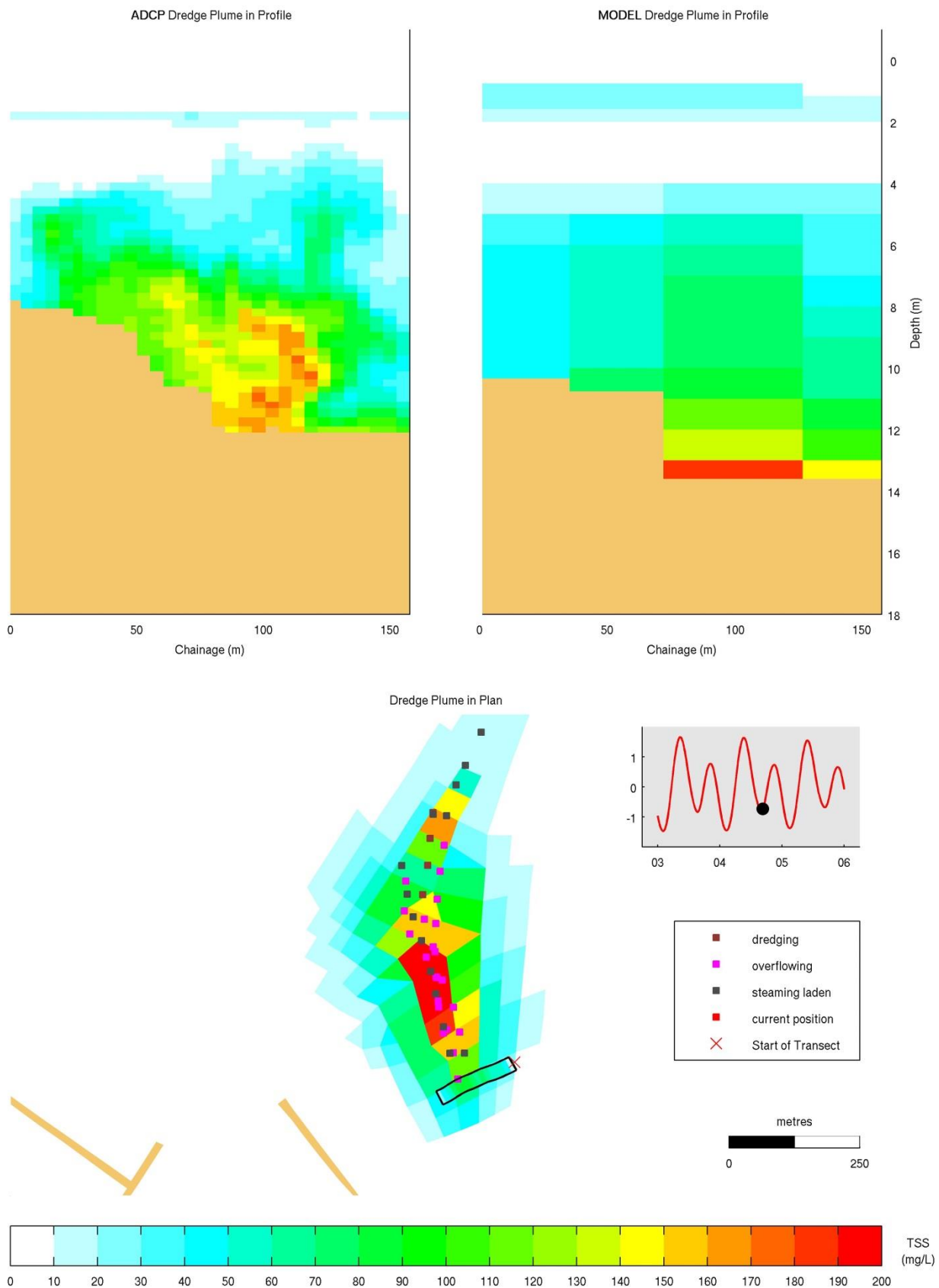
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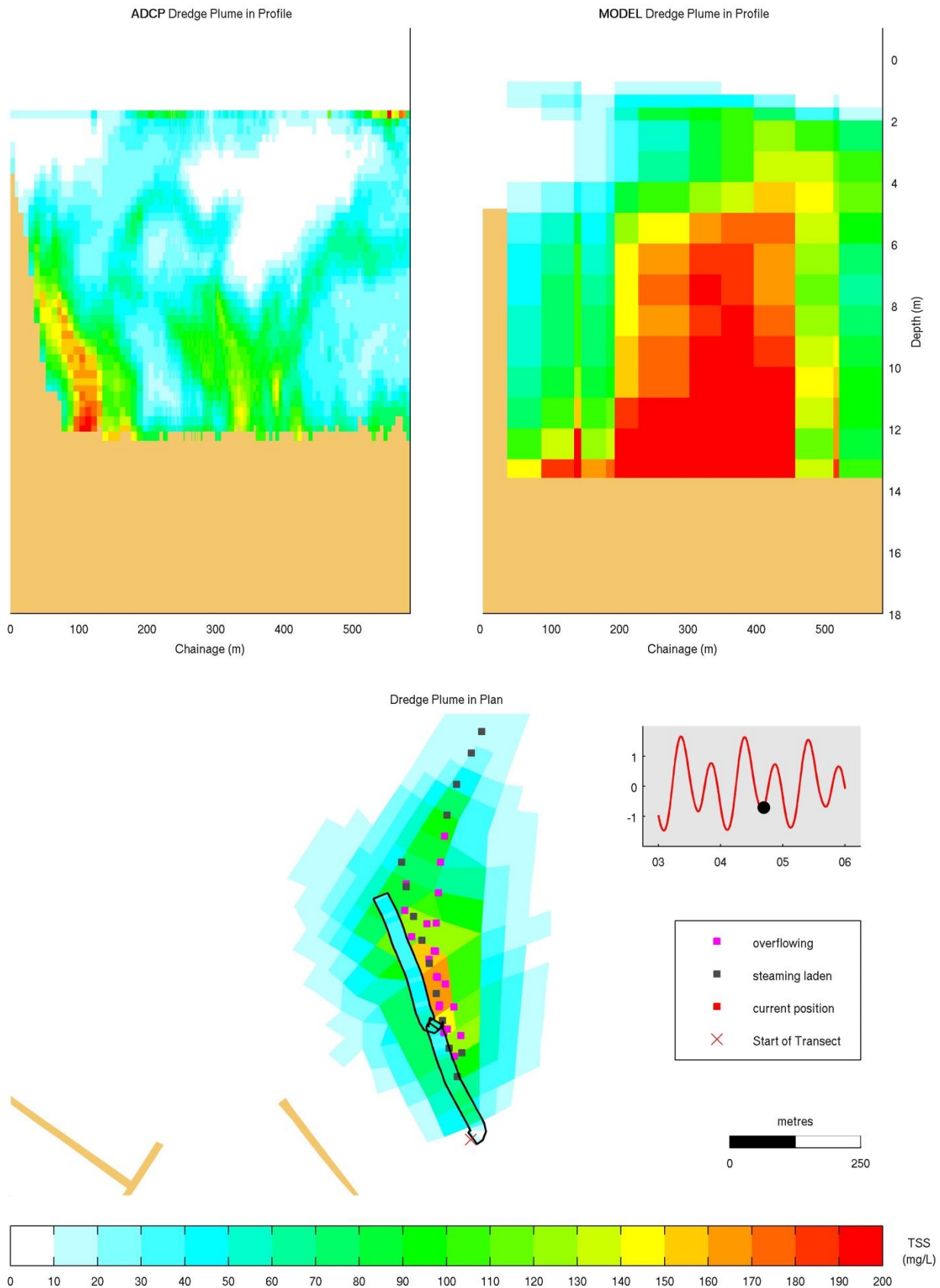
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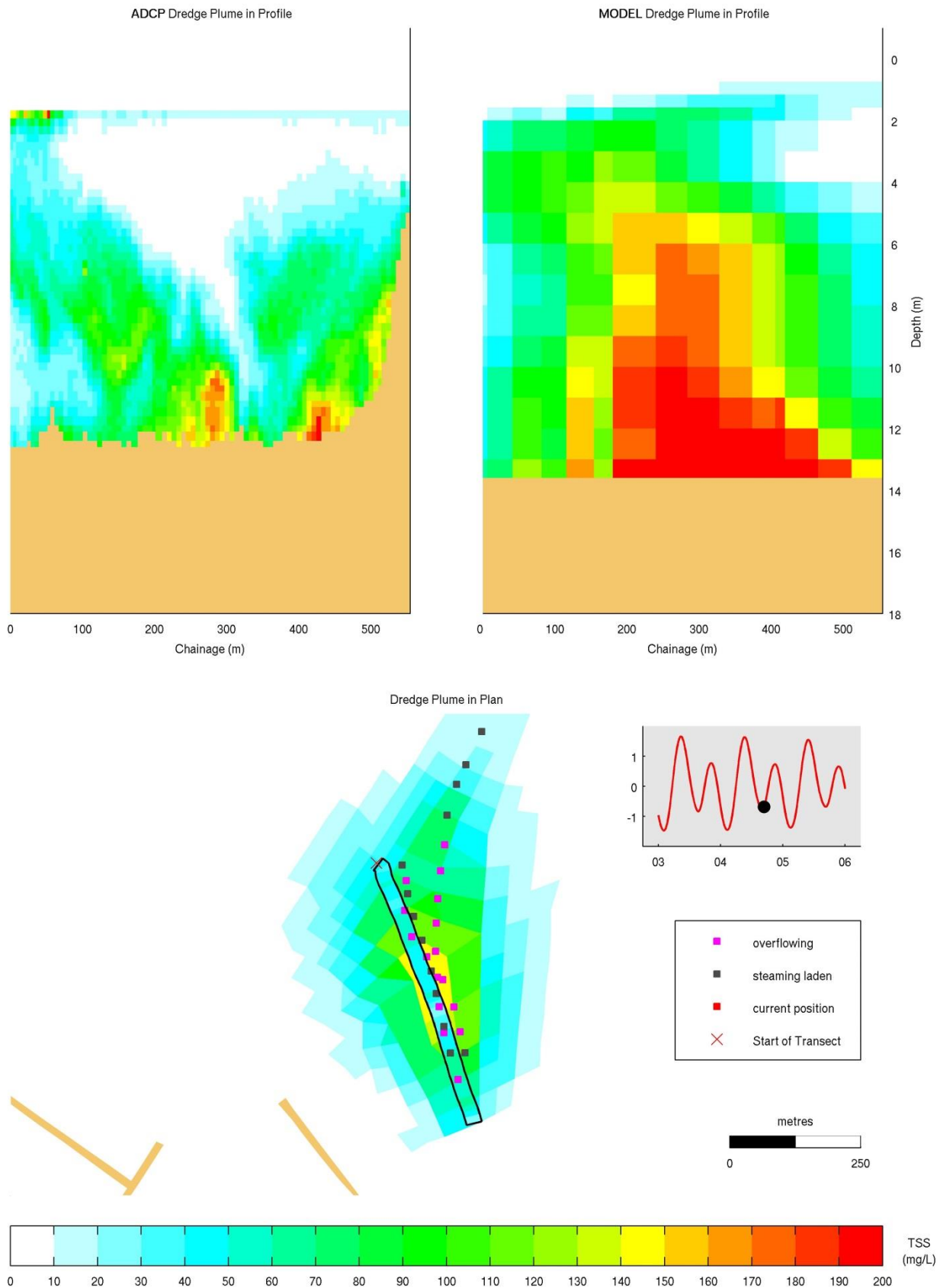
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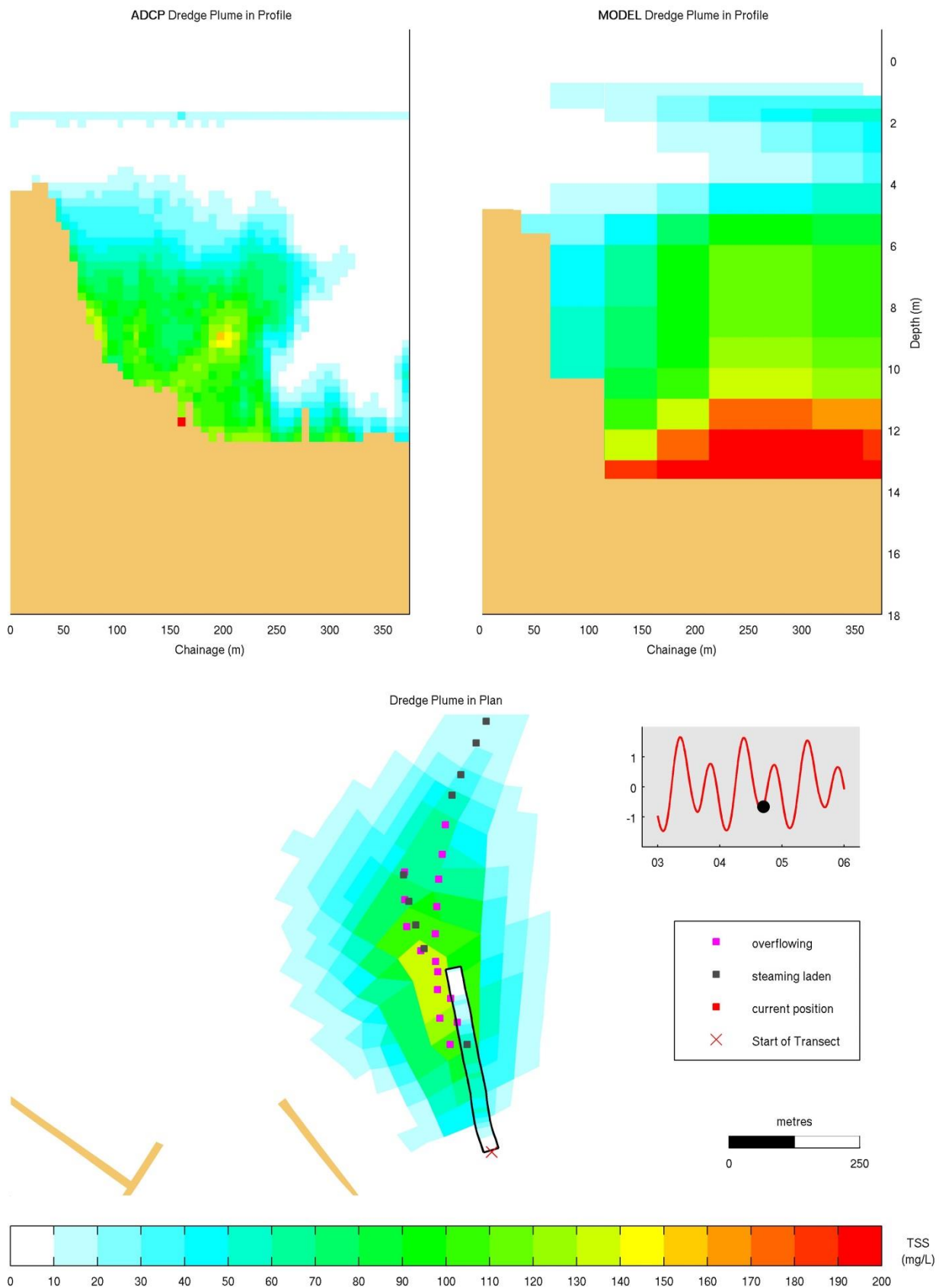
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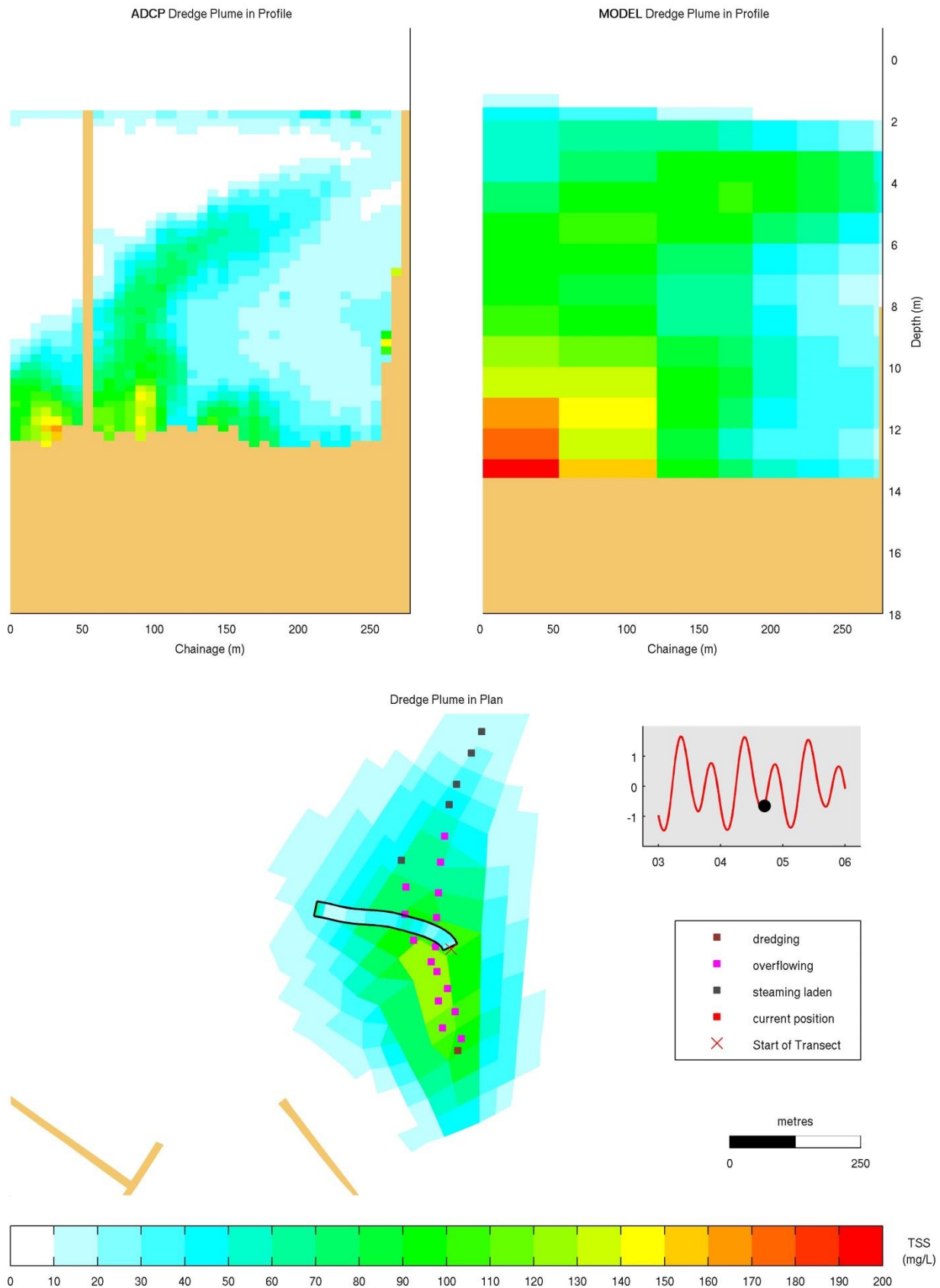
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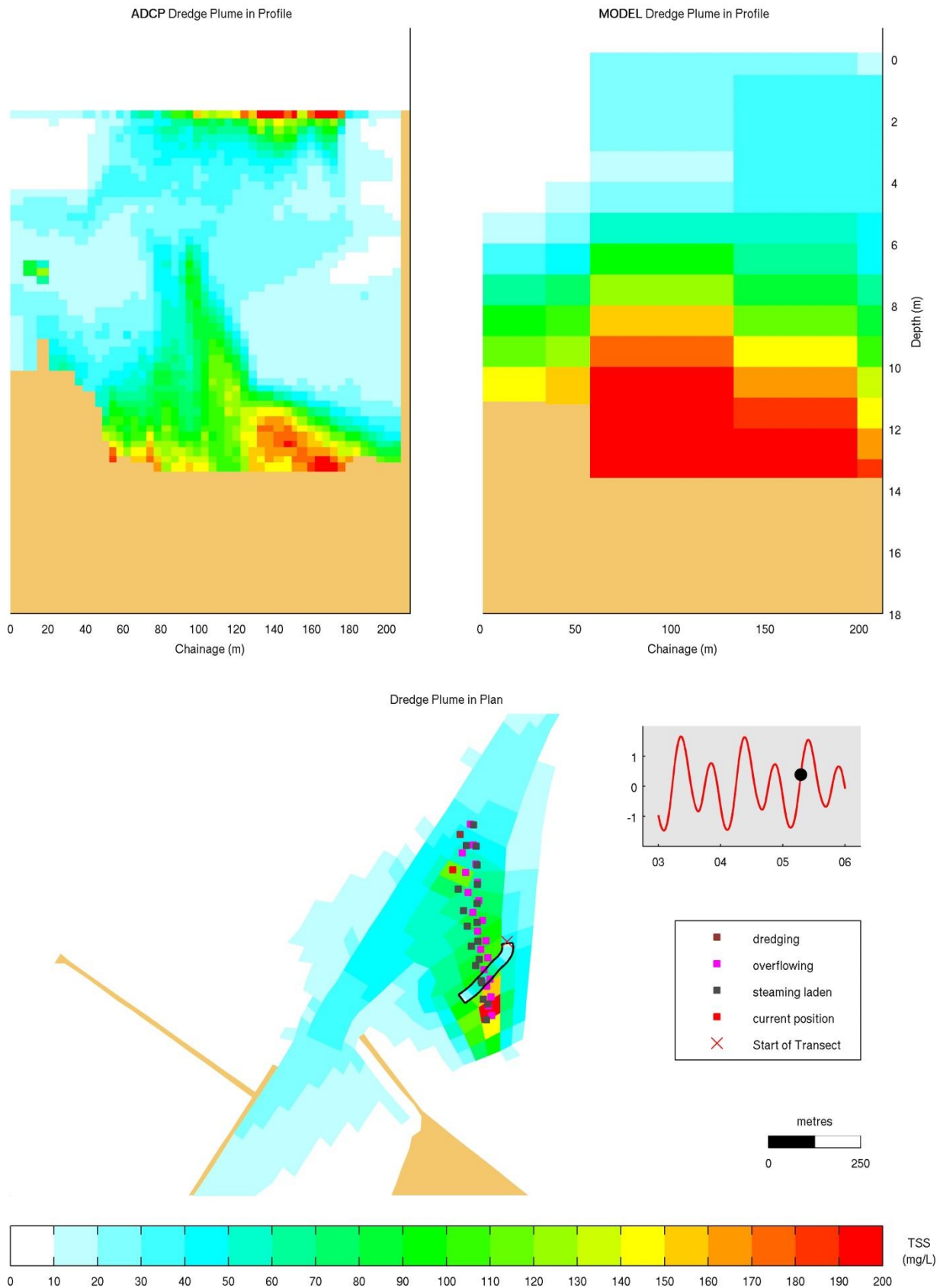
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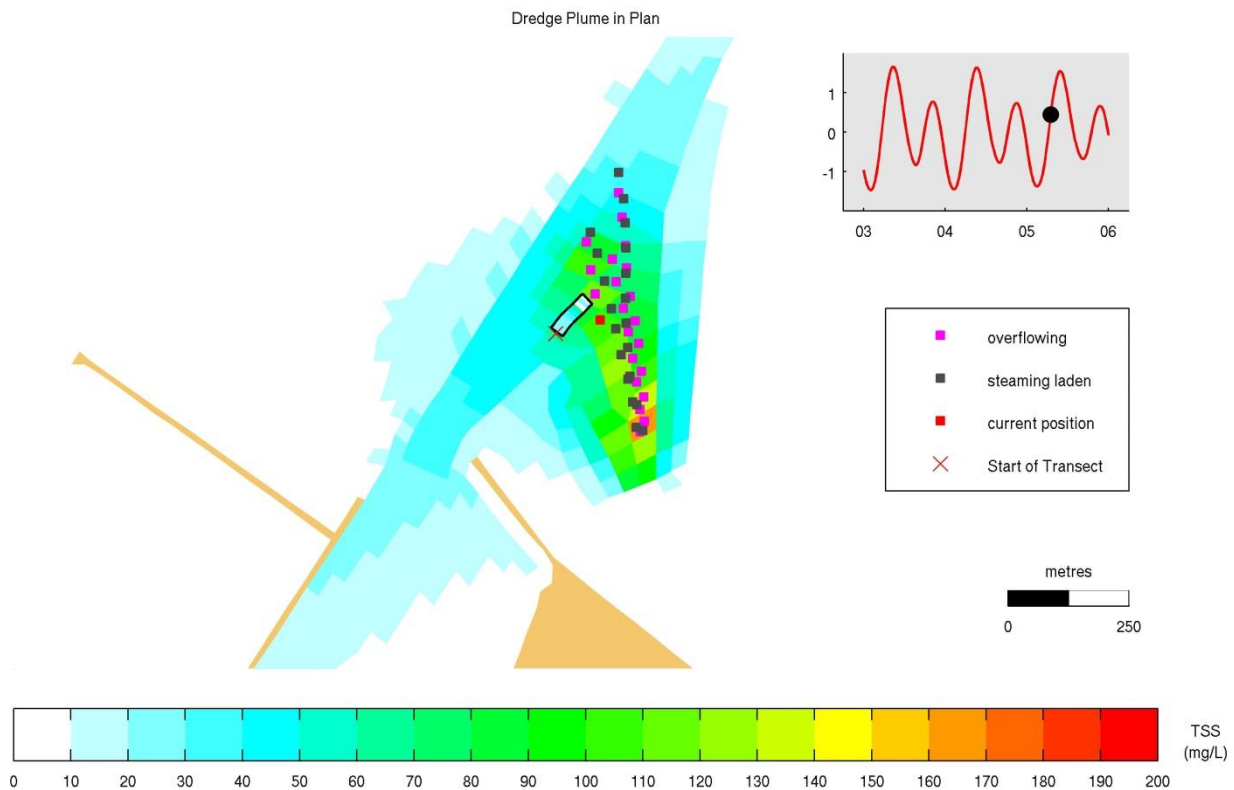
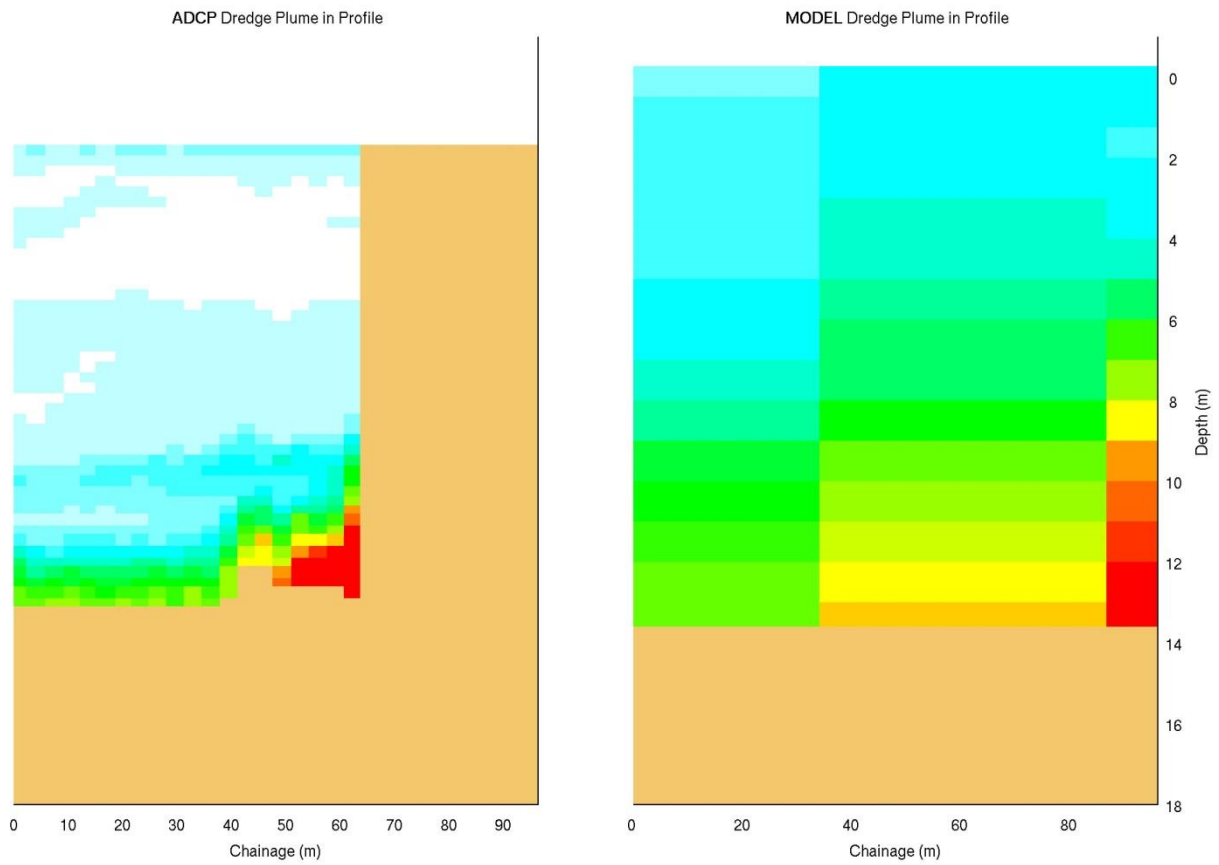
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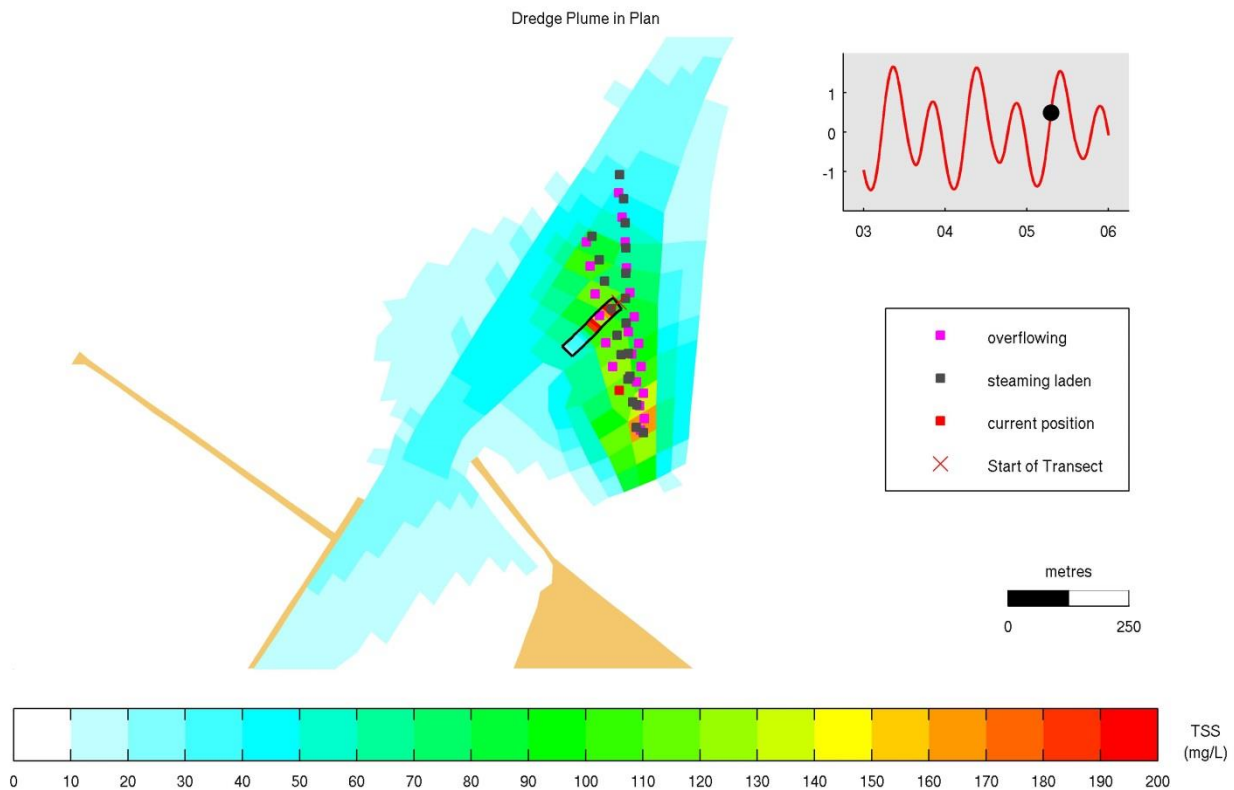
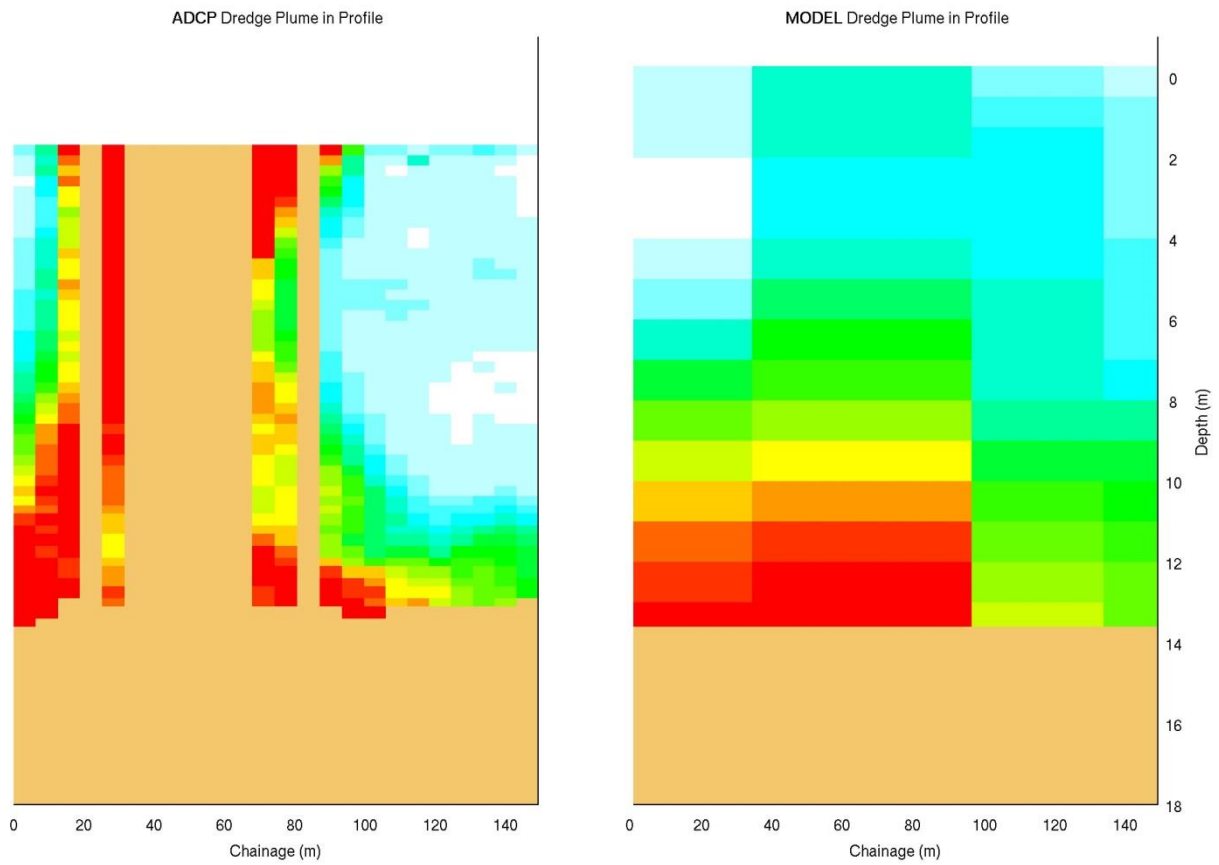
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05-Jan-2011 07:03

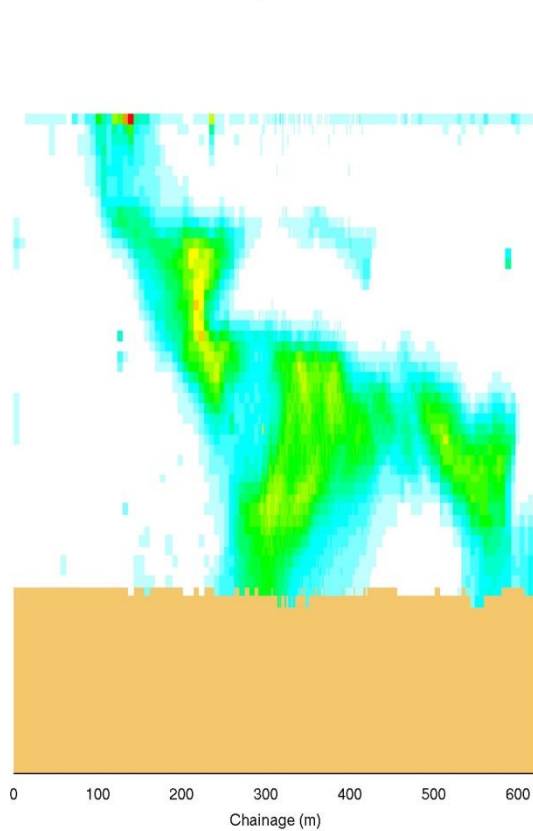


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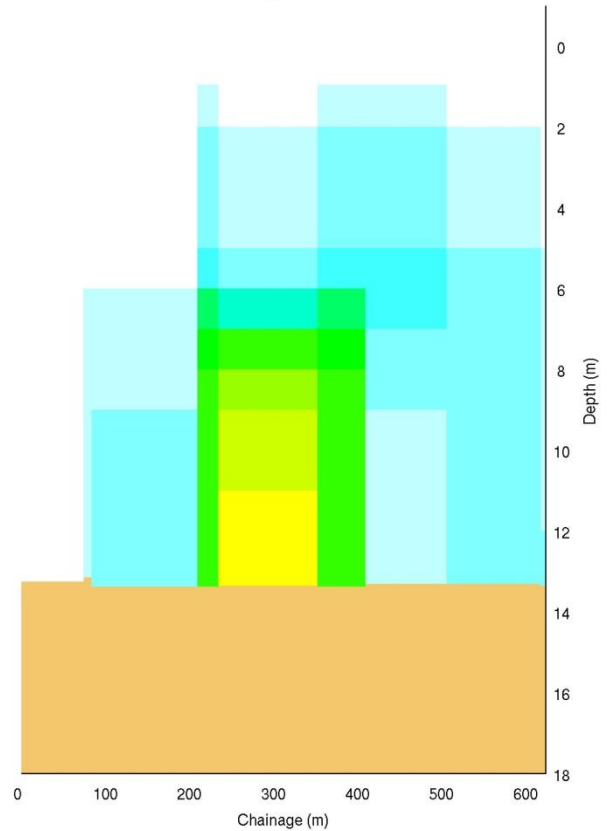


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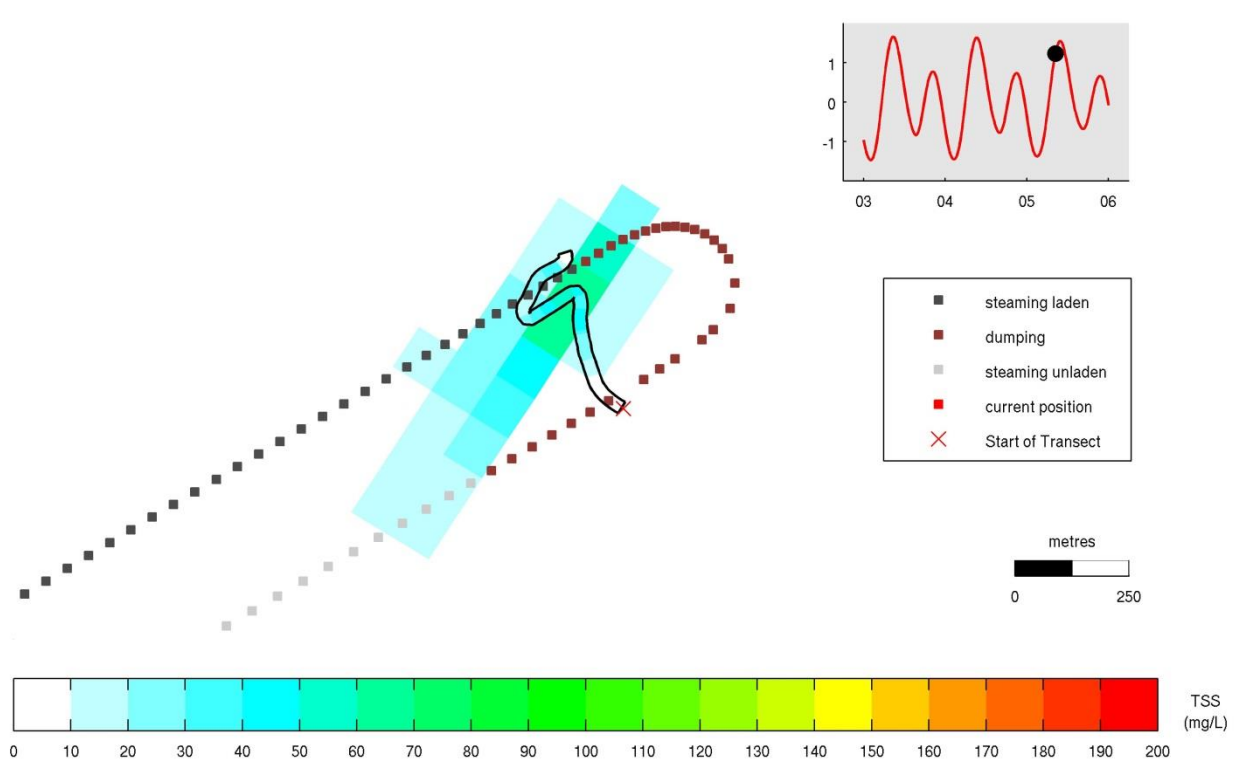
ADCP Dredge Plume in Profile



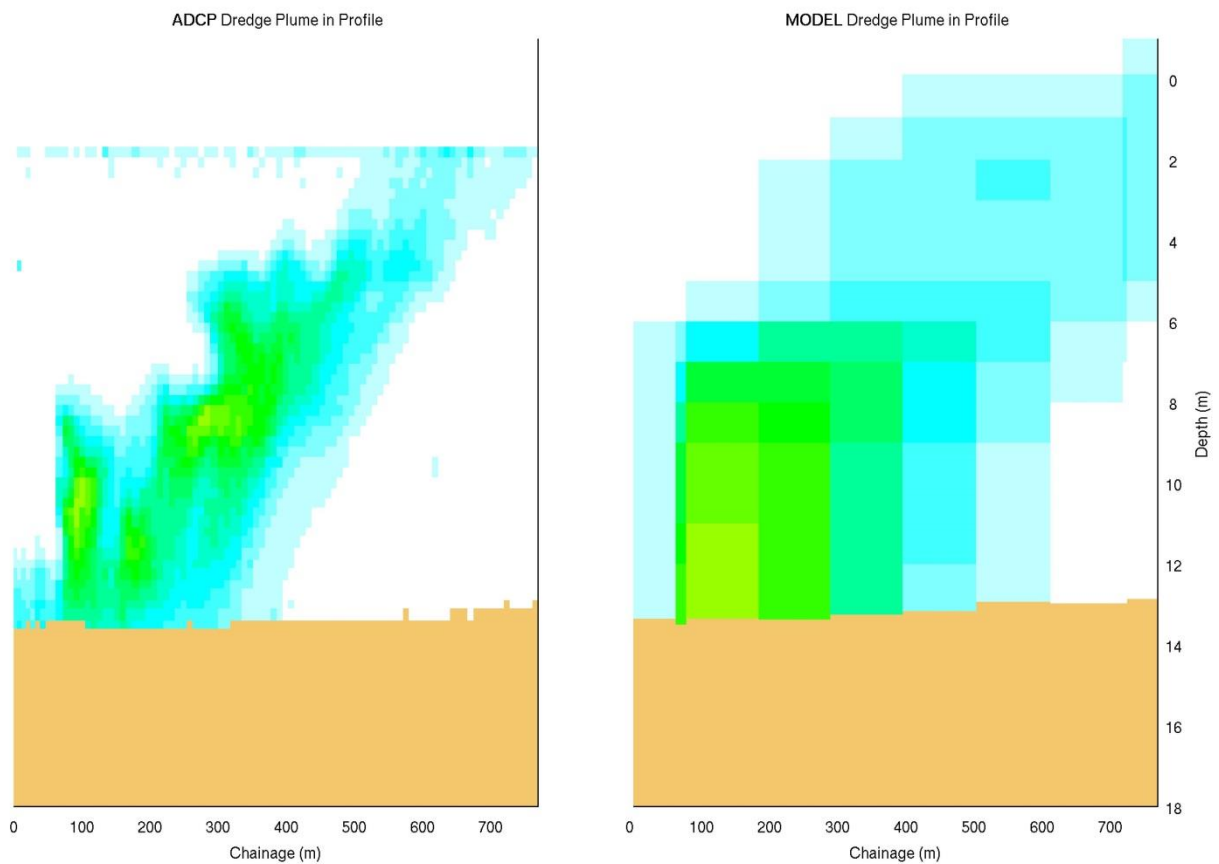
MODEL Dredge Plume in Profile



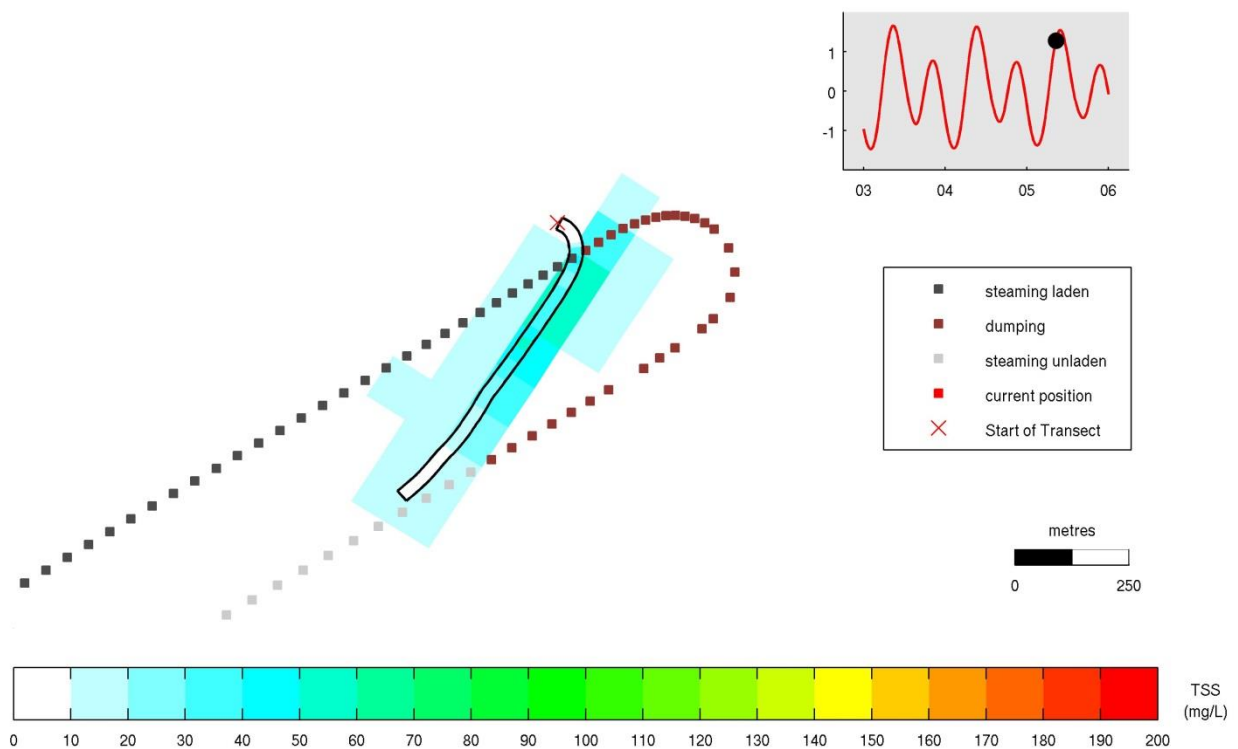
Dredge Plume in Plan



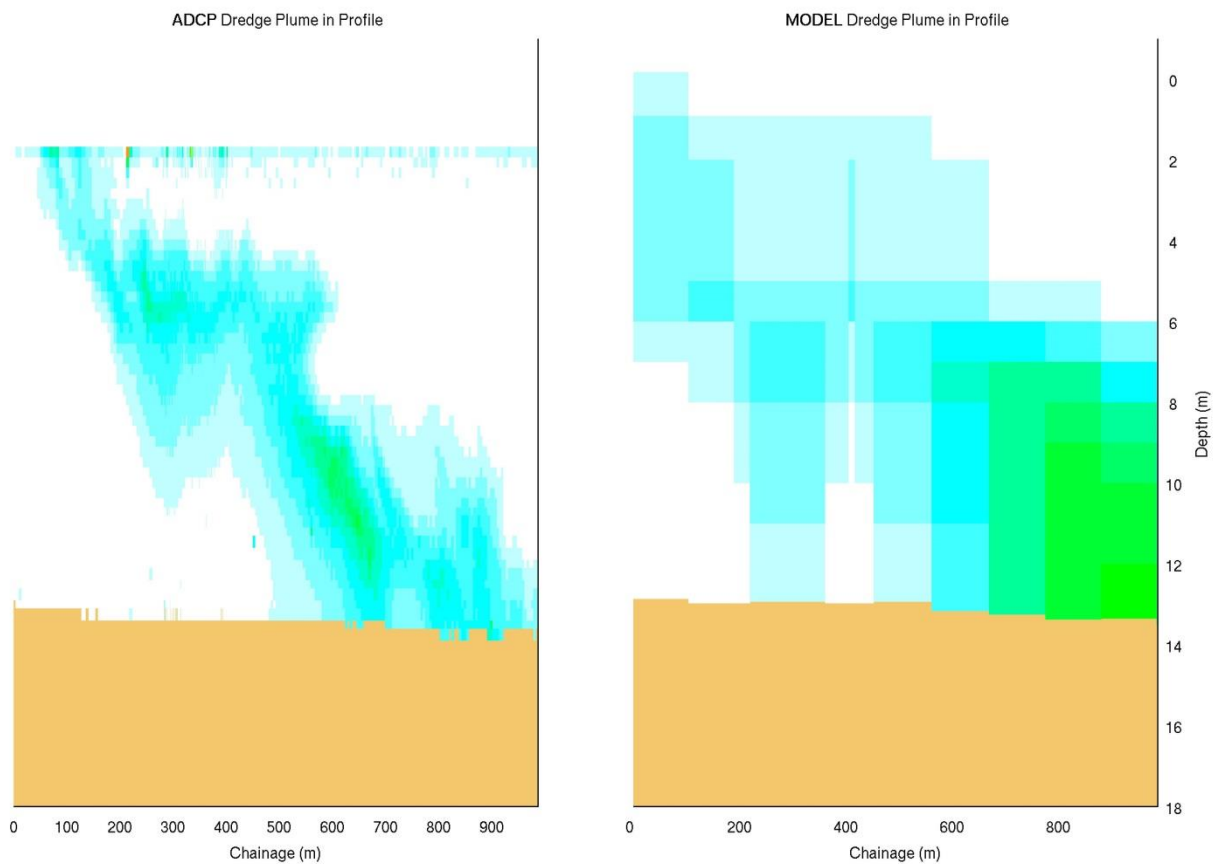
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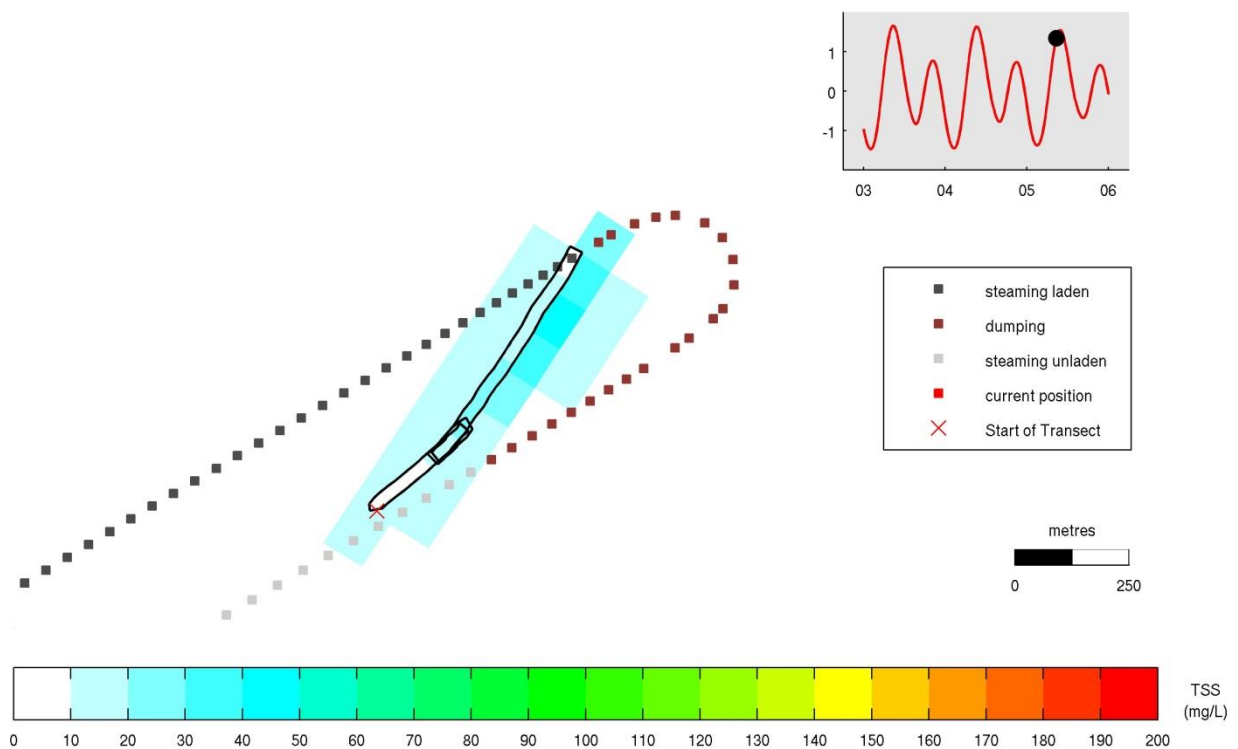
Dredge Plume in Plan



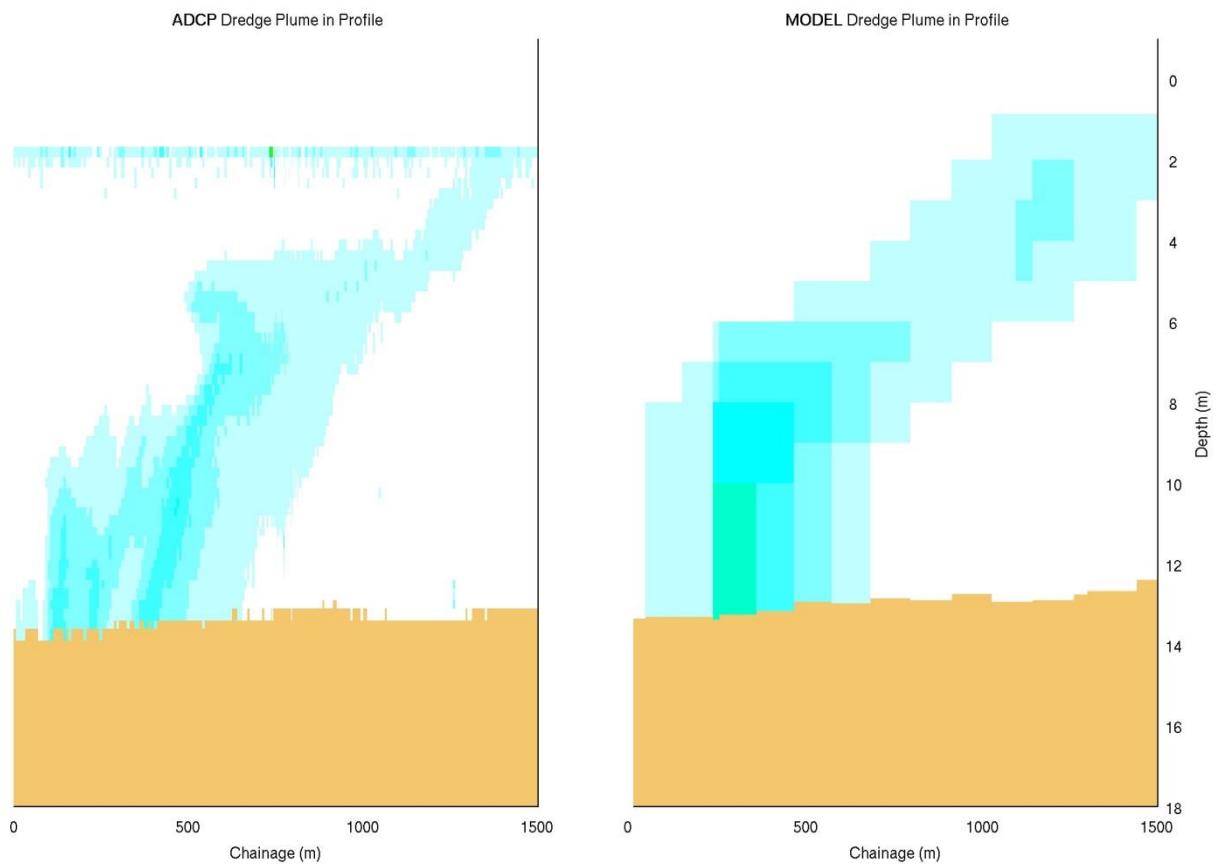
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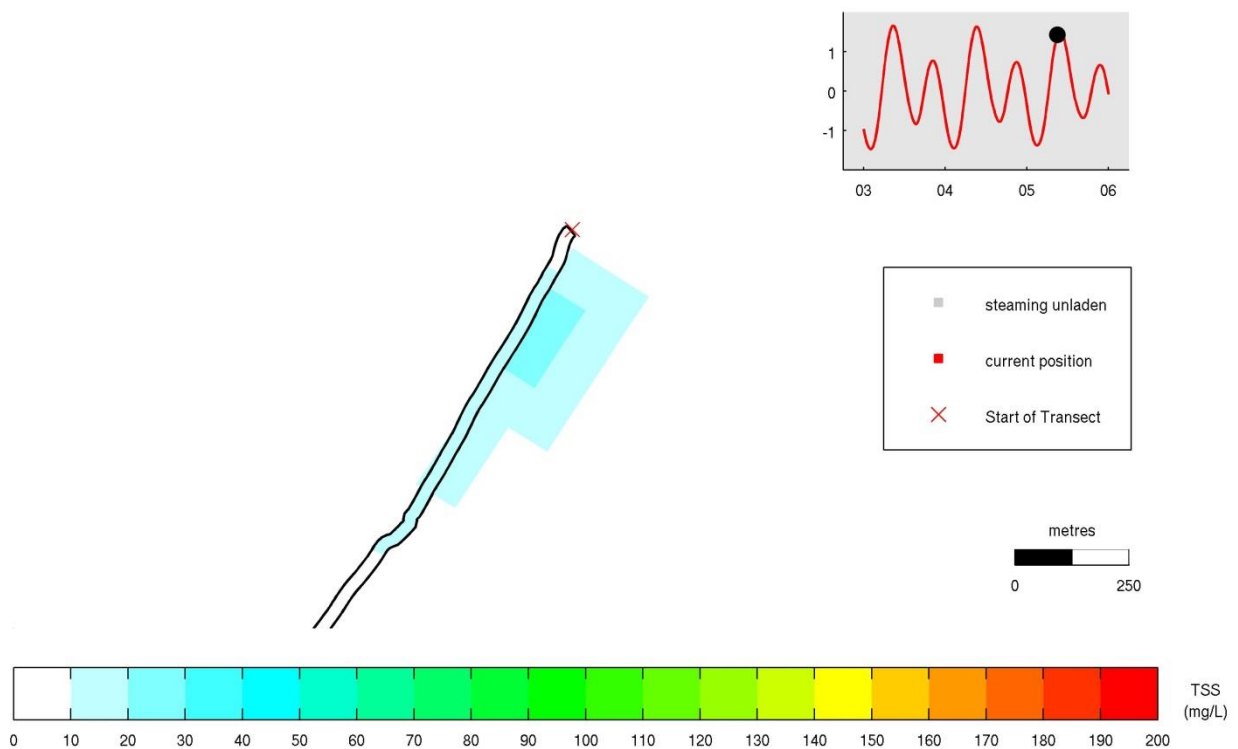
Dredge Plume in Plan



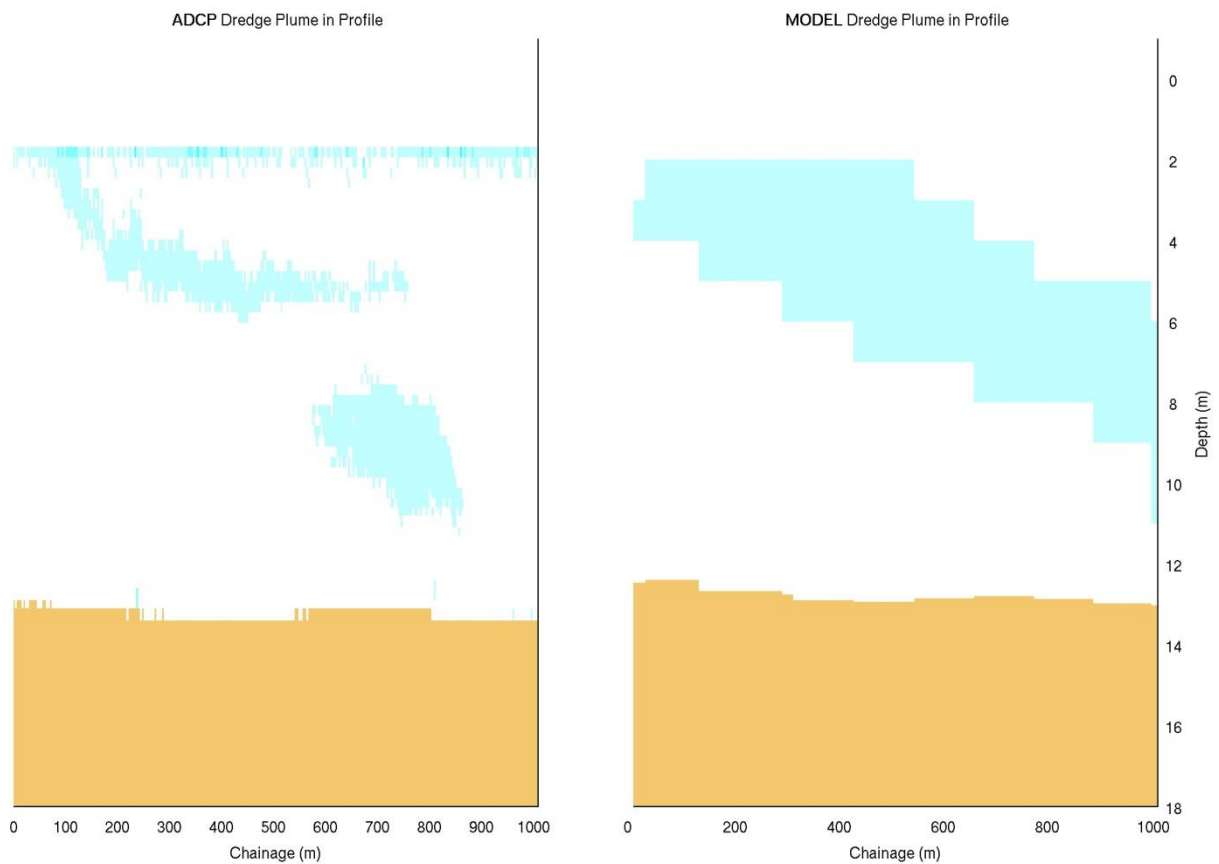
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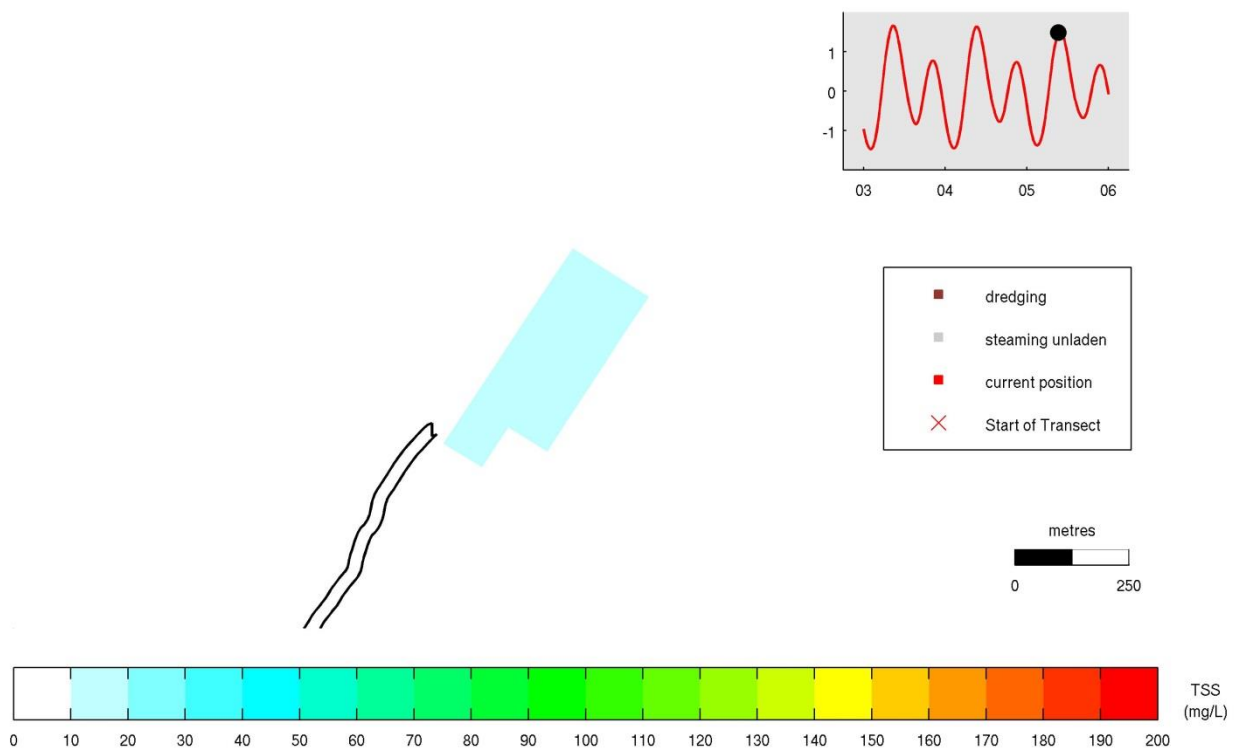
Dredge Plume in Plan



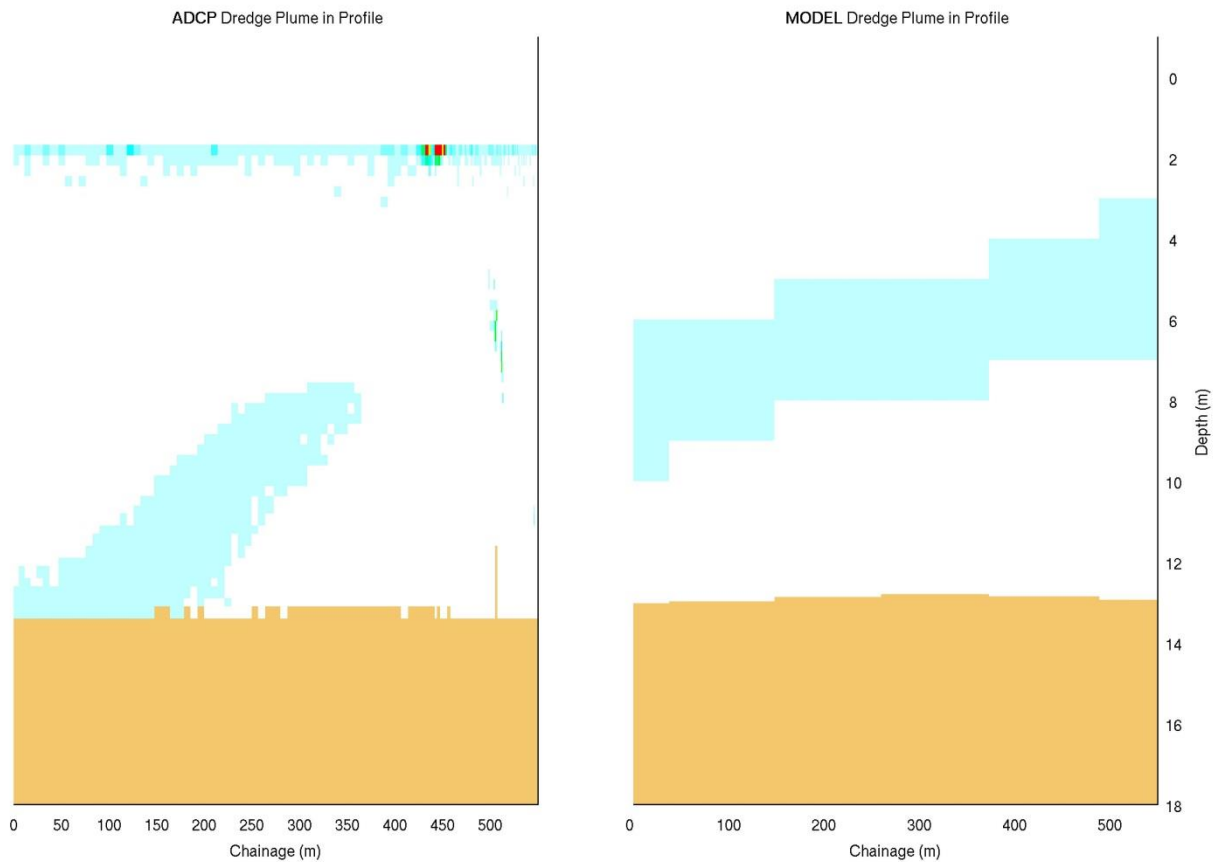
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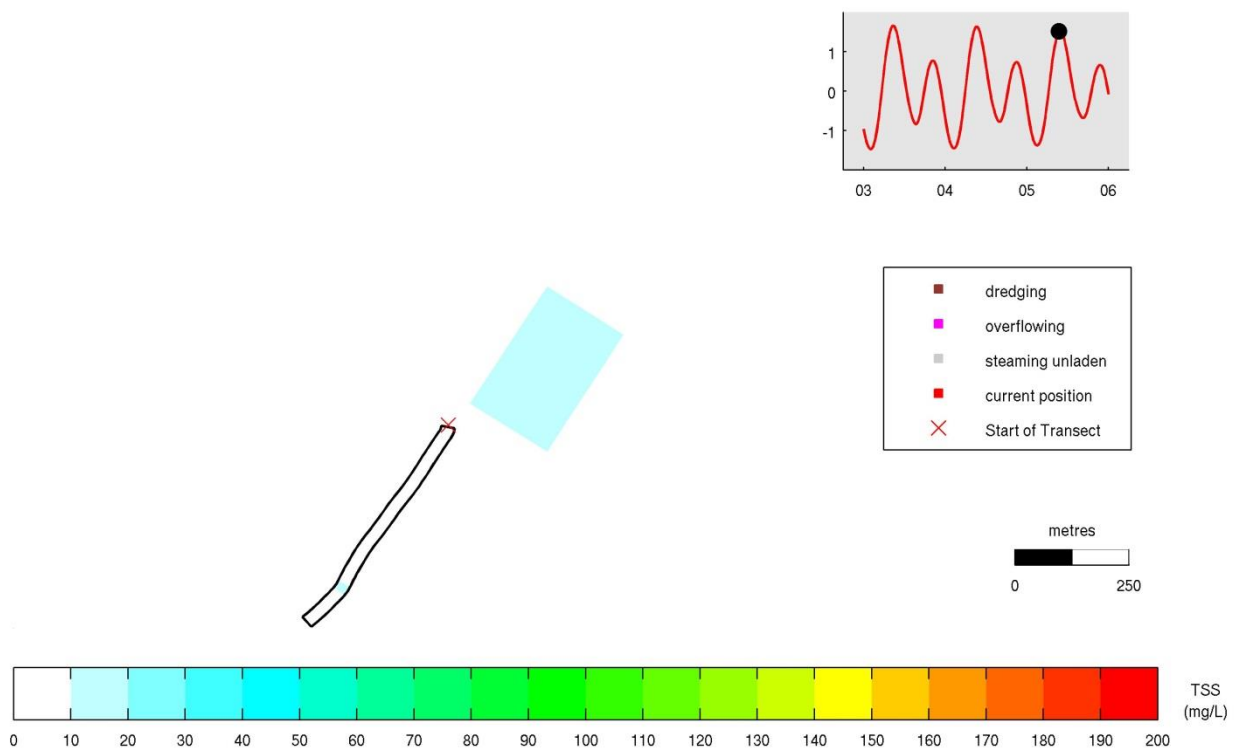
Dredge Plume in Plan



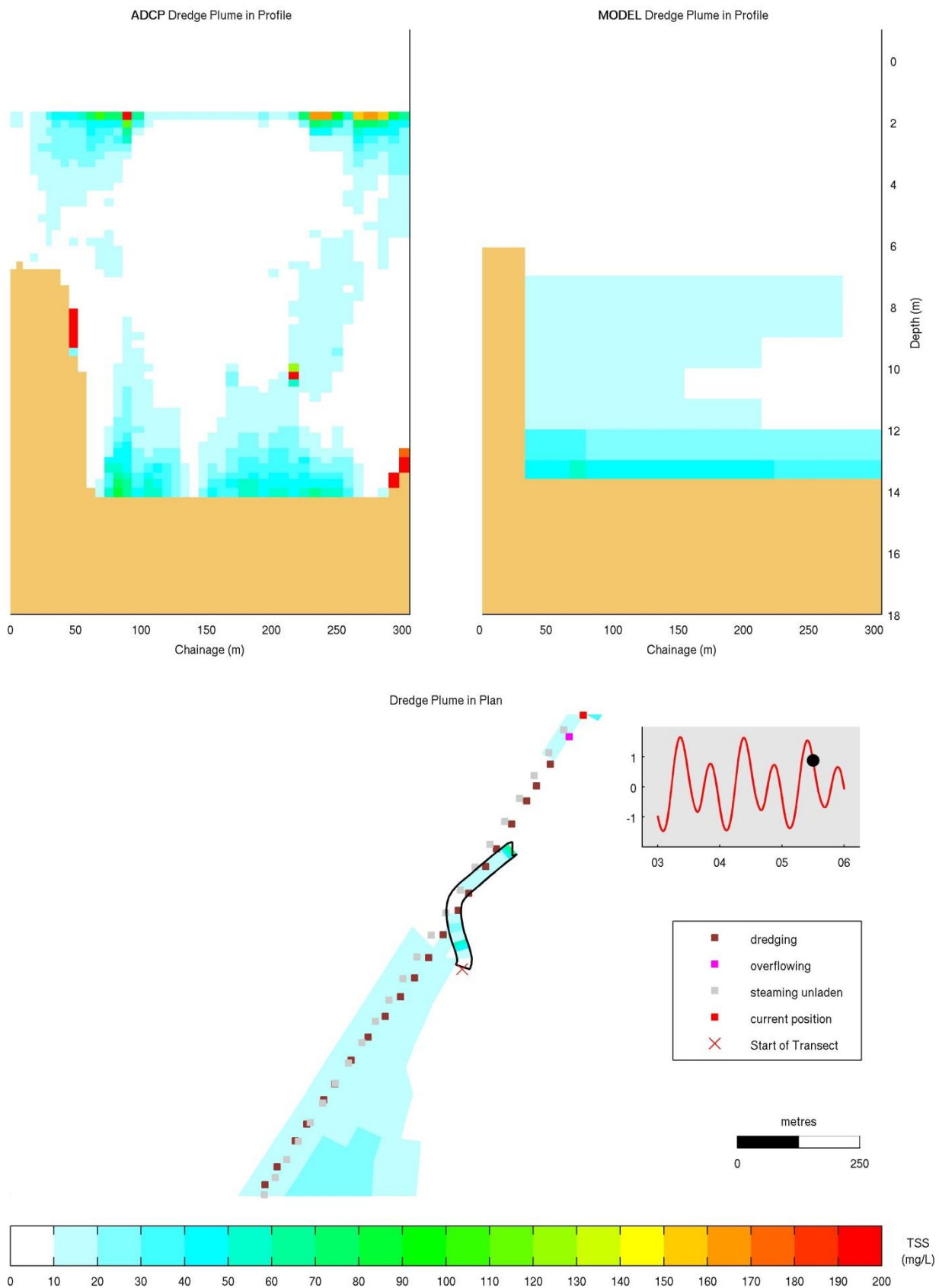
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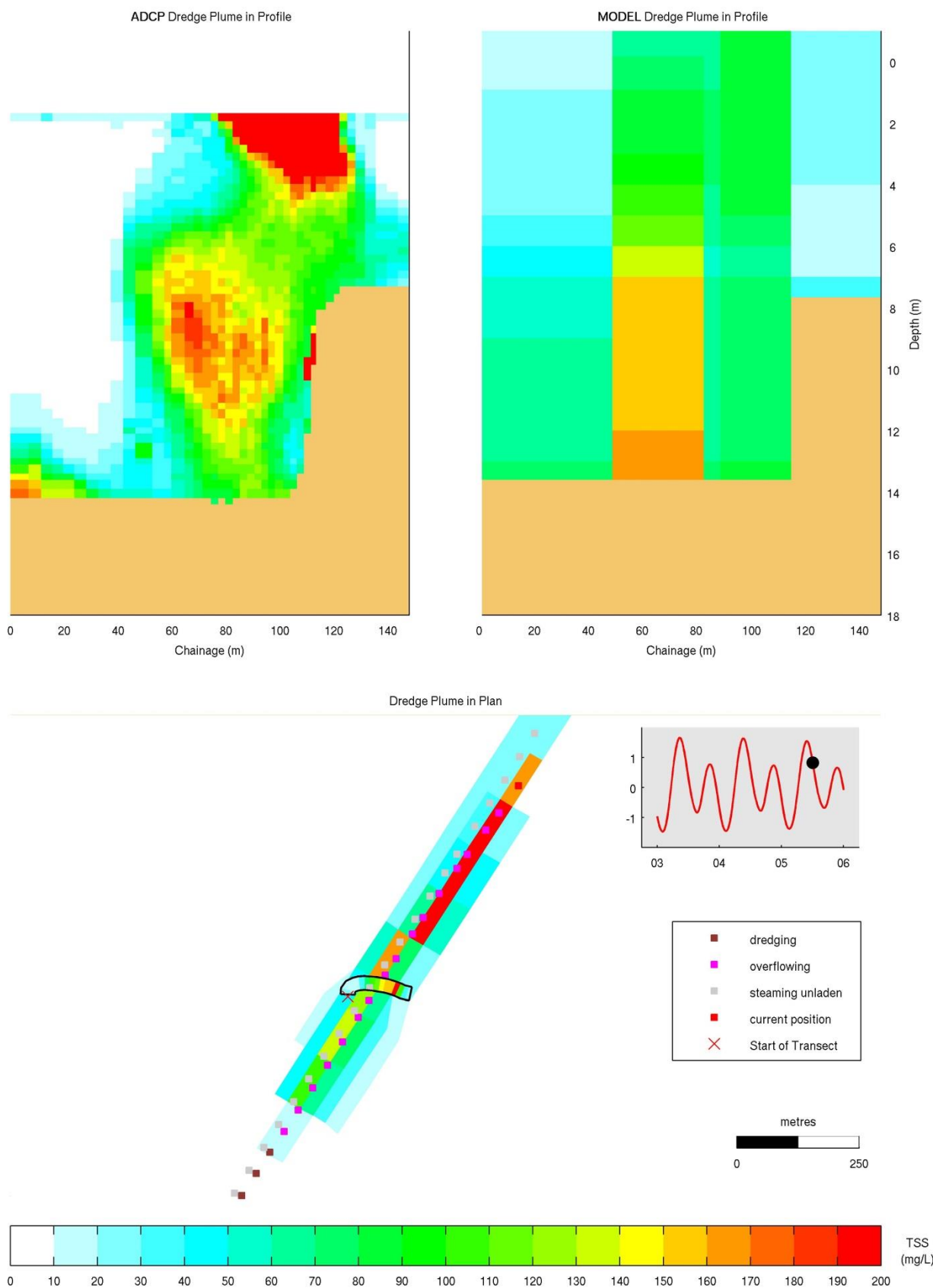
Dredge Plume in Plan



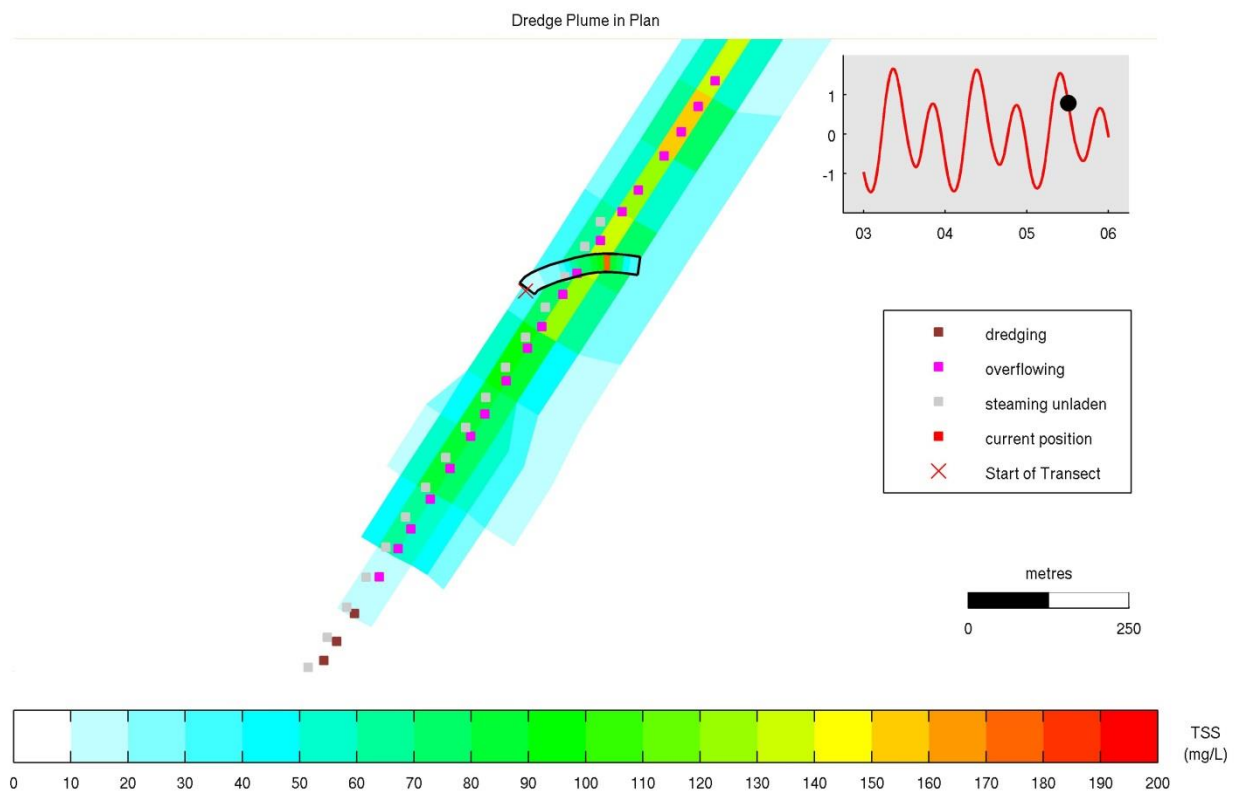
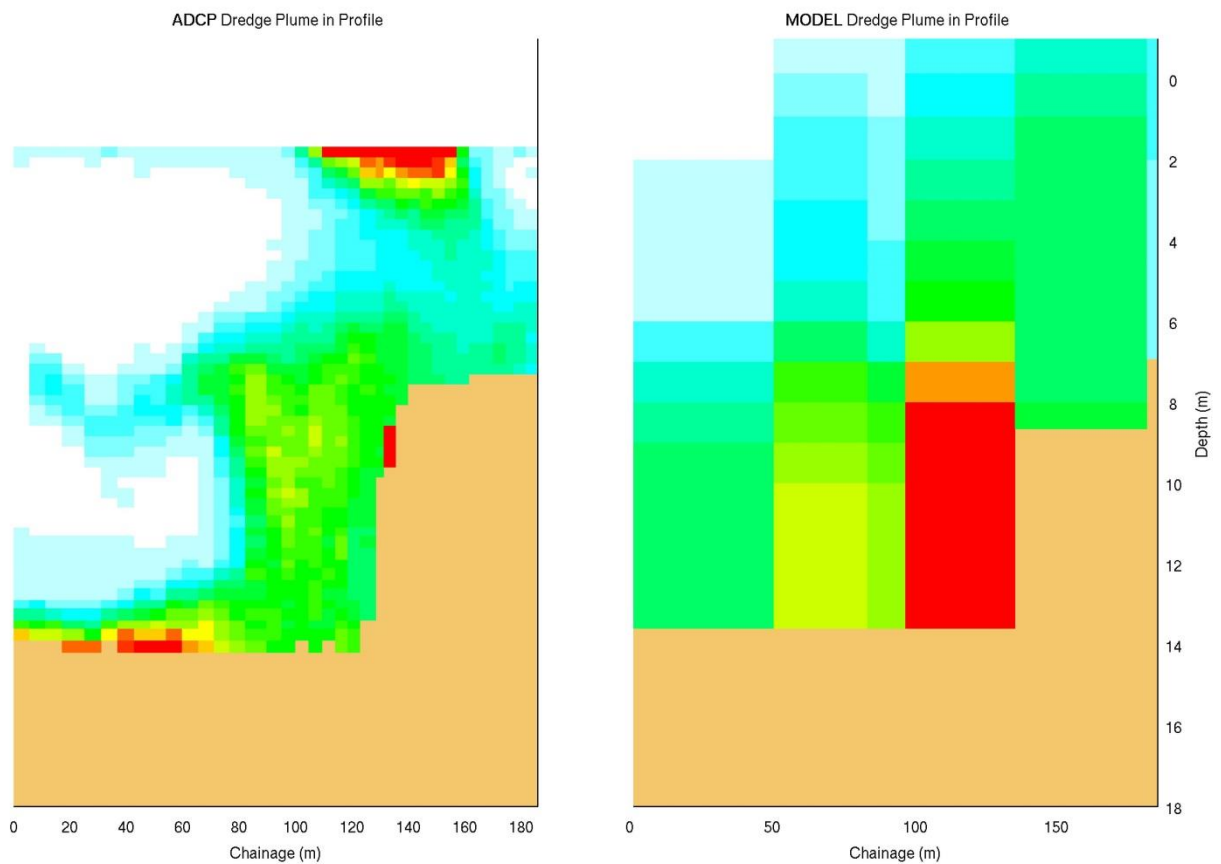
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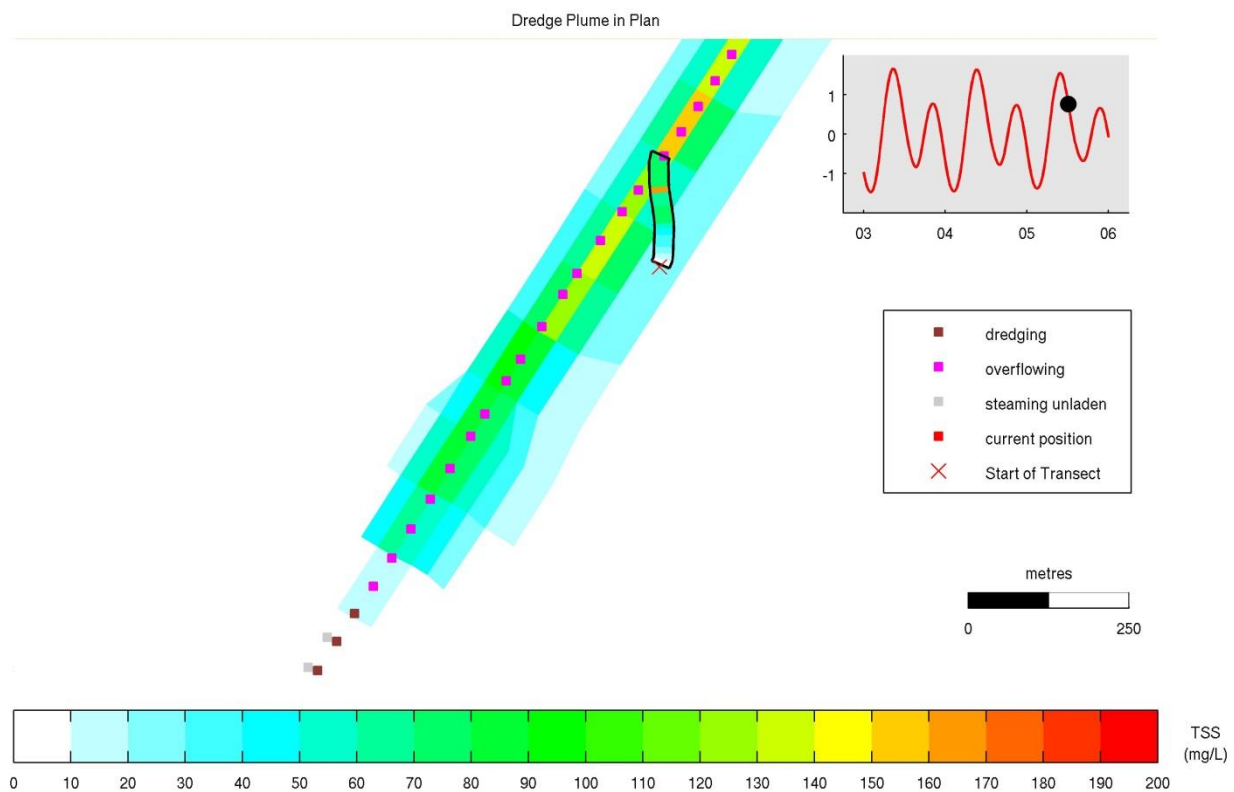
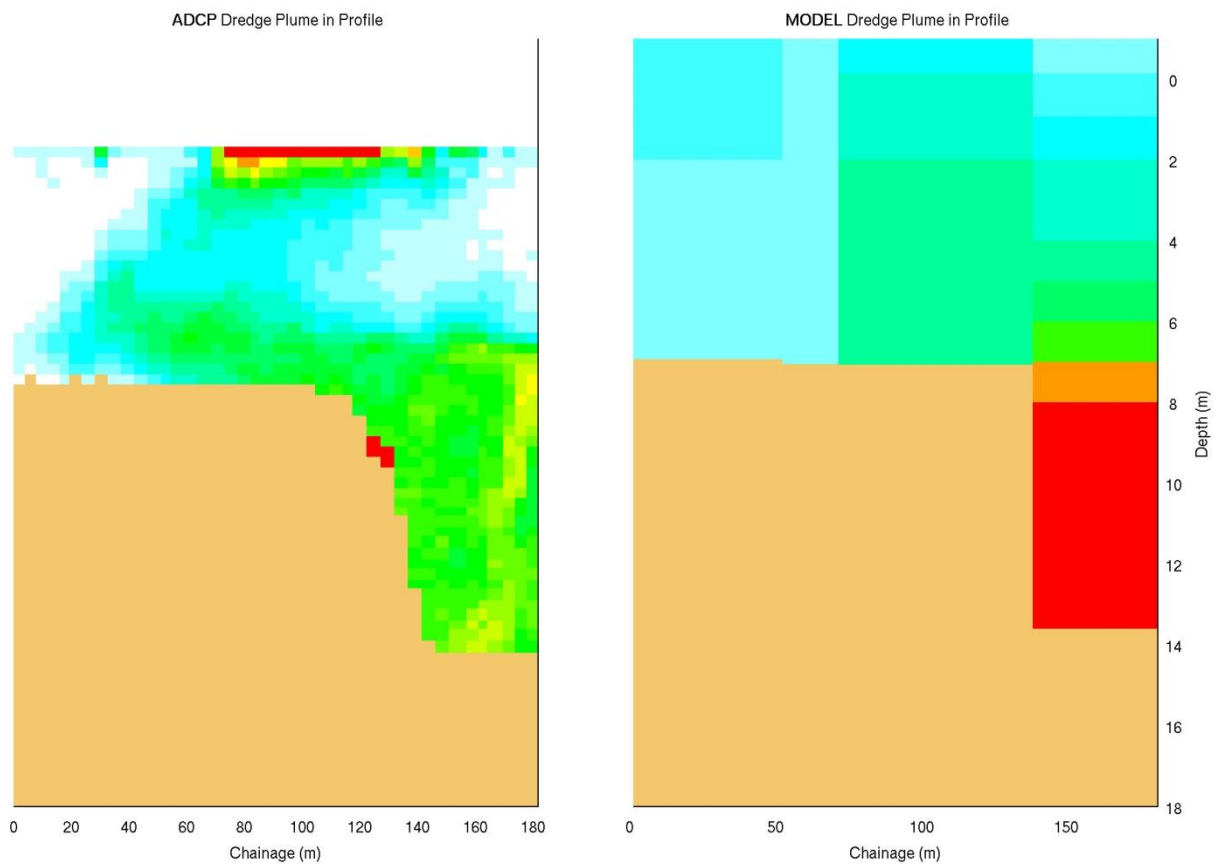
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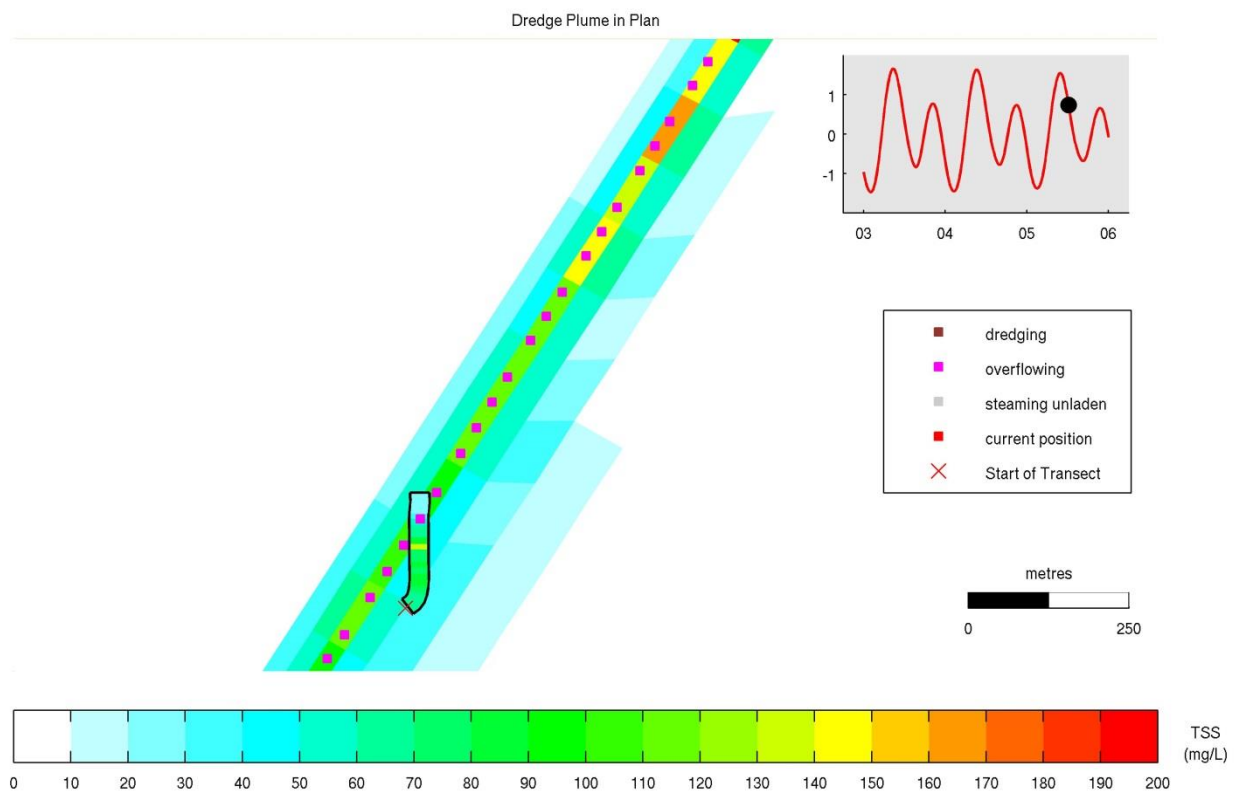
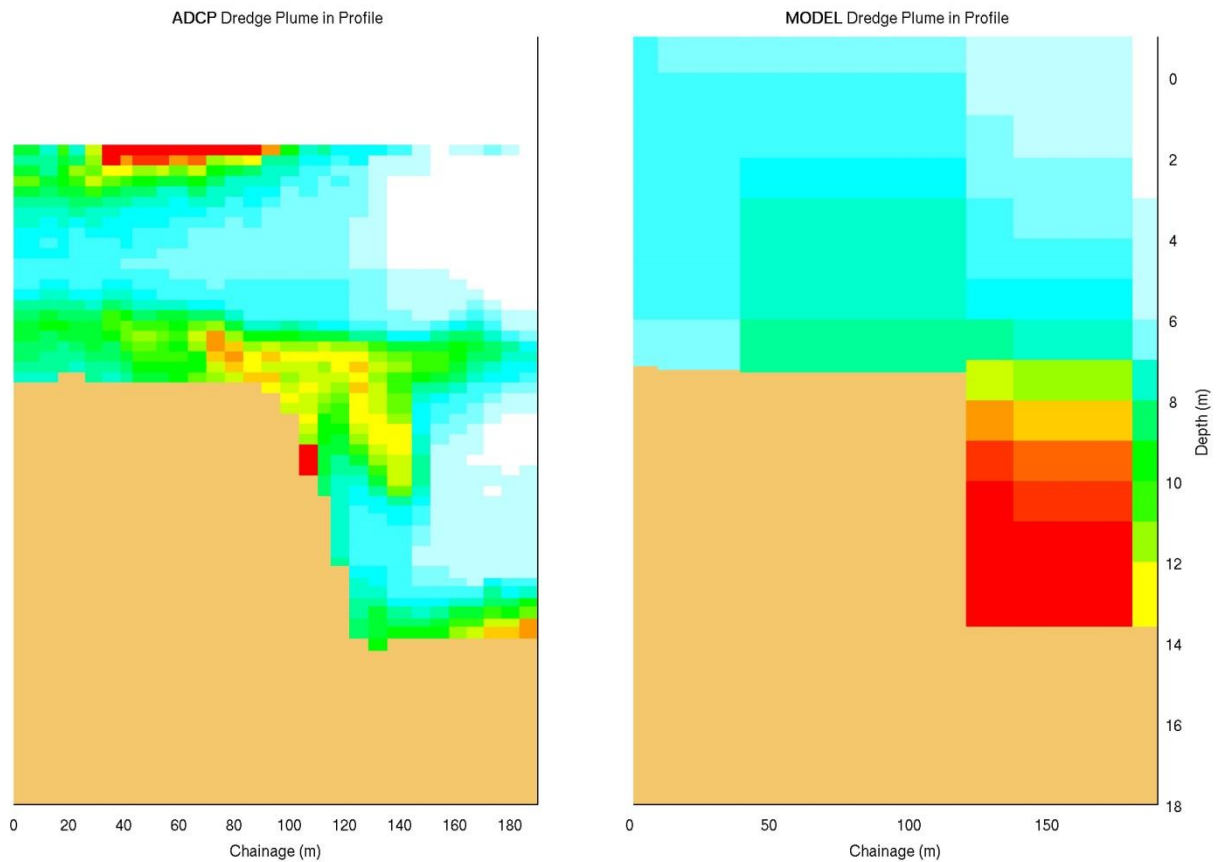
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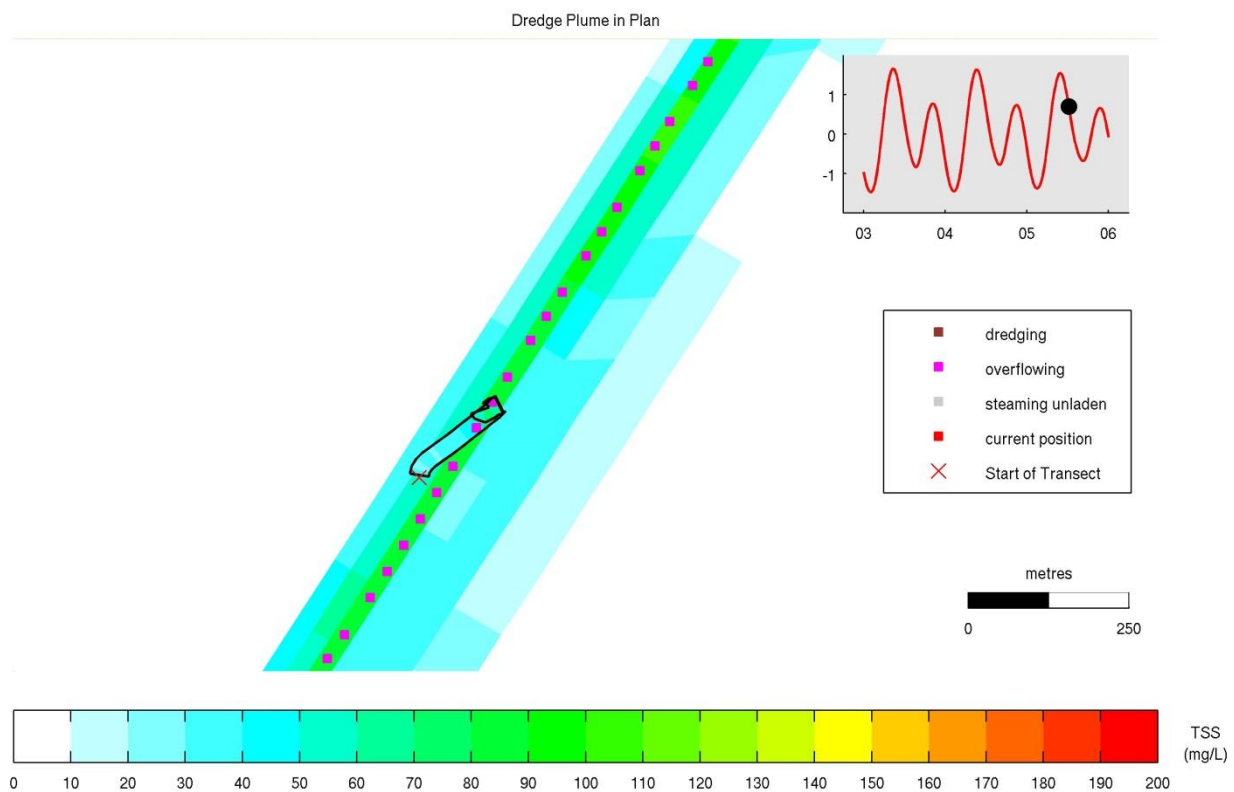
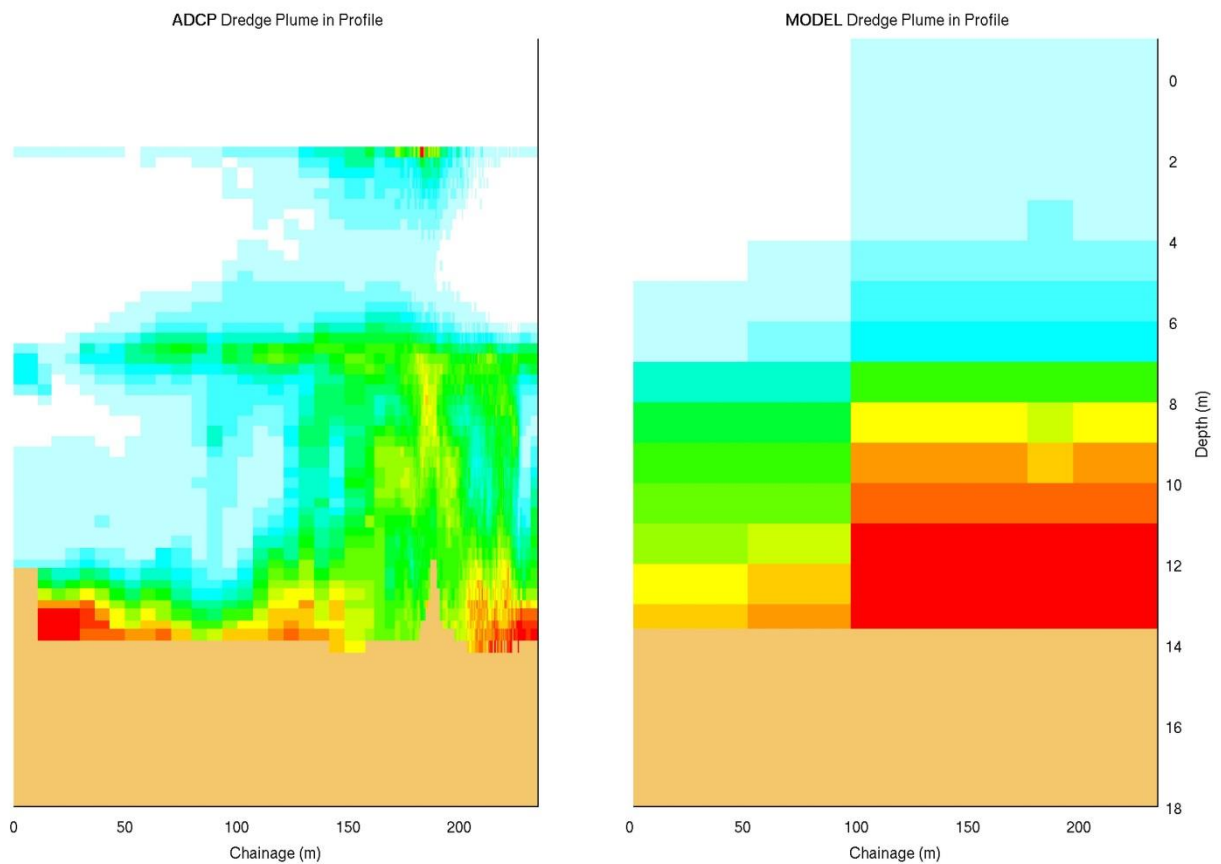
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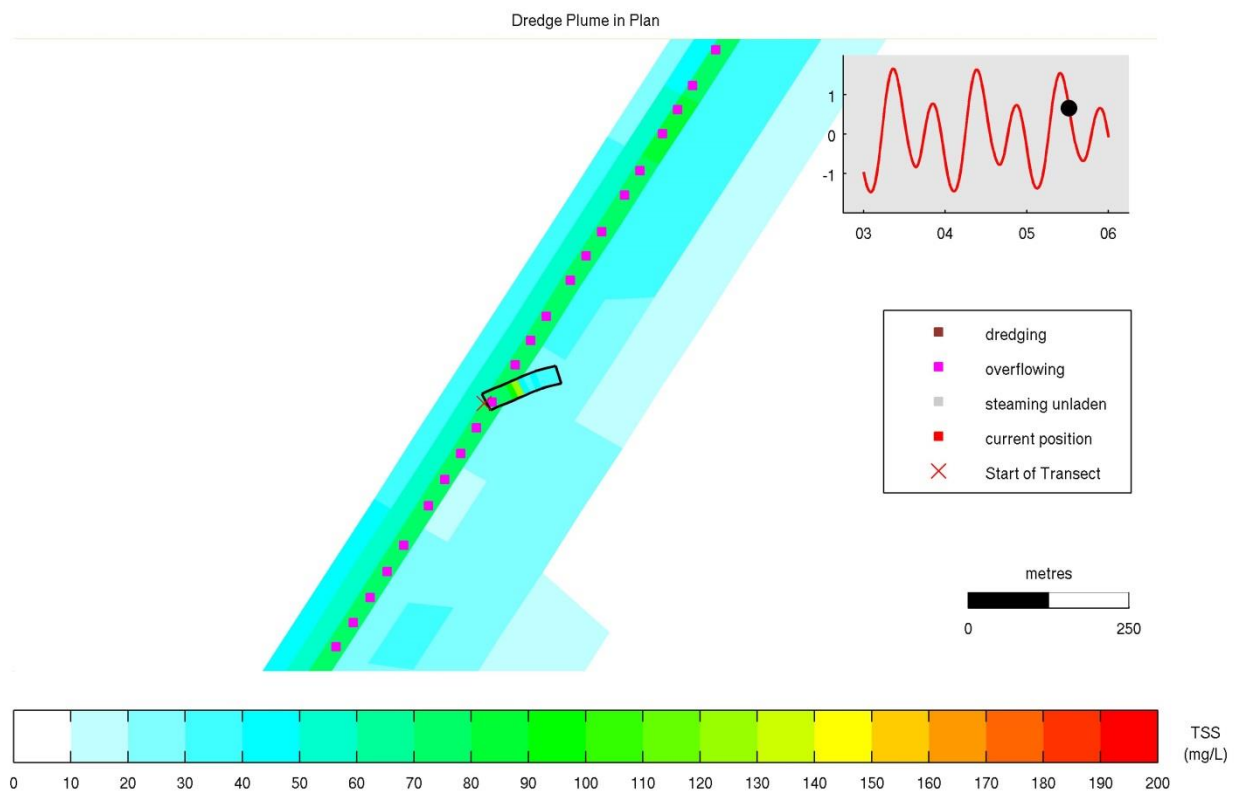
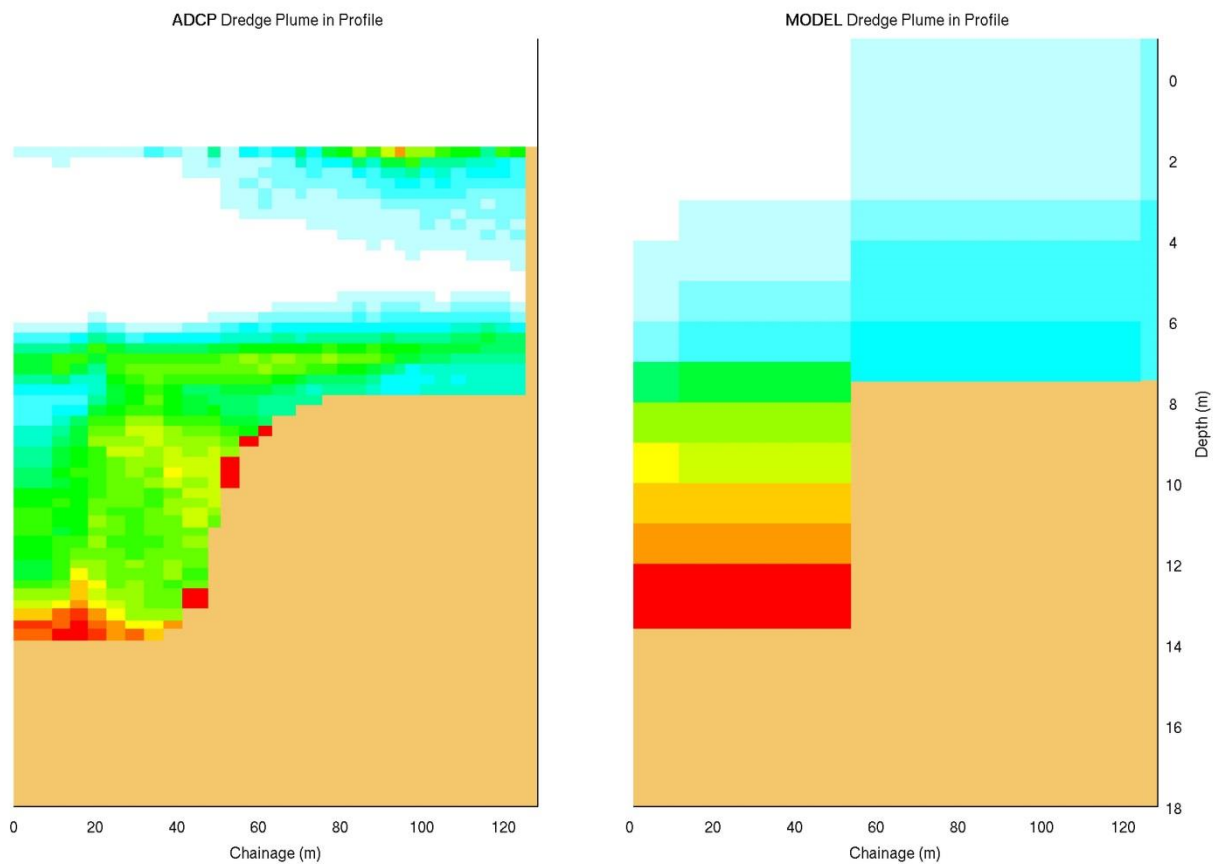
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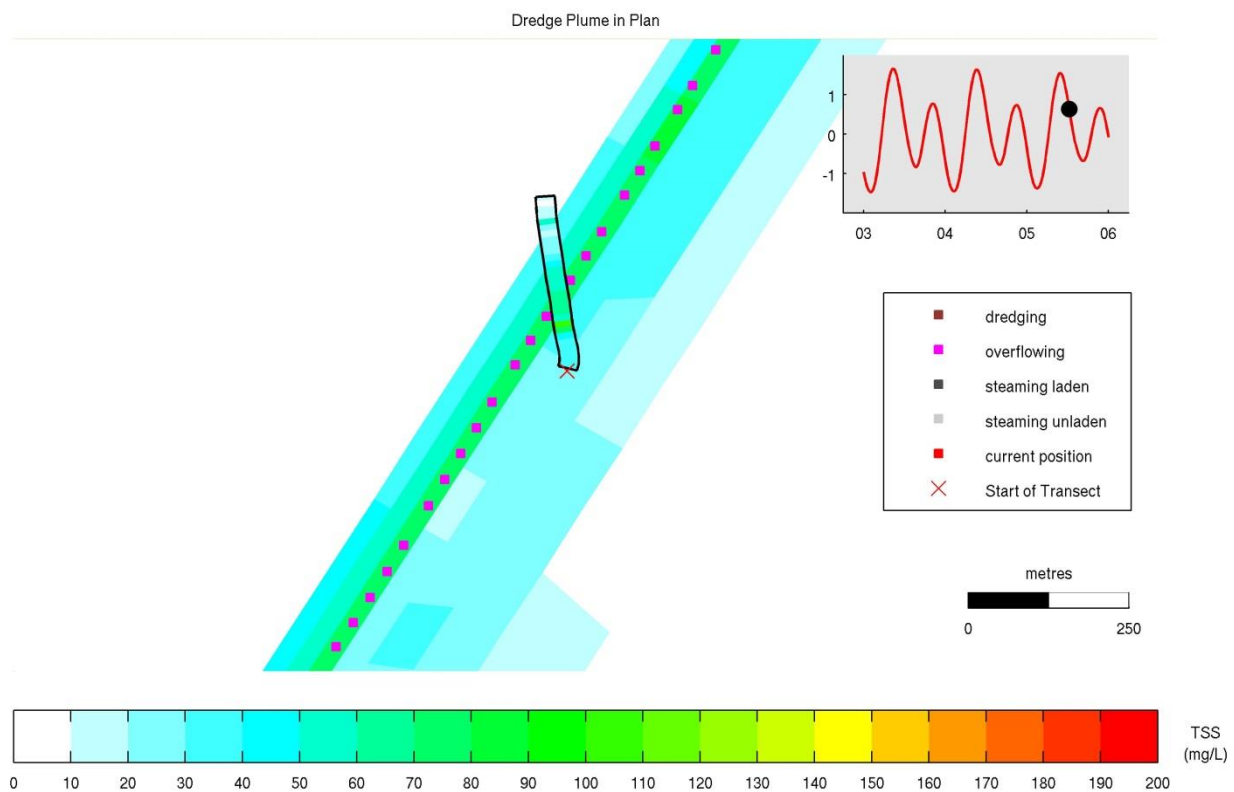
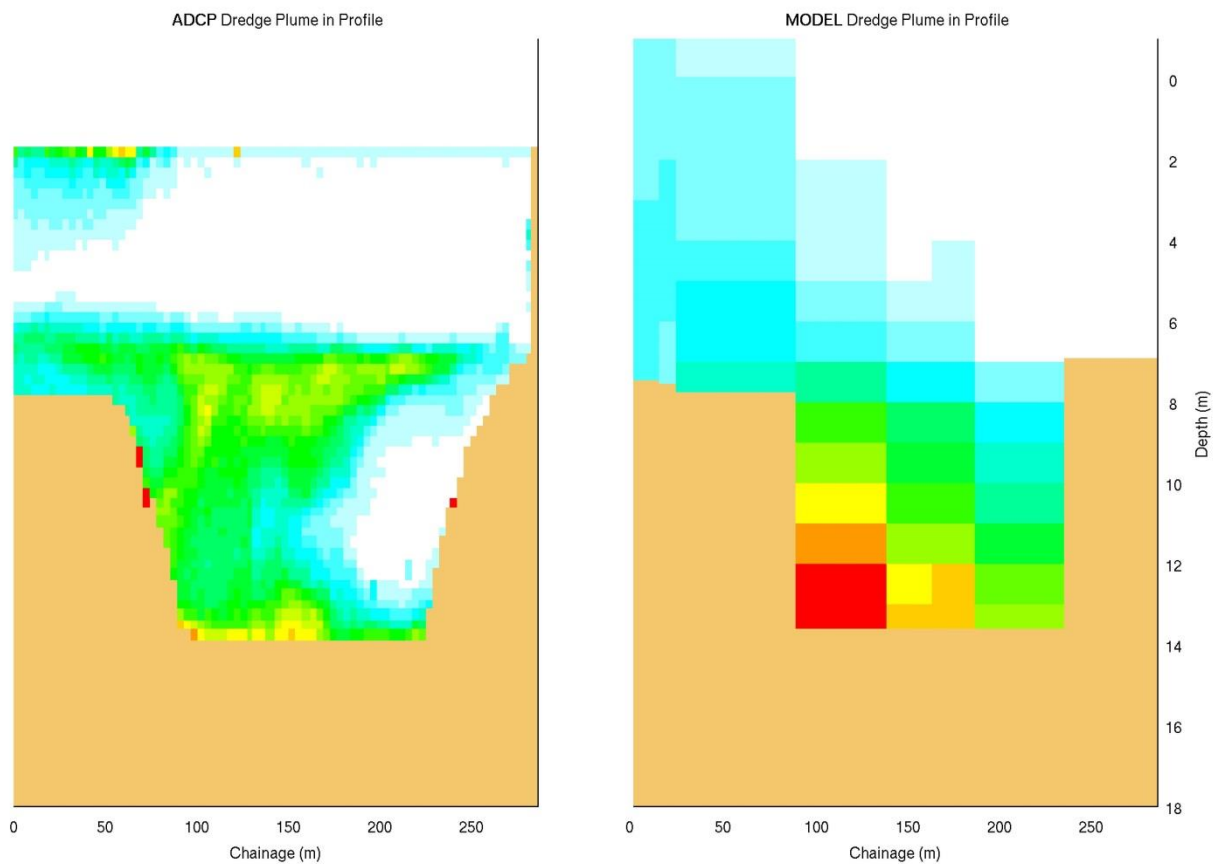
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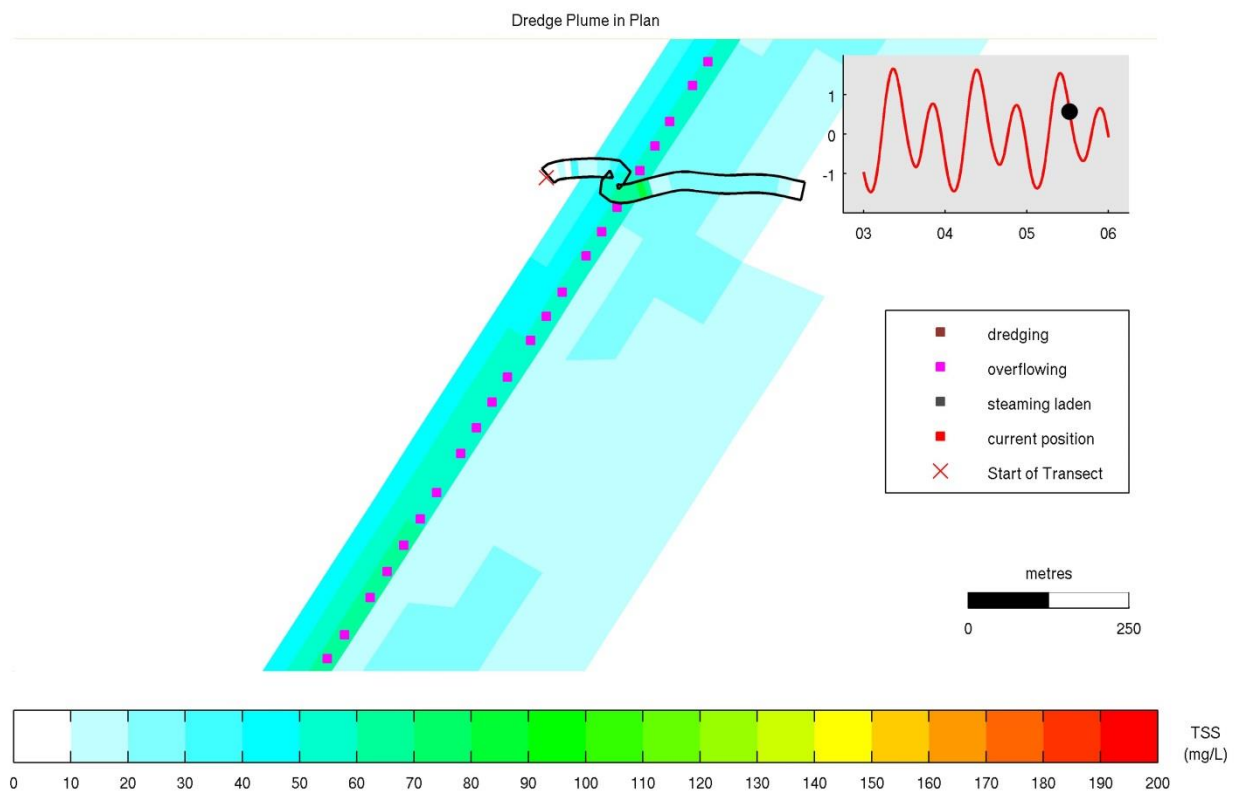
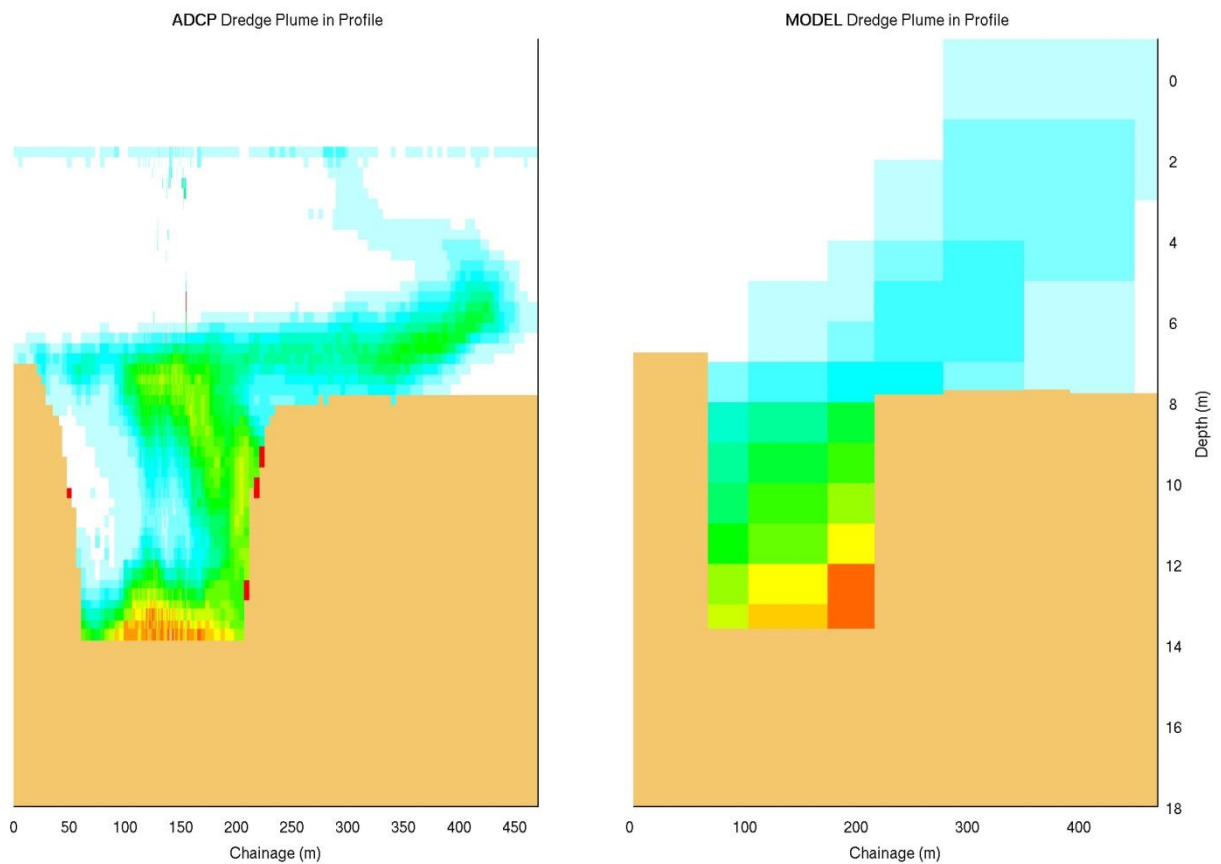
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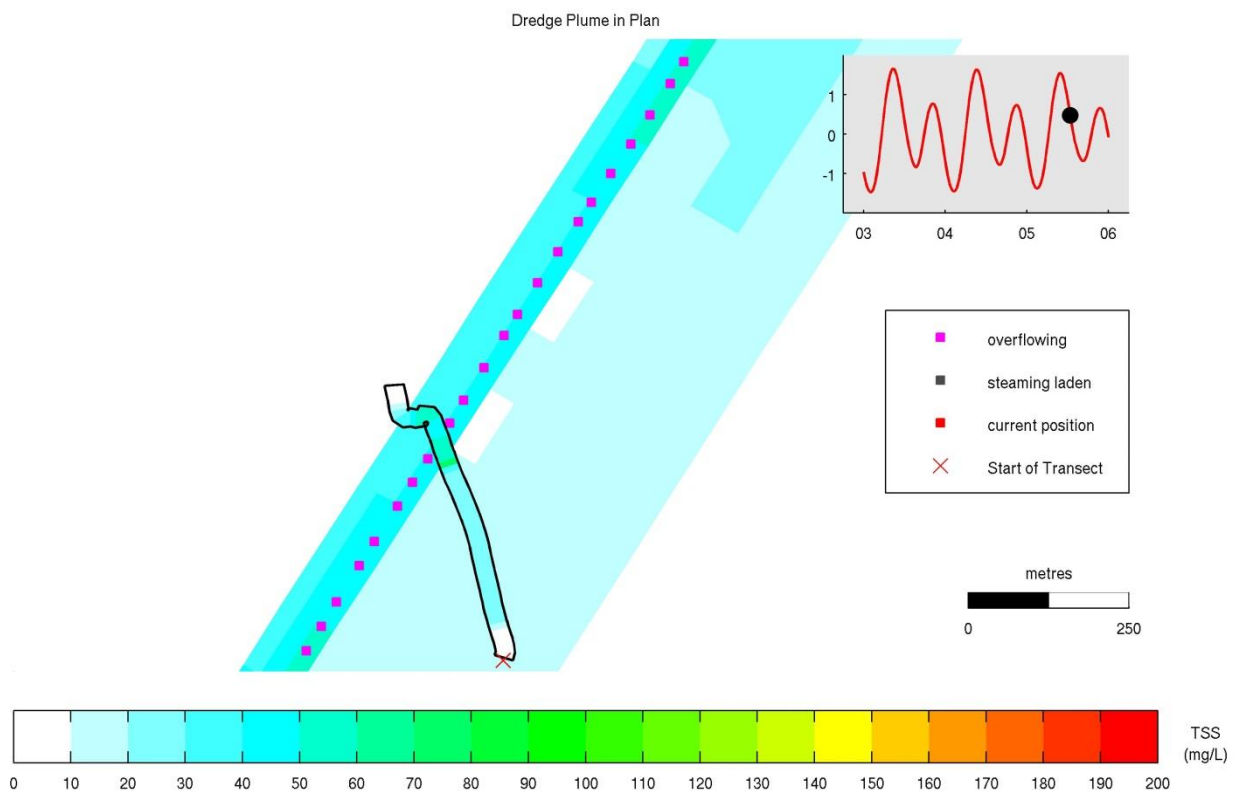
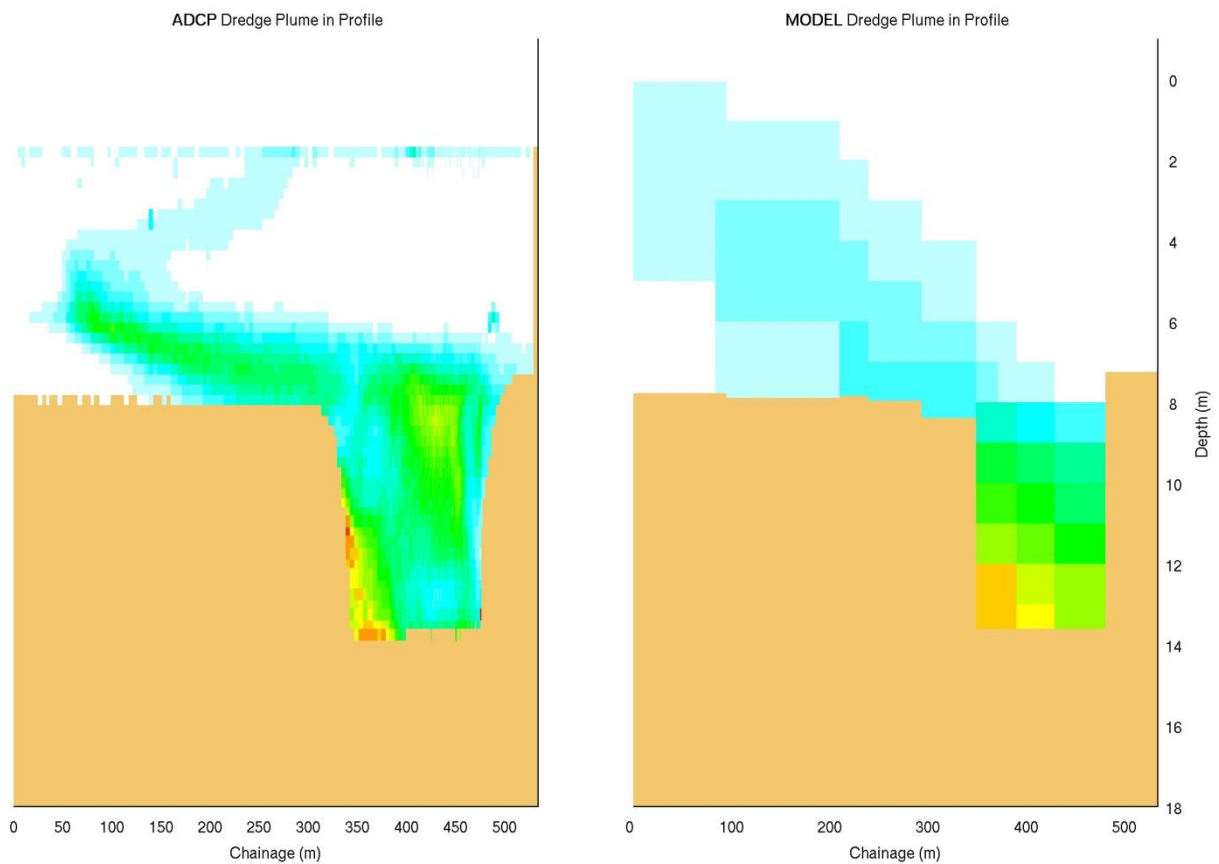
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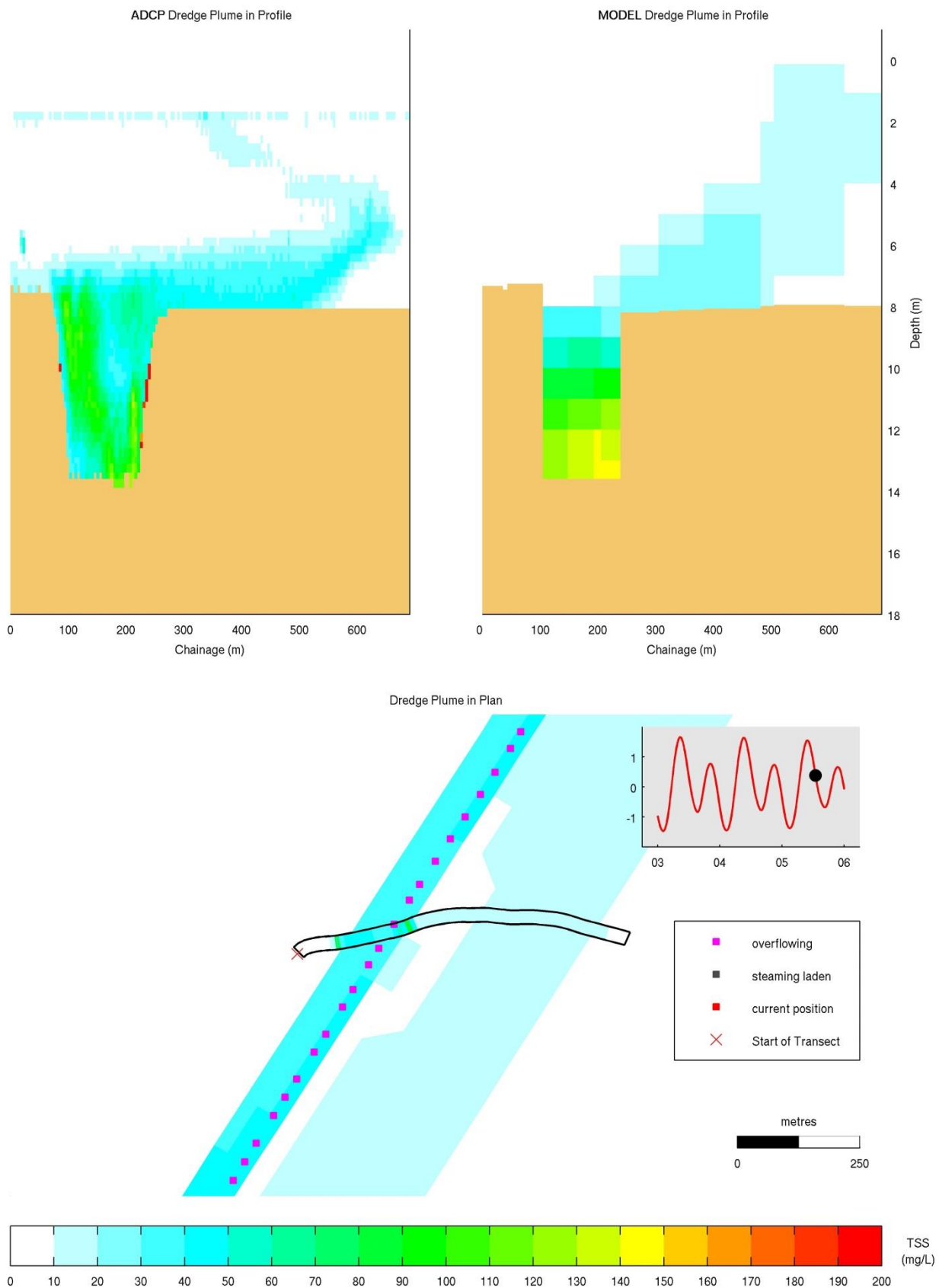
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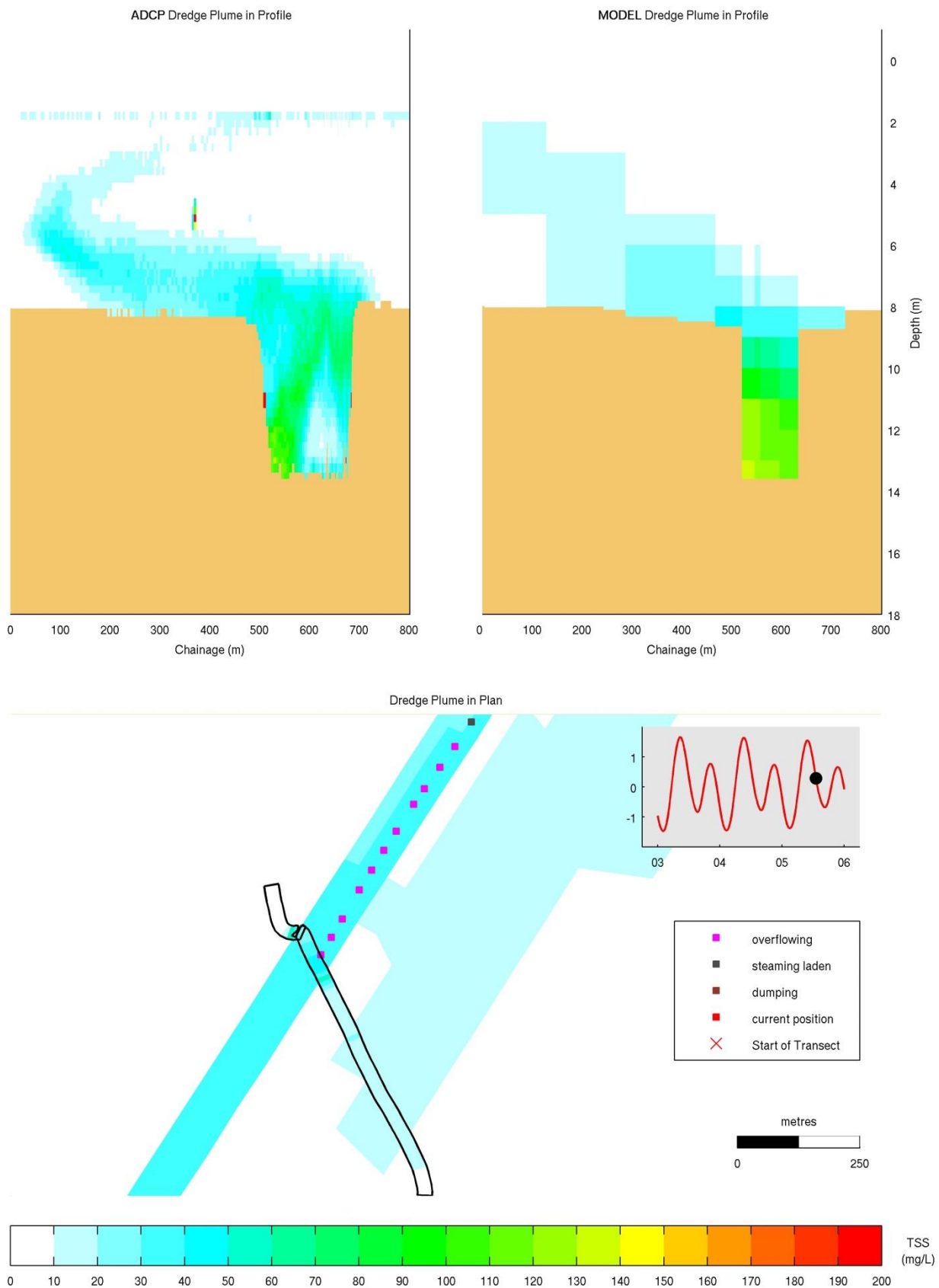
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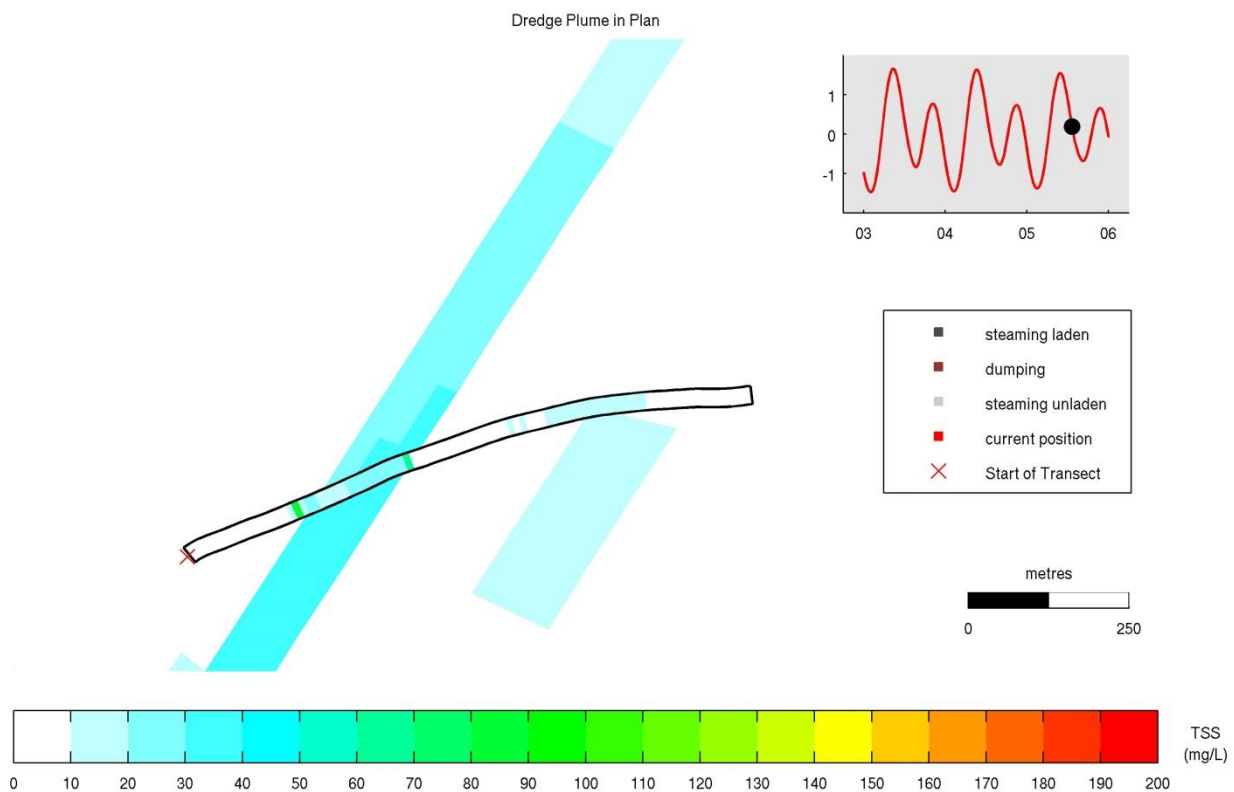
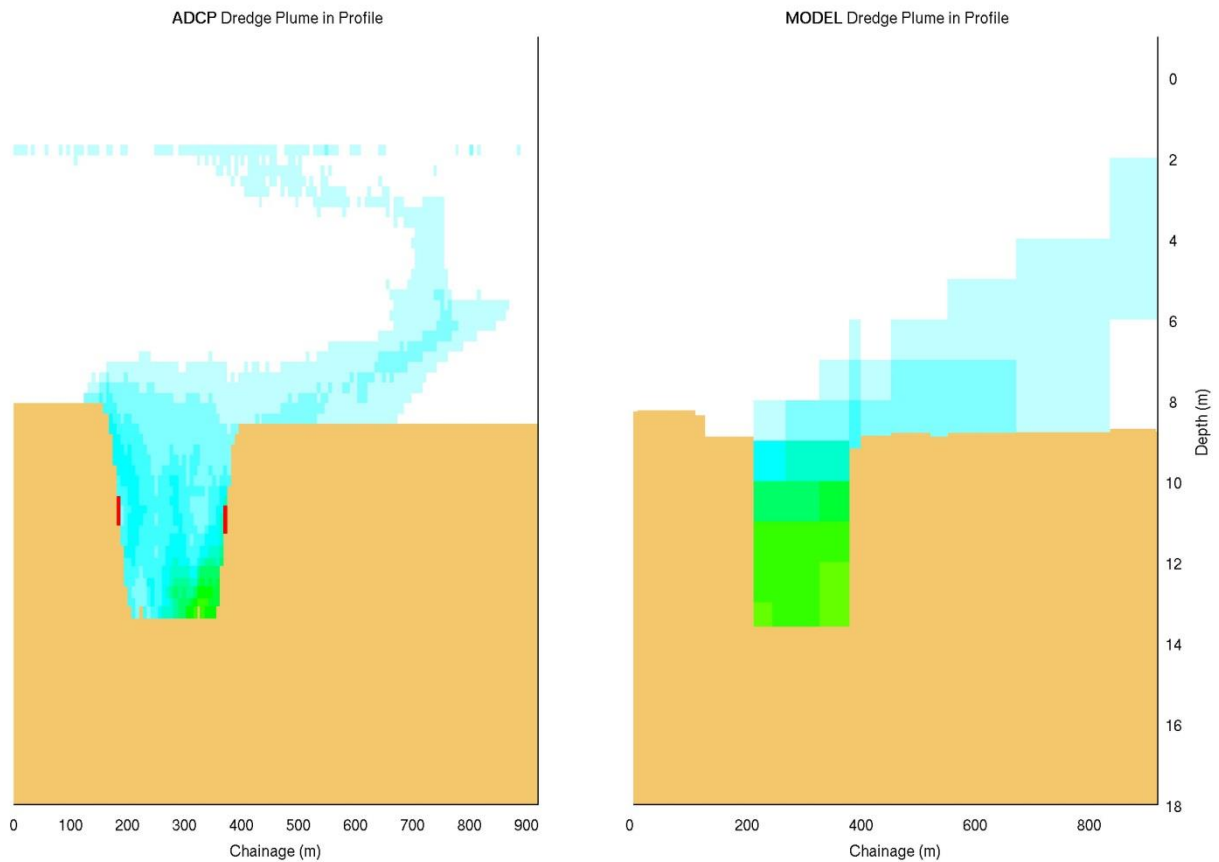
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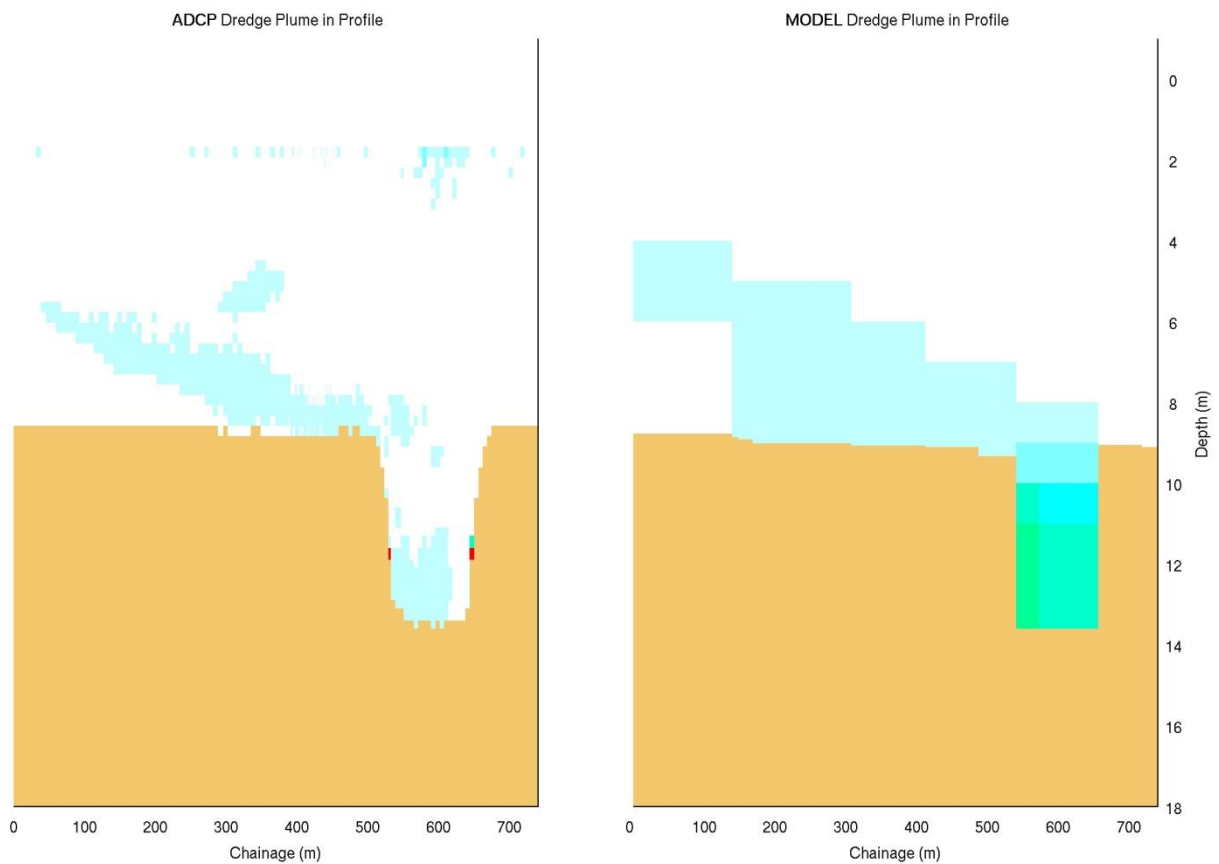
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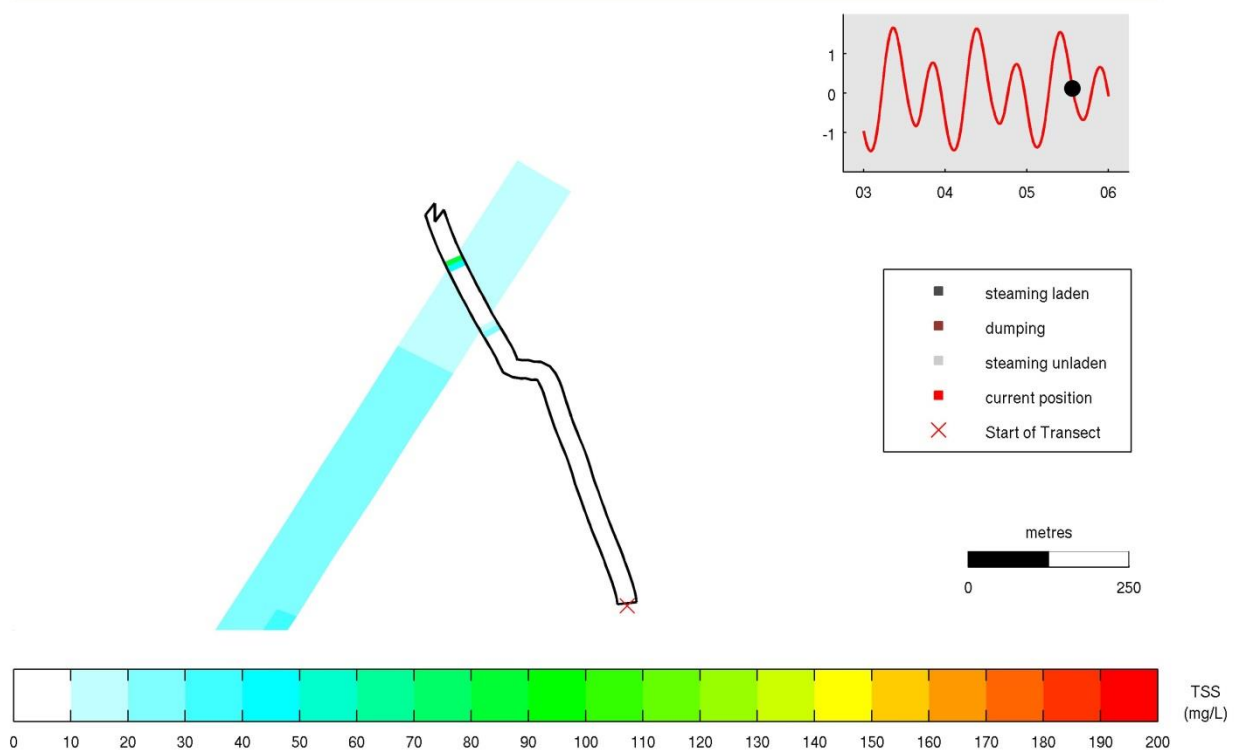
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05-Jan-2011 13:24



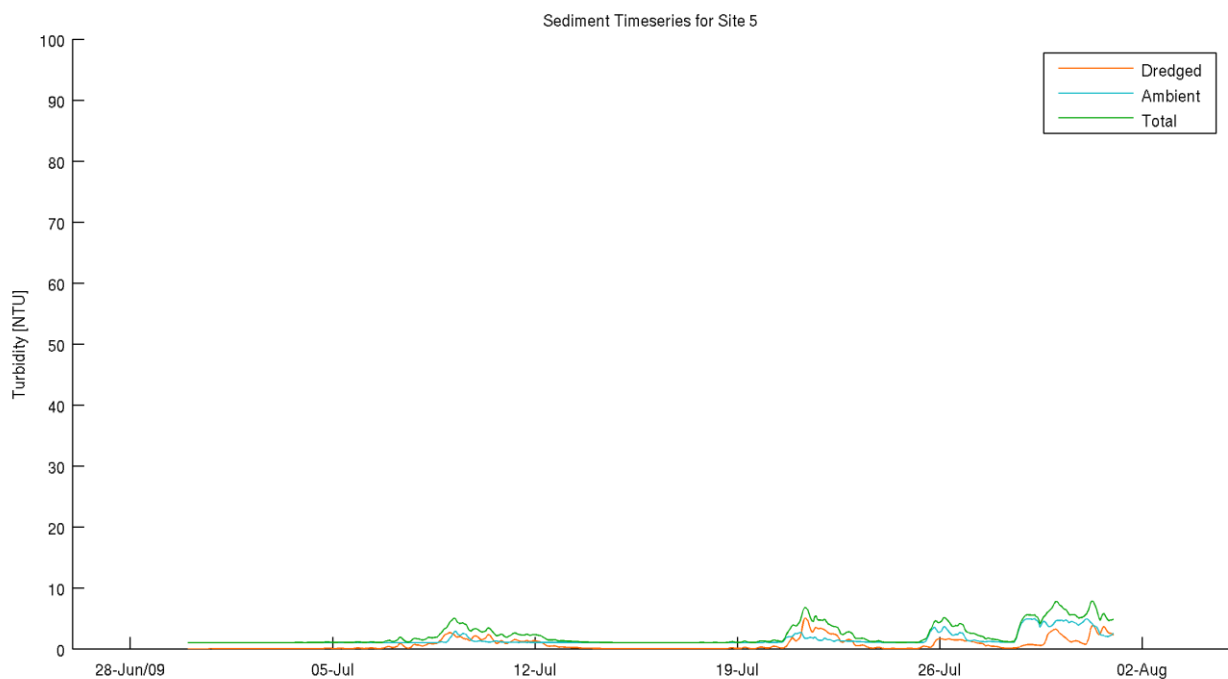
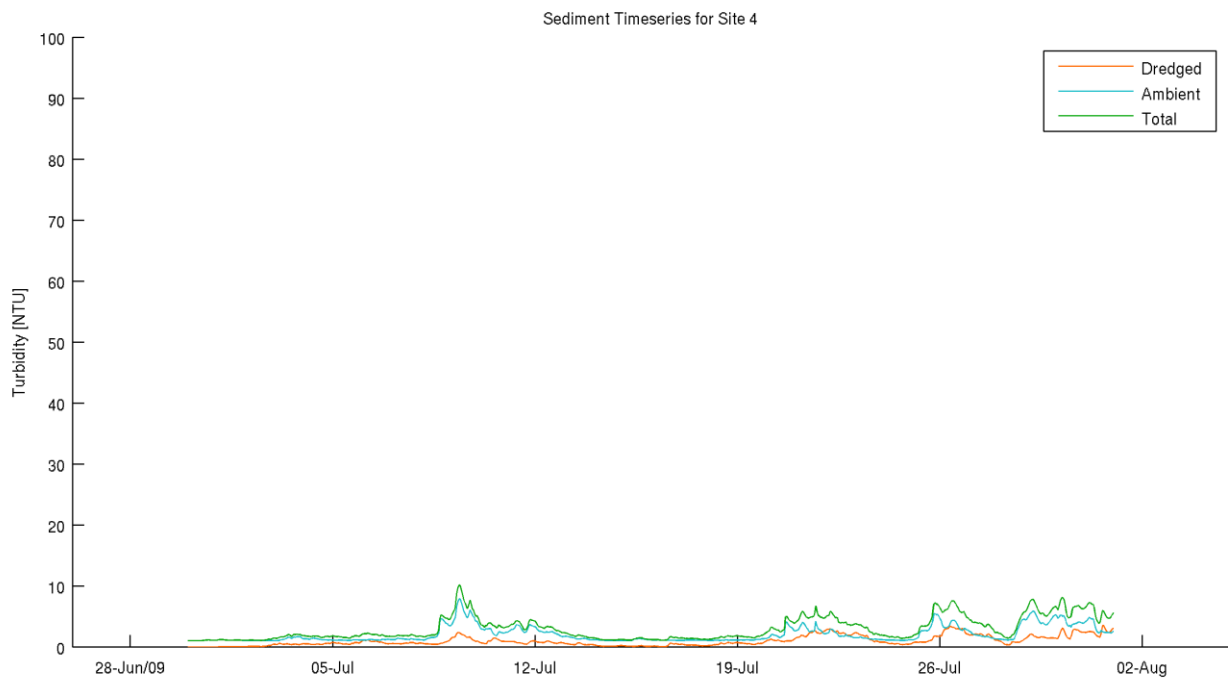
Dredge Plume in Plan

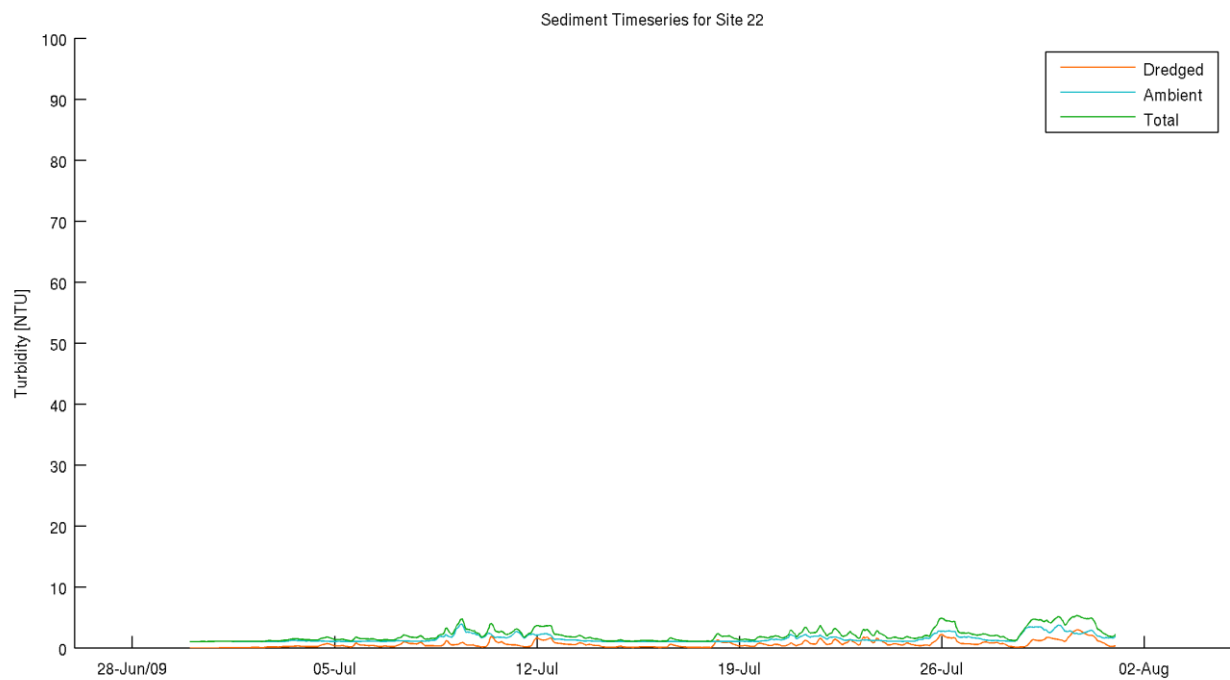
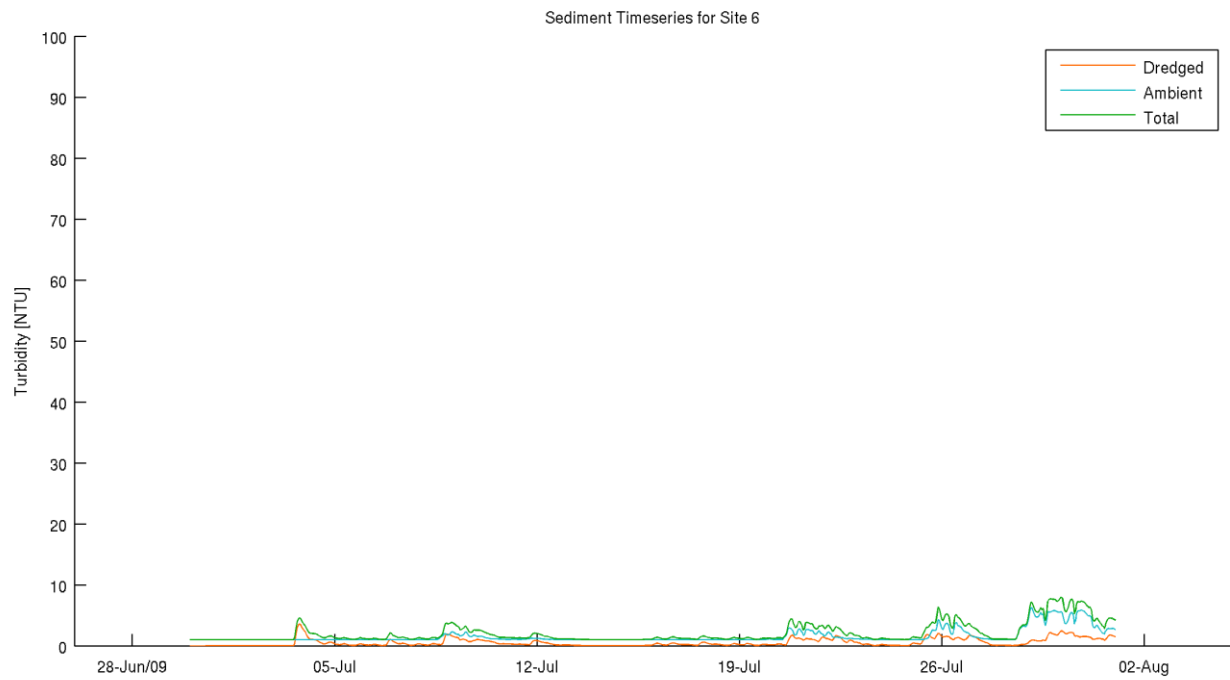


Appendix D Plume Modelling Time Series Output

Turbidity Time Series Plots

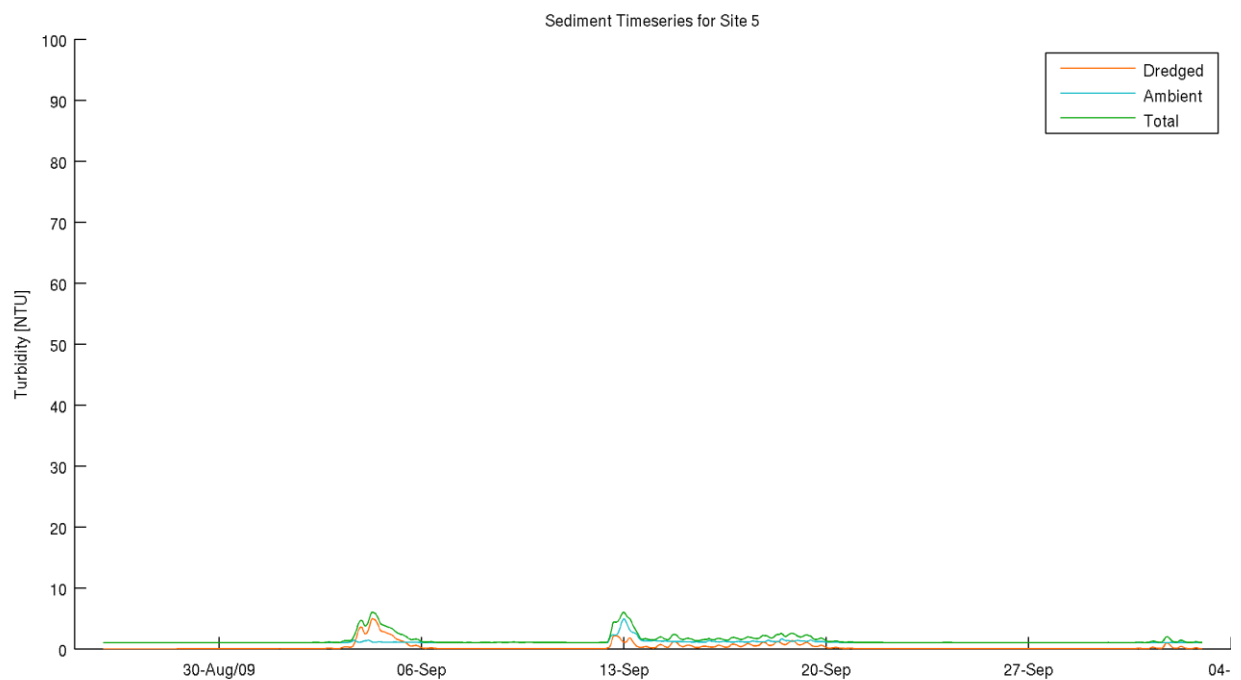
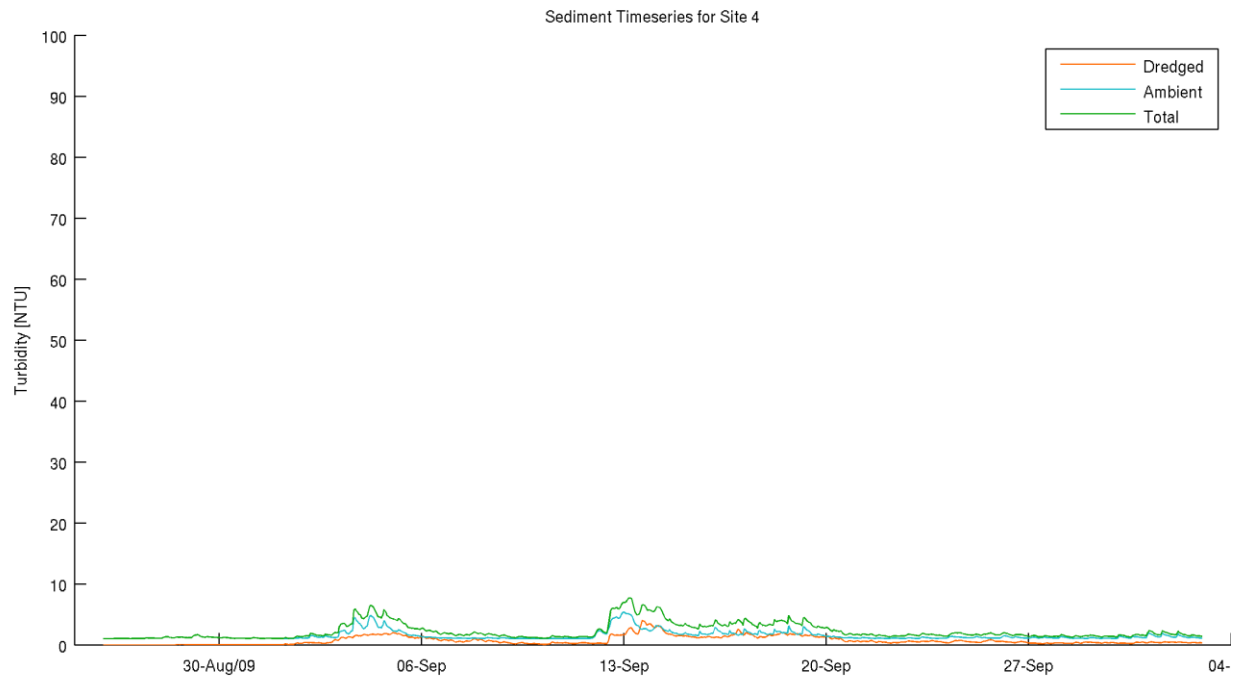
Stage 3 – Small TSHD Channel Dredging – Dense Clayey Sand Material – July 2009 Conditions

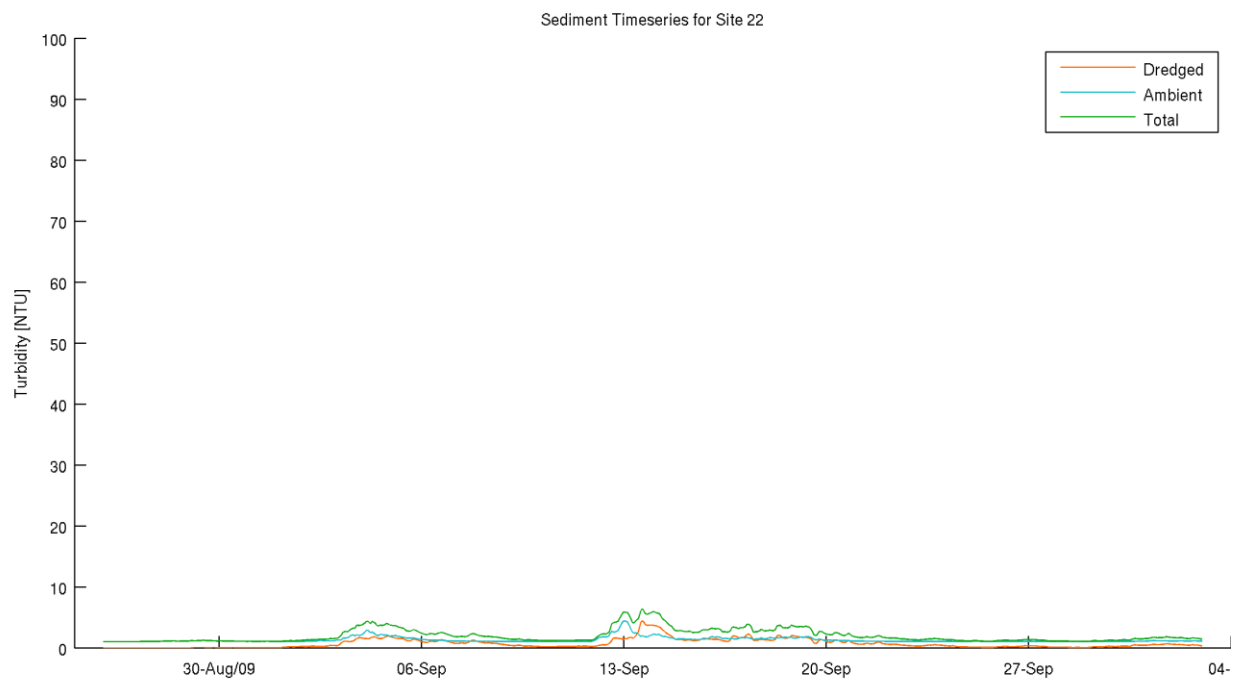
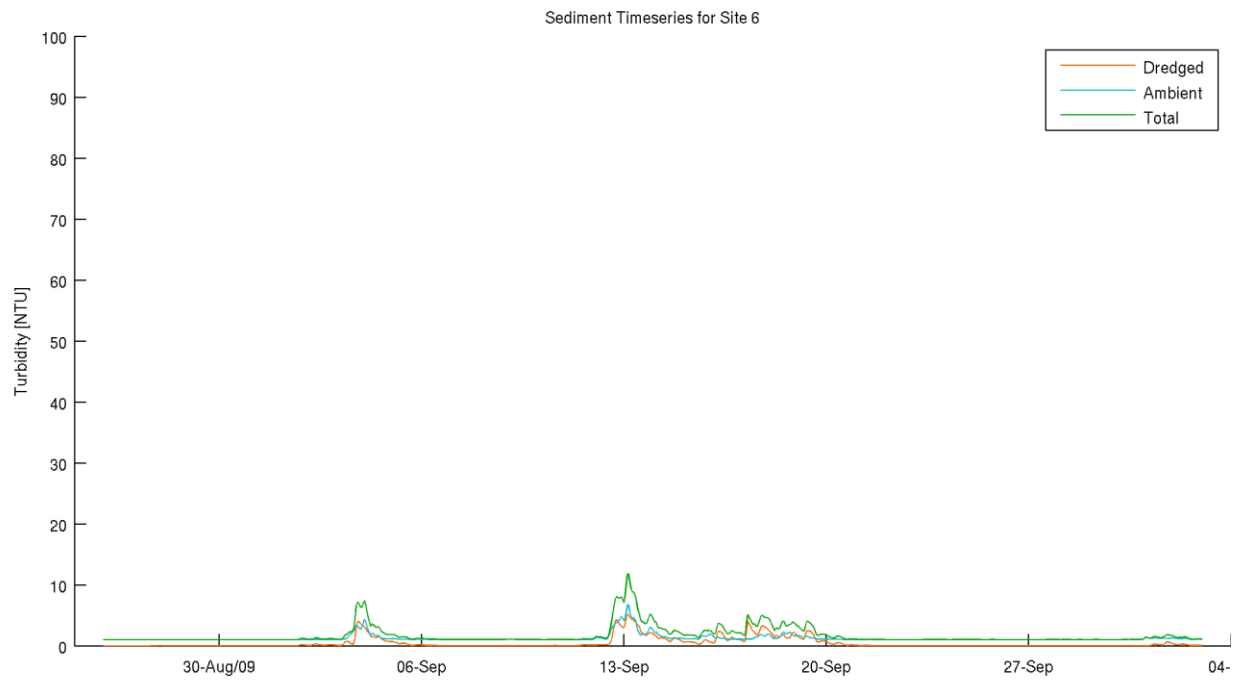




Turbidity Time Series Plots

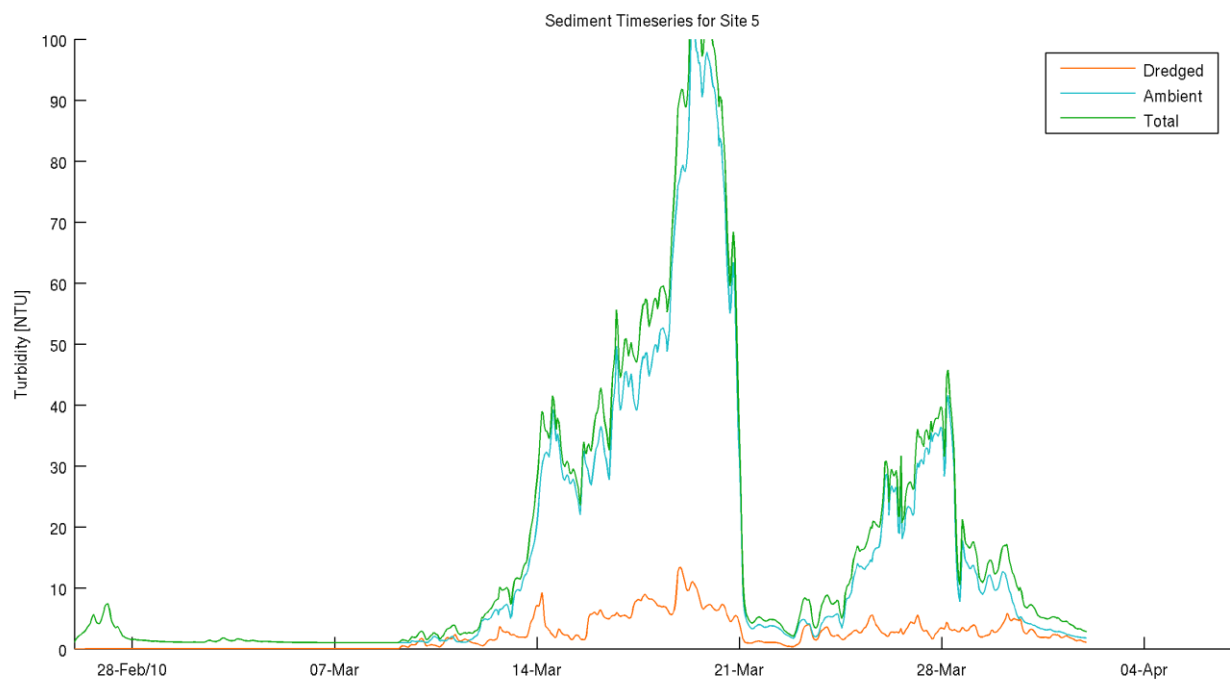
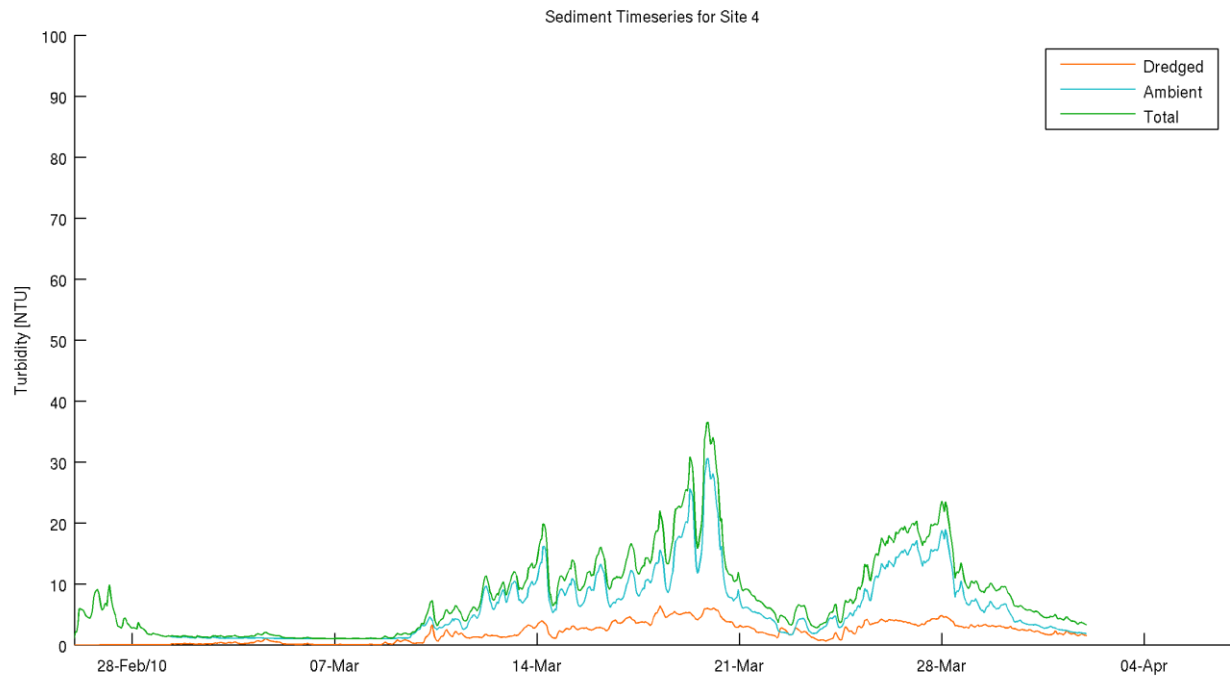
Stage 3 – Small TSHD Channel Dredging – Dense Clayey Sand Material – September 2009 Conditions

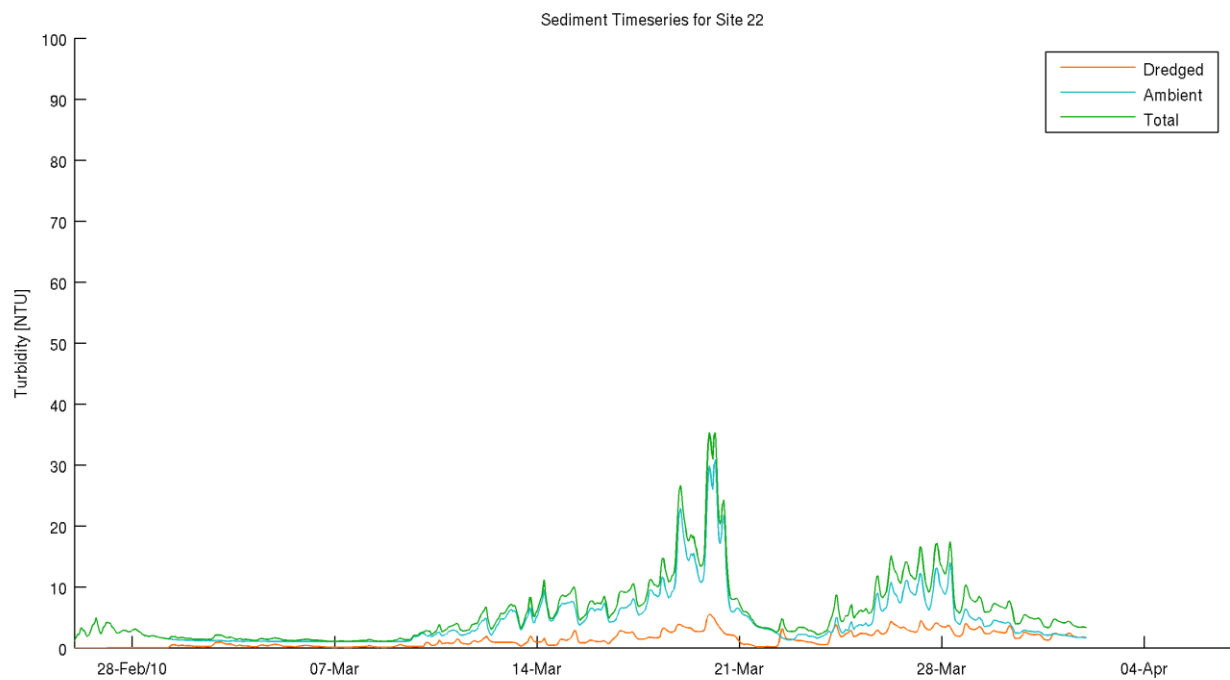
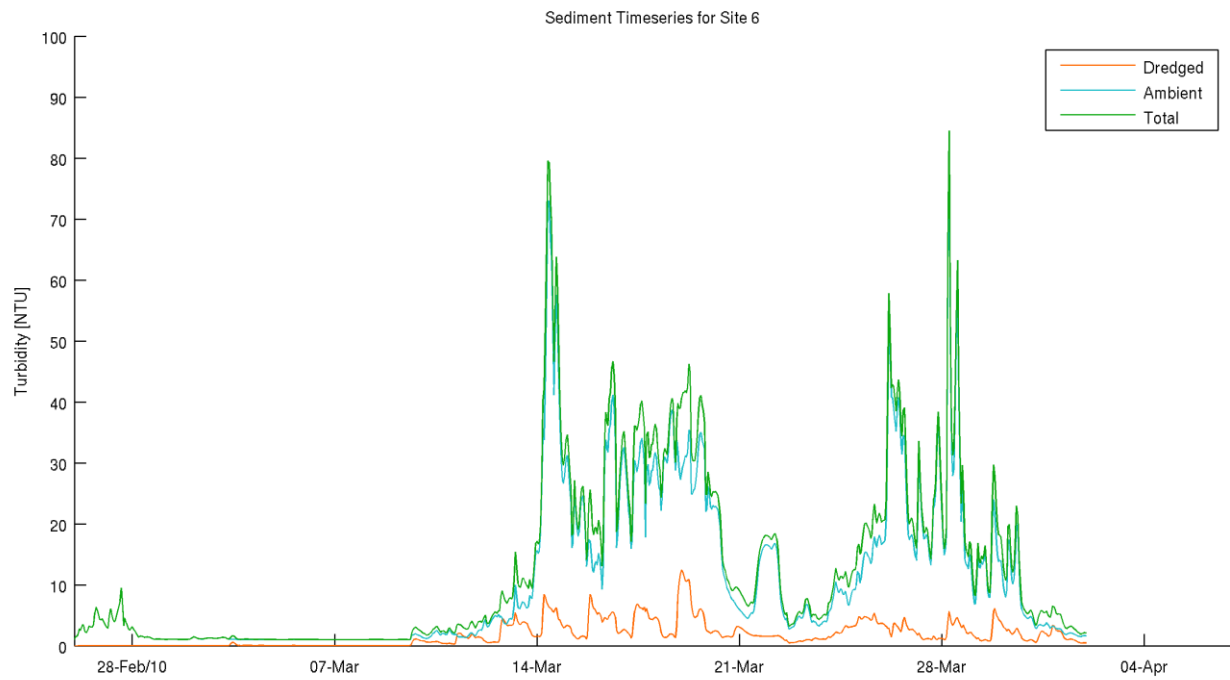




Turbidity Time Series Plots

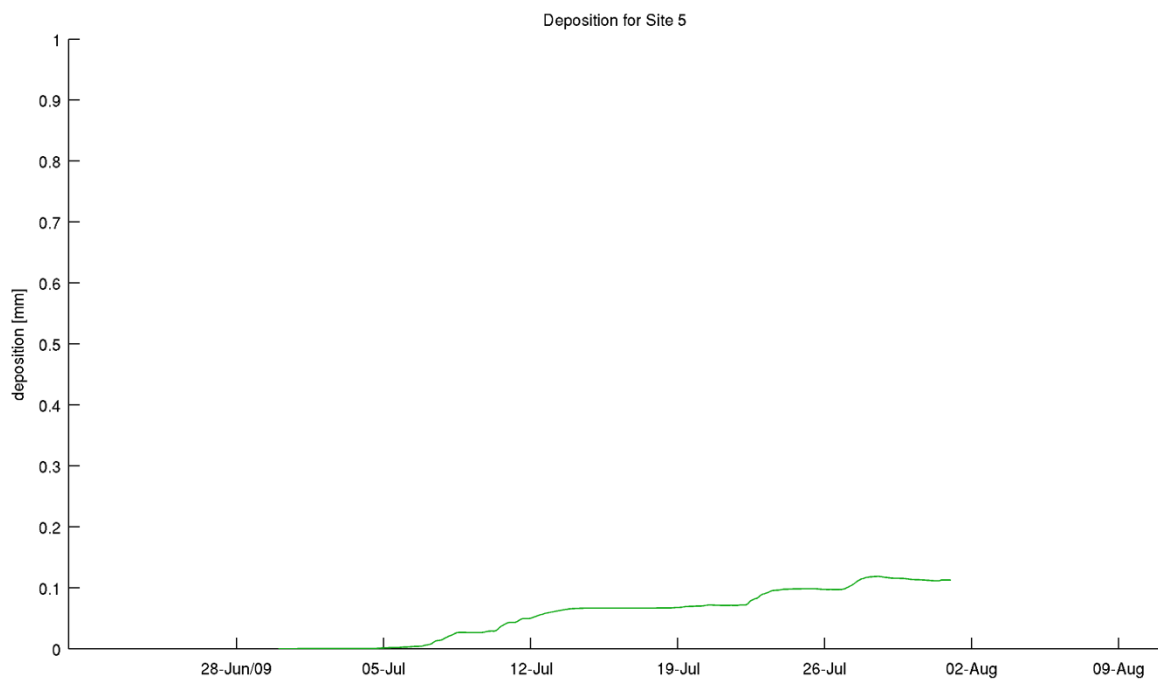
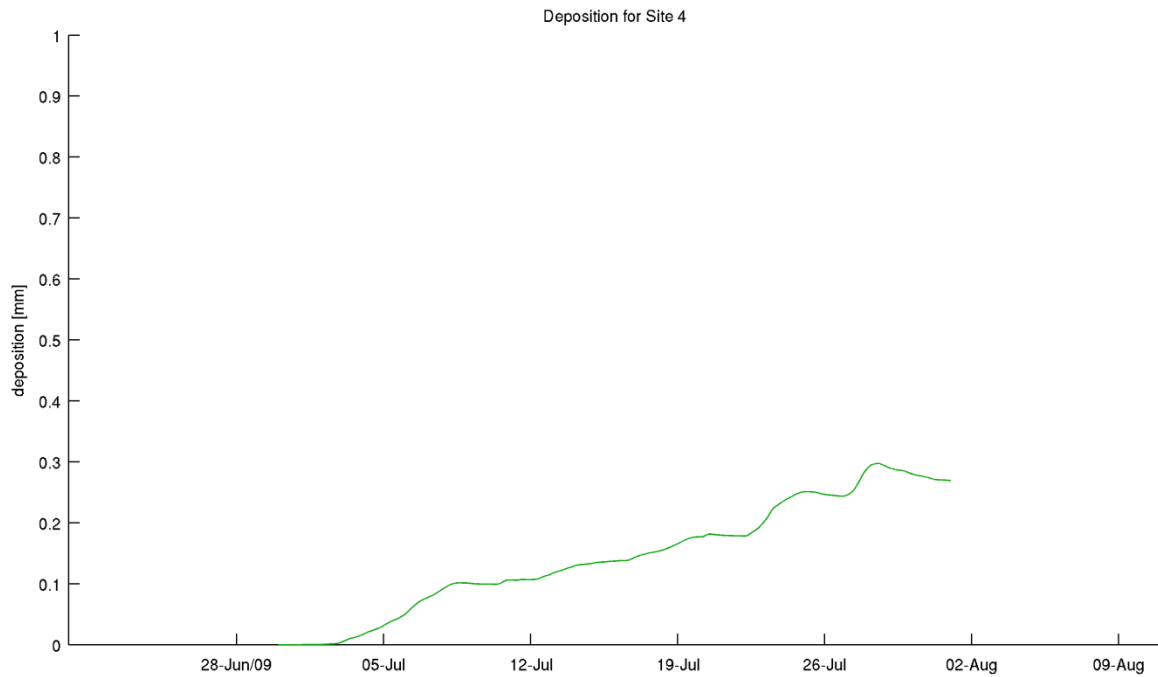
Stage 3 – Small TSHD Channel Dredging – Dense Clayey Sand Material – March 2010 Conditions

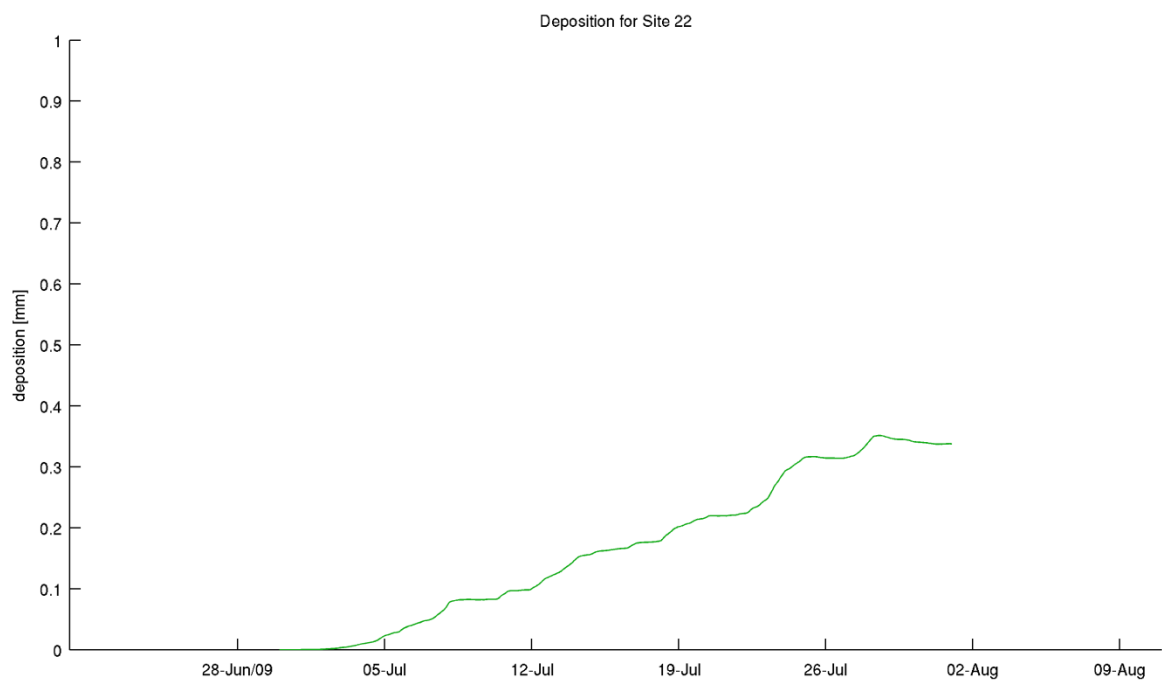
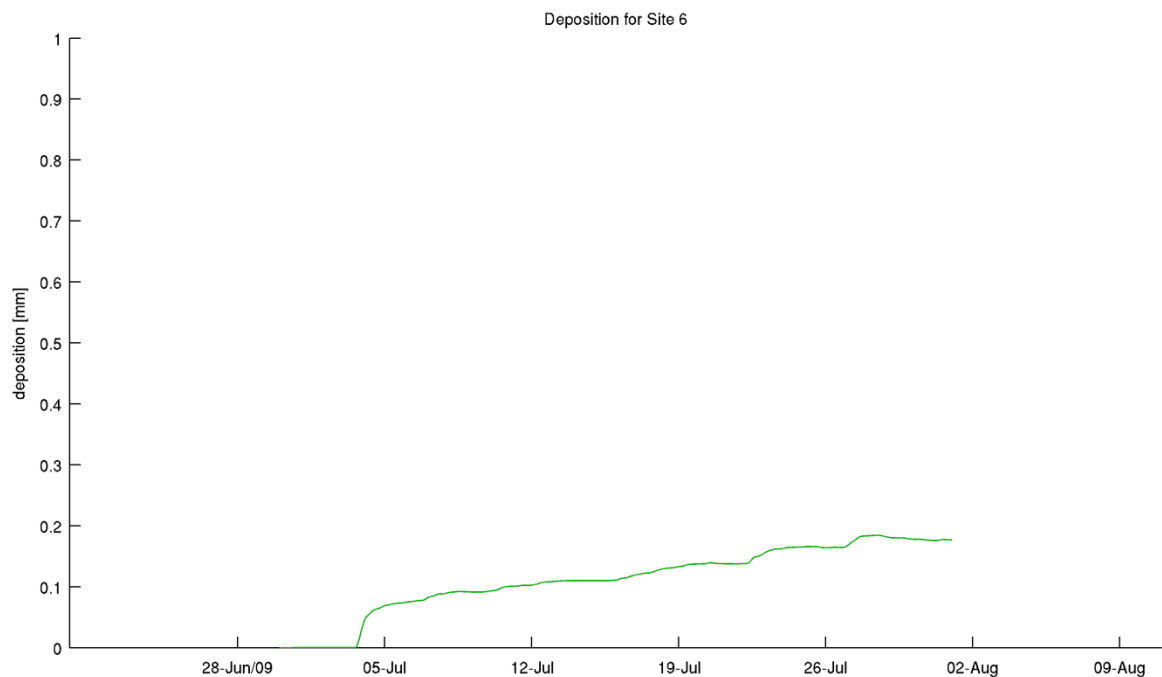


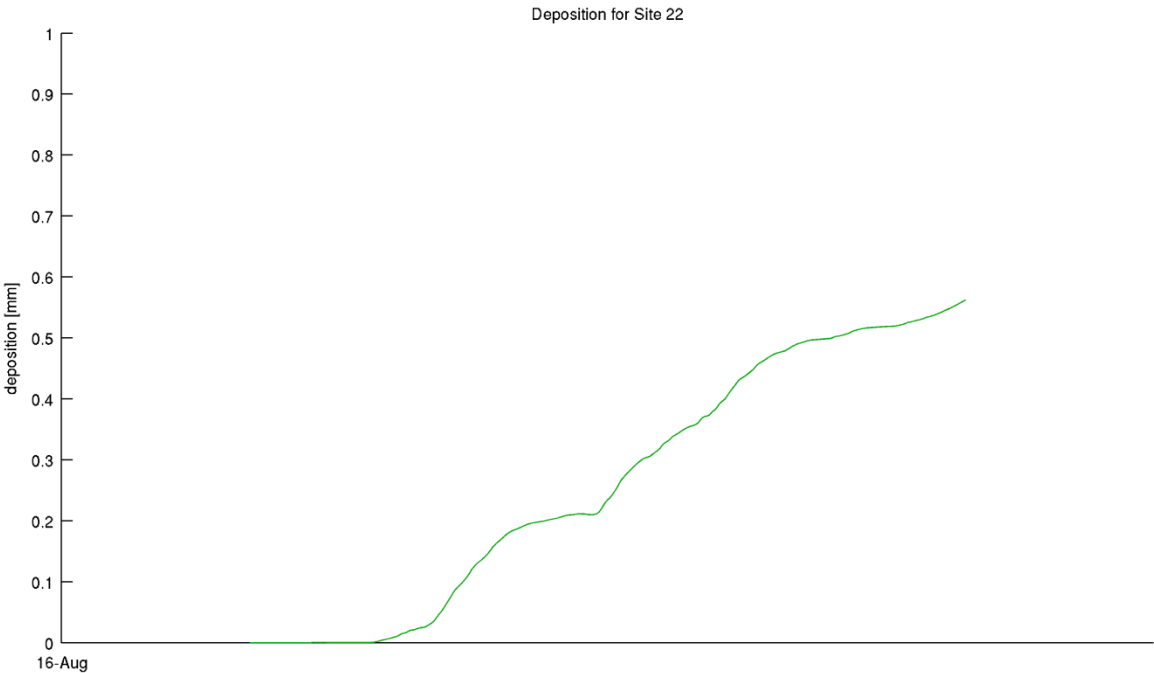
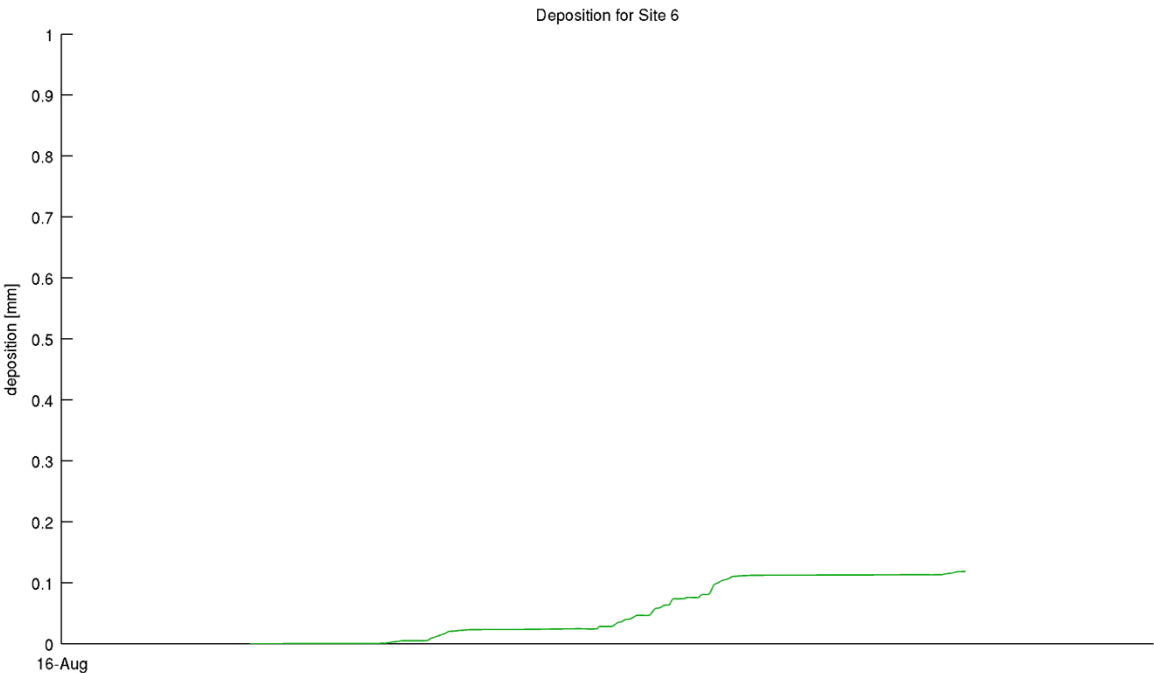


Sediment Deposition Time Series Plots

Stage 3 – Small TSHD Channel Dredging – Dense Clayey Sand Material – July 2009 Conditions

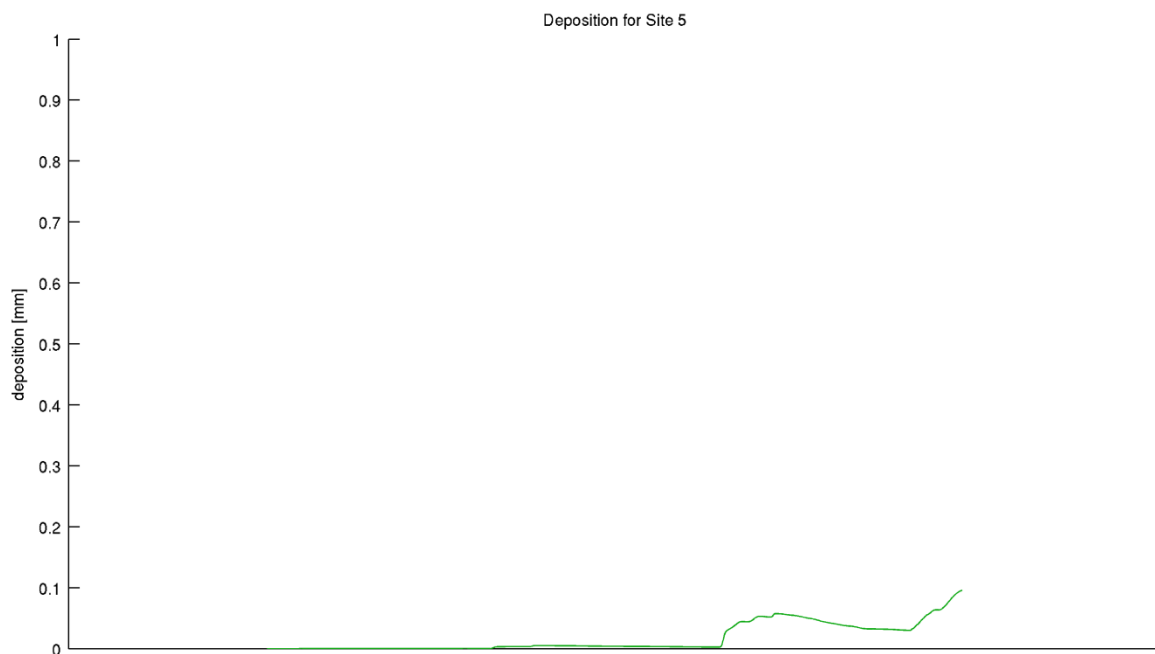
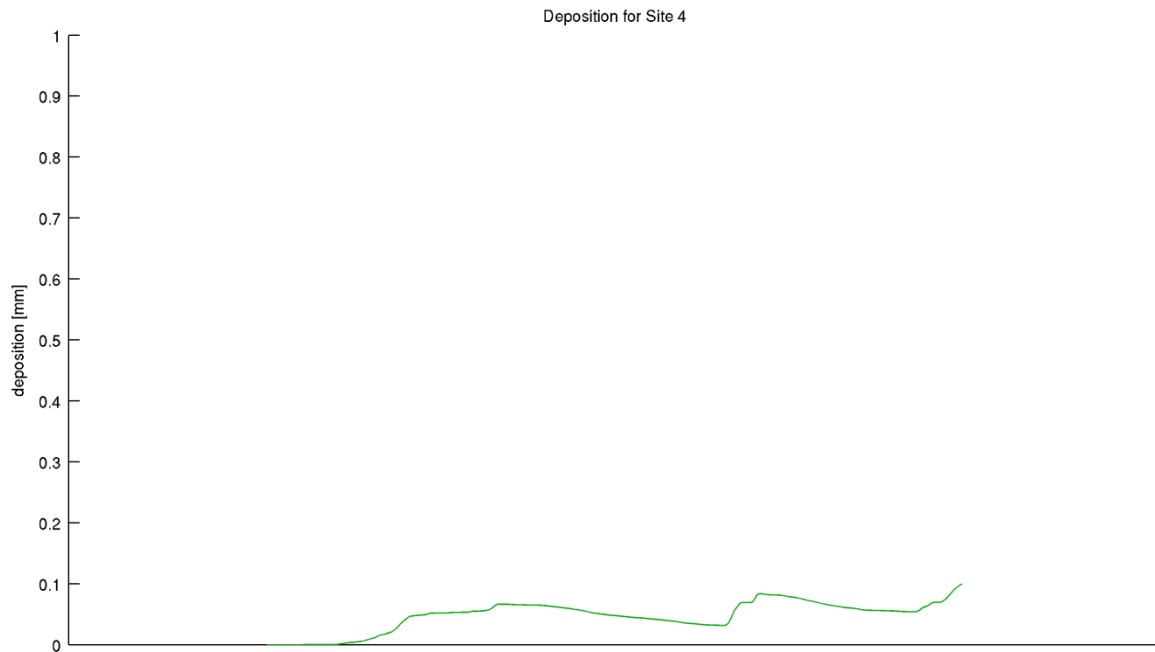


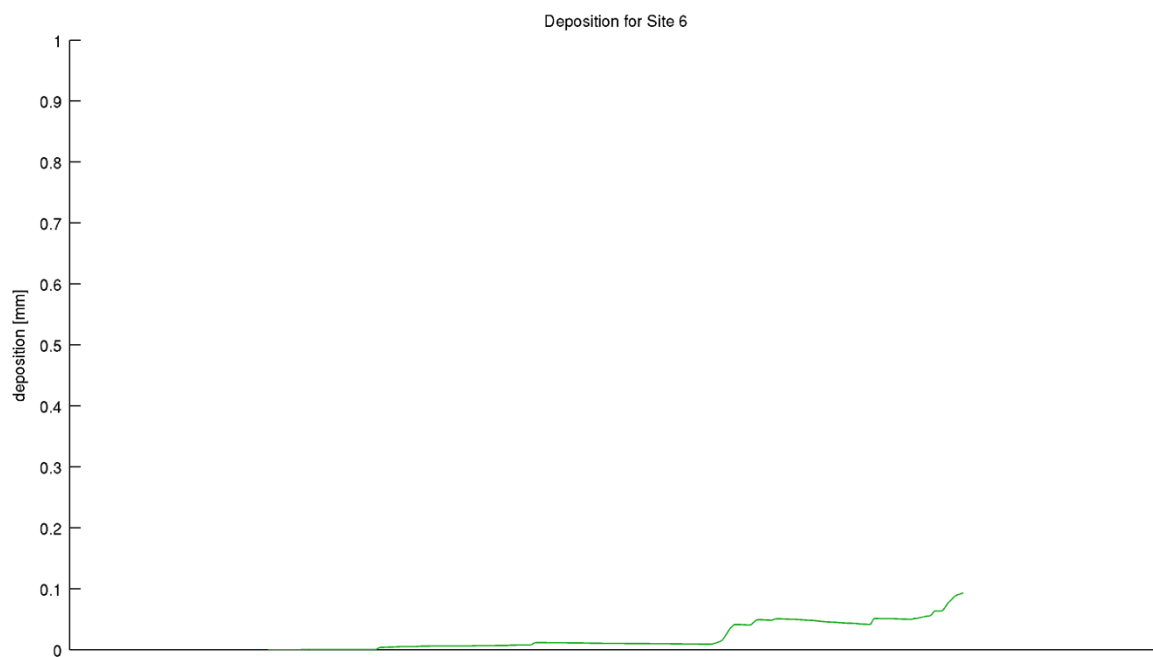




Sediment Deposition Time Series Plots

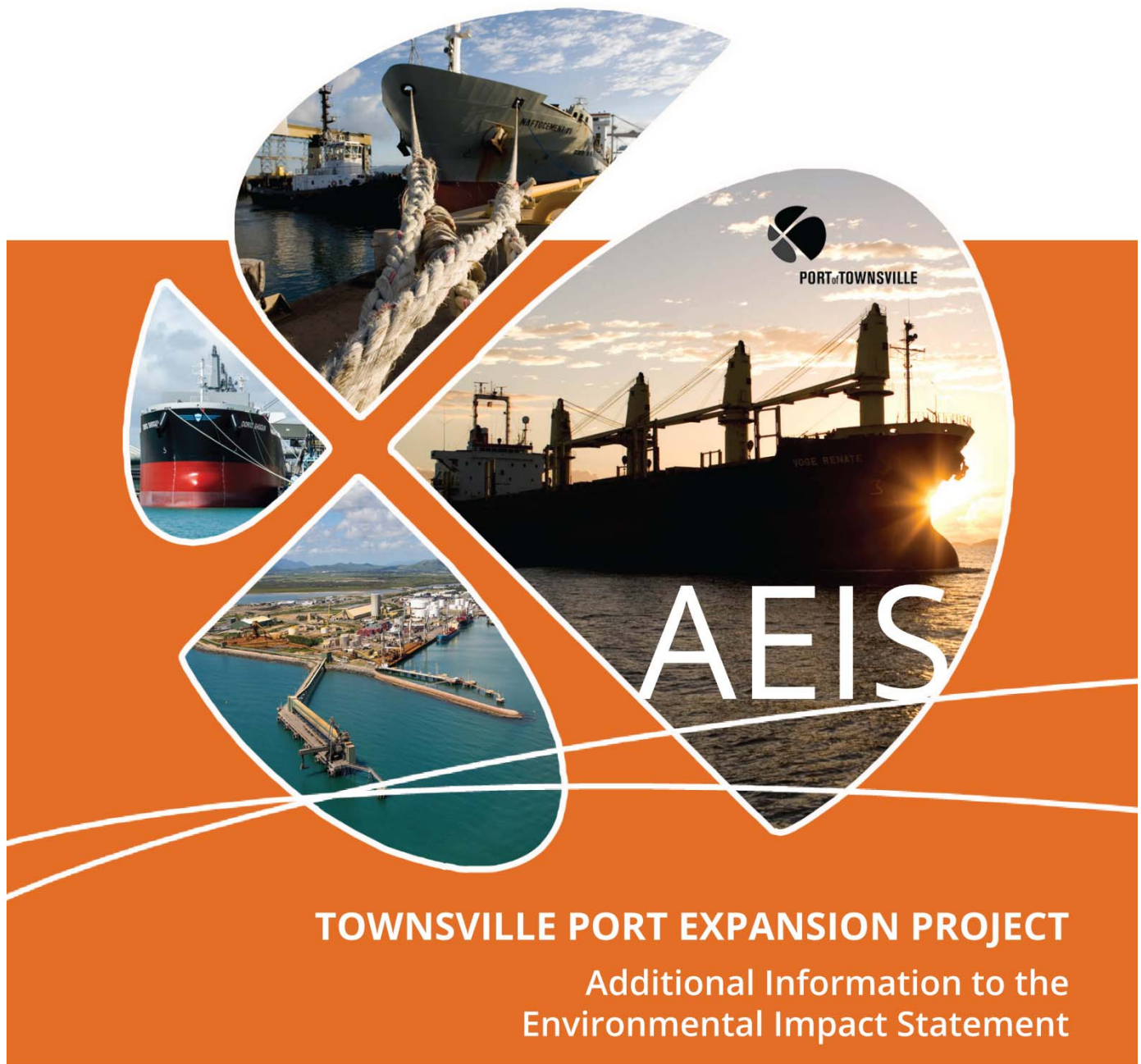
Stage 3 – Small TSHD Channel Dredging – Dense Clayey Sand Material – March 2010 Conditions







BMT WBM Bangalow	6/20 Byron Street, Bangalow 2479 Tel +61 2 6687 0466 Fax +61 2 66870422 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Brisbane	Level 8, 200 Creek Street, Brisbane 4000 PO Box 203, Spring Hill QLD 4004 Tel +61 7 3831 6744 Fax +61 7 3832 3627 Email bmtwbm@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Denver	8200 S. Akron Street, #B120 Centennial, Denver Colorado 80112 USA Tel +1 303 792 9814 Fax +1 303 792 9742 Email denver@bmtwbm.com Web www.bmtwbm.com
BMT WBM London	International House, 1st Floor St Katharine's Way, London E1W 1AY Email london@bmtwbm.co.uk Web www.bmtwbm.com
BMT WBM Mackay	PO Box 4447, Mackay QLD 4740 Tel +61 7 4953 5144 Fax +61 7 4953 5132 Email mackay@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Melbourne	Level 5, 99 King Street, Melbourne 3000 PO Box 604, Collins Street West VIC 8007 Tel +61 3 8620 6100 Fax +61 3 8620 6105 Email melbourne@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Newcastle	126 Belford Street, Broadmeadow 2292 PO Box 266, Broadmeadow NSW 2292 Tel +61 2 4940 8882 Fax +61 2 4940 8887 Email newcastle@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Perth	Level 3, 20 Parkland Road, Osborne, WA 6017 PO Box 1027, Innaloo WA 6918 Tel +61 8 9328 2029 Fax +61 8 9486 7588 Email perth@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Sydney	Level 1, 256-258 Norton Street, Leichhardt 2040 PO Box 194, Leichhardt NSW 2040 Tel +61 2 8987 2900 Fax +61 2 8987 2999 Email sydney@bmtwbm.com.au Web www.bmtwbm.com.au
BMT WBM Vancouver	Suite 401, 611 Alexander Street Vancouver British Columbia V6A 1E1 Canada Tel +1 604 683 5777 Fax +1 604 608 3232 Email vancouver@bmtwbm.com Web www.bmtwbm.com



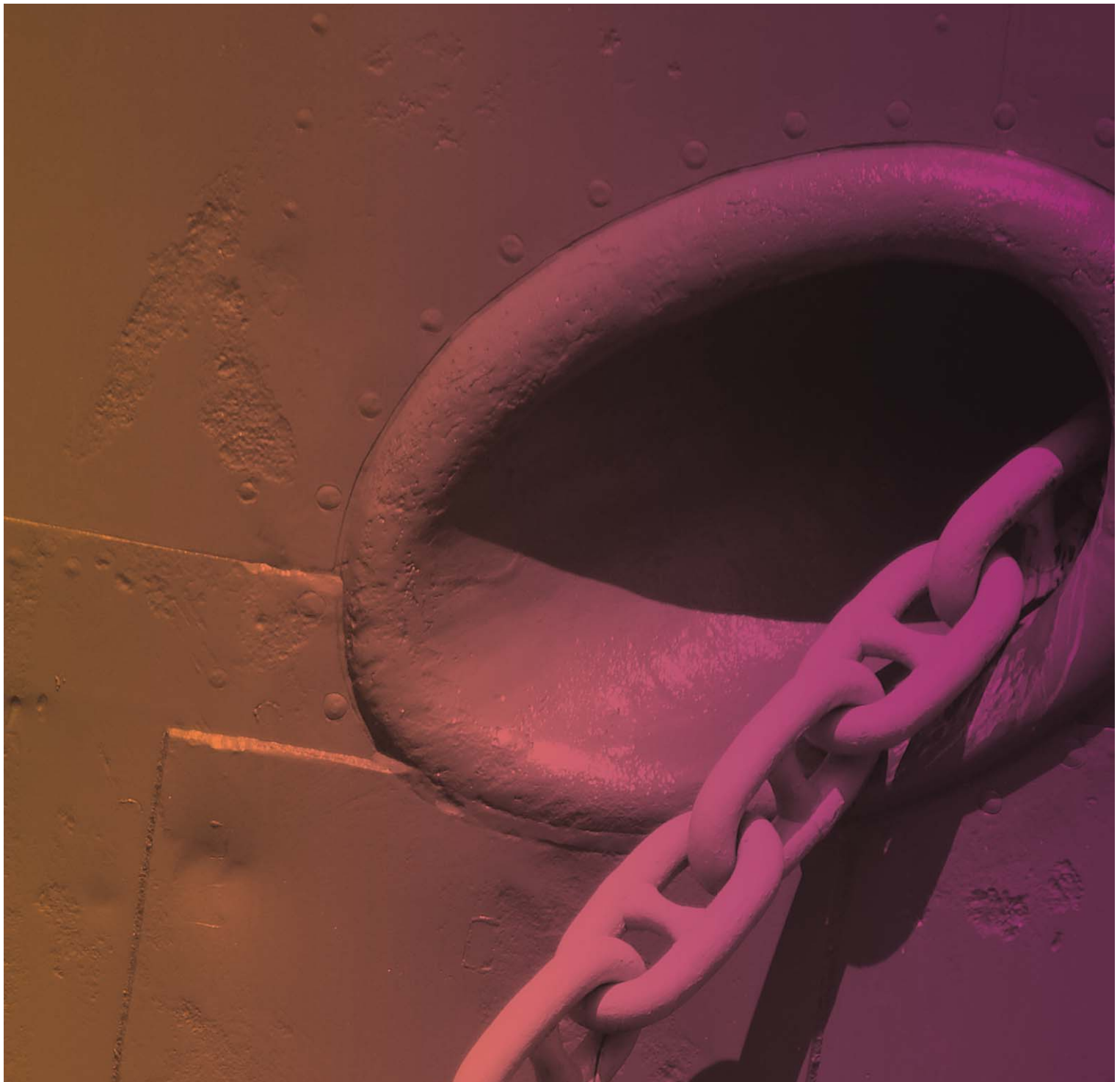
APPENDIX A3

Consideration of the PEP Design Refinement on Wave Climate at the Port of Townsville; Wave Analysis



Consideration of the PEP Design Refinement on wave climate at the Port of Townsville

Wave Analysis



Consideration of the PEP Design Refinement on wave climate at the Port of Townsville

Wave Analysis

Client: Port of Townsville Limited

Prepared by

AECOM Australia Pty Ltd

Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 7 3553 2000 F +61 7 3553 2050 www.aecom.com
ABN 20 093 846 925

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Quality Information

Document Consideration of the PEP Design Refinement on wave climate at the Port of
Townsville

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Reviewed by Stuart Bettington

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			Name/Position	Signature
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1.0 Introduction

In response to comments received around the Port Expansion Project (PEP) Environmental Impact Statement (EIS) a revised channel design has been adopted. The refined design involves widening of the channel to a width of 180 m at channel marker P16 tapering to a width of 135 m at channel markers P1/P2, and only partial deepening of the channel to an average design depth of -12.8 m chart datum (CD). In comparison the EIS reference design considered a channel width of 92 m (the existing channel width), widening to 130 m at channel markers P11/P12. The partial channel deepening involved in the revised reference design represents a reduction from the design depth of -13.7 m CD considered in the EIS.

This report presents the results of Boussinesq wave modelling and assessment of the probable impacts of the changes in the reference design on the wave climate leeward of the channel. The Boussinesq model used in this study is a phase resolving model that represents the interaction of the waves and steep dredged slopes. This modelling supplements the spectral wave modelling undertaken previously to provide greater insight into the interactions of waves with the dredged channel.

In undertaking this assessment, a particular focus has been on the transmitted waves. These waves ultimately progress to foreshores on the western side of the channel, such as The Strand and Rows Bay, and bays on Magnetic Island.

2.0 Partial channel deepening

A deeper channel can influence the degree of wave refraction as the waves pass over the dredge faces. Previous work undertaken for the Port of Townsville examined the impact of the approach channel on wave fields propagating across Cleveland Bay using Boussinesq wave modelling. This work (Knight & Bettington, 2012) was verified against recorded wave data in and around Platypus Channel. It was found that Snell's law provides a reliable first principle assessment of the impacts of the channel on waves in Cleveland Bay. Thus for this review the impact of changes in channel depth has been assessed using Snell's law. In developing the study methodology previous research into wave interactions with dredge channels was referenced (Cruickshank *et al.* 2008; Grey *et al.* 2010; Misra *et al.* 2008; Nielsen, Bonner & Berthot. 2012; Tao & Long. 2001; Zwamborn and Grieve. 1974).

Snell's law is used in the following form to describe the wave refraction processes occurring at dredged channels,

$$\alpha_r = \cos^{-1} \left(\cos(\alpha_i) \times \frac{C_i}{C_r} \right) \quad (1)$$

where C_i is the incident wave celerity, α_i is the incident wave angle, C_r is the refracted wave celerity, and α_r is the refracted wave angle.

The incident wave direction that results in the refracted wave running parallel to the edge of the channel is known as the critical angle, α_c . Waves that approach the channel from angles less than the critical angle will be internally reflected by the dredged slope and prevented from crossing into the channel. Such occurrences can be identified using Eq. 1.

For longer period waves, for which the wave celerity within the channel is dependent on the water depth, deepening of the channel will result in an increase in wave celerity within the channel. This increase in wave celerity will result in a change in the refracted wave direction and therefore the critical angle, as described by Snell's Law. For shorter period waves, where the wave celerity within the channel is not impacted by the water depth, the channel deepening will not impact the refracted wave direction.

Wave celerity is known to be dependent on water depth for relative water depths (h/L , where h is the water depth and L is the wave length) less than 0.5. Based on this criterion, wave celerity within the Refined Design channel (-12.8 m CD) will be dependent on the channel depth for waves with periods greater than approximately 4 seconds. Therefore, the change in channel depth will only impact wave refraction for waves with periods longer than 4 seconds.

Snell's law was used to assess the change in critical angle resulting from refined channel depth. Figures 1 to 3 show the variation of critical angle with wave period for wave reflection off the Platypus Channel for the PEP EIS design channel depth (-13.7 m CD) and refined PEP Additional Information to the Environmental Impact Statement (AEIS) design channel depth (-12.8 m CD), estimated using Snell's Law. The graphs also include 5

months of incident wave period and direction data recorded from September 2009 to February 2010 by an ADCP (Acoustic Doppler Current Profiler) located on the South-Eastern edge of the Platypus channel near channel marker P10. The changes in critical angle are small over the range of wave periods recorded on site, ranging from no change for a 2 second wave, up to 0.8° for a 10 second wave.

The Platypus Channel is orientated approximately perpendicular to the sea bed contours, and longer period waves refract to become more aligned with the channel. As a result, the longer period waves, for which wave refraction is impacted by the water depth in the channel, approach the channel from less than critical angle and are reflected off the channel for both the previous design and refined design scenarios. Therefore, the reduction in channel depth from -13.7 m CD in the PEP EIS design, to -12.8 m CD in the refined PEP AEIS design, is considered to have little impact on the transmitted wave climate.

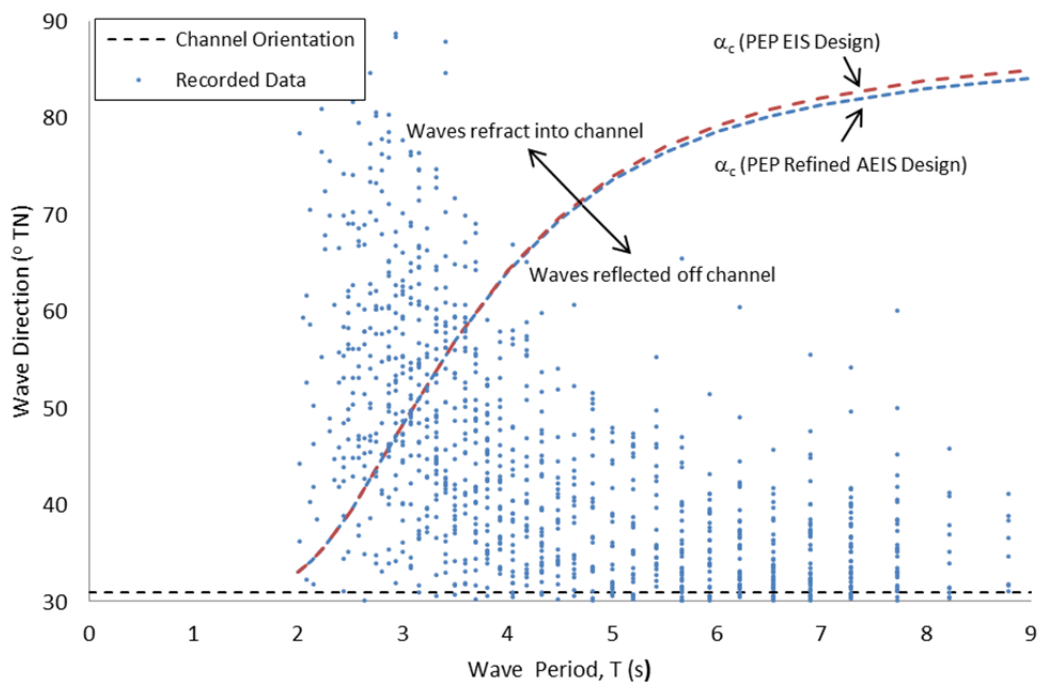


Figure 1 Theoretical assessment of impact of the change in channel depth on the critical angle for a water level of +0.00 CD m (LAT)

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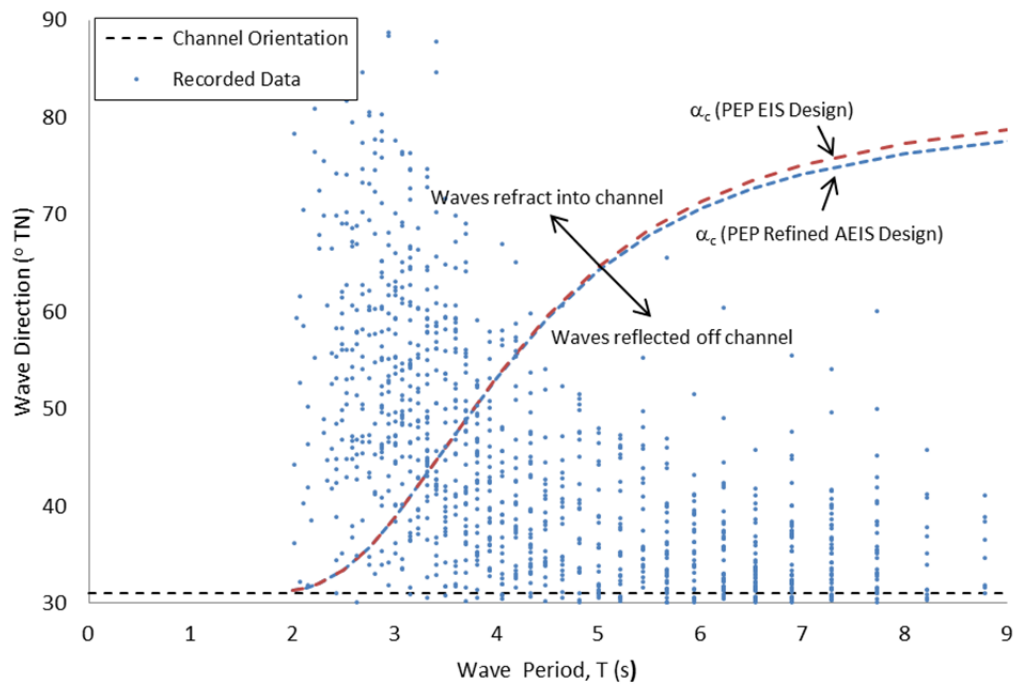


Figure 2 Theoretical assessment of impact of channel change in channel depth on the critical angle for a water level of +1.94 CD m (MSL)

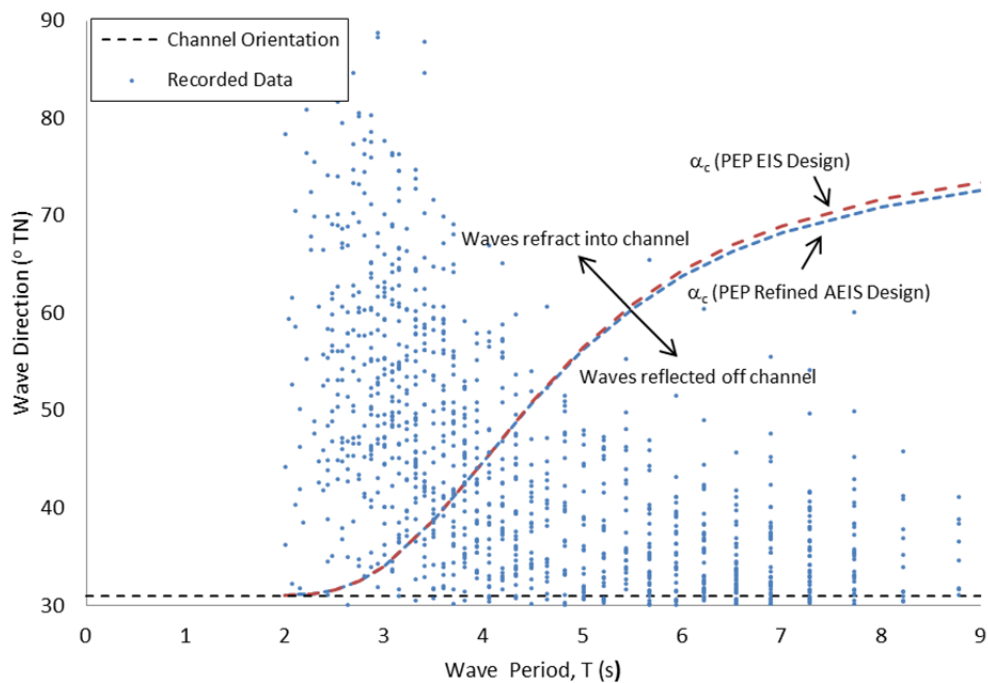


Figure 3 Theoretical assessment of impact of channel change in channel depth on the critical angle for a water level of +4.11 CDm (HAT)

3.0 Channel widening

The potential impact of the Design Refinement channel widening has been considered using the DHI MIKE21 BW modelling suite. MIKE21 BW is a phase resolving numerical model that is capable of accurately reproducing the wave transformation processes associated with abrupt changes in water depth, such as dredged channels.

3.1 Model setup

An existing Boussinesq model of Townsville Port and its approach channel was updated to include the proposed PEP AEIS reclamation and used to assess the impact of the Refined Design on the transmitted wave climate. The existing model had been set up to assess the wave climate within Townsville Port harbour, and the model results of interest for this study (i.e. the transmitted waves north of Townsville Port) were impacted by boundary effects (refer Section 3.3). The offshore model extents were therefore expanded to provide a larger area north of the channel not impacted by boundary effects (refer Section 3.3).

Figures 1 to 3 indicate that longer period waves approach the channel from directions that are less than critical angle relative the channel and are therefore reflected off the channel slope. As this assessment is primarily concerned with the impacts of the Design Refinement on the wave climate west of the channel, modelling needs to consider waves that pass over the channel. Modelling has therefore been performed using a wave period of 4 seconds, which allows for modelling of scenarios captured within the 5 months of recorded wave data at incident angles less than the critical angle.

The Boussinesq model has limitations on the relative water depth (h/L) and the ratio of wave length to spatial resolution ($L/\Delta x$) which limit simulation of shorter period waves. The maximum water depth (water depth in the channel) was consequently decreased to a hypothetical 7.5 m CD for the purpose of considering the channel widening to allow modelling of these shorter period waves. The modelling therefore does not incorporate changes in channel depth, which have been assessed separately in Section 2.0.

Wave inputs were generated using unidirectional, JONSWAP frequency spectra and input into the model using internal wave generation lines. As MIKE21 BW requires the water depth to be constant along the internal wave generation line, an artificial slope was incorporated into the model bathymetry to create a boundary with a constant water depth.

Three model bathymetries were created. The first has a constant channel width of 92 m. This is representative of the current channel width and the channel width over much of the channel within the PEP EIS design, as channel widening was only proposed for the stretch of channel between the port and channel markers P11/P12 in the PEP EIS design. The second model bathymetry is representative of the PEP EIS design and has a channel width of 92 m increasing to 130 m at channel marker P11/P12. This model bathymetry was used to assess the localised impact of the abrupt increase in channel width at channel markers P11/P12. The third bathymetry represents the refined PEP AEIS design and has a channel width of 180 m at channel marker P16 tapering to 135 m at channel markers P1/P2.

Figures 4 to 6 display the three model bathymetries and indicate where the internal wave generation line was located and where the transmitted wave climate was extracted. Waves entering the channel at the wave generation line impacted the results over much of the northern part of the model domain (refer Section 3.3). The transmitted wave extraction line was therefore located to avoid these impacts as much as possible.

Bottom friction has been included in the modelling, with a Chezy number of 65 being adopted (Manning's n of approximately 0.02).

This model setup is considered to be appropriate for considering the PEP AEIS Design Refinement changes.

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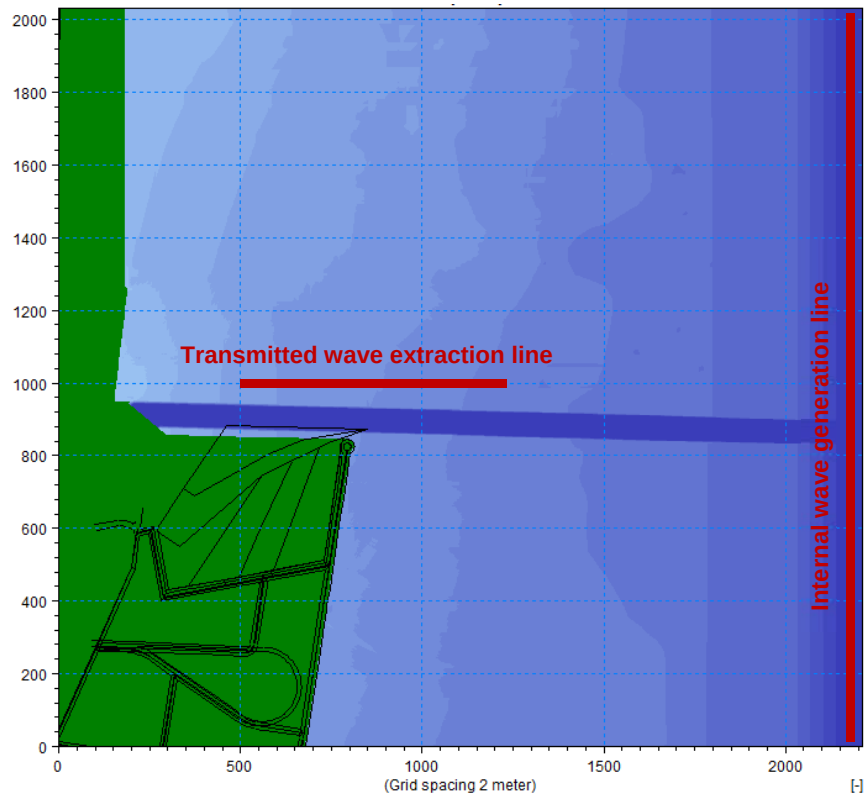


Figure 4 Model bathymetry with existing channel configuration (constant channel width of 92 m), indicating the location of the internal wave generation and transmitted wave extraction lines

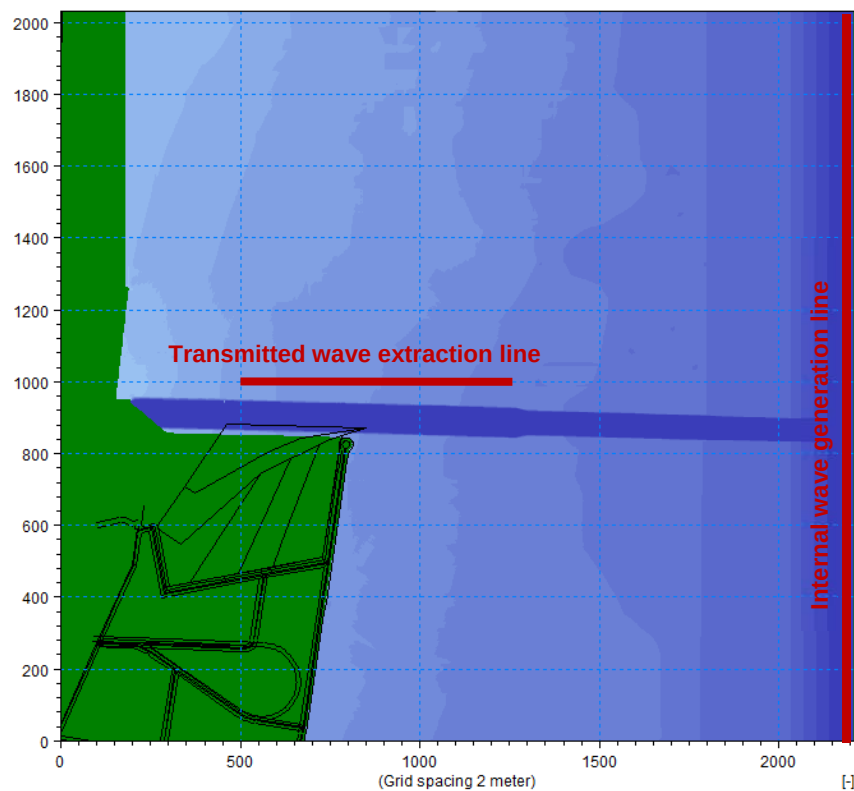


Figure 5 PEP EIS design model bathymetry with 92m wide channel increasing to 130 m wide at channel markers P11 and P12, indicating the location of the internal wave generation and transmitted wave extraction lines

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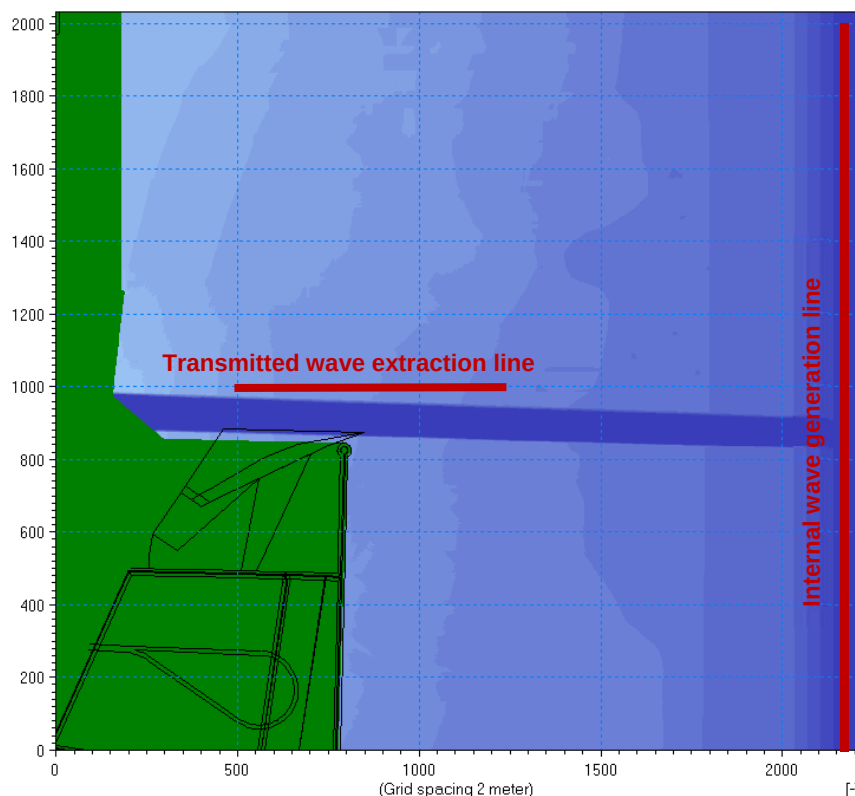


Figure 6 PEP Refined AEIS design model bathymetry with 180 m wide channel at channel marker P16 tapering to 135 m at channel markers P1/P2, indicating the location of the internal wave generation and transmitted wave extraction lines

3.2 Modelled scenarios

Table 1 presents a summary of the scenarios modelled using the bathymetries displayed in Figures 4 to 6. Figure 7 shows the modelled scenarios compared to the 5 months of data recorded from September 2009 to February 2010 by an ADCP (Acoustic Doppler Current Profiler) located on the South-Eastern edge of the Platypus channel near channel marker P10. For all model runs the water level was constant at Mean Sea Level (MSL) equivalent to +1.94 CD m.

Table 1 Modelled scenarios

Design Scenario	Wave Height Hs (m)	Peak Period Tp (s)	Incident wave direction (°)
Existing channel configuration	1	4	40
			50
			60
PEP EIS Design*	1	4	50
Refined PEP AEIS Design	1	4	40
			50
			60

*Modelling was only undertaken for a wave direction of 50 degrees for the PEP EIS Design as the impact of the abrupt widening of the channel at channel markers P11/P12 was not captured along the wave extraction line for the other wave directions.

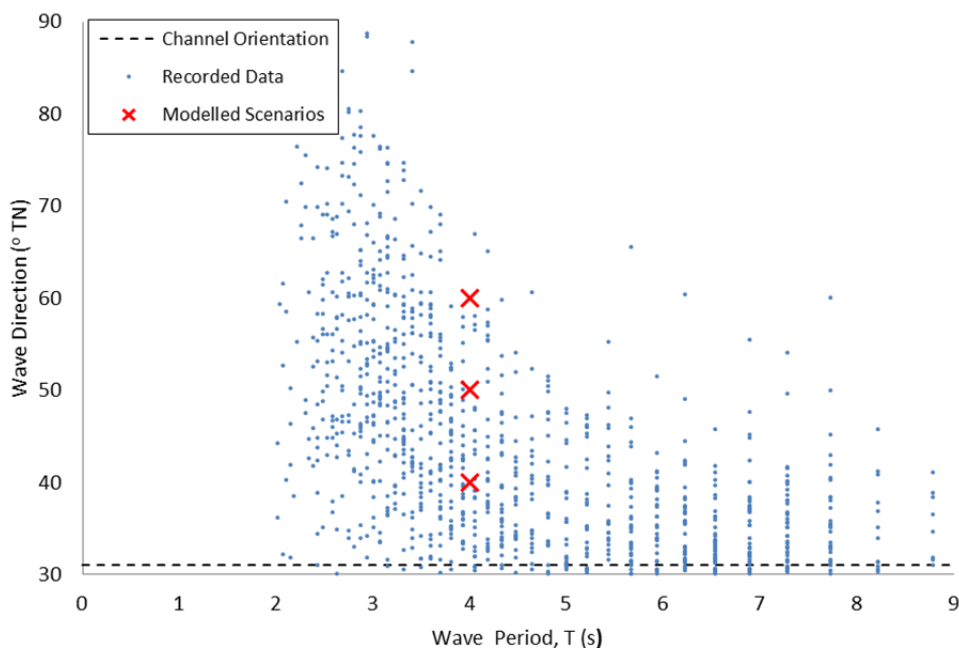


Figure 7 Modelled wave scenarios compared to recorded data and theoretical estimates of the critical angle of wave reflection

3.3 Results

Maps of the modelled wave heights for all model runs are displayed in Appendix A. The artificial slope required to achieve the constant water depth boundary for the internal wave generation results in waves entering the channel near the wave generation line, which impact the wave climate over the northern part of the model. The results of the model run for the 60° incident wave direction are also impacted by boundary effects from the bottom end of the wave generation line. The results should therefore not be relied upon in absolute terms.

The profiles of the transmitted significant wave height (H_s) along the extraction line for the model simulations considering the channel at the constant 92 m and the refined PEP AEIS design configuration of 135 m wide increasing to 180 m wide near the port are displayed in Figures 8 to 10. It is noted that significant wave height (H_s) is the average height of the 1/3 biggest waves in a wave field and is the common characteristic used to describe the wave height. The results indicate only very minor differences in the transmitted wave height for the change in channel width from the constant 92 m to the refined PEP AEIS design configuration of 135 m wide increasing to 180 m wide near the port.

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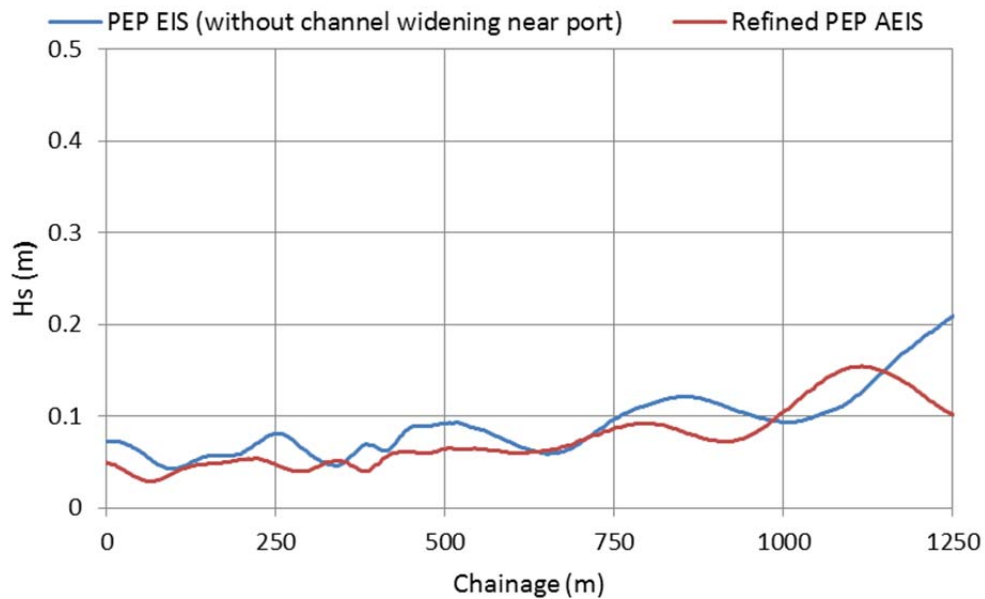


Figure 8 Impact of channel layout on the modelled transmitted wave climate, $T_p = 4$ seconds, Wave direction = 40°

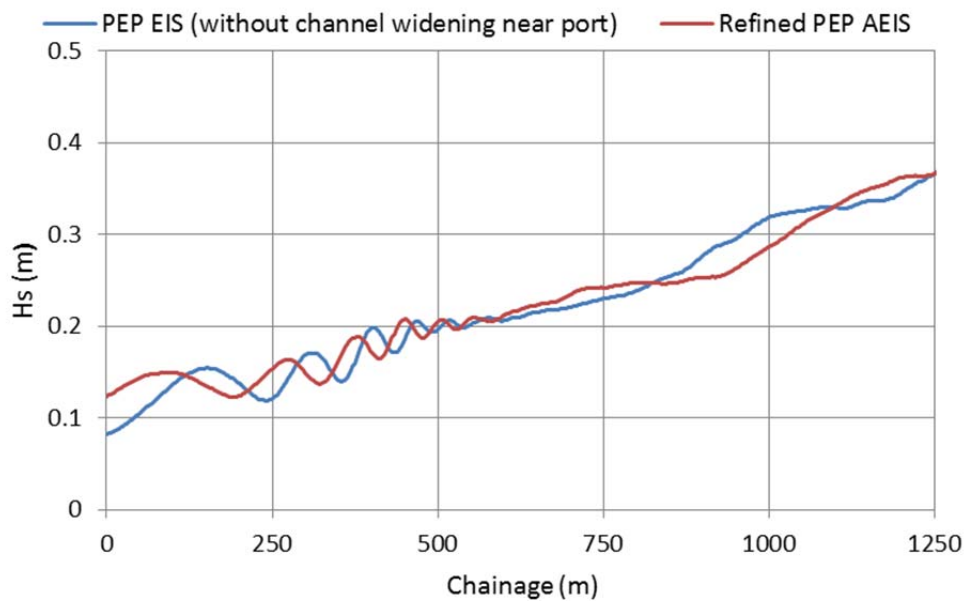


Figure 9 Impact of channel layout on the modelled transmitted wave climate, $T_p = 4$ seconds, Wave direction = 50°

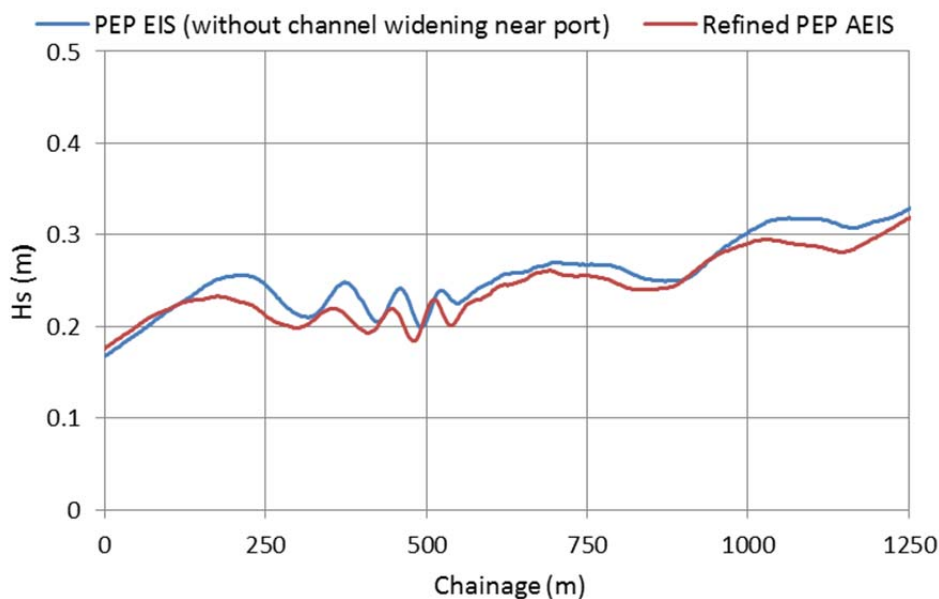


Figure 10 Impact of channel layout on the modelled transmitted wave climate, $T_p = 4$ seconds, Wave direction = 60°

The profile of the transmitted significant wave height (H_s) along the extraction line for the model simulation that includes the increase in channel width at the P11/P12 channel is compared against that for the refined PEP AEIS design configuration of 135 m wide increasing to 180 m wide near the port in Figure 11. The results indicate that the abrupt increase in channel width at channel markers P11/P12 in the PEP EIS design may result in a minor, localised redistribution of wave energy west of channel markers P11/P12. As the refined PEP AEIS uses a gradual increase in channel width this localised redistribution of wave energy does not occur.

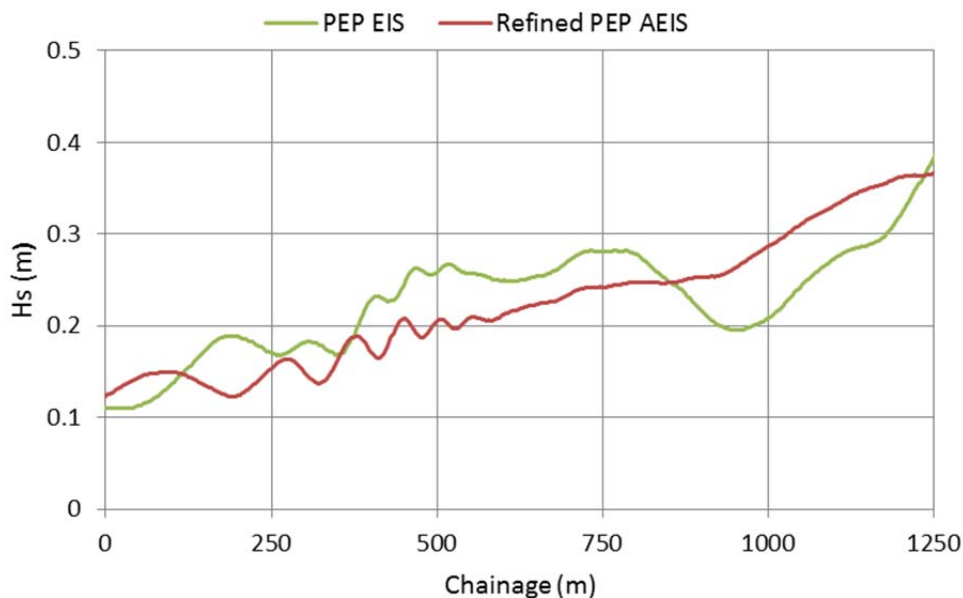


Figure 11 Impact of abrupt increase in channel width at channel marker P11/P12 on transmitted wave climate, Wave direction = 50°

4.0 Summary

The impact of changing the channel depth on wave interaction with the channel slope has been assessed using first principles. This assessment indicated that changes in channel depth would have minimal impact on wave interactions for the shorter period waves passing over the channel. The change in channel depth was found to have a minor impact on longer period waves, however these swell waves approach from offshore and encounter the channel from much less than the critical angles of wave reflection. Thus swell waves currently and will continue to reflect off the channel under both the PEP EIS and refined PEP AEIS design layout. Therefore the proposed changes in channel depth will have minimal impact on the wave climate in Cleveland Bay.

The impact of changes to the channel layout on the transmitted wave climate, including reduced energy dissipation due to bottom friction, has been assessed using a Boussinesq numerical model. The results indicate that widening the channel has a minimal impact of the transmitted wave climate. Whilst the modelling shows that the PEP EIS design may result in a minor redistribution of wave energy west of the increase in channel width at channel markers P11/P12, the gradual increase in channel width in the refined PEP AEIS design does not result in this localised effect.

Assessment of the impact of both the change in channel depth and channel width on the transmitted wave climate have been undertaken, and found to not have a significant impact. The combined channel deepening and widening together indicate that the design refinement will have a negligible change on transmitted waves which is not anticipated to be physically measurable beyond the channel edge and therefore is not expected to materially alter the transmitted waves that may ultimately progress to foreshores on the western side of the channel, such as The Strand, Rowes Bay and bays on Magnetic Island.

5.0 References

- Cruickshank, I.C., Beresford, P., Grey, S.M, Tozer, N.P. (2008). Innovative techniques to reduce or remove the need for a breakwater, Proceedings of the 7th International Conference on Coastal and Port Engineering in Developing Countries, Dubai, Paper 11.
- Grey, S.M., Cruickshank, I.C., Beresford, P.J. and Tozer, N.P. (2010). The impact of navigation channels on berth protection, Proceedings of the ICE – Civil Engineering, Vol. 163
- Knight, S.J.F., Bettington, S.H., (2013), “Wave Interactions with Dredged Areas”, Coasts and Ports 2013: 21st Australasian Coastal and Ocean Engineering Conference and the 14th Australasian Ports and Harbours Conference, September 2013
- Misra, S.K, Driscoll, A.M., Kirby, J.T., Cornet, A., Lomonaco, P., Sayao, O. and Yavary, M. (2008). Surface gravity wave interactions with deep-draft navigation channels – Physical and numerical modelling case studies, Proceedings of the 31st International Conference on Coastal Engineering, Hamberg, Vol. 3, pp. 2786-2798
- Nielsen, A.F., Bonner, R.I. and Berthot, A. (2011). Wave energy reflection off dredged channels, Proceedings of the 20th Australasian Coastal Ocean Engineering conference and the 13th Australasian Ports and Harbour Conference, pp 535-539
- Tao, J. and Long, W. (2001). The critical angle of wave refraction and multiple refraction by harbour approach channels and basins, Proceedings of the 29th IAHR Congress, Cardiff, pp 472 – 478
- Zwamborn, J.A. and Grieve, G. (1974). Wave attenuation and concentration associated with harbour channels, Proceedings of the 14th International Conference on Coastal Engineering, Copenhagen, pp 2068-2085

6.0 Appendix A

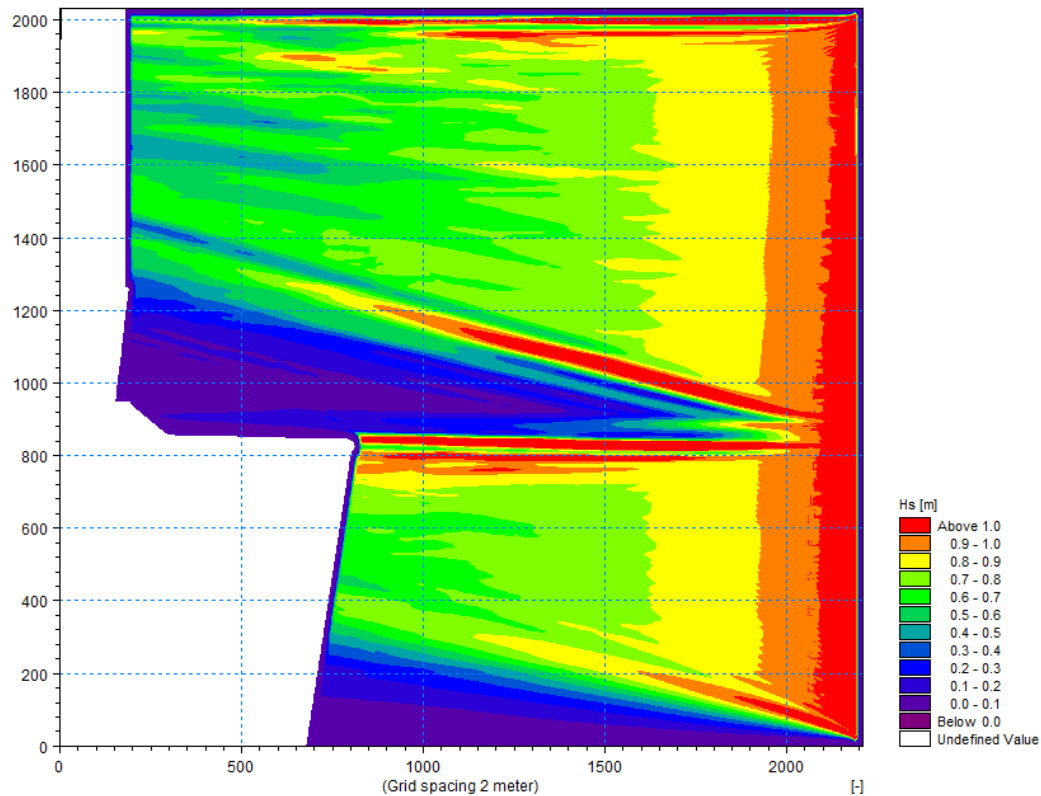


Figure A1 Boussinesq model results for PEP EIS design with a channel width of 92 m, $T_p = 4$ seconds, Wav direction = 40°

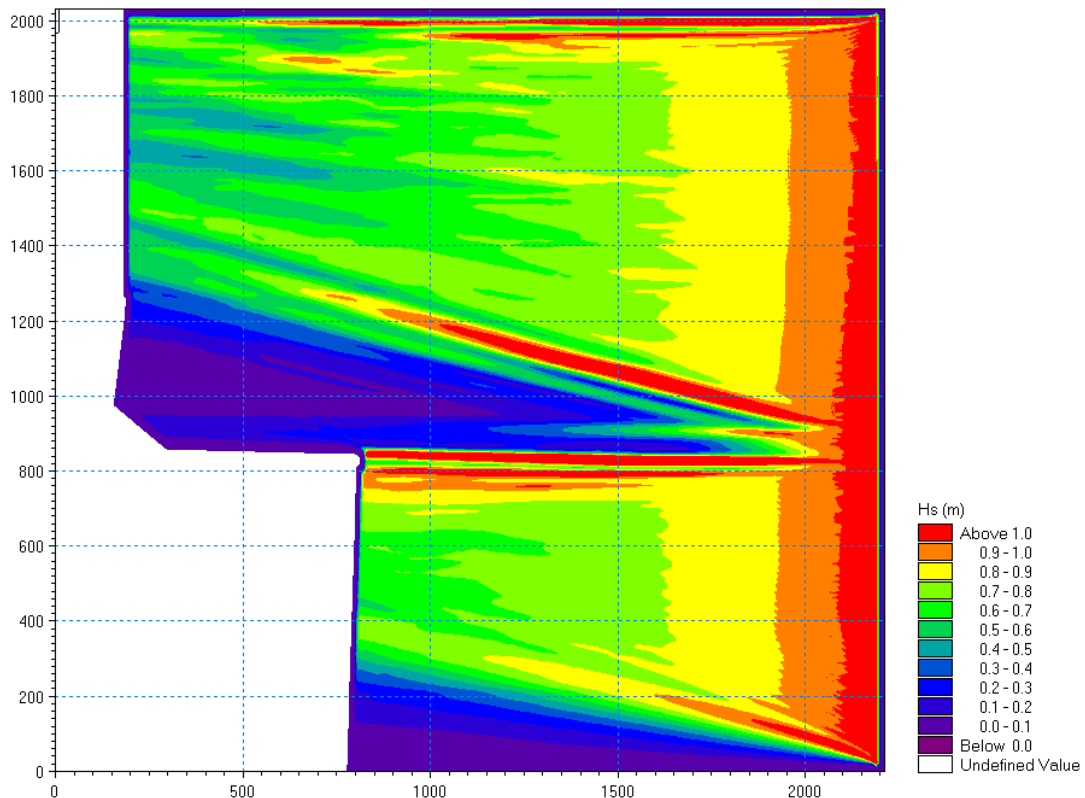


Figure A2 Boussinesq model results for refined PEP AEIS design, $T_p = 4$ seconds, Wav direction = 40°

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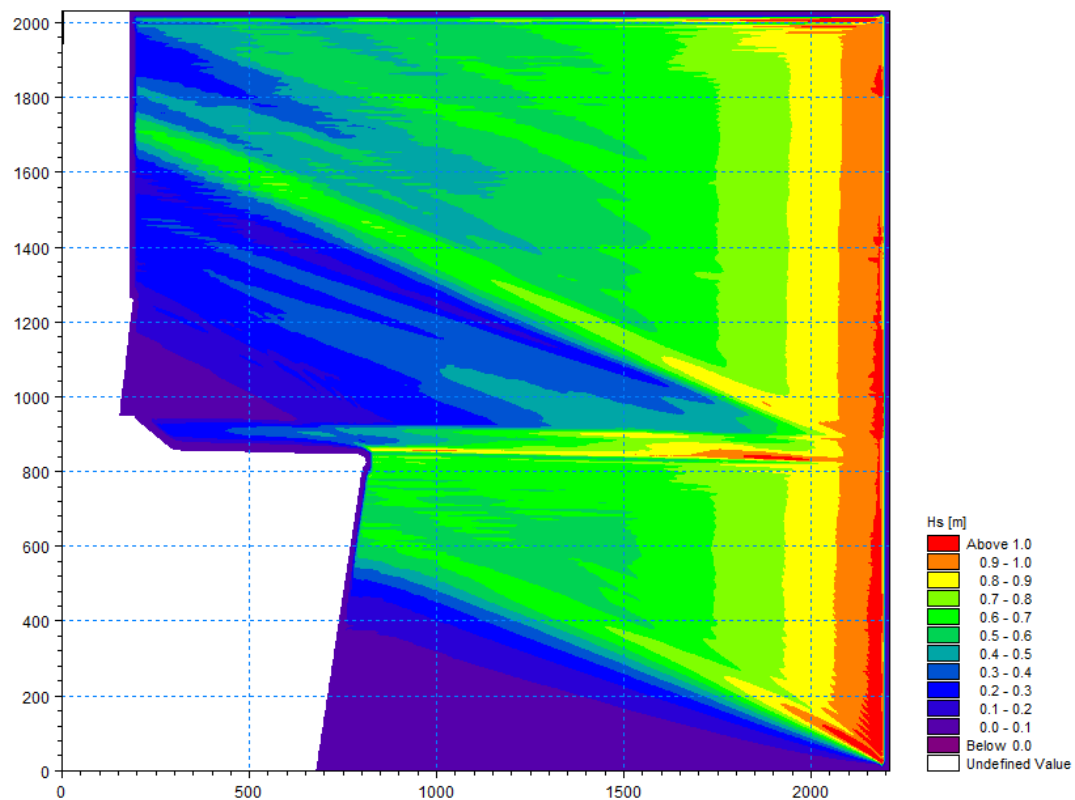


Figure A3 Boussinesq model results for PEP EIS design with a channel width of 92 m, $T_p = 4$ seconds, Wav direction = 50°

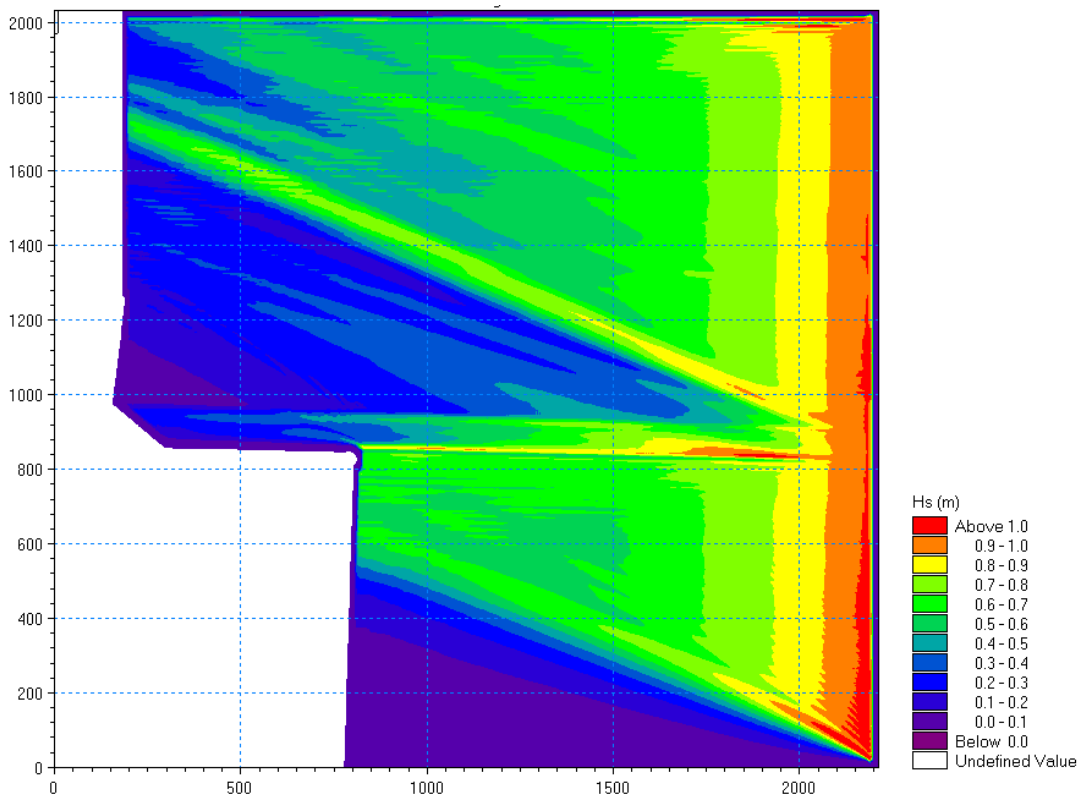


Figure A4 Boussinesq model results for refined PEP AEIS, $T_p = 4$ seconds, Wav direction = 50°

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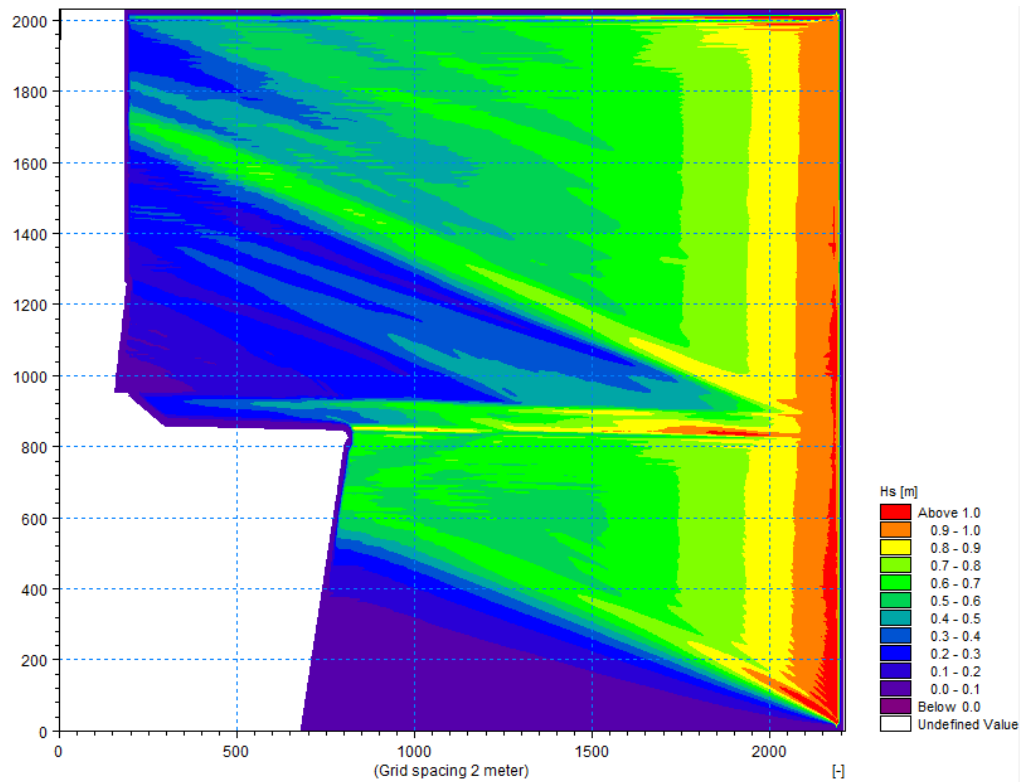


Figure A 5 Boussinesq model results for PEP EIS design with a channel width of 92 m, increasing to 130 m at channel markers P11/P12, $T_p = 4$ seconds, Wav direction = 50°

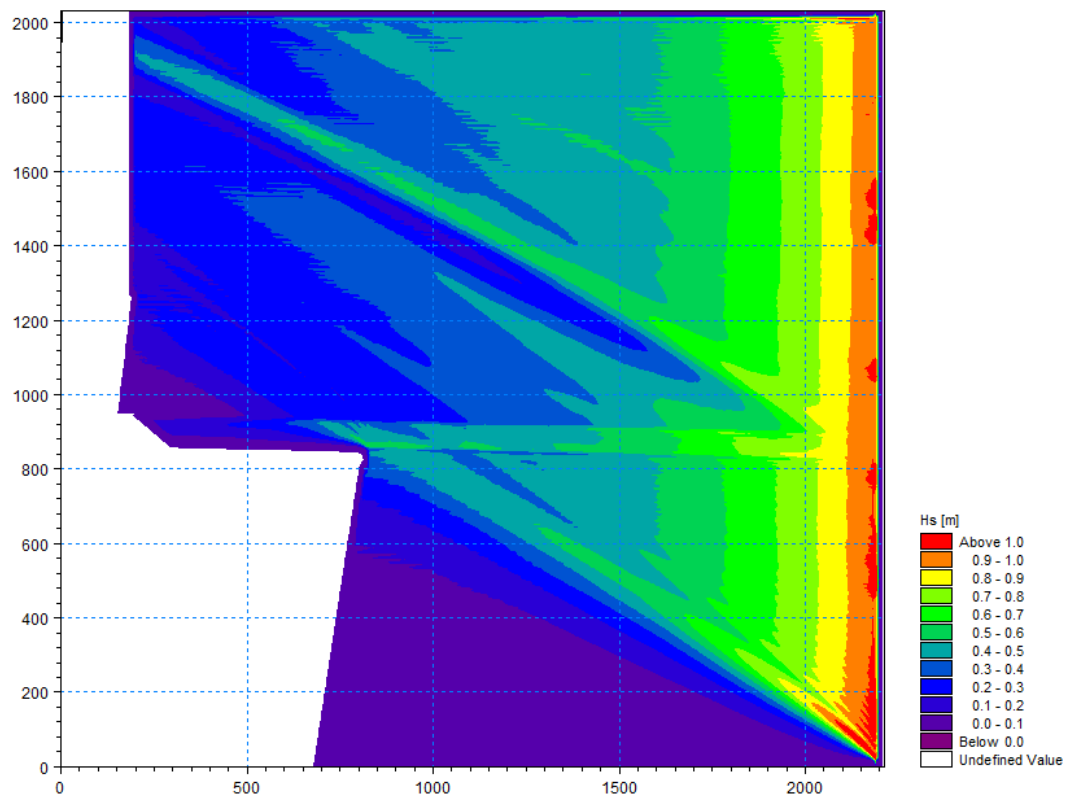


Figure A 6 Boussinesq model results for PEP EIS design with a channel width of 92 m, $T_p = 4$ seconds, Wav direction = 60°

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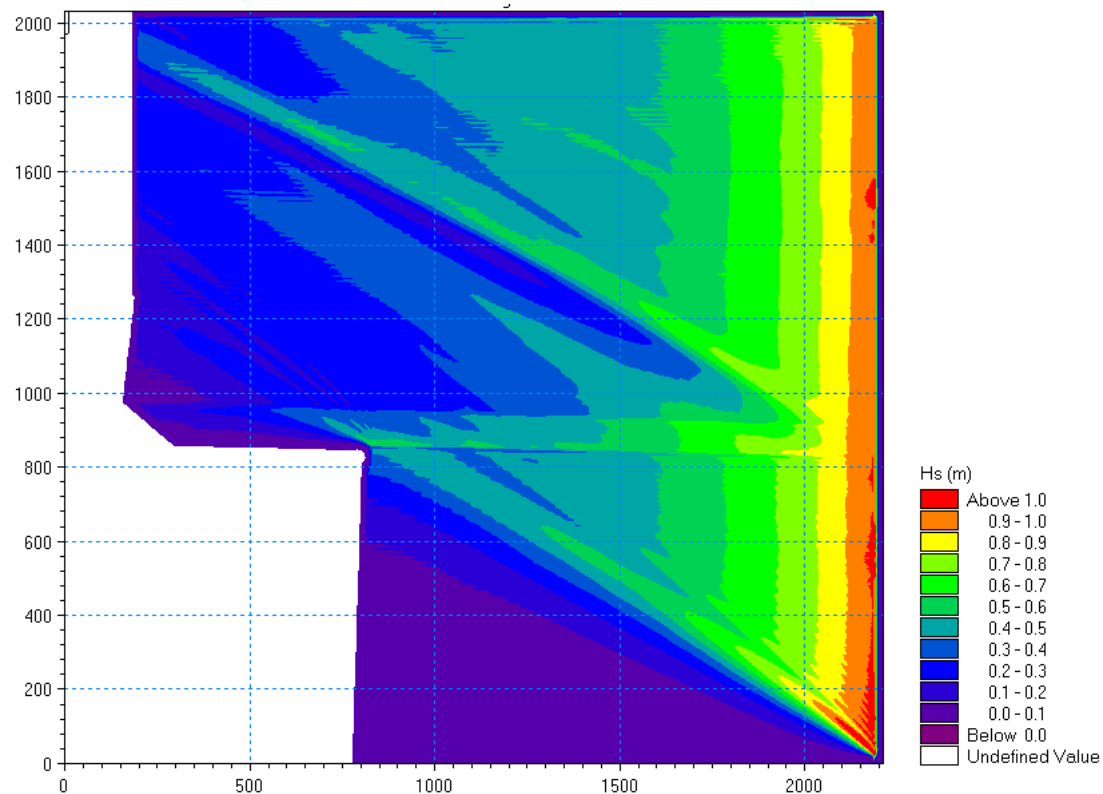
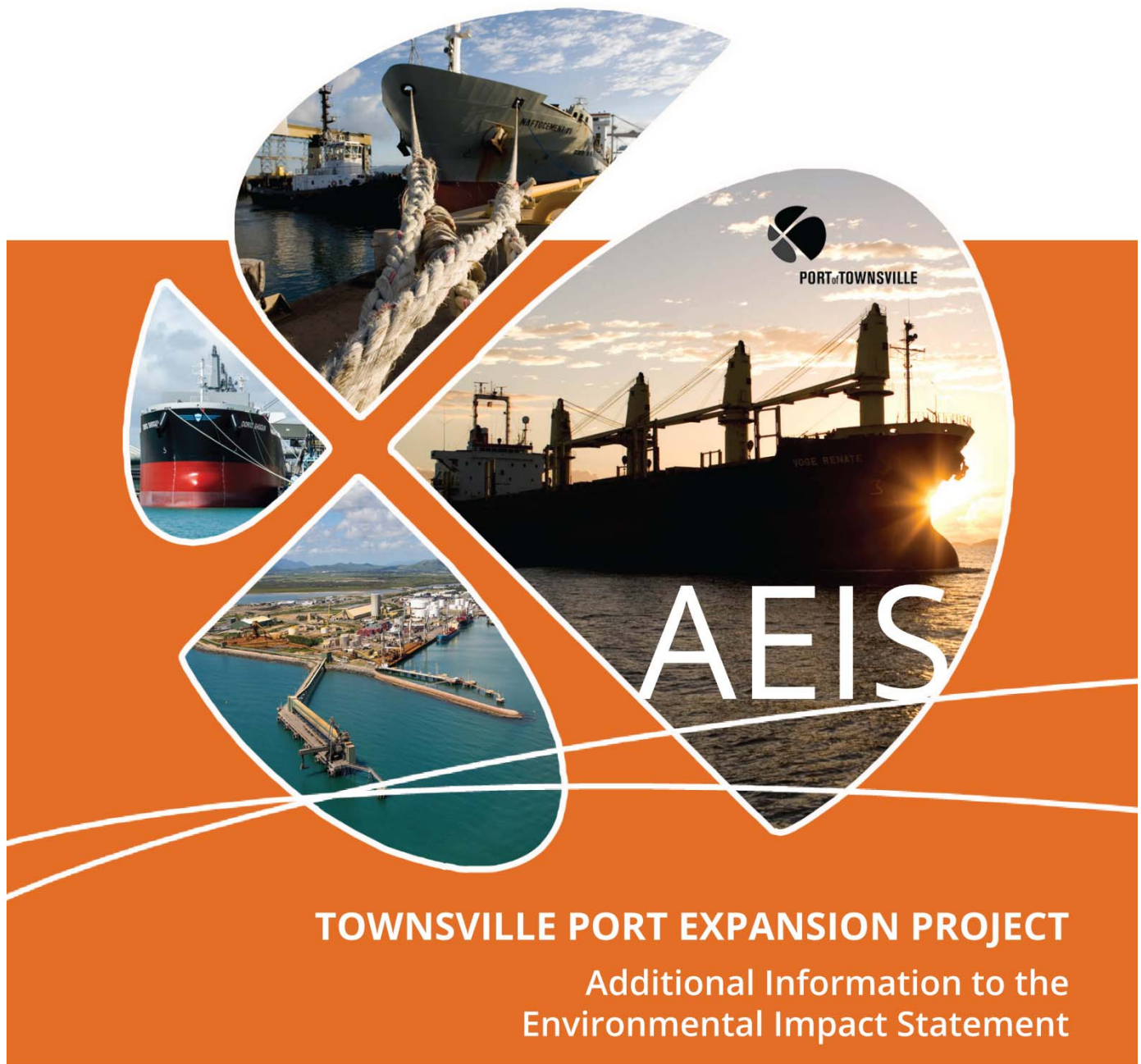


Figure A 7 Boussinesq model results for refined PEP AEIS design, $T_p = 4$ seconds, Wav direction = 60°



APPENDIX A4

Air Quality Impact Assessment Supporting Information



1.0 Introduction

The following summary outlines the aspects of the air quality assessment that were modified as a result of the design refinement and the findings of the revised dispersion modelling.

2.0 Ambient Air Quality Objectives

The *Environmental Protection (Air) Policy 2008* (EPP [Air]) sets ambient air quality objectives for priority air pollutants in Queensland. Table 1 presents air quality objectives for particulate matter and combustion gases included in this air dispersion modelling assessment, making reference to the environmental values the criteria were specifically developed to protect. It should be noted that the objectives for the particulate matter and combustion gases listed below are not applicable to air emissions experienced within a workplace that are emitted from that workplace, i.e. the objectives do not apply to the construction site itself.

These criteria are designed to provide a level to meet the health and well-being environmental value.

Table 1 Queensland EPP (Air) ambient air quality objectives

Indicator	Averaging Period	EPP (Air) Criteria	Environmental Value	Units
TSP	1 year	90	Health and well-being	$\mu\text{g}/\text{m}^3$
PM ₁₀	24 hours	50*	Health and well-being	$\mu\text{g}/\text{m}^3$
PM _{2.5}	24 hours	25	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	8	Health and well-being	$\mu\text{g}/\text{m}^3$
NO ₂	1 hour	250	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	62	Health and well-being	$\mu\text{g}/\text{m}^3$
CO	8 hours	11,000	Health and well-being	$\mu\text{g}/\text{m}^3$
SO ₂	1 hour	570	Health and well-being	$\mu\text{g}/\text{m}^3$
	24 hours	230	Health and well-being	$\mu\text{g}/\text{m}^3$
	Annual	57	Health and well-being	$\mu\text{g}/\text{m}^3$

Notes: * 5 days allowable exceedances per year. On this basis, the sixth highest predicted 24-hour concentration has been compared with the criterion.

To aid in the assessment of the dust emitted from the facility, additional criteria were sought to assist in the overall understanding of the potential for air quality impacts. The Queensland Department of Environment and Heritage Protection (DEHP) criteria for deposited dust and the NSW EPA criteria for annual average PM₁₀ (DEC, 2005) were also used for assessment to assist in the understanding of dust fallout potential and long term particulate impacts from PM₁₀. Criteria adopted were as follows:

- Deposited dust (dustfall) limit of 120 mg/m².day averaged over 1 month.
- Annual average PM₁₀ criterion of 30 $\mu\text{g}/\text{m}^3$.

3.0 Background Air Quality

The adopted background PM₁₀, Total Suspended Particulate (TSP), and dust deposition values were discussed in Section B.9.3.4.1 in the EIS. These values were still considered representative of existing conditions at Townsville Port and have been adopted again for this Air Quality impact Assessment AQIA. The adopted values are presented in Table 2 and Table 3.

Nitrogen dioxide and sulfur dioxide are monitored in the Townsville area by DEHP at Pimlico, approximately 7 km to the south west of Townsville Port. Maximum concentrations measured during the period 2011 to 2013 were adopted as background air quality concentrations.

Table 2 Adopted background concentrations for dust

Particulate Matter Type	Averaging Period	Adopted Value ($\mu\text{g}/\text{m}^3$)
PM ₁₀	24 hours	24.7
	Annual	21.4
TSP	Annual	43.6
Dust Deposition	Annual	46.0 mg/m ² .day

Carbon monoxide is not monitored in the Townsville area. Carbon monoxide data were sourced from the DEHP operated monitoring station in Woolloongabba, Brisbane. The Woolloongabba station is located adjacent to a major freeway in a densely populated urban environment. CO concentrations at this location are likely to be higher than in the Townsville Port area due to higher population density and vehicle numbers. The Woolloongabba data were adopted as a conservative estimate of existing CO concentrations in Townsville.

PM_{2.5} data are not available in the Townsville area. These data were sourced from the DEHP Boat Creek monitoring station in Gladstone. PM_{2.5} concentrations at Boat Creek are likely to be higher than in the Townsville area due to proximity of the monitoring station to heavy industry in the Gladstone area. The Boat Creek data were adopted as a conservative estimate of existing PM_{2.5} concentrations in Townsville.

Table 3 Adopted background concentrations for combustion gases

Combustion Gases	Averaging Period	Station	Data period	Adopted Value (µg/m ³)
NO ₂	1 hour	Pimlico	2011 - 2013	86.3
	Annual	Pimlico	2011 - 2013	12.3
SO ₂	1 hour	Pimlico	2011 - 2013	25.7
	24 hours	Pimlico	2011 - 2013	17.1
	Annual	Pimlico	2011 - 2013	2.9
CO	8 hour	Woolloongabba	2012 - 2013	2,250.0
PM _{2.5}	24 hours	Boat Creek	Feb 2013 – Jan 2014	19.9
	Annual	Boat Creek	Feb 2013 – Jan 2014	4.8

4.0 Receptors

Potential nearby sensitive receptors to the PEP are presented in Table 4 and Figure 1. Most receptors locations are identical to those included in the EIS, with the exception of Receptor 1, 2 and 3 which are flagpole receptors at The Ville Resort - Casino tower. The flagpole receptors at the Resort - Casino were included to account for the inclusion of shipping emissions, which are emitted from tall stacks and are have the potential to result in elevated concentrations above ground level.

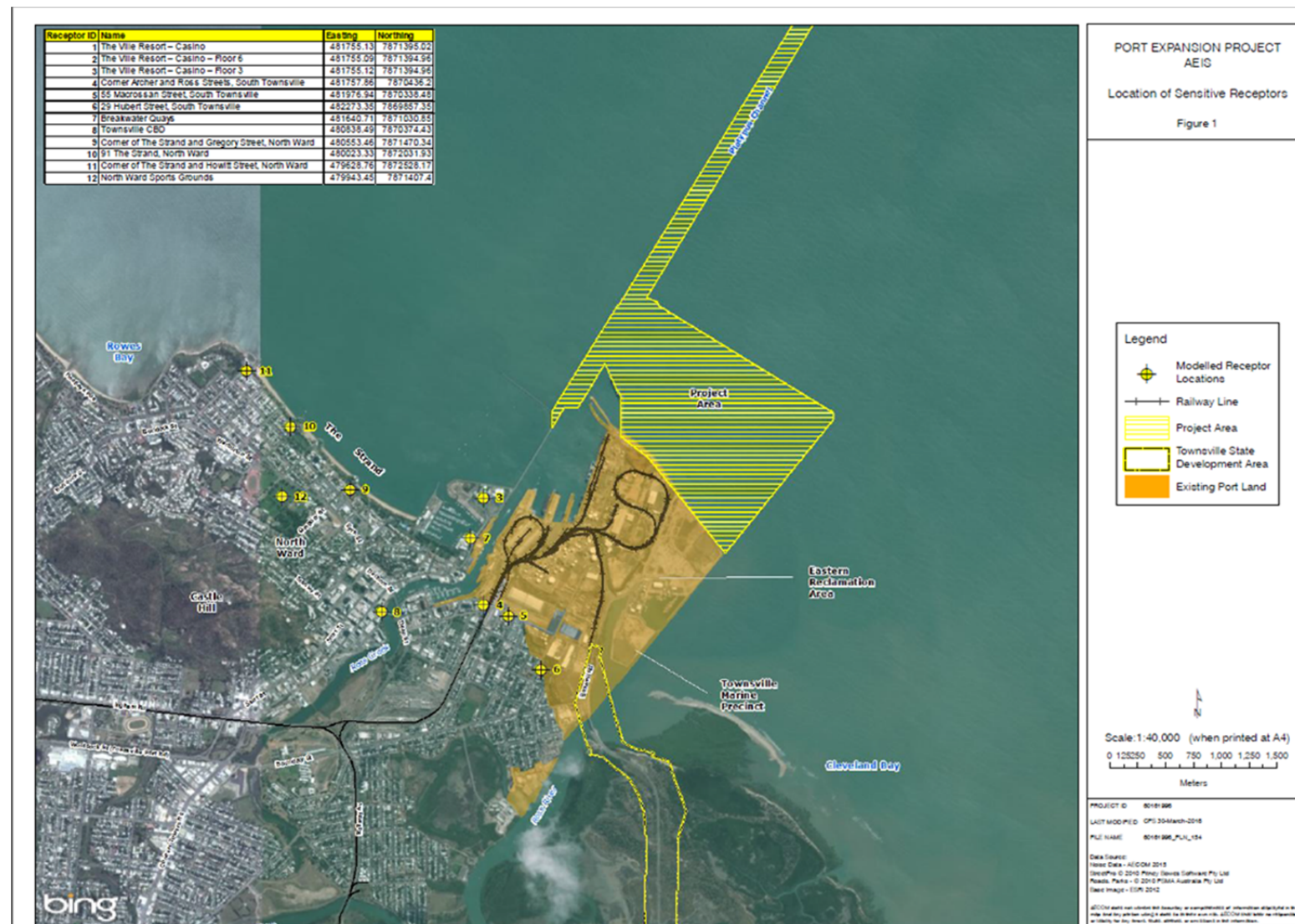


Figure 1 Sensitive Receptors

Table 4 Sensitive receptors

Receptor ID	Modelled Receptor Location	Approximate Distance from PEP (km)	Receptor Type
1	The Ville Resort - Casino – Top Floor	1.4	Commercial
2	The Ville Resort - Casino – Floor 6	1.4	Commercial
3	The Ville Resort - Casino – Floor 3	1.4	Commercial
4	Corner Archer and Ross Streets, South Townsville	1.8	Residential
5	55 Macrossan Street, South Townsville	1.9	Residential
6	29 Hubert Street, South Townsville	2.0	Residential
7	Breakwater Quays	1.6	Residential
8	Townsville CBD	2.7	Residential
9	Corner of The Strand and Gregory Street, North Ward	2.6	Residential
10	91 The Strand, North Ward	3.1	Residential
11	Corner of The Strand and Howitt Street, North Ward	3.6	Residential
12	North Ward Sports Grounds	3.2	Public Space

5.0 Dispersion Modelling

5.1 Model

The CALPUFF air dispersion model (ASG, 2012) was used in the air quality impact assessment. CALPUFF is a non-steady-state, three-dimensional Gaussian puff model developed for the US Environmental Protection Agency for use in situations where basic Gaussian plume models are not effective, such as coastal areas with re-circulating sea breezes. Input parameters used in the CALPUFF dispersion modelling are summarised in Table 5. Further details of the modelling inputs are provided in the following sections.

Table 5 CALPUFF input parameters

Parameter	Input
CALPUFF version	6.42
Modelling domain	25 x 25 km
Modelling grid resolution	1 km
Number of sensitive receptors	13
Terrain data	Included in CALMET
Building wake data	Not included in model
Dispersion algorithm	Turbulence computed from micrometeorology using PDF method
Hours modelled	8,760 hours (365 days)
Meteorological data period	1 January 2013 to 31 December 2013

5.2 Meteorological data

Meteorological data for the period January to December 2013 used in the dispersion modelling were developed using a combination of prognostic data generated by The Air Pollution Model (TAPM) with inputs from measured data from the Coast Guard monitoring station. These data were generated in order to represent meteorological conditions at the Project area.

5.2.1 Validation of the meteorological data set

When using a single year of meteorological data as input into a dispersion model, it is necessary to demonstrate that the data are representative of the long term meteorological conditions at the site and of long term regional behaviour. The main features of the generated data set and a comparison with measured meteorological data are provided in this analysis. Note that the meteorological conditions for the single year of data used for the model will not match the long term data exactly due to yearly variation in meteorology. The purpose of this section is to demonstrate that the general long term trends are replicated by the 2013 data set.

The generated meteorological data set was considered representative of long term meteorological conditions and expected regional behaviour and, subsequently, suitable for use in this assessment.

5.2.1.1 Wind

Wind rose diagrams for the site, from data generated by TAPM and CALMET meteorological models, are shown in Figure 2. For comparative purposes, the Bureau of Meteorology (BoM) wind roses from Townsville Airport are also shown.

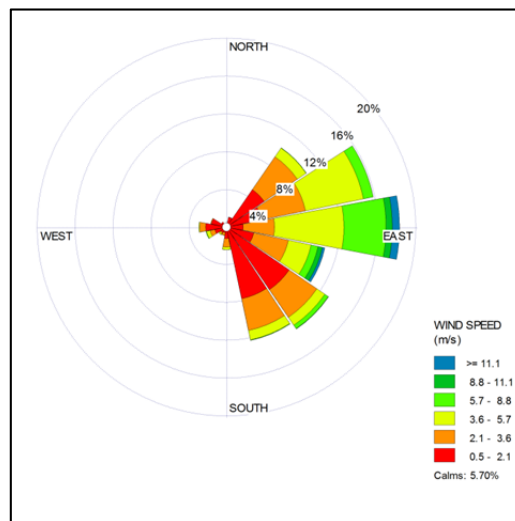
Note that the wind roses for the BoM station at Townsville Airport and the CALMET wind roses are presented on different scales. The BoM wind roses are provided in km/hr and cannot be changed whereby the CALMET wind roses are presented in m/s and have no option for presenting the data in km/hr. In addition, the number of sectors presented in the CALMET wind roses is 16, compared with 8 for the BoM wind roses. The difference in sectors results in a generally lower percentage for each sector in the CALMET wind roses. This accounts for the difference in the wind roses presented in Figure 3.

The wind roses show the frequency of occurrence of winds by direction and strength. The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds) and so on. The length of the bar represented frequency of occurrence of winds from that direction. The widths of the bars correspond to wind speed categories, the narrowest representing the lightest winds.

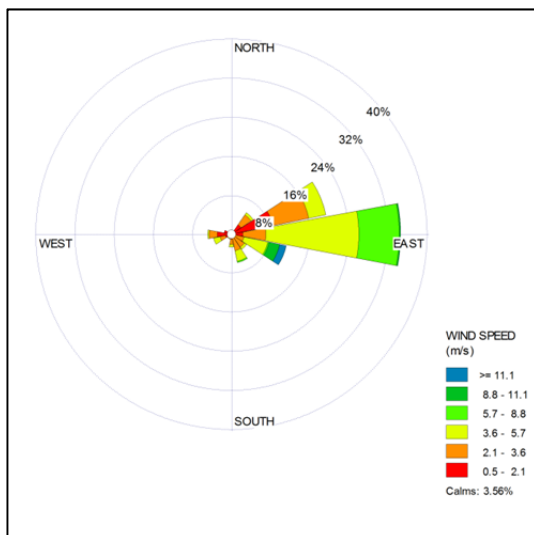
Morning winds at Townsville Port are dominated by easterly flows, rather than the south-easterly dominant BoM station at Townsville Airport. The difference is likely due to the location of the BoM station, which sits to the west of Castle Hill and is more influenced by morning south-easterly land breezes lighter easterly winds are blocked, and redirects easterlies blowing due east at the Airport. Afternoon winds are dominated by north easterly sea breezes at both the Port and Airport. The winds at Townsville Port are generally the same during the dry season (Figure 3).

The estimated mean wind speed for the 2013 CALMET data was 12.9 km/hr (2.8 m/s) and 14.7 km/hr (4.1 m/s) at 9 am and 3 pm respectively. These average values are similar to the long term average 9 am wind speed but slightly lower than the long term 3 pm wind speed at BoM Townsville Airport, (11.2 m/s at 9 am and 20.8 m/s at 3 pm).

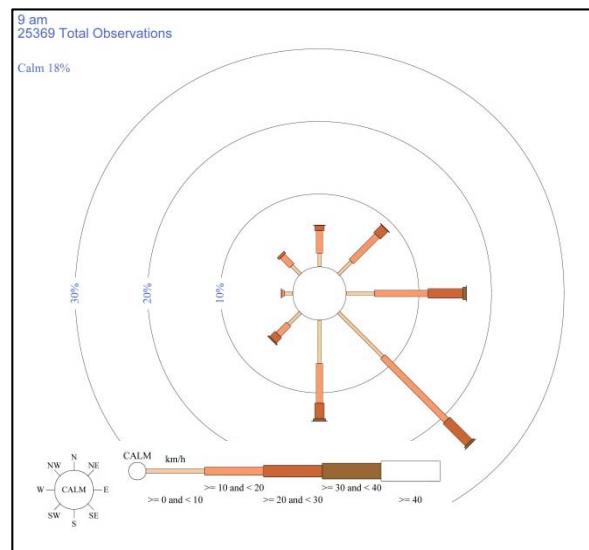
The frequency distribution of hourly averaged wind speed values is shown in Figure 4. Predicted wind speeds up to 9 m/s are relatively common, although slower wind speeds were predicted more frequently.



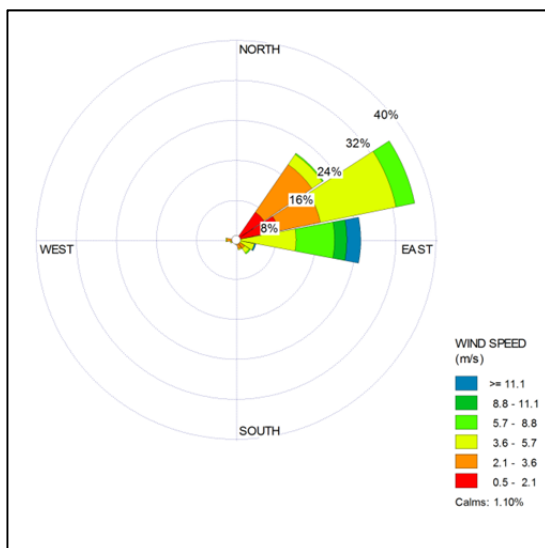
All hours – CALMET



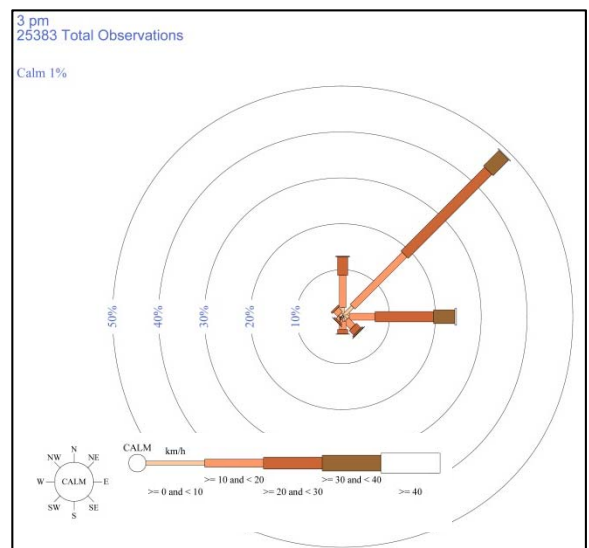
9 am - CALMET



9 am – BoM

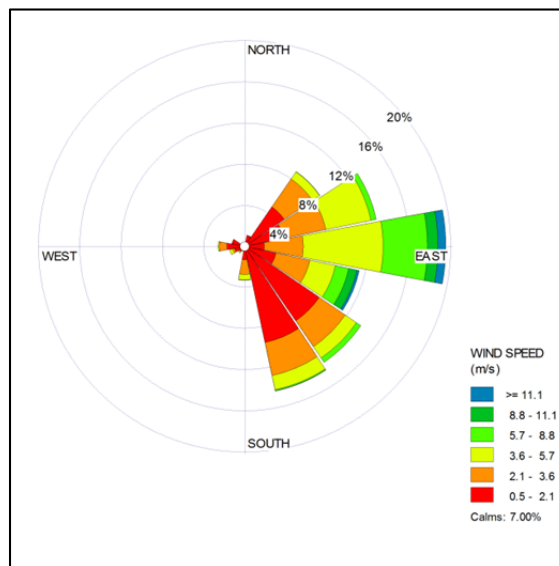


3 pm - CALMET

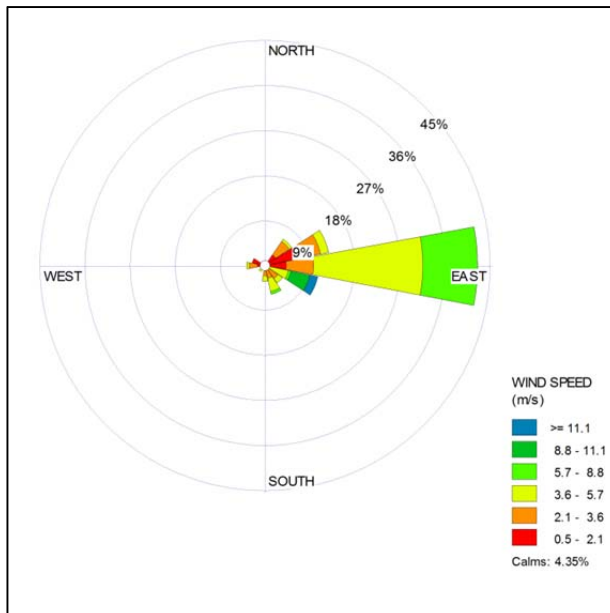


3 pm - BoM

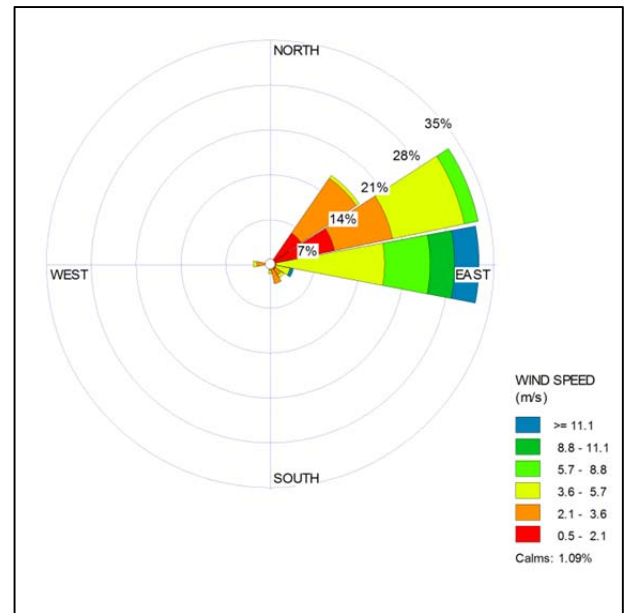
Figure 2 Wind roses for site data generated by TAPM – CALMET, 2013 vs BoM Townsville Airport, 1940 - 2010



May to October all hours - CALMET



May to October 9 am - CALMET



May to October 3 pm - CALMET

Figure 3 Dry season wind roses for site data generated by TAPM – CALMET, 2013

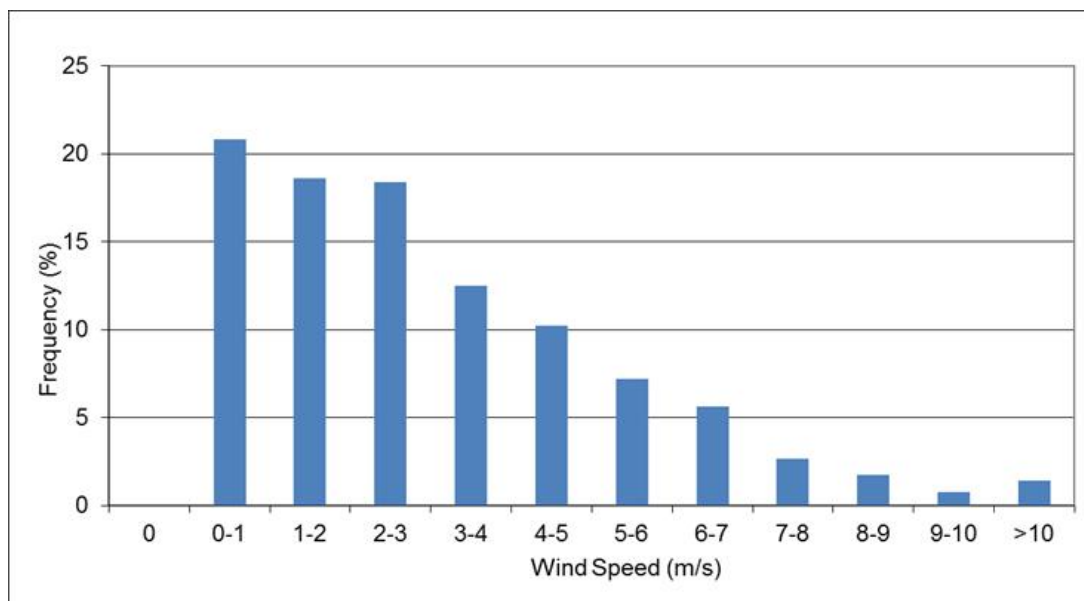


Figure 4 2013 Wind Speed Frequency Distribution – CALMET

As shown in Figure 5, average wind speeds are typically lower during the night hours, and increase during the morning and strongest by mid-afternoon. The predicted wind speeds generated from TAPM and CALMET were similar in the morning to those measured at BoM Townsville Airport but a slightly lower in the afternoon. Lower wind speeds typically results in worst-case dispersion and hence at locations close to the source for ground-based emissions lower wind speeds will result in worst-case impacts (due to the lower levels of turbulence and therefore lower mixing associated with lower wind speeds).

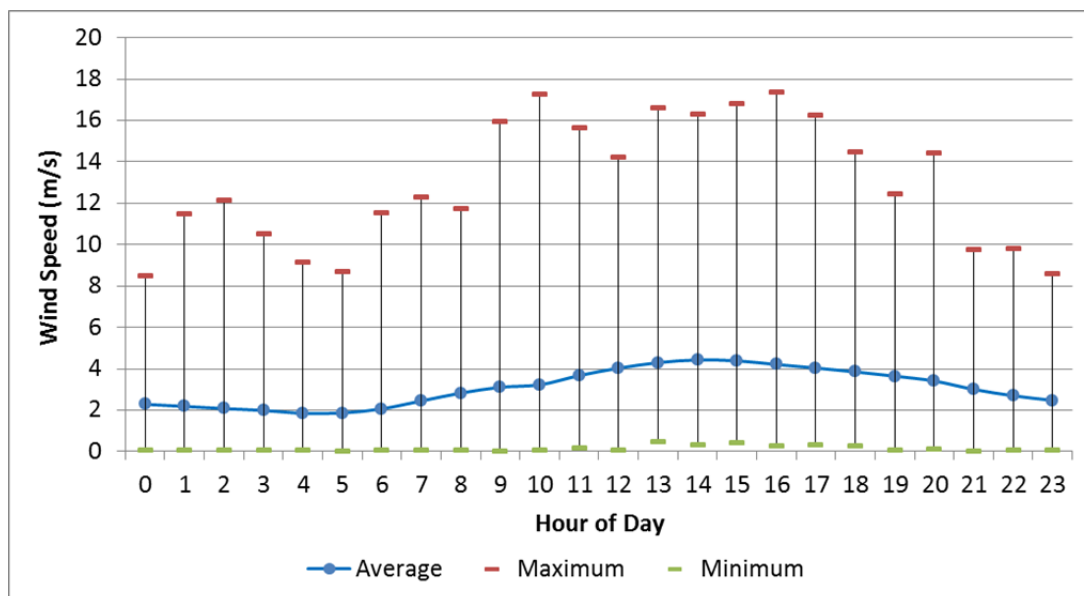


Figure 5 Wind Speed Analysis – CALMET Data

5.2.1.2 Mixing Height

Mixing height is the depth in the atmospheric surface layer beneath an elevated temperature inversion. It is an important parameter within air pollution meteorology. Vertical diffusion or mixing of particulates and gases is generally considered to be limited by the mixing height, above which air tends to be stable with limited vertical movement.

CALMET was used to calculate mixing heights at the site. The diurnal variation of mixing height is presented in Figure 6. On average, mixing heights are lowest during the night and early morning hours (< 200 m), increasing after sunrise as the sun heats the air near the ground and drives vertical convection in the atmosphere. This pattern is consistent with the coastal location of the site.

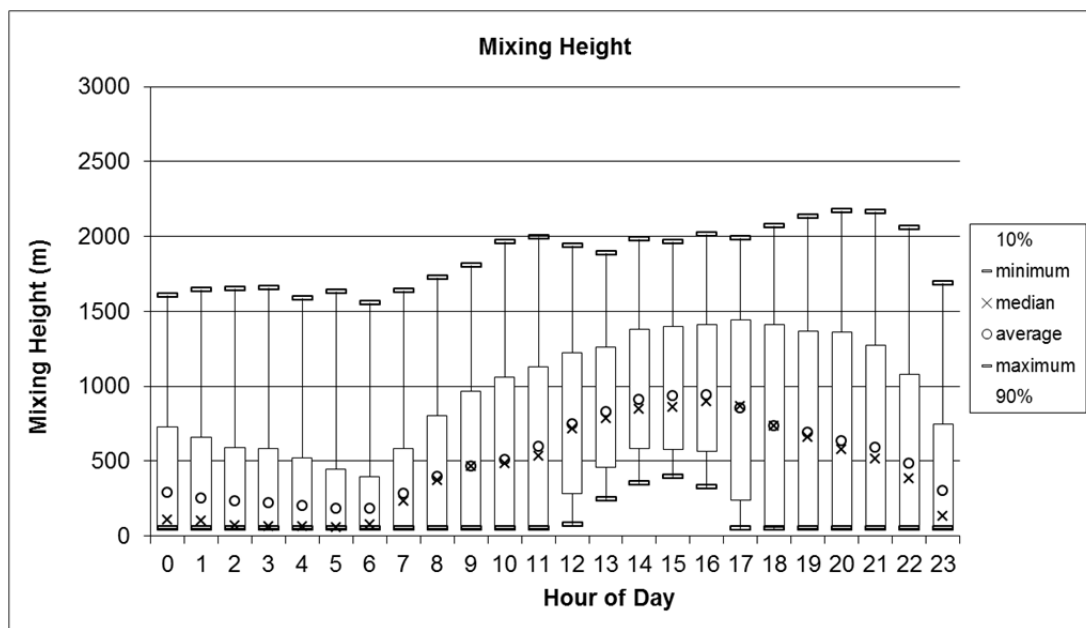


Figure 6 Hourly Mixing Height – CALMET Data, 2013

5.2.1.3 Stability Class

The Pasquill-Gifford stability classification scheme denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and enhanced dispersion. At the other extreme, Class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions, pollution is trapped beneath the inversion layer and can remain undiluted for considerable distances downwind from a source. Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Wind classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small. As a general rule, unstable (or convective) conditions dominate during daytime and stable flows are dominant at night. The diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

The frequency distribution of estimated stability classes in the CALMET data file are presented in Figure 7. Nearly half of the data represent stable conditions (Classes E and F). This is consistent with the expected occurrence of stable conditions at site, given the coastal location and the relatively low occurrence of light winds.

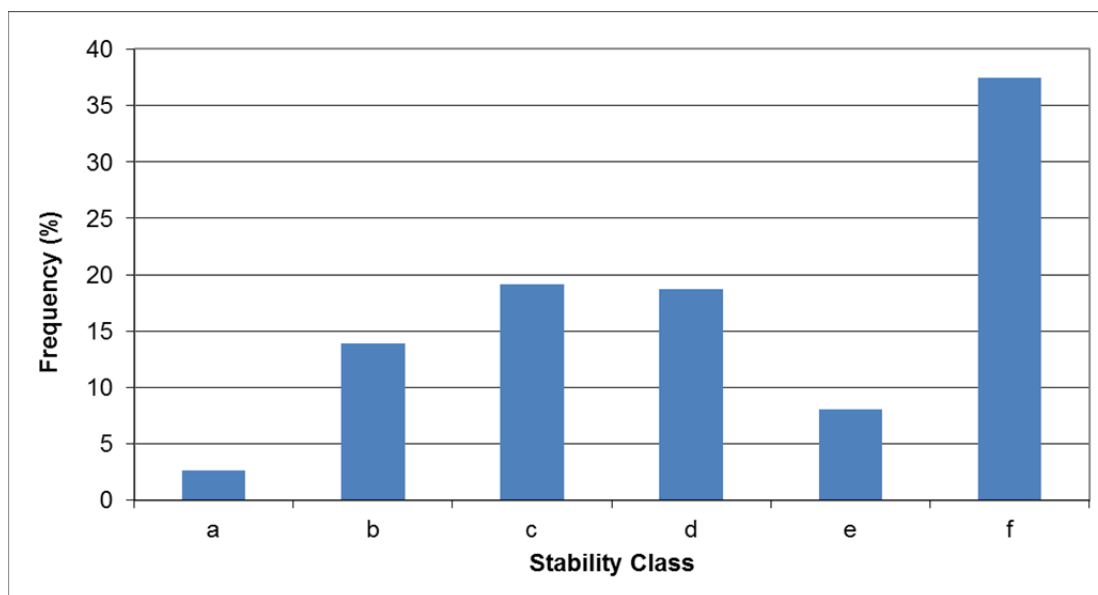


Figure 7 Pasquill-Gifford Stability Classes – CALMET Data, 2013

5.2.1.4 Temperature

The temperature distribution of the CALMET-generated data is presented in Figure 8. As expected, temperatures are coolest in the early morning and night. Maximum temperatures occur during early to mid-afternoon.

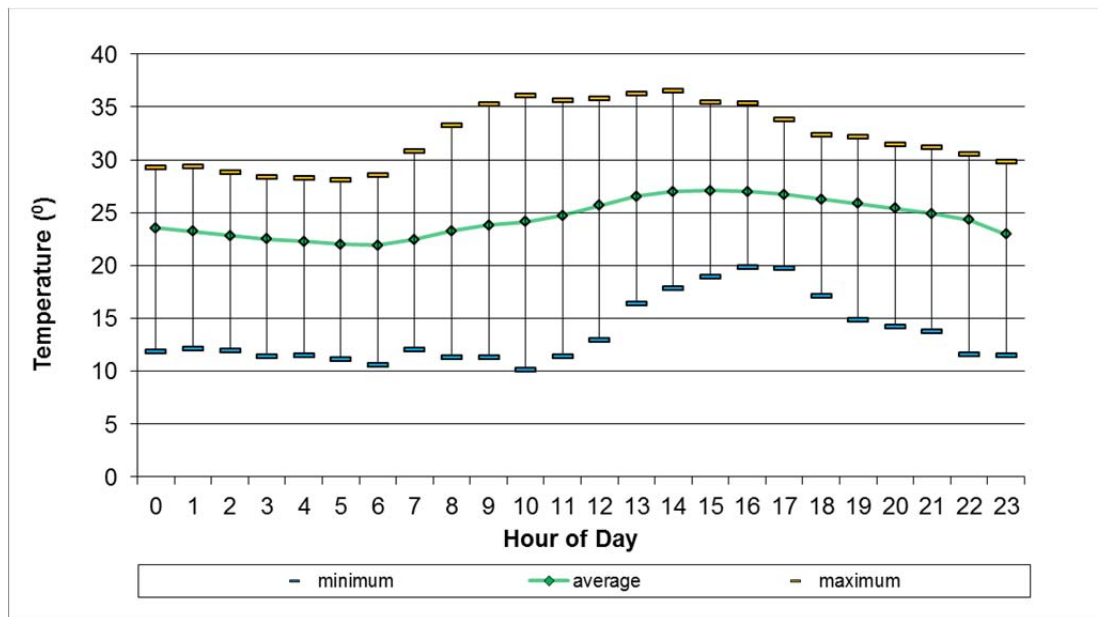


Figure 8 Temperature Distribution – CALMET Data, 2013

A comparison of the CALMET-generated monthly average maximum and minimum temperature data against long-term monthly average BoM data is presented in Figure 9. The monthly average BoM data site right on the average CALMET monthly averages, suggesting 2013 was a normal year when compared with long term averages.

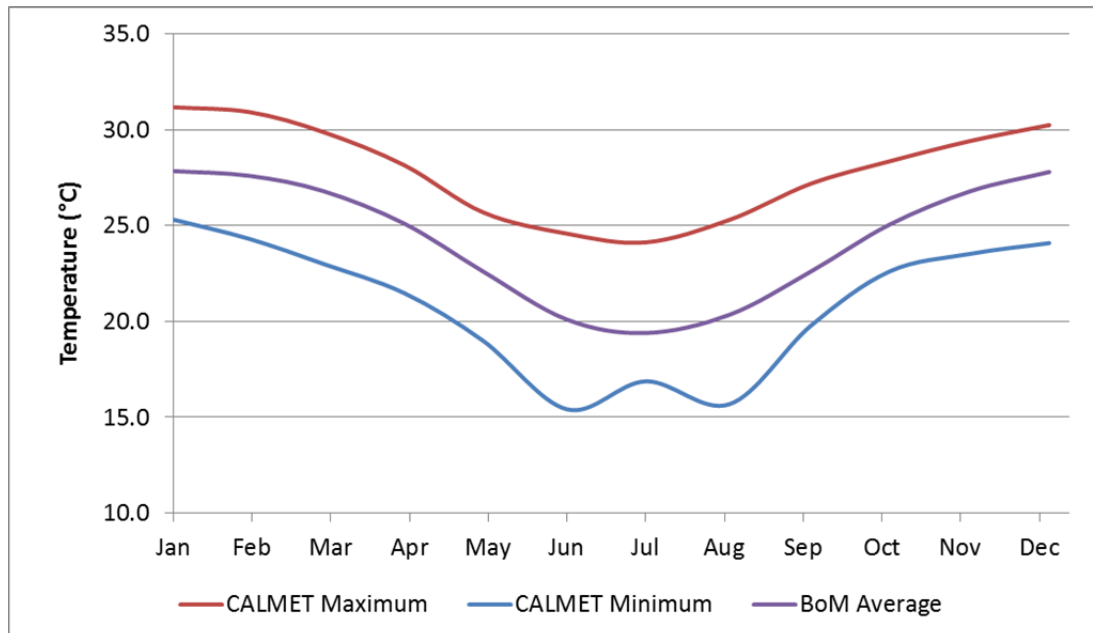


Figure 9 Temperature Data Comparison

5.3 Modelling Scenarios

The construction works for the refined PEP are expected to be undertaken in 3 stages (Stages 1 to 3). As part of this revised assessment, three scenarios, one for each of the revised PEP construction stages were selected to provide more detail on potential air quality impacts. The three modelling scenarios are described as follows.

- **Stage 1 Scenario:** Dust and shipping emissions for construction Stage 1, with haul roads unsealed. The haul roads are assumed to run from the boundary of the existing sealed section of road to approximately the centre of the Stage 1 reclamation area. The length of the unsealed haul road was modelled as 1 km (2 km round trip per vehicle). Wind erosion emissions were included for approximately 25 ha of the reclamation area.
- **Stage 2 Scenario:** Dust and shipping emissions for construction Stage 2, with internal haul roads from construction Stage 1 which have been sealed to a degree whereby negligible dust is emitted. This scenario assumed unsealed haul road distance of 1 km and that the initial entry road onto the PEP had been sealed. Wind erosion emissions were included only for newly reclaimed land in Stage 2 — reclaimed land from Stage 1 was assumed to be sealed (through surface sealing or vegetation).
- **Stage 3 Scenario:** Dust and shipping emission sources for construction Stage 3 with internal haul roads from construction Stage 1 and 2 which have been sealed to a degree whereby negligible dust is emitted. Wind erosion emissions were included only for newly reclaimed land in Stage 3. — reclaimed land from Stage 1 and 2 was assumed to be sealed (through surface sealing or vegetation).

The proposed development layout for construction Stages 1, 2 and 3 are presented in Figure 10 to Figure 12.

Shipping parameters for each scenario are presented in Table 6. Historical data provided by POTL indicated an approximately 65 % berth utilisation at the existing port. This utilisation rate was used to estimate the number of berths occupied in both the existing port and the PEP for each modelled scenario.

Construction activities and fleet data for each scenario are presented in Table 7.

Table 6 Summary of shipping emission included in each scenario

Scenario	Construction Stage	PEP Berths	PEP Berths Modelled	Existing Port Berths	Existing Port Berths Modelled	Dredge Emissions
Stage 1	1	Nil	Nil	9 ¹	6	Yes
Stage 2	2	2	2	9	6	Yes
Stage 3	3	5	3	9	6	Yes

¹ Existing Berth 7 is currently being demolished (at the time of this report drafting) but was included in the modelling for consistency with EIS

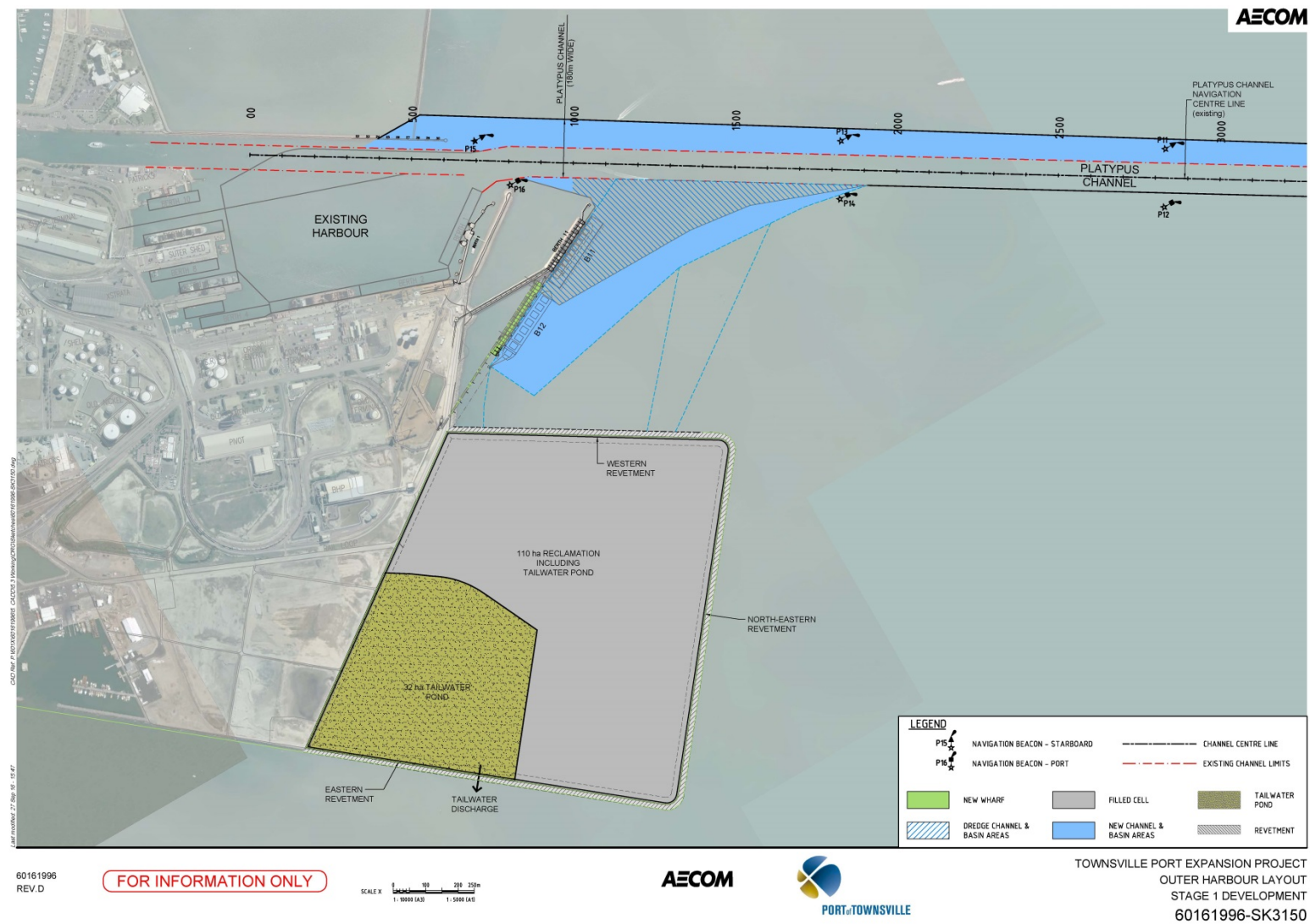


Figure 10 PEP Stage 1 Development



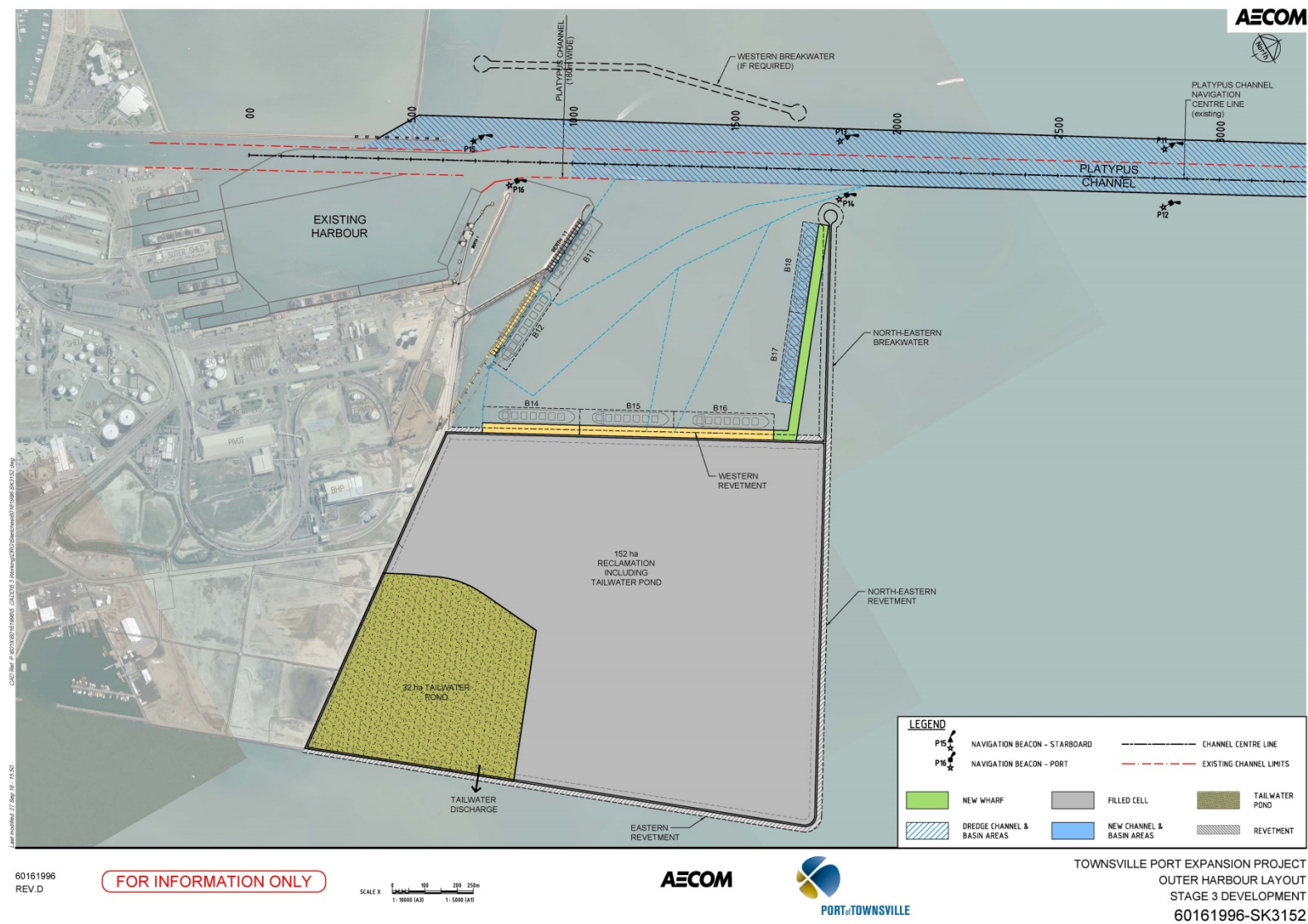


Figure 12 PEP Stage 3 Development

Table 7 Summary of construction emission sources

Works and Activities	Location	Equipment	Stage 1		Stage 2		Stage 3	
			Duration (weeks)	Number	Duration (weeks)	Number	Duration (weeks)	Number
Bund, Revetment Structures for Reclamation and Wharf Construction (24/7)								
Delivery of material for bunds, revetments, breakwaters and wharfs	Perimeter	Trucks	48	9 (trips/hour)	48	8 (trips/hour)	NA	NA
Handling and placing rockfill	Perimeter	Excavator	48	3	48	3	NA	NA
Trimming/level finish surface	Perimeter	Bulldozer	48	1	48	1	NA	NA
Construction management	Perimeter	Utility vehicles	48	2 (trips/hour)	48	2 (trips/hour)	NA	NA
Reclamation area (dredge discharge activity 24/7; capping layer activity 24/7)								
Reclamation operations involving moving of pipelines, shifting surcharge material, placement of capping layer	Reclamation area	Bulldozers/front-end loaders/ excavator	167	4	175	4	121	4
Delivery of material for capping layer and pavements	Reclamation area	On-road dump trucks	39	2 (trips/hour)	39	2 (trips/hour)	121	2 (trips/hour)
Construction management	Reclamation area	Utility vehicles	230	2 (trips/hour)	39	2 (trips/hour)	121	2 (trips/hour)

5.4 Emissions Estimation

5.4.1 Shipping Emissions

Shipping emissions were estimated based on a number of assumptions around ship size and engine power. Only ships at berth were considered for inclusion in the emissions inventory. All ships at berth were assumed to be running a single auxiliary engine 24 hours a day seven days a week. Dredging emissions were based on total on-board engine power rating.

Emissions factors for specific engine type and fuel type were sourced from Browning and Bailey (2006). A summary of emission factors is presented in Table 8. Ship engine power ratings were estimated.

Emission rates were calculated using the emission factors for each ship class based on 24 hours a day, 7 days a week operation, by means of the following equation [from Browning and Bailey (2006)]:

$$Emission\ Rate = P * LF * A * EF$$

Where:

- P = maximum continuous rating power (kilowatts [kW])
- LF = load factor (percent of vehicles total power)
- A = activity (hours [h])
- EF = emission factor (grams per kilowatt hour [g/kWh])

The numbers of ships in each size class that were included in each modelled scenario are presented in

Table 9. The number of ships included was based on an historical berth occupancy rate at the Port of 65 %.

Total calculated shipping emission rates (in grams per second) for each scenario are presented in Table 10. The emission rates represent the sum of emissions from all ships at berth and dredging activities.

Ship auxiliary engine exhaust stack parameters used in the modelling are presented in

Table 11. No data was available for ships berthed at the existing Townsville Port. These data were based on ship stack parameter data used in SKM (2007).

Table 8 Summary of shipping emission and correction factors

Ship Engine Type	Fuel Type	Emission Factor (g/kWh)	Engine Power (kW)	Load Factor	Factor Source
Ocean going vessel auxiliary engine	Marine Diesel Oil	NO _x = 13.9 SO ₂ = 2.76 CO = 1.1 PM ₁₀ = 0.37 PM _{2.5} = 0.34	Support Vessels = 23 - 82 Hopper barge = 450 Small Ships = 500 Medium Ships = 1500 Large Ships = 6000	Hotelling 22% of the time	Browning and Bailey (2006)
Large backhoe dredge	Diesel	NO _x = 10 SO ₂ = 0.63 CO = 1.5 PM ₁₀ = 0.4 PM _{2.5} = 0.39	1600	100 %	NPI (2008)
TSHD (trailing suction hopper dredger) pump (channel dredging)	Diesel	NO _x = 13 SO ₂ = 0.63 CO = 2.5 PM ₁₀ = 0.3 PM _{2.5} = 0.29	1755	100 %	NPI (2008)

Table 9 Number of ships modelled by scenario

Scenario	Existing Port					PEP					
	No. Port Berths	No. Large Ships	No. Medium Ships	No. Small Ships	Total Ships	No. Port Berths	No. Large Ships	No. Medium Ships	No. Small Ships	Total PEP Ships Modelled	No. Port Berths
Stage 1	9	2	2	2	6	NA	NA	NA	NA	NA	9
Stage 2	9	2	2	2	6	2	2	0	0	2	9
Stage 3	9	2	2	2	6	3	2	1	0	3	9

Table 10 Summary of shipping emission rates

Scenario	Emission Rate (g/s)				
	NO _x	SO ₂	PM ₁₀	PM _{2.5}	CO
Stage 1	20.7	2.7	0.6	0.5	2.6
Stage 2	30.3	4.8	1.2	1.1	3.8
Stage 3	31.5	5.0	1.2	1.1	3.9

Table 11 Ship stack parameters

Ship Class	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (°K)
Small/ Medium/ Dredge	32.2	1.0	13.0	623
Large	39.8	1.0	32.8	623

5.4.2 Conversion of NO_x to NO₂

Nitrogen oxides (NO_x) are produced in most combustion processes and are formed by the oxidation of nitrogen in the fuel and nitrogen in the air. During high-temperature processes a variety of nitrogen oxides are formed including nitric oxide (NO) and NO₂. At the point of emission NO will generally comprise the majority of the emissions, with 95% by volume with the remaining 5% taken up mostly by NO₂.

The oxidation of NO to NO₂ can be assessed by various methods. In this assessment a conservative assumption that 100% of NO_x emitted is converted to NO₂ was used.

5.4.3 Construction dust

A Project-specific emissions inventory of construction activities at the PEP for each emission of interest and each modelling scenario was developed based on published emission factors listed in the National Pollutant Inventory (NPI, 2012) and the US Environmental Protection Agency 'Emissions Factors and AP-42 – Compilation of Air Pollutant Emission Factors' (AP-42) (USEPA, 1998). In the absence of site-specific emissions data, the published emission factors have been adopted for this assessment.

Relevant mitigation control efficiencies listed in the NPI and AP-42 for were applied to construction activity emission rates. These measures were:

- road watering for unsealed roads
- watering of bulldozer activities on friable soil (where wet soils are being spread, watering is not required)
- areas which are not to be worked for long periods of time are to be sealed to prevent the generation of dust; for example, using one of a variety of methods such as hydromulching, chemical sealing etc.

A summary of the emission factors and relevant mitigation correction factors used are presented in Table 12.

Table 12 Summary of dust emission and correction factors

Activity	Emission Factor	Source	Units	Variables	Correction Factors
Wheel generated dust from unsealed haul roads –trucks	$EF_{TSP} = \frac{0.4536}{1.6093} \times 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$ $EF_{PM_{10}} = \frac{0.4536}{1.6093} \times 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP-42 (USEPA 2006) recommended in NPI (2012)	kg/VKT ¹	s = material silt content in % W = weight of vehicle in t	Level 2 Watering 75 %
Wheel generated dust from unsealed haul roads –light vehicles	Default of 0.94 for TSP Default of 0.33 for PM ₁₀	NPI (2012)	kg/VKT ¹		Level 2 Watering 75 %
Bulldozers on fill material	Default of 17 for TSP Default of 4.1 for PM ₁₀	NPI (2012)	kg/h/vehicle	-	Watering 50 %
Excavator on revetments/ reclamation fill material	Default of 0.018 for TSP Default of 0.008 for PM ₁₀	AP-42 Chapter 11.9 Table 11.9-4 (USEPA 1988)	kg/t	-	-
Trucks dumping rocks/ fill material	Default of 0.012 for TSP Default of 0.0042 for PM ₁₀	NPI (2012)	kg/t	-	-
Wind erosion from exposed areas	Default of 0.4 for TSP Default of 0.2 for PM ₁₀	NPI (2012)	kg/ha/h	-	-

¹ VKT = vehicle kilometres travelled

Emission rates for construction activities for each modelling scenario are presented in Table 13 to Table 16. For Stages 1, 2 and 3, dust emission rates were estimated to be higher for construction of the reclamation area than for construction of the revetments. Because the reclamation area will be constructed after the construction of the revetments is finished, revetment construction emission sources were not considered for Stages 1, 2 or 3. Worst case construction emissions are expected to occur during the reclamation and as such the omission of the revetment construction is not expected to affect the result or conclusions of the assessment.

Table 13 Stage 1 construction activity emission rates

Stage 1	TSP (g/s)	% Contribution	PM ₁₀ (g/s)	% Contribution
Reclamation Area Construction Sources				
Truck Haul Emissions Loaded	1.33	14%	0.38	11%
Truck Haul Emissions Unloaded	0.81	8%	0.23	7%
Truck Dumping Emissions	0.31	3%	0.11	3%
Excavator Emissions	0.49	5%	0.24	7%
FEL Emissions	0.16	2%	0.08	2%
Bulldozer Emissions	3.50	37%	0.90	25%
Small Vehicle Emissions	0.10	1%	0.04	1%
Open Area Wind Erosion	2.93	30%	1.47	43%
Total Emissions	9.68	-	3.39	-
Contribution percentages have been rounded which has resulted in minor rounding errors when summed.				

Table 14 Stage 2 construction activity emission rates

Stage 2	TSP (g/s)	% Contribution	PM ₁₀ (g/s)	% Contribution
Reclamation Area Construction Sources				
Truck Haul Emissions Loaded	1.81	15%	0.52	11%
Truck Haul Emissions Unloaded	1.11	9%	0.32	7%
Truck Dumping Emissions	0.50	4%	0.18	4%
Excavator Emissions	0.79	6%	0.38	8%
FEL Emissions	0.26	2%	0.13	3%
Bulldozer Emissions	3.50	28%	0.90	19%
Small Vehicle Emissions	0.08	1%	0.03	1%
Open Area Wind Erosion	4.41	35%	2.20	48%
Total Emissions	12.51	-	4.61	-
Contribution percentages have been rounded which has resulted in minor rounding errors when summed.				

Table 15 Stage 3 construction activity emission rates

Stage 3	TSP (g/s)	% Contribution	PM ₁₀ (g/s)	% Contribution
Reclamation Area Construction Sources				
Truck Haul Emissions Loaded	0.81	10%	0.23	9%
Truck Haul Emissions Unloaded	0.50	6%	0.14	5%
Truck Dumping Emissions	0.46	6%	0.16	6%
Excavator Emissions	0.71	9%	0.34	13%
FEL Emissions	0.24	3%	0.11	4%
Bulldozer Emissions	3.50	45%	0.90	32%
Small Vehicle Emissions	0.05	1%	0.02	1%
Open Area Wind Erosion	1.53	20%	0.77	29%
Total Emissions	7.83	-	2.63	-
Contribution percentages have been rounded which has resulted in minor rounding errors when summed.				

6.0 Modelling Results Summary

The following section outlines the tabulated results for the sensitive receptors for the following emissions:

- Construction Emissions:
 - PM₁₀
 - TSP
 - Dust deposition rate.
- Shipping Emissions:
 - NO₂
 - SO₂
 - CO
 - PM_{2.5}.

6.1 Construction Dust (PEP in isolation from background)

The results for the dispersion modelling for the construction scenarios are presented in this section. Predicted 6th highest 24 hour average PM₁₀ and annual average PM₁₀ concentrations from PEP emissions in isolation at each modelled sensitive receptor are presented in Table 16. Predicted concentrations were well below the relevant criteria at all sensitive receptors.

Table 16 Predicted PM10 concentrations – PEP in isolation

Receptor ID	Predicted PEP Contribution PM ₁₀ (µg/m³)					
	6th Highest 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	5.0	5.2	4.0	1.8	1.8	1.3
2 – Casino Floor 6	6.8	6.8	4.9	2.3	2.2	1.7
3 – Casino Floor 3	12.8	12.4	8.8	3.7	3.5	2.7
4 – Archer and Ross	14.7	13.5	10.5	3.0	3.1	2.3
5 – Macrossan	17.9	17.7	15.4	3.5	3.8	2.8
6 – Hubert	13.9	15.8	10.0	1.9	2.6	1.8
7 – Breakwater	12.2	13.1	11.0	3.2	3.1	2.6
8 – CBD	6.7	6.3	5.1	1.4	1.5	1.2
9 – Strand and Gregory	11.9	15.5	11.4	2.6	3.4	2.5
10 – Strand	12.1	14.4	11.4	2.8	3.5	2.7
11 – Strand and Howitt	9.9	15.8	12.3	3.0	3.8	2.9
12 – North Ward	7.9	8.8	6.9	1.7	1.9	1.4
Criteria	50			30		

Maximum predicted 24 hour average PM₁₀ concentrations at each sensitive receptor are presented in Table 17. All predicted concentrations for PEP emissions in isolation were predicted to be below criteria at all sensitive receptors for all scenarios.

Table 17 Predicted maximum 24 hour average PM10 concentrations – Revised PEP in isolation

Receptor ID	Predicted PEP Contribution PM ₁₀ Maximum 24 Hour Average (µg/m ³)		
	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	7.3	6.3	4.9
2 – Casino Floor 6	10.2	8.1	5.9
3 – Casino Floor 3	18.0	14.0	11.4
4 – Archer and Ross	29.2	28.4	21.6
5 – Macrossan	37.2	33.0	26.0
6 – Hubert	26.9	24.3	16.8
7 – Breakwater	20.2	19.5	12.6
8 – CBD	16.6	15.2	10.6
9 – Strand and Gregory	20.2	28.4	17.4
10 – Strand	15.3	17.4	19.2
11 – Strand and Howitt	14.9	17.4	16.0
12 – North Ward	17.8	13.8	11.2

Predicted annual average TSP concentrations and dust deposition rates at sensitive receptors from PEP emission in isolation are presented in Table 18. Predicted TSP and dust deposition impacts were well below criteria at all sensitive receptors.

Table 18 Predicted TSP concentrations and dust deposition rates – PEP in isolation

Receptor ID	Predicted PEP Contribution Annual Average TSP (µg/m ³)			Predicted PEP Contribution Dust Deposition Rate (g/m ² /month)		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	5.7	5.5	4.0	0.00	0.00	0.00
2 – Casino Floor 6	9.1	7.2	5.3	0.00	0.00	0.00
3 – Casino Floor 3	7.2	11.1	8.3	0.00	0.00	0.00
4 – Archer and Ross	8.6	9.6	7.2	0.04	0.02	0.01
5 – Macrossan	4.6	12.2	8.7	0.04	0.03	0.01
6 – Hubert	7.6	8.4	6.2	0.02	0.01	0.00
7 – Breakwater	3.4	9.6	7.8	0.06	0.04	0.02
8 – CBD	6.2	4.7	3.8	0.02	0.01	0.01
9 – Strand and Gregory	6.6	10.0	7.8	0.03	0.03	0.02
10 – Strand	7.0	10.7	8.6	0.03	0.02	0.02
11 – Strand and Howitt	3.8	11.3	8.7	0.02	0.02	0.02
12 – North Ward	3.8	5.9	4.5	0.02	0.01	0.01
Criteria	90			4		

6.2 Shipping Emission Results (PEP in isolation from background)

The following Table 19 to Table 22 present the modelling results for the shipping emissions in isolation to the background. The predicted pollutant concentrations presented in these tables include emissions from ships berthed at both the existing port and the PEP. Predicted concentrations of combustion gases due to port operations in isolation were all below relevant air quality criteria at all sensitive receptors.

Table 19 Predicted NO₂ concentrations at sensitive receptors - shipping emissions in isolation

Receptor ID	Predicted PEP NO ₂ Contribution (µg/m ³)					
	Maximum 1 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	77.2	138.9	102.4	3.5	4.1	4.4
2 – Casino Floor 6	91.4	136.9	110.6	3.5	4.0	4.4
3 – Casino Floor 3	137.2	134.2	146.0	3.5	4.0	4.4
4 – Archer and Ross	66.4	80.1	80.6	1.6	2.2	2.1
5 – Macrossan	59.3	90.9	79.2	1.3	2.0	1.8
6 – Hubert	73.1	55.8	80.3	0.7	1.2	1.0
7 – Breakwater	60.0	97.8	78.5	2.7	3.5	3.4
8 – CBD	45.7	76.0	67.4	1.3	1.8	1.8
9 – Strand and Gregory	128.9	58.3	128.3	1.3	1.5	1.7
10 – Strand	72.6	51.2	64.9	0.9	1.2	1.2
11 – Strand and Howitt	75.9	44.4	105.2	0.8	1.0	1.0
12 – North Ward	41.0	53.6	44.6	1.1	1.3	1.4
Criteria	250			62		

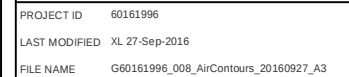
Figures 13 – 15 illustrate NO₂ concentrations (µg/m³) at sensitive receptors for Stage 1, Stage 2 and Stage 3.

Stage 1
NO₂ Concentrations (µg/m³)

Legend

-  Railway Line
-  Existing Channel Limits
-  Channel Centre Line
-  Concentration Contours
-  Existing Port Land
-  Port Expansion Area

Scale:1:35,000 (when printed at A4)



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PORT EXPANSION PROJECT
AEIS

Stage 2
NO₂ Concentrations (µg/m³)

Figure 14



Legend

- A** Modelled Receptor Locations
- +— Railway Line
- - - Existing Channel Limits
- - - Channel Centre Line
- Concentration Contours
- Existing Port Land
- Port Expansion Area

1

Scale: 1:35,000 (when printed at A4)

0 0.5 1
Kilometres

PROJECT ID 60161996
LAST MODIFIED XL 27-Sep-2016
FILE NAME G60161996_009_AirContours_20160927_A3

Data Source:
StreetPro © 2010 Pitney Bowes Software Pty Ltd
Roads, Parks © 2010 PSMA Australia Pty Ltd
Imagery - Qbing 2016
Receptors - AECOM 2016

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PORT EXPANSION PROJECT
AEIS

Stage 3
NO₂ Concentrations (µg/m³)

Figure 15

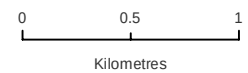


Legend

- A** Modelled Receptor Locations
- +— Railway Line
- - - Existing Channel Limits
- - - Channel Centre Line
- Concentration Contours
- Existing Port Land
- Port Expansion Area

1

Scale: 1:35,000 (when printed at A4)



PROJECT ID 60161996
LAST MODIFIED XL 27-Sep-2016
FILE NAME G60161996_010_AirContours_20160927_A3

Data Source:
StreetPro © 2010 Pitney Bowes Software Pty Ltd
Roads, Parks - © 2010 PSMA Australia Pty Ltd
Imagery - Q-Bing 2016.
Receptors - AECOM 2016

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Table 20 Predicted SO₂ concentrations at sensitive receptors - shipping emissions in isolation

Receptor ID	Predicted PEP SO ₂ Contribution (µg/m ³)								
	Maximum 1 Hour Average			Maximum 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	15.3	20.3	20.2	2.3	2.6	2.6	0.6	0.7	0.7
2 – Casino Floor 6	15.1	20.1	19.9	2.3	2.6	2.6	0.6	0.7	0.7
3 – Casino Floor 3	14.9	19.8	19.6	2.3	2.6	2.5	0.6	0.7	0.7
4 – Archer and Ross	11.4	14.7	14.7	1.6	2.2	2.2	0.3	0.4	0.4
5 – Macrossan	11.2	15.2	15.2	1.6	2.1	2.1	0.2	0.3	0.3
6 – Hubert	11.6	11.6	11.7	1.4	1.8	1.8	0.1	0.2	0.2
7 – Breakwater	11.3	15.3	15.2	2.5	3.2	3.2	0.5	0.6	0.6
8 – CBD	9.3	13.6	13.6	1.4	2.0	2.0	0.2	0.3	0.3
9 – Strand and Gregory	4.8	9.6	9.6	1.5	1.6	1.6	0.2	0.3	0.3
10 – Strand	4.4	10.1	10.1	0.7	1.6	1.6	0.1	0.2	0.2
11 – Strand and Howitt	4.0	8.7	8.7	1.1	2.1	2.1	0.1	0.2	0.2
12 – North Ward	4.3	5.4	5.2	1.4	1.8	1.8	0.1	0.2	0.2
Criteria	570			230			57		

Table 21 Predicted CO concentrations at sensitive receptors - shipping emissions in isolation

Receptor ID	Predicted PEP CO Contribution Maximum 8 Hour Average (µg/m ³)		
	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	10.0	6.1	9.3
2 – Casino Floor 6	11.0	5.1	10.9
3 – Casino Floor 3	12.3	4.6	13.3
4 – Archer and Ross	2.1	3.1	2.3
5 – Macrossan	2.5	4.5	2.7
6 – Hubert	2.5	5.0	2.8
7 – Breakwater	2.8	4.8	2.9
8 – CBD	1.5	5.0	1.8
9 – Strand and Gregory	4.8	2.9	4.9
10 – Strand	1.9	2.9	1.9
11 – Strand and Howitt	2.4	2.0	2.8
12 – North Ward	5.2	6.5	4.9
Criteria	11,000		

Table 22 Predicted PM_{2.5} concentrations at sensitive receptors - shipping emissions in isolation

Receptor ID	Predicted PEP PM _{2.5} Contribution (µg/m ³)					
	Maximum 24 Hour Average			Annual Average		
	S Stage cenario 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	0.5	0.8	0.5	0.09	0.12	0.11
2 – Casino Floor 6	0.6	0.7	0.5	0.09	0.12	0.11
3 – Casino Floor 3	0.7	0.6	0.7	0.09	0.12	0.11
4 – Archer and Ross	0.2	0.5	0.3	0.04	0.07	0.05
5 – Macrossan	0.2	0.5	0.3	0.03	0.07	0.04
6 – Hubert	0.2	0.5	0.3	0.02	0.05	0.03
7 – Breakwater	0.3	0.7	0.4	0.07	0.11	0.08
8 – CBD	0.2	0.6	0.2	0.03	0.06	0.04
9 – Strand and Gregory	0.3	0.4	0.4	0.03	0.04	0.04
10 – Strand	0.1	0.4	0.2	0.02	0.03	0.03
11 – Strand and Howitt	0.1	0.3	0.3	0.02	0.03	0.02
12 – North Ward	0.3	0.7	0.3	0.03	0.04	0.03
Criteria	25			8		

7.0 Cumulative Emissions

Cumulative dust emissions have been discussed in Section 11.3.4 of the AEIS. The following section outlines the cumulative results for the shipping emissions only.

Predicted cumulative concentrations of NO₂, SO₂ and CO at nearby sensitive receptors are presented in Table 23, Table 24 and Table 25. Predicted cumulative concentrations of these emissions were predicted to be below criteria at all sensitive receptors.

Table 23 Predicted cumulative NO₂ concentrations at sensitive receptors

Receptor ID	Predicted Cumulative NO ₂ (µg/m ³)					
	Maximum 1 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	163.5	225.2	188.7	15.8	16.4	16.7
2 – Casino Floor 6	177.7	223.2	196.9	15.8	16.3	16.7
3 – Casino Floor 3	223.5	220.5	232.3	15.8	16.3	16.7
4 – Archer and Ross	152.7	166.4	166.9	13.9	14.5	14.4
5 – Macrossan	145.6	177.2	165.5	13.6	14.3	14.1
6 – Hubert	159.4	142.1	166.6	13.0	13.5	13.3
7 – Breakwater	146.3	184.1	164.8	15.0	15.8	15.7
8 – CBD	132.0	162.3	153.7	13.6	14.1	14.1
9 – Strand and Gregory	215.2	144.6	214.6	13.6	13.8	14.0
10 – Strand	158.9	137.5	151.2	13.2	13.5	13.5
11 – Strand and Howitt	162.2	130.7	191.5	13.1	13.3	13.3
12 – North Ward	127.3	139.9	130.9	13.4	13.6	13.7
Criteria	250			62		

Table 24 Predicted cumulative SO₂ concentrations at sensitive receptors

Receptor ID	Predicted Cumulative SO ₂ (µg/m ³)								
	Maximum 1 Hour Average			Maximum 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	39.7	42.4	44.1	20.3	20.3	20.4	3.9	3.9	3.9
2 – Casino Floor 6	41.7	43.8	45.4	19.8	19.7	19.8	3.7	3.6	3.7
3 – Casino Floor 3	41.4	43.5	45.1	19.9	19.8	19.9	3.7	3.6	3.6
4 – Archer and Ross	41.3	43.4	45.0	20.0	19.9	20.0	3.7	3.6	3.6
5 – Macrossan	40.1	41.0	41.0	19.3	19.4	19.4	3.3	3.3	3.3
6 – Hubert	41.2	42.5	42.8	19.2	19.3	19.3	3.2	3.2	3.3
7 – Breakwater	37.5	37.3	37.3	18.8	18.8	18.8	3.1	3.1	3.1
8 – CBD	40.9	41.4	42.0	20.4	20.5	20.6	3.5	3.5	3.5
9 – Strand and Gregory	40.4	40.3	40.5	19.4	19.2	19.4	3.2	3.2	3.2
10 – Strand	31.6	31.2	31.3	18.8	18.9	18.9	3.2	3.2	3.2
11 – Strand and Howitt	35.2	33.5	33.5	18.6	18.5	18.5	3.1	3.1	3.1
12 – North Ward	33.3	33.3	33.3	18.3	18.3	18.3	3.1	3.1	3.1
Criteria	570			230			57		

Table 25 Predicted Cumulative Maximum 8 Hour Average CO Concentrations at Sensitive receptors

Receptor ID	Predicted Cumulative CO Maximum 8 Hour Average (µg/m ³)		
	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	2,260	2,256	2,259
2 – Casino Floor 6	2,261	2,255	2,261
3 – Casino Floor 3	2,262	2,255	2,263
4 – Archer and Ross	2,252	2,253	2,252
5 – Macrossan	2,252	2,255	2,253
6 – Hubert	2,252	2,255	2,253
7 – Breakwater	2,253	2,255	2,253
8 – CBD	2,252	2,255	2,252
9 – Strand and Gregory	2,255	2,253	2,255
10 – Strand	2,252	2,253	2,252
11 – Strand and Howitt	2,252	2,252	2,253
12 – North Ward	2,255	2,256	2,255
Criteria	11,000		

Predicted cumulative PM_{2.5} concentrations at nearby sensitive receptors are presented in Table 26. Predicted short term 24 hour average concentrations and long term annual average concentrations were predicted to be below criteria at all sensitive receptors.

Table 26 Predicted cumulative PM_{2.5} concentrations at sensitive receptors

Receptor ID	Predicted Cumulative PM _{2.5} (µg/m ³)					
	Maximum 24 Hour Average			Annual Average		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1 – Casino Top Floor	20.4	20.7	20.4	4.9	4.9	4.9
2 – Casino Floor 6	20.5	20.6	20.4	4.9	4.9	4.9
3 – Casino Floor 3	20.6	20.5	20.6	4.9	4.9	4.9
4 – Archer and Ross	20.1	20.4	20.2	4.8	4.9	4.9
5 – Macrossan	20.1	20.4	20.2	4.8	4.9	4.8
6 – Hubert	20.1	20.4	20.2	4.8	4.9	4.8
7 – Breakwater	20.2	20.6	20.3	4.9	4.9	4.9
8 – CBD	20.1	20.5	20.1	4.8	4.9	4.8
9 – Strand and Gregory	20.2	20.3	20.3	4.8	4.8	4.8
10 – Strand	20.0	20.3	20.1	4.8	4.8	4.8
11 – Strand and Howitt	20.0	20.2	20.2	4.8	4.8	4.8
12 – North Ward	20.2	20.6	20.2	4.8	4.8	4.8
Criteria	25			8		

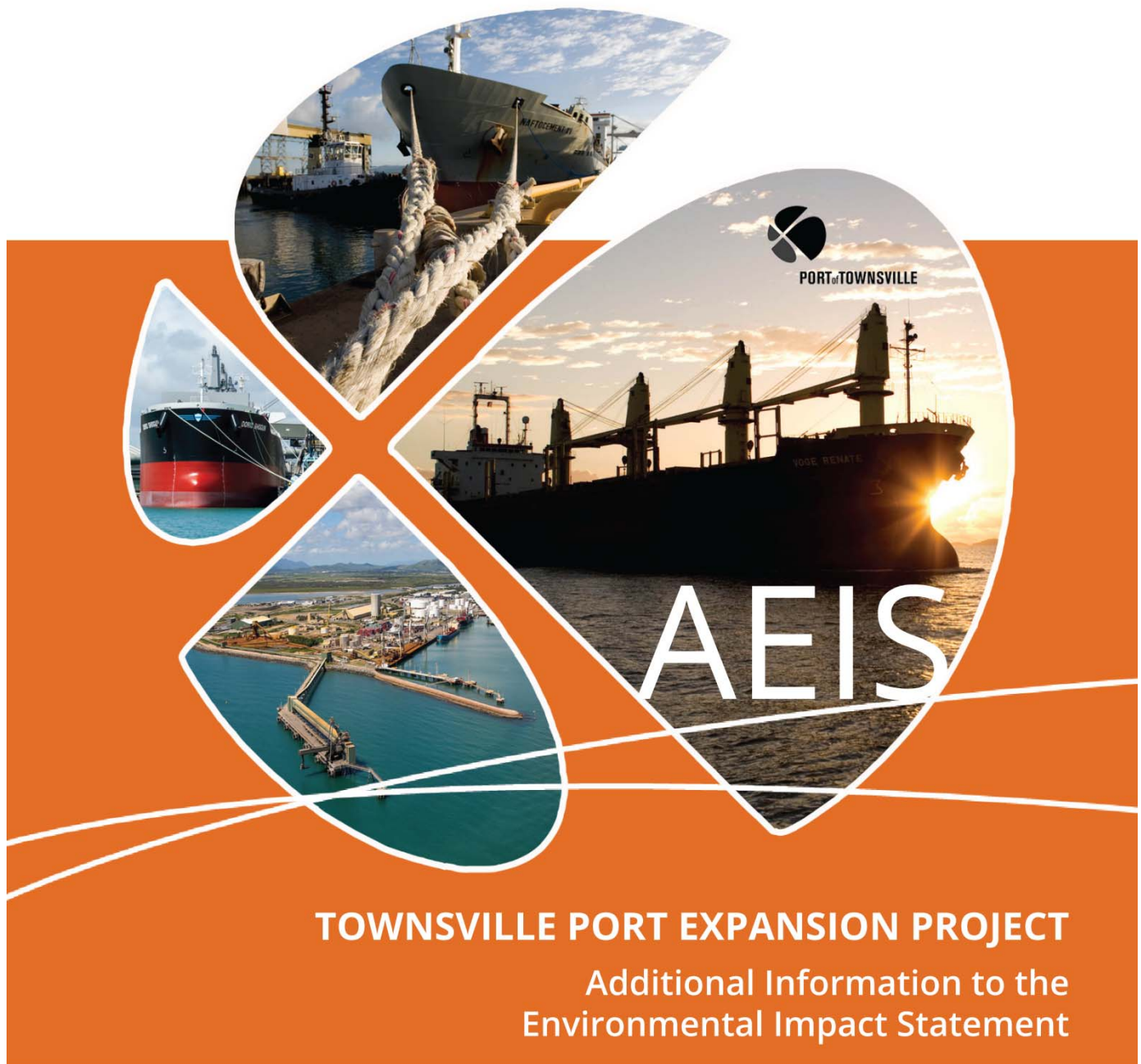
8.0 Conclusion

The potential air quality impacts associated with the construction of the proposed Port Expansion Project (PEP) were reassessed, with the inclusion of shipping emissions at both the existing port and the PEP. The magnitude of dust emissions from PEP construction activities was reduced (compared with the EIS) due to major construction activities not occurring concurrently. Concentrations of particulates and combustion gases at indicative sensitive receptor locations were estimated using the CALPUFF model.

Concentrations of PM₁₀ and TSP were predicted to be below the EPP (Air) criteria (established for health and well-being) for all averaging periods, at all indicative sensitive receptors. Dust deposition rates were predicted to be below the NSW criterion for dustfall at all indicative sensitive receptors.

Concentrations of NO₂, SO₂, CO, and PM_{2.5} from shipping emissions were predicted to be below the EPP (Air) criteria (established for health and well-being) for both short term and long term averaging periods, at all indicative sensitive receptors. The overall risk to health and well-being from shipping emissions was considered low.

In order to minimise adverse impacts, a range of mitigation measures should be implemented during the construction period. An air quality monitoring and management plan, which outlines mitigation measures and site practices to minimise the generation of dust from the site, particularly during periods where the meteorological conditions are likely to transport the dust off-site, should be prepared and implemented for both the construction and operational periods of the development. All activities on the site should be undertaken with the objective of preventing visible emissions of dust beyond the site boundary. In the event of visible dust emissions occurring at any time, all practicable dust mitigation measures, including cessation of dust-generating works, should be identified and implemented.



APPENDIX A5

Cumulative Impacts Assessment Supporting Information



1.0 Supporting Information to the Revised Cumulative Impacts Assessment

1.1 Introduction

This report provides relevant information that was used to develop the revised cumulative impact assessment prepared as part of this AEIS as outlined in Chapter 25.0 of the AEIS. Information presented below includes:

- identification of the potential stressors that may impact upon Sensitive Ecological Receptors
- characterisation of the likelihood of occurrence of these stressors
- consideration of how the distribution and condition of the Sensitive Ecological Receptors varies over time
- the risks of these individual stressors on Sensitive Ecological Receptors in Cleveland Bay.

Consistent with recently released guidelines, including the Great Barrier Reef Marine Park Authority (GBRMPA) *Framework for Understanding Cumulative Impacts Supporting Environmental Decisions and Informing Resilience-Based Management of the Great Barrier Reef World Heritage Area* (GBRMPA Guidelines) (Anthony, Dambacher, Walshe, & Beeden, 2013), the focus of this assessment has been on two particular Sensitive Ecological Receptors; namely coral reefs and seagrass meadows.

1.2 Identified Potential Stressors on Sensitive Ecological Receptors

The stressors considered in this cumulative impact analysis are categorised into:

- large-scale external drivers, including climate change derived ocean warming and ocean acidification
- strong synoptic weather events, especially cyclones
- contribution of sediments, nutrients and pesticides, from land-use changes, urban development and sediments re-mobilised by dredging activities
- fishing, tourism and marine transport stressors.

The key cause-effect relationships discussed in this assessment can be seen in the influence diagram presented in Figure 1. This figure shows the main cause-effect or risk propagation linkages (risk pathways) between stressors and ecological endpoints (Sensitive Ecological Receptors).

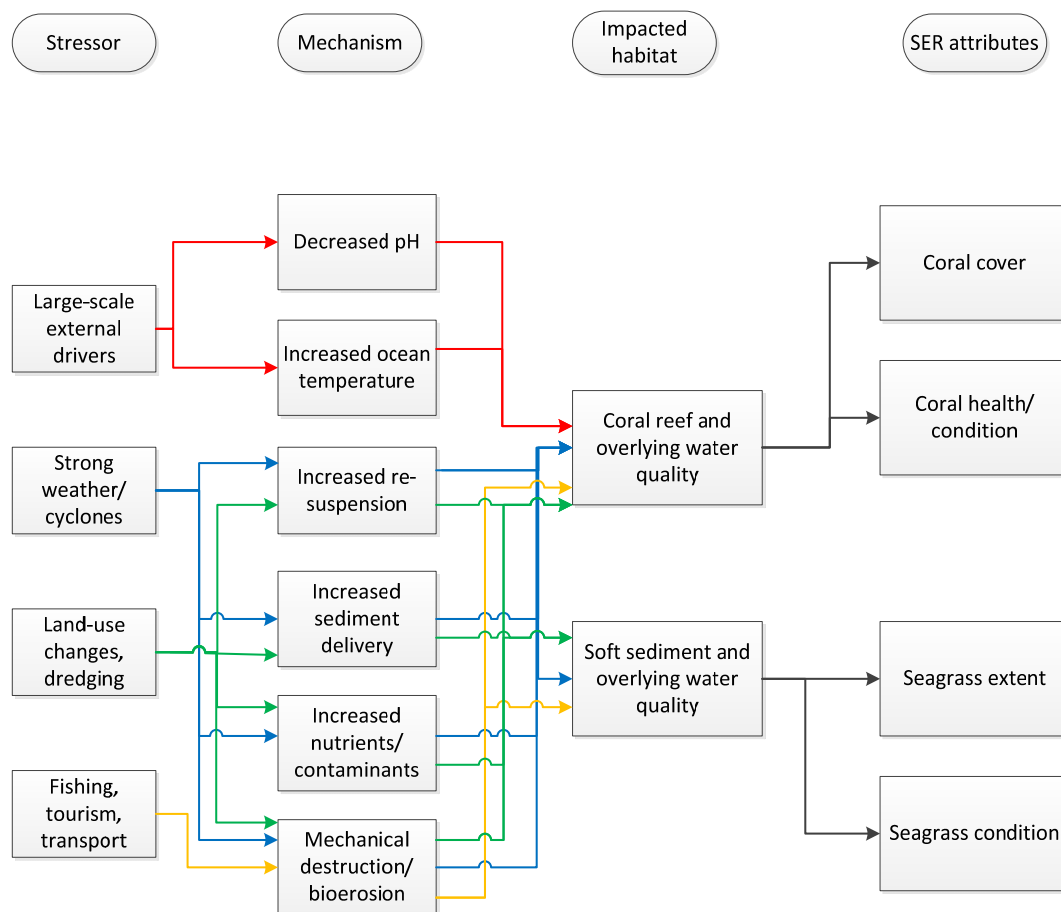


Figure 1 Influence diagram showing key cause-effect risk pathways considered in this analysis.

As outlined in detail in Chapter B.6 (Marine Ecology) of the EIS and further discussed in Section 8.0 of the AEIS, the main risk to the Sensitive Ecological Receptors are:

- reduced water clarity (increased turbidity)
- increased sedimentation rates in the vicinity of the Sensitive Ecological Receptors.

Both seagrasses and corals have shown sensitivity to periods of elevated turbidity and sedimentation rates. Increased turbidity reduces light availability to these Sensitive Ecological Receptors. Increased sedimentation rates can smother seagrass beds and lead to a requirement of coral colonies to expend energy clearing fine sediments. Therefore any mechanism that mobilises fine sediments must be considered to be a stressor for the Sensitive Ecological Receptors in the study area. This includes both project related and non-project related mechanisms, and as such, capital dredging impacts from the proposed Project need to be considered in the context of other stressors operating on these Sensitive Ecological Receptors.

The key project related stressor is the capital dredging campaign; in particular when the TSHD (Trailer Suction Hopper Dredger) is operating. Capital dredging can break up consolidated sediments and along with losses from dredger hopper overflow, additional fine sediments effectively enter the water-column during and post dredging operations. These fine sediments generated by dredging activities can contribute to the overall fine sediments budget that enter from catchments following flooding events and existing fine sediments that have entered the lagoon over geological timescales and are routinely re-suspended. These project related stressors are discussed in detail in the Section 6.0 and Appendix A1.

Key non-project stressors include turbidity which can be increased through the presence of either suspended fine mineralogical sediments, or flocs produced through primary biological production. 'New' fine sediments predominantly enter the Great Barrier Reef (GBR) lagoon from catchment sources and are primarily deposited within tens of kilometres of major river mouths (Lewis *et al.* 2014). Wet season cyclone events can disturb and redistribute these fine sediment across the shelf as well as import new fine sediments into the system through land based runoff associated with heavy rainfall.

However fine sediments have been entering the GBR lagoon over geological timescales and in the case of Cleveland Bay, the majority of fine sediments that are routinely re-suspended are 'old' sediments that were deposited during the Holocene period (Lewis *et al.* 2014).

It has also been recognised that the supply of fine sediment since European colonisation in the 1800s has increased up to six-fold by comparison to pre-European periods (Kroon *et al.* 2012). Whilst this increase is substantial, the relative increase is small by comparison to the similar post-European settlement increases in sediment delivery in other more urbanised Queensland catchments such as the catchments that flow into Moreton Bay (Dr Tim Stevens-Griffith University. Pers. Comm.).

The input of these 'new' fine sediments from catchments can also form a vector for the delivery of nutrients from catchment sources and these additional nutrients can stimulate primary production in the inner shelf region, which can further contribute to increases in turbidity over near-shore Sensitive Ecological Receptors.

The stressors described above can also be intensified by non-project sources of anthropogenic origin. In particular, other infrastructure projects underway near or within the study area need to be considered.

The proposed PEP is located in an established and existing port which has been identified in the Queensland Ports Strategy as one of the Priority Port Development Areas. The port has grown over last century in response to the regional development of North Queensland, underpinned by the strategic role Townsville has played in the Australian Defence capability.

Over the same period the biodiversity values of the GBR have increasingly been recognised and managed through the establishment of multiple conservation management zones including the GBR Marine Park zones and declared Fish Habitat Areas. The Port is located within declared port limits situated adjacent to conservation and management areas.

The Sensitive Ecological Receptors in the study area are also potentially impacted by other activities occurring within the region. These can be classified into the following categories:

- general urban development of the Townsville region
- other projects occurring within the Port boundaries
- land-use activities occurring within the regional catchments
- development of other GBR ports.

Impacts from urban development, including discharges from wastewater treatment plants are generally managed through:

- sediment, erosion and nutrient release measures for point source discharges
- through recommended measures by the Townsville City Council in relation to erosion and sediment control.

Relevant assessments (where available) for these activities concluded these activities are not having substantive far-field impacts on the Cleveland Bay or GBR-wide ecosystem. The other main activity occurring within the port boundaries are ongoing maintenance dredging activities. These are considered in Section 6.0 and Section 8.0 of the AEIS.

Land-use activities occurring within the broader region and wider GBR catchments are considered in detail in the remainder of this cumulative impacts assessment.

1.3 Characterisation and Likelihood of Stressors

This section characterises the identified stressors, and their variability. In risk assessment terminology this would be described as characterising the stressors and determining the likelihood that these stressors could lead to impacts in any given year.

As highlighted above, four stressors or general sources of risk have been considered in line with the GBRMPA Cumulative Impacts Framework (Anthony, Dambacher, Walshe, & Beeden, 2013).

- 1) Intense weather events (i.e. cyclones).
- 2) Large scale externalities.
- 3) Dredging and catchment land use practices.
- 4) Fishing, marine tourism and transport.

The risk characteristics of these sources, in terms of how they can impact Sensitive Ecological Receptors and how often they typically occur, are described below.

1.3.1 Intense weather events (cyclones)

Mechanisms and risk pathways

Intense weather events, including cyclones and other strong wind and rain events can be a source of risk through the following risk pathways.

- Over synoptic time-scales (i.e. hours, days), large storm-induced waves can lead to direct mechanical destruction of Sensitive Ecological Receptors, including coral colonies.
- Over synoptic and seasonal time-scales, large rainfall events and wetter wet seasons can mobilise large volumes of sediments within catchments. This sediment, and attached nutrients can enter the inner shelf, reduce light levels and increase short term sedimentation rates on Sensitive Ecological Receptors.
- Over synoptic and seasonal time-scales, large rainfall events can lead to extensive freshwater plumes that can impact freshwater intolerant and light sensitive species.
- Over geological time-scales, cyclones act to control the inflows of new sediments in the GBR lagoon and the cross-shelf distribution and allocation of existing sediments within the lagoon and shorelines.

The majority of investigations of the impacts of cyclones on Sensitive Ecological Receptors in the GBR mostly focus on short term synoptic events (events occurring over periods of days). By contrast, the most important role of cyclones occurs over geological timescales where repeated cyclones cumulatively act to control the inflow of new sediments into the lagoon through seabed erosion, reef breakage (bio-erosion) and river flooding, and importantly control and maintain partitioning of sediments and restrict development of new reefs in the inner shelf sediment prism (Larcombe & Carter, 2004).

Reoccurrence and likelihood

Figure 2, extracted from Puotinen (2004) and Figure 3 from BoM (Bureau of Meteorology) data, shows the tracks and number of cyclones that entered Queensland waters during the 20th century. Details of these cyclones can be found in Section 2.0.

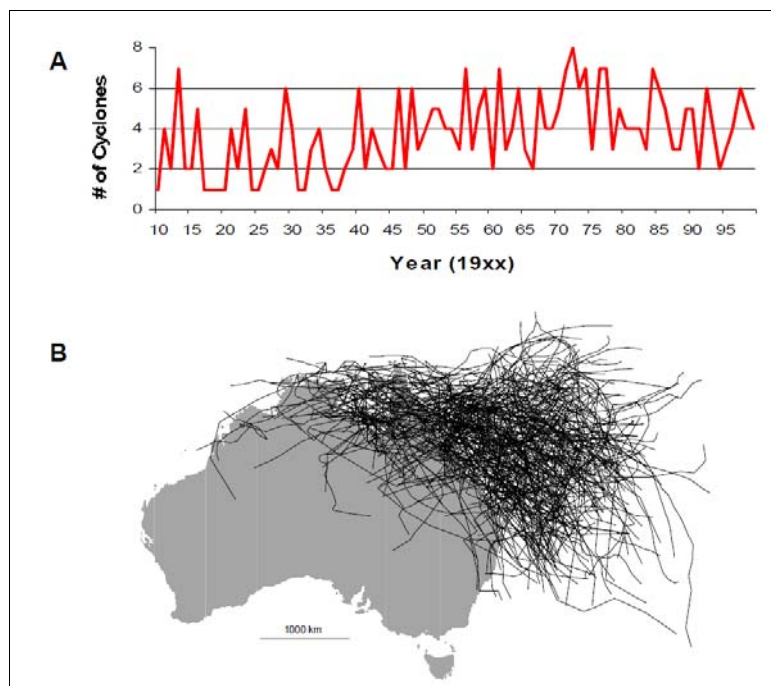


Figure 2 Number (A) and paths (B) of tropical cyclones that entered Queensland Australia from 1910 to 1999. Tracks were generated from the tropical cyclone database (Puotinen M., 2004).

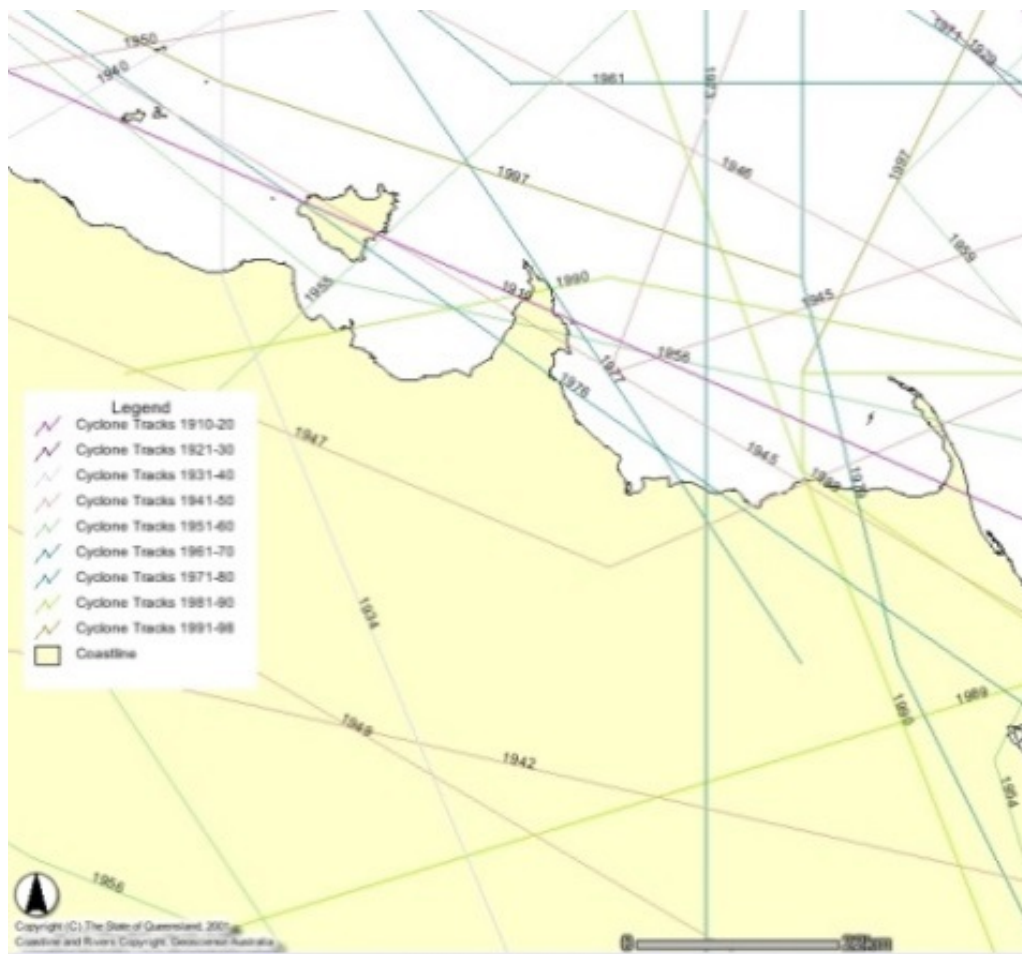


Figure 3 Major cyclones near Cleveland Bay. Data provided by the BoM.

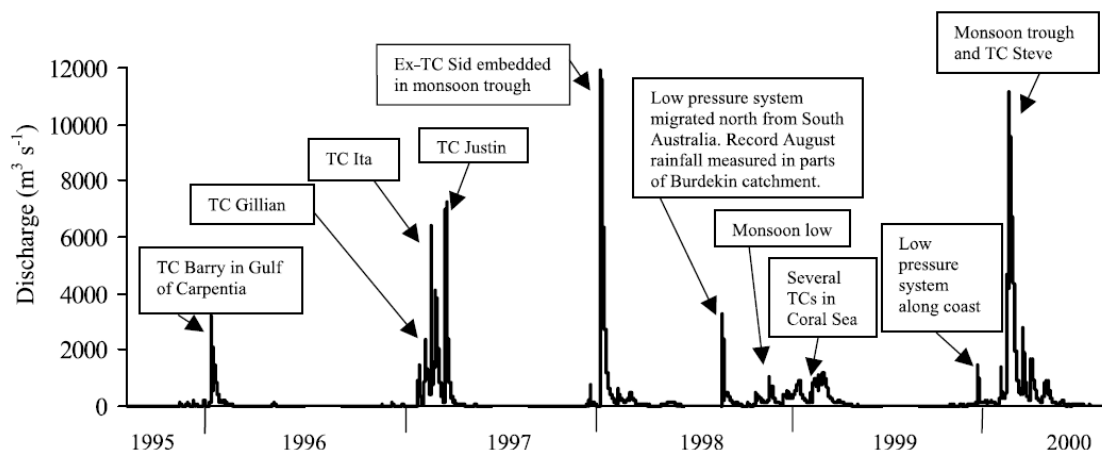


Figure 4 Hydrograph from the Burdekin River (extracted from (Amos, Alexander, Horn, Pocock, & Fieldings, 2004)).

The hydrograph data shown in Figure 4 demonstrates that cyclones are an integral part of the GBR climatology. This is evident in the central GBR where the PEP is proposed.

Deriving likelihood from first principles, given that the length of the GBR is approximately 2,300 km, and that on average four named cyclones cross the GBR every year, if it is assumed that catastrophic damage occurs 25 km either side of each cyclone and that any cyclone will cross perpendicular to the coast, then, as a result, every time a cyclone crosses the GBR it will impact at least one of 46, 50 km-wide sections. Therefore, on average 4 of these 46 sections are impacted every year, as a long term average, which is close to a 10% likelihood that any given 50 km section of reef will be impacted by cyclone damage in any given year. This would equate to every reef within the GBR being impacted by one major cyclone event every ten years.

A refined version of this calculation was performed by Puotinen (1994; 1997). Assuming cyclones can create destructive conditions 100 to 200 km away from the centre (Done T., 1992), and given known distributions of coral

reefs, Puotinen (1994; 1997) estimate that for the period 1969-1997 every reef in GBR was influenced by at least one cyclone.

Similarly, based on a minimum destructive wind speed of around 25 m s^{-1} for periods of 20 hours, Puotinen (1994; 1997) estimate that for the latitude of Townsville, reefs were impacted by a cyclone on average every other year between the years of 1969-2003. Figure 5 shows recent cyclones that have crossed the GBR.

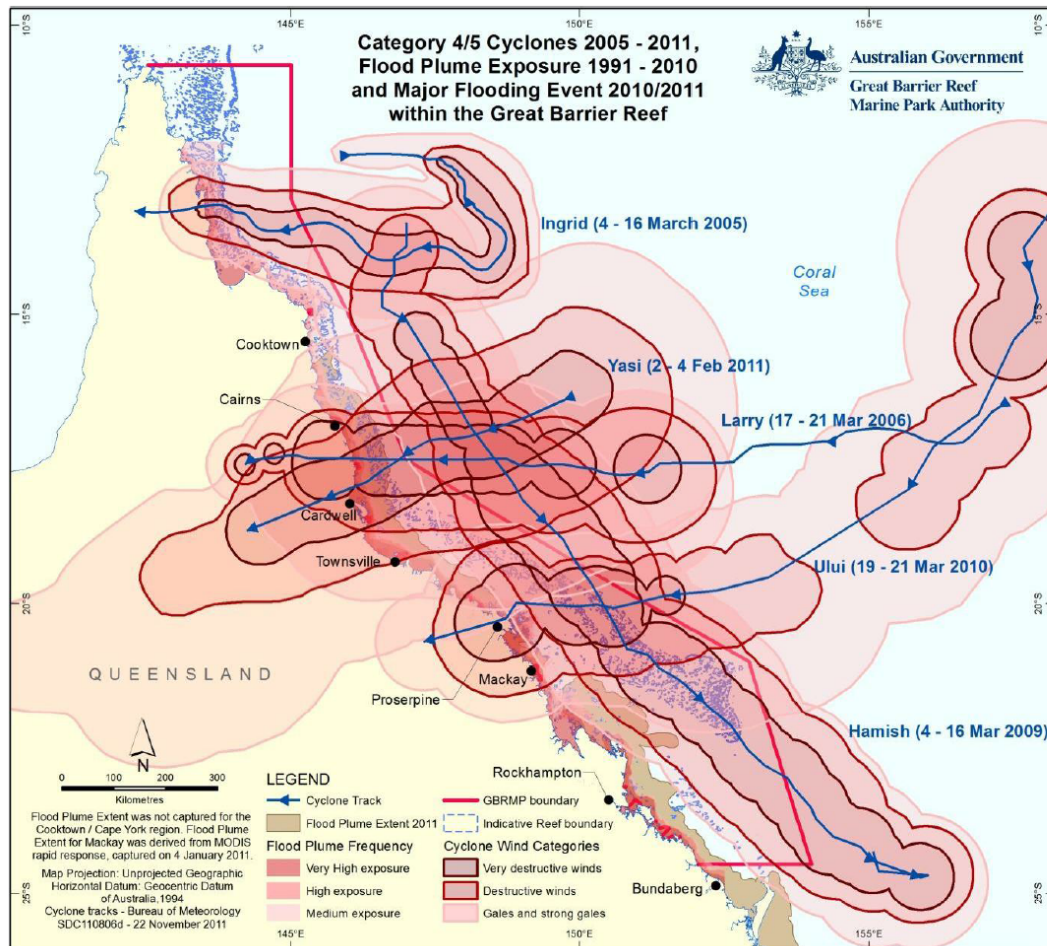


Figure 5 Area of the Great Barrier Reef affected by the cumulative impacts of major cyclones over six years overlaid with the major flood plume extents over the last two decades.

These estimates support that on average, reefs in the central GBR will be impacted by cyclonic activity somewhere between every other year and once every decade. Given the relatively short return period in terms of all cyclones, and even for major cyclones, studies show that cyclones play a major role in controlling the regional and local reef community structure, reef-scale, growth rates of reefs and general recovery periods of 1-20 years. This also implies that many, if not most reefs do not get time to fully recover from cyclonic activity. In summary, evidence of past cyclones exist on most if not all reefs in the central GBR. Nott and Hayne (2001) also use coral core records to suggest that every 2 or 3 centuries a 'super cyclone' impacts the GBR.

It is also important to factor that fewer cyclones cross the coast during El Niño years. This implies that both major inputs of sediments during flood events (that are often associated with cyclones) and mechanical destruction from cyclones are often reduced during El Niño years.

Major cyclonic events rarely if ever completely destroy all coral colonies or seagrass meadows within the path of the cyclone (Lukoschek, Cross, Torda, Zimmerman, & Willis, 2013). However, the idea that coral reefs in the Townsville area only experience destructive cyclone events rarely, and have time to fully recovery in between these events is not supported by the available evidence.

Despite common speculation on the potential impacts of climate change on cyclones, there is no compelling evidence to suggest that long-term averages of either the frequency or intensity of cyclones crossing the coast at or near Cleveland Bay has changed significantly over the last century; although this may be a result of lack of data. An increasing number of ecological research papers have speculated that climate change will increase the frequency and/or intensity of cyclones in Queensland. The Intergovernmental Panel on Climate Change (IPCC) in the most current assessment report (AR5) notes that (Intergovernmental Panel on Climate Change, 2013):

"Globally, there is low confidence in attribution of changes in tropical cyclone activity to human influence. This is due to insufficient observational evidence, lack of physical understanding of the links between anthropogenic drivers of climate and tropical cyclone activity, and the low level of agreement between studies as to the relative importance of internal variability, and anthropogenic and natural forcings."

And that:

"Projections for the 21st century indicate that it is likely that the global frequency of tropical cyclones will either decrease or remain essentially unchanged, concurrent with a likely increase in both global mean tropical cyclone maximum wind speed and rain rates".

The best evidence suggests the possibility that less, but more intense cyclones may be a result of global warming during this century. However, these projections are inherently uncertain. Furthermore, as highlighted by the IPCC AR5 studies, current datasets do not indicate any significant trends in global tropical cyclone frequency over the past century. Therefore the best estimates of near future cyclone return intervals are the historical records.

1.3.2 Large-scale externalities

Mechanisms and risk pathways

Large-scale externalities encompass sources of risk that are essentially external to the GBR and wider Queensland region. The major source of the externalities is through climatological processes, especially global warming and ocean acidification.

The cause-effect or dose-response mechanism whereby increased ocean temperatures lead to coral bleaching has been well-established, although it is believed to be complicated by other factors including variability in nutrient and sediment concentrations and incoming solar radiation. Bleaching occurs when coral colonies reject or expel endosymbiotic zooxanthellae typically in response to a combination of high incoming irradiance and elevated sea surface temperatures when sea surface temperatures remain several degrees above typical seasonal ambient conditions. This bleaching threshold is commonly around 30°C for the GBR (Wooldridge, 2009) (Figure 6). Coral bleaching resulting from heat stress has been observed in Hawaii (Jokiel & Coles, 1990), the Caribbean (Winter, Apeldoorn, Bruckner, Williams, & Goenaga, 1998), the Indian Ocean (Wilkinson, Linden, Cesar, Hodgson, Rubens, & Strong, 1999) and Panama (Glynn & D'Croz, 1990).

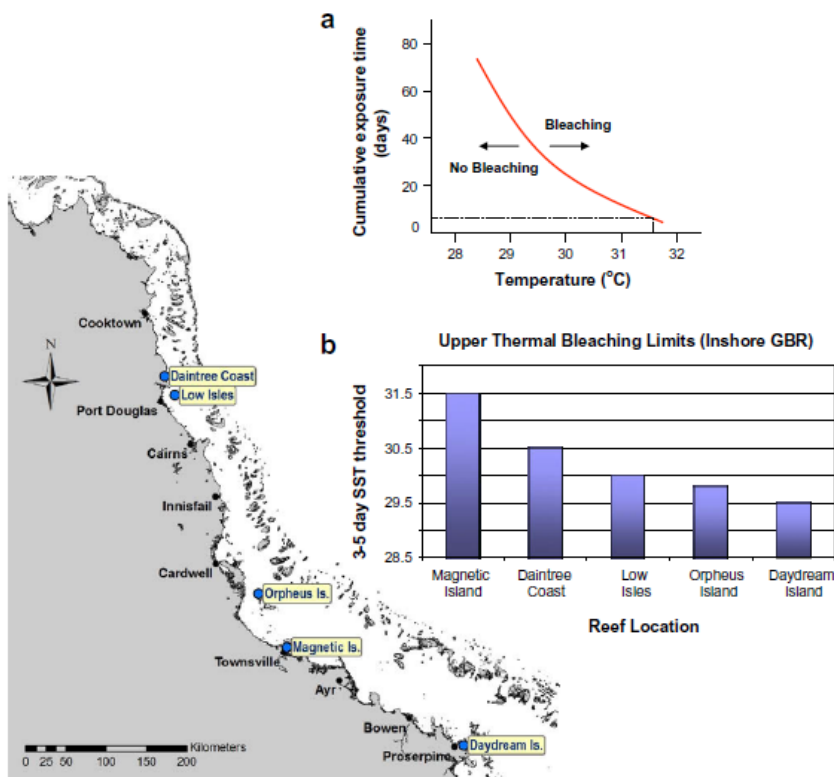


Figure 6 Time-integrated thermal bleaching threshold curve for a hypothetical reef (after Benkelman's, 2002). Temperature and exposure time combinations to the right of the thermal bleaching curve are predicted to induce a bleaching response. (b) Regional-scale variability in the upper thermal bleaching limits of the inshore reefs of the GBR (after Berkelmans, 2002; Berkelmans, 2008). Extracted from Wooldridge (2009).

Similarly, ocean acidification resulting from a rise in partial pressure of carbon dioxide can reduce calcification and accelerate bio-erosion rates in coral reefs (Wissak, Schonberg, Form, & Freiwalk, 2012). As highlighted by Veron (2011), rates of coral calcification are partly determined by the availability of carbonate ions via the level of aragonite saturation. Furthermore, geological analyses highlight the correlation between previous mass reduction in coral reefs and acidification (i.e. (Veron J. , 2008).

Recurrence and likelihood

In the GBR, major coral bleaching events were observed in 1998, 2002, and 2006 in parts of the GBR (Berkelamans, De'ath, Kininmonth, & Skirving, 2004). During the 2002 event around 41% of reefs surveys showed signs of bleaching.

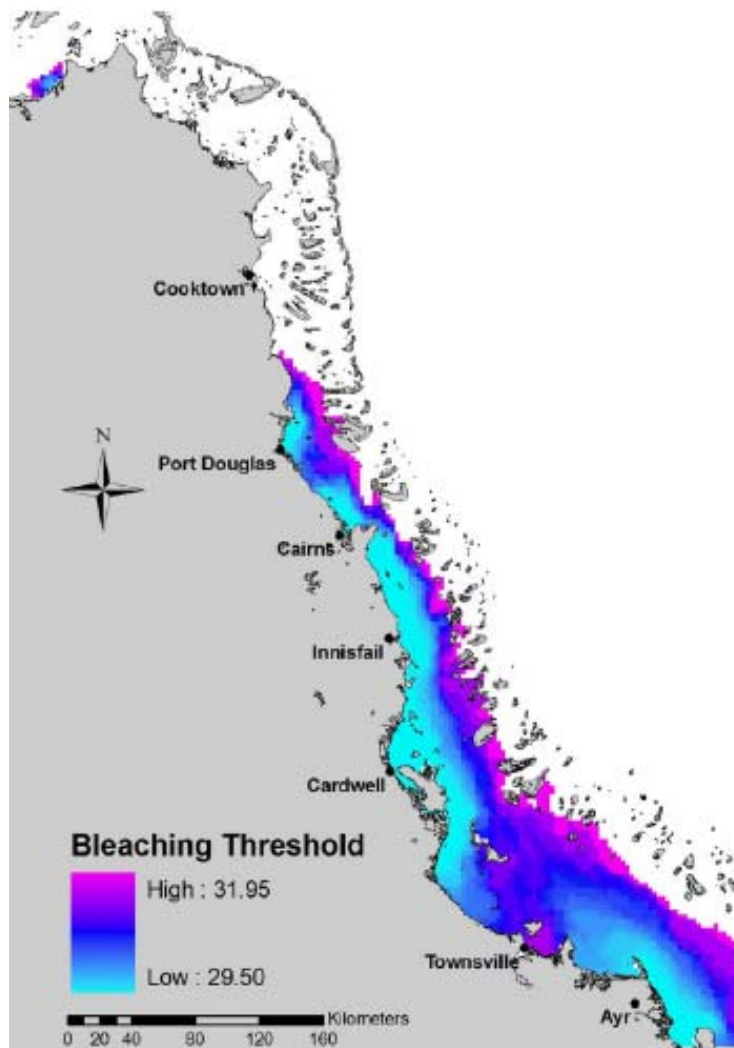


Figure 7 Spatial extrapolation of the quantitative relation between degree of exposure to nutrient enriched terrestrial water and the upper thermal bleaching thresholds of inshore reefs of the central GBR. Extracted from Wooldridge (2009).

Wooldridge (2009) estimated the spatial distribution of bleaching thresholds for the GBR and these are shown in Figure 7. Of relevance, this figure indicates that Cleveland Bay has an equivalent bleaching threshold or vulnerability to the outer shelf reefs.

IPCC AR5 projections continue to support the view that under most emissions scenarios there will be continued warming of the upper-ocean, and acidification of the global oceans. However as expected the projected rate of increase is strongly determined by future emissions scenarios, which are unknown.

Figure 8 shows estimated bleaching probabilities for coral bleaching at Heron Island, extracted from the study of Yara *et al* (2014) that used projections from 23 climate models using the IPCC A1B emissions scenarios. These projections suggest that over the next two decades the most likely return period for bleaching events remains between 5 and 10 years. By contrast, by the end of the century it is projected that bleaching events will be occurring every year on average.

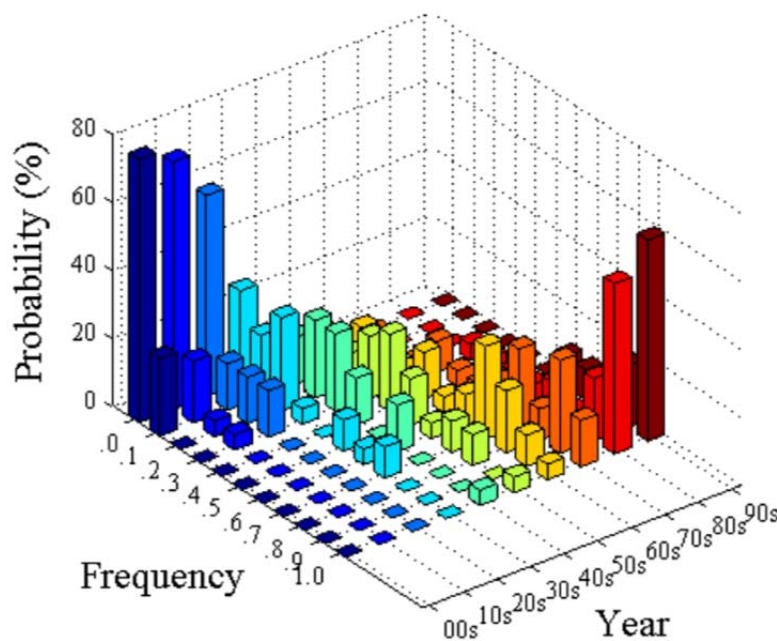


Figure 8 Projected bleaching events (Extracted from Yara *et al* (2014)).

The likelihood that acidification will impact specific Sensitive Ecological Receptors, especially corals, in any given year is difficult to even characterise at present. Whilst the mechanisms through which acidification could impact coral are becoming clearer, whether they are actually occurring at present and how much is far from clear.

1.3.3 Dredging and catchment land use practices

Mechanism and risk pathways

Changed catchment land-use practices and coastal development have led to a change in the rate of delivery of nutrients, pollutants and contaminants, and fine and coarse sediments entering coastal regions worldwide. For example, the damming of large rivers on many continents has curtailed the downstream delivery of coarse sediments resulting in increases in coastal erosion as a result of shutting off the supply of coarse sediments to the coastal zone.

Similarly, world-wide, coastal water quality has been impacted by agricultural runoff and urban development in many receiving catchment environments. This can lead to increased eutrophication from elevated nutrient loads, and increased concentrations of contaminants in sediments and in the water-column, especially around heavily industrialised coastal regions.

Fine sediments in tropical waters can reduce light levels to coral colonies and seagrass beds, and increased sedimentation rates can smother seagrasses and corals and lead to requirements for increased energy expenditure for clearing fine sediments in coral colonies.

Increased nutrient loads into the GBR lagoon has also been strongly linked with outbreaks of Crown of Thorns Starfish (CoTS; *Acanthaster planci* – Fabricius *et al* 2010).

Dredging operations have the potential to generate fine sediments when the cutting head is operating. These fine sediments can temporarily reduce the water clarity (increase the turbidity) within the footprint of the dredge plume. The characteristics of expected plume can be found in Section 6.0 of the AEIS (Marine Water Quality).

1.3.3.1 Recurrence and likelihood

Land-use changes occurring within the GBR catchments (total catchment area 424 000 km²) can influence coastal marine Sensitive Ecological Receptors through the delivery of nutrients, pesticides and fine sediments which enter the GBR lagoon mainly during 'wetter' wet seasons. These inflows or waterway discharges vary both through and over time.

Figure 9 shows the relative discharges from the major waterways that drain into the GBR lagoon. The Burdekin River is the single-largest point source by volume in the GBR catchment. The Burdekin enters the GBR upstream (south) from Cleveland Bay where river plumes typically flow northwards as result of near-shore wind-driven flows forced by the predominant south-easterly trade winds.

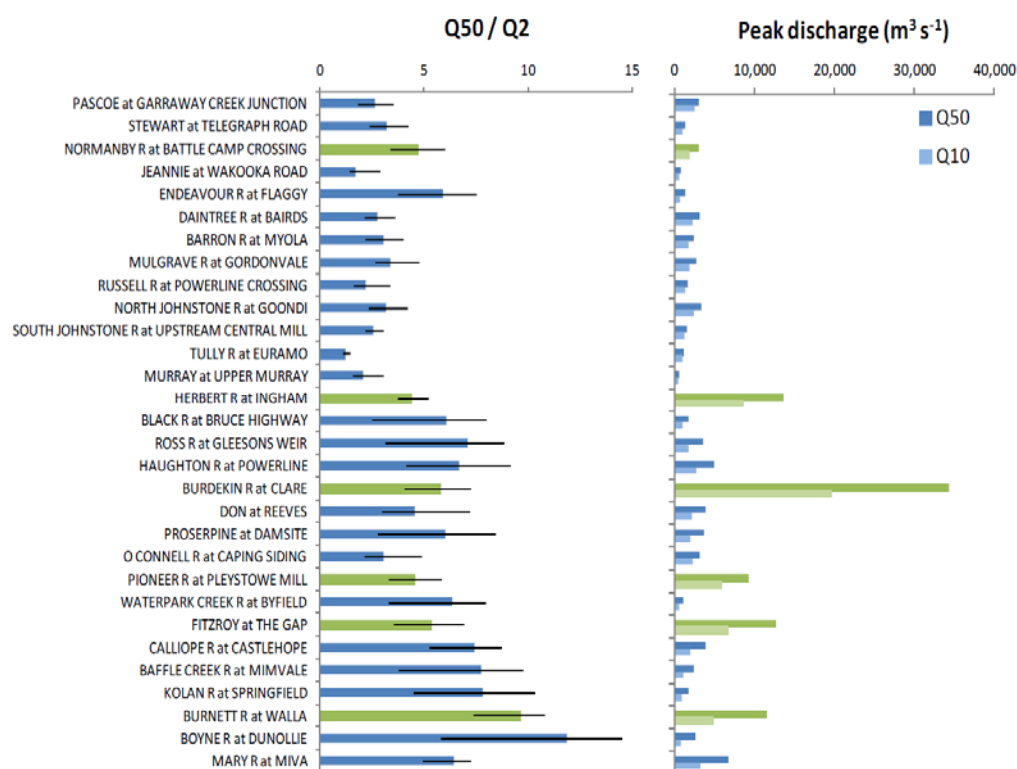


Figure 9 Left: Flood variability at selected GBR river gauges, represented by the ratio of the peak discharge of the flood with 50 years recurrence interval relative to peak discharge of the flood with two-year recurrence interval (Rustomji, 2009) Rivers indicated in green are the largest for their respective resource management region.

Information on discharges over recent years from rivers that flow into the GBR are shown in Figure 10, Figure 11 and Figure 12. The prolonged dry period, followed by the intense floods during 2010/11 can be seen in Figure 10. For a number of catchments the 2010/11 flows were the largest in the historical record.

In the GBR system there is strong agreement that post-European clearing in the catchment has increased the annual average delivery of contaminants, nutrients and fine sediments several-fold by comparison to pre-European settlements periods (Kroon, et al., 2012). Therefore whilst large flood events have always occurred in the catchments, over recent decades the volumes of pesticides, sediments and nutrients associated with these flood events have increased.

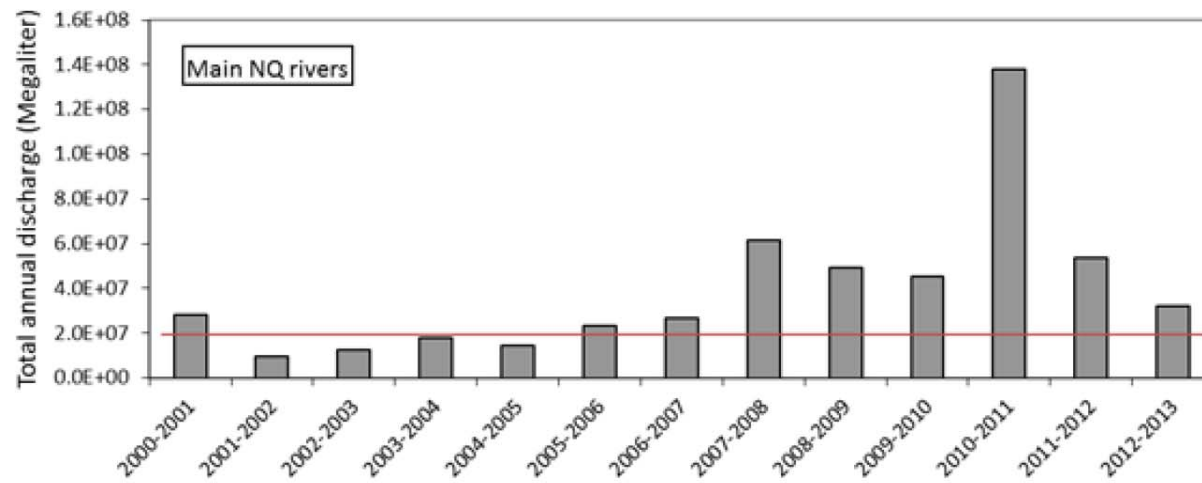


Figure 10 Total discharge from main GBR rivers showing above median flow since 2007-2008. Units are in Megalitres (Reproduced from <http://watermonitoring.derm.qld.gov.au>).

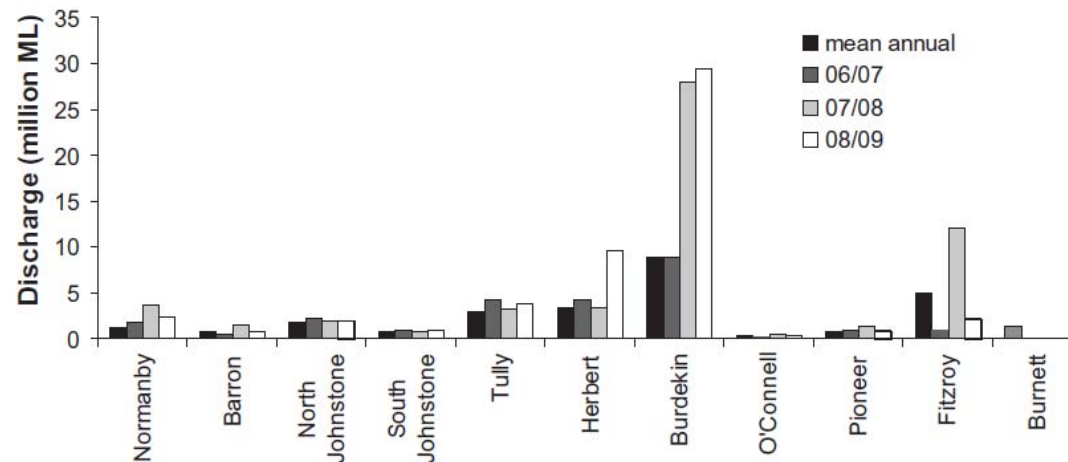


Figure 11 Annual discharge volume (2006-09) and long term mean annual discharge (table) in the major catchments of the GBR. Units are in millions of megalitres (Reproduced from Joo *et al* (2012)).

Combined flow standardised TSS and nutrient loads (mean annual concentrations) at the monitored EOS sites.

Monitoring year	Discharge (million ML)	TSS (mg/L)	TN ($\mu\text{g/L}$)	TP ($\mu\text{g/L}$)	NO _x -N ($\mu\text{g/L}$)	NH ₄ -N ($\mu\text{g/L}$)	FRP ($\mu\text{g/L}$)
2006/07	25	308	744	190	158	13	17
2007/08	57	334	1029	289	100	11	35
2008/09	53	242	709	176	73	20	22
Mean	45	295	827	218	110	15	25

Figure 12 Combined flow standardised TSS (total suspended solids), Total Nitrogen (TN), Total Phosphorus (TP) and nutrient loads (mean annual concentrations) at the monitored in major GBR rivers (see Joo *et al.*, 2012 for details).

1.3.4 Fishing, marine tourism and transport

Mechanism and risk pathways

The potential and probable impacts of fishing activities have been well-researched over numerous decades, and a considerable research effort has been directed towards understanding the impacts of fishing on the GBR during the 1980s and 1990s. Impacts have included direct habitat destruction of soft-sediment habitats as a result of trawling activities, and changes to predator-prey relationships when reef fishes are exploited.

Marine tourism and transport, principally dive and fishing charters, and commercial shipping and ferry services all involve the passage of vessels that create noise and in the case of shipping and other vessels, can release fine sediments into the local marine environment. Diving tourism has also had significant impacts on reefs through mechanical destruction associated with vessel anchors and divers themselves.

Recurrence and likelihood

Fishery values, baseline conditions and use of Cleveland Bay were addressed in Section 8.0 of the EIS. Below is a summary of the key findings.

C & R Consulting (2007) compiled records of soft sediment habitat associated demersal fish species in Cleveland Bay. These records identified 253 species from 65 families in Cleveland Bay and the lower reaches of Ross Creek and Ross River. Around one-third of these species are migratory, including over 40 species that migrate between marine and freshwaters (amphidromous), 23 species that migrate in marine waters, 12 species that migrate between marine and freshwaters for breeding, and two species that migrate in freshwater environments.

Commercial fisheries operating in Cleveland Bay include:

- Queensland Mud Crab fishery
- East Coast Otter Trawl
- Queensland Blue Swimmer Crab fishery
- Queensland East Coast Spanish Mackerel fishery
- Queensland East Coast Inshore fin fish fisheries.

The Queensland Spanner Crab fishery includes waters adjacent to Cleveland Bay.

Analysis of the Department of Agriculture and Fisheries (then DEEDI) catch data indicates that Cleveland Bay is not considered to represent a key production area for mud, spanner, and blue swimmer crabs, but does produce regionally important catches for the East Coast Otter Trawl, the East Coast Spanish Mackerel fisheries, and local net fishery (focusing on barramundi, but also threadfin salmon and grey mackerel).

Cleveland Bay and surrounds are not known to represent regionally important areas for the aquarium fish or sea cucumber fisheries.

Restrictions to commercial fishing activities in Cleveland Bay include a Dugong Protection Area (netting restrictions), Cleveland Bay Fish Habitat Area (trawling restrictions), and commercial fishing closures of Ross River, Ross Creek, Alligator River and Crocodile Creek.

Cleveland Bay also supports recreational fisheries, and a number of inshore, reef and pelagic species are targeted. Recreational fishers generally target similar species to commercial fishers including barramundi, mullet, whiting, bream and mud crabs in inshore areas; and reef fish such as coral trout (*Plectropomus* spp.), snapper (*Lutjanidae*), sweetlip (*Lethrinidae*) and trevally (*Caranx* spp.) when further from shore (Ludescher, 1997). The value of recreational fishing is likely to be greater than the commercial fishing industry.

Most line-based recreational fishing tends to occur around artificial structures such as navigation structures and breakwaters, as well as reef environments around Middle Reef and Magnetic Island. Some crabbing occurs in coastal creeks throughout the bay.

Estuarine areas in the south-east of Cleveland Bay (e.g. Ross River, Alligator and Crocodile Creeks) are commonly used for targeting species such as barramundi, mangrove jack, flathead, whiting and mud crabs. Cast netting for prawns and herring occurs extensively along Ross Creek, the Ross River mouth and along foreshore areas; and yabbie pumping occurs on the eastern side of Ross River (Sinclair Knight, 1991).

The breakwaters around the Port of Townsville are popular recreational fishing locations, primarily for fishing from small boats (CPL, 2007). The only Port of Townsville breakwater that recreational anglers have access to for land-based fishing is the western breakwater. Reef and deep-sea recreational fishing is focused around Cape Cleveland, Middle Reef, the shipping channel, Pallarenda Point and Magnetic Island (Sinclair Knight, 1991).

Although some limited recreational fishing data are collected by DEEDI (2011) for the wider region, little is known about the catch and value of recreational fishing in Cleveland Bay and surrounds. It is also difficult to quantify the overall market value of the recreational fishing industry because it supports a wide network of businesses and

tourism-related operations in Townsville and on Magnetic Island. It is likely to be considerably more than the commercial fishing industry, as previous estimates of the economic value of recreational fishing in the area (Sinclair Knight, 1991) are high. At that time that this report was compiled approximately 70,000 kg of bait was sold annually at a retail value of ~\$200,000. It was also estimated the annual retail value of bait and tackle sales to be \$2.5 million, whilst outlay on boats, motors and chandlery was estimated to be a further \$2 million.

There is little information about the amount of Indigenous fishing conducted, however it is likely to be small when compared to the general recreational and commercial sectors.

The GBRMPA Strategic Assessment identifies that tourism is strongly focused offshore of Cairns, Port Douglas and the Whitsunday Island. It is evident from the Strategic Assessment that tourism within Townsville and Magnetic Island holds a lesser value than other key areas within the GBR Marine Park area but is comparable to other locations outside of the key tourist areas (GBRMPA, 2014).

1.4 Sensitive ecological receptors and variability

The extent and condition of Sensitive Ecological Receptors in the study area are outlined in Chapter B.6 (Marine Ecology) of the EIS. In response to comments on the EIS this assessment has been reviewed and updated as part of this AEIS. This revision involved both undertaking a new survey and field data collection. A summary of these findings with a focus on the relevance of these findings to potential cumulative impacts is presented in the following sections. This analysis also includes considerations of how the distribution and condition of the Sensitive Ecological Receptors vary between years.

1.4.1 Corals

Coral reefs within Cleveland Bay are located between Magnetic Island and the mainland (for example Middle Reef), or fringing reefs on Magnetic Island, for example in Nelly Bay.

Browne *et al* (2010) examined the condition and community structure of Middle Reef, and observed changes to the community structure over years, including an average increase in coral cover over the windward slope for the period 1993-2008 Figure 13.

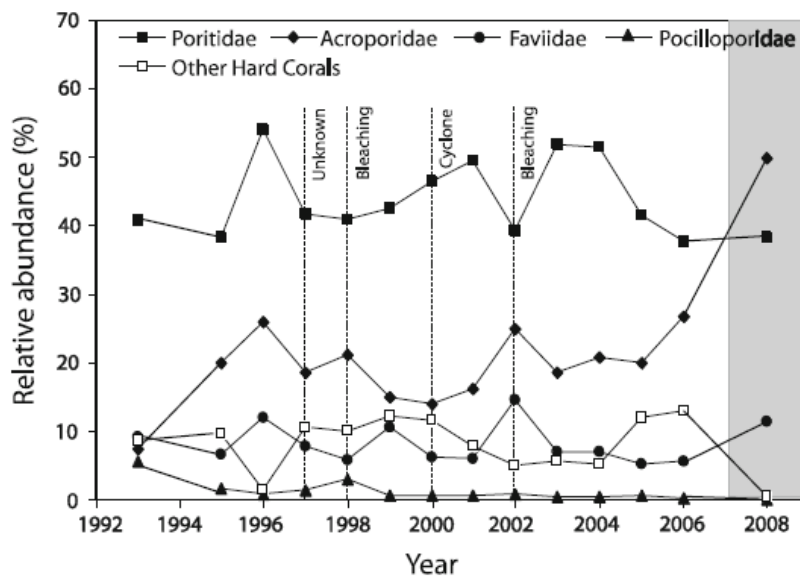


Figure 13 Changes in the relative abundance of the dominant hard coral families. Data collected by the long-term monitoring research teams at AIMS from 1993 to 2007. Shaded area represents data collected as part of this study in 2008. (Browne, Smithers, & Perry, 2010).

Lewis *et al* (2012) conducted a detailed examination of the geological history of the fringing reefs at Nelly Bay and concluded:

“Our integrated approach provides insights into natural compositional variability of fringing reefs and demonstrates that in the past the coastal fringing reefs in the GBR region were exposed to considerable turbid conditions and yet managed to grow rapidly and form extensive reef flats. This suggests that turbidity levels may not seriously limit reefal growth”.

Coral monitoring conducted in 2012 for the Reef Rescue Program monitored sites at Middle Reef and Geoffrey Bay on Magnetic Island. This monitoring noted that the deeper communities at Middle Reef were not heavily exposed to cyclone damage for recent cyclones including Cyclone Yasi. However, bleaching during the period 1998 and flood plumes during 1994, 1997, 1998 and 2008 following the Millennium Drought were also thought to have impacted reefs in the Burdekin region.

Figure 14 shows time series of percentage cover for hard corals from the Reef Rescue program at Middle Reef and Geoffrey Bay. These data show some evidence in a declining trend in coral cover at the shallower sites, but little change at the deeper parts of the reef (5 m) where measured.

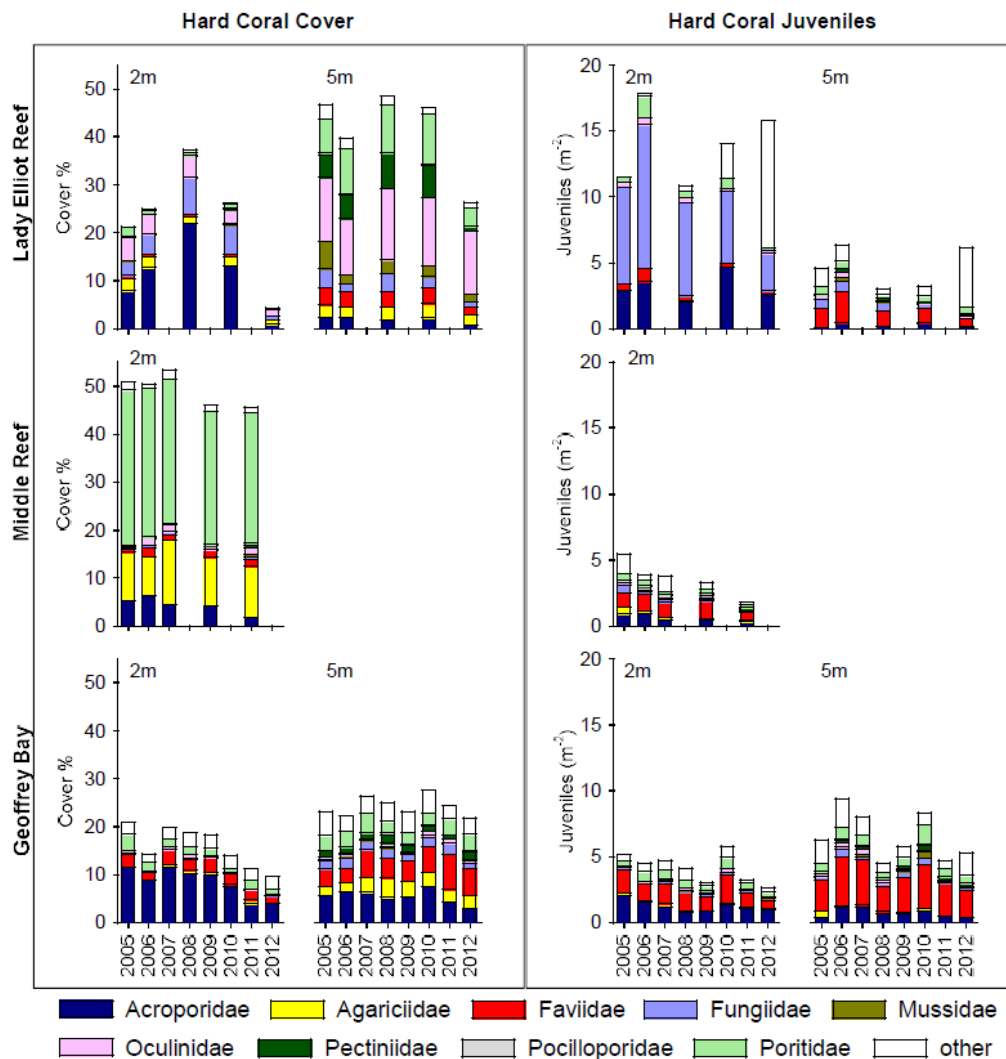


Figure 14 Extracted from Figure 29 of Thompson *et al* (2013).

The most comprehensive time series of GBR coral cover is contained in the AIMS long-term monitoring dataset; some of which is used in the Reef rescue program. Figure 15 shows results from this monitoring program. The Burdekin region (H) identified in this figure is relevant for this study.

The first years from 1995 of the record show an increasing trend in coral cover. By contrast, the coral cover decreased during the majority of the record. The reason for this decrease is suggested to be a series of closely spaced events including bleaching events and major storm events (refer to the dots in Figure 15).

Two main conclusions can be drawn from these data:

- in the absence of major weather events it is plausible that coral condition could have continued to increase
- the identified external stressors (storms and bleaching) were likely to be of sufficient frequency and magnitude to reverse the trend in recovering condition.

These results are consistent with the data collected during the baseline monitoring for this Project, as presented in the Appendix A1 (Additional Field Studies for the Townsville Port Expansion Project AEIS) of the AEIS.

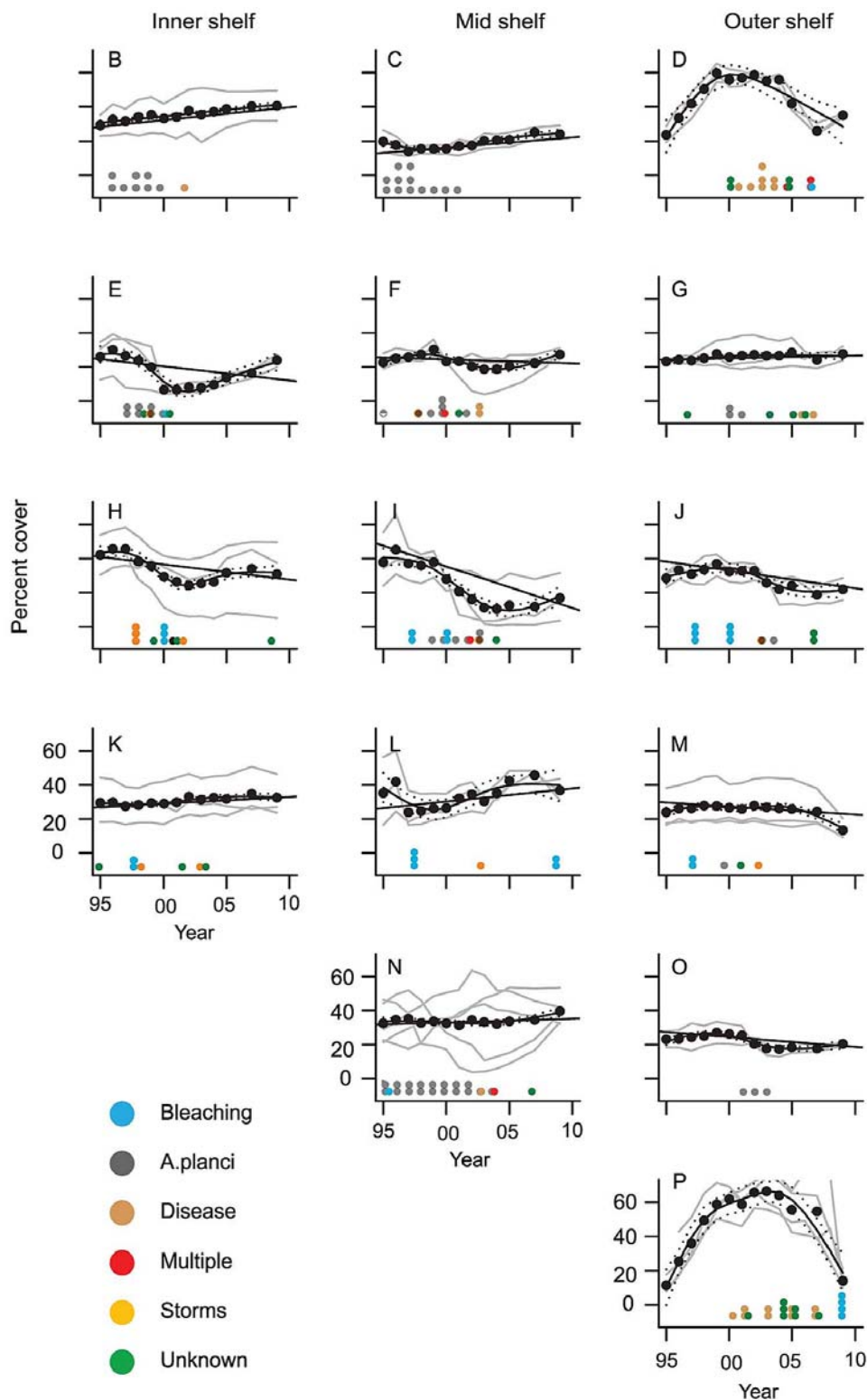
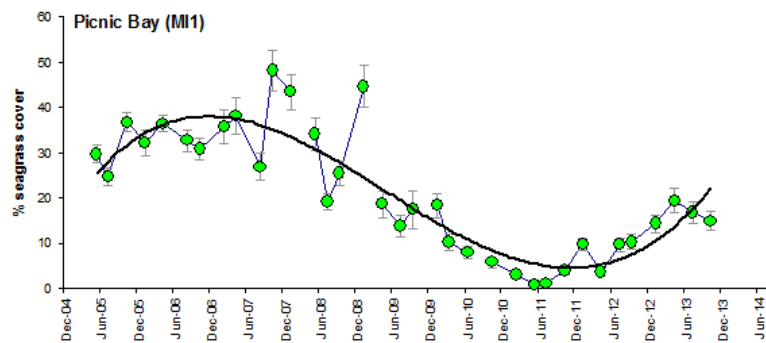
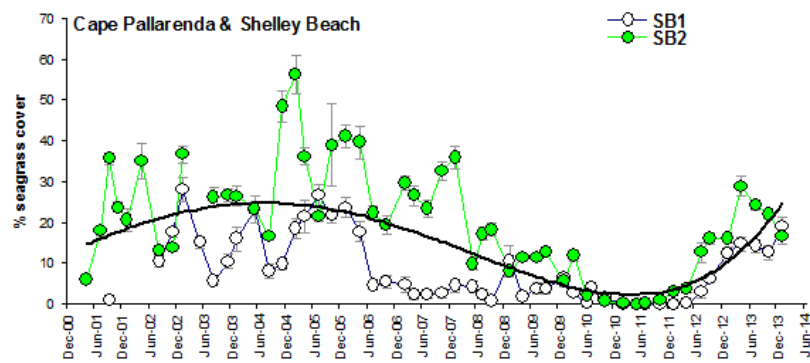
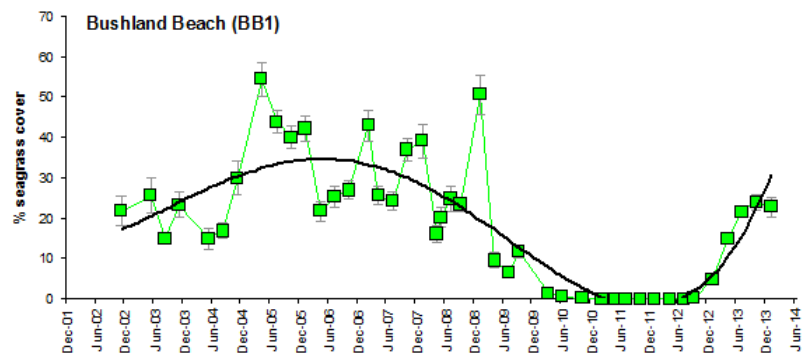


Figure 15 Temporal trends in percent cover of hard coral on the GBR (1995 - 2009). From Osborne *et al.* (2011)

1.4.2 Seagrass

The distribution and density of seagrass meadows within Cleveland Bay can show great variation over a range of temporal scales. At seasonal scales, there is a typically a seasonal growth cycle of intertidal and shallow subtidal seagrass meadows (Waycott, Longstaff, & Mellors, 2005), with higher percentage cover in late spring/summer (Johnson, Brando, Devlin, Kennedy, McKenzie, & Morris, 2011). This is the typical seasonal pattern of seagrass meadows in near-shore waters of the GBR region (Waycott, Longstaff, & Mellors, 2005; Unsworth, McKenna, & Rasheed, 2010), with higher water temperatures during summer periods promoting seagrass growth rates (Collier & Waycott, 2010).

Large inter-annual changes in seagrass meadow extent and community structure resulting from synoptic and climate-driven disturbances have been observed in the Port's annual seagrass monitoring program (McKenna & Rasheed, 2011). For example, a major reduction in seagrass above-ground biomass and extent (at the deepest boundaries of the meadows) was recorded in Cleveland Bay between 2007 and 2011. Similar declines in seagrass cover were recorded by Seagrass Watch at Cape Pallarenda and Magnetic Island over the measurement period (Figure 16). Johnson, *et al.* (2011) found that there was declining trends in seagrass cover at the mainland sites (i.e. Cape Pallarenda) since 2005, whereas those around Magnetic Island only began to decline in 2008.



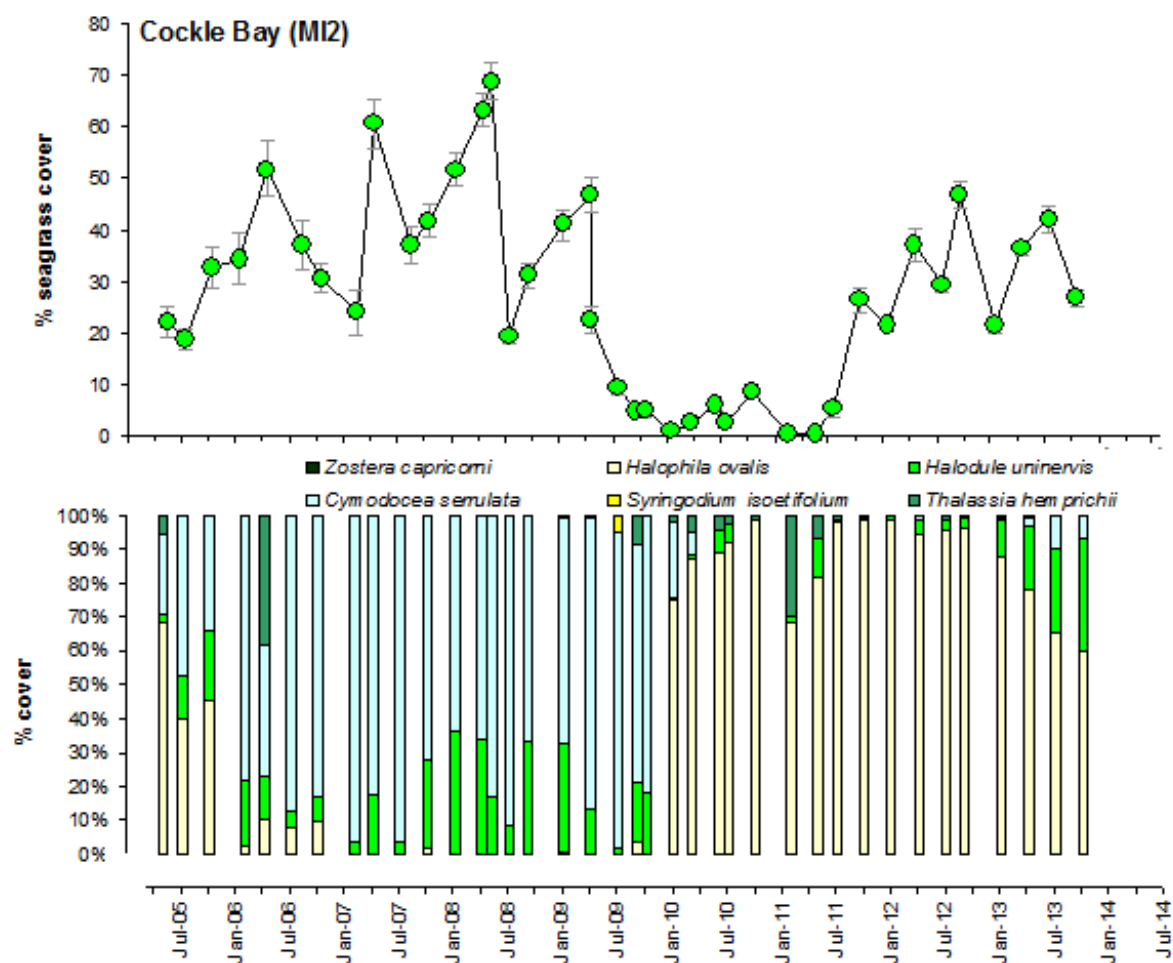


Figure 16 Seagrass monitoring data

The Reef Rescue Marine Monitoring Program (Johnson, Brando, Devlin, Kennedy, McKenzie, & Morris, 2011) assessed the condition of seagrass meadows, and found that seagrass meadows of the Burdekin-Townsville region were classified as being in a 'poor state' throughout the 2009/10 monitoring period (Johnson, Brando, Devlin, Kennedy, McKenzie, & Morris, 2011).

By contrast, more recent monitoring indicates recovery at all sites within and close to Cleveland Bay (Figure 17 and Figure 18). This most recent survey indicates that the degradation that occurred following the 2010/11 major flood plume events has been followed by a subsequent recovery to the 7-year average of seagrass habitat area.

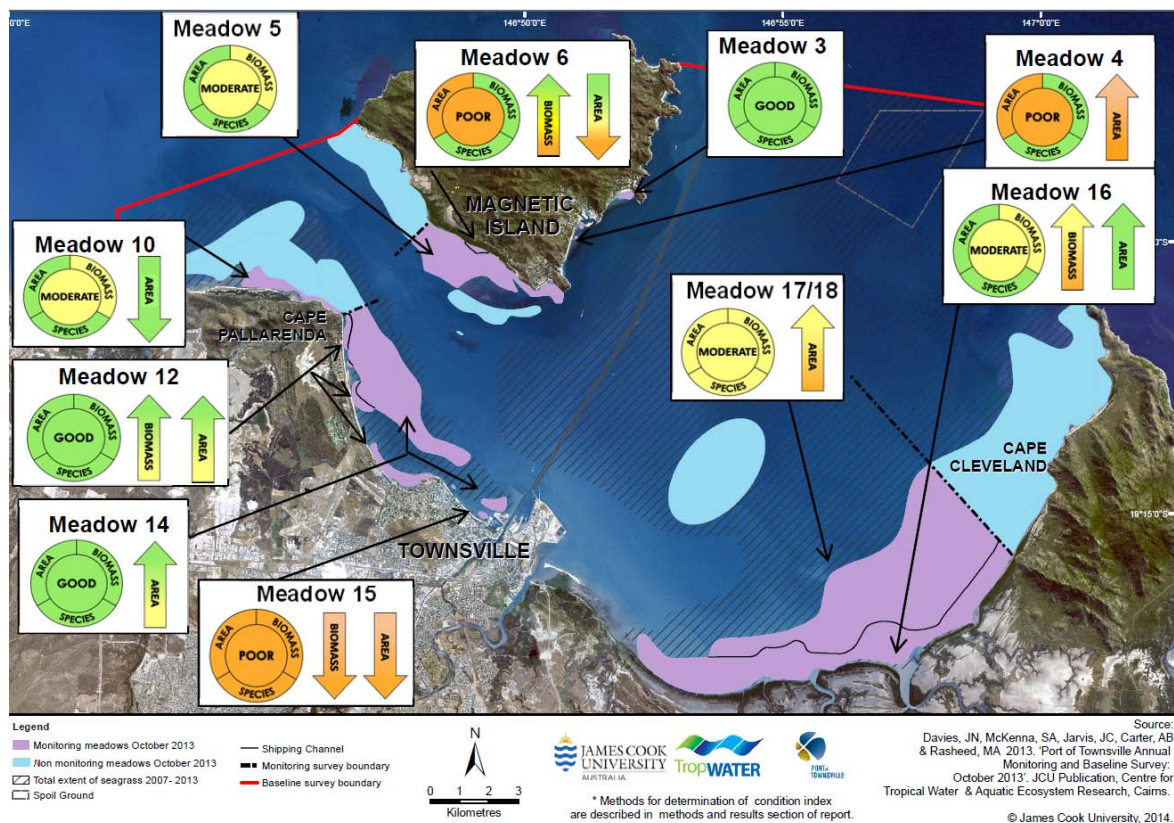


Figure 17 Results of 2013 seagrass monitoring (Extracted from Port of Townsville Annual Monitoring and Baseline Survey 2013 - TropWATER Report No. 14/02)

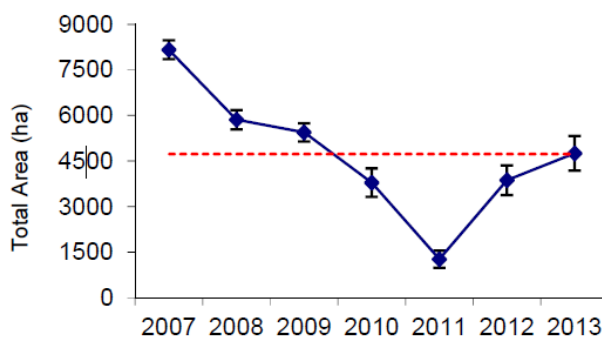


Figure 18 Total area of seagrass within the Townsville monitoring meadows from 2007 to 2013 (error bars = "R" reliability estimate). Red dashed line indicates 7-year mean of total meadow area

1.5 Impacts and Risks of Individual Stressors on Sensitive Ecological Receptors in Cleveland Bay

The previous sections characterised the stressors, considered the variability or likelihood of occurrence of stressors and the changes in condition of the Sensitive Ecological Receptors. This section investigates the impacts and risk of impact of the identified stressors on the Sensitive Ecological Receptors. The estimation of risk is determined by both the likelihood of occurrence (discussed above) and the consequences of occurrence.

1.5.1 Cyclones

Impacts on corals

The most obvious impact from large storm events is the direct mechanical destruction of coral communities (Figure 19). Van Woessik *et al.* (1991) observed large scale destruction of the upper 2 m of impacted reefs and identified considerable damage to coral colonies at depth of 30 m following Cyclone Ivor in 1990. Similarly, Bongaerts *et al.* (2013) identified storm damage to reefs in the mesophotic zone down to depths of 60 m, presumably as a result of the passage of Cyclone Yasi around 100 km to the north of the study site at Myrmidon Reef.

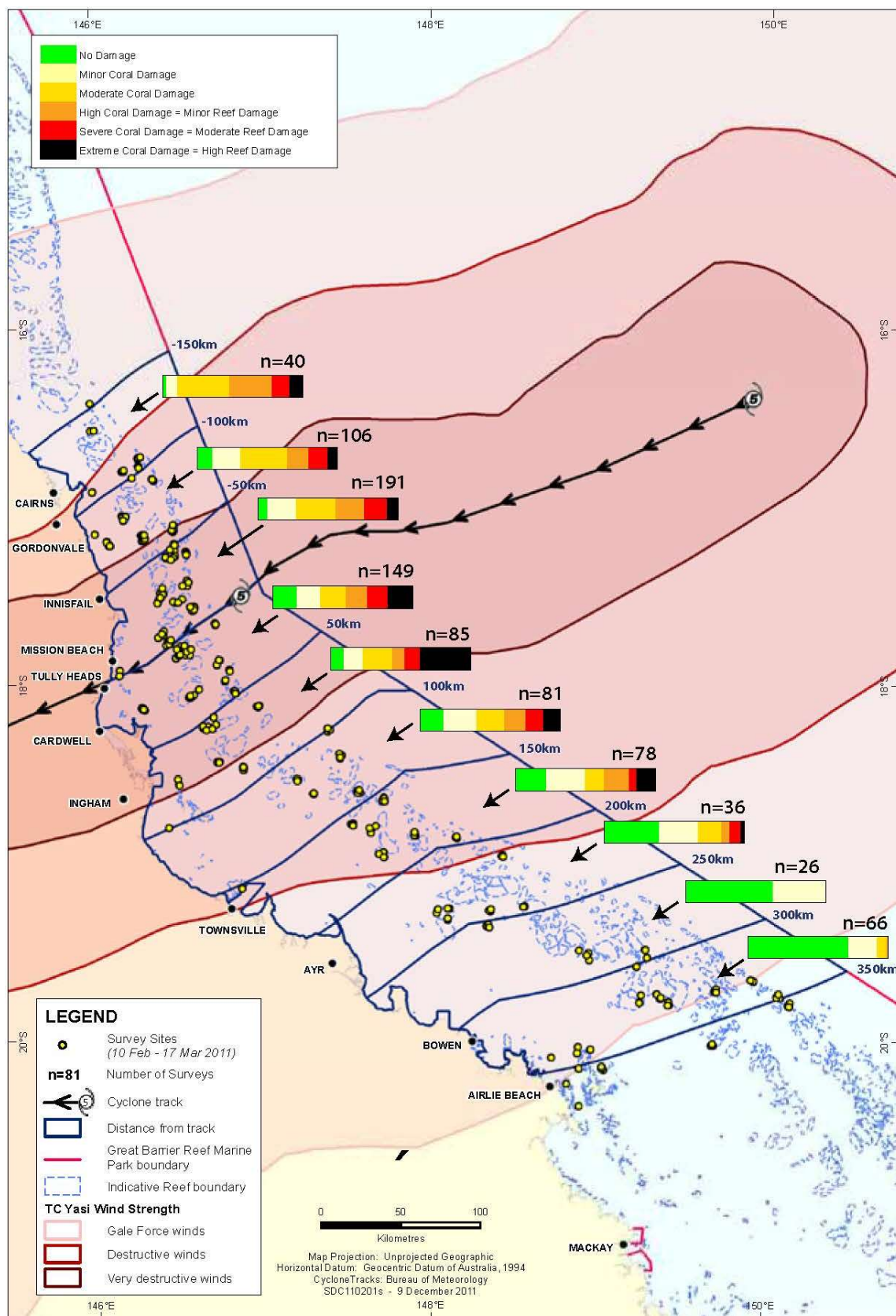


Figure 19 From GBRMPA report: extreme weather and the GBR report 2010 – 2011.

Fabricius *et al* (2008) recorded severe impacts including an 800% decrease in hard coral cover for inshore reefs within 70 km of a cyclone path. These reefs experienced wind speeds in excess of 33 m s^{-1} (119 km/h).

For outer shelf reefs, De'ath *et al* (2012) estimated that cyclones accounted for 48% of direct mortality of coral colonies during the period 1985-2012.

Severe and moderate direct damage has been attributed to within around 50 km either side of cyclone paths (Puotinen M. , 2004; Connell, Hughes, & Wallace, 1997) although damage has been observed 100-200 km from cyclone paths (Puotinen M. , 2004; Done T. , 1992). Major disturbance and damage is very common 25 km either side of a cyclone path (Puotinen M. , 2004).

Loss of coral cover during major storm events is variable and dependent upon the exposure and vulnerability of individual reefs. This in turn depends on their location and orientation with respect to the cyclone track, the community structure and successional stage of development of the individual reef (Fabricius, De'ath, Puotinen, Done, Cooper, & Burgess, 2008).

For example, Figure 20 below, extracted from Fabricius *et al* (2008) demonstrates the patchy nature of loss of coral cover. These data were derived from observations of coral condition and cover following the passage of Cyclone Ingrid in March 2005. Prior to the passage of the storm, some reefs were around 40% cover and reduced to 8% in places.

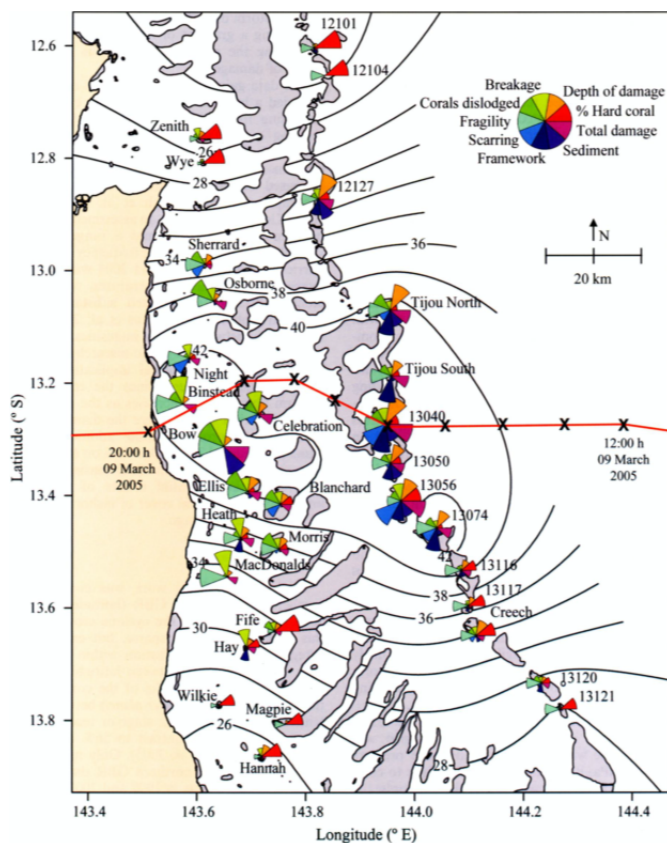


Figure 20 Distribution of coral damage for Far North Queensland. Extracted from from Fabricius *et al* 2008.

Fabricius *et al.* (2008) also identified that the best predictor variable for cyclone damage is the maximum 10-min averaged wind speed. Furthermore, various forms of damage were only observed at winds above a certain threshold. Inshore, sites suffered catastrophic destruction at $>33 \text{ m s}^{-1}$ winds (category 3 or more) and storm duration of $>12 \text{ h}$. Threshold thought to be 28 m s^{-1} .

Figure 21 below shows estimates of local damage resulting from different categories of cyclones.

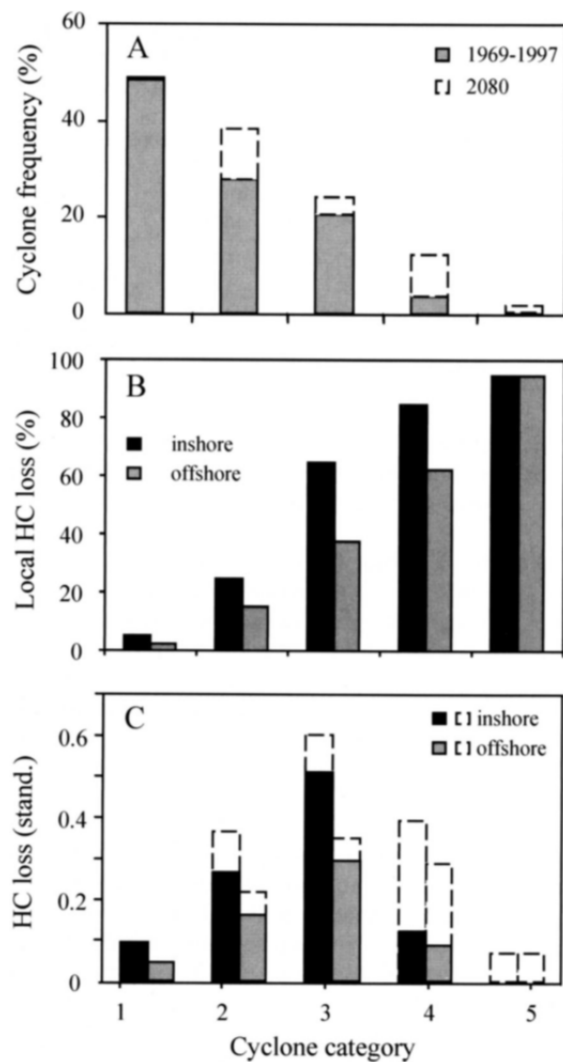


Figure 21 Observed and predicted cyclone intensity distribution, and changes in coral cover by tropical cyclones on the GBR. (A) Frequency distribution of tropical cyclones on the GBR as observed between 1969 and 1997, and with a increase in cyclone intensity of half a category as predicted for 2080; (white dashed bars). (B) Observed local loss in coral cover in response to cyclone intensity on inshore and offshore reefs. (C) GBR-wide loss of coral cover on inshore and offshore reefs, at cyclone intensity distributions as observed 1969 – 1997 (black and grey bars), and as predicted for 2080 (white dashed bars). Values are standardized to cumulative present-day losses on undisturbed inshore reefs (black bars) as 1.0. (Figure 7) from Fabricius *et al* 2008, Note: Hard Coral = (HC).

Jones and Berkemans (2014) also identified that the freshwater plume from Cyclone Tasha in 2010 bathed shallow reefs 12 km offshore causing 40-100% mortality of fringing reefs in Keppel Bay down to a depth of 8 m. Of relevance, the mortality from salinity stress was thought to far outweigh any mortality from pollutants.

Given that recovery periods from large cyclones events can be of the order 10-20 years (Lukoschek, Cross, Torda, Zimmerman, & Willis, 2013) and often led by recovery of *Acropora* colonies, and that return periods of major cyclones can be of the same order or less, then it is not unreasonable to assume that on average many if not most of the coral reefs in the Townsville region are commonly in some degree of recovery from a major cyclone event, all of the time.

Impacts on seagrass

Seagrass beds are particularly susceptible to impacts from flood plumes as they mostly occur in shallow depths (< 20 m) and rely on consistently high levels of incoming irradiation for survival. During repeated or extended flood plumes incoming light levels can be reduced to the point of mortality. For example, Preen *et al* (1995) report that around 24% of the entire seagrass population along the Queensland Coast was lost during a three week period in 1992 following a cyclone and two major floods. Substantial recovery was observed two years later for the deeper bed (> 10 m depth) but some beds in shallow depths had failed to substantially recover. Similarly, following the widespread flood-related loss of seagrass meadows in the Great Sandy Strait in February 1999, Campbell and McKenzie (2004) report that recovery periods were of the order 2–3 years (Campbell, 2004).

1.5.2 Large scale externalities

Impacts on corals

Most projections of future climatic conditions suggest that there will be continued warming and acidification of surface ocean waters although the rate of increase cannot be accurately predicted as a result of a number of factors, not the least of which is uncertainty over future greenhouse gas emissions.

Similarly, there is also a range of predictions over the impacts in the form of bleaching and reduced availability of carbonate to coral reefs in both Queensland and globally. Predictions that irreversible declines in the distribution of coral reefs will occur at a global scale within decades have been made (for example, Hoegh-Gulberg (1999)). By contrast, other researchers highlight that these estimates commonly discount plasticity and adaptability of reef systems. For example Pandolfi *et al* (2011) state that:

“recent work highlighting the role of phenotypic plasticity in evolution and the potential for rapid adaptation indicate that this view about the time scale of reef response may not adequately take account of reef organisms’ capacity for coping with stress and their potential for adaptation”.

Bleaching events do lead to mortality and loss of condition of coral colonies in the GBR, and there is a strong likelihood that such bleaching events will not reduce in frequency or magnitude over this century. Yara *et al* (2014) estimate that at Heron Island the average return period for bleaching events over the next decade is less than once every ten years, which is a similar return period for category 4 and 5 cyclones.

This annual likelihood is strongly influenced by the ENSO cycle, in particular with increased likelihood of bleaching conditions occurring during strong El Niño years.

Estimates of loss of coral cover resulting from bleaching events on the GBR were derived from studies of the 1998 and 2002 bleaching events.

Marshall and Baird (2000) report bleaching on Magnetic Island reefs during 1998 (Figure 22). They estimate that six weeks after first reports of bleaching 53% of colonies were affected, including 13% moderately affected, 30% severely and 6% dead. Fast growing species such as acroporids and pocilloporids were most affected.

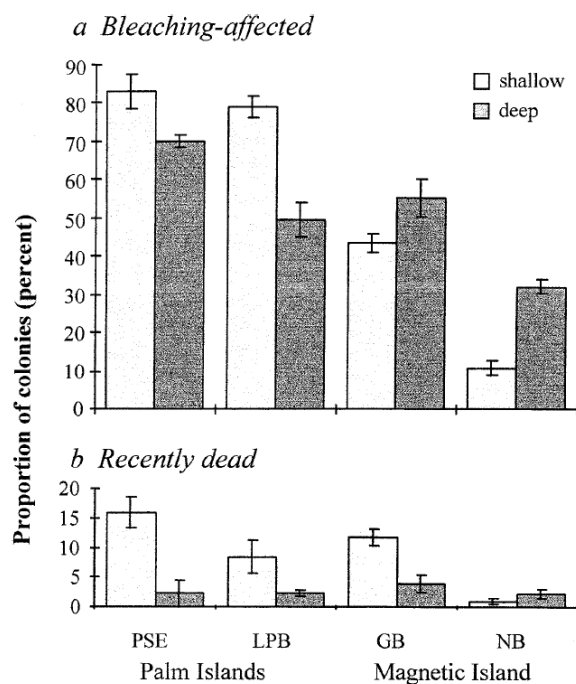


Fig. 2 Severity of bleaching. Mean ($\pm$ SE) proportion of colonies **a** affected by bleaching and **b** recently dead at two depths at each study site. *Light bars* Shallow assemblages; *dark bars* deep assemblages. Site codes as for Fig. 1

Figure 22 Severity of bleaching for PSE (Pelorus, Little Pioneer Bay, Geoffrey Bay and Nelly Bay). Extracted from Marshall and Baird (2000).

Similarly, Berkelmans *et al* (2004) estimated that around 42% of reefs bleached to some extent during the 1998 event (18% strongly bleached) while in 2002, 54% of reefs bleached to some extent (Figure 23). These statistics and the fact that nearly twice as many offshore reefs bleached in 2002 compared to 1998 (41% as compared to 21%) suggests that the 2002 event was more severe than the 1998 event.

The first field evidence of coral bleaching in 2002 was identified on 7 January 2002 at Magnetic Island (Berkelmans, De'ath, Kininmonth, & Skirving, 2004) (Figure 23, 24). By 8 February 2002, bleaching had intensified and up to 30% of hard corals on the reef crest were estimated to be white with another 50% pale. Osborne *et al* (2011), used a value of 30-35% coral cover loss during bleaching events, based on Berkelmans *et al* (2004).

Fig. 2 Raw aerial survey results of coral bleaching in 1998 and 2002 overlaid on the maximum 3-day SST for every pixel during the warmest austral summer months (December–March)

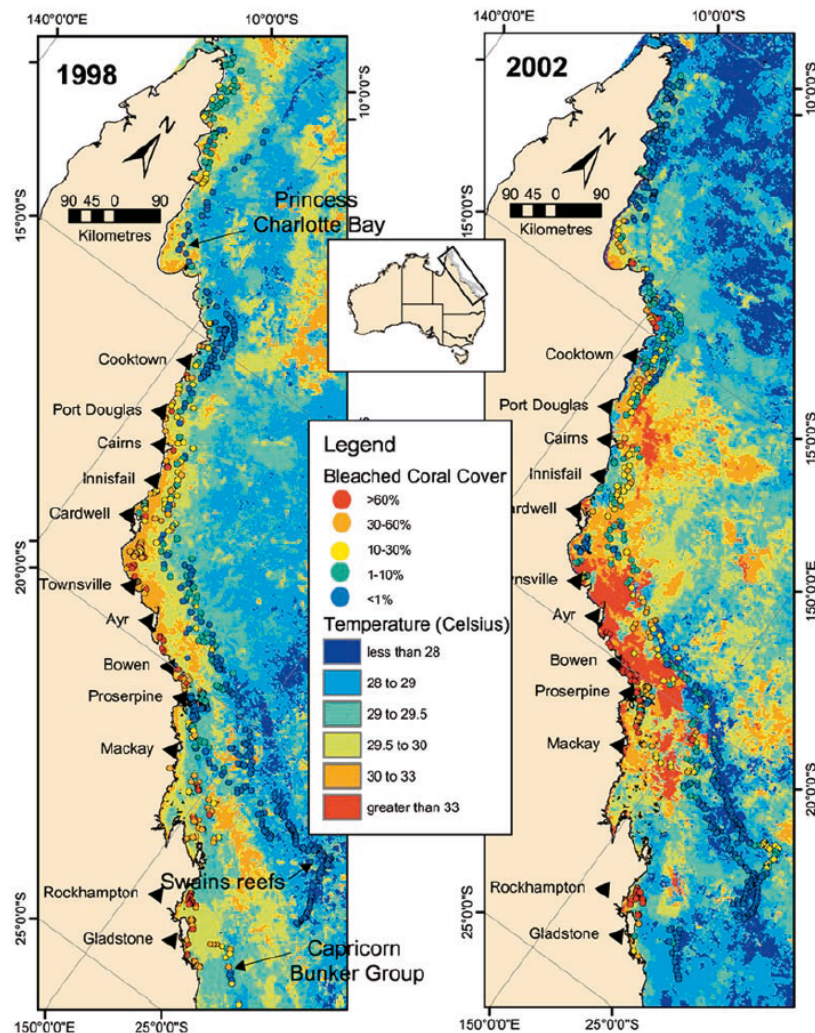


Figure 23 Distribution of bleaching. from Berkelmans *et al* (2004).

Fig. 3 Temperatures and timing of onset of bleaching at a Magnetic Island (Nelly Bay) and b Davies Reef in early 2002. Magnetic Island temperatures measured with an in-situ temperature logger and the mean calculated over a 10-year period with a 14-day smoothing function applied. Davies Reef temperatures from an automatic weather station and the mean calculated over a 15-year period with a 14-day smoothing function applied

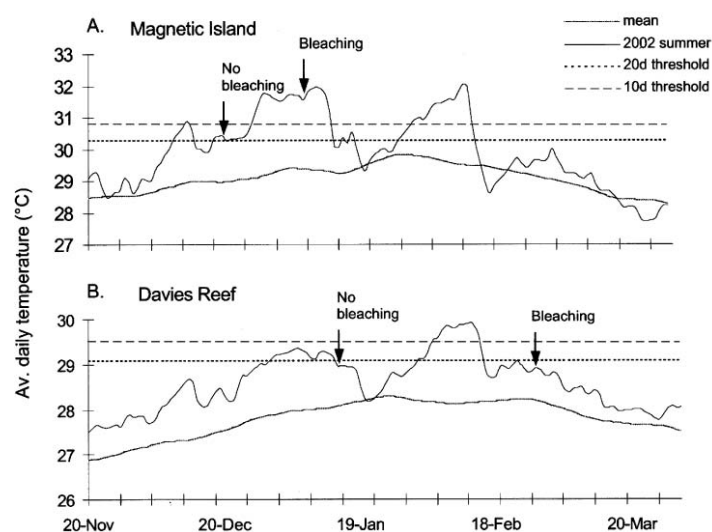


Figure 24 Evidence of bleaching. From Berkelmans *et al* (2004).

Whilst it is widely suspected that acidification is already impacting coral species, there is at present little reliable observations of direct and measurable impacts of acidification to specific reefs. Rather it is considered as a more general 'press' type effect that is acting to reduce the resilience of reefs worldwide.

Impacts on seagrass

Large-scale externalities, especially ocean warming are likely to somewhat alter the species and spatial distributions of seagrasses along the Queensland coast. For example the southward extension of the distribution of *Halophila minor* into Moreton Bay has been assumed to be a result of strengthening of the East Australian Current (Rod Connolly, Griffith University Pers. Comm). However, there is expected to be little likelihood that changes to mean global ocean temperatures alone will lead to the long-term loss of seagrass meadows in the study area. Rather, impacts from changes to runoff and storms are likely to dominate impacts. This is because the study area is not located near the latitudinal edge of the present or projected future distribution of common species in Queensland.

1.5.3 Dredging

The estimates of the direct impacts from capital dredging are derived from the modelling studies presented in the Chapter B.4 (Marine Water Quality) and B.6 (Marine Ecology) in the EIS and updated in Section 6.0 and 8.0 of the AEIS.

The most relevant example of an assessment for direct impacts from dredging in Cleveland Bay is the monitoring of the previous major capital dredging program was undertaken in 1993. The subsequent review of the environmental monitoring of this campaign concluded that the monitoring was clearly able to identify the dose-responses of the identified Sensitive Ecological Receptors to suspended sediment generated by the dredging. It is therefore helpful to revisit the results from the reactive and longer term monitoring of this campaign in order to give insight into the probable impacts of the proposed capital dredging campaign of the PEP.

The Eastern Reclaim Port Development involved the reclamation of 100 ha in the port precinct for the development of an outer berth, rail balloon loop and a cement handling facility. The Platypus and Sea channels were lengthened and deepened in order to accommodate entry of Panamax class vessels.

The capital dredging campaign involved relocating 0.75 Mm³ with a suction dredge during the period 19 January to 6 April 1993. The capital dredging program was intensely monitored and the monitoring and dredging was overseen by an independent Technical Advisory Committee (TAC). In addition, the Queensland Department of Environment and Heritage deployed a site supervisor (seconded from GBRMPA) who convened the Initial Response Group and had oversight over day to day operations.

Both a reactive monitoring program and a longer-term monitoring program were established and these programs monitored changes to oceanographic parameters including suspended sediment concentration and impacts to Sensitive Ecological Receptors in the form of coral colonies and seagrass meadows. The reactive monitoring program involved 30 marine scientists from a range of institutions and featured at least weekly monitoring of the condition of 20 of each of the four coral species (*Acropora latistella*, *Merulina ampliata*, *Montipora aequituberculata*, *Pocillopora damicornis*). Extensive monitoring of regional seagrass beds in Cleveland Bay was also performed. The longer-term monitoring covered a broader suite of indicators including ten taxonomic groups and a Before-After Control-Impact (BACI) survey design able to detect changes to the 20% detectability level.

The overall conclusion from the intensive monitoring programs was:

"Seagrass beds in Cleveland Bay were unaffected and not one of the hundreds of monitored coral colonies on Magnetic Island fringing reefs died as a result of dredging".

No major changes in community structure were observed and the only coral colony that suffered full mortality was a colony of *Merulina ampliata* at Geoffrey Bay that was considered to have perished as a result of other factors. Of relevance is that considerably more variability in condition of the colonies was observed than is commonly thought.

The 1993 campaign was undertaken during a seagrass recovery period (see Figure 17), similar to the current situation where seagrasses are believed to be recovering from the 2010/11 wet season.

Given the high level of governance, independence and scientific scrutiny of the monitoring program, it is reasonable to conclude that the results from the monitoring programs are defensible. Therefore, in conclusion, for the duration of the dredging program, intensity of dredging and the pre-condition of the Sensitive Ecological Receptors, it is considered that the proposed dredging operations of similar magnitude can be undertaken without undue adverse impacts, such as substantial short-term mortality or obvious long term loss of condition.

1.5.4 Catchment modification

The impacts from changed land-use practices since European colonisation in the mid-1850s in the catchments adjoining the GBR remain somewhat contentious. The literature demonstrates there have been two main hypothesis on these impacts.

The first focuses on the role of synoptic-scale (large scale) events and hypothesises that the increased sediment, nutrient and pesticide runoff following post-European land-use changes have led to changes to the near-shore

turbidity regime, which has then led to anthropogenic-derived reductions in condition of Sensitive Ecological Receptors in the near-shore zone such as Middle Reef.

The second is marine geological or sedimentological based rather than synoptic-based. This second hypothesis focuses on marine sediments built up over geological timescales and proposes that these sediments are repeatedly and routinely re-suspended during wind events. The long term distribution of sediments is thought to be largely controlled by cyclones. This implies little change to long-term condition of Sensitive Ecological Receptors as they have always been exposed to reduced turbidity.

Both of these hypothesis are supported by different, but incomplete sets of evidence. The first is supported by widespread agreement, based on a series of studies, that there has been a multiple-fold increase in the delivery of fine sediments, nutrients and pesticides into the GBR lagoon post European settlement (Kroon, et al., 2012). A number of studies have also demonstrated that flood plumes following major wet season floods can be observed considerable distances downstream (commonly to the North) of major river mouths such as the Burdekin (Sandstrom, 1988; Schroeder, et al., 2012; Devlin, et al., 2012).

There is also some evidence that water quality in inshore regions near the mouths of major rivers declines following major flood events (Figure 25), and that resulting reduction in underwater light attenuation can lead to at least temporary changes to the condition of some Sensitive Ecological Receptors. This is perhaps best evidenced by the changes in seagrass cover.

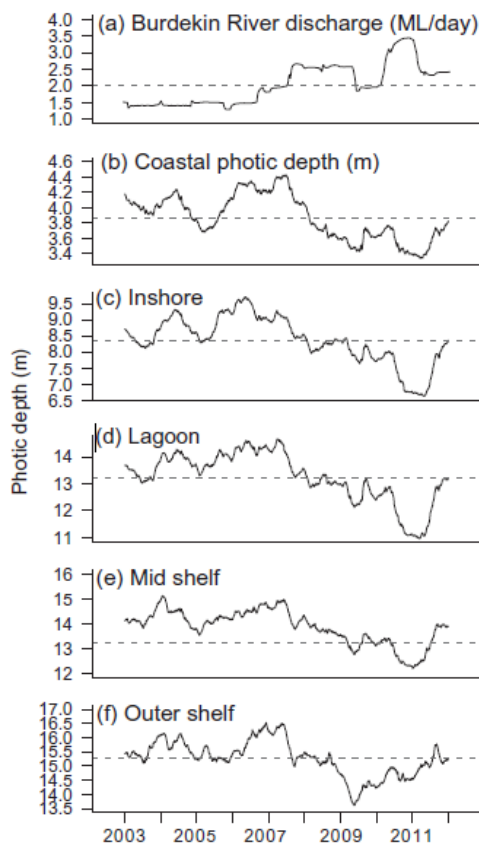


Fig. 6. Ten-year long-term trend in daily Burdekin River discharge (a) and daily mean photic depth from 2002 through 2012 for the five bands across the continental shelf within the central GBR (b–f). The horizontal dashed lines indicate the mean value of each data set.

Figure 25 Long-term trends in river discharges. Fabricius *et al* 2014.

By contrast, there is little direct evidence that there has been a long-term or chronic ‘press’ effect directly attributable to the ‘new’ sediments resulting from changes in catchment land uses leading to a reduction in coral reefs. However this may be a direct result of the lack of consistent long-term monitoring data.

The second hypothesis is also supported by a number of studies that have focused on Cleveland Bay (Maxwell, 1968; Johnston & Searle, 1984; Way, 1987; Carter, Johnson, & Hooper, 1993; Belperio, 1983; Orpin, Brunskill, Zagorskis, & Woolfe, 2004; McIntyre, 1996; Larcombe & Carter, 1998; Lambeck & Woolfe, 2000). This evidence is more sedimentological in nature and demonstrates, through marine geological surveys, that the inshore region of the GBR lagoon features a sometimes very thick (20 m) lens of sediments, and that this source of ‘old’ sediments far outweighs the input of ‘new’ sediments.

Assuming the GBR coastline length is 2,000 km (the actual coastline length is considerably longer), and this prism extends 5 km seaward and is up to 20 m thick (Figure 26 and Figure 27), then this represents a volume of at least $2,000,000 \times 5,000 \times 20$, or $200,000 \text{ Mm}^3$ of accumulated fine sediments. In reality this is likely to be an underestimate as the actual fine-scale coastline length is considerably longer than 2,000 km.

If the average annual inflow of fine sediments into the GBR lagoon from the Burdekin (the dominant source) is 4 Mt, (equivalent to around 4 Mm^3 dry weight) this then implies that on average since the 1850s, every year an additional 0.002% is added to the near-shore sediment prism from the Burdekin.

Importantly, the recent study by Lewis *et al* (2014) highlights that almost no sediment has been supplied to Cleveland Bay during the last 1,000 years. This study indicates that the majority of the sediment presently within Cleveland Bay was laid down during the Burdekin Holocene alluvium when the Burdekin entered the GBR somewhere close to what is now Cleveland Bay.

It is also widely accepted that the majority of the variability in near-shore turbidity can be explained by re-suspension associated with routine and common wind events that occur through the year. Lewis *et al* (2014), Woolfe and Larcombe, (1998), Larcombe and Woolfe (1999) and Orpin and Ridd (2012) all made the same conclusion in relation to the overall suspended sediment during these events. This conclusion was that the majority of sediments suspended during common or routine wind events through the year were existing marine sediments that had been deposited over geological timescales from previous cyclones and were resuspended by waves during the routine or common wind events.

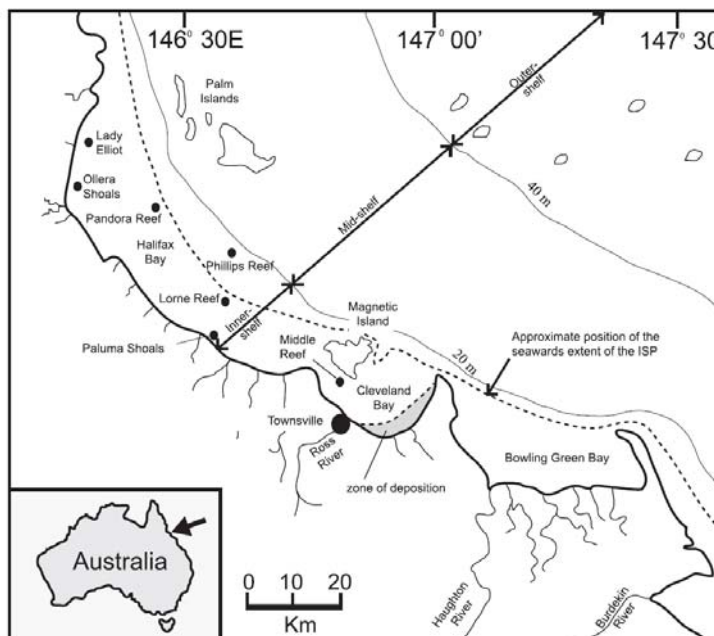


Figure 26 Sedimentary zones in the GBR (Extracted from (Browne N. , 2012).

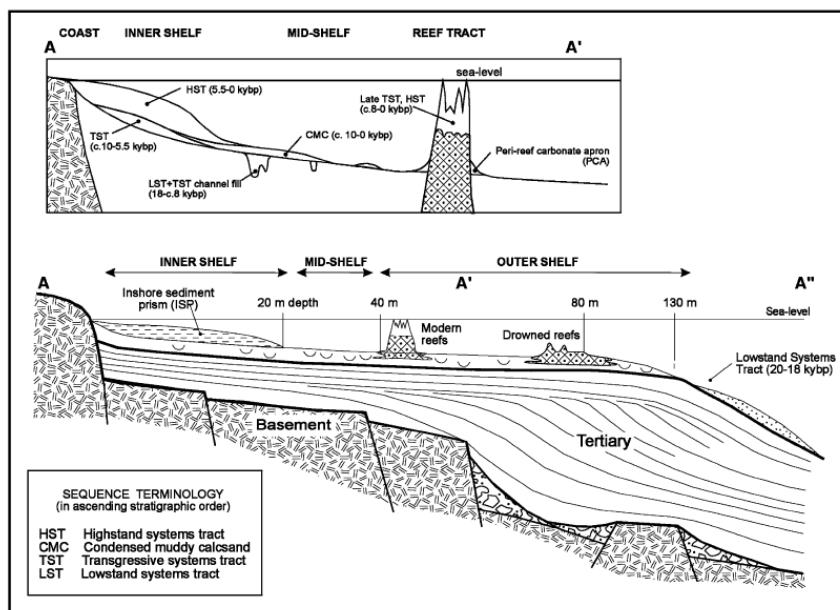


Figure 27 Typical geological cross section on the GBR (from Larcombe and Carter, 2004).

This implies that the near-shore fine sediment and hence turbidity regime may have largely remained unchanged over recent centuries, and hence there is little reason to believe that there is a long-term 'press' effect that would result in long term reduction in the condition of Sensitive Ecological Receptors. Once again a lack of long-term data on the condition of inshore Sensitive Ecological Receptors is unhelpful, as are the lack of long term water quality data.

However both schools have recently identified a possible explanation that would satisfy both hypotheses. Lewis *et al* (2014) identify that no 'new' sediments have been entering Cleveland Bay over the last 100 years, and that the majority of sediments are deposited within 50 km of major river mouths. Concurrently Bainbridge *et al* (2012) identified that river plumes following major events become organic rich floccs as they move downstream of river mouths. Fine sediments contained in river plumes mix with seawater. These fine sediments and the associated nutrient flocculates join to form larger particles or floccs. These floccs, that are by now large exopolymer particles can then also combine or associate with mineral particles to form marine snow that can be 'stickier' than sand particles. 'Marine snow' when settled on coral, can force coral colonies to expel more energy clearing these particles in comparison to sand particles (Ayukai & Wolanski, 1993, Fabricius *et al.*, 2003; Passow, 2001).

This transformation from mainly mineralogical or physical particles to more consolidated floccs takes place as river plumes are transported away from river mouths. By the time Burdekin flood plumes are offshore of Cleveland Bay, the majority of the fine sediment particles have thought to have settled out and hence particles at the entrance to Cleveland Bay are likely to be very porous floccs. Increases in turbidity following major river plumes that occurred in 2011, were caused from larger flocc particles as opposed to mineralogical fine sediments alone.

Both are sources of variability in turbidity in the near-shore zones such as Cleveland Bay:

- routine re-suspension of old sediments by frequent wind events
- reductions in turbidity resulting from increased intensity of floccs during the season following major flood events.

Unfortunately it can be difficult to separate the two sources as most measurements using electronic sensors simply measure the total turbidity. As a result it can be difficult to unravel the importance or relative contributions of 'new' sediments derived from catchments and dredging operations, from the re-suspension of 'old' sediments.

Feedback from the EIS suggested that the impacts from the proposed capital dredging would have to be greater than predicted in the EIS on the basis that the dredging would create new suspended sediments on the same scale as sediments released from catchments; which were assumed to be the major source of fine sediments impacting Sensitive Ecological Receptors.

Superficially this can appear to be a valid comparison. However all of the fine sediment washed out through waterways are immediately available to increase turbidity. By contrast, whilst less than 10% of fine sediments are mobilised during dredging operations, the vast majority are contained within the reclamation site. This is illustrated schematically in Figure 28.

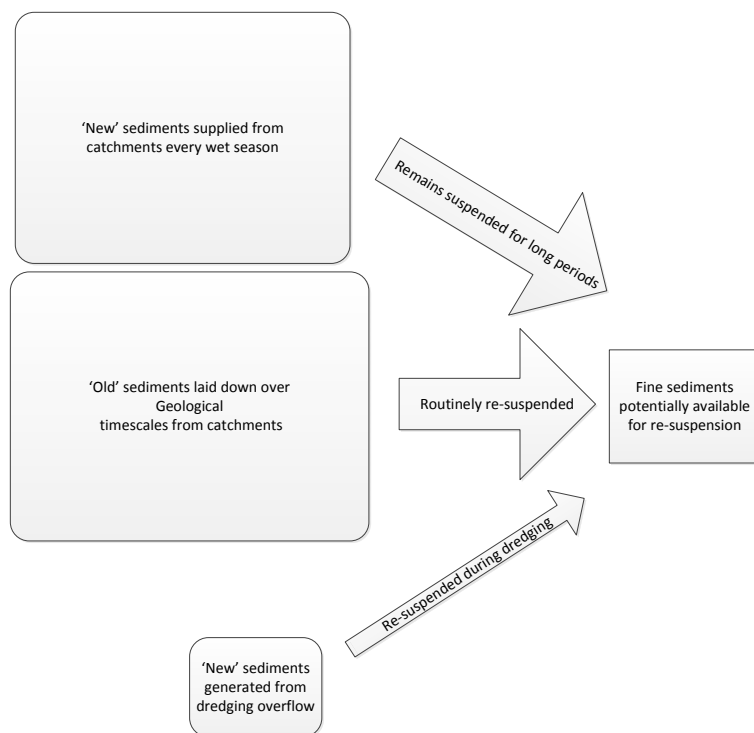


Figure 28 Schematic of sediments inputs into Cleveland Bay. Not to scale.

In light of these assumptions, increased turbidity is primarily a result of the routine re-suspension of 'old' sediments in Cleveland Bay, it becomes clear that these comparisons do not support the conclusion that sediments mobilised during dredging operations are a major contributor to the overall suspended sediment budget.

1.5.5 Effect of Nutrient Inflows on CoTS

Nutrient inflows from catchment sources (through controlling phytoplankton availability; Fabricius *et al.*, (2010) Figure 29) have also been postulated to underpin outbreak of the coral-consuming Crown of Thorns (CoTS) starfish (*Acanthaster planci*); (Brodie, Fabricius, De'ath, & Okaji, 2005).

Bell *et al* (2014) have argued that the role of point source nutrient inputs, such as wastewater treatment plants has been greatly under-estimated and by implication that the emphasis on the impacts of suspended sediments as the primary determinant on the ability of Sensitive Ecological Receptors to recover from events such as cyclones is over-emphasised. However, this result has been questioned by Furnas *et al* (2014).

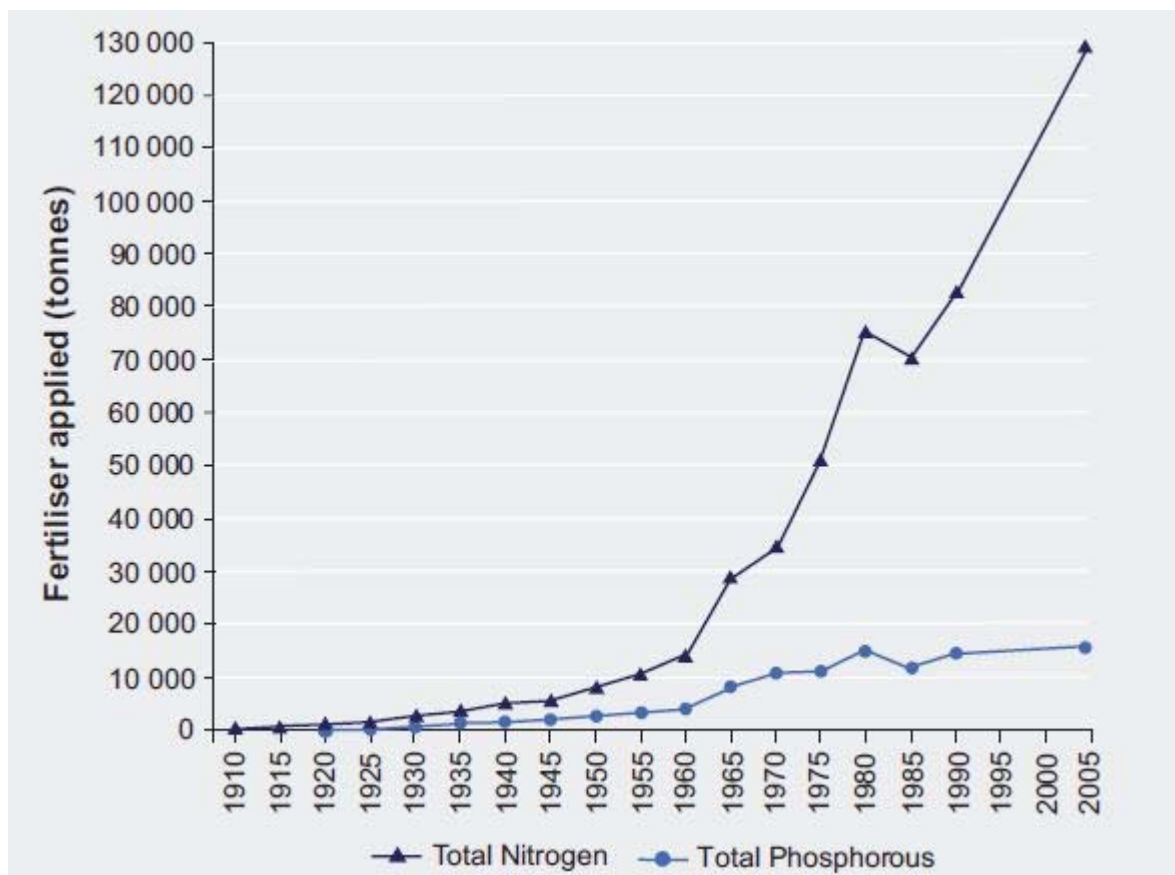


Figure 29 Fertilized inflows into the GBR lagoon (Extracted from (Great Barrier Reef Marine Park Authority, 2011))

CoTS outbreaks have been observed in the GBR since the 1960s, although there are suggestions that outbreaks have occurred previously. Major outbreaks were recorded in 1966, 1979 and 1994 and these were preceded by large discharge events from GBR catchments. Each cycle appears to have begun near Cairns. The first outbreak was observed at Green Island in 1962 (Barnes, 1966), the second also at Green Island in 1979 (Endean, 1982) and the third detected firstly by tourist operators at Michaelmas Cay (a reef neighbouring Green Island) in 1993 and then at Lizard Island (Wachenfeld, Oliver, & Morrissey, 1998).

Fabricius *et al* (2010) suggest that outbreak of the Crown of Thorns starfish are causally linked to river plumes and phytoplankton availability in the GBR lagoon (Figure 30).

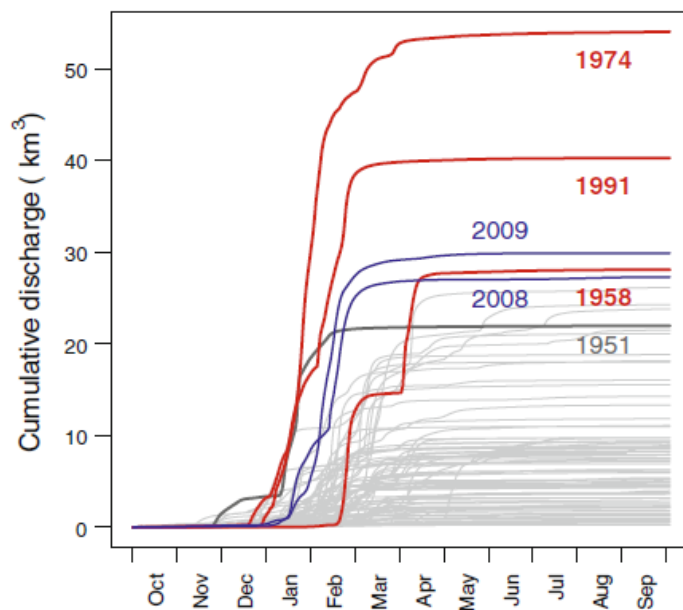


Figure 30 Burdekin discharges and CoTS (Extracted from Fabricius *et al* 2010)

Fabricius *et al* (2010) also estimated between 1985 and 1997, CoTS were observed on 32% of monitored reefs on the GBR. Coral cover on these reefs with CoTS averaged 9% 1 year after the outbreak; as compared with a mean of 28% coral cover on reefs that had not experienced an outbreak in the same period (Lourey, Ryan, & Miller, 2000). These estimates imply a GBR-wide reduction in coral cover of 0.5% year⁻¹ due to CoTS during this 12-year period. CoTS outbreaks can result in large reductions in coral cover over multiple years. This is equivalent to an average reduction on coral cover of around 19%. Lourey *et al* (2000) estimate just under 50% of inner shelf reefs in the central GBR experienced CoTS outbreaks between 1985 and 1997.

1.5.6 Fishing, marine tourism and transport

Given the estimated low level of recreational and commercial fishing and tourism activity particularly directed at the Sensitive Ecological Receptors in the study area by comparison with popular reefs in the middle and outer shelf regions, it is expected that impacts from these activities will be minimal.

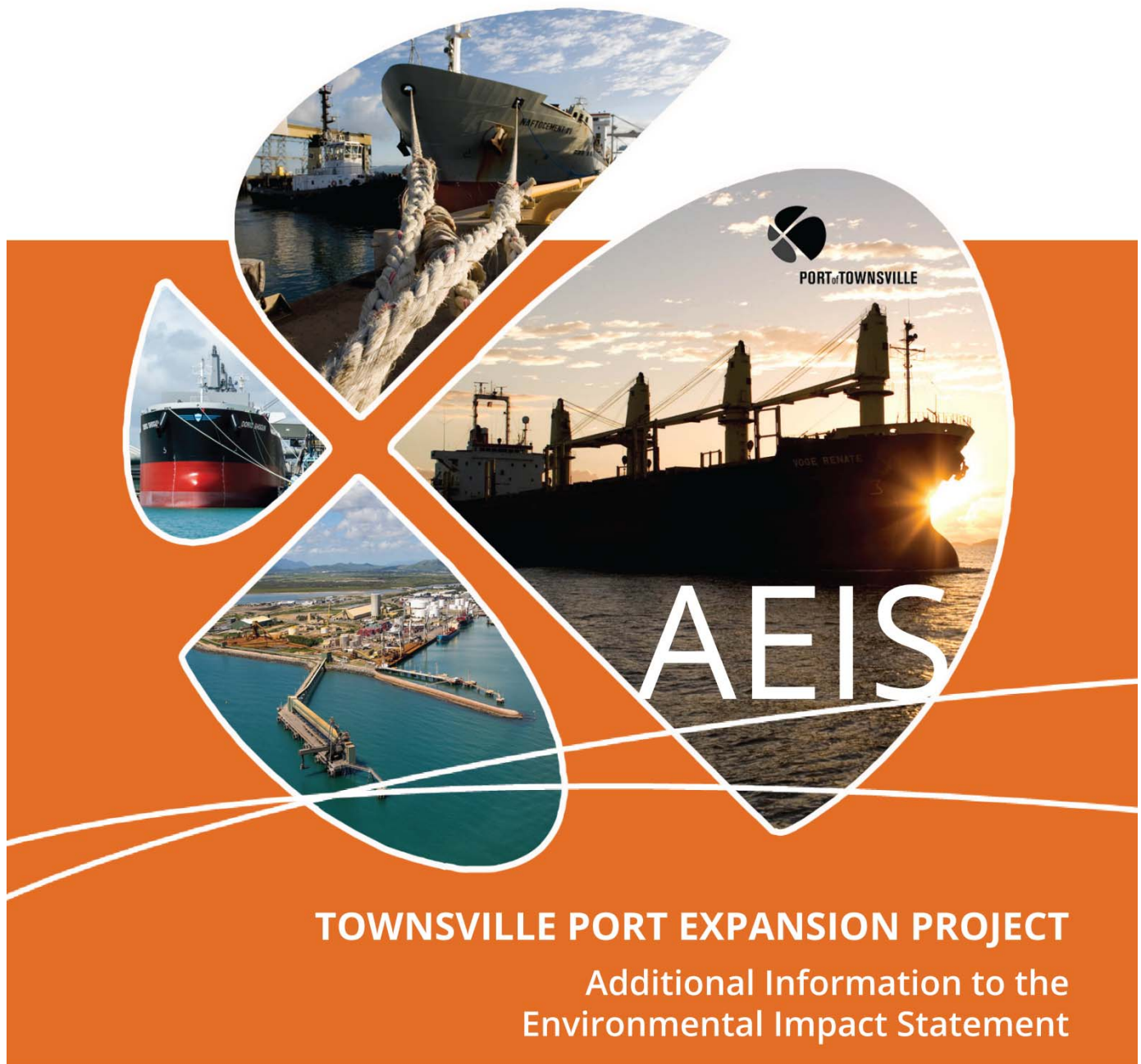
2.0 Cyclones to have impacted Queensland, Australia from 1864 – 2004

The following table presents, in chronological order, cyclones that have occurred in Queensland since 1964. The grey highlighted cells indicate the events which have occurred in the vicinity of the Townsville area.

Date	Event
2 - 3 March, 1867.	Gale winds at Bowen with buildings damaged. Boats smashed. Townsville hit with every third building blown down.
30 January, 1870.	Floods and damage in Bowen. Clermont and Peak Downs flooded. 15 lives lost.
20 February, 1870.	Nearly every house in Townsville damaged with some completely unroofed. Flooding and ships sunk.
24 February, 1875.	Steamer <i>Gothenberg</i> wrecked off Cape Upstart near Ayr with 102 lives lost.
17 February, 1876.	17 February, 1876. Severe gales at Townsville.
21 March, 1876.	Heavy winds at Townsville. SS <i>Banshee</i> wrecked at Hinchinbrook Island with 17 people drowned.
8 March, 1878.	Cairns suffers huge damages. Ships <i>Louise</i> , <i>Merchant</i> , <i>Kate Conley</i> and <i>Hector Miss</i> were sunk with no survivors.
2 February, 1882.	Cardwell suffers considerable damage.
30 January, 1884.	Bowen township all unroofed. Heavy flooding to Mackay.
17 February, 1888.	Cyclone hits east of Mackay. Ships and houses damaged.
24 March, 1890.	Cyclone hits Townsville. Ravenswood has 431mm rain in 24 hours.
29 March, 1890.	Ingham suffers damage from cyclone.
1 February, 1893.	Tropical cyclone hits Yeppoon causing extreme damage. Severe floods in Ipswich and Brisbane with Indooroopilly railway bridge and Victoria bridge washed away. More than 12 deaths.
26 January, 1896.	Cyclone Sigma. Hits Townsville causing damage and severe flooding in suburbs for around 5 kilometres. 17 drowned and a sailor killed.
4 February, 1898.	Cyclone Eline. Considerable damage around Mackay.
5 March, 1899.	Cyclone Mahima. Crosses coast at Princess Charlotte Bay. 307 fatalities of Asian and Island origin. Over 100 Aborigines were swept out to sea. Over 150 ships were sunk. Storm surge at Barrow Point was 14.6 metres. On Flinders Island, porpoises were found 15.2 metres up on the cliffs.
9 March, 1903.	Cyclone Leonta. Hurricane force winds hit Townsville. The Townsville Hospital was wrecked and the brick Grammar School was destroyed. 10 lives lost.
28 January, 1906.	Cairns devastated.
19 January, 1907.	Cooktown buildings severely damaged.
12 March, 1908.	Widespread damage to buildings, trees, fences and telegraph lines near St Lawrence.
28 January, 1910.	Heavy seas and tremendous gales at Cairns.
11 January, 1911.	Tropical cyclone passes from the Gulf of Carpentaria Inland and causes severe destruction at Marburg in south west Queensland. Areas suffer gale force winds.
10 February, 1911.	Crops and buildings damaged at Port Douglas.
16 March, 1911.	Port Douglas left with only 7 out of 57 houses standing. Mossman and Cairns also hit.
23 March, 1911.	Cyclone wrecks <i>Yongala</i> east of Townsville with 120 lives lost.
7 April, 1912.	Cairns and Innisfail have damage to structures with 40% of banana and sugar crops lost.
31 January, 1913.	Cyclone crosses near Cairns. Damage and flooding also to Innisfail. 4 lives lost.
9 February, 1915.	Bowen gets damaged.
10 December, 1915.	Tropical cyclone his north of Mackay.
27 December, 1916.	Whitsunday Island damaged. Flooding at Clermont causes loss of 62 lives.
15 December, 1917.	Heavy rain and gales at Bowen.
21 January, 1918.	Mackay hit by cyclone with almost every building damaged. A storm surge of 7.6 metres saw almost 3 metre waves breaking in the town centre. Huge flood at Rockhampton. 30 lives lost.
10 March, 1918.	Of 3500 residents in Innisfail only 12 houses remained. Mission Beach to the Atherton Tableland suffered destruction. Almost 100 dead.
3 March, 1919.	Cyclone crosses coast at Maryborough. Serious washouts.
3 February, 1920.	Cyclone crossed north of Cairns. Every house at Mt Molloy and Kuranda unroofed or destroyed. Widespread flooding and enormous cattle losses inland.
1 April, 1921.	Tropical cyclone crosses Cape York sinking boats. Heavy flooding.
28 March, 1923.	Cape York and the Gulf have severe wind forces.
26 February, 1925.	Damage to buildings at Cooktown and Mossman.
9 February, 1926.	Cyclone crosses near Townsville. Floods in Herbert and Tully Rivers.

Date	Event
9 February, 1927.	Tropical cyclone hits north of Cairns. Structural damage.
23 & 29 February, 1929.	Two cyclones. One at Townsville the other at Mossman. Flooding.
5 January, 1930.	Serious flooding after cyclone crosses at Princess Charlotte Bay. Luggers in Torres Strait are sunk.
20 January, 1930.	Cyclone action over large part of the State finally crossing at Mossman. 6 deaths due to flooding. Huge stock losses.
1 - 8 February, 1931.	Travels from Cooktown down to Hervey Bay causing state-wide flooding.
19 January, 1932.	Townsville hit. Flooding from Cairns to Mackay.
22 January, 1934.	Cairns suffers damage and flooding.
12 March, 1934.	At sea many luggers and 75 lives lost as cyclone crossed coast near Cape Tribulation.
18 February, 1940.	Crosses near Cardwell. Substantial wind damage in Townsville.
6 March, 1940.	Crosses north of Cooktown. Flooding.
23 March, 1940.	Crossed Cape York. Tremendous Gulf flooding.
7 April, 1940.	Townsville and Ayr suffer damages costing \$1 million (at 1940 value).
2 March, 1946.	Cairns to Townsville had damage with some loss of life.
7 January, 1948.	Heavy floods between Cooktown and Cardwell as cyclone crosses Cape York.
10 February, 1948.	Extensive structural damage and widespread flooding when cyclone passes north of Cooktown.
15 January, 1950.	Cyclone near Cooktown with gales and floods in several areas.
16-19 January, 1950.	Tracked from the Gulf to Sydney. 7 lives lost in NSW. 2 metre waves in Moreton Bay with houses evacuated at Sandgate.
19-24 January, 1951.	Cyclone hits south east Gulf region. Major flooding to Burdekin.
7 February, 1954.	Tropical cyclone crosses south of Townsville producing heavy flooding.
7 March, 1955.	Widespread structural damage and flooding at Sarina. Lugger <i>Barrier Princess</i> lost with 8 people.
6 March, 1956.	Cyclone Agnes. Passed over Townsville. Widespread damage from Cairns to Mackay. Recorded wind gusts to 79 knots.
20 February, 1958.	Cyclone crossed the coast south of Ayr then moved back to sea. Heavy floods to Mackay with 3 lives lost.
1 April, 1958.	Cyclone and 2 metre storm surge hit Bowen. Wind gusts over 98 knots. Considerable damage to houses and other buildings. Other areas hit by induced tornadoes.
20 January, 1959.	Cyclone moved from the Gulf to cross between Cooktown and Cairns. Flooding.
16 February, 1959.	Cyclone Connie. Severe wind damage at Ayr, Home Hill and Bowen where wind gusts up to 100 knots were recorded over a two hour period. Other damage in Mackay and Rockhampton.
13-14 January, 1964.	Cyclone Audrey. Tracked from Gulf to Coffs Harbour causing extensive wind damage in the western areas such as St George (74 houses damaged) and Goondiwindi where over 50 buildings suffered. Glen Innes and Grafton, NSW also had wind damage.
15-16 April, 1964.	Cyclone Gertie. Hits the Whitsunday Islands with heavy coastal rain. Floods.
6 December, 1964.	Cyclone Flora. Innisfail to Cardwell reported damage.
30 January, 1965.	Cyclone Judy. Near Innisfail causing floods south to Townsville.
17 January, 1970.	Cyclone Ada. Passed through the Whitsunday Islands to hit Airlie Beach. Tourist resorts destroyed and 80% of buildings at Airlie Beach damaged. 14 lives lost. Floods around Bowen and Mackay.
20-22 February, 1971.	Cyclone Fiona. Tracked from the Gulf to Rockhampton. Some damage to infrastructure.
24 December, 1971.	Cyclone Althea. \$50 million damage (at 1971 value) caused to Townsville. 90% of houses damaged or destroyed on Magnetic Island. 3.66 metre storm surge recorded just north of the area. 3 deaths. Hundreds of homes damaged (including over 200 Housing Commission homes).
4 March, 1973.	Cyclone Madge. Hit Cooktown. Considerable flooding to Townsville.
19 December, 1973.	Cyclone Una. Crossed near Townsville. Some damage and flooding. 4 deaths.
16 January, 1975.	Cyclone Gloria. Stayed offshore but caused flooding from Lucinda to Mackay.
19 January, 1976.	Cyclone David. Passed near St Lawrence after extending from Papua New Guinea to Lord Howe Island. Buildings damaged at Yeppoon and Mt Morgan. Wind gusts were recorded at 84 knots with wave heights peaking at 9.2 metres at recording stations.
1 February, 1976.	Cyclone Alan. Crossed the North Queensland coast near Bloomfield River mission. Became an intense monsoon travelling through Tennant Creek in the Northern Territory before heading back to sea through Byron Bay, NSW.
10 March, 1977.	Cyclone Otto. Crossed at Cape Tribulation and again at Bowen. Aggravated flood damage in Cairns.
31 January, 1977.	Cyclone Keith. Hit east of Cairns and the crossed again at Cape Cleveland near Townsville. Extensive crop damage.
1-2 January, 1979.	Cyclone Peter. Record rainfall south of Cairns (1140mm in 24 hours) caused serious flooding estimated at \$10 million (at 1979 value). 2 deaths.

Date	Event
11 January, 1979.	Cyclone Greta. Crossed Princess Charlotte Bay.
1 March, 1979.	Cyclone Kerry. Passed the coast near Proserpine. Some damage around Mackay and resort islands. Wind gust recorded at 76 knots. \$1 million damage (at 1979 value) to boats in harbour.
7-8 January, 1980.	Cyclone Paul. Near St Lawrence causing record floods around Bowen. Wave peaks recorded at Brisbane station at 9.8 metres.
10 February, 1981.	Cyclone Eddie. Crossed at Princess Charlotte Bay.
26 February, 1981.	Cyclone Freda. Developed near Cooktown and moved away from the coast.
3-4 March, 1983.	Cyclone Elinor. Hit near Carmilla causing minimal damage to houses.
8 March, 1984.	Cyclone Jim. Crossed the Peninsula Coast near Cape Grenville with foliage damage.
19 March, 1984.	Cyclone Kathy. Crossed the Peninsula Coast near the Pascoe River.
22 February, 1985.	Cyclone Pierre. Hit Shoalwater Bay. Minor flooding.
1 April, 1985.	Cyclone Tanya. Crossed the Peninsula Coast at Coen. Vegetation damage.
1 February, 1986.	Cyclone Winfred. Crossed near Innisfail with an eye diameter of 41km. A wind gust was calculated at 145 knots. Houses damaged. Cost was \$130 million (at 1986 value). 3 deaths.
1 March, 1988.	Cyclone Charlie. Made landfall at Upstart Bay near Ayr. Wind gusts recorded to 80 knots. Some structural damage and flooding at Ayr.
4 April, 1989.	Cyclone Aivu. Building damage costs were \$40 million while agriculture costs were \$40 million and \$10 in infrastructure (at 1989 values). Major flooding. One death.
19 March, 1990.	Cyclone Ivor. Passed the coast near Princess Charlotte Bay with some damage in Coen. As a monsoon moved south to cause extensive flooding at Yeppoon.
22-25 December, 1990.	Cyclone Joy. Travelled past Cairns to weaken in intensity crossing at Townsville. 97 knot wind gusts recorded. Structural damage south of Cairns. Induced tornado hit Mackay damaging buildings and causing floods. 6 lives lost. Cost \$62 million (1990 value).
20 January, 1994.	Cyclone Rewa. Stayed 100km off the coast but caused flash flooding around Brisbane which resulted in 4 deaths.
9 January, 1996.	Cyclone Barry. Moved down from the Gulf past Sarina to Hervey Bay causing structural and vegetation damage.
27 January, 1996.	Cyclone Celeste. Came close to Bowen with an eye of 40km. wind gusts to 64 knots and some damage to buildings.
12 March, 1996.	Cyclone Ethel. Crossed at Cape Melville. 60 knot winds reported.
22 March, 1997.	Cyclone Justin II. Crossed near Cairns. Wind damage to buildings from the Atherton Tablelands to Townsville. Considerable flooding and evacuations. Cost almost \$200 million.
10-11 January, 1998.	Cyclone Sid. Moved from Gulf across Cape York and intensified into a monsoon low near Townsville. Severe flooding and landslides. Peak wave height recorded at 5.41 metres. Total damage cost over \$100 million (at 1998 value).
11 February, 1999.	Cyclone Rona. Made landfall near the mouth of the Daintree River. Considerable vegetation damage. Maximum wind gust was 85 knots and the peak wave height recorded was 6.3 metres. Cost of crop and infrastructure damage estimated at \$150 million.
27 February, 2000.	Cyclone Steve. The cyclone passed the coast at the northern beaches of Cairns causing structural damage and flooding. Wind gusts up to 85 knots were recorded and the peak wave measurement was 5 metres at Cairns Wave Recording Station. Prominent buildings were unroofed. Mareeba reached a record flood level of 12.4 metres and evacuations were conducted.
17 March, 2000.	Tropical low created gales around Lucinda. Record flooding occurred at Giru.
2 April, 2000.	Cyclone Tessi. Crossed north of Townsville causing extensive crop damage and to some isolated buildings in the area. Townsville then suffered wind damage to buildings and widespread flooding. 70 knot winds recorded.
15 - 16 February, 2001.	Cyclone Wylva. Hovered around Mornington Island but caused very little damage. Maximum wind gust recorded was 64 knots.
23 - 27 February, 2001.	Cyclone Abigail. Crossed north-west of Cairns at Ellis Beach before entering the Gulf and reforming before crossing the coast again near the Queensland / Northern Territory border. Some damage was sustained on Mornington Island where the wave surge was 1.3 metres and the Maximum wind gust was 64 knots. Both Cairns and Green Island had considerable winds to 50 knots.
11 February 2004.	Cyclone Fritz This crossed the coast at Cape Melville. Flash flooding occurred around the Innisfail/South Johnstone area with 74mm of rainfall in one hour. 309mm was recorded over 24 hours.
19 - 24 March 2004.	Cyclone Grace Flooding between Cairns and Cooktown. 372mm of rainfall in 24 hours. Wind speeds up to 54 knots were recorded. Estimated US\$20M damage to Cairns region.



APPENDIX A6

Noise and Vibration Supporting Information



Operating Noise Modelling Assumptions

Plant and Equipment

A variety of fixed and mobile equipment types will be utilised during the operational phase of the Port Expansion Project (PEP), each of which will generate noise. The indicative types of equipment to be used at the port expansion are summarised in the following sub-sections.

The equipment sound power levels used in the environmental noise modelling are based on levels measured during a site visit to the existing Port in June 2011 and checked against equipment noise measurements taken by AECOM at other ports in Australia. It is noted that noise from ships moving in and out of the port has not been incorporated into the noise model. This is because shipping does not represent a significant noise source; it occurs for short periods of time only, and is infrequent compared with the continuous operation of the plant and equipment serving the ships at berth.

Published noise levels for stationary equipment often differ from the noise levels produced by the same equipment moving around on site. The noise emission of machinery can vary with a number of factors, including the age and condition of the machine, the type of terrain the machine is operating on, the type of operation the machine is performing, the quality of lubricants and oils, and the ability of the operator.

Whilst the actual sound power levels can vary, the levels used in the environmental noise model are indicative of the predicted level when proper maintenance and operating procedures are followed. Table 1 provides assumptions for sound power levels, the average height of the noise source and the forecast number of items used in the noise model.

Table 1 Indicative sound power levels of equipment proposed for the PEP

Noise source	Number operating	Height of Noise Source (m)	Overall L _w Level, dB(A)	A-weighted sound levels (dB(A))							
				31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Forklift	4	1	109	109	118	122	110	103	100	96	88
Semi trailer moving	9	1	98	96	109	106	98	94	93	90	83
Vessel Exhaust noise	6	20	111	122	117	117	113	110	103	98	90
30 tonne crane	2	30	112	120	120	121	114	109	104	100	93
Conveyor/Ship Loader	3	10	87 per metre	97	93	93	84	84	83	75	68

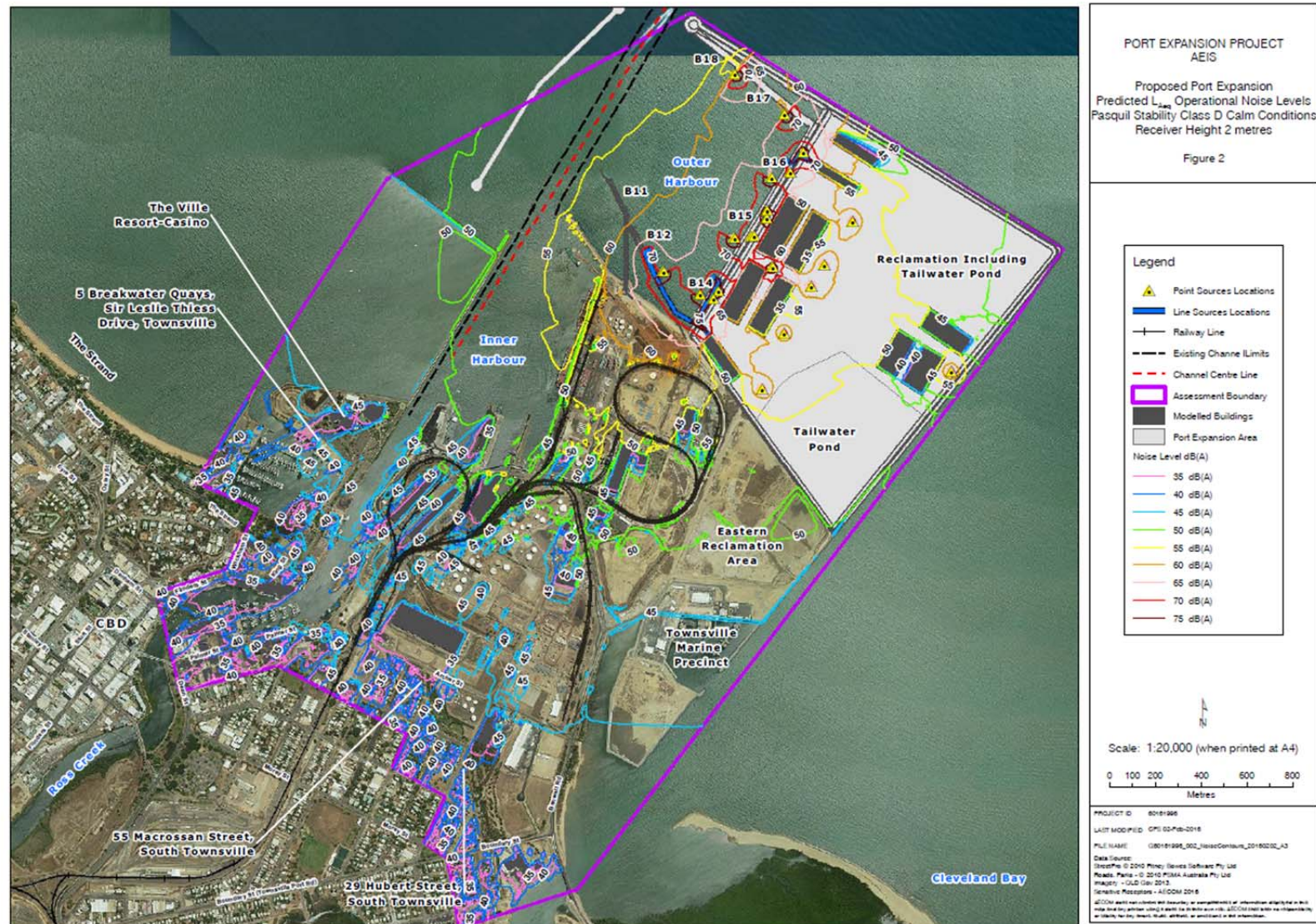
Noise Model Locations

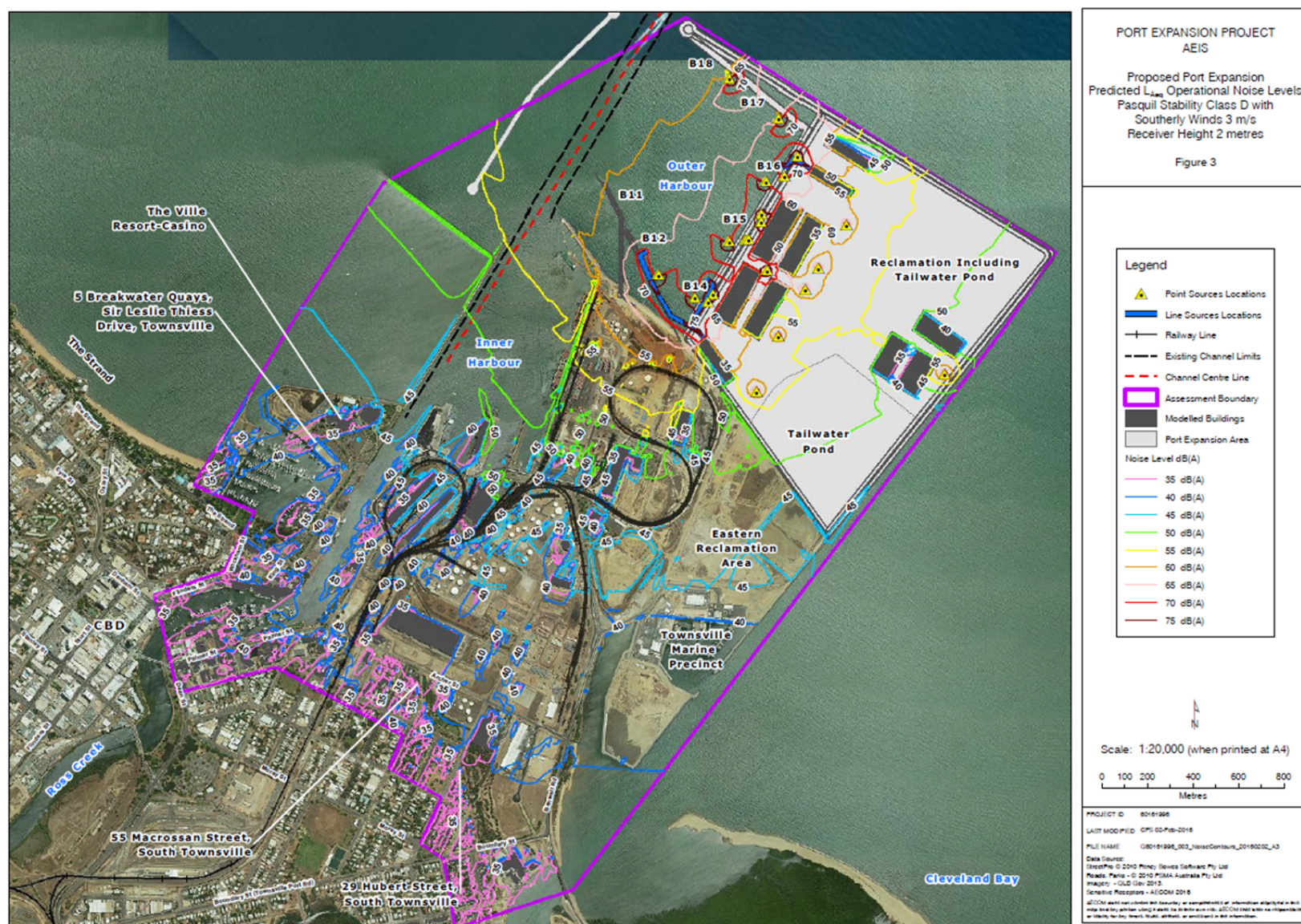
Locations of the mobile equipment have been based on observations of existing working relationships between loading / unloading / transportation equipment and the ships at berth made by AECOM personnel during site visits to the port. Locations were chosen to represent 'typical worst case' mobile plant locations. Fixed equipment locations were estimated.

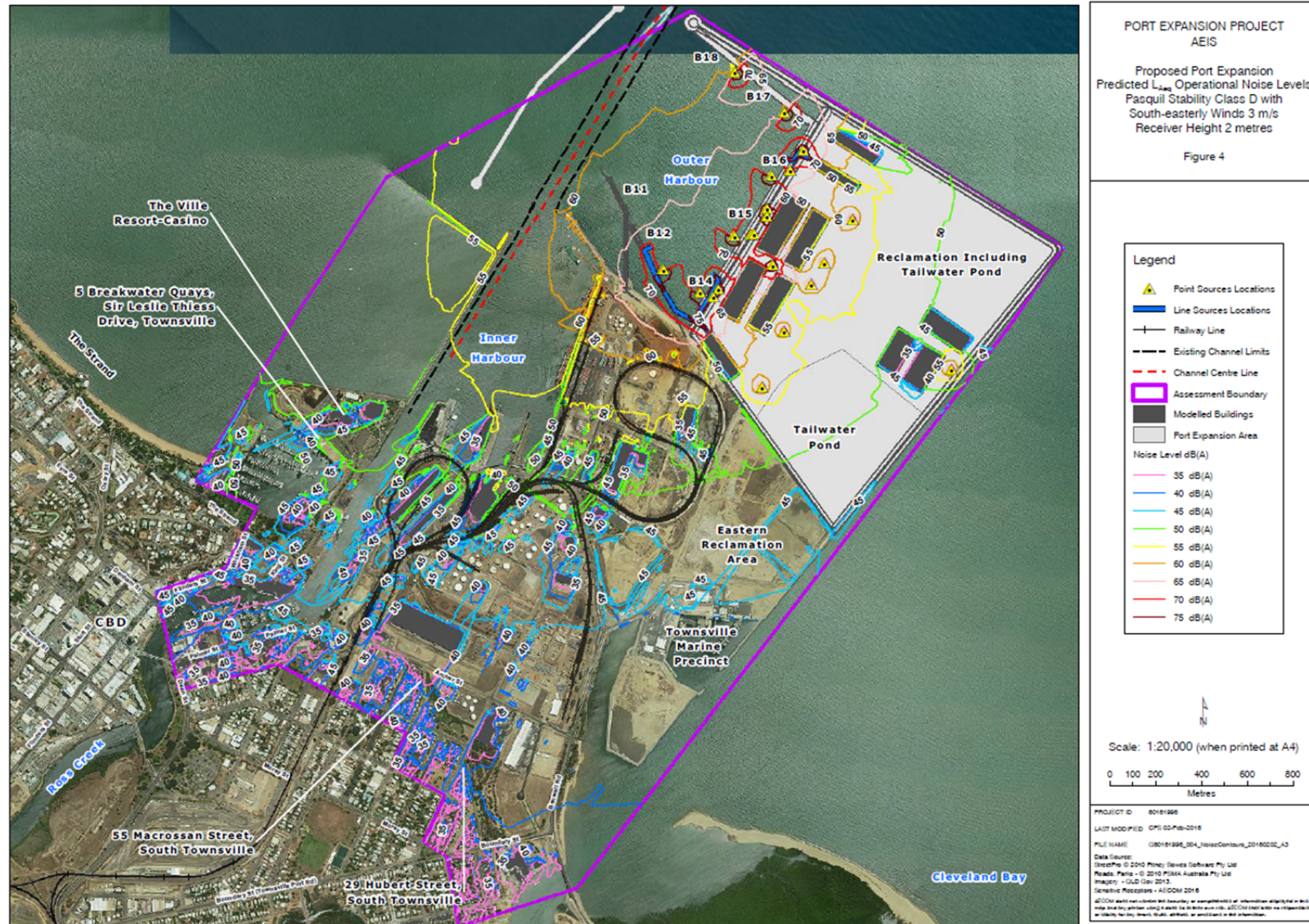
Figure 1 shows the existing port layout and proposed PEP area. Figures 2 to 4 show predicted operational noise levels in calm and windy conditions.

Noise Contour Plots – Operational Port Expansion









Operational Noise Goals

Summary of Operational Noise Goals

Noise goals for the PEP are summarised in Table 2 below.

Table 2 Summary of noise goals applicable at nearest noise sensitive receivers

Period	Time	Environmental Protection Policy (Noise) 2008 $L_{Aeq, 1hr}$ dB(A)	Planning for Noise Control $L_{Aeq, 1hr}$ dB(A)	World Health Organisation guidelines L_{Aeq} dB(A)	ECOACCESS Low Frequency dB(Lin)
Day	7am – 6pm	50	28 – 48*	40 – 45	50 dB(Lin) Screening test (indoors)
Evening	6pm – 10pm	50	28 – 46*	40 – 45	
Night	10pm – 7am	45	28 – 44*	35 – 40	

*Note: These are specific for each noise sensitive receiver. Table 3 below displays the Planning for Noise Control noise goals for each noise sensitive receiver.

Table 3 Summary of Planning for Noise Control goals

Location	Planning for Noise Control goals, $L_{Aeq, 1hr}$ dB(A)		
	Day	Evening	Night
29 Hubert Street, South Townsville	41	42	41
55 Macrossan Street, South Townsville	44	38	35
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	45	46	44
The Ville Resort - Casino, Townsville	48	48	42
1 Esplanade, Picnic Bay, Magnetic Island	28	28	28

The above noise goals are based on the legislation and policies discussed hereafter.

Environmental Protection Act 1994

Section 440Q (2) of the Act states that:

- 2 A person does not contravene a noise standard by causing an environmental nuisance mentioned in schedule 1, part 1.

Schedule 1 *Exclusions relating to environmental nuisance or environmental harm* of the Act outlines a number of activities which are excluded from being classified as contravening a noise standard. The Schedule states:

Part 1 Environmental nuisance excluded from ss 440 and 440Q

1 *Safety and transport noise*

Environmental nuisance caused by any of the following types of noise –

(d) noise from operating a ship, including noise from –

- (i) machinery and equipment; or*
- (ii) shore and ship based port operations for loading onto a ship, or unloading from a ship, items other than bulk goods; or*
- (iii) ship to shore communications relating to safe berthing and cargo handling; or*
- (iv) a ship's horn;*

The purpose of this Environmental Impact Statement is to inform the application process of the expected impact of the port expansion, rather than necessarily address the issue of environmental nuisance as defined by the Act. Therefore, the general environmental noise goals which would otherwise apply are applied in this assessment as a guide to the understanding of what would constitute “acceptable” environmental noise emissions from an industrial facility.

Environmental Protection (Noise) Policy 2008

Part 3 of the Environmental Protection Policy (Noise) specifies that the environmental values to be enhanced or protected under the policy are:

- (a) the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems; and*

- (b) *the qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following—*
- (i) *sleep;*
 - (ii) *study or learn;*
 - (iii) *be involved in recreation, including relaxation and conversation; and*
- (c) *the qualities of the acoustic environment that are conducive to protecting the amenity of the community.*

Schedule 1 of the Environmental Protection Policy (Noise) details specific acoustic quality objectives to be met for various types of sensitive receptors. This includes the noise goals for receptors used in this assessment and is summarised in Table 4.

Table 4 EPP (Noise) 2008 acoustic quality objectives at dwelling

Sensitive receptor	Time of day	Acoustic quality objectives (measured at the receptor) dB(A)		
		$L_{Aeq, adj, 1hr}$	$L_{A10, adj, 1hr}$	$L_{A1, adj, 1hr}$
Dwelling (outdoors)	Daytime and evening	50	55	65
Dwelling (indoors)	Daytime and evening	35	40	45
	Night	30	35	40
Commercial and retail (indoors)	When the activity is open for business	45	-	-

It is noted that the limits presented in Table 4 above are objectives designed as maximum long-term noise limits and are not designed for assessment of any individual project or enterprise.

Planning For Noise Control

In 2004 the Environmental Protection Agency produced a noise guideline entitled "Planning for Noise Control". The methods and procedures described in the guideline are applicable for setting conditions relating to noise emitted from industrial premises, commercial premises and mining operations. The nominated noise goal is the lower of the Specific Noise Level and the Maximum Planning Noise Level. These noise levels are discussed in the following sections (EPA, 2004).

As the noise guidelines provided by the Planning for Noise Control document are applicable to external noise levels, and the Environmental Protection Policy provides an internal guideline noise value for commercial activities, no Specific Noise Level targets are set for the Townsville Marine Precinct (EPA, 2004).

Specific Noise Level

The specific noise level for the residences in the vicinity of the port is based on the Rating Background Levels provided in Table 2. These specific noise levels have been determined by the following equation: $L_{Aeq, 1hr} = \text{Rating Background Level} + 3$.

The specific noise levels for each measurement location and a summary of the measured Rating Background Levels are provided in Table 5.

Table 5 Specific noise levels

Location	Measured Rating Background Level ($\min L_{A90, 1hr}$) dB(A)			Specific noise levels ($L_{Aeq, 1hr}$) dB(A)		
	Day	Evening	Night	Day	Evening	Night
29 Hubert Street, South Townsville	38	39	38	41	42	41
55 Macrossan Street, South Townsville	41	35	32	44	38	35
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	42	43	41	45	46	44
The Ville Resort - Casino, Townsville	45	44	44	48	47	47

Noise measurements were not conducted at Magnetic Island, and therefore environmental noise goals for this location cannot be calculated from actual background noise data.

For Magnetic Island, the background noise levels are anticipated to be low, akin to rural noise levels, and so the lowest threshold background noise level of 28 dB(A) has been assumed for this location (Table 6).

Table 6 Summary of applied noise criteria

Location	Specific noise levels ($L_{Aeq, 1hr}$) dB(A)		
	Day	Evening	Night
1 Esplanade, Picnic Bay, Magnetic Island	28	28	28

Maximum Planning Noise Levels

The Planning for Noise Control guideline defines maximum planning noise levels for the setting of long-term noise goals. The category which currently best defines the sensitive receptors surrounding the Port of Townsville would best be defined as Z4, while the receptors on Magnetic Island are best defined by Category Z2. Table 7 provides a description of the Z2 and Z4 categories, as defined in the Planning for Noise Control guideline (EPA 2004, Table 3).

Table 7 Planning for Noise Control Z2 and Z4 noise area categories

Noise area category	Description of neighbourhood	Maximum hourly sound pressure level $L_{Aeq, 1hr}$ (Planning Noise Level)		
		Day	Evening	Night
Z2	Negligible transportation (less than 80 vehicles an hour).	50	45	40
Z4	Medium density transportation (less than 600 vehicles an hour) or some commerce or industry	60	55	50

The Planning for Noise Control guideline states that:

Table 3 must only be used as a guideline. Whenever possible, values of the background $minL_{A90, 1hr}$ and residual $L_{Aeq, 1hr}$ in the appropriate time period must be measured prior to development. (EPA, 2004)

The measured maximum hourly sound pressure levels are found in Table 8. No adjustments for tonality or impulsiveness were applied to the specific noise levels as none were detected during the measurements.

Planning for Noise Control states that:

Where the existing noise level from specific noise sources is close to the maximum planning level, the noise level from any new source(s) must be controlled to preserve the amenity of an area. (EPA, 2004)

The Planning for Noise Control guideline outlines (in Table 4), these modifications to the planning noise level to account for existing levels of specific noise (EPA, 2004). The PEP, is for new industrial development near a suburban area for which existing ambient noise levels are controlled by existing industry (Port) and traffic noise. Hence, the methodology outlined in example C2 in Appendix C of the Planning for Noise Control guideline is the most relevant to this development for residential receivers other than Magnetic Island, for which the example in C4 is considered to be more appropriate.

The existing noise level in the surrounding area is unlikely to decrease in the future.

Accordingly, Table 4 of the Planning for Noise Control guideline recommends that the $L_{Aeq, 1hr}$ noise level from any new source should be equal to the relevant Planning Noise Level. This is shown in Table 8.

Table 8 Recommended Planning Noise Level levels $L_{Aeq, 1hr}$

Location	Planning Noise Levels $L_{Aeq, 1hr}$ dB(A)		
	Day	Evening	Night
29 Hubert Street, South Townsville	(60+0) 60	(55-1) 54	(50-2) 48
55 Macrossan Street, South Townsville	(60-3) 57	(55-2) 53	(50-6) 44
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	(60+0) 60	(55-4) 51	(50-4) 46
The Ville Resort - Casino, Townsville	(60-6) 54	(55-2) 53	(50-10) 40
1 Esplanade, Picnic Bay, Magnetic Island	(50-8) 42	(45-8) 37	(40-8) 32

Summary of Planning for Noise Control Noise Goals

The Planning for Noise Control noise goals are summarised in Table 9. The noise goal applied to the proposed PEP for each time period is the lowest value of the Specific Noise Level and the maximum Planning Noise Level.

Table 9 Summary of Planning for Noise Control Noise Goals

Location	Specific Noise Levels			Planning Noise Levels $L_{Aeq, 1hr}$			Planning For Noise Control noise goal (minimum) $L_{Aeq, 1hr}$		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
29 Hubert Street, South Townsville	41	42	41	60	54	48	41	42	41
55 Macrossan Street, South Townsville	44	38	35	57	53	44	44	38	35
5 Breakwater Quays, Sir Leslie Thiess Drive, Townsville	45	46	44	60	51	46	45	46	44
The Ville Resort - Casino, Townsville	48	47	47	54	53	40	48	48	42
1 Esplanade, Picnic Bay, Magnetic Island	28	28	28	42	37	32	28	28	28

World Health Organisation

The World Health Organisation issued its "Guidelines for Community Noise" in April 1999. The following sections are applicable to the current Project:

Section 4.2.1 Interference with Communication

a. Speech in relaxed conversation is 100% intelligible in background noise levels of about 35 dB(A), and can be understood fairly well in background levels of 45 dB(A).

Section 4.2.3 Sleep Disturbance Effects

...Where noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided... (WHO, 1999)

A summary of the World Health Organisation Guidelines is provided in Table 10.

Table 10 Summary of World Health Organization Night-time Noise Goals (WHO, 1999)

Descriptor	Indoor noise goal	Outdoor noise goal
Residential		
Communication Interference	L_{eq} 35 dB(A)	40-45 dB(A)*
Sleep Disturbance	L_{eq} 30 dB(A)	35-40 dB(A)*
Annoyance – night time	L_{eq} 35 dB(A)	40-45 dB(A)*
Commercial		
Hearing impairment	L_{eq} 70 dB(A)	L_{eq} 70 dB(A)

Note: * Based on an outdoor-to-indoor noise reduction of 5 to 10 dB(A) through open windows.

ECOACCESS Guideline for the Assessment of Low Frequency Noise

The Environmental Protection Agency has produced a draft guideline for the assessment of low frequency noise in the proceedings of the Annual Conference of the Australian Acoustical Society 2004. The following sections are applicable to the current proposal:

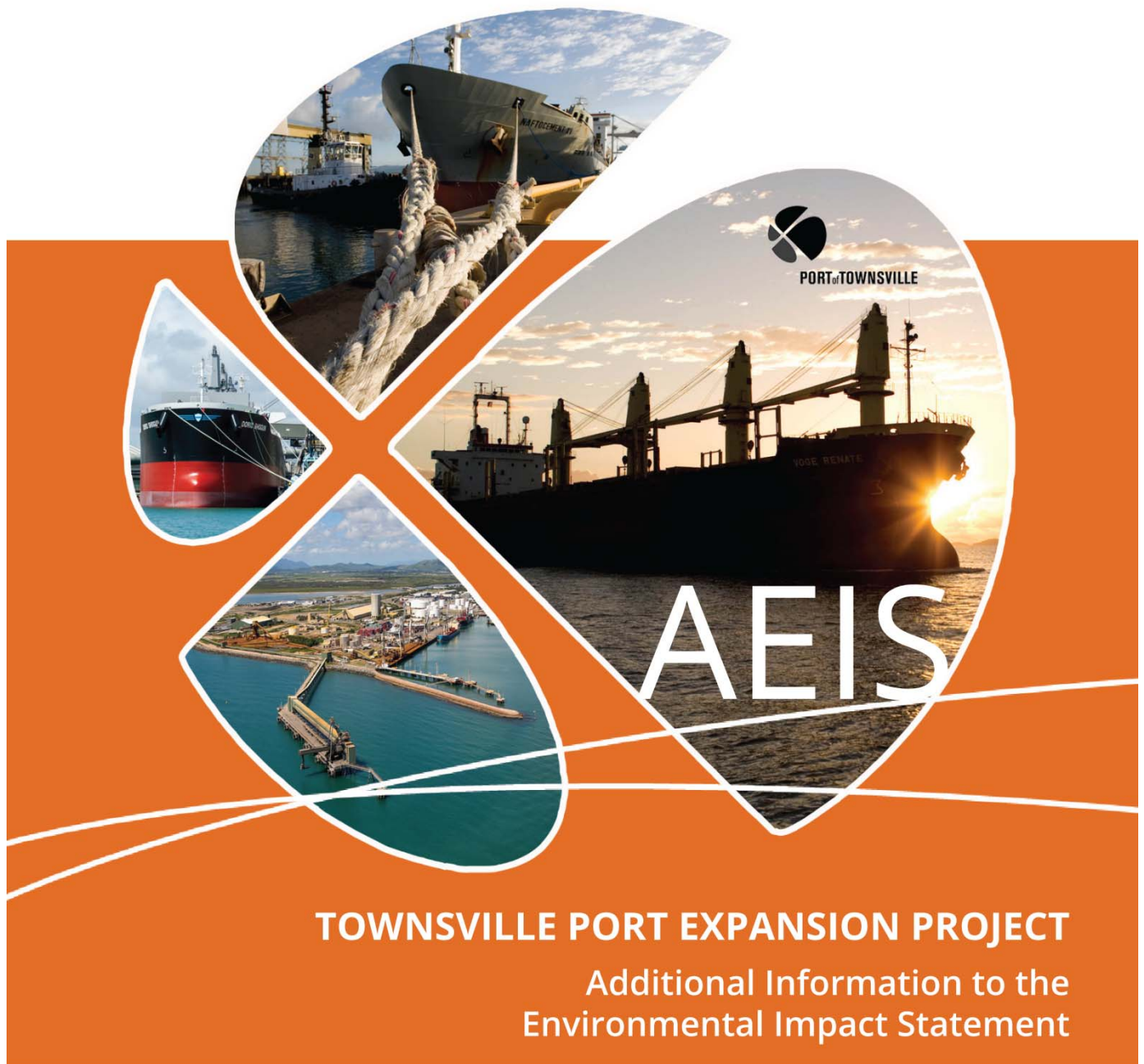
Low frequency noise above 20Hz

Initial assessment.

The following two requirements are specified as part of the initial screening test for audibility of low frequency noise.

- The overall sound pressure level does not exceed 50 dB(Lin) within dwellings
- The overall dB(Lin) level does not exceed the dB(A) level by more than 15 dB, within dwellings.

Where these conditions are not met, there is an increased likelihood that low frequency noise may be audible and that additional assessment by way of measurement is recommended. It is noted that this initial screening test only identifies the risk of increased audibility and does not verify whether this is likely to cause annoyance.



APPENDIX A7

Terrestrial Ecology Likelihood Supporting Information



Species Likelihood Table

Table 1 has been updated in order to reflect changes in species status under the *Nature Conservation Act 1992*. Text with strikethrough font represents species which did not occur in the updated searches.

Footnotes are provided at the bottom of the table to provide further information on abbreviations and references. Numbers located in the 'Sources' column correlate to relevant data sources detailed in Footnote 5. Footnote 6 and 7 correlate to updated searches undertaken in 2016.

Table 1 Table of threatened, migratory and marine species detected during desktop reviews and site surveys

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
Birds											
<i>Accipiter fasciatus</i>					Y	This a raptor species occurring in riparian areas and water holes among a range of woodland and open forests. It is a partially migratory species that will exploit farming areas in addition to dry scrublands, forests and woodlands. This species is also known to occupy areas of open paperbark, monsoon and riverine forest and wetland with sparse trees, parks and gardens.	Present	Unlikely	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	3
<i>Accipiter novaehollandiae</i>	grey goshawk		NT			The grey goshawk is found in most forest types, especially tall closed forests, including rainforests.	Possible	Unlikely	Low	Species identified on Magnetic Island by MICDA and MINCA	4
<i>Actitis hypoleucos</i>	common sandpiper		SL	Y	Y	Inhabits coastal and interior wetlands where it forages along the narrow muddy edges of billabongs, river pools, mangroves and reefs or rock beaches.	Present	Present flyover	Low	Species identified using habitat near the mouth of the Ross River by Driscoll and historical records	1, 2, 3
<i>Aerodramus terraereginae</i>	Australian swiftlet		NT C			Skies over coastal ranges, gorges, islands and woodlands.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	2
<i>Anseranas semipalmata</i>	magpie goose		C		Y	Shallow wetlands (usually <1 m deep) with dense growth of rushes and sedges. Wetlands associated with floodplains of rivers and large shallow wetlands formed by runoff.	Possible	Unlikely	Low	Suitable habitat in the broader area	1, 2
<i>Apus pacificus</i>	fork-tailed swift		SL	Y	Y	Low to very high airspace over varied habitat, rainforest to semi-desert.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1

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<i>Pandion cristatus</i>	eastern osprey		SL			Littoral and coastal habitats and terrestrial wetlands and offshore islands.	Present	Present Flyover	Low	Suitable habitat in the broader area	7
<i>Ardea modesta</i>	eastern great egret		SL	Y	Y	Wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 3
<i>Ardea ibis</i>	cattle egret		SL	Y	Y	The cattle egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Will also forage at garbage dumps, and is often seen with cattle and other stock.	Present	Present, flyover	Low	Suitable habitat in the broader area	1, 2, 3
<i>Ardea intermedia</i>	intermediate egret				Y	It is distributed throughout eastern Australia and significant coastal areas of the Northern Territory, being absent from more arid ones. The intermediate egret has similar habitat preferences to the little and great egret, found in shallows of wetlands and shallow margins of inland rivers and lakes.	Present	Possible, flyover	Low	Historical records of this species in the area	3
<i>Arenaria interpres</i>	ruddy turnstone		SL	Y	Y	Inhabits beaches and coasts with exposed rocks, stony or shell beaches, mudflats and exposed reefs.	Possible	Possible, flyover	Low	Suitable habitat in the broader area, historic records	1, 3
<i>Sula dactylatra</i>	masked booby		SL			The masked booby lives on the open ocean. It only comes on land to breed and raise its young.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	7
<i>Sula sula</i>	red-footed booby		SL			Breeds on islands in most tropical oceans. When not breeding it spends most of the time at sea, and is therefore rarely seen away from breeding colonies. It nests in large colonies, laying one chalky blue egg in a stick nest.	Present	Possible, flyover	Low	Suitable habitat in the broader area	7
<i>Sula leucogaster</i>	brown booby		SL			Nests on islands, covering a wide range of vegetation types, geologic features, and weather patterns. Found at sea in nonbreeding season.	Present	Possible, flyover	Low	Suitable habitat in the broader area	7

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<i>Plegadis falcinellus</i>	glossy ibis		SL			A wide variety of inland wetland habitats such as shallow lakes, swamps and marshes, ponds, rivers, floodplains, wet meadows and irrigated agricultural fields, as well as occasionally using coastal lagoons, mudflats and estuaries.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	7
<i>Calidris acuminata</i>	sharp-tailed sandpiper		SL	Y	Y	The species prefers the grassy edges of shallow inland freshwater wetlands. It is also found around swage farms, flooded fields, mudflats, mangroves, rocky shores and beaches. Its breeding habitat in Siberia is the peat-hummock and lichen tundra of the high Arctic.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Calidris alba</i>	sanderling		SL	Y	Y	Open sandy beaches.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 2, 3
<i>Calidris canutus</i>	red knot		SL	Y	Y	Tidal sands and mudflats.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Calidris ferruginea</i>	curlew sandpiper			Y	Y	Inter-tidal mudflats of estuaries, lagoons, mangrove channels, lakes, dams, floodwaters and flooded saltbush around inland lakes.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Calidris ruficollis</i>	red-necked stint		SL	Y	Y	Tidal and inland mudflats, salt marshes, beaches, salt fields and temporary floodwaters.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Calidris tenuirostris</i>	great knot		SL	Y	Y	Sheltered coastal habitats with large, inter-tidal mudflats or sandflats, including inlets, bays, harbours, estuaries, lagoons, sandy spits, islets and sometimes on exposed reefs or rock platforms.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3

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<i>Charadrius leschenaultii</i>	greater sand plover		SL	Y	Y	Coastal species, foraging on inter-tidal sand and mudflats in estuaries, and roosting during high tide on sandy beaches or rocky shores. Individuals have also been recorded on inshore reefs, rock platforms, small rocky islands and sand cays on coral reefs. Occasional sightings have also occurred on near-coast saltlakes, brackish swamps, shallow freshwater wetlands and grassed paddocks.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Charadrius mongolus</i>	lesser sand plover		SL	Y	Y	Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large inter-tidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores, often with other waders.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Charadrius ruficapillus</i>	red-capped plover		C		Y	Estuaries, beaches, inland lakes.	Present	Present, flyover	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 2, 3
<i>Charadrius veredus</i>	oriental plover			Y	Y	Found generally inland; in open grasslands in arid and semi-arid zones; and less often in estuarine or littoral environments. This species prefers flat inland plains, sparsely vegetated short grass with hard bare ground including claypans, playing fields, lawns and cattle camps. The oriental plover may move to lightly-wooded grasslands with the onset of the wet season.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Fregata ariel</i>	lesser frigatebird		SL	Y	Y	<i>It is common in tropical seas, breeding on remote islands, including Christmas Island.</i>	Present	Possible, flyover	Low	Suitable habitat in the broader area	7
<i>Sterna hirundo</i>	common tern		SL	Y	Y	<i>Are marine, pelagic and coastal.</i>	Present	Possible, flyover	Low	Suitable habitat in the broader area	7
<i>Sterna sumatrana</i>	black-naped tern		SL	Y	Y	<i>Associated with small, offshore sand and coral cays, coral reefs and lagoons, and sandy and rocky islands and islets, and in the surrounding seas. The species is only occasionally recorded in inshore waters.</i>	Present	Possible, flyover	Low	Suitable habitat in the broader area	7

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<i>Onychoprion anaethetus</i>	bridled tern		SL	Y	Y	Breed on islands. Nests are usually found in rocky areas or on coral, concealed in crevices or caves up to 1.5 m deep, under rocks, among talus or coral rubble, on ledges of cliffs, or on the ground beneath low shrubs, roots of Pandanus, vines or among grasses.	Present	Possible, flyover	Low	Suitable habitat in the broader area	7
<i>Sternula albifrons</i>	little tern		SL	Y	Y	Inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll and on Magnetic Island by MICDA and MINCA <i>Suitable habitat nearby at the mouth of Ross River.</i>	1, 2, 3, 7
<i>Chlidonias leucopterus</i>	white-winged tern		SL	Y	Y	Mostly inhabits fresh, brackish or saline, and coastal or subcoastal wetlands. White-winged terns frequent tidal wetlands, such as harbours, bays, estuaries and lagoons, and their associated tidal sandflats and mudflats. Terrestrial wetlands, including swamps, lakes, billabongs, rivers, floodplains, reservoirs, saltworks, sewage ponds and outfalls are also inhabited. Wetlands may be open, or with floating emergent or marginal vegetation. They rarely occur on inland wetlands in Australia.	Present	Possible, flyover	Low	Historical records of this species in the area by Driscoll	3
<i>Coracina novaehollandiae</i>	black-faced cuckoo-shrike		C		Y	This common species is widely dispersed throughout most of the Australian continent in habitats ranging from rainforest, eucalypt forests and woodlands, riparian vegetation, farming areas and gardens. Breeding pairs return to the same breeding site every year.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	3

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<i>Coracina papuensis</i>	white-bellied cuckoo-shrike		C		Y	A common species in the Townsville area, and is found from mid-South Australia to Queensland and the Northern Territory, with an inland extension to the arid zone. Preferred habitat includes sclerophyll and gallery forest, rainforest, woodland and mangroves.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by GHD	3
<i>Cuculus optatus</i>	oriental cuckoo, horsfield's cuckoo			Y	Y	<i>It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground. It is usually secretive and hard to see.</i>	Present	Possible, flyover	Low	Suitable habitat in the broader area	5
<i>Motacilla flava</i>	yellow wagtail			Y	Y	<i>Yellow Wagtails can turn up just about anywhere in Australia but always in quite rich open-country habitats with disturbed ground and some water. Sewage farms, dams and grassy margins to lakes are all potential habitat.</i>	Present	Possible,	Low		5
<i>Egretta sacra</i>	eastern reef egret		C	Y	Y	Freshwater marshes and inland waters also rocky and sandy shoreline and/or beaches, tidal mud flats.	Present	Present, flyover	Low	Historical records of this species in the area by Driscoll	3
<i>Ephippiorhynchus asiaticus</i>	black-necked stork		NT C			Inhabits open freshwater environments along the margins of billabongs, lagoons, swamps, floodplains, dams and their adjacent grasslands, pastures and woodlands. They also forage in or around estuaries and along inter-tidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Driscoll, Maunsell and on Magnetic Island by MICDA and MINCA	2, 3
<i>Erythrorhynchus radiatus</i>	red goshawk	V	E			It inhabits tropical grassy woodlands mostly in undulating stony lands. The red goshawk occurs in coastal and subcoastal areas in wooded and forested lands. They are found in habitats that support high bird numbers and biodiversity, especially medium to large species which the goshawk requires for prey. The red goshawk nests in large trees and are year-round residents.	Possible	Unlikely	Low	Suitable habitat in the broader area	1

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<i>Esacus magnirostris</i>	beach stone-curlew		V		Y	The beach stone-curlew occurs on open, undisturbed beaches, islands, reefs and estuarine inter-tidal sand and mudflats. The species prefers beaches with estuaries or mangroves nearby. The species also frequents river mouths, offshore sandbars associated with coral atolls, reefs and rock platforms and coastal lagoons.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Driscoll, Maunsell and on Magnetic Island by MICDA and MINCA	2, 3
<i>Gallinago hardwickii</i>	latham's snipe		SL	Y	Y	Open, freshwater wetlands with low, dense vegetation e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies.	Possible	Unlikely	Low	Suitable habitat in the broader area	2
<i>Gallinago megala</i>	swinhoe's snipe			Y	Y	During the non-breeding season Swinhoe's snipe occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams. The species is also known to occur in grasslands, drier cultivated areas (including crops of rapeseed and wheat) and market gardens. Habitat specific to Australia includes the dense clumps of grass and rushes round the edges of fresh and brackish wetlands. This includes swamps, billabongs, river pools, small streams and sewage ponds. They are also found in drying claypans and inundated plains pitted with crab holes.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Gallinago stenura</i>	pin-tailed snipe			Y	Y	During non-breeding period the pin-tailed snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of the species range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands.	Unlikely	Unlikely	Low		1

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<i>Geophaps scripta scripta</i>	squatter pigeon (southern subspecies)	V	V			Inhabits open grassy woodlands on sandy soils with gravelly ridges. The squatter pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts, but is also found in disturbed landscapes used for grazing.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Haematopus fuliginosus</i>	sooty oystercatcher		NT C			Inhabits rocky shorelines, rocky islets, boulders below cliffs and reefs.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Driscoll and on Magnetic Island by MICDA and MINCA	2, 3, 4
<i>Haliaeetus leucogaster</i>	white-bellied sea eagle		C	Y	Y	Usually coastal, over islands, reefs and headlands, beaches, bays and estuaries, mangroves, lagoons and floodplains. Breeding territories for the white-bellied sea eagle are located close to water, and mainly in tall open forest or woodland. Absence of vegetation at the site means that nesting and/or breeding birds are unlikely to be present.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell, GHD and Driscoll	1, 2, 3
<i>Haliastur indus</i>	brahminy kite		C		Y	The brahminy kite is a bird of the coast, particularly mangrove swamps and estuaries. It is sometimes seen over forests and along rivers.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by GHD and in historical records	3
<i>Haliastur sphenurus</i>	whistling kite		C		Y	This raptor is widely distributed throughout Australia but avoids dense forests and arid areas where trees are absent, and is one of the most commonly encountered birds outside of built up areas. Habitat consists of cane fields, farmlands, woodlands and forest where there is a water supply in close proximity and they are frequently observed responding to fires and scavenging carrion from roads.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by GHD	3

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<i>Tringa brevipes</i>	grey-tailed tattler		SL	Y	Y	Inter-tidal pools, shallows, soft surfaces of mudflats, sand beaches, rock ledges and reefs.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 3
<i>Tringa incana</i>	wandering tattler			Y	Y	Open reefs and rocky shores.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Himantopus himantopus</i>	black-winged stilt		C		Y	The black-winged stilt is a social species, and is usually found in small groups. Black-winged stilts prefer freshwater and saltwater marshes, mudflats, and the shallow edges of lakes and rivers.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 2, 3
<i>Hirundapus caudacutus</i>	white-throated needletail			Y	Y	Breeds outside Australia. Low to very high, open airspace over oceans, forests and deserts. At times gathers over ranges, headlands, often in humid, unsettled weather preceding thunderstorms. In Australia, the white-throated needletail is almost exclusively aerial and are recorded most often above wooded areas. The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Hirundo rustica</i>	barn swallow		SL	Y	Y	Welcome swallows visit a wide variety of habitats with the exception of the more heavily forested regions and drier inland areas. Open habitats and towns usually near water.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1, 2
<i>Hydroprogne caspia</i>	caspian tern		SL	Y	Y	Species frequents sheltered sea coasts, estuaries, inlets, bays, harbours, coastal lagoons, saltmarshes and salt pans, also occurring inland on fresh or saline wetlands including large lakes, inland seas, large rivers, creeks, floodlands, reservoirs and sewage ponds.	Present	Present	Low	Species identified by Driscoll	3

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<i>Limicola falcinellus</i>	broad-billed sandpiper		SL	Y	Y	Sheltered coastal estuaries, lagoons with soft inter-tidal mudflats; muddy coastal creeks, swamps, occasionally reefs.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 2, 3
<i>Limosa lapponica</i>	bar-tailed godwit		SL	Y	Y	Coastal mudflats, sandbars, shores of estuaries, salt marsh and sewerage ponds.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Limosa limosa</i>	black-tailed godwit		SL	Y	Y	Sheltered bays, estuaries and lagoons with large inter-tidal mudflats and/or sandflats. In inland areas, found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Has also been recorded in wet fields and sewerage treatment works.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Fregetta grallaria grallaria</i>	white-billed Storm Petrel	V	C			In the non-breeding season, it reaches and forages over near-shore waters along the continental shelf of mainland Australia. It breeds, in Australian territory, on offshore islets and rocks in the Lord Howe Island group.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	6
<i>Neochmia ruficauda ruficauda</i>	star Finch (eastern, southern)	E	E			The Star Finch (eastern) occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	6
<i>Macronektes giganteus</i>	southern giant petrel	E	E	Y	Y	Breeds in sub-Antarctic. Marine, over open seas and inshore waters; favours edge of continental shelf and edge of pack-ice.	Possible	Unlikely	Low	Suitable habitat in the broader area	2
<i>Merops ornatus</i>	rainbow bee-eater		SL	Y	Y	Open country of woodlands, open forest, semi-arid scrub, grasslands, clearings in heavier forests, farmlands; avoids heavy forest. In breeding season, requires open clearing or paddock with loamy soil soft enough for nest tunnelling, yet firm enough to support the tunnel.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	1, 2, 3

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<i>Ardena tenuirostris</i>	short-tailed shearwater		SL	Y	Y	<i>It is a migratory species that breeds mainly on small islands in Bass Strait and Tasmania.</i>	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	7
<i>Ardena pacifica</i>	wedge-tailed shearwater		SL	Y	Y	The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	7
<i>Monarcha melanopsis</i>	black-faced monarch			Y	Y	Rainforest, mangroves, eucalypt forests and woodlands.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by GHD and Driscoll	1, 3
<i>Monarcha trivirgatus</i>	spectacled monarch			Y	Y	Usually rainforests, eucalypt forests and mangroves; often in moist gullies of dense wet eucalypt forests.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Myiagra cyanoleuca</i>	satin flycatcher			Y	Y	Forests and woodlands, mangroves, coastal heath scrubs but avoids rainforests.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Neochmia ruficauda ruficauda</i>	star finch (eastern), star finch (southern)	E	E	Y	Y	The star finch is a largely sedentary inhabitant of grasslands and riparian grassy woodlands near water. It is vulnerable to grazed areas and has all but disappeared from areas where rainfall is unreliable. The star finch (eastern) occurs mainly in grasslands and grassy woodlands that are located close to bodies of freshwater.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Nettion coromandelianus albipennis</i>	Australian cotton pygmy-geese		NTG		Y	Tropical lowlands: well-vegetated deep freshwater pools, lakes, lagoons; also marshes, swamps, slow-flowing rivers, streams.	Possible	Unlikely	Low	Suitable habitat in the broader area	1

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<i>Numenius madagascariensis</i>	eastern curlew	CE	ENV	Y	Y	The eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large inter-tidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell, Driscoll and on Magnetic Island by MICDA and MINCA	1, 2, 3
<i>Numenius minutus</i>	little curlew		SL	Y	Y	Little curlews may gather in large flocks on coastal and inland grasslands and black soil plains in northern Australia, near swamps and flooded areas. They also feed on playing fields, paddocks and urban lawns.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Driscoll	1, 2, 3
<i>Numenius phaeopus</i>	whimbrel		SL	Y	Y	Mudflats of estuaries, lagoons, occasionally sandy beaches, reefs and salt lakes.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Philomachus pugnax</i>	ruff		SL	Y	Y	Breeds in grassy fields. Winters on estuaries and marshes.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	2
<i>Pluvialis fulva</i>	pacific golden plover		SL	Y	Y	Estuaries, inter-tidal mudflats, beaches, reefs, salt marshes and offshore islands.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3
<i>Pluvialis squatarola</i>	grey plover		SL	Y	Y	Marine shores and estuaries, sand bars, beaches, rock platforms and reef flats.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2, 3

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<i>Poephila cincta cincta</i>	black-throated finch	E	E	Y	Y	Open woodland, scrubby plains, <i>Pandanus</i> sp. flats with deep cover of grasses, never far from water. The black-throated finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by <i>Eucalyptus</i> , <i>Corymbia</i> and <i>Melaleuca</i> or other habitats often along or near watercourses, or in the vicinity of freshwater.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Recurvirostra novaehollandia</i>	red-necked avocet				Y	Found in large shallow freshwater or saltwater wetlands and estuarine mudflats.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1
<i>Rhipidura rufifrons</i>	rufous fantail		SL	Y	Y	Rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps, riverside vegetation, open country on migration.	Possible	Possible, flyover	Low	Suitable habitat in the broader area	1, 2
<i>Rostratula australis</i>	Australian painted snipe	V E	V	Y	Y	Shallow inland wetlands, brackish or freshwater that are permanently or temporarily inundated. The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands and also use inundated or waterlogged grassland or saltmarsh, dams and bore drains. The Australian painted snipe prefers to breed in areas with overhanging vegetation.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Tyto novaehollandiae kimberli</i>	masked owl (northern)	V	V			<i>In northern Australia, the Masked Owl has been recorded from riparian forest, rainforest, open forest, Melaleuca swamps and the edges of mangroves, as well as along the margins of sugar cane fields.</i>	Possible	Unlikely	Low	No suitable habitat in the area	6
<i>Tadorna radjah</i>	radjah shelduck		NT C	Y	Y	Favours shallow pools and mudbanks or the shallow fringes of deep pools.	Possible	Unlikely	Low	Suitable habitat in the broader area	2
<i>Thalasseus bengalensis</i>	lesser crested tern			Y	Y	The species inhabits tropical and subtropical sandy and coral coasts and estuaries, breeding on low-lying offshore islands, coral flats, sandbanks and flat sandy beaches, foraging in the surf and over offshore waters.	Present	Possible, flyover	Low	Species identified by Driscoll	3

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
<i>Thalasseus bergii</i>	crested tern		C		Y	The species inhabits tropical and subtropical coastlines, foraging in the shallow waters of lagoons, coral reefs, estuaries, bays, harbours and inlets, along sandy, rocky, coral or muddy shores, on rocky outcrops in open sea, in mangrove swamps and also far out to sea on open water. It shows a preference for nesting on offshore islands, low-lying coral reefs, sandy or rocky coastal islets, coastal spits, lagoon mudflats, and artificial islets in saltpans and sewage works, within three kilometres of the coast.	Present	Possible, flyover	Low	Species identified by Driscoll	3
<i>Threskiornis molucca</i>	Australian ibis		C		Y	Habitat for this species consists of wetlands and pastures of both freshwater and tidal influence. Mangrove habitats are also frequented and the Australian white ibis has been expanding its range into expanding agricultural areas over the past decades.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by GHD	3
<i>Todiramphus sanctus</i>	sacred kingfisher		C		Y	The sacred kingfisher is widely spread across the Australian continent, with the exception of the arid interior. Habitats occupied by this species include open forest areas, woodlands, scrublands and mangroves and riparian vegetation. Nesting for this species is reliant on the availability of hollows in trees and termite mounds with occasional burrows excavated in river banks and fence posts.	Present	Unlikely	Low	Species identified using habitat near the mouth of the Ross River by GHD	3
<i>Tringa brevipes</i>	grey-tailed tattler		SL	Y	Y	The grey-tailed tattler is often found on sheltered coasts with reefs and rock platforms or with inter-tidal mudflats. It can also be found at inter-tidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide. It has been found around shores of rock, shingle, gravel or shells and also on inter-tidal mudflats in embayments, estuaries and coastal lagoons, especially fringed with mangroves.	Present	Present	Low	Species identified by Driscoll Port area	3

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
<i>Tringa glareola</i>	wood sandpiper		SL	Y	Y	The wood sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, and often with fallen timber. They are also found at some small wetlands only when they are drying.	Possible	Unlikely	Low	Suitable habitat in the broader area	1, 2
<i>Tringa nebularia</i>	common greenshank		SL	Y	Y	The common greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms.	Present	Present	Low	Species identified by Driscoll. Port and Ross River sandspit	3
<i>Tringa stagnatilis</i>	marsh sandpiper		SL	Y	Y	Coastal and inland salt or freshwater wetlands: estuaries, mudflats, mangroves, beaches, swamps, lakes, dams, billabongs, and temporary floodwaters.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2
<i>Xenus cinereus</i>	terek sandpiper		SL	Y	Y	Coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near mangroves, but also rocky pools and reefs. Roosts communally, often with related wader species.	Present	Present	Low	Species identified using habitat near the mouth of the Ross River by Maunsell and Driscoll	1, 2

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
Mammals											
<i>Dasyurus hallucatus</i>	northern quoll	E				Most abundant in rocky eucalypt woodlands but occurs in a variety of habitats. The most successful breeding occurs near creek lines, and dens are usually in hollow tree trunks. The northern quoll has declined significantly across most of its range in recent years. The northern quoll is a solitary carnivorous marsupial that makes its dens in rock crevices, tree holes or occasionally termite mounds, and is predominantly nocturnal.	Possible	Highly unlikely	Low	Rediscovered on Magnetic Island by Turner and Batianoff	1
<i>Phascolarctos cinereus</i>	koala	V				They live in a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypt species.	Possible	Unlikely	Low	No suitable habitat in the area	6
<i>Hipposideros semoni</i>	semon's leaf-nosed bat	E	E			Inhabits caves, mines and buildings, tree hollows and forages a wide range of habitats including rainforest and savannah woodland.	Possible	Unlikely	Low	Suitable habitat in the broader area	1
<i>Saccolaimus saccolaimus nudicluniatus</i>	bare-rumped sheath-tail Bat	CE	E			The Bare-rumped Sheath-tail Bat occurs mostly in lowland areas, typically in a range of woodland, forest and open environment.	Possible	Unlikely	Low	No suitable habitat in the broader area	6
<i>Pteropus conspicillatus</i>	spectacled flying fox	V				The spectacled flying fox occurs in north-east Queensland, north of Cardwell and is restricted to tropical rainforest areas.	Unlikely	Unlikely	Low	No suitable habitat in the broader area. Species range north of Cardwell	1
<i>Rhinolophus philippinensis (large form)</i>	greater large-eared horseshoe bat	E	E			The greater large-eared horseshoe bat is found in lowland rainforest, along gallery forest-lined creeks in open eucalypt forest, <i>Melaleuca</i> forest with rainforest understorey, open savannah woodland and tall riparian woodland of <i>Melaleuca</i> , forest red gum (<i>E. tereticornis</i>) and Moreton Bay ash (<i>E. tessellaris</i>) Daytime roosting habitat for the greater large-eared horseshoe bat includes caves and underground mines located in rainforest, and open eucalypt forest and woodland. Roosts have also been observed in	Possible	Unlikely	Low	Suitable habitat in the broader area	1

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
						road culverts, and it is suspected that the species uses basal hollows of large trees, dense vegetation, rockpiles and areas beneath creekbanks.					
<i>Taphozous australis</i>	coastal sheath-tail bat		V			This species is believed to be unevenly distributed throughout its range, due to its reliance on coastal roosts. The coastal sheath-tail bat forages within approximately one kilometre of the ocean, including sand dune scrub, mangroves, <i>Melaleuca</i> swamps, coastal heathlands, open eucalypt forest, and grasslands.	Present	Possible, flyover	Low	Species identified using habitat near the mouth of the Ross River by GHD and recorded on Magnetic Island by Turner and Batianoff	3
<i>Xeromys myoides</i>	water mouse, false water rat	V	V			The species occupies coastal mangrove and saltmarsh habitats. The water mouse lives in mangrove communities, adjacent freshwater lagoons, swamps and sedged lakes close to coastal foredunes. In central Queensland, the species has only been captured in fringing mangroves in the high inter-tidal zone dominated by <i>Ceriops tagal</i> and/or <i>Bruguiera</i> spp. despite extensive searching in other mangrove habitats.	Possible	Highly unlikely	Low	Suitable habitat in the broader area	1
Reptiles											
<i>Acanthopis antarcticus</i>	common death adder		NT			This species is found in a wide variety of well-drained habitats, including rainforests and wet sclerophyll forests, woodland, shrublands, grasslands and coastal heathlands, preferring sites with deep fixed leaf litter. The importance of these habitats to this species is not known.	Present	Highly unlikely	Low	Mapped Essential habitat on Magnetic Island and by MICDA and MINCA	4
<i>Crocodylus porosus</i>	saltwater crocodile, estuarine		V	Y	Y	Saltwater crocodiles inhabit coastal rivers and swamps extending well inland via major rivers and billabongs. They are a tropical species, extending south to Rockhampton.	Possible	Likely	Low	Suitable habitat in the broader area	2

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
<i>Delma labialis</i>	striped-tailed delma	V	V C			A terrestrial to fossorial species found in dry open woodland and tall wet forest.	Present	Highly unlikely	Low	Mapped Essential habitat on Magnetic Island and identified by Turner and Batianoff	1, 4
<i>Denisonia maculata</i>	ornamental snake	V	V			<i>The Ornamental Snake's preferred habitat is within, or close to, habitat that is favoured by its prey - frogs. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland Regional Ecosystem Land Zone 4.</i>	Possible	Highly unlikely	Low	No suitable habitat	6
<i>Egernia rugosa</i>	yakka skink	V	V			Yakka skinks occur in a wide variety of habitats including poplar box, alluvial soils, low ridges, cypress on sands, belah, mulga and eucalypt woodland, log piles and rabbit warrens. They are considered to be a habitat generalist. Usually found in open dry sclerophyll forest or woodland. Skinks often take refuge among dense ground vegetation, hollow logs, cavities in soil-bound root systems of fallen trees and beneath rocks. The species is restricted to dry woodlands and outcrops of Queensland's eastern interior.	Possible	Highly unlikely	Low	Suitable habitat in the broader area	1
<i>Lampropholis mirabilis</i>	saxicoline sunskink		NT			Inhabits rocky areas in thickets of hoop pine and pockets of rainforest.	Present	Highly unlikely	Low	Mapped Essential habitat on Magnetic Island	1, 4

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
<i>Menetia sadleri</i>	sadliers-dwarf skink		✓			The Sadlier's skink is endemic to Queensland and is known only from Magnetic Island, off Townsville. The species may occur on parts of the nearby mainland, but no targeted surveys have been conducted to clarify this. Basic habitat requirements are poorly understood. Most surveyed species have been from the low-lying areas on Magnetic Island. In the lowland areas, Sadlier's skinks appear to prefer seasonally dry <i>Melaleuca</i> swamps and areas with thick leaf litter. It is not known whether the skink occurs on the granite boulder hills that dominate the island.	Possible	Highly unlikely	Low	Identified by Turner and Batianoff	4
Plants											
<i>Acacia jacksoniana</i>			NT			Grows in brown loam, over Argentine schist, in open eucalypt woodland.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Bonamia dietrichiana</i>			NT			This species occurs in vine thicket vegetation.	Present	Highly unlikely	Low	Mapped Essential habitat on Magnetic Island and by MICDA and MINCA	4
<i>Cassia</i> sp. (<i>Paluma Range</i> <i>G. Sankowsky + 450</i>)	golden shower		NT			Grows in monsoon forest, vine forest, rain forest, open forest and woodlands.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Corchorus hygrophilus</i>			✓			Occurs on vine forest margins or in sclerophyll forest adjacent to vine forest. It grows among boulders and on soils derived from granite or limestone.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Croton magneticus</i>		✓	✓			This species grows in deciduous vine thickets on soils derived from sandstone, granite or acid agglomerate substrates.	Present	Highly unlikely	Low	Mapped essential habitat on Magnetic Island and by MICDA and MINCA	4

Species Name	Common Name ¹	EPBC Act Status ²	NC Act Status ²	Migratory ³	Marine ³	Preferred Habitat	Likelihood of Occurrence in Region	Likelihood to Occur in Project Area	Sensitivity to Project	Comments ⁴	Sources ⁵
<i>Grewia graniticola</i>			NT			A shrub, recorded in woodlands on hill slopes or coastal dunes, in sandy or skeletal soil.	Present	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	2, 4
<i>Hydrocharis dubia</i>	frogbit	✓	✓			Floating in deep water or rooted in shallow pools, lakes and slow moving streams.	Possible	Highly unlikely	Low	Suitable habitat in the broader area	4
<i>Leucopogon cuspidatus</i>		✓				Mountain tops on poor skeletal soils, amongst granite or serpentinite outcrops.	Possible	Highly unlikely	Low	Suitable habitat in the broader area	4
<i>Marsdenia brevifolia</i>	scrubby bush pear	V	V			Most plants restricted to the hills of Magnetic Island.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Peripleura scabra</i>			NT C			Limited habitat information available for this species.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Solanum sporadotrichum</i>			NT C			The species is now better known and its range is extended north to west of Townsville and it has been recorded from vine thicket, rainforest margins and <i>Argyrodendron</i> -dominated rainforest.	Possible	Highly unlikely	Low	Species identified using habitat on Magnetic Island by MICDA and MINCA	4
<i>Taeniophyllum muelleri</i>	minute orchid, ribbon-root orchid	✓				Epiphytic vine on the branches of rainforest trees in coastal areas. <i>Taeniophyllum muelleri</i> is a rainforest species, epiphytic on the trunks, branches and branchlets of trees.	Possible	Highly unlikely	Low	Suitable habitat in the broader area	1

1 Common and scientific names for birds follow Christidis and Boles (2008); other names follow EPBC Act lists of threatened species (DSEWPC, 2012).

2 CE - Critically Endangered; E - Endangered; V - Vulnerable; NT - Near Threatened; C - Common; SLC - Special Least Concerned;

3 Y - Yes

4 References: (Driscoll V. , 2009), (GHD, 2009), (Maunsell AECOM, 2008), (MICDA & MINCA, 2004), (Turner & Batianoff, ?, 2007), (Turner & Batianoff, 2007)

5 1 - EPBC Protected Matters Search; 2 - Wildlife Online Search; 3 - Previous Surveys; 4 - Other literature

6 EPBC Protected Matters Search; January 2016

7 Wildlife Online Search January 2016



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.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 28/01/16 12:59:33

[Summary](#)

[Details](#)

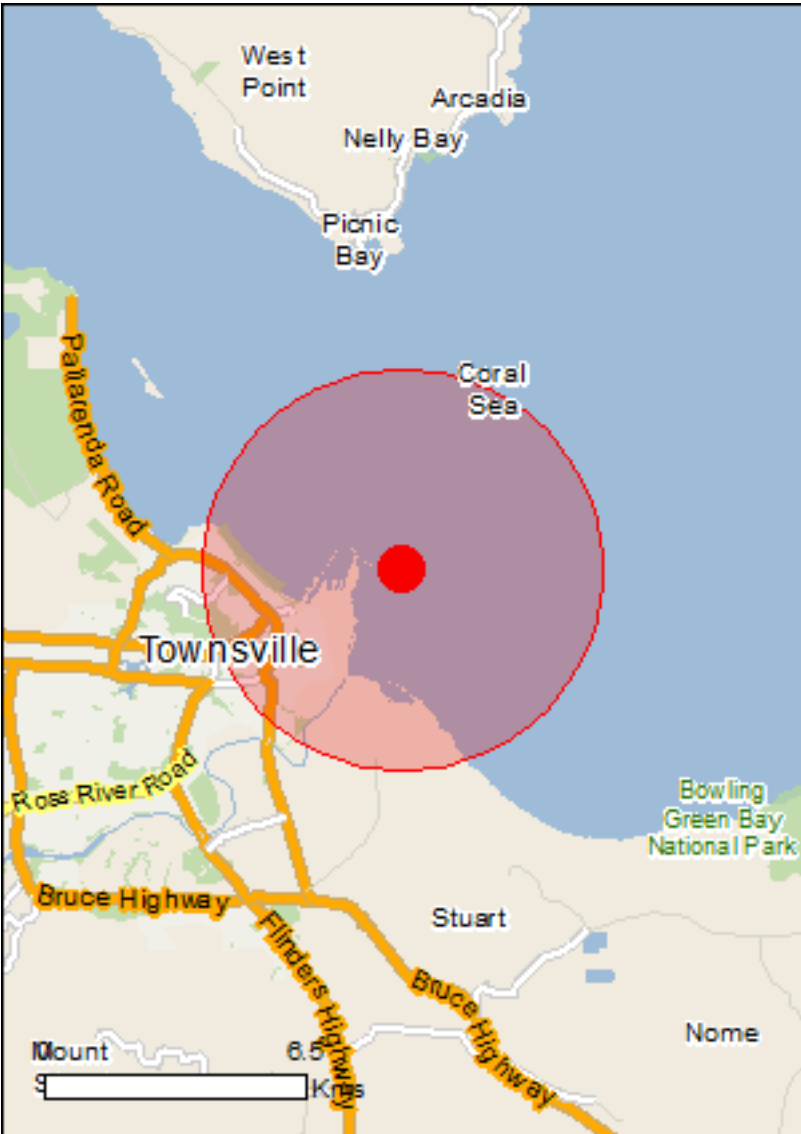
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

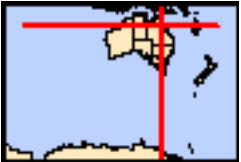
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[Coordinates](#)

Buffer: 5.0Km



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](#).

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	2
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	30
Listed Migratory Species:	63

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. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

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.

Commonwealth Land:	4
Commonwealth Heritage Places:	None
Listed Marine Species:	105
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	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:	None
Regional Forest Agreements:	None
Invasive Species:	35
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties		[Resource Information]
Name	State	Status
Great Barrier Reef	QLD	Declared property
National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Great Barrier Reef	QLD	Listed place
Wetlands of International Importance (Ramsar)		[Resource Information]
Name		Proximity
Bowling green bay		Within 10km of Ramsar
Great Barrier Reef Marine Park		[Resource Information]
Type	Zone	IUCN
Conservation Park	CP-19-4059	IV
General Use	GU-16-6004	VI
Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew [847]	Critically Endangered	Roosting known to occur within area
Poephila cincta cincta Black-throated Finch (southern) [64447]	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Hipposideros semoni Semon's Leaf-nosed Bat, Greater Wart-nosed Horseshoe-bat [180]	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat may occur within area
Pteropus conspicillatus Spectacled Flying-fox [185]	Vulnerable	Species or species habitat likely to occur within area
Rhinolophus robertsi Large-eared Horseshoe Bat, Greater Large-eared Horseshoe Bat [87639]	Endangered	Species or species habitat may occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheathtail Bat [66889]	Critically Endangered	Species or species habitat likely to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Plants		
Marsdenia brevifolia [64585]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis pristis Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Breeding likely to occur

Name	Status	Type of Presence
[68442] Rhincodon typus Whale Shark [66680]	Vulnerable	within area Species or species habitat may occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur

Name	Threatened	Type of Presence
Orcaella brevirostris Irrawaddy Dolphin [45]		within area Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding likely to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Foraging, feeding or related behaviour known to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]	Critically Endangered	Roosting known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]		Foraging, feeding or related behaviour known to occur within area
Calidris ferruginea Curlew Sandpiper [856]		Foraging, feeding or related behaviour known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]		Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]		Foraging, feeding or related behaviour known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]		Foraging, feeding or related behaviour known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Foraging, feeding or related behaviour known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting may occur within area
Gallinago megala Swinhoe's Snipe [864]	Critically Endangered	Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Foraging, feeding or related behaviour known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew [847]		Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Foraging, feeding or related behaviour known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Tringa glareola Wood Sandpiper [829]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land	[Resource Information]
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The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - Commonwealth Centre
Defence - JEZZINE BARRACKS - TOWNSVILLE
Defence - NORTH WARD TRAINING DEPOT - TOWNSVILLE
Defence - ROSS ISLAND BARRACKS

Listed Marine Species	[Resource Information]
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* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Foraging, feeding or related behaviour known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
		to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]		Foraging, feeding or related behaviour known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]		Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]		Foraging, feeding or related behaviour known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]		Foraging, feeding or related behaviour known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Foraging, feeding or related behaviour known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Foraging, feeding or related behaviour known to occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting may occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Foraging, feeding or related behaviour known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
Limosa lapponica Bar-tailed Godwit [844]		to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Roosting known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew [847]		Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Foraging, feeding or related behaviour known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]	Critically Endangered	Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Foraging, feeding or related behaviour known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Foraging, feeding or related behaviour known to occur within area
Rhipidura rufifrons Rufous Fantail [592]	Endangered*	Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]		Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Tringa glareola Wood Sandpiper [829]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish [66203]		Species or species habitat may occur within area
Corythoichthys paxtoni Paxton's Pipefish [66204]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus darrosanus D'Arros Pipefish [66207]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus bargibanti Pygmy Seahorse [66721]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus zebra Zebra Seahorse [66241]		Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area
Micrognathus brevisrostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Nannocampus pictus Painted Pipefish, Reef Pipefish [66263]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowellii null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species

Name	Threatened	Type of Presence
Laticauda colubrina a sea krait [1092]		habitat may occur within area Species or species habitat may occur within area
Laticauda laticaudata a sea krait [1093]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311] Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171] Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913] Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507] Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree,		Species or species

Name	Status	Type of Presence
Horse Bean [12301]		habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Lepidodactylus lugubris Mourning Gecko [1712]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands		[Resource Information]
Name		State
Burdekin - Townsville Coastal Aggregation		QLD
Great Barrier Reef Marine Park		QLD

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 and National Heritage properties, Wetlands of International and National 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 following provisions of the EPBC Act have been mapped:

- migratory and
- marine

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.

Coordinates

-19.24831 146.84754

Acknowledgements

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

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Parks and Wildlife Commission NT, Northern Territory Government](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-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](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

Search Criteria Species List for a Defined Area

Species: All
 Type: All
 Status: All
 Record: All
 Date: All
 Latitude: 19.2158 to 19.2746
 Longitude: 146.8107 to 146.8776
 Email: kristina.ihme@aecom.com
 Date sent: Thursday 28 Jan 2016 11:56:04
 Date received: Thursday 28 Jan 2016 12:00:06

The number of records retrieved = 388

Disclaimer

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

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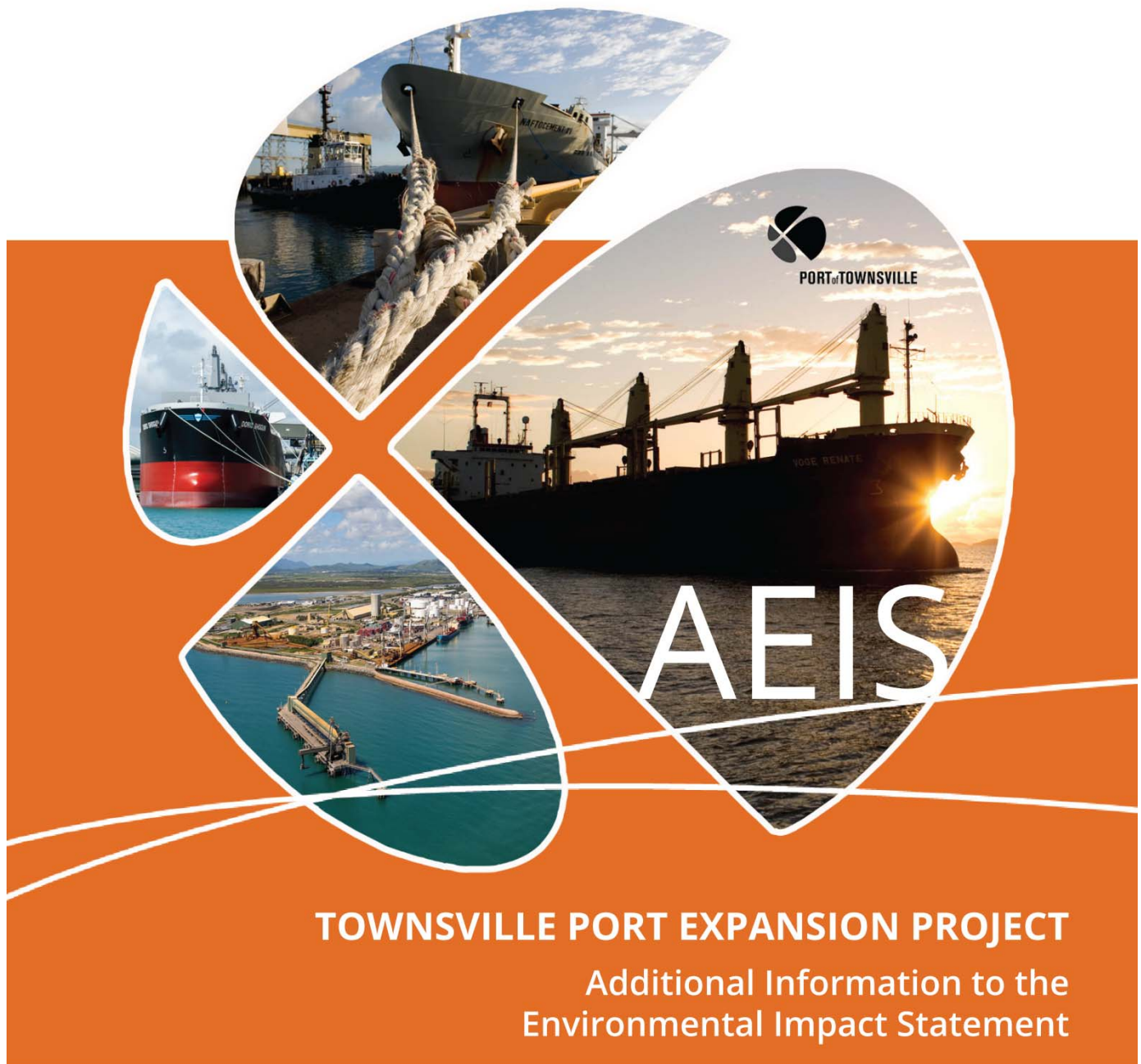
Description of the CODES

- I - Y indicates that the taxon is introduced to Queensland and has naturalised.
- Q - Indicates the Queensland conservation status of each taxon under the Nature Conservation Act 1992. The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ().
- A - Indicates the Australian conservation status of each taxon under the Environment Protection and Biodiversity Conservation Act 1999. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
 The second number located after the / indicates the number of specimen records for the taxon.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Sighting	Specimen Records
animals	birds	Accipitridae	Pandion cristatus	eastern osprey		SL		10	0
animals	birds	Ardeidae	Ardea alba modesta	eastern great egret		SL		23	0 needs to be added to table 1
animals	birds	Ardeidae	Ardea ibis	cattle egret		SL		1	0
animals	birds	Burhinidae	Esacus magirostris	beach stone-curlew		V		12	0
animals	birds	Charadriidae	Charadrius leschenaultii	greater sand plover		SL		6	0
animals	birds	Charadriidae	Pluvialis squatarola	grey plover		SL		4	0
animals	birds	Charadriidae	Charadrius mongolus	lesser sand plover		SL		12	0
animals	birds	Charadriidae	Pluvialis fulva	Pacific golden plover		SL		14	0

animals	birds	Fregatidae	Fregata ariel	lesser frigatebird	SL		1	0
animals	birds	Hirundinidae	Hirundo rustica	barn swallow	SL		1	0
animals	birds	Laridae	Anous stolidus	common noddy	SL		1	0
animals	birds	Laridae	Sterna hirundo	common tern	SL		2	0
animals	birds	Laridae	Sterna sumatrana	black-naped tern	SL		2	0
animals	birds	Laridae	Hydroprogne caspia	Caspian tern	SL		23	0
animals	birds	Laridae	Gelochelidon nilotica	gull-billed tern	SL		22	0
animals	birds	Laridae	Chlidonias leucopterus	white-winged black tern	SL		1	0
animals	birds	Laridae	Onychoprion anaethetus	bridled tern	SL		1	0
animals	birds	Laridae	Sternula albifrons	little tern	SL		8	0
animals	birds	Meropidae	Merops ornatus	rainbow bee-eater	SL		13	0
animals	birds	Procellariidae	Ardenna tenuirostris	short-tailed shearwater	SL		4	3
animals	birds	Procellariidae	Ardenna pacifica	wedge-tailed shearwater	SL		1	0
animals	birds	Rhipiduridae	Rhipidura rufifrons	rufous fantail	SL		1	0
animals	birds	Scolopacidae	Calidris tenuirostris	great knot	SL		20	0
animals	birds	Scolopacidae	Numenius madagascariensis	eastern curlew	V	CE	32	0
animals	birds	Scolopacidae	Gallinago hardwickii	Latham's snipe	SL		5	0
animals	birds	Scolopacidae	Calidris ruficollis	red-necked stint	SL		16	0
animals	birds	Scolopacidae	Calidris ferruginea	curlew sandpiper	SL	CE	7	0
animals	birds	Scolopacidae	Tringa stagnatilis	marsh sandpiper	SL		6	0
animals	birds	Scolopacidae	Philomachus pugnax	ruff	SL		2	0
animals	birds	Scolopacidae	Calidris acuminata	sharp-tailed sandpiper	SL		14	0
animals	birds	Scolopacidae	Limicola falcinellus	broad-billed sandpiper	SL		1	0
animals	birds	Scolopacidae	Calidris alba	sanderling	SL		4	0
animals	birds	Scolopacidae	Limosa limosa	black-tailed godwit	SL		7	0
animals	birds	Scolopacidae	Xenus cinereus	terek sandpiper	SL		7	0
animals	birds	Scolopacidae	Tringa brevipes	grey-tailed tattler	SL		13	0
animals	birds	Scolopacidae	Tringa glareola	wood sandpiper	SL		1	0
animals	birds	Scolopacidae	Calidris canutus	red knot	SL		4	0
animals	birds	Scolopacidae	Limosa lapponica	bar-tailed godwit	SL		23	0
animals	birds	Scolopacidae	Numenius minutus	little curlew	SL		1	0
animals	birds	Scolopacidae	Tringa nebularia	common greenshank	SL		16	0
animals	birds	Scolopacidae	Numenius phaeopus	whimbrel	SL		23	0
animals	birds	Scolopacidae	Actitis hypoleucos	common sandpiper	SL		3	0
animals	birds	Scolopacidae	Arenaria interpres	ruddy turnstone	SL		4	0
animals	birds	Sulidae	Sula dactylatra	masked booby	SL		1	0
animals	birds	Sulidae	Sula sula	red-footed booby	SL		1	0
animals	birds	Sulidae	Sula leucogaster	brown booby	SL		8	1
animals	birds	Threskiornithidae	Plegadis falcinellus	glossy ibis	SL		3	0



APPENDIX B1

Dredge Management Plan



1.0 Introduction

This Dredge Management Plan (DMP) outlines requirements related to dredging operations associated with the Port Expansion Project (PEP).

1.1 Purpose, Scope and Outcomes

Purpose

The purpose of this DMP is to identify the preferred means of addressing environmental aspects associated with dredging and associated management of dredge material placement via reclamation for the PEP, namely: widening of the Platypus and Sea Channels and dredging of Berth 12 (Stage 1); dredging of a new harbour basin seaward of the existing eastern breakwater, and reclamation to create Berths 14, 15 and 16 (Stage 2); deepening of the Platypus and Sea channels, construction of the eastern breakwater and remaining berths in the outer harbour (Stage 3).

In general, the DMP reflects and/or provides a greater level of detail to mitigation and monitoring commitments discussed in the preceding chapters of the PEP EIS and AEIS and sets out the framework for management, mitigation and monitoring of relevant impacts affiliated with dredging.

Scope

The scope of the DMP covers dredging-related works associated with the PEP as follows:

- Capital dredging activities by various plant
- Placement of dredged material in reclamation
- Management of dredge tailwater at the reclamation site; and
- General operation of dredge vessels upon commissioning, during the dredging campaigns and prior to decommissioning.

The DMP does not address the construction of maritime structures such as breakwaters, marine pile driving or other land-based aspects of the reclamation as these are covered in the Construction Environmental Management Plan from the EIS. It also does not apply to operational (maintenance) dredging which will be addressed as part of POTLs standard operational approvals and controls as required.

Objectives

The principal objectives of this DMP are as follows:

- To protect environmental values from long term adverse effects due to dredging-related water quality effects
- To reduce impacts to marine flora and fauna, and their habitats, during capital dredging and dredge material placement activities
- To adopt best practice management for the handling and storage of waste materials on board the dredger
- To manage the risk of translocation of organisms in ballast water by the dredger
- To reduce the risk of an environmental incident occurring such as an oil spill, vessel collision or similar to prevent damage to the surrounding marine environment and the public
- To reduce nuisance noise on surrounding sensitive receptors from the dredging; and
- To reduce the air emissions produced during dredging operations and thereby reduce potential effects on the natural airshed.

1.2 Relationship with Future Approvals

The DMP is a framework document to guide future activities and decision-making associated with the PEP. The DMP contains procedures, guidance and commitments to monitoring and other environmental management measures that will be required to be carried through into more detailed approvals (such as tidal works approvals under the *Sustainable Planning Act 2009*) and by the future dredge contractor for the works as part of the contractor's Management Plans.

It is recognised that compliance with the requirements of this DMP does not remove general obligations and responsibilities under relevant legislation or for approvals or permits that will need to be obtained in the future in order to carry out the development.

1.3 Environmental Legislation

The DMP has been developed in accordance with, and taking into account legislative requirements set out in Acts and Regulations at Commonwealth and State level that are listed below. The DMP has been developed to include

measures that POTL believes are necessary for protection of sensitive environmental receptors, however will need to incorporate any additional actions / controls as required by approvals and/or permits that are issued under the EIS or the state assessment process.

Commonwealth legislation considered in development of this DMP (including Acts implementing relevant international conventions) includes:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*
- *Great Barrier Reef Marine Park Act 1975; and*
- *Great Barrier Reef Marine Park Zoning Plan 2003 and associated regulations.*

The following State legislation is relevant to the dredging:

- *State Development and Public Works Organisation Act 1971*
- *Coastal Protection and Management Act 1995 and Coastal Management Pla;*
- *Environmental Protection Act 1994 and Environmental Protection Policies and Regulations*
- *Fisheries Act 1994 and Regulations*
- *Marine Parks Act 2004 and Marine Parks (Great Barrier Reef Coast) Zoning Plan*
- *Transport Operations (Marine Safety) Act 1994 and Regulations*
- *Transport Infrastructure Act 1994*
- *Transport Operations (Marine Pollution) Act 1995 and Regulations*
- *Land Act 1994*
- *Nature Conservation Act 1992 and Conservation Plans*
- *Sustainable Planning Act 2009 and Regulations; and*
- *Sustainable Ports Development Act 2015.*

In particular, the requirements of the Queensland State Development Assessment Provisions (SDAP), Module 10 (Coastal Protection) as it relates to dredging and material placement have been accounted for in developing this DMP.

2.0 Dredging Design and Plan of Operations

The revised PEP design consists of three stages (1-3) which are described in greater detail below. The design and construction methodology represents the most likely approach to undertaking the works including identification of the most suitable plant and equipment for the work however will need to be revisited prior to each of the three stages.

Stage 1

Stage 1 will be undertaken over a 4.5 year period and consists of the following:

- Construction of temporary perimeter revetment structures to capture any soft sediments and subsequent construction of revetment structures including removal of soft sediments (0.3 million m³) under retaining wall structures along the perimeter of the proposed interim reclamation area. This will be carried out by a mechanical dredger and relocated to temporary bund area.
- Widening the Platypus Channel on its western side (a new width of 180 m at the outer harbour, tapering to 135 m at its northern end), and widening the Sea Channel on its eastern side (for 135 m at the southern end to 120 m at its northern end). The soft marine sediments and dense clayey sands will be dredged by TSHD (dredge volume of 1.5 million m³). The stiff, very stiff and hard clays will be dredged by a mechanical dredger (dredge volume of 2.4 million m³).
- The dredging of Berth 12 by mechanical dredger (dredge volume of 1.4 million m³).
- Total dredge volume of approximately 5.6 million m³.
- All dredge material to be placed in the reclamation.
- Duration of dredging for Stage 1 estimated as follows:
 - Construction of temporary revetment structures including placement of soft material – 12 months
 - Channel widening by TSHD – 4 months

- Channel widening by mechanical dredger – 2.3 years
- Berth 12 – 15 months
- Total duration of Stage 1 ~ 4.5 years.

For the purposes of the AEIS, it was assumed that a small TSHD (hopper capacity of approximately ~ 3,000 m³) would complete the TSHD dredging.

Stage 2

Stage 2 involves dredging Berths 14, 15 and 16 in the outer harbour (3.6 million m³), as well as soft sediments under the footprint of the final reclamation bunds and breakwater (0.2 million m³). The total dredge volume is expected to be 3.8 million m³ and be undertaken over a duration of 4.5 years by a mechanical dredger as follows:

- Reclamation works – 12 months
- Berths 14, 15 and 16 ~ 3.5 years
- Total ~ 4.5 years.

Stage 3

Stage 3 dredging will be undertaken over a 2.5 year period and consists of the following:

- Deepening of the Platypus Channel and the Sea Channel to a Navigation Design Depth of -12.8m LAT. The total dredge volume is expected to be 2.0 million m³, with the soft marine sediments and dense clayey sands will be dredged by TSHD (dredge volume of 0.7 million m³), and the stiff, very stiff and hard clays will be dredged by a mechanical dredger (dredge volume of 1.3 million m³).
- The dredging of the berth pockets for Berths 17 and 18 by a mechanical dredger (0.08 million m³).
- Duration of dredging is:
 - Channel deepening by TSHD – 8 weeks
 - Channel deepening by mechanical dredger – 2.2 years
 - Berths 17 and 18 – 5 weeks
 - Total ~ 2.5 years.

3.0 Mitigation Strategies for Water Quality and Benthic Ecology

3.1 Introduction

Dredging activities associated with the PEP have the potential to impact on benthic communities such as corals and seagrass in the marine environment of Cleveland Bay. The widening (in Stage 1) and deepening (in Stage 3) of the Platypus and Sea Channels undertaken by a TSHD is considered to have the greatest potential for environmental impacts due to the proximity to sensitive environments and extent of suspended sediments generated by the dredge. As such, this activity is the main focus of this DMP, however controls are included for all dredge plant where relevant.

The key threatening processes to water quality and benthic ecology identified in the AEIS that are relevant for developing further mitigation measures include:

- Periodic light extinguishment of benthic communities above background conditions along Magnetic Island; and
- Sedimentation in benthic communities along Magnetic Island.

The AIES has concluded that the Port Expansion Project (unmitigated scenario) is not likely to cause any significant impacts to water quality, benthic ecological receptors and marine megafauna in Cleveland Bay, which are key components of the Outstanding Universal Values (OUV) of the Great Barrier Reef World Heritage Area. Nevertheless, predicted impacts are able to be further reduced through the implementation of mitigation strategies (discussed below).

This section of the DMP outlines the key mitigation strategies that will be implemented during dredging. Further, specific environmental management strategies are outlined in Sections 10.0 to 20.0 of this DMP.

3.2 Mitigation Measures – Dredging and Placement

A range of mitigation measures will be committed to and required to be undertaken by the dredge contractor from the outset of the Project. These commitments are outlined in the relevant chapters of the AEIS and are summarised as follows:

- No dredging (all plant) is to be undertaken outside of approved dredge footprint.

- Hopper compartments / barges (all plant) are maintained water tight at all times.
- The top of overflow valves on TSHD are not lowered during the transport component of the dredging cycle (dredging area to reclamation) to reduce spillage/overflow during transport (within the safety constraints of the vessel).
- The TSHD is fitted with a 'green valve' in order to reduce the spatial extent of turbidity plumes generated by dredge operation. The green valve ensures that overflow from the TSHD during dredging is released under the keel of the vessel rather than the surface (TSHD).
- Marine turtle deflectors will be mounted on the draghead of the TSHD.
- Any washdown of the hopper/barge compartment (all plant) must be appropriately contained and managed.
- Undertake capital dredging with the TSHD of the channel (during Stage 1 and Stage 3) during the most appropriate time to avoid coral spawning, seagrass recruitment, turtle breeding and extreme weather events.
- Develop and implement a Reactive Monitoring Program (RMP) with appropriate triggers and corrective actions (this program is outlined below).

The environmental windows for dredging and the reactive monitoring program are discussed in greater detail in Section 8.0.

4.0 Governance and Implementation

4.1 Governance Structure

Further refinement of the governance structure for implementation of mitigation commitments has occurred since the EIS DMP and is outlined below.

As shown in Figure 4.1, three main bodies will be created to oversee the RMP and other mitigation commitments:

- (i) a regulatory 'Oversight Committee' made up of the key approving agencies for the PEP that would review and approve subsequent plans and strategies as well as oversee compliance with the RMP during dredging.
- (ii) the 'Technical Advisory Committee' of both government and non-government scientific experts to review and advise on the technical aspects of the RMP including the location of control and impact sites, ecological thresholds, monitoring design and triggers for corrective action as well as oversight of the RMP during operation.
- (iii) a 'Dredging Implementation Committee' made up of the proponent, its dredging consultant/contractor and the Regional Harbour Master which would oversee the dredge campaign and interact where necessary with the other committees with respect to operational and logistical issues.

It would be envisaged that these bodies are funded, organised and provided secretariat services by POTL through its PEP Environment Supervisor (see below).

Implementation Strategy and Governance

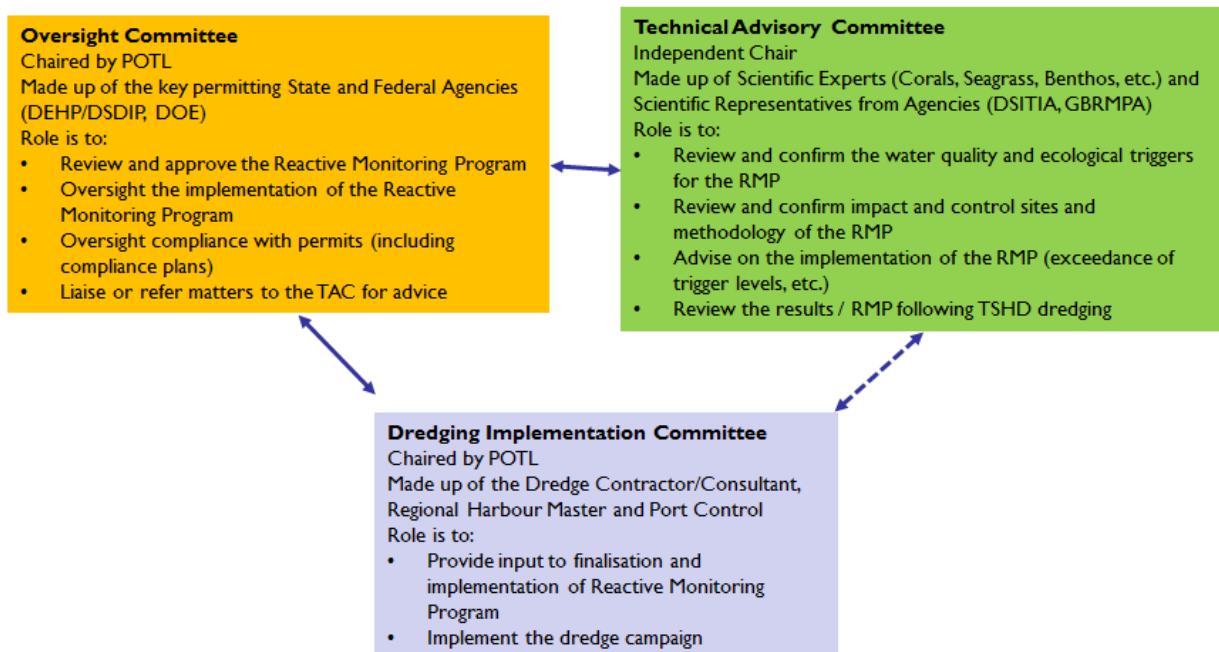


Figure 4.1 Governance Arrangements

4.2 Technical Advisory Committee

A Technical Advisory Committee will be appointed by and funded by the port and would likely include representation from the following:

- POTL Chair
- Recognised specialists with expertise on seagrass, turtles, coral health, water quality, monitoring and statistics, and
- Regulatory bodies that would be able to have scientific input such as the Queensland Department of Science, Information Technology, Innovation (DSITI).

The function of the Technical Advisory Committee will be to provide advice to POTL in relation to the following:

- 1) Oversee the development of trigger values with consideration of condition and tolerances of coral and seagrasses
- 2) Endorse the control and impact site location plan and dredge mitigation strategy prior to commencement of works; and
- 3) Review environmental performance of the dredging against criteria and triggers and evaluate corrective actions implemented.

The Interim RMP design, monitoring locations and trigger values will need to be approved by the Technical Advisory Committee prior to commencement of dredging.

4.3 Environmental Supervisor

The implementation of the mitigation commitments will be overseen by an Environmental Supervisor for the PEP appointed by POTL.

The Environmental Supervisor's role will be to:

- Oversee the dredging contract on behalf of POTL
- Oversee the development and implementation of the RMP and other mitigation commitments
- Provide secretariat and support services to the Oversight Committee, Technical Advisory Committee, and Dredging Implementation Committee

- Liaise with Regulatory Agencies prior to, during and following the dredge campaigns including recording and responding to any complaints
- Prepare and review internal and external compliance reports (to be confirmed as part of future conditions and management arrangements) which are likely to include the following:
 - Compile and maintain a data register for monitoring data (updated weekly and archived for a minimum period of 10-15 years)
 - Prepare and submit a validation of modelling report based on validation monitoring (see below)
 - Provide reports (likely weekly) to regulatory agencies of dredge campaign progress and environmental performance against the RMP including recorded exceedances of trigger values and corrective actions implemented
- Undertake reviews of the dredge contractor's compliance with the DMP
- Prepare specific incident reports with respect to environmental or other major incidents and/or the implementation of corrective actions to POTL and external agencies where relevant.

5.0 Condition of Benthic Communities Prior to Dredging

The impact predictions in the AEIS should be considered in the context of the condition of sensitive ecological receptors (e.g. seagrass and corals) prior to dredging. If their condition is poor and resilience is low (e.g. due to a major coral bleaching event), the impacts may be greater than predicted.

To address this, the condition of seagrass and corals in areas that may be affected by dredging are to be assessed prior to commencement of dredging. If their condition is poor, then the trigger values as discussed in Section 8.2.4 may need to be revised (more conservative) in consultation with the Technical Advisory Committee.

6.0 Validation Monitoring

Separate to impact monitoring described above, specifically targeted monitoring will be undertaken to validate the dredge plume source assumptions that underpin the water quality impact assessments in the AEIS. This further 'validation' monitoring would be undertaken ahead of the commencement of each stage of capital dredging that was modelled as part of the PEP.

The methodologies associated with this monitoring component will be governed by the goal of obtaining additional data for the dredge plume model validation. It is likely to involve a combination of vessel-mounted ADCP (or similar) and in-situ water quality measurements and sampling for laboratory analysis, specifically targeted at characterising the dredge plume intensity and spatial dimensions on top of the ambient suspended sediment climate.

Outcomes of the monitoring will be spatial and temporal maps of the dredge plume during the validation exercise, quantification of the plume sediment characteristics and quantification of the range of plume generation source rates associated with the monitored dredging operations. These results will directly feed into water quality model simulations to validate the model configuration used in the AEIS and to suggest any improvements to model input parameters (i.e. dredge plume source rates).

7.0 Adaptive Management and New Technology

With a number of years between the major dredging campaigns of the channels with the TSHD, the initial channel widening to be undertaken in Stage 1 will also provide a blueprint for the deepening to be undertaken in Stage 3 of the dredge methodology.

Given this, it will be critical to ensure proper documentation of the achievement of performance criteria, monitoring data and behaviour of the plume, and dredging techniques such that the outputs and results of the initial dredging can inform future activities both in terms of capital dredging and maintenance dredging. In this context, a formal review of the RMP is recommended to be undertaken following completion of Stage 1 by the Technical Advisory Committee.

While care has been taken in preparing this RMP to recommend the best current approaches to monitoring and impact detection, new or improved technology or approaches may also be available by the time the campaigns are undertaken. A performance based approach is therefore the preferred approach as it allows flexibility to adopt new or improved technology as it becomes available and allows for the consideration of current conditions (as outlined in Section 5.0).

8.0 Mitigation Measures in Detail

8.1 Environmental Windows for Dredging

The preferred time to undertake capital dredging of the channels with the TSHD during Stage 1 and Stage 3 is in the autumn and winter months from April to September. The months of October through to the end of March are proposed to be avoided in terms of TSHD capital dredging of the channels.

This time period has been chosen on the basis of the following:

- (i) to minimise impacts to key coral spawning periods in the region and identified spawning periods for Magnetic Island corals after the full moon in October
- (ii) to limit impacts to seagrass during a potentially important period for growth; and
- (iii) to reduce impacts to corals that may have lower resilience in the summer months (due to the greater frequency of extreme weather events);

This proposed programming to avoid summer months also presents a beneficial avoidance of the marine turtle nesting season.

The adopted timing for TSHD dredging will further reduce potential impacts on sensitive receptors and is seen as a best practice management measure given the current low resilience of these receptors.

8.2 Reactive Monitoring Program

8.2.1 Program Aims and Design

The overall aim of the Reactive Monitoring Program (hereafter referred to as the RMP) will be to avoid or otherwise reduce impacts to sensitive marine environments that could be affected by TSHD dredging.

The RMP will have two interlinked components:

- A water quality dredge plume suspended sediment monitoring program; and
- A seagrass and coral monitoring program.

The RMP will only be undertaken during the TSHD dredging. Dredging by the mechanical dredger will be undertaken over a number of years and dredge plumes from this plant are expected to be negligible. Therefore routine water quality monitoring undertaken by POTL will be sufficient to monitor these activities.

The design of the program is similar to that undertaken in 1993 as part of the last major capital dredging campaign for the channels and will be overseen by an Technical Advisory Panel and employs a range of trigger levels for further investigation and instigation of corrective actions. The monitoring of the two components of the RMP would be done in parallel. The approach, methodology and equipment recommended for use is discussed below.

8.2.2 Sampling Locations and Monitoring

Indicative monitoring locations under the RMP are shown in Figure 8.1. These monitoring sites have been initially selected based on the location of sensitive ecological receptors, the location of previous data collection sites, and the outputs of water quality modelling with respect to areas of impact.

These locations will be reviewed by the Technical Advisory Committee (TAC), which was discussed previously in Section 4.2.

Water quality instruments capable of continuous logging of data for a range of parameters, eg. of turbidity, dissolved oxygen (DO), pH, salinity and conductivity and photosynthetically active radiation (PAR) are proposed to be deployed for the construction water quality monitoring as part of the RMP. Telemetry and other appropriate water quality monitoring equipment would also be installed to ensure dredging can be reactive in a timely manner and flag exceedances in real time. This data would be available to both the contractor and POTL Project Superintendent, with alerts via mobile text message or email of any exceedance under the RMP.

Ecological monitoring approaches under the RMP would be expected to consist of collecting data on the following indicators:

- Collection of data on additional physical-chemical parameters such as light (PAR), temperature and salinity
- Coral cover and health parameters (to be determined by the Technical Advisory Committee); and
- Seagrass cover and health parameters (to be determined by the Technical Advisory Committee).

Baseline monitoring would occur at regular intervals (frequency to be determined by Technical Advisory Committee) throughout the dredge campaign (to measure chronic or long term trends), supported by rapid deployments in response to water quality impacts to investigate potential acute impacts.

In this context, key constraints/issues to be considered in further developing the ecological component of the program would need to be able to:

- Cover off a large number of potential impact sites
- Allow rapid deployment of field staff and turnaround of results
- Be measurable in poor visibility
- Detect acute and chronic (stress) effects; and
- Take into account differences in communities in and among sites.

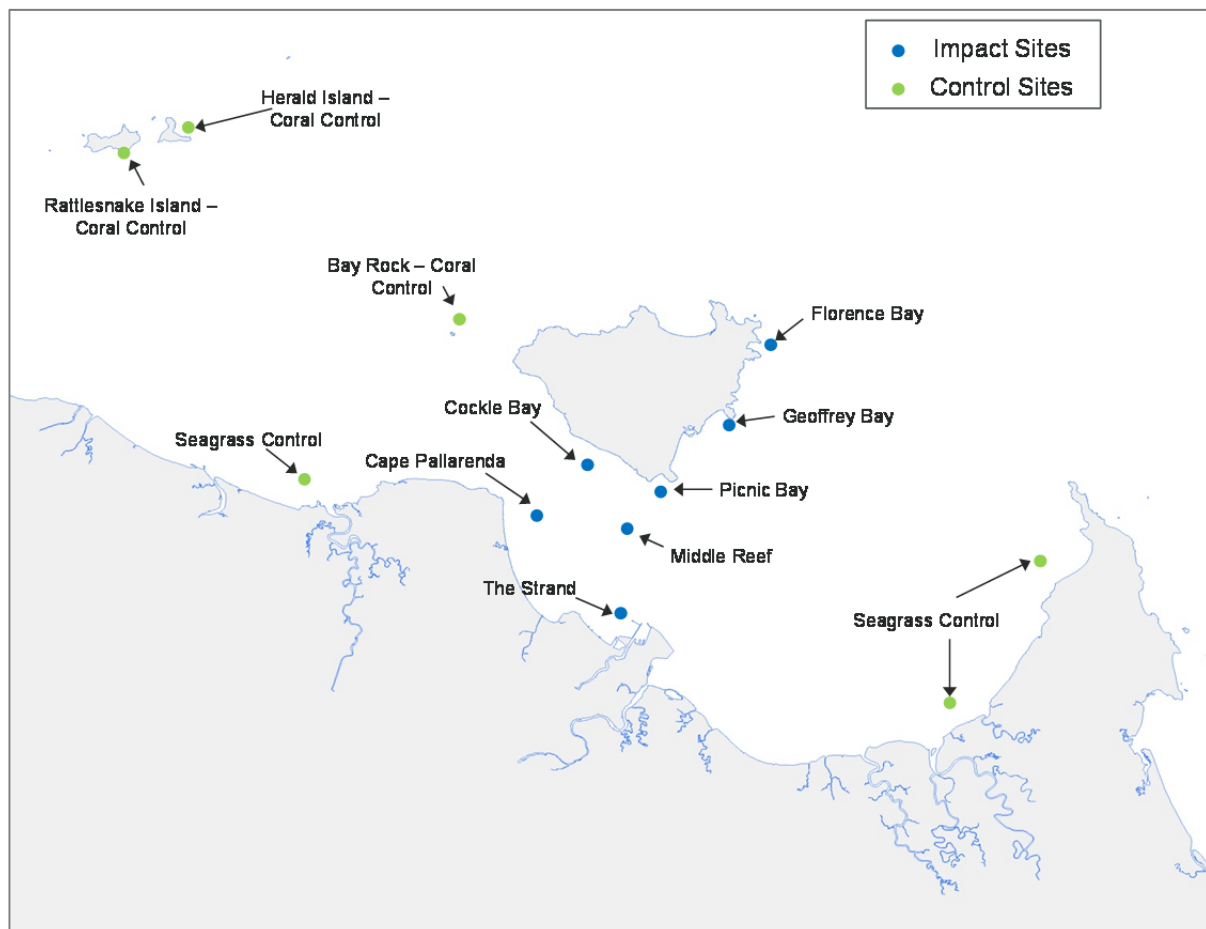


Figure 8.1 RMP Possible Impact and Control Sites

8.2.3 How the RMP will work

A schematic of the RMP is shown in Figure 8.2.

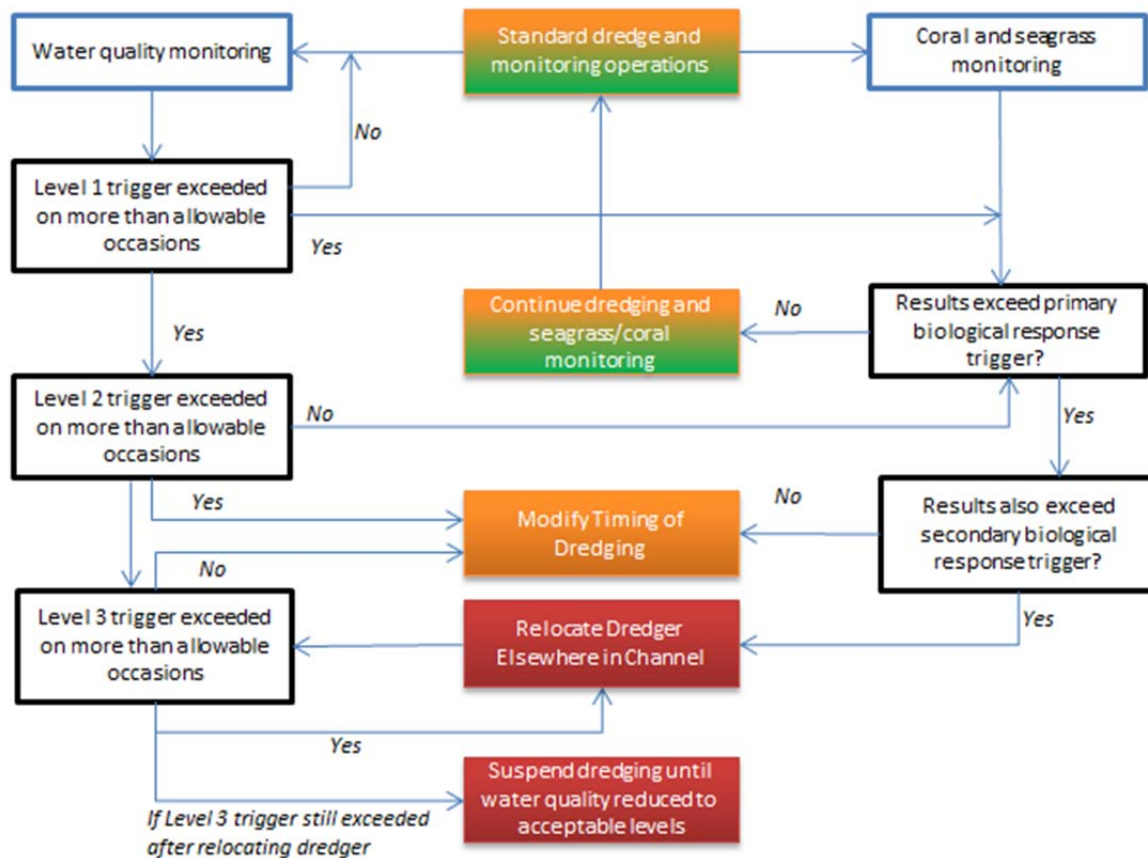


Figure 8.2 Framework for RMP Trigger Levels

As shown in Figure 8.2, the RMP will have three trigger levels which are described as follows:

- **Level 1 Investigation Level (Green)** – This trigger level provides for an initial water quality assessment through comparison of monitoring data to derived triggers values and background conditions. Water quality measured at putative ‘impact’ locations (as shown in Figure 8.1) would be compared against ‘control’ locations to determine if increased turbidity levels are attributable to dredging or are shown to be within natural ranges for the ambient conditions. If it is determined as part of this investigation phase that the water quality is attributable to the dredging, there is a requirement to examine coral and seagrass monitoring data to determine if the detected water quality impacts are resulting in a biological response in sensitive receptors (seagrass and corals). The dredge would continue to operate during this period of investigation up until a level 2 trigger is reached.
- **Level 2 Management Response Level (Orange)** – Exceedance of a level 2 trigger levels means that the dredger will likely need to review its operations and/or take corrective actions to either control a water quality impact. There are several practical mitigation measures and corrective actions that can be employed by the dredger to reduce impacts. Water quality and biological triggers as part of level 2 will be set on the basis of known stress tolerances of coral and seagrass. Where possible, the design of the RMP will be to ensure that these trigger levels are set such as to ensure they are triggered prior to unacceptable impacts occurring.
- **Level 3 Compliance Level (Red)** – Exceedance of this trigger level would require immediate action by the dredger to suspend dredging or otherwise implement other mitigation measures such as moving the dredge away from the habitat where the exceedance occurs. Dredging would not be able to resume in this area until monitored water quality reduced back to acceptable levels (below level 3). Generally this trigger will be set on the basis of known impact levels for biological systems (partial mortality of corals or seagrass) based on background data. Level 3 trigger levels would also generally be set commensurate with performance measures set in development conditions.

The RMP will be used in ‘real time’ to guide the dredging campaign.

If an initial/investigation (level 1) trigger level is exceeded the dredge would continue to operate while the data from control and impact sites are compared to determine if the impact is attributable to dredging and further ecological monitoring is carried out.

However, once management action (level 2) triggers are reached, the dredge contractor will be responsible for taking actions to ensure impacts are avoided at sensitive receptors and impacts are controlled prior to defined trigger level exceedance (level 3). This will occur in consultation with POTL and the advisory panel discussed previously in Section 4.0.

The subsections below set out the additional mitigation measures and corrective actions that can be implemented by the dredger to reduce impacts and ensure exceedances are reduced or avoided during the campaign. As outlined above, these actions would be assessed and are intended to be implemented prior to a level 3 exceedance in the RMP being reached.

TSHD Dredging in Flood and Ebb Tidal Currents

Numerical modelling and previous dredging activities undertaken by similar TSHD dredges in Cleveland Bay have demonstrated the behaviour of plumes under various tidal conditions. In general, dredging during a flood tide will result in the movement of plumes to the west from the dredge position while dredging during an ebb tide will have the effect of a localised plume around the dredge that will be somewhat stationary and then tend to move northward.

Advice from the Project dredging advisers is that capital dredging of the Platypus and Sea Channel in 1993 trialed an approach whereby dredging was phased with the tides and where practical, dredging in the Sea Channel and outer Platypus Channel was undertaken on the ebb tide and dredging closer to the port (e.g. the inner Platypus Channel) was undertaken on the flood tide.

This approach was employed as a means to further reduce the normal movement of the plume westward into Magnetic Island embayments and was able to be implemented by the dredge contractor without significant impact on the overall dredge programme.

Additional numerical modelling was undertaken as part of the EIS to quantify if such an approach would lead to an improvement in overall water quality compared to the expected mode of operation (which does not differentiate dredging mode or direction by tide). In general, the modelling demonstrated a widespread reduction in above-background TSS/NTU levels to the west of the channel and between Cape Pallarenda and Magnetic Island which would be of ecological benefit to these environments.

Implementation of this approach can be factored into the program during each tidal cycle based on the trigger levels detected in the RMP (pending Regional Harbour Master approval and shipping schedules).

Preferential Movement of the TSHD Dredge to Other Areas

Similar to the approach above, the dredger will have some flexibility in terms of the areas of channel dredging. If impacts are detected at a particular sensitive receptor, the TSHD dredge can be relocated to another dredge area. Given that the key impacts are light deprivation, preferentially dredging other areas while allowing a particular area to settle can be an important strategy to ensure coral environments are obtaining necessary light to maintain photosynthetic processes.

It should also be noted that the dredge vessel will need to undertake routine maintenance, refuelling and crew changes during campaigns. During these 'down time' periods of the dredge, there will be environmental benefits accrued related to settlement of fines and allowance of greater light penetration back into surrounding environments (assuming background turbidity levels are also low). To a certain extent, the dredger can plan such maintenance to maximise environmental benefits in accordance with the RMP.

TSHD Dredging on High Tides

A component of the overall TSS plume generated by the TSHD dredger is through the operation of the propellers. This impact is generally greater where there is less underkeel clearance between the bottom of the dredger (particularly when fully laden) and the seabed that is being dredged.

Based on this principle, an additional mitigation measure that can be employed by the dredge contractor is to dredge particularly sensitive areas of the channel (e.g. near sensitive receptors) on higher tides which maximise underkeel clearance. This approach will help to reduce the amount of TSS generated by the dredge, also reducing the amount of displaced sediment that can be resuspended by natural wave and wind action.

Implementation of this approach can be factored into the program based on the trigger levels detected in the RMP (pending Regional Harbour Master approval and shipping schedules).

Temporary Suspension of Dredging

Suspension of dredging would be implemented if all other mitigation measures and corrective actions as outlined above have been unsuccessful to control impacts and the compliance (red) trigger has been exceeded.

The work method for TSHD operations is designed to operate 24/7 so as to reduce the overall duration of the campaign which has both cost and environmental benefits compared to a longer term dredge operation or intermittent capital dredge operations that involve multiple deployments of vessels.

Notwithstanding this, suspension of dredging operations will be undertaken if compliance trigger levels in the RMP (level 3) are exceeded and dredging not re-commenced until water quality levels are within defined parameters.

8.2.4 Establishing Trigger Values

The level of data collection and modelling investigations undertaken as part of the AEIS are robust and in accordance with all relevant guidelines including the data collection and modelling guidelines published by the Great Barrier Reef Marine Park Authority. As such, the impact predictions are considered to be robust and suitable to allow regulators to determine the acceptability of impacts from dredging and placement activities on marine environmental values.

That said, final water quality and ecological trigger values to support the RMP are not proposed to be set within the AEIS based on the need for final input of regulatory and scientific experts as part of the Technical Advisory Committee (see Section 4.2).

The water quality trigger levels will be based on an assessment and understanding of prevailing baseline conditions within Cleveland Bay, and at least a 12 month water quality data set. This data set will likely be supplemented with further monitoring just prior to commencement of dredging to re-confirm baseline conditions and establish final trigger levels.

The trigger values will be set using an approach similar to that used to determine impact assessment threshold values in Section 6 of the AEIS (Marine Water Quality). The final trigger levels will consider a range of temporal scales, including 20th, 50th and 80th percentile trigger levels. This approach provides a metric for both chronic and acute impacts. These trigger levels will be based on different levels of concern, as follows:

- Level 1 (green) – slightly greater than average conditions. Trigger level calculated using background mean plus half of one standard deviation at each percentile for nearshore sites and one standard deviation for offshore sites.
- Level 2 (orange) – approaching limits of natural variability. Trigger value calculated using background mean plus one standard deviation at each percentile for nearshore sites and two standard deviations for offshore sites. These trigger levels represents the delineation of the Zone of Moderate impact as per Section 6 of the AEIS (Marine Water Quality).
- Level 3 (red) – limits of natural variability. Trigger value calculated using background mean plus two standard deviations at each percentile for nearshore sites and three standard deviations for offshore sites. These trigger levels represents the delineation of the Zone of High impact as per Section 6 of the AEIS (Marine Water Quality).

The continuous monitoring data collected at each compliance monitoring location throughout the dredge campaign will be analysed using percentiles (20th, 50th and 80th). These will then be compared to the trigger values, with implementation of management actions if trigger levels are exceeded.

If trigger levels are exceeded during unusually high ambient turbidity conditions which may occur during large storms or unusually strong and sustained wind periods, the data from the control sites will be assessed to see if the high turbidity at the compliance monitoring sites is naturally occurring or attributable to the dredger.

9.0 General Requirements – Dredge Contractor

This section of the document outlines the general environmental requirements of the DMP that a future dredge contractor would be expected to fulfil. POTL's role with respect to this section would be to ensure these requirements are addressed and met by the contractor as part of the contract and to ensure activities are being carried out consistently with any existing procedures or protocols in Port Limits or under relevant corporate environmental policies or strategies, and all approvals, conditions and licences.

Section 10.0 (Specific Environmental Strategies) identifies particular elements or aspects of the dredging activity under which there are specific requirements that will need to be met by the Dredge Contractor in addition to the general requirements stated in Table 1 below.

Table 1 General requirements - dredging

General Requirements - Dredging	
Objective	To ensure dredging operations and associated activities comply with relevant environmental duties and obligations as set out in Queensland legislation and with environmental permit requirements.
Applicability	All capital dredging works and associated activities
Performance Criteria	All relevant permit and licence conditions will be met.
Implementation Strategy	The dredge contractor will need to address the following requirements: General Method Statement A general method statement will need to be prepared outlining the intended scope of works and methodology to be employed. At a minimum, the method statement should include the following: Introduction ▪ Description of the General Scope of Works (noting this may need to be by Stage only). ▪ References to International Dredging Standards. Company Standards (such as quality, OHS and environment management systems), how they apply to the current project and any other project specific document. ▪ Responsibilities of the Contractor and Key Staff (on the dredge vessel and on shore). ▪ Provide a clear map of the areas where the dredging activities are to take place consistent with regulatory approvals. ▪ Provide a general description of the dredging process and the specifics of the plant to be used in the dredging process including the dredging methods, dredging control, possible dredging patterns, vessel navigation routes to be used and vessel operations while at the pump out location including ancillary activities such as waste management and fuel bunkering. ▪ Include Specific Method Statements in accordance with the requirements outlined in this DMP. Site-Based Environmental Management Plan (Dredge Operations) Preparation of a site-based environmental management plan related to the dredging operation to be submitted to the relevant regulatory agencies (e.g. DEHP) as required. The management plan (hereafter referred to as the 'Dredge Operations' EMP) must address the following: ▪ Environmental commitments – including a commitment by senior management of the contractor to achieve specified and relevant environmental goals; ▪ Identification of environmental aspects and potential impacts; ▪ Control measures for routine operations to reduce the likelihood of environmental harm; ▪ Contingency plans and emergency procedures for non-routine situations; ▪ Organisational structure and responsibility; ▪ Proposed communication; ▪ Staff training; ▪ Record Keeping; and ▪ Periodic review of environmental performance and continual improvement. In addition to the general requirements above, the Dredge Operations EMP must also address specific requirements (such as water quality monitoring) as outlined in this DMP. Maintenance of Measures, Plant and Equipment The dredge contractor must ensure that all measures, plant and equipment necessary to undertake the activity are operated and maintained in a proper and efficient condition. This includes appropriate servicing and maintenance of engines and emission control devices such that emissions comply with relevant guidelines and standards. Complaint Response (General Requirements) All complaints received by the dredge contractor related to environmental issues such as noise, air, or water quality must be recorded including investigations undertaken, conclusions formed and actions taken. Notification about the complaint and any associated response must be provided to POTL in a timely fashion. The complaint response procedure will include: (a) The time, date name and contact details of the complainant; (b) Reasons for the complaint; (c) Any investigations undertaken;

General Requirements - Dredging	
	(d) Conclusions formed; and (e) Any actions taken. Reasonable and Practicable Measures The dredge contractor must take all reasonable and practicable measures to prevent and/or minimise the likelihood of environmental harm being caused. Notification of Environmental Harm The dredge contractor is responsible for ceasing activities and notifying POTL and appropriate regulatory bodies eg DoE or DEHP if it becomes aware of material or serious environmental harm (as defined in the <i>Queensland Environmental Protection Act 1994</i>) as a result of carrying out of the dredging and associated works. The contractor must also contact the relevant agencies as per approvals/legislation as soon as practicable after becoming aware of any release of contaminants not in accordance with the condition of any approvals granted, and in the event of injuries caused to fauna. Notifications of Commencement The contractor must inform POTL and regulatory agencies of its intention to commence dredging in timeframes identified in any approvals granted.
Monitoring	Record of Monitoring The dredge contractor must keep records of all monitoring results required by POTL or as part of regulatory agency permit requirements. Specific monitoring requirements of reporting are contained in Section 10.0. Record of Dredging Volumes and Megafauna Sightings/Incidents The dredge contractor must keep records on the volume and size distribution of material removed from the approved dredge footprint area. These records must be provided to POTL in the timeframe specified. The dredge contractor must also keep records of megafauna sighted and/or any incidents with megafauna as required in any approvals granted.
Reporting	The documentation outlined in the 'Implementation Strategy' above will need to be to the satisfaction of regulatory agencies. Copies of all plans will be provided to POTL for review prior to lodgement with regulatory authorities. A weekly report containing dredging volumes must be provided by the contractor to POTL as outlined above. Other specific reporting requirements are outlined in Section 10.0 of this DMP.
Auditing	All relevant documentation outlined in the 'Implementation Strategy' must be lodged and confirmed as approved by regulatory agencies prior to commencing work. Proof of this must be provided to POTL. Audits may be conducted by regulatory authorities periodically during any permit term. POTL can monitor contractor performance in line with DMP.
Corrective Action	Corrective action will be required in the context of the findings of the audits or in the context of any issues raised by regulatory bodies. Corrective actions may also be required as a result of complaints in accordance with the complaint response process outlined above.

10.0 Specific Environmental Strategies of the DMP

10.1 General

This section of the DMP identifies specific environmental strategies for each element of the DMP related to the dredging and dredge material placement (in reclamation) activity that will need to be addressed by the dredge contractor.

Unless specifically stated, given the long timeframes involved and the scale of the Project over several stages, commitments to activities such as environmental monitoring may be undertaken by the contractor, by POTL or by a third party contracted by POTL depending on the procurement approach taken for the works. As such, the focus of the DMP is on outlining the management and monitoring commitments with the responsibility for implementing the commitments to be developed as part of the procurement strategy for the Project and subsequently as part of the final DMP developed in consultation with relevant Agencies.

The requirements in this section are intended to apply in addition to the general requirements outlined in Section 3.2 of this DMP and in most cases will need to be integrated in documentation and any conditions of approval imposed on the dredging activity under relevant legislation (including the EPBC Act and relevant State legislation).

POTL would ensure these requirements are addressed and met by its appointed dredge contractor as part of project planning and to ensure activities are being carried out consistently with any existing procedures or protocols in Port Limits or under relevant corporate environmental policies or strategies.

10.2 Purpose

The purpose of the environmental strategies and DMP are to:

- Identify potential and actual environmental aspects and impacts associated with the works
- Describe the appropriate measures to prevent, monitor and manage all possible effects; and
- Indicate the corrective action(s) to be undertaken if an undesirable impact or unforeseen level of impact occurs.

10.3 Elements and Structure

The following are the key elements that make up the DMP:

- Marine Megafauna Management
- Tailwater Management
- Sediment Quality
- Vessel wastewater management (including washdown of plant and equipment)
- Ballast water and marine pest incursion management
- Vessel waste management
- Fuel management
- Noise Quality
- Air quality; and
- Emergency planning and procedures.

The structure used for the specific management plans within the DMP is identified in Table 2 below.

Table 2 **Structure for management plan within the DMP**

Item	Content
Element	The aspect of dredging to be managed (as it affects environmental values).
Objective	The guiding policy of management objective that applies to the element.
Applicability	Aspect of dredging that this strategy applies to.
Performance Criteria	The measurable performance criteria (outcomes)/indicators for each element.
Implementation Strategy	The strategies, tasks or action programme (to nominated standards) that would be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements to measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements to demonstrate implementation of agreed dredge management strategies and compliance with agreed performance criteria.
Reporting	The format, timing and responsibility for reporting of auditing and monitoring results.
Corrective Action	The action of options to be implemented in case a performance criteria is not reached and the person(s) responsible for action (including staff authority and management structure).

11.0 Marine Megafauna

This section outlines requirements that are to be met associated with the management of potential interactions between dredge equipment and marine megafauna. Management of underwater noise from marine piling and other construction activities associated with PEP are addressed in Appendix B2 – Construction Environmental Management Plan.

Element/Issue	Marine Megafauna
Objective	- To reduce the risk of disturbance or injury to marine mammals and sea-turtles resulting from the dredging and placement activities. - Establish and maintain awareness of the importance of protecting marine mammals and sea turtles.
Applicability	All dredge vessels
Performance Criteria	- No incidents of vessel related disturbance to marine mammals and sea-turtles. - All members of the dredging team to complete an induction, which will include information on marine mammal and sea turtle management requirements. - Vessel masters and spotters trained in marine mammal and sea turtle interaction procedures.
Implementation Strategies	- Prior to commencement of dredging activities, employees responsible for marine megafauna spotting will be appropriately trained. - Marine mammal and turtle observation and response procedures including the application of a 300 m exclusion zone will be implemented during dredging activities. Dredging operations shall be stopped where these fauna are observed within 300 m of the operating dredge until the animals have moved further than 300 m or have not been sighted for 15 minutes. - A lookout will be maintained for cetaceans while the dredge sails between the dredging area and reclamation. In the event that a cetacean is sighted, vessel speed and direction will be adjusted to avoid impact on the observed individual (within the safety constraints of the vessel). - Marine mammal and turtle observation during night dredging will be undertaken using appropriate lighting.. - Turtle deflectors will be mounted on the draghead of the TSHD. - TSHD dredge pumps will only be started when the draghead is close to the seafloor (not while lowering pipe). - The TSHD dredge pump will be stopped as soon as possible after the completion of dredging. - Light levels from the dredging works will be limited to those lights that are necessary for the safe operation of the vessel, for spotting marine megafauna at night, and the health and safety of those on board. - Any injury to marine megafauna shall be recorded and reported immediately as per below.
Monitoring	Marine mammal and turtle activity will be performed by a person at a suitable location on each vessel.
Auditing	POTL will undertake checks of the dredge contractor's compliance with the DMP
Reporting	- A record of sighted animals will be maintained, indicating the sighting of each individual animal and actions taken. - Down-time will be reported as Environmental Delay in the equipment daily report. - Immediate reporting of any incident involving injured or killed animals to POTL and regulatory agencies. - Any injury to marine megafauna shall be recorded and reported immediately via the Department of National Parks, Sport and Racing (NPSR) online incident report form (https://www.business.qld.gov.au/industry/tourism/parks-recreation-forests/incident-report-form). - Details of the incident are to be compiled into an incident report.
Corrective Action	- In the event of an environmental incident, appropriate emergency response measures shall be implemented to ensure environmental harm from the event is reduced. - If injury to marine megafauna occurs, liaise with NPSR immediately to identify rescue options and develop future corrective strategy. - Assist in capture of injured animals per advice from regulatory agencies. - Other strategies will implemented, as advised by regulatory agencies or POTL, to reduce likelihood of incident recurring.

12.0 Tailwater Management

This section outlines requirements that are to be met associated with management of tailwater discharged from the reclamation. The dredged material will be hydraulically placed into the reclamation, with supernatant tailwater moving through the various cells of the reclamation to an ultimate discharge point at the mouth of the Ross River. The guidelines below identify environmental management measures and monitoring that will be undertaken by the construction/dredge contractor in undertaking this work.

Element/Issue	Tailwater Quality Management
Objective	To ensure discharge water (dredging tailwaters) released to the environment is of an acceptable standard.
Applicability	Tailwater from the reclamation area during dredging works.
Performance Criteria	- Tailwater discharge is to achieve the following limit prior to release: - TSS: 80th percentile < 100 mg/L (or equivalent turbidity level); and - pH: between a range of 6.5 – 8.5. - Specified number of exceedances of TSS/turbidity and pH trigger levels at the discharge outlet.
Implementation Strategies	- Cells to be established in a manner that maximises settlement of sediments and reduces further erosion and mobilisation of sediments. - Development of a turbidity/TSS relationship to enable in situ turbidity readings to be taken on site and correlated to a TSS concentration. To achieve this, samples for TSS and turbidity are required to be taken at the same time, over a period long enough to provide a sufficient dataset necessary to determine a good correlation between the two parameters. - If turbidity/TSS exceeds the performance criteria in the tailwater ponds, the control measures on site will be promptly reviewed to ensure that all reasonable and practicable measures are being taken in terms of both pond operation and the hydrologic and sediment loading on the tailwater ponds (refer to Corrective Actions below). - ASS and PASS to be managed in accordance with the ASS Management measures outlined in Chapter B1 of the EIS.
Monitoring	Implement a tailwater monitoring program, comprising the following: - Turbidity/TSS and pH monitoring of tailwater at the discharge point from the sediment ponds. - Visual observations to check for scum formations, oil spills etc. - Plume validation monitoring of turbidity/TSS in receiving waters adjacent to the discharge point. This monitoring is to be used to validate modelling results.
Auditing	POTL will undertake checks of the dredge contractor's compliance with the DMP Reporting of tailwater performance to be provided to POTL regularly.
Reporting	Tailwater Monitoring Program - Monitoring results to be maintained in a database within one week of each monitoring episode. On completion of the reclamation, the database is to be stored in accordance with legal retention requirements. - A surveillance report is to be prepared at the completion of each monitoring episode. The surveillance report will be submitted to POTL within one week of each monitoring episode, and will identify any significant changes to tailwater discharge and corrective actions implemented. - A post construction monitoring report will be prepared at the end of each stage of the reclamation process. Incident Reporting - An Incident Report is to be prepared in the event of any exceedances of performance criteria. The report will be submitted to POTL within one week of the exceedance and stating corrective actions taken.
Corrective Action	If continual turbidity/TSS exceedances are observed, the following contingency actions could be implemented: - Increase tailwater residence time in the tailwater pond. - Redirect supernatant from the filling cells to other cells to allow further settlement before being discharged. - Modify decanting rates and ensure hydraulic efficiency. - Install additional controls in the tailwater ponds or other controls that can regulate wind and wave action in the pond. If the pH of tailwater is outside of the specified range: - Add lime or other mechanism to increase pH and monitor pH during dosing to limit risk of over dosing. - Review ASS/PASS treatment measures to ensure they are being properly implemented.

13.0 Sediment Quality

This section outlines requirements that are to be met associated with sediment quality, and controls that will be implemented to reduce impacts to water quality, seabed and marine flora and fauna through the disturbance of any contaminated sediments. These are documented in Chapter B4 (Marine Sediment Quality) of the EIS, and are primarily designed to ensure contaminated sediments are identified through further sediment sampling, and if detected, can be segregated and disposed of at an appropriate onshore facility. The environmental commitments include the following actions:

- Undertake sediment quality testing prior to works to characterise dredged sediments before dredge operations (note: while indicative testing has been undertaken, additional contemporary sediment quality data is required closer to the commencement of works to ensure currency of data).
- Develop and implement procedures and arrangements to appropriately manage and remove any contaminated materials if encountered.

Element/Issue	Sediment Quality
Objective	To reduce impacts to water quality, seabed and marine flora and fauna through the disturbance of any contaminated sediments.
Applicability	All dredged material
Performance Criteria	▪ Ensure further sediment quality testing occurs in general accordance with National Guidelines (i.e. NAGD). ▪ Ensure appropriate treatment of contaminated material if required.
Implementation Strategies	▪ Use appropriate methods to excise any contaminated sediment hot spots identified by detailed sediment quality testing. ▪ Excised contaminated materials to be placed onshore and treated in the reclamation or other suitable onshore facility and disposed at an appropriate location, in accordance with relevant Queensland guidelines (and licenses sort if required).
Monitoring	Construction Monitoring ▪ Monitoring will be undertaken in general accordance with the NAGD guidelines prior to construction. ▪ Monitoring of treatment/dewatering of land based material disposal will be undertaken. Long Term Monitoring ▪ Once Stage 1 is constructed and operational, the existing long term sediment monitoring program will be extended to monitor operational impacts. ▪ Prior to construction of subsequent stages, further sediment testing will be undertaken to guide sediment management or disposal.
Auditing	POTL will undertake checks of the dredge contractor's compliance with the DMP
Reporting	▪ Dredge volumes will be reported to regulatory agencies in accordance with any permits granted. ▪ For any contaminated sediment excised and taken to land, report the following: ▪ Volume excised ▪ Treatment applied ▪ Volume removed to landfill after dewatering ▪ Any validation testing required Incident Reporting ▪ The dredge contractor will prepare an Incident Report in the event of any corrective actions being implemented.
Corrective Action	As indicated above, corrective action will be taken where monitoring shows potential impacts to the marine environment from sediment contamination, or otherwise, where exceedances of trigger levels or permit conditions are observed. If contaminated sediments are identified, this material will be treated (if required) and appropriately placed.

14.0 Vessel Wastewater Management

This section outlines requirements that are to be met associated with vessel washdown procedures during operations such as washdown of the decks and the dredge head and other equipment. It does not include discharge of sewage or other waste (addressed later in this document).

Element	Vessel Wastewater Management (including Washdown of Dredge Plant and Equipment)
Objective	To prevent the release of potential contaminants to the environment from washdown operations.
Applicability	All dredge vessels.
Performance Criteria	No inappropriate use of degreasers or washdown in sensitive environments.
Implementation Strategy	- Washdown of the deck and/or dredge head shall only be undertaken in accordance with relevant permits and approvals. - Degreasers only to be used if other methods, such as sweeping or watering the deck/equipment, is not appropriate or practicable.
Monitoring	Visual inspection for contamination of waters while washing deck or equipment.
Auditing	Nil
Reporting	POTL is to be notified in the event of any unintentional spill of contaminant associated with washdown.
Corrective Action	If an unintentional release of contaminant occurs, review of procedures and rectify immediately.

15.0 Ballast Water and Marine Pest Incursion Management

This section outlines requirements that are to be met by the dredge contractor associated with ballast water management before leaving the port of origin, during transit between areas of operation, during operations, and following completion of dredging activities prior to departing the Port of Townsville.

Element	Ballast Water and Marine Pest Incursion Management
Objective	To ensure risk of translocation of organisms in ballast water or on the hull of a dredge vessel is prevented.
Applicability	All dredge vessels and equipment brought in for the Project.
Performance Criteria	- No high risk ballast water brought into Port limits. - Ensure ballast water discharge and marine pest inspections occur in accordance with Department of Agriculture and Water Resources (DAWR) standards. - No harmful marine organisms are translocated on the underkeel hull, dredge heads or in the hopper of the dredge.
Implementation Strategy	Port of Origin Prior to leaving the port of origin: - The dredge vessel is to be thoroughly washed. - If discharge pipes have been utilised in prior operation, undertake a thorough flush of these systems. - Inspect ship hull, hopper and dredge gear (especially dredge heads) to ensure that no material which may transport organisms (sediments, organic material, or waters) is retained. During transit between Port of Origin and Port of Operations (Port of Townsville) - No deep water ballast exchanges to occur in the Great Barrier Reef Marine Park. - Any ballast tanks holding seawaters to be exchanged with a minimum 150% of design volume with seawaters at a location as distant from the coastline or other shallow (<100 m) areas as possible but not less than 5 nautical miles from the coast (in accordance with IMO requirements). - Any waters held in the hopper during transit to be treated as for other ballast waters. During operation at Port of Townsville - On arriving at the port of operations, the dredge is to operate in accordance with DAWR and Australian Customs regulations. - Hull inspections to be carried out if requested by DAWR for attached marine pests. Vessels to comply fully with DAWR requirements. Leaving Port of Townsville - When leaving the port of operations, relevant State and Commonwealth requirements pertaining to ballast water management are complied with.
Monitoring	Monitoring may be carried out by DAWR on the dredge contractor at their prerogative. POTL will assist the agency as required.
Auditing	Audits may be carried out by DAWR on the dredge contractor at their prerogative. POTL will assist the agency as required.
Reporting	- Hopper water discharge and replacement records are to be kept in the Ship's log and made available upon request. - A record will be kept of volumes, location and time of ballasting and deballasting operations.
Corrective Action	- If an unintentional release or exchange occurs, review of ballast and deballasting procedures and rectify immediately. - If marine pests are encountered on ships hulls or other equipment, they are to be treated and removed in accordance with DAWR instruction before commencing work.

16.0 Vessel Waste Management

This section outlines requirements to manage wastes generated from or incidental to the dredging operations. It is separated into three categories:

- Solid waste and garbage
- Sewage treatment; and
- Hazardous waste management.

Element	Vessel Waste Management: Solid Waste and Garbage
Objective	To ensure that general refuse produced on-board the dredge vessel is collected, retained, and transferred to an appropriate facility without unintentional material loss.
Applicability	All dredge vessels.
Performance Criteria	▪ No loss of solid wastes material overboard during collection or transfer. ▪ No discharge other than at berth.
Implementation Strategy	▪ Vessel fitted with appropriately sized waste disposal bins. ▪ These bins are to be secured and fitted with secure lids to prevent material being blown overboard during storage or handling. ▪ Where practicable, ensure material compacted to further prevent unintentional loss. ▪ Ensure the bins are collected and emptied at appropriate intervals.
Monitoring	Dredge crew to carry out regular visual inspections of collection points and visual inspection of on-deck bins.
Auditing	Nil.
Reporting	Dredge Contractor to report any loss of waste material or any community complaints received about solid waste management to POTL.
Corrective Action	If practicable, take measures to retrieve material that is lost. Review procedures causing material loss and take immediate action to rectify.
Element	Vessel Waste Management: Sewage Treatment
Objective	To ensure sewage generated on-board is appropriately treated and managed.
Applicability	All dredge vessels.
Performance Criteria	Sewage discharge to meet relevant legislative requirements (<i>Queensland Transport Operations (Marine Pollution) Act 1995</i> and regulation).
Implementation Strategy	▪ Must comply with relevant regulation and maritime requirements depending on the size of the vessel. ▪ Where possible, material is to be held on board and disposed onshore ▪ The holding tank is to be pumped out either in accordance with untreated sewage requirements under Queensland legislation or otherwise by appropriate licensed contractors while the dredge is in port.
Monitoring	Monitoring of treatment system as required by legislation.
Auditing	Nil.
Reporting	Report any breach and maintain records of sewage pumped ashore
Corrective Action	Ensure regular review of sewage storage system inputs and operation. Modify procedures to meet discharge requirements.
Element	Vessel Waste Management: Hazardous / Regulated Waste Management
Objective	To ensure hazardous waste generated on-board is appropriately managed.
Applicability	All dredge vessels.
Performance Criteria	No inappropriate storage or disposal of hazardous waste.

Element	Vessel Waste Management: Hazardous / Regulated Waste Management
Implementation Strategy	During at-sea operations: ▪ Hazardous waste must be stored in an appropriate and secure manner and clearly marked in accordance with legislative requirements. During transfer: ▪ Where required, hazardous wastes shall be transferred to appropriate containers and transported to an appropriate facility for disposal. ▪ Collection and transport of designated hazardous wastes is to be undertaken only by a licensed contractor. Procedures to reduce spills or leakage during storage and transfer shall be followed. Spill response equipment must be easily identifiable and conveniently located so as to respond to a spill if it occurs.
Monitoring	Dredge crew to carry out regular visual inspections of hazardous waste storage containers to determine their integrity and identify if any spills or leakage has or is occurring.
Auditing	Nil.
Reporting	Incident reports to be provided to POTL detailing any spills or incidents involving hazardous waste and clean-up operations.
Corrective Action	If procedures breakdown or a spill occurs, procedures to be reviewed and staff trained about appropriate responses.

17.0 Fuel Management

This section outlines requirements that are to be met associated with the bunkering of fuel by the dredge vessel during the operation. This section deals with fuel transfer; the section below on emergency planning and procedures deals with general oil spills and response.

Element	Fuel Management
Objective	To ensure bunkering of fuel to the dredge vessel is appropriately transferred and spillage is prevented. In the event of a spill, there is a rapid response to reduce impacts on the marine environment.
Applicability	All dredge vessels that will require bunkering of fuel during the dredge campaign.
Performance Criteria	No spills or leaks during fuel transfer operations.
Implementation Strategy	During transfer: ▪ A licensed contractor is used; and ▪ Fuel levels are being monitored both by the contractor and the dredge vessel. Vessel to apply for and give notification as to the transfers of bulk liquids to Port Control as per Port of Townsville Procedures and appropriate forms.
Monitoring	Visual inspections of fuel-dispensing equipment and surrounding water are undertaken during operations and after fuel transfer.
Auditing	Nil.
Reporting	POTL is to be notified in the event of any unintentional spill of fuel or oil associated with fuel bunkering.
Corrective Action	If an unintentional release or spill occurs, review of procedures and rectify immediately. Implement contingency and clean up procedures as per relevant plans outlined in the Emergency Planning and Procedures DMP element.

18.0 Noise Quality

This section outlines requirements that are to be met with regard to nuisance noise issues from dredging operations.

Element	Noise Quality
Objective	- To protect the acoustic amenity and reduce nuisance noise on surrounding sensitive receivers. - To respond effectively to any noise complaints that may arise during construction.
Applicability	All dredge vessels.
Performance Criteria	There are no complaints received about noise associated with dredge operations.
Implementation Strategy	- Ensure that engines and equipment on board the dredge are properly maintained in good working order. - Maintain and operate all equipment on board the dredge in a safe and efficient manner. - Carry out non-essential maintenance during day-light hours. - The contractor staff are aware of noise requirements in relevant permits and/or approvals. - Operate a complaints management system.
Monitoring	Noise monitoring will be conducted in response to non-vexatious noise complaints received during the dredging operations. Noise monitoring will be conducted at the location / receiver considered to be most affected during the works.
Auditing	Nil.
Reporting	In the event that the monitoring indicates an exceedance of a performance criteria set out in a permit or other statutory instrument, refer to Corrective Actions.
Corrective Actions	In the event that responsive noise monitoring indicates an exceedance of the performance criteria, investigate and if warranted, implement actions to reduce noise emission levels to nearby receivers.

19.0 Air Quality

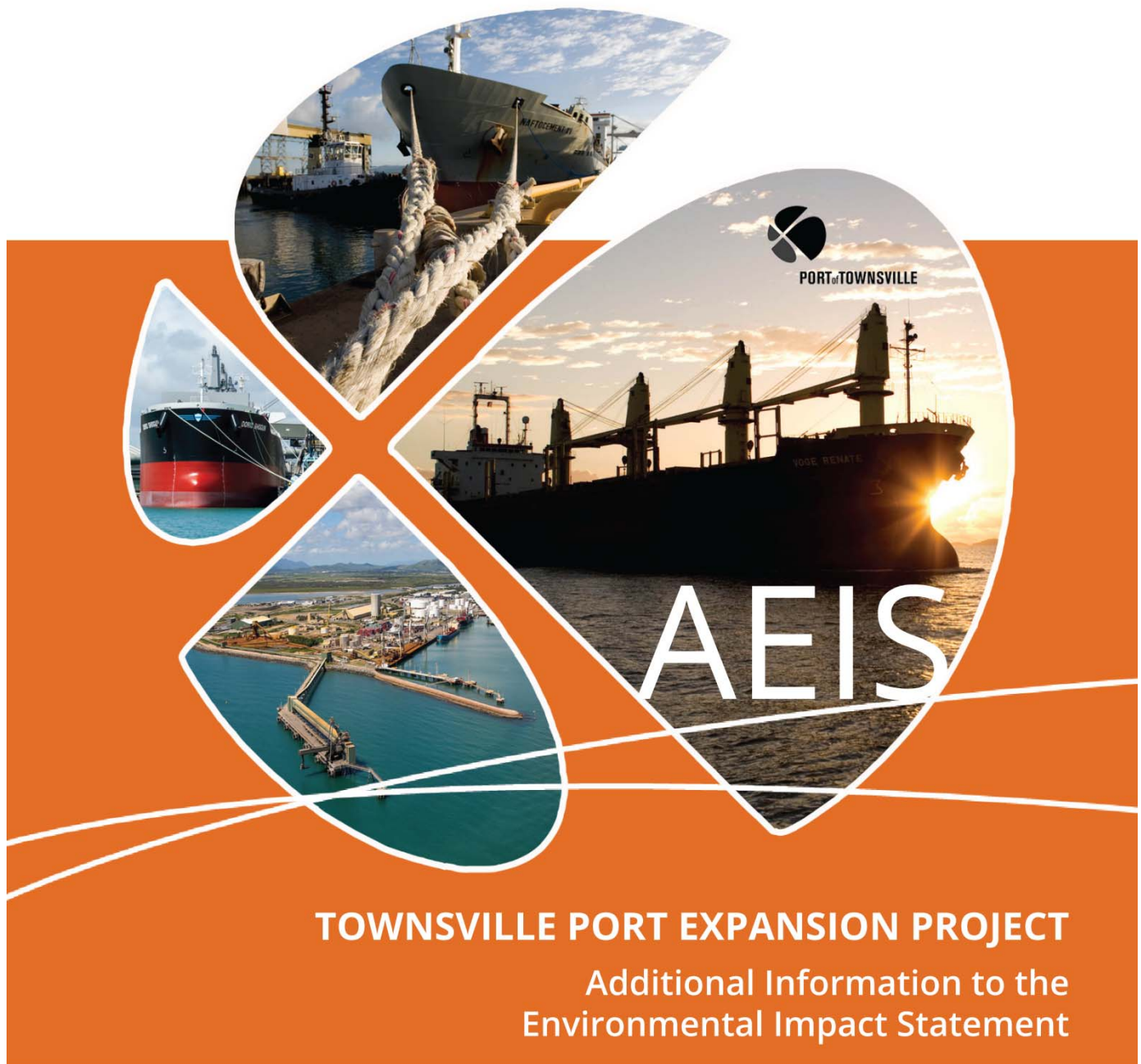
This section outlines requirements that are to be met with regard to nuisance air quality issues from dredging operations.

Element	Air Quality
Objective	- To protect the air quality of surrounding sensitive receivers. - To respond effectively to any air quality issues that arise during dredging.
Applicability	All dredge vessels.
Performance Criteria	There are no complaints received regarding air quality associated with dredge operations.
Implementation Strategy	- Ensure that engines and equipment on board the dredge are properly maintained in good working order. - Maintain and operate equipment on board the dredge in a safe and efficient manner. - The contractor staff are aware of air quality requirements in relevant permits and/or approvals.
Monitoring	Investigation of complaints and review of equipment versus relevant standards / requirements
Auditing	Nil.
Reporting	- The results of any air quality monitoring are to be provided to POTL within two weeks following completion of any monitoring / investigation. - In the event that the monitoring indicates an exceedance of a performance criteria set out in a permit or other statutory instrument, refer to Corrective Actions.
Corrective Actions	- In the event that responsive air quality monitoring indicates an exceedance of the air quality criteria, an investigation shall be undertaken into potential cause/s. - Follow up measurements are to be conducted two weeks later to confirm whether air quality is within performance criteria. If air quality continues to exceed criteria, the Contractor is to submit a plan to POTL indicating how air quality issues can be further mitigated.

20.0 Emergency Planning Procedures

This section outlines requirements that are to be met associated with emergency planning and procedures for environmental incidents that could result from dredging and pump-out operations. This includes, but is not limited to, oil spills, ship collision, and similar incidents.

Element	Emergency Planning and Procedures
Objective	To identify and reduce the potential for an environmental incident before it occurs so as to prevent damage to the surrounding marine environment and the public.
Applicability	All dredge vessels.
Performance Criteria	- No environmental incidents occur during the dredging campaign. - In the event of an incident, there is a rapid response to reduce impacts on the marine environment.
Implementation Strategy	- The dredge vessel has and maintains a shipboard oil pollution emergency plan (or equivalent) which outlines the role, responsibilities, and actions to be followed should an uncontrolled release of oils/fuels occur. - A risk assessment regarding potential environmental incidents that could occur during the dredge operation is to be prepared by the dredge contractor prior to commencing work. The risk assessment will: - Identify the incidents/hazards that may occur during the campaign - Identify the environmental consequences of the hazard occurring - For each hazard, identify measures that can be implemented to prevent the likelihood of the hazard occurring and/or will reduce the severity of consequences - Contingency measures that are to be implemented in the event of an incident occurring. - On-board procedures are to be made available to crew. - The vessel is to have at least two lines of communication (VHF and mobile phone) with port control and maintain constant contact. - Meet requirements of the Regional Harbour Master, including Notice to Mariners. Protocols will be developed with the Regional Harbour Master for dropping the anchor lines as part of normal operations to ensure safe passage of vessels.
Monitoring	Nil.
Auditing	POTL will undertake checks of the dredge contractor's compliance with the DMP.
Reporting	POTL to be provided with copies of the following prior to the commencement of work: - The shipboard oil pollution emergency plan as required in the above Implementation Strategy. - The environmental incident risk assessment as required in the above Implementation Strategy. POTL is to be notified within 24 hours in the event of any incident while the vessel is operating in port limits.
Corrective Actions	If an incident occurs, review procedures and rectify immediately. Implement contingency and/or clean up procedures as set out in relevant plans.



APPENDIX B2

Construction Environmental Management Plan



1.0 Introduction

This Construction Environmental Management Plan (CEMP) details environmental management procedures to be incorporated into Contractor's Environmental Management Plan (EMP) during the construction phase of the Port of Townsville Limited (POTL) Port Expansion Project (PEP).

The aim of the CEMP is to manage risk and reduce the potential for negative impacts on the environment associated with PEP construction. The CEMP has been developed from, and is consistent with, the PEP Environmental Impact Statement (EIS) and Additional Information to the Environmental Impact Statement (AEIS). The CEMP has been updated in response to submissions received through the EIS process, and considers the design refinement where appropriate.

1.1 Project Overview

The Port of Townsville is located on Cleveland Bay, approximately three kilometres east of the city centre in Townsville, North Queensland (refer to Figure 1). The Port is situated in the Great Barrier Reef World Heritage Area and the majority of the port infrastructure is not within the Great Barrier Reef Marine Park.

The Port of Townsville is a multi-purpose port that handles predominantly bulk and general cargo. The PEP aims to address capacity constraints and accommodate future growth in trade over a planning horizon to 2040.

The PEP includes development of port infrastructure and work to 'top of wharf': dredging, reclamation, breakwaters and revetments, wharves, access roads, rail loop, and trunk services and utilities. The PEP does not include the development 'above wharf', which may include terminal pavements, ship-loaders and unloaders, materials conveyors, storage buildings for products, rail loaders and unloaders, stacking and reclaiming equipment, storage tanks and pipelines.

As the Port develops, individual Port tenant operations will be subject to separate statutory assessment and approval requirements. Operators will be required to obtain all necessary approvals and licenses in accordance with their statutory requirements prior to the start of operations or in accordance with statutory timing requirements.

1.2 Purpose

The purpose of this CEMP is to identify the preferred means of addressing and reducing potential adverse environmental impacts associated with the construction phase of the PEP. The CEMP:

- describes POTL's commitments regarding environmental performance and the reduction of adverse impacts
- specifies the actions that would be taken to implement the commitments (such as monitoring)
- identifies corrective actions to rectify any deviation from performance standards
- provides an action program to enable delivery of the environmental commitments so they are achieved and implemented.

The contents of this CEMP may be incorporated into either the successful construction tenderer(s) management plans or undertaken by the Port depending on ultimate contractual arrangements.

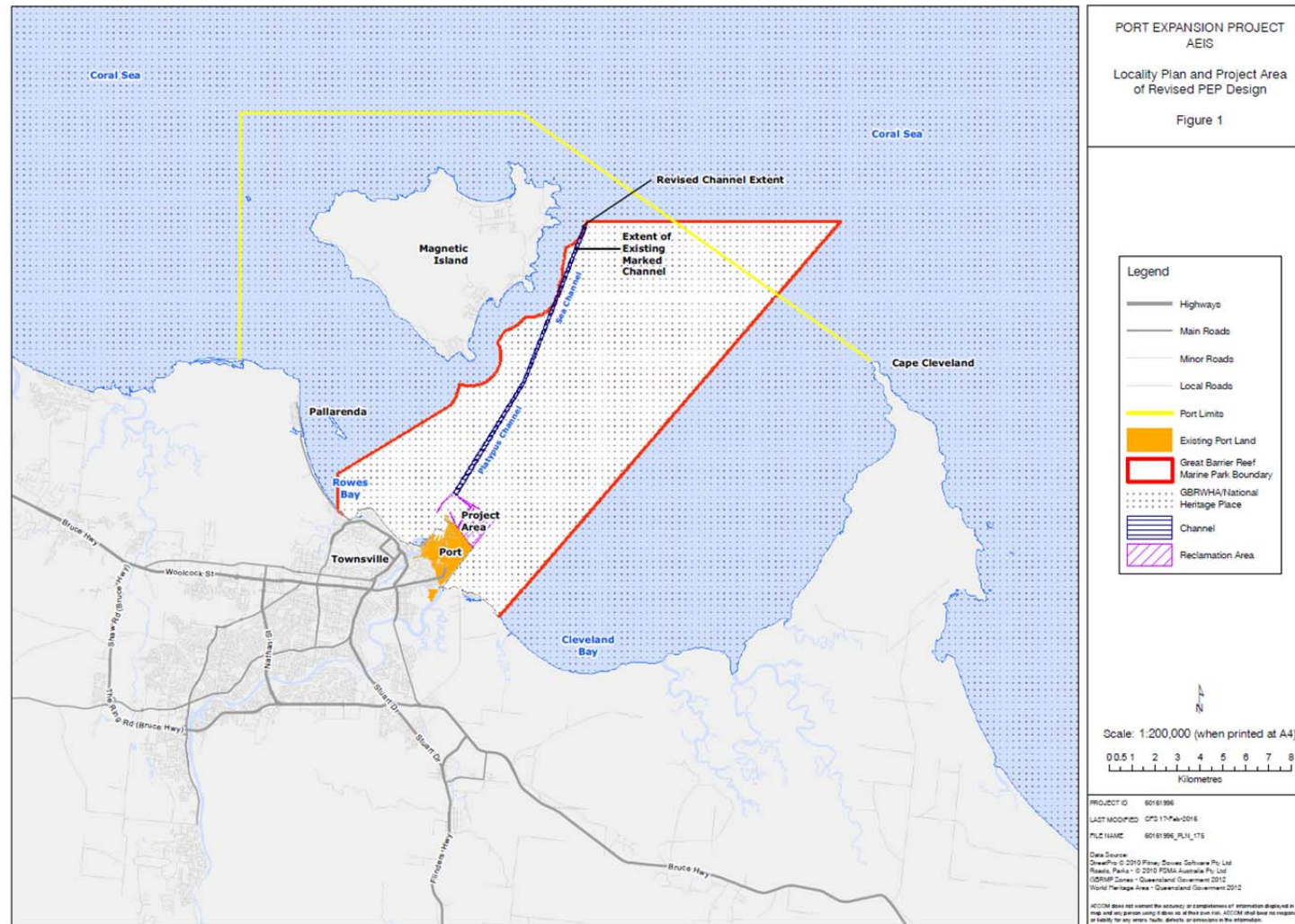


Figure 1 Port of Townsville locality plan

1.3 Scope

The CEMP addresses the on-land construction phase of the PEP and builds upon the Environmental Management Plan (Overview) (refer Chapter C1 of the EIS).

A separate Dredge Management Plan (Appendix B1 of the AEIS) and a Maritime Operations Management Plan (Chapter C2.4 of the EIS) have been prepared to cover the in-water aspects and management associated with the dredging phase and vessel movements of the PEP and the future outer harbour operations.

A Vessel Traffic Management Plan for Construction (Chapter C.2.3 of the EIS) has also been prepared and is to be used as a template for individual vessel operators to develop and implement their own plans in accordance with regulatory requirements.

A separate Operational Environmental Management Plan (Appendix B3 of the AEIS) has been prepared to cover operational activities associated with POTL's operation of the expanded port.

The key environmental values likely to be affected by on-land construction activities associated with the PEP were identified in the EIS and re-assessed in the AEIS. For each key value identified, the environmental management procedures to address potential risks and impacts have been provided. General environmental requirements for the construction phase are provided at Part A of the EIS.

1.4 Terms of Reference

The CEMP also responds to the Queensland government's *Townsville Port Expansion Project - Terms of Reference for an Environmental Impact Statement*, February 2012, issued by the Coordinator General (Appendix A1 of the EIS). Section 10 of the Terms of Reference states the detail required in the Environmental Management Plans (EMPs). The requirements of Section 10, and where these requirements are addressed in this Plan, are shown in Table 1.

The Terms of Reference also refer to additional information that is to be provided in the EMPs. The information required - and where these requirements are addressed in this Plan - are paraphrased in Table 2.

This CEMP has also been prepared to satisfy the requirements of Section 5.11 of the *Commonwealth Guidelines for an Environmental Impact Statement for Port of Townsville Port Expansion Project, Queensland*, as they apply to the construction phase.

Table 1 Terms of Reference Section 10 – EMP requirements

Requirement	Addressed in Section
Detail the EMPs for both the construction and operation phases of the Project.	This CEMP details the management measures for the pre-construction and construction phase. Separate EMPs have been prepared for operations, dredging and shipping.
The EMP is developed from, and be consistent with, the information in the EIS. The EMPs must address discrete project elements and provide life-of-proposal control strategies. It must be capable of being read as a stand-alone document without reference to other parts of the EIS.	The project elements from the EIS that require management measures are detailed in Section 3.0 and form the basis of this CEMP.
The EMP must comprise the following components for performance criteria and implementation strategies: the proponent's commitments to acceptable levels of environmental performance, including environmental objectives, performance standards and associated measurable indicators, performance monitoring and reporting.	Refer to Section 2.0 for an outline of POTL's Environmental Management System. Refer to Section 5.0 for specific environmental commitments during construction.
Impact prevention or mitigation actions to implement the commitments.	Management actions are provided in Section 5.0.
Corrective actions to rectify any deviation from performance standards.	Management actions are provided in Section 5.0.
An action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to: - continuous improvement - environmental auditing - monitoring - reporting - staff training - a rehabilitation program for land to be disturbed under each relevant aspect of the proposal.	Management actions are provided in Section 5.0. An action program is provided in Section 6.0.
The recommended structure of each element of the EMP is: - element/issue - operational policy	Refer to Section 5.1.1.

Requirement	Addressed in Section
- performance criteria - implementation strategy - monitoring - auditing - reporting - corrective action.	

Table 2 Terms of Reference - additional EMP requirements

Section from Terms of Reference	Requirement	Addressed in Section
5. Environmental values and management impacts	<i>The mitigation measures, monitoring programs etc. identified in ... the EIS should be used to develop the EMP for the Project.</i>	The Plan has been developed from, and is consistent with, the PEP EIS and AEIS.
3.6.2 Objectives of the EIS	<i>The purpose of the EIS is to:... provide information to formulate the Project's EMP.</i>	
5.3.5 Transport management strategies	<i>Conditions of approval for transport management impacts should also be detailed in the EMP.</i>	Transport impacts and transport management measures are provided in Section 5.1.11. Marine transport is addressed in the Dredge Management Plan, Vessel Traffic Management Plan and Maritime Operation Management Plan (Part C of the EIS).
5.5.1 Sensitive environmental areas	<i>Outline how these measures [to mitigate impacts on sensitive environmental areas] will be implemented in the overall EMP for the Project.</i>	Measures to mitigate impacts on sensitive marine and land environments are provided in Section 5.0.
	<i>The overall EMP for the Project should address the performance requirements of the relevant policies and regional vegetation management codes published by Department of Environment and Heritage Protection (DEHP).</i>	There is no on-land vegetation impact by the PEP as such DEHP performance requirements are not applicable. Mitigation measures for terrestrial ecology are provided in Section 5.1.5.
5.5.2 Terrestrial flora	<i>Include details of any post construction monitoring programs.</i>	Not applicable. There are no terrestrial flora impacts to monitor.
	<i>Outline how these measures [addressing harm to the ecological values of the area] will be implemented in the overall EMP for the Project.</i>	Not applicable. There are no terrestrial flora impacts to mitigate.
	<i>Discuss the [weed management] strategies in accordance with provisions of the Land Protection (Pest and Stock Route Management) Act 2002 (Qld)...in the pest management plan in the EMP for the Project.</i>	Pest management element is provided at Section 5.1.6
5.5.3 Terrestrial Fauna	<i>Outline how these measures [for protecting rare or threatened species] will be implemented in the overall EMP for the PEP.</i>	Mitigation measures for terrestrial ecology are provided in Section 5.1.5.
	<i>Discuss the [feral animal (including pest)] strategies in accordance with the provisions of the Land Protection (Pest and Stock Route Management) Act ... in the pest management plan in the EMP for the PEP.</i>	Pest management element is provided at Section 5.1.6.
5.5.4 Aquatic ecology	<i>Outline how ... [aquatic ecosystem] measures will be implemented in the overall EMP for the PEP.</i>	Aquatic ecology aspects are covered in the Dredging Management Plan (Appendix B1).
5.6.2 Potential impacts and mitigation measures	Incorporate strategies to enhance water resource values into the EMP (paraphrased).	Mitigation measures for water resources are provided in Section 5.1.3.
13 Appendices – Consultation report	<i>...plans for ongoing consultation to be outlined and included in the EMP.</i>	Refer Section 7.0.

1.4.1 Legislation

The CEMP has been developed cognisant of legislative requirements set out in Commonwealth and State government Acts and Regulations. Specific requirements including permits and works approvals are described in Section C1.0 of the EIS and revised in Appendix C2 of the AEIS.

1.4.1.1 Commonwealth legislation

Commonwealth legislation considered in development of this CEMP (including Acts implementing relevant international conventions) includes:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Great Barrier Reef Marine Park Act 1975.*

1.4.1.2 State legislation

The following State legislation is relevant to the construction and has been considered in the development of this CEMP:

- *Sustainable Ports Development Act 2015*
- *State Development and Public Works Organisation Act 1971*
- *Coastal Protection and Management Act 1995*
- *Environmental Protection Act 1994 and Regulations*
- *Environmental Protection and Other Legislation Amendment Act 2014*
- *Fisheries Act 1994 and Regulations*
- *Marine Parks Act 2004 and Marine Parks (Great Barrier Reef) Zoning Plan*
- *Land Act 1994*
- *Nature Conservation Act 1992*
- *Transport Infrastructure Act 1994*
- *Sustainable Planning Act 2009 and Regulations.*
- *Aboriginal Cultural Heritage Act 2003*
- *Queensland Heritage Act 1992.*

1.4.1.3 State Planning Policies

The following State policies and plans are relevant to the construction and have been considered in the development of this CEMP:

- State Planning Policy
- State Development Assessment Provisions
- Environmental Protection Policies
- Conservation Plans
- Port notices and Port Land Use Plan.

2.0 Environmental Management System

POTL maintains its commitment to sustainable development and operation through its Environmental Management System (EMS). The EMS provides a framework for environmental management at the Port and reflects POTL's Environmental Policy and commitments to manage its activities with concern for people and the environment.

POTL's EMS is compliant with AS/NZS ISO 14001 2004 and facilitates continual improvement of environmental performance by:

- integrating environmental considerations into decision making and work practices related to the Corporation's core functions
- maintaining a high level of environmental awareness throughout the Corporation and the wider port community
- utilising systems which act to reduce the risk of environmental harm through the identification reporting, assessment, monitoring and control of environmental risks.

This CEMP includes the work elements necessary to satisfy environmental requirements in the construction phase of the PEP and generally complies with applicable elements of POTL's EMS.

Continuous improvement is a mandatory requirement of POTL's EMS. As part of the continuous improvement, the CEMP may be updated or amended as required, which may include being merged with other documents to streamline the EMP documentation or be incorporated into the Contractors CEMP. Any future amendments will take into account the intent of this document and the conditions of the existing approvals.

2.1.1 Environmental Policy

POTL Environmental Policy applies to POTL lands and activities, including the common user areas of the Port. It is:

- displayed at prominent locations in the workplace of POTL employees and on the website
- communicated to POTL employees and Contractors during induction and training
- reviewed regularly.

POTL's Environmental Policy (POTL, 2014) states:

Port of Townsville Limited (POTL) is committed to the protection of the environment and considers it as critical corporate value in the delivery and maintenance of port infrastructure and services and in planning for the future development of the Port of Townsville and Port of Lucinda.

POTL is committed to sustainable development and operation through responsible environmental management and continual improvement of environmental performance and the effectiveness of its Environmental Management System.

To achieve corporate performance consistent with this policy, POTL will employ the following principles: -

- *Integrate environmental considerations into decision making and work practices related to POTL's core functions.*
- *Maintain a high level of environmental awareness throughout POTL and the wider port community.*
- *Implement systems which act to minimise the risk of environmental harm through the identification, reporting, assessment, monitoring and control of environmental risks.*
- *Establish a framework for setting and reviewing environmental objectives and targets and measuring POTL's performance.*
- *Establish and maintain systems for assessing the environmental impacts associated with POTL's activities, identifying and acting on opportunities for improvement.*
- *Compliance with all relevant legislation, codes of practice and standards.*
- *Core functions to be conducted in a manner that will minimise waste, prevent pollution, promote efficient use of resources, reduce environmental impacts, and continually improve environmental and management system performance.*
- *Providing adequate resources including finances, to facilitate the fulfilment of POTL's environmental responsibilities.*

POTL's Board and senior management are responsible for providing the leadership to support the development and implementation of this Policy and for ensuring it is effectively applied.

This policy will be regularly reviewed following legislative or organisational changes, or as a minimum, every three years.

POTL personnel, Contractors and visitors must comply with the spirit and intent of the policy.

3.0 Project Description

The construction phase of the PEP includes the development of the following infrastructure and construction activities as summarised in Table 3.

Table 3 Summary of key PEP construction components

Component	Description
Construction of breakwater and land perimeter revetments	
Breakwater and revetment infrastructure (around reclamation perimeter).	Stage 1 will commence with the construction of a temporary revetment structure to capture soft material from under perimeter revetment bunds. Revetments with rock armouring will be constructed to protect the north-eastern and eastern edges of the Stage 1 reclamation area. Soft sediments from under revetments structures will be placed within the temporary revetment bunds. Stage 2 will continue construction of the revetment structure to the ultimate Project footprint. Soft sediments from under revetments structures will be placed within the Stage 1 reclamation area. A new north-eastern rubble mound breakwater with rock armouring will be constructed approximately one kilometre seaward of the existing eastern breakwater. The breakwater and revetment layouts will be configured to provide a protected outer harbour basin and the structural design will address extreme wave and water level events for the port infrastructure and land reclamation.
Western Breakwater (if required).	Contingent upon detailed analysis, construction of a new western breakwater for additional outer harbour protection without affecting the port design and operations.
Dredging works for augmentation of channels and development of outer harbour	
Handling and placement of dredged sediments (onshore).	Approximately 11.4 million m³ of dredged marine sediments from dredging in the outer harbour basin and Sea and Platypus channels will be placed within revetment bunds as part of land reclamation activities (note that management of dredge tailwater is addressed in the Dredge Management Plan). Dewatering and ground improvement of emplaced sediments on tidal lands will be undertaken.
Development of Port Land	
Bunds and treatment areas.	A reclaimed area of approximately 150 ha will be developed on tidal lands eastwards of the existing harbour (and defined by the north-eastern and eastern revetments and the wharf alignments). Selected fill material from land sources will be used to build bunds over tidal lands, constructed as conventional earth/rock fill structures, to contain the reclamation material. Internal bunds will be constructed on the alignments of future key infrastructure (including rail and roads) as suitable foundations for heavy loading. Bund structures will be constructed and configured to retain fill in stages and provide settlement areas for the temporary management and treatment of reclamation tailwater and thereafter permanent reclamation areas for created land. Select ponds will be used for the treatment of stormwater. A surface capping layer (approximately one metre thickness) and pavement layer will be applied where necessary
Port Infrastructure	
Berths and wharves.	Up to six berths will be constructed in the outer harbour (termed Berth 12 and Berth 14 through Berth 18) to support import and export trades and cargo handling requirements. At berths, wharves will be constructed similar to the existing wharf structures for vessel berthing, mooring, loading and unloading of general cargo, dry bulk and bulk liquid goods. Berths will be sized for vessels with a nominal length overall of 250 m. Construction will be staged to meet the demand for cargo throughput. This may be sequential on a berth-by-berth basis, or in stages involving multiple berth development. Berth pockets will be dredged to an all-tides depth of up to approximately -15.5 m Lowest Astronomical Tide (LAT).

Component	Description
Development on port land and ancillary services	
Cargo storage and handing areas.	Land area of approximately 150 ha to accommodate: ▪ cargo operations, ▪ cargo storage area ▪ road and rail transport corridors ▪ cargo storage area in rail loop. Final finished reclamation level nominally +7.5 m LAT (+5.6 m AHD) adjacent to the wharf structures and falling to the eastern revetment to accommodate drainage of stormwater.
Road Infrastructure.	Internal circulation road on the reclamation area to access facilities and key infrastructure. Vehicles ranging from cars to articulated combination vehicles will have access. Connection via existing Benwell Road to the Eastern Access Corridor. Access corridors along the back of wharves and from the main access road to individual storage areas will be built.
Rail Infrastructure.	A rail loop is proposed behind cargo storage and handling areas with provision for connecting to the existing rail network and Eastern Access Corridor (once feasible).
Buildings.	Construction of temporary and permanent port operations buildings as required for specific operations.
Utilities and other services.	Installation of services infrastructure relating to stormwater, water supply (including for fire fighting), power supply, waste water reticulation and telecommunications. Port security infrastructure. Area and road lighting.
Maritime operations	
Vessel movements during construction.	Establishment of temporary navigational aids.

3.1.1 Materials

The land area required for the PEP will be reclaimed using dredged material from the outer harbour basin as well as the Sea and Platypus Channels.

Selected fill material will be required from land sources to build bund structures to retain the dredged fill, to protect the reclamation from erosion and wave attack, and provide settlement areas for the management and treatment of the reclamation tailwater. Engineered fill material will also be required for construction of capping and pavement layers on the surface of the reclamation.

The bund walls will be constructed as conventional earth/rock fill structures. POTL intends to use the project specific Granitevale quarry and/or other quarries within the Townsville Region to supply the rock required for the breakwaters, revetments and bund walls for the PEP.

Construction materials will be transported to the site by road from various suppliers in the region and will predominantly be via the Eastern Access Corridor. Some construction materials may also be delivered via ship directly to the Port.

3.1.2 Design requirements

Perimeter bund walls exposed to the sea will be designed to withstand extreme metocean conditions with limited overtopping.

The bund walls will be designed and constructed to retain fine sediments within the reclamation, thereby avoiding the uncontrolled loss of fine sediments from the dredged material through the bund wall and back into Cleveland Bay.

The perimeter bund structure would typically incorporate a height adjustable weir box in the last settling pond to allow control of the overflow tailwater discharge over a period of time.

Internal bund walls will control the movement of sediment and water so that areas can be dewatered and suspended sediments can settle to control the quality of tailwater. Internal bund walls need to withstand wind-wave action that may be generated within the bunded areas.

Height adjustable weir boxes may be implemented between bunded areas to control the flow of water and suspended sediments. These are generally located to create a long path for the movement of water to maximise retention time.

3.1.3 Construction period

Construction of the PEP berths and associated land-side infrastructure is scheduled to occur over many years as shown in Figure 2. This figure outlines the revised Project construction timing based on the development staging described in Section 2.4 and Table 2.2 of the AEIS). Note that the program has assumed pre-construction planning activities commencing in 2017, which is dependent upon approval and approval timeframes.

As recognised in the AEIS, predicting exactly when the new berths and associated infrastructure would be required is dependent on trade growth and available port capacity. Other considerations including the long lead time in obtaining approvals, procuring contractors, construction timing and duration, require that the proposed sequence and timing of development would be regularly reviewed and adjusted to reflect the actual demand for cargo handling capacity and shipping requirements.

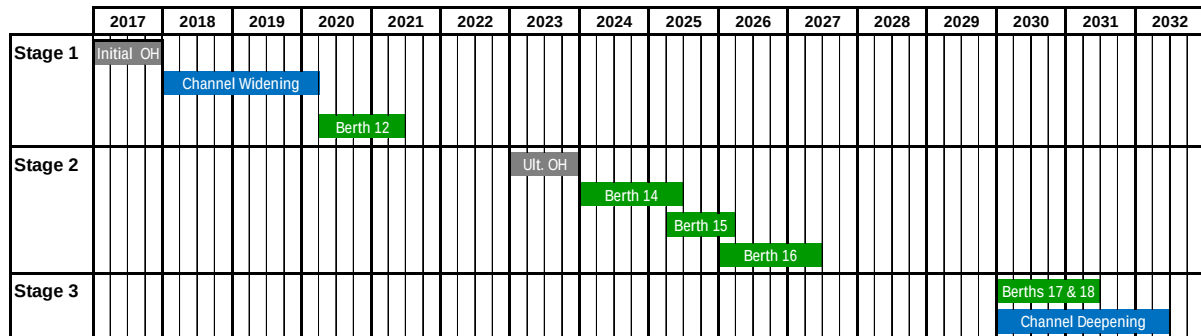


Figure 2 Indicative PEP staging program

Stage 1 will require construction of the perimeter bund wall / revetment structures for the initial outer harbour reclamation area prior to dredging work associated with the development of a widened channel and Berth 12. Similarly, Stage 2 will require construction of the perimeter bund wall / revetment structures for the ultimate outer harbour reclamation area prior to dredging work associated with the development of the berths.

There are seven key construction activities over the sequence of stages:

- *Construction of the Perimeter Revetments.* Construction will be undertaken in Stage 1 and completed in Stage 2.
- *Construction of the Main Breakwater.* Construction will be undertaken in Stage 2
- *Construction of the Western Breakwater* (if required). Construction would be undertaken in Stage 2.
- *Dredging.* Dredging is covered in the Dredge Management Plan. Dredging of the outer harbour basin would occur during all stages. Dredging to widen the Sea and Platypus channels will occur during Stage 1 and the dredging to deepen these channels will occur during Stage 3.
- *Construction of the reclamation area* – commences in Stage 1 and continues throughout construction phases.
- *Installation of road, rail, civil works and services* – commences in Stage 1 and continues throughout construction phases
- *Wharf construction* – commences in Stage 1 and continues throughout each of the construction phases for the respective berths.

3.1.4 Construction equipment

During the construction phase, for the land-based construction activities, a range of plant and equipment will be used to develop the Port, including:

- trucks (on road and off-road)
- excavators
- bulldozers
- cranes
- utility vehicles
- front end loaders
- stone column or wick drain rig
- bobcats
- grader

- paving machine
- track machine.

4.0 General Requirements

This section outlines the general environmental requirements that Construction Contractors would be expected to fulfil, in addition to meeting specified requirements for the environmental values set out in Section 5.0.

To ensure that activities are being carried out consistently with any existing procedures or protocols and comply with relevant environmental duties and obligations as set out in legislation and with environmental permit requirements, Contractors would be expected to address these general requirements as part of project planning, and throughout the construction period.

4.1.1 General method statement

For each construction work package, a general method statement will be prepared outlining the intended scope of works and methodology to be employed. At a minimum, the method statement will include the following:

- introduction
- description of the general scope of works (noting this may need to be by Stage only)
- references to relevant legislation, company standards (such as quality, occupational health and safety and environment management systems), how they apply to the current project and any other project specific document
- responsibilities of the Contractor and key staff
- a clear map of the areas where the construction activities are to take place consistent with regulatory approvals
- a general description of the construction process and the specifics of the plant to be used including the construction methods and controls.

4.1.2 Site/activity-based Environmental Management Plan

A site/activity-based EMP will need to be prepared by the Construction Contractor prior to commencement of construction. The Contractor's EMP must address the following:

- environmental commitments – including a commitment by senior management of the Contractor to achieve specified and relevant environmental goals
- identification of environmental risks and potential impacts
- control measures for routine operations to reduce the likelihood of environmental harm
- a suitable Emergency Spill/Incident Response Plan and Cyclone Plan
- contingency plans and Emergency Response Procedures for non-routine situations, organisational structure and responsibility
- development and implementation of hazardous material handling procedures
- monitoring commitments
- conducting environmental assessments
- appropriate staff training
- record keeping
- periodic review of environmental performance and continual improvement.

4.1.3 Hazardous substances, health and safety

The Construction Contractor is to meet Occupational Health and Safety requirements. Appropriate precautions and controls will be implemented to address all identified risks and protect the health and safety of people working at the site. Maintenance of measures, plant and equipment.

The Construction Contractor must check that measures, plant and equipment necessary to undertake the activity are operated and maintained in a proper and efficient condition.

This includes appropriate servicing and maintenance of engines and emission control devices such that emissions comply with relevant guidelines and standards.

4.1.4 Reasonable and practicable measures

The Construction Contractor must take reasonable and practicable measures to prevent and/or reduce the likelihood of environmental harm being caused.

4.1.5 Notification of environmental harm

The Construction Contractor is responsible for complying with all legislation. This includes complying with the general environmental duty which is to do all that is reasonable and practicable to minimise the risk of environmental harm.

In the case of material or serious environmental harm (as defined in the Queensland *Environmental Protection Act 1994*) occurring as a result of carrying out of the construction works the Contractor is responsible for ceasing activities and notifying POTL and the DEHP Pollution Hotline or local DEHP office as soon as practicable after becoming aware. Other notifications may be required in accordance with legislation and port notices as relevant to the specific event.

5.0 CEMP Elements

This section of the CEMP identifies specific environmental management procedures related to the on-land construction phase of the PEP. The requirements in this section are intended to apply in addition to the general requirements outlined in Section 4.0 of this CEMP. In most cases it will need to be integrated in broader site-based management plans and documentation and any conditions of approval imposed on the PEP under relevant legislation.

These requirements are to be addressed by either POTL or its Construction Contractor (whomever is applicable) as part of project planning so that the activities being carried out are consistent with any existing procedures or protocols in port limits or under relevant corporate environmental policies or strategies.

5.1.1 Structure of the EMP

The following environmental values have been identified in the EIS as key risks for the set of factors that require consideration in the CEMP:

- land
- water resources (surface water aspects) *
- marine water quality (reclamation aspects) *
- marine sediment quality (reclamation aspects) *
- marine ecology and conservation (reclamation aspects) *
- terrestrial ecology
- air quality
- noise and vibration
- greenhouse gases
- waste
- transport and infrastructure
- indigenous cultural heritage
- non-indigenous cultural heritage
- visual amenity and lighting
- pest management
- hazards and hazardous materials.

*Note: Marine aspects in relation to these factors are considered in the Dredge Management Plan.

For each value identified, an environmental management strategy and actions have been developed to address potential risks that may arise as a result of construction activities. Each value has a stated environmental objective, performance criteria, management actions, monitoring, reporting, and corrective actions. The structure used for the strategy and actions are outlined in Table 4.

Table 4 CEMP structure

Order of Implementation	Plan Component	Description of Content
1	Environmental risks (Aspect-Impact)	The environmental aspect of construction requiring management response - strategies and actions.
2	Environmental Performance Objective	The guiding performance objective that applies to the values of the factor.
3	Performance Criteria	The criteria by which the success of the implementation of the policy will be determined.
4	Monitoring and Reporting	The process of measuring actual performance, or how well the policy has been achieved, including format, timing and responsibility for reporting and auditing of the monitoring results.
5	Implementation Strategies and Management Actions	The mechanisms and management actions through which the performance objective will be achieved.
6	Corrective Action	The action to be implemented and by whom in the case where a performance criterion is not met.

A separate table is provided to address each value (refer to Section 5.0). Mitigation of some potential impacts, such as the removal of marine habitat through reclamation, will be considered through potential offsetting opportunities rather than construction management measures, and are not included in this CEMP.

5.1.2 Land

Aspects and Impacts	- Disturbed dredged or excavated Potential Acid Sulfate Soils (PASS) material, or imported contaminated soil/fill placed in the reclamation area - Spills or leakage of fuels/oil and other contaminants, hazardous materials or dangerous goods causing soil contamination.
Environmental Performance Objectives	- To avoid environmental harm as a result of changes to landforms in relation to: - contamination - PASS.
Performance Criteria	- No soil contamination from leaks and spills on site - No contaminated fill from external sources brought into site - PASS management procedures and plans developed and implemented.
Monitoring and Reporting	- Regular site inspections to check for leaks, spillage and damage to bunded/storage/refuelling areas and equipment - Monitor the pH of retained water in the dewatering ponds - Monitor and record sources, condition of fill and any movement offsite.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Minimise the risk of fuel/oil spills by undertaking regular inspections and maintenance of machinery, including: - daily inspection of machinery - inspecting for leaks prior to allowing any external vehicles or machinery on site - maintenance of site machinery in accordance with manufacturers recommendations.	Construction Contractor	Throughout the construction period.	Any material impacted by spills shall be managed through: - investigation - excavation of impacted material. Disposal of impacted material at a suitable disposal facility, with appropriate DEHP approvals and by a licensed waste disposal subcontractor as required.
Store hazardous materials, chemicals, oils and fuels in clearly designated storage areas, as far as practicable from sensitive receptors. Ensure storage areas consist of a compacted base and appropriate bunding to contain spillages in accordance with applicable standards at the time of construction. Cover storage areas to prevent stormwater infiltration.		Install designated storage areas prior to storing hazardous material on site.	Inspect and maintain storage areas, including repair of bunds if necessary. Clean up any spilled material promptly.
Store chemicals in accordance with appropriate standards. Maintain an up-to-date hazardous and potentially hazardous materials register on site.		Throughout the construction period.	A permit shall be obtained from the appropriate authority for bulk storage of chemicals, oils and/or petroleum products, where on site storage exceeds minor storage limits.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Develop Acid Sulfate Soil Management Plan in consultation with DEHP for management and monitoring of the reclamation area to inform the contractor of the risks and management requirements for PASS. Include appropriate triggers and protocols eg monitor water quality (pH and DO, minimum) of standing water within the reclamation area and tailwaters prior to discharge.	POTL / Construction Contractor	Prior to construction period.	Review and revise controls required.
Sample Pleistocene soils in dredge areas to confirm PASS status/management requirements. Place any PASS dredge spoil in reclamation area below LAT. Survey to confirm top of placed PASS. Where PASS is placed above LAT, sample in accordance with relevant standards to confirm the need for further management measures.			
Maintain significant depths of filling over soft Holocene sediments in the reclamation area to prevent heaving and displacement of PASS above sea level.	Construction Contractor	Throughout the construction period.	Review reclamation management practices if adverse impacts are observed.
Keep dredged materials wet and saturated during transport to reclamation area. Ensure compliance with holding times outlined in the Queensland Acid Sulfate Soil Technical Manual.			Review reclamation management practices if pH drops observed in waters within the reclamation area.

5.1.3 Water resources (stormwater and drainage)

Aspects and Impacts	- Increased turbidity of marine waters during construction of PEP lands due to sediment in stormwater runoff (note that dredge tailwater management is discussed in the Dredge Management Plan) - Stormwater contamination may arise due to oil/fuel leaks - Effects on marine life, as well as indirect potential impacts to human health, through the exposure and potential release of contaminants in stormwater to marine waters.
Environmental Performance Objectives	- No adverse impacts to water and sediment quality of Cleveland Bay - To avoid contaminants discharging into the environment from construction activities - To minimise to the extent practicable, turbidity impacts from stormwater discharges beyond the development footprint.
Performance Criteria	- No exceedance of limits set in reactive monitoring program for suspended sediment concentrations for open waters - Fuel / chemical storage is secure or any spill is adequately contained and cleaned up - No failure of erosion and sediment controls.
Monitoring and Reporting	- Regular inspections of stormwater runoff areas to check for cleanliness and potential for contaminants to impact on water quality - Regular site inspections to check for leaks, spillage and damage to bunded storage areas - Immediately notify POTL in the event of an uncontained spill - Site specific management actions including erosion and sediment controls, will be developed and implemented by the Contractor prior to construction.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Direct stormwater to sediment basins to eliminate off-site migration of sediment. Stage the design and placement of sediment basins according to construction schedules.	Construction Contractor	Prior to construction of reclamation area.	Review and modify equipment and controls if any adverse impacts are observed.
Control surface drainage from the reclaimed area through appropriate site management (i.e. drainage reports to sediment ponds and drains are collected and prevented from entering the sea by use of low bunds, sand bags or other temporary control measures). Integrate on-site containment in the turbidity management/treatment that is required for any discharge water.	Construction Contractor and POTL during periods between construction stages.	During construction of the reclamation area.	Increase tailwater residence time in the tailwater pond. Redirect supernatant from the filling cells to other cells to allow further settlement before being discharged.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Minimise the risk of fuel/oil spills by undertaking regular inspections and maintenance of machinery, including: - daily inspection of machinery - visual inspection for leaks prior to allowing any external vehicles or machinery on site - maintenance of site machinery in accordance with manufacturers recommendations.	Construction Contractor	Throughout the construction period.	Any material impacted by spills shall be managed through: - investigation - excavation of impacted material - disposal of impacted material at a suitable disposal facility, with appropriate DEHP approvals and by a licensed waste disposal subcontractor.
Store hazardous materials, chemicals, oils and fuels in clearly designated storage areas, as far as practicable from sensitive receptors. Ensure storage areas consist of a compacted base and appropriate bunding to contain spillages in accordance with applicable standards at the time of construction. Cover storage areas to prevent stormwater infiltration.		Install designated storage areas prior to storing hazardous material on site.	Inspect and maintain storage areas, including repair of bunds if necessary. Clean up any spilled material promptly.
Minimise the risk of contaminant spills by: - undertaking spill response training for staff - developing and implementing hazardous material handling procedures - implementing emergency response procedures - installing oil and grit separators for equipment maintenance areas on site - providing spill control materials including booms and absorbent materials in the event of a chemical spill.		Develop procedures applicable for each construction area and update for change of work as appropriate.	Regularly review the spill clean-up procedures / equipment and update as required.
Minimise to the extent practicable contamination of surfaces exposed to runoff generation through source controls.		Install in each staged construction area prior to staged construction commencement.	Review and modify equipment and controls if adverse impacts are observed.

5.1.4 Marine ecology and conservation (reclamation aspects)

Aspect and Impacts	- Increased turbidity and potential contamination from on-site facilities, potentially affecting water quality, species or the quality of their habitats - Light spill from construction plant and port facilities may lead to disorientation of marine animals - Emission of waste may increase the risk of entanglement and/or ingestion of marine debris by marine vertebrates - Increase in noise and vibration leading to marine fauna temporarily avoiding affected area.
Environmental Performance Objectives	- To avoid indirect effects on marine megafauna and the marine ecology - To prevent contamination from construction activities entering the marine environment.
Performance Criteria	- No injury or fatality to marine megafauna as a result of PEP construction activities - No reduction in fauna diversity or occurrence evident from light spill - No permanent loss of benthic habitat beyond the development footprint.
Monitoring and Reporting	- Regular site inspections carried out to monitor the construction area for compliance with light and waste management procedures, and hazardous material handling procedures - Marine performance monitoring of relevant aquatic indicators.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Implement light management procedures to reduce light spill to the marine environment (refer to Scenic Amenity and Lighting 5.1.15) whilst ensuring that Health and Safety including Navigation Safety is maintained.	Construction Contractor	During design phase; implement and check during construction phase.	Review light management procedures.
Implement waste management procedures (refer to Waste Section 5.1.10).		During construction phase.	Review waste management procedures and modify if required so that rubbish does not enter water and potentially affect marine animals.
Implement control measures to reduce the likelihood and impact of contaminant spills (refer to Land Section 5.1.2 and Water Resources Section 5.1.3).			Review and modify equipment and controls if any adverse impacts are observed.
Implement control measures to reduce the likelihood and impact of turbidity (refer to Water Resources, Section 5.1.3).	Reclamation area Contractor		Review and modify site practices if any adverse impacts are observed (refer also to tailwater management elements of the Dredge Management Plan).

5.1.5 Terrestrial ecology

Aspect and Impacts	▪ Injury/mortality to avifauna resulting from construction activities such as vehicle movements ▪ Noise emissions (and vibration) e.g. piling leading to behavioural disturbance in fauna ▪ Light spill from construction plant leading to disturbance to avian habitats ▪ Introduction and/or spread of declared weeds or animal pests.
Environmental Performance Objectives	▪ To avoid injury and death of avifauna from construction activities ▪ To avoid or minimise to the extent practicable the level of noise and light spill on adjacent habitat areas used by shorebirds ▪ To avoid introduction and/or spread of declared weeds or animal pests.
Performance Criteria	▪ Light spill from Project site to bird habitat areas on the sand spit is avoided or minimised to the extent practicable whilst ensuring that Health and Safety including Navigation Safety is maintained ▪ No reported incidents of harm or mortality to terrestrial fauna as a result of construction activities ▪ Effective control of declared weeds on the construction site ▪ No increase to the number of pest species on the construction site above background levels in surrounding port.
Monitoring and Reporting	▪ Regular site inspections for injured wildlife ▪ Any incidents that affect terrestrial fauna to be reported to relevant authorities ▪ Regular site inspections for declared weed infestations, and animal pests.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Enforce site speed limits to reduce fauna collision.	Construction Contractor	Prior to and during construction.	Review and modify controls as required.
Limit unnecessary vehicle use near sensitive areas to prevent disturbance to sensitive receptors.			
Implement procedures on the handling and reporting of injured fauna.			
Maintain plant equipment and machinery.			
Orientate light and noise emitting equipment away from foreshore whilst ensuring that Health and Safety including Navigation Safety is maintained.			
Consider lighting design and arrangements to reduce light spill from the site to shorebird habitat on the spit at the mouth of Ross River.			
Implement control measures to manage noise risks to fauna outside of the Port (refer to Noise and Vibration, Section 5.1.8).			
Implement weed and animal pest management on site (refer to Weed and Animal Pest Management Section 5.1.6).			

5.1.6 Weed and animal pest management

Aspects and Impacts	- Introduction and/or spread of declared weeds by site movements and to and from site - Introduction or spread of pest animals into the construction site.
Environmental Performance Objectives	- To avoid the spread of declared weeds and pests to and from the site - To minimised to the extent practicable the attraction of the PEP area to pest animals.
Performance Criteria	- Effective control of declared weeds on the construction site - No increase to the number of pest species on the construction site above background levels in surrounding port - No mosquito breeding habitat is created.
Monitoring and Reporting	- Regular site inspections for declared weed infestations - Monitor the presence and abundance of pest animal species in the PEP reclamation area - Regular site inspection for mosquito breeding areas prior to and during the wet season.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Limit vehicle movement through known declared weed infested areas.	Construction Contractor	Throughout construction period.	Review and modify controls as required.
Wash down vehicles and plant equipment entering or leaving site for the first or last time in accordance with industry standards.			Review and modify operational practices if there is a breach.
Use wheel wash whenever vehicles move from unsealed roads to sealed roadways e.g. road between excavation area and off-site.			
Keep construction work area free of food waste or other attractants to mice and rats.		Throughout construction period.	Mice and rats will be trapped or poisoned before numbers cause human health concerns.
Keep construction work area free of food waste or other attractants to dogs, cats and foxes.			Feral dogs, foxes and cats will be trapped and euthanised humanely.
Keep construction work area free of food waste or other attractants to cane toads and birds.			Licensed pest control contractor engaged to control numbers if required.
Ensure imported fill material is weed free.			Review and modify controls as required.
Inspect construction site for potential mosquito breeding locations.		Prior to and during the wet season.	Regularly review the construction site and implement controls if required during the construction phase.

5.1.7 Air quality

Aspects and Impacts	- Fugitive dust from exposed surfaces during construction may result in: - increased risks to human health - nuisance - discolouration of buildings or structures - Fuel combustion emissions from vehicles and equipment.
Environmental Performance Objectives	- To meet or exceed air quality standards relating to dust from construction activities - To meet or exceed air quality standards relating to vehicle emissions from construction activities - Record and address air quality complaints.
Performance Criteria	- Construction meets or exceeds Environmental Protection (Air) Policy 2008 standards and appropriate ambient air quality guidelines at sensitive receptor locations - Adaptive management in response to complaints from stakeholders affected by dust emissions or in accordance with reactive dust monitoring result and trigger values.
Monitoring and Reporting	- Visual monitoring and observation of weather conditions that result in dust liberation and elevated particle concentration - Continuous monitoring and/or air quality monitoring campaigns - Record and respond to complaints.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Implement Reactive Monitoring Program and trigger values.	POTL and Construction Contractor	Prior to and throughout construction period.	Review and modify measures as required.
Reduce fuel combustion emissions through management measures such as: - turning engines off while parked on site - regularly tuning, modifying or maintaining equipment, plant and machinery to reduce visible smoke and emissions - implementing site speed limits - reducing haul road lengths - managing vehicle movement to prevent queuing/idling.	Construction Contractors	Throughout construction period.	Review and modify measures as required.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Implement dust control measures including: - erecting localised windbreak barriers on activities (to 2.4 m height), particularly to the west of works, if required - using water sprays on stockpiled and disturbed areas - using water sprays (water truck) to suppress dust on trafficked areas - using a wheel wash whenever vehicles move from unsealed roads to sealed roadways e.g. road between excavation area and off-site - adjusting work practices (as required) based on wind observations (e.g. ceasing dust-generating works under extreme windy conditions or when dust is observed to leave the site) - adjusting work practices (as required) based on real time dust monitoring - where necessary vehicles to cover loads when transporting fill.	Construction Contractor / POTL		Implement corrective measures outlined in Air Quality Reactive Monitoring Program which includes triggers against a staged approach: Investigate, Action and Stop Work: - Investigate: designed to identify the issue, the likely reasons and formulate a response should the Action stage be reached. - Action: designed to implement those measures formulated in the Investigate stage and review their effectiveness. - Stop Work: there is a high likelihood that the pollutant criterion may be reached. Works are to stop at this stage until the measured pollutant levels are below the Action level. Amend construction program for modifying or scheduling works that mobilise particulates depending on ambient conditions that may cause wind re-suspension.
Stabilise vacant land areas (by methods such as planting / hydro mulching) as soon as practicable after reclamation construction has been completed.	Construction Contractor	Following construction of each stage.	Review and implement additional corrective measures to avoid unacceptable dust nuisance.
Maintain vacant fill areas between PEP development stages so as to minimise dust nuisance.	POTL	Between stages.	Increase frequency of inspection of vacant areas and undertake identified maintenance actions.
Operate a complaints management system.	POTL	At all times.	Review and modify management practices as required.

5.1.8 Noise and vibration

Aspects and Impacts	- Onsite construction equipment, particularly during piling works and rockfill reclamation, causing offsite disturbance of sensitive receivers - Heavy vehicles impacting receivers on Boundary Street and near the boundary of the site - Vibration effects during the construction phase from use of plant and equipment and haulage.
Environmental Performance Objectives	- To meet or exceed noise and vibration standards relating to dust from construction activities - To minimise to the extent practicable the number of complaints related to noise and vibration events during the construction phase.
Performance Criteria	- Noise and vibration levels to meet relevant Queensland standards or appropriate noise guidelines at sensitive receptors - Record and address noise and vibration complaints.
Monitoring and Reporting	- Noise and/or vibration monitoring will be carried out by Construction Contractor as required - Record and respond to complaints.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Proactively notify any affected residents and commercial operators of planned construction activities (including timing and duration of piling and rockfill placement).	POTL / Construction Contractor	Prior to noise generating activities.	Revise notification procedures and times to allow adequate consideration of potential noise impacts by the community.
Restrict piling activities to prescribed daytime work hours, excluding Sundays and Public Holidays. Consider alternative piling types, e.g. screw-type piling in place of impact piling if these alternative methods are available and feasible. Implement strategies to avoid megafauna interactions e.g. undertake visual monitoring during piling activities, soft starts etc.	Construction Contractor	During piling operations.	Review and modify construction practices if effects are anticipated to be prolonged. Monitoring, and adjusting where necessary, elements of piling such as reducing the height and weight of the impact hammer.
Consider noise mitigation when operating construction equipment / plant, including: - selecting low-noise plant and equipment in good working order - ensuring that equipment has high-quality mufflers installed - ensuring that equipment has been well maintained and fitted with appropriate silencers that meet the design specifications - orientating plant known to emit noise strongly in one direction (ie. manifolds on compressors) so that noise is directed away from noise sensitive receptors - ensuring that machines that are used intermittently are shut down in the intervening periods between works or throttled down to a minimum - ensuring that silencers and enclosures are kept intact, rotating plant is balanced, loose bolts tightened, frictional noise reduced through lubrication and cutting noise reduced by keeping blades sharp		Throughout construction period.	Review and modify construction practices as required.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
- ensuring that equipment which is not in use is shut down - ensuring that only necessary power levels are used to complete construction tasks.			
Install an acoustic enclosure around noisy plant if it is fixed in a stationary location for one week or longer and likely to adversely affect sensitive receptors. The acoustic enclosure will be constructed in accordance with AS 2436-2010 - Guide to noise and vibration control on demolition and maintenance sites.		If plant remains stationary, where sensitive receptor may be impacted for at least a week.	Review and modify equipment and construction practices if adverse effects occur.
Locate site compounds and noisy plant as far away from noise sensitive receptors as practicable.		Throughout construction period.	Review and modify construction practices if adverse effects occur.
Operate a complaints management system.	POTL	At all times.	Review and modify management practices as required.

5.1.9 Greenhouse gases

Aspects and Impacts	Greenhouse gas emissions will be produced during construction.
Environmental Performance Objectives	To identify and reduce unmitigated greenhouse gas emission loads.
Performance Criteria	- To reduce the calculable greenhouse gas emissions through implementation of planning, design and management actions - To meet applicable Commonwealth and State legislation and standards for greenhouse gas emissions release.
Monitoring and Reporting	- Monitoring energy use and changes to efficiency on site, primarily through the use of monitoring fuel consumption - Monitoring key performance indicators to track construction greenhouse gas emissions, detect trends early and implement measures to address any unforeseen increases in emissions.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Develop targets and goals through: - developing a set of key performance indicators for carbon management for the construction of the port expansion to track performance over time - monitoring key performance indicators on a monthly basis to enable Construction Contractor to monitor construction greenhouse gas emissions, detect trends early and implement corrective actions.	Construction Contractor	Prior to and during construction.	Review practices and monitor ongoing performance.
Increase awareness through: - including greenhouse gas awareness training as part of site inductions - undertaking periodic energy audits to monitor energy use and changes to efficiency on site - keeping informed of best practice industry standards, research into new technology and energy efficiency and trial new approaches where appropriate.			
Implement energy efficiency measures through: - maintaining equipment - installing energy saving timers, light sensitive switches and energy efficient lighting in and around the buildings - selecting appliances considering energy efficiency.	Construction Contractor	Throughout construction period.	Review practices and monitor ongoing performance.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Reduce fuel use during construction by a number of measures such as: - reducing transport distances and mobilisation of plant - planning construction works to avoid double handling of materials - using fuel efficient vehicles and investigate replacing diesel with a less emission intensive fuel, such as biodiesel or use of hybrid vehicles. Turning off engines when any significant delays occur - coordinating and optimising staff travel arrangements. Reducing energy through material use and selection, including: - considering use of materials with high recycled content or lower embodied construction materials - considering the feasibility of sourcing polyester geotextile manufactured from recycled PET for the reclamation area - where feasible, reducing the quantity of required construction material.			
Investigate the use of renewable energy on site, including: - investigating renewable energy options for construction administration facilities - investigating the feasibility of generating electricity from a renewable source on-site - considering the use of solar panels for rock wall, security and road lighting during construction and powering isolated items such as pumps.	Construction Contractor	Detailed design phase.	Review practices and monitor ongoing performance.

5.1.10 Waste

Aspects and Impacts	- Incorrect handling and storage of waste materials may result in the introduction of wastes into the marine environment or surrounding lands - Presence of waste materials may encourage pests and provide breeding habitats for mosquitoes.
Environmental Performance Objectives	- To coordinate the handling, storage, recycling and disposal of waste materials during construction - No litter or waste lost from PEP development footprint into adjacent marine environment.
Performance Criteria	- Waste materials are handled, stored and disposed of in a safe and secure manner in accordance with relevant legislation - Environmental disturbance to surrounding marine area from construction waste is avoided - No mosquito or animal pest breeding habitat is created.
Monitoring and Reporting	- Auditing the management and disposal of waste from construction area - Incident reporting in the Contractor database to identify areas where waste management is creating adverse impacts - Regular site inspection for mosquito breeding areas prior to and during the wet season.

Implementation Strategies and Management Actions*	Responsibility	Timing	Corrective Actions
Minimise the amount of any substance required by construction activities to be brought and stored on site.	Construction Contractor	Throughout construction period.	Review waste management practices and modify if required if any adverse impacts are experienced.
Reuse construction waste on site (for examples bricks/concrete and timber) where appropriate.	POTL / Construction Contractor		
Take products that can be recycled to a licensed recycling facility where appropriate.	Construction Contractor		
Engage a licensed waste contractor to regularly remove and dispose of waste at licensed facilities and maintain waste disposal areas.			
Dispose of any waste products that cannot be re-used or recycled at a licensed waste disposal facility.			
Provide separate stockpiles or bins for different waste streams to avoid cross contamination of waste streams. Provide waste bins/receptacles to isolate liquid wastes.			
Store hazardous and asphaltic wastes in an appropriate bunded and covered area in accordance with Hazardous and Waste requirements listed in 5.1.14.			

Implementation Strategies and Management Actions*	Responsibility	Timing	Corrective Actions
Monitor the management (storage, handling) and disposal of waste from the construction area. Regular site inspections for mosquito breeding areas prior to and during wet season.			
Remove sewage via a temporary connection to reticulated waste water system if possible.		Until alternative or permanent connection established.	
Store empty drums and storage containers in an appropriately bunded area.		Throughout construction period.	
Store, handle and transport regulated waste in accordance with DEHP requirements, and where applicable the Hazardous and Waste requirements listed in 5.1.14.	POTL / Construction Contractor		
Inspect construction site for potential mosquito breeding locations.		Prior to and during the wet season.	Regularly review the construction site and implement controls if required during the construction phase.

*Management actions listed in order of preference in accordance with the waste hierarchy.

5.1.11 Transport and infrastructure

Aspect and Impacts	- Traffic congestion at some key road intersections due to construction traffic - Degradation of pavement due to additional traffic loading on pavements from construction activities.
Environmental Performance Objectives	To avoid disruption to existing road transport infrastructure.
Performance Criteria	Traffic delays from construction at the port do not contribute significantly to peak traffic loads.
Monitoring and Reporting	- All heavy vehicle movements to be recorded by Contractor and reported to POTL - Record and respond to complaints.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Undertake additional impact assessments (Road Impact Assessment, Traffic Operations Assessment) a minimum of six months prior to haulage of quarry material commencing.	POTL	Prior to construction.	Review requirements and engage in discussions.
Undertake a Road Safety Audit a minimum of six months prior to haulage of quarry material commencing.			
Update the Port Community Forum as required for any transport and safety issues.			
Determine the need for pavement rehabilitation and maintenance in consultation with DTMR.			
POTL to consider contractual requirements for Contractor to use certain routes.	POTL / Construction Contractor	Prior to and during construction.	Contractor to be penalised for not meeting obligations.
Investigate intersection improvements to mitigate against additional traffic impacts from construction related activities. Investigate cost effective solutions to alleviate additional traffic impacts from the expanded port activities.	Construction Contractor	Following commencement of construction and to be maintained throughout the construction phase.	Review intersection performance and apply alternative improvements if adverse impacts are experienced.
Heavy construction vehicles to use designated heavy vehicle routes. Consider future planning projects (i.e. Riverway Drive) in allocating haul routes.		Throughout construction period.	Review heavy vehicle route or driver training/induction.
Pavement rehabilitation and maintenance to cater for the additional loadings from construction related heavy vehicles if required by pavement impact assessment.		As required based on pavement impact assessment.	Road repairs to be undertaken as soon as practicable.
Operate a complaints management system.		Throughout construction period.	Review and modify management practices as required.

5.1.12 Indigenous and non-Indigenous cultural heritage

Aspects and Impacts	- Disturbance or loss of significant Indigenous cultural heritage values or artefacts in the marine environment or land - Degradation or loss of non-Indigenous heritage item or place.
Environmental Performance Objectives	- To avoid disturbance of significant Indigenous values or artefacts - To avoid disturbance or degradation of significant non-Indigenous heritage items or places.
Performance Criteria	- No loss or disturbance of significant Indigenous values or artefacts or non-Indigenous heritage items or places as a result of construction - No complaints from people likely to be affected by damage to Indigenous or non-Indigenous areas or sites.
Monitoring and Report	- Reporting suspected Indigenous discoveries in accordance with the Cultural Heritage Management Plan - Reporting suspected non-Indigenous discoveries to DEHP.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Engage in ongoing consultation with Indigenous parties in accordance with the Cultural Heritage Management Plan.	POTL	Prior to and during construction.	Review the Cultural Heritage Management Plan and consultation protocol if there are risks of unexpected adverse effects or complaints are made.
Provide cultural heritage induction to relevant personnel and contractors involved in the construction prior to commencement of work.	Construction Contractor / POTL		Review the induction package and procedures if adverse impacts are observed.
Cease work immediately if any Aboriginal cultural heritage sites, materials or values are discovered during development pending an inspection by a representative from the Aboriginal Parties.	Construction Contractor	Throughout construction period.	Follow advice provided on inspection by the representative from the Aboriginal Parties.
Cease work immediately (within 100 m of the remains) If human skeletal material is discovered during development works. Immediately contact the Queensland Police, Cultural Heritage Coordination Unit (DEHP) and an Aboriginal representative.			If works do not cease, penalties apply. Follow advice provided by DEHP and the Aboriginal representative regarding established policy and procedures for dealing with human remains. .
Cease work around suspected non-Indigenous heritage discoveries and notify DEHP immediately.	Construction Contractor	Throughout construction period.	Follow advice provided by DEHP.

5.1.13 Scenic amenity and lighting

Aspect and Impacts	- Scenic amenity could be adversely affected by artificial light associated with the port infrastructure used during night time construction - Local scenic amenity may be affected by constructional plant, waste and suspended sediment in the marine environment - Dust emissions on residents and recreational users.
Environmental Performance Objectives	To minimise to the extent practicable any temporary adverse visual effects associated with constructional activities of the PEP.
Performance Criteria	- Minimal visual impact on water clarity from construction activities - Minimal visual impact from dust on surrounding areas - Minimise light spill outside of POTL controlled areas.
Monitoring and Reporting	- Daily site inspections to monitor for water pollution, rubbish and dust associated with the construction - Regular inspection of areas surrounding the port development area, particularly following changed lighting conditions e.g. at the start-up of a stage - Record and respond to complaints.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Manage lighting and design to reduce light spill from the site in so far as consistent with existing Operational Health and Safety and Land Use codes. Exterior lighting is to comply with relevant guidelines.	Construction Contractor	Throughout construction period.	Review and modify lighting management practices if any adverse impacts are observed.
Implement control measures to reduce: - fugitive dust (refer to Air Quality, Section 5.1.7) - stormwater releases (refer to refer to Water Resources, Section 5.1.3) - suspended sediment from dredging (refer to Dredge Management Plan) - waste control measures, including shipping waste.			Review and modify management practices if any adverse effects are reported.
The new site will be fenced and access controlled in a similar manner to the existing Port.			Inspect and repair damaged fencing.
Maintain a high standard of site cleanliness and presentation. Regularly remove and dispose of rubbish and manage waste in accordance with Waste, Section 5.1.10).			Review and modify site house-keeping practices and waste management if any adverse impacts are observed.
Progressive stabilisation of reclaimed land and reducing disturbed and exposed areas (e.g. access road verges).			Disturbed land to be established and vegetated as appropriate as soon as practical after reaching final levels.
Operate a complaints management system.	POTL	At all times.	Review and modify management practices as required.

5.1.14 Hazards and hazardous materials

Aspect and Impacts	Potential impacts to human and environmental health from exposure to hazards and hazardous materials.
Environmental Performance Objectives	To handle and store hazardous materials in the appropriate manner.
Performance Criteria	Hazardous materials to be stored and handled in accordance with relevant standard or manufacturer's instruction.
Monitoring and Reporting	- Contractor to regularly inspect the Safety Data Sheet register for currency and completeness - Conduct inspections to monitor construction area for compliance with hazardous material handling and storage procedures.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Store and handle hazardous materials in accordance with relevant standards of manufacturer instructions (refer to Waste, Section 5.1.10).	Construction Contractor	Throughout construction period.	Review of handling and storage products to be undertaken.
Hold and display Safety Data Sheets (SDS) for hazardous materials in a prominent location near the storage and usage sites of hazardous materials.			Inspection of hazardous material storage and use areas for correct SDS.
Minimise the use of hazardous materials where possible and implement alternatives if feasible.			Review hazardous materials and identify alternatives where feasible.
Plan the delivery of hazardous materials to site in line with programmed use to avoid the need to store significant quantities of hazardous materials on site.			Review procurement procedures of hazardous materials in accordance with programmed use.

6.0 Action Program

6.1.1 Continuous improvement

CEMPs are 'living documents' that require review (at least annually) during the construction phase and amended, as necessary, to allow new or changing environmental risks relating to the PEP to be addressed. Feedback systems will be in place for the duration of the Project to enable the CEMP to be updated and responsive to learning from any incidents, complaints and ongoing monitoring results.

This CEMP would be reviewed and updated to reflect knowledge gained during the course of construction and to reflect new knowledge and changed community standards (values). Changes to the CEMP may be developed and implemented in consultation with relevant authorities and stakeholders over time.

Other triggers for CEMP review may include:

- findings and recommendations of Contractor EMPs and/ or work procedures
- changes to organisational structure, roles and responsibilities
- changes in environmental legislation and/or policies
- new technologies / innovation relevant to applied methods and controls that provide innovative means of executing work in order to meet performance criteria.

6.1.2 Environmental auditing

POTL will monitor performance against the contract held with the Construction Contractor in accordance with its EMS during the Contractor's construction campaign.

6.1.3 Monitoring

Monitoring for each value is detailed at Section 5.0. This monitoring will enable:

- early detection of environmental management issues during construction
- where applicable, development of baseline environmental information for the Port from which trends and changes in the environmental quality of the Port over the period of construction can be detected.
- equipment to be maintained and calibrated in accordance with the manufacturer's instructions.

6.1.4 Records

During construction, records of the ongoing site monitoring shall be maintained. A range of records will be required during construction which include but are not limited to:

- those maintained to meet detailed design specifications and standards, construction works will be subjected to Inspection Test Plans (ITPs) that will confirm and ensure the design intent is achieved through quality testing and verification processes
- monitoring data sheets, calibration records, results and reports
- incident and complaints.

Records would allow auditing and encourage the use of preventative action, as well as corrective action following non-compliance.

Environmental records will be:

- kept as objective evidence of compliance with environmental requirements
- maintained according to POTL's Record Keeping Procedure and contract.

Environmental records and the EMP will be controlled in accordance with the Contractor Management System.

6.1.5 Staff training

Construction personnel shall attend an induction prior to commencing work at the site. The induction will include the environmental commitments and measures contained in this CEMP. Construction workers attending the induction will be mentored to support the implementation of commitments by construction staff.

7.0 Community Engagement

This section outlines plans for on-going consultation with the community.

7.1.1 General enquiries, information and visitors

Contact can also be made via POTL's website. POTL invites public comment via their 'Tell us what you think' page (<http://www.townsville-port.com.au/feedback>). General contact details for POTL are also provided on their website:

Telephone: 07 4781 1500

Facsimile: 07 4781 1525

Email: info@townsville-port.com.au.

Established lines of communication (e.g. Port Community Partnerships Forum, Stakeholder Engagement Management Plan or Complaints Policy (see below)) will be used as avenues to regularly convey information and receive feedback regarding POTL's practices to maintain high standards of community health and wellbeing for adjoining residents and visitors to the area. Project related information will be circulated via a range of avenues, well in advance of undertaking construction works to keep the community well informed. Such considerations include communication regarding:

- transport and safety issues to nearby residents and the general community
- entry restrictions, available sites of shore-based fishing and POTL plans for maritime activity and temporary signage at boat ramps in Ross Creek and Ross River
- stages for the PEP and potential effects on recreational and other boating into Cleveland Bay from Ross River and Ross Creek to the boating community and other organisations such as the Townsville Motor Boat and Yacht Club and the Coast Guard).

7.1.2 Complaints handling

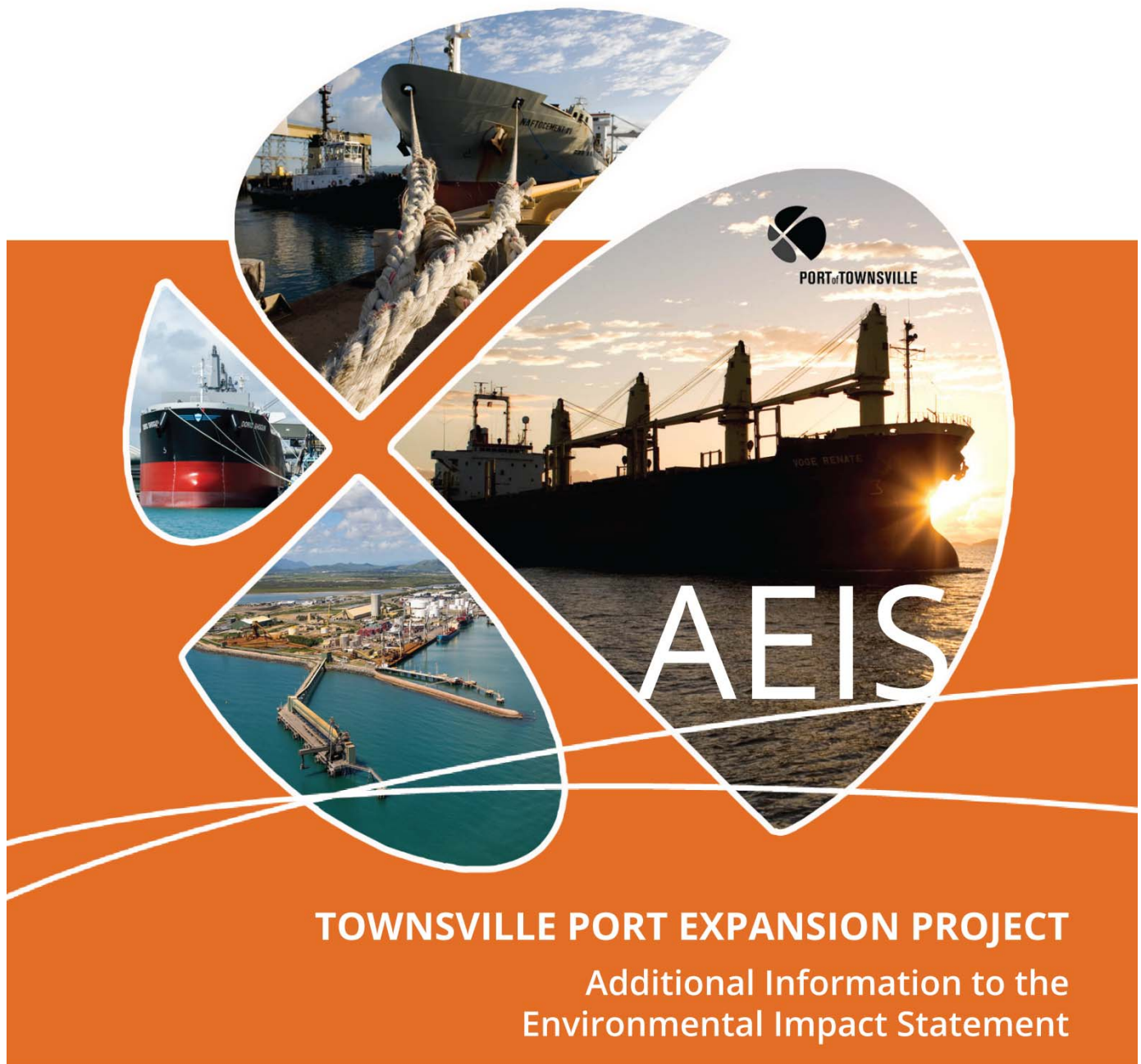
Complaints can be made via POTL's website.

Complaints received directly by the Contractor must be recorded including investigations undertaken, conclusions formed and actions taken. Notification about the complaint and any associated response must be provided to POTL in a timely fashion.

The complaint response procedure will include:

- (a) the time, date name and contact details of the complainant
- (b) reasons for the complaint
- (c) any investigations undertaken
- (d) conclusions formed
- (e) any actions taken.

All outcomes of complaint (s), including the full detail of the complaint and corrective actions undertaken by the Construction Contractor, shall be communicated to POTL for further review of corrective actions. Corrective actions shall be communicated to the complainant to close out the issues raised.



APPENDIX B3

Operational Environmental Management Plan



1.0 Introduction

This Operational Environmental Management Plan (OEMP) details environmental management procedures to be implemented during the operational phase of the Port of Townsville Limited (POTL) Port Expansion Project (PEP). The aim of the OEMP is to reduce potentially adverse impacts on the environment associated with the PEP operations.

The OEMP has been developed from, and is consistent with, the PEP Environmental Impact Statement (EIS) and Additional Information to the Environmental Impact Statement (AEIS). The OEMP has been updated in response to submissions received through the EIS process, and to consider the Design Refinement where appropriate.

1.1 Project Overview

The Port of Townsville is located on Cleveland Bay, approximately three kilometres east of the city centre in Townsville, North Queensland. The port is situated in the Great Barrier Reef World Heritage Area and the majority of the port infrastructure is not within the Great Barrier Reef Marine Park.

The Port of Townsville is a multi-purpose port that handles predominantly bulk and general cargo. The PEP aims to address capacity constraints and accommodate future growth in trade over a planning horizon to 2040.

The PEP includes development of port infrastructure and work to 'top of wharf' including: dredging, reclamation, breakwaters, revetments, wharves, access roads, rail loop, trunk services and utilities. The PEP does not include development 'above-wharf', which may include: terminal pavements, shiploaders and unloaders, material conveyors, storage buildings for products, rail loaders and unloaders, stacking and reclaiming equipment, storage tanks and pipelines.

As the Port develops, individual Port tenant operations will be subject to separate statutory assessment and approval requirements. Operators will be required to obtain all necessary approvals and licenses prior to the start of operations or in accordance with relevant statutory timing requirements.

1.2 Purpose

The OEMP is focussed on sound environmental management practices, to be undertaken to minimise adverse impacts on the environment through normal operation. In addition, an OEMP identifies what measures or actions are in place to manage incidents and emergencies that may occur. An OEMP must clearly state the measures employed on site to minimise potential adverse environmental impact. All activities are to be undertaken in accordance with relevant Commonwealth, State and local government legislation. The OEMP:

- describes POTL's commitments regarding environmental performance and the reduction of adverse impacts
- specifies the actions that would be taken to implement commitments (such as monitoring)
- identifies corrective actions to rectify any deviation from performance standards
- provides an action program to enable delivery of the environmental commitments so they are achieved and implemented.

1.3 Scope

This OEMP only applies to the on-land operations of the PEP and only to those activities that are under POTL's control in the common user areas. It does not address activities in tenant areas of the port, and does not address operational (maintenance) dredging. Maintenance dredging will be incorporated in POTL's relevant dredging documentation and permits at the time of operation. Site specific Environmental Management Plans (EMP's) will be developed by tenants and implemented during port operations.

This OEMP falls under the overall PEP EMP framework which includes:

- Construction phase:
 - Construction Environmental Management Plan
 - Dredge Management Plan
 - Vessel Traffic Management Plan.
- Operational phase:
 - Operational Environmental Management Plan (this document)
 - Maritime Operations Management Plan.

The key environmental values likely to be affected by on-land operational activities associated with the PEP were identified in the EIS. These values are further specified in Section 4.0 below. For each key value identified, the environmental management procedures to address the potential risks and impacts have been provided.

1.4 Terms of Reference

The OEMP also responds to the Queensland Government's *Townsville Port Expansion Project - Terms of reference for an environmental impact statement*, February 2012, issued by the Coordinator General (Appendix A of the EIS). Section 10 of the Terms of Reference (TOR) states the requirements of the EMPs. These requirements, and if appropriate where these requirements are addressed in this OEMP, are summarised in Table 1.

Table 1 Terms of Reference Section 10 - EMP requirements

Requirement	Where addressed in this OEMP
Detail the EMPs for both the construction and operation phases of the Project.	This OEMP details the management measures for the on-land operational phase of the PEP. A separate Maritime Operations Management Plan (MOMP) details the management measures associated with maritime operational activities (operational shipping) of the PEP.
The EMP should be developed from, and be consistent with, the information in the EIS. The EMP must address discrete project elements and provide life-of-proposal control strategies. It must be capable of being read as a stand-alone document without reference to other parts of the EIS.	The project elements from the EIS that require management measures are detailed in Section 4.0 below and form the basis of this OEMP.
The EMP must comprise the following components for performance criteria and implementation strategies: the proponent's commitments to acceptable levels of environmental performance, including environmental objectives, performance standards and associated measurable indicators, performance monitoring and reporting.	Refer Section 5.0 for specific environmental commitments during port operations.
Impact prevention or mitigation actions to implement the commitments.	Management actions are provided in Section 5.0
Corrective actions to rectify any deviation from performance standards.	Management actions are provided in Section 5.0
An action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to: - continuous improvement - environmental auditing - monitoring - reporting - staff training - a rehabilitation program for land proposed to be disturbed under each relevant aspect of the proposal.	There has been no on-land vegetation disturbed as a result of the PEP, therefore a rehabilitation program is not applicable. An action program to address other environmental commitments is provided in Section 5.0 below.
The recommended structure of each element of the EMP is: - element/issue - operational policy - performance criteria - implementation strategy - monitoring - auditing - reporting - corrective action.	Refer Section 5.0

The TOR also refers to additional information that is to be provided in the EMPs. The information required, and where these requirements are addressed in this OEMP, is summarised in Table 2.

Table 2 Terms of Reference - additional EMP requirements

Section from Terms of Reference	Requirement	Where addressed in this OEMP
5. Environmental values and management impacts	<i>The mitigation measures, monitoring programs etc., identified in ... the EIS should be used to develop the EMP for the Project.</i>	The OEMP has been developed from, and is consistent with, the PEP EIS and AEIS.
3.6.2 Objectives of the EIS	<i>The purpose of the EIS is to:... provide information to formulate the Project's EMP.</i>	The OEMP has been developed from, and is consistent with, the PEP EIS and AEIS.
5.3.5 Transport management strategies	<i>Conditions of approval for transport management impacts should also be detailed in the EMP.</i>	Transport impacts and transport management measures are provided in Section 5.10.
5.5.1 Sensitive environmental areas	<i>Outline how these measures [to mitigate impacts on sensitive environmental areas] will be implemented in the overall EMP for the Project.</i>	Measures to mitigate impacts on sensitive marine and land environments are provided in Section 5.3 and Section 5.4.
	<i>The overall EMP for the Project should address the performance requirements of the relevant policies and regional vegetation management codes published by DERM (now DEHP).</i>	There are no on-land vegetation impacts by the PEP. Performance requirements from DERM for native vegetation are not applicable. Mitigation measures for terrestrial ecology are provided in Section 5.4.
5.5.2 Terrestrial flora	<i>Include details of any post construction monitoring programs.</i>	Post-construction monitoring is included for each value/element in Section 5.0.
	<i>Outline how these measures [addressing harm to the ecological values of the area] will be implemented in the overall EMP for the Project.</i>	Mitigation measures for terrestrial ecology are provided in Section 5.4.
	<i>Discuss the [weed management] strategies in accordance with provisions of the Land Protection (Pest and Stock Route Management) Act 2002 (Qld)...in the pest management plan in the EMP for the Project.</i>	Pest management measures are provided in Section 5.5.
5.5.3 Terrestrial fauna	<i>Outline how these measures [for protecting rare or threatened species] will be implemented in the overall EMP for the Project.</i>	Mitigation measures for terrestrial ecology are provided in Section 5.4.
	<i>Discuss the [feral animal (including pest)] strategies in accordance with the provisions of the Land Protection (Pest and Stock Route Management) Act 2002 (Qld) ... in the pest management plan in the EMP for the Project.</i>	Pest Management measures are provided in Section 5.5.
5.5.4 Aquatic ecology	<i>Outline how ... [aquatic ecosystem] measures will be implemented in the overall EMP for the Project.</i>	Marine ecology measures are provided Section 5.3 of this OEMP. Marine ecology measures in relation to operational shipping are provided in the MOMP.
5.6.2 Water resources	<i>Incorporate strategies to protect or enhance water resource values into the EMP (paraphrased).</i>	Measures to protect and / or enhance water resources are provided in Section 5.2.
13 Appendices – Consultation report	<i>...plans for ongoing consultation to be outlined and included in the EMP.</i>	Community consultation for the operations of PEP will be included within POTLs consultation and communication activities at the time. A commitment has been included, however the specific mode may be different by the time the OEMP is in effect.

2.0 Environmental Management System

This Section describes POTL's commitments regarding environmental performance and the reduction of any adverse impacts.

2.1 POTLs Environmental Management Strategy

POTL maintains its commitment to sustainable development and operation through its Environmental Management System (EMS). The EMS provides a framework for environmental management at the Port, reflects POTL's Environmental Policy and commitments to manage its activities with concern for people and the environment.

POTL's EMS is compliant with AS/NZS ISO 14001 2004 and facilitates the continual improvement of environmental performance by:

- integrating environmental considerations into decision making and work practices related to the core functions of the corporation
- maintaining a high level of environmental awareness throughout the corporation and the wider port community
- utilising systems which act to reduce the risk of environmental harm through identification reporting, assessment, monitoring and control of environmental risks.

This OEMP includes the work elements necessary to satisfy environmental requirements during the operation of the PEP and will be incorporated into POTL's EMS. These work elements will be included in an overarching POTL EMP covering the common user areas which will be included in POTLs EMS. These actions include: management responsibilities, incident management, emergency responses, non-conformances, environmental training, monitoring, reporting, auditing and complaint handling.

Continuous improvement is a required deliverable of the EMS. As part of the continuous improvement, the OEMP may be updated or amended as required. This may include the merging of other documents to streamline EMP documentation. Any future amendments will take into account the intent of this document and the conditions of the existing approvals.

2.2 Environmental Policy

POTL Environmental Policy applies to POTL lands and activities, including the common user areas of the port. It is:

- displayed at prominent locations in the workplace of POTL employees and on the website
- communicated to POTL employees and Contractors during induction and training
- reviewed regularly.

POTL's Environmental Policy (POTL, 2014) states:

Port of Townsville Limited (POTL) is committed to the protection of the environment and considers it as critical corporate value in the delivery and maintenance of port infrastructure and services and in planning for the future development of the Port of Townsville and Port of Lucinda.

POTL is committed to sustainable development and operation through responsible environmental management and continual improvement of environmental performance and the effectiveness of its Environmental Management System.

To achieve corporate performance consistent with this policy, POTL will employ the following principles: -

- Integrate environmental considerations into decision making and work practices related to POTL's core functions
- Maintain a high level of environmental awareness throughout POTL and the wider port community
- Implement systems which act to minimise the risk of environmental harm through the identification, reporting, assessment, monitoring and control of environmental risks
- Establish a framework for setting and reviewing environmental objectives and targets and measuring POTL's performance
- Establish and maintain systems for assessing the environmental impacts associated with POTL's activities, identifying and acting on opportunities for improvement
- Compliance with all relevant legislation, codes of practice and standards
- Core functions to be conducted in a manner that will minimise waste, prevent pollution, promote efficient use of resources, reduce environmental impacts, and continually improve environmental and management system performance

- Providing adequate resources including finances, to facilitate the fulfilment of POTL's environmental responsibilities.

POTL's Board and senior management are responsible for providing the leadership to support the development and implementation of this Policy and for ensuring it is effectively applied.

This policy will be regularly reviewed following legislative or organisational changes, or as a minimum, every three years.

3.0 Project Description

At completion of the PEP it is anticipated that approximately 1,300 cargo ships per annum will call at the Port of Townsville and the port will continue to operate on a 24 hour, 7 day per week basis. POTL will own and manage the new 150 ha (approximate) reclaimed port-side outer harbour, and have control over the common areas. POTL will lease the land and berth facilities to tenants to occupy and undertake port related activities. Tenants will develop their leased areas and construct and install their own operating infrastructure. These may include: terminal pavements, ship loaders and unloaders, materials conveyors, storage buildings for products, rail loaders and unloaders, stacking and reclaiming equipment, storage tanks and pipelines. Necessary approvals for operations in the leased areas will be independently undertaken by the tenants at the appropriate time in the future. The tenants will need to meet legislative requirements that apply at the time of their application.

A range of environmental controls are incorporated at the time of lease and tenant activities need to be undertaken in accordance with the existing operational protocols established at the port. This will help ensure that the use of the facilities will follow the existing port protocols and meet the overall environmental requirements established for the port. Lease provisions could include provisions such as:

- requirement to meet legislative requirements
- appropriate stockpiles, conveyors and facilities control including being enclosed
- implementation of dust control and management to meet regulatory requirements
- stormwater runoff is to be handled in accordance with relevant guidelines, regulatory and POTL requirements
- wastewater and solid waste is to be treated and managed in accordance with relevant licensing requirements
- noise levels at specified receptors are not to exceed specified guidelines
- tanks, pipelines and associated facilities will be bunded and any spillage collected and treated in accordance with relevant standards and best practise management
- operational areas to be secured (fenced and gated) in accordance with the port's security protocols
- operational activity is to be undertaken in accordance with port procedures
- exterior lighting is to comply with relevant guidelines
- buildings and equipment are to comply with maximum height and visual amenity provisions established by the port.

Many of these provisions are detailed in Section 4.0 below. POTL also require tenants to develop site specific EMPs and Emergency Management Plans.

Commissioning activities for fixed port infrastructure will be minimal. Trunk services (stormwater, sewer, power, water supply, and telecommunications) will be commissioned by or in close consultation with the relevant authority in accordance with standard procedures.

The new site will be fenced and access controlled in a similar manner to the existing port. POTL and port tenants will be responsible for port security.

4.0 Operational Environmental Management Plan Structure

4.1 Management Issues

The environmental values listed in Table 3 have been identified in the EIS as key areas of concern that require consideration in the OEMP in order to deliver sound environmental management practices, and minimise adverse impacts on the environment.

Table 3 OEMP components

Reference	Management Issue	Scope
Section 5.1	Land	Manage the potential impacts to land and manage the use of land through the operation of the Port.
Section 5.2	Water resources	Manage surface water and drainage issues to reduce impacts to water quality and the receiving catchment.
Section 5.3	Marine ecology and conservation	Reduce any impacts to marine ecology as a result of landside operational activities.
Section 5.4	Terrestrial ecology	Reduce any impacts to terrestrial ecology as a result of operational activities.
Section 5.5	Pest management	Manage potential risk during port operations.
Section 5.6	Air quality	Manage impacts to air quality as a result of operational processes and activities.
Section 0	Noise and vibration	Manage and reduce noise and vibration impact as a result of operational activities to acceptable levels.
Section 0	Greenhouse gases	Reduce greenhouse gas production from operational activities.
Section 0	Waste	Reduce waste generation and maximise the use of the waste hierarchy in managing operational waste.
Section 5.10	Transport and infrastructure	Implement and maintain appropriate levels of transport infrastructure during the development of the PEP to reduce congestion and impacts to other stakeholders.
Section 5.11	Indigenous and non-Indigenous cultural heritage	Monitor and manage as required.
Section 5.12	Scenic amenity and lighting	Maintain appropriate levels of lighting and reduce potential effects on the environment (such as shore birds and turtles) and public amenity.

For each value identified, an environmental management strategy and actions have been developed to address potential risks that may arise. Each value has a stated environmental objective, performance criteria, management actions, monitoring, reporting, and corrective actions. The structure used for the strategy and actions is outlined in Table 4.

4.2 Structure of the OEMP

Table 4 EMP Structure

Management Strategy Component	Description of Content
Element/Issue	The aspect of the operational environmental issue to be managed (as it affects environmental values).
Potential Impacts	The potential impacts the issue/element may create without management.
Performance Objective	The aims and objectives which drive the need for management of the issue/element.
Performance Criteria	Measurable performance criteria (outcomes) for each element of the operation.
Monitoring and reporting	The monitoring requirements to measure actual performance (for example, specified limits to pre-selected indicators of change).
Management Actions	The strategies, tasks or action program (to nominated operational design standards) that would be implemented to achieve the performance criteria.
Responsibility	Identify who will be responsible for: implementing the management actions, undertaking monitoring of actions, subsequent reporting requirements, and other responsibilities which may arise out of the individual management actions.
Timing	Identify the frequency at which management actions need to be implemented.

Management Strategy Component	Description of Content
Corrective Actions	The action to be implemented and by whom in the case where a performance criterion is not met.

5.0 Management Plan Elements

This section of the OEMP identifies specific environmental management procedures related to the on-land operations of the PEP. The requirements in this section are intended to apply in addition to the general requirements for tenants (common user area) under POTL's lease arrangements.

These requirements are to be addressed by POTL and aims to ensure the activities being carried out are consistent with any existing procedures or protocols and requirements.

A separate MOMP details the management measures associated with maritime operational activities (operational shipping) of the PEP.

5.1 Land

Potential Impacts	Impacts to land from spillage or leakage of goods/cargo in the common user areas (for example, petroleum products, chemicals, wastes, including hazardous or regulated wastes and loose bulk products such as mineral concentrates).
Environmental Performance Objectives	To reduce the potential for environmental harm as a result of changes to landform.
Performance Criteria	- Spills are reported - Spills are appropriately cleaned up - Spilled material is appropriately disposed.
Monitoring and Reporting	- Any spill or contamination of land to be reported to relevant agencies and POTL as required in accordance with POTL procedures - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include spill response awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Operate berths and cargo handling facilities in compliance with relevant management plans and licences.	Port tenants are to be aware of compliance responsibilities. On-going operational compliance is the responsibility of the port tenants.	POTL is to advise port tenants of the responsibilities prior to signing lease. The port tenants are to maintain compliance at all times during the lease.	Engagement with port tenant to address non-compliance and investigate. Follow breach provision, where required.
Follow POTL vessel/plant refuelling Standard Operating Procedure when using POTL plant and equipment.	POTL	Procedure is to be implemented during refuelling.	Investigate breach and take disciplinary action if required. Review staff training and awareness.
Manage any spills of dangerous goods in accordance with relevant incident / emergency plans.	POTL / Tenant (common user area)	Ongoing	Investigate breach. Take disciplinary actions if required.
Undertake risk assessments for all activities and have in place relevant emergency spill kits at risk areas.			Review and revise controls as required. Replace spill kits as soon as practicable after use or if missing.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.2 Water Resources

Potential Impacts	- Disturbance of marine waters due to release of contaminants (e.g. oil/fuel leaks and spills) or sediment-laden stormwater runoff into Cleveland Bay from the common user or POTL controlled areas (note that dredge tailwater management is addressed in the Dredge Management Plan). - Effects on marine life, as well as indirect potential impacts to human health, through the exposure to substances released in stormwater into marine waters.
Environmental Performance Objectives	- To reduce adverse impacts on water and sediment quality of Cleveland Bay. - To reduce the introduction of contaminants into the environment from the operational activities.
Performance Criteria	- No discharge of contaminated surface water to the surrounding environment. - Spills are adequately contained and cleaned up.
Monitoring and Reporting	- Regular visual site inspections of stormwater runoff areas, to check for cleanliness and potential for contaminants to impact on water quality. - Regular site inspections to POTL controlled common areas, to check for leaks, spillage and damage to bunded storage areas. - POTL Immediately notified in the event of an uncontained spill. - Site specific Environmental Management Plans (EMP's) developed by tenants and implemented during port operations. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include stormwater management awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Design drainage as a means of source control focusing on reducing the occurrence of uncontaminated runoff entering contaminated surfaces, and to separate contaminated and uncontaminated areas in common user areas.	POTL / Tenant(s) (common user areas)	Detailed design	Report breaches to appropriate regulatory authorities.
Develop a site based stormwater management strategy, including the preparation of a Stormwater Management Plan, based on applicable guidelines at the time.	POTL / Tenant(s) (common user areas)	Detailed design	Review and amend controls if adverse impacts are observed.
Make provision for containment and removal of any spillage prior to it entering the stormwater system in design and response provisions.	POTL / Tenant(s) (common user areas)	Prior to tenant occupation.	Implement treatment control measures if source control measures fail.
Holistically review stormwater plans and new sites / activities to be undertaken for development. Dependent upon proposed activity this may require treatment devices to meet the relevant codes and be industry compliant.	POTL/Tenant(s)		Review and amend controls as necessary.
Regularly inspect erosion and sediment controls for maintenance and efficiency. Changes may have to be made to Environment and Sediment Control Plans to meet environmental conditions.	POTL / Tenant(s) (common user areas)	Ongoing	Review and amend controls if adverse impacts are observed.
Implement specific operational controls to contain contaminants at the source, or reduce runoff areas with the potential to generate contaminants. Source control measures to be implemented, include, but are not limited to: - vehicle wash racks - machinery drip pans - covered rubbish compartments - dry cleaning - chemical cabinets.	POTL	Ongoing	Engagement with tenant to address non-compliance and investigate. Follow breach provision, where required.

Management Actions	Responsibility	Timing	Corrective Actions
Manage any spills of dangerous goods in accordance with Emergency Spill Response Plans.	POTL / Tenant(s) (common user areas)	Ongoing	Review and amend controls if adverse impacts are observed.
Chemicals/fuels/contaminates to be stored appropriately with proper signposting and bunding.	POTL / Tenant(s) (common user areas)	As required	Review and amend controls if adverse impacts are observed.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.3 Marine Ecology and Conservation

Potential Impacts	- General disturbance and degradation of benthic communities in the harbour basin through day to day port operations (such as stormwater discharges or spills). - Light spill from the port facilities potentially leading to disorientation of shore birds or turtles. - Increase in rubbish production, increasing the risk of entanglement and/or ingestion of marine debris by turtles and marine mammals.
Environmental Performance Objectives	- To reduce indirect effects on marine ecology during the operational phase. - To prevent contamination from operations entering the marine environment.
Performance Criteria	- No injury or fatality to marine vertebrates as a result of PEP operational activities. - No permanent loss of benthic habitat as a result of PEP operational activities.
Monitoring and Reporting	- Regular visual site inspections will be carried out to monitor the site for compliance with light (when required) and waste management procedures, and hazardous material handling procedures. - Marine monitoring to will be carried out for relevant aquatic indicators. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include marine ecology awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Implement stormwater and waste management measures (refer to Water Resources, Section 5.2 and Waste, Section 5.9).	POTL	Opportunistic ally checked during regular inspection.	Review measures and modify if any adverse impacts are observed.
Implement light management procedures to reduce light spill to the marine environment to the extent possible whilst meeting all safety requirements.	POTL / Tenant(s) (common user areas)		Review and modify equipment and controls if any adverse impacts are observed.
Manage any spills of dangerous goods in accordance with relevant incident / emergency plans.		During incident response.	
Include new operational areas in routine monitoring programs.	POTL	Ongoing	Review measures and modify if any adverse impacts are observed.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.4 Terrestrial Ecology

Potential Impacts	Injury/mortality to fauna resulting from operational activities.
Environmental Performance Objectives	To avoid injury and death of terrestrial fauna from operational activities.
Performance Criteria	No reported incidents of harm to terrestrial fauna.
Monitoring and Reporting	- Any incidents that affect terrestrial fauna to be reported to relevant authorities. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include terrestrial ecology awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Implement control measures to reduce the likelihood and impact of pests (refer to Weed and Animal Pest Management, Section 5.5).	POTL / Tenant(s) (common user areas)	Ongoing	Review and modify management practices if any adverse impacts are observed.
Manage lighting to reduce light spill away from foreshore in so far as consistent with existing Operational Health and Safety and land use codes.		Regularly checked as per maintenance schedules	Review and modify lighting management practices if any adverse impacts are observed.
Put in place and enforce site speed limits to reduce the risk of fauna collision.		Ongoing	Review and modify controls as required.
Restrict vehicle access to designated access routes to prevent disturbance to sensitive receptors.			
Maintain plant equipment and machinery in good working order to reduce potential noise impacts from equipment running inefficiently.			
Use low-noise equipment where possible and orientate noise emitting equipment away from foreshore.			
Include terrestrial ecology awareness training as part of site inductions.			
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.5 Weed and Animal Pest Management

Potential Impacts	- Spread of weeds (into landscaped port lands) by movement of vehicles, machinery and equipment via rail or road, to and from site. - Introduction and / or spread of pest animals to port land and surrounding areas.
Environmental Performance Objectives	- To reduce the spread of weeds to and from the site. - To reduce attraction of the PEP area to pest animals.
Performance Criteria	- Control of weeds on the PEP area. - Animal pests discouraged and mosquito breeding habitats are not created.
Monitoring and Reporting	- Regular site inspections for weed infestations. - Monitor the presence and abundance of pest animal species in the PEP area. - Regular site inspection for mosquito breeding areas. - Record complaints

Management Actions	Responsibility	Timing	Corrective Actions
Include weed and animal pest awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Routinely undertake site inspections for possible mosquito breeding areas. Implement chemical control measures to control mosquito breeding if required.	Tenant(s) (common user areas) and POTL	Beginning and during every wet season.	If mosquito larvae are present on PEP lands, manual or chemical control must be implemented to interrupt the mosquito breeding cycle. Removal and/or action to prevent standing water from occurring.
Minimise shallow standing water to collect in structures on site to minimise mosquito breeding habitat.		Ongoing	Prevent water from collecting in structures or around buildings.
Ensure PEP area contains enclosed bins that are emptied on a regular basis to avoid attracting pest animals.			Review and modify controls as required. Licensed pest control contractor engaged to control pest animals as required.
Implement regular weed control activities (for example, spraying, mowing and removal).	POTL / Tenant(s) (common user areas)	Ongoing	Review and modify controls as required.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.6 Air Quality

Potential Impacts	- Fugitive dust from exposed surfaces may result in: - nuisance - increased risks to human health - discolouration of buildings or structure - depositions into the marine environment. - Fugitive dust from spillage of goods/cargo in common user areas. - Fuel combustion emissions from vehicles and equipment result in increased risk to human health.
Environmental Performance Objectives	To reduce the effects from emissions generated during the PEP operation so ambient air quality is maintained.
Performance Criteria	- No complaints from affected persons due to air or dust emissions from POTL controlled areas. - Performance in relation to relevant standards or appropriate guidelines at sensitive receptors including stipulated EPP (Air) criteria.
Monitoring and Reporting	- Visual monitoring of dust and observation of weather conditions. - Boundary dust monitoring. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include air quality awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
To reduce fugitive dust: - clean up spills of dry products - contain potentially dust generating cargos in common user areas - Implement appropriate controls to prevent material being tracked onto sealed roads.	POTL / Tenant(s) (common user areas)	Ongoing	Review and modify controls if any adverse impacts are observed. Boundary air quality monitoring.
To reduce fuel combustion emissions: - turn engines off while parked on site - regularly tune, modify or maintain equipment, plant and machinery to reduce visible smoke and emissions - manage vehicle movement to prevent queuing / idling.			
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.7 Noise and Vibration

Potential Impacts	- Night time noise from the port operations may adversely affect adjacent residents. - Reduction of daytime acoustic amenity for the closest residential locations as a result of operations (including tenants loading and unloading activities) and heavy vehicle movement on public and internal roads.
Environmental Performance Objectives	To reduce noise generated by operational activities so that ambient noise quality is maintained.
Performance Criteria	- Adaptive management during operations, in response to any complaints related to noise and vibration - Noise levels to meet relevant standards or appropriate noise guidelines at sensitive receptors.
Monitoring and Reporting	Noise and vibration complaints recorded to inform the need for corrective actions

Management Actions	Responsibility	Timing	Corrective Actions
Include noise and vibration awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Equipment management includes the following: - select low noise plant and equipment suitable for purpose - equipment has high-quality mufflers installed - equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications - equipment / plant known to emit noise strongly in one direction (such as manifolds on compressors) are orientated so that noise is directed away from noise sensitive areas - machines that are used intermittently are shut down in the intervening periods between works or throttled down to a minimum. Equipment shut down when not in use - silencers and enclosures are kept intact; rotating plants are balanced; loose bolts are tightened; frictional noise is reduced through lubrication; and cutting noise is reduced by keeping blades sharp. - equipment to be in good working condition.	POTL / Tenant(s) (common user areas)		Review and modify equipment and controls if any adverse impacts are observed.
Incorporate operational Noise Management into site-specific EMP's to ensure that port operators are aware of the need to control environmental noise to sensitive receptors and have in place appropriate controls.	Tenant(s) (common user areas)	Ongoing	In the event of exceedances to the operational noise and vibration performance goals and criteria, or complaint, the activity in question will be reviewed and alternative methods/equipment/timing investigated and implemented where practical.
Where possible undertake noisy activities during daytime working hours to reduce any offsite impacts.	POTL / Tenant(s) (common user areas)	Ongoing	Review and modify operational practices if any adverse impacts are observed.
Implement general good site working practices.			
Port Tenants to consider noise mitigation and incorporate into applications, management plans and operations as part of assessments of actions and activities assessed under the Integrated Development Assessment System.	POTL / Tenant(s) (common user areas)		Review and where necessary modify operational practices if adverse impacts are identified. For example; consider alternative methods/equipment/timing and implement where practical.

Management Actions	Responsibility	Timing	Corrective Actions
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.8 Greenhouse Gases

Potential Impacts	▪ Increase in greenhouse gas emissions produced from operations.
Environmental Performance Objectives	▪ To consider greenhouse gas emissions from POTL controlled areas during port operations and reduce these where possible.
Performance Criteria	▪ Reduction in calculable greenhouse gas emissions through implementation of management actions. ▪ Meet the applicable Commonwealth and State legislation and standards for the release of greenhouse gas emissions from POTL controlled areas.
Monitoring and Reporting	▪ Undertake periodic energy audits to monitor energy use and changes to efficiency on site. ▪ Monitor key performance indicators on a regular basis to track operational greenhouse gas emissions, detect trends early and implement measures to address any unforeseen increases in emissions.

Management Actions	Responsibility	Timing	Corrective Actions
To implement energy efficiency measures: ▪ undertake preventative maintenance on equipment and engines ▪ switch off lighting and other electrical equipment that is not in use, where possible under OHS requirements ▪ use variable speed drives with high efficiency linings ▪ consider the use of high efficiency electrical motors ▪ consider purchasing electricity from renewable sources through Green Power. To investigate use of renewable energy on POTL controlled areas: ▪ investigate the feasibility of generating electricity from a renewable source on-site ▪ consider the use of solar panels for road lighting and powering isolated items.	POTL / Tenant(s) (common user areas)	Ongoing	Review and modify practices if adverse impacts are experienced.
Consider energy efficiency in the procurement of equipment.			
Purchase offsets as required by legislation through a certified offset provider in Australia.			

5.9 Waste

Potential Impacts	- Incorrect handling and storage of waste materials may result in the introduction of wastes into the marine environment or surrounding lands. - Incorrect handling and/or storage of waste materials may encourage pests and provide breeding habitats for mosquitos. - General waste and debris generated from port operations potentially causes amenity or health and safety impacts.
Environmental Performance Objectives	Appropriately manage the handling and storage of waste materials in PEP area.
Performance Criteria	- Waste materials are handled and stored in a safe and appropriate manner. - No environmental impact on or disturbance to, the surrounding marine area from loss of waste. - Animal pests discouraged and mosquito breeding habitats are not created.
Monitoring and Reporting	- POTL will monitor the management and disposal of waste for POTL controlled areas. - Any incidents will be recorded in POTL database in order to identify areas where waste management is creating adverse impacts. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include waste awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Ensure that waste reduction in alignment with EHP. 2014. <i>Waste—Everyone's responsibility: Queensland Waste Avoidance and Resource Productivity Strategy (2014–2024)</i> . Brisbane: Department of Environment and Heritage Protection, Queensland Government.	POTL to implement for common areas and POTL buildings through provision of appropriate waste facilities.	Ongoing	Review waste measures.
Supply designated collection bins or other appropriate containers to facilitate segregation and encourage waste recycling or re-use. Store waste in designed areas using internationally recognised, and where possible ISO signage to aid international visitors/crews to meet AMSA and Department of Agriculture and Water Resources requirements for their waste and prevent mixing.	POTL / Tenant(s) (common user areas)	Opportunistic checked during regular inspection.	Modify bins where appropriate if any adverse impacts are observed.
Maintain the Port common user areas in a clean and tidy manner and regularly remove waste to avoid accumulation.	POTL / Tenant(s) (common user areas)		Review tenant management procedures if waste management becomes an issue.
Remove any trade or regulated waste through a licensed trade waste contractor to a licensed reception facility.	POTL / Tenant(s) (common user areas)	At all times	Review tenant management procedures if waste becomes an issue in common areas.
Record the movement and quantities of regulated and quarantine wastes.			
Seal waste receptacles and regularly remove waste to reduce attraction of pests or vermin.		Ongoing	Review waste storage arrangements and removal frequencies if pests become an issue.

Management Actions	Responsibility	Timing	Corrective Actions
Store, use , handle and dispose of hazardous materials, regulated and quarantine wastes on site in accordance with Australian Standards and relevant regulations , maintain hazardous materials register and provide access to relevant Safety Data Sheets.			Review and modify practices as required.
Discharge quarantine waste from vessels at berth for land disposal in accordance with relevant MARPOL annexes and other legislative requirements for the disposal of quarantine wastes.			
Dispose of sewage to an approved system and / or facility.			
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.10 Transport and Infrastructure

Potential Impacts	- Traffic congestion at some key intersections. - Pavement degradation from additional traffic loading. - Increase in demand for rail infrastructure reduces performance of rail network.
Environmental Performance Objectives	To deliver appropriate traffic performance during operations.
Performance Criteria	- No loss of travel time. - Pavement condition meets appropriate standards. - No decrease in the standard of rail infrastructure or network performance.
Monitoring and Reporting	- Monitoring for infrastructure wear and tear and pavement degradation. - Record complaints.

Management Actions	Responsibility	Timing	Corrective Actions
Include traffic management awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Incorporate traffic management into site-specific management plans or applications for tenants or facilities that will generate significant traffic.	Port tenants. POTL to review	Prior to operation	Review of Traffic Management Plan in consultation with POTL.
Work closely with Queensland Rail to identify appropriate trigger points and when commercially viable, plan for the rail access via the Eastern Access Corridor.	POTL	Prior to operation	Review and modify the rail planning if adverse impacts are experienced.
Liaise with government to further implement the 'Mount Isa Rail Infrastructure Master Plan' to address future rail capacity requirements.		Ongoing	Review and modify controls as required.
Investigate cost effective solutions to alleviate additional traffic impacts from the expanded port activities.			
Determine the need for pavement rehabilitation and maintenance in consultation with DTMR.			
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.11 Indigenous and Non-Indigenous Cultural Heritage

Aspects and Impacts	Disturbance or loss of indigenous or non-indigenous cultural heritage values or artefacts in the marine environment or on land.
Environmental Performance Objectives	- Reduce the potential for disturbance of significant Indigenous values or artefacts. - Reduce the potential for disturbance or degradation of significant Indigenous and non-Indigenous heritage items or places.
Performance Criteria	- No loss or disturbance of significant Indigenous values or artefacts or non-Indigenous heritage items or places as a result of operations. - No complaints received regarding damage to Indigenous or non-Indigenous areas or sites.
Monitoring and Report	- Reporting suspected Indigenous discoveries in accordance with the Cultural Heritage Management Plan. - Reporting suspected non-Indigenous discoveries to DEHP.

Implementation Strategies and Management Actions	Responsibility	Timing	Corrective Actions
Include cultural heritage awareness training as part of site inductions.	POTL / Tenant(s) (common user areas)	Ongoing	Regularly review site induction training and update when required.
Continue ongoing consultation with Indigenous parties in accordance with the POTL Cultural Heritage Management Plan.	POTL	Ongoing	Review Program and consultation protocol where risks of unexpected adverse effects or complaints made.
If any Aboriginal cultural heritage sites, materials or values are discovered then operations work and other activities are to cease pending an inspection by a representative from the Aboriginal Parties.			Follow advice provided by Indigenous parties on inspection.
If human skeletal material is discovered during development works operations will cease immediately within 100m of the remains. The Queensland Police, Cultural Heritage Coordination Unit (DEHP) and an Aboriginal representative will be contacted immediately.			If works do not cease, penalties apply. Follow advice provided by DEHP and the Aboriginal representative regarding established policy and procedures for dealing with human remains.
Cease work around suspected non-Indigenous heritage discoveries and notify DEHP immediately.			Follow advice provided by DEHP.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

5.12 Scenic Amenity and Lighting

Potential Impacts	- Local scenic amenity adversely affected by waste, water pollution, and sediment plumes in the marine environment. - Scenic amenity adversely affected by artificial light associated with the new port infrastructure.
Environmental Performance Objectives	- To reduce adverse visual impacts associated with operational activities. - To reduce and/or manage adverse lighting impacts of operation.
Performance Criteria	- Light levels from POTL controlled areas meet relevant standards or appropriate guidelines and standards. - No complaints regarding lighting overspill. - Meet waste, water resources, air quality and marine ecology and conservation performance criteria.
Monitoring and Reporting	- Regular site inspections to monitor for water pollution, rubbish and dust associated with port operations. - Record complaints

Management Actions	Responsibility	Timing	Corrective Actions
Manage lighting to reduce direct light spill from the site, consistent with OHS requirements and land use codes.	POTL / Tenant(s) (common user areas)	Regularly checked as per maintenance schedules.	Review and modify lighting management practices if any adverse impacts are observed.
Implement the following management measures: - waste (refer to Waste, Section 5.9) - water quality (Water Resources, Section 5.2) - air quality (Air Quality, Section 5.6) - marine ecology (Marine Ecology and Conservation, Section 5.3).		Opportunistically checked during regular inspection.	Review measures and modify if any adverse impacts observed.
Operate a complaints management system.	POTL	At all times	Review and modify controls if any adverse impacts are observed.

6.0 Action Program

6.1 Continuous improvement

This OEMP is a 'living document' that will be reviewed (every 3 years, or as required by changes to Port operations or legislation) and amended as necessary. This allows for new or changing environmental risks relating to the port operations to be incorporated and addressed.

As part of POTL's overall environmental management system, feedback systems are in place. This will enable the OEMP to be updated and responsive to learning's from any incidents, complaints and ongoing monitoring. The OEMP is a living document and will be subject to continual improvement, as such changes will be developed and implemented over time with current versions provided to relevant authorities as required.

Other triggers for OEMP review may include:

- changes to organisational structure and roles and responsibilities
- changes in environmental legislation and/or policies
- new technologies and innovation relevant to applied methods and controls.

6.2 Environmental auditing

POTL undertakes regular reviews of its systems, plans, procedures and processes including the performance against performance criteria, in accordance with the relevant EMP. This includes monitoring records, complaints and actions taken. Records shall be maintained as per retention schedule and accessible.

6.3 Monitoring

Monitoring for each value is detailed in Section 4.0. That monitoring will enable:

- early detection of environmental management matters
- development of baseline environmental information from which trends and changes in the environmental quality can be detected. For example monitoring waste quantities and monitoring generation rates over time measures effectiveness of reduction measures.

6.4 Records

As noted in Section 6.2, records would be kept of environmental monitoring and actions taken in regards to the OEMP.

Environmental records will be:

- kept as objective evidence of compliance with environmental requirements
- maintained according to POTL's Recordkeeping Procedure, or in the case of tenants, individual tenant record keeping procedures.

Environmental records and the OEMP will be controlled in accordance with POTL's integrated management system.

6.5 Staff training

In accordance with POTL and tenant requirements, personnel will attend an induction prior to commencing work in the PEP area.

7.0 Community Protocols

This section outlines plans for on-going community enquiries and complaints.

7.1 General Enquiries

POTL's general contact details phone number and email is:

Telephone: 07 4781 1500

Facsimile: 07 4781 1525

Email: info@townsville-port.com.au.

Contact can also be made via POTL's website. POTL invites public comment via their 'Tell us what you think' page (<http://www.townsville-port.com.au/feedback>).

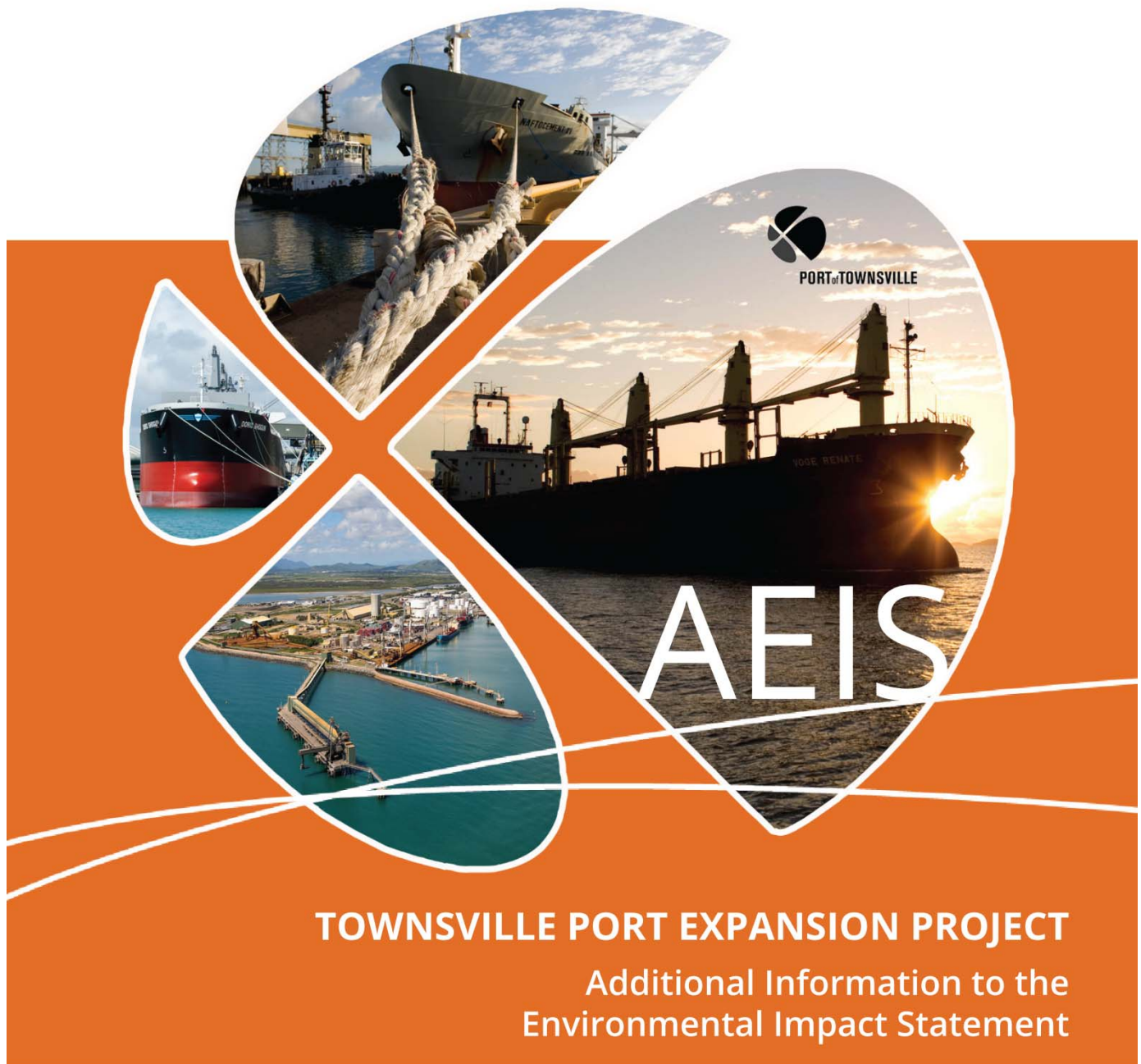
7.2 Complaints Management

Complaints can be made via POTL's website.

Complaints received directly by tenants must be recorded including investigations undertaken, conclusions formed and actions taken. Notification about the complaint and any associated response must be provided to POTL in a timely fashion.

The complaint response procedure will include:

- (a) the time, date name and contact details of the complainant
- (b) reasons for the complaint
- (c) any investigations undertaken
- (d) conclusions formed
- (e) any actions taken.



APPENDIX C1

Submissions



List of Submitters

ID Number	Submitter Name	Commonwealth (C) / State (S)
1	Private Submitter	S
2	Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA)	S
3	Private Submitter	S
4	Department of Energy and Water Supply	S
5	Private Submitter	S
6	Private Submitter	S
7	Private Submitter	S
8	Private Submitter	S
9	Private Submitter	S
10	Department of State Development, Infrastructure and Planning - Strategy and Governance	S
11	Private Submitter	S
12	Private Submitter	S
13	Department of Tourism, Major Events, Small Business and the Commonwealth Games	S
14	Private Submitter	S
15	Private Submitter	S
16	Private Submitter	S
17	Private Submitter	S
18	Private Submitter	S
19	Legal Centre	S
20	Private Submitter	S
21	Private Submitter	S
22	Private Submitter	S
23	Private Submitter	S
24	Private Submitter	S
25	Private Submitter	S
26	Private Submitter	S
27	Private Submitter	S
28	Private Submitter	S
29	Regional Services - Department of State Development, Infrastructure and Planning	S
30	Department of Justice and Attorney-General - Hazardous Industries and Chemicals Branch, Work Health and Safety QLD	S
31	Private Submitter	S
32	Private Submitter	S
33	Department of Economic Development Queensland (DSDIP)	S
34	Private Submitter	S

ID Number	Submitter Name	Commonwealth (C) / State (S)
35	Private Submitter	S
36	Private Submitter	S
37	Private Submitter	S
38	Private Submitter (FS*)	S
39	Private Submitter (FS*)	S
40	Private Submitter	S
41	Private Submitter	S
42	Private Submitter (FS*)	S
43	Private Submitter	S
44	Private Submitter (FS*)	S
45	Department of Agriculture and Fisheries	S
46	Private Submitter (FS*)	S
47	Private Submitter	S
48	Private Submitter (FS*)	S
49	Private Submitter (FS*)	S
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ID Number	Submitter Name	Commonwealth (C) / State (S)
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76	Private Submitter	S
77	Private Submitter	S
78	Private Submitter	S
79	Private Submitter	S
80	Private Submitter	S
81	Private Submitter (FS*)	S
82	North Queensland Wildlife Care	S
83	Private Submitter (FS*)	S
84	Private Submitter (FS*)	S
85	Private Submitter (FS*)	S
86	Private Submitter (FS*)	S
87	Private Submitter (FS*)	S
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ID Number	Submitter Name	Commonwealth (C) / State (S)
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123	Private Submitter (FS*)	S
124	Private Submitter (FS*)	S
125	Private Submitter	S
126	Private Submitter (FS*)	S
127	Foodworks Magnetic Island	S
128	Private Submitter (FS*)	S
129	Private Submitter (FS*)	S
130	Private Submitter	S
131	Private Submitter	S
132	Private Submitter	S
133	BirdLife Townsville	S
134	Private Submitter	S
135	Private Submitter	S
136	Private Submitter	S
137	Magnetic Island Community Development Association (MICDA)	S
138	Private Submitter	S
139	Private Submitter	S
140	Private Submitter (FS*)	S
141	Private Submitter (FS*)	S
142	Private Submitter (FS*)	S
143	Private Submitter (FS*)	S
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ID Number	Submitter Name	Commonwealth (C) / State (S)
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162	Private Submitter (FS*)	S
163	Private Submitter (FS*)	S
164	Private Submitter (FS*)	S
165	Private Submitter (FS*)	S
166	Magnetic Island Nature Care Association (MINCA)	S
167	Private Submitter	S
168	Private Submitter	S
169	Private Submitter	S
170	North Queensland Conservation Council (NQCC)	S
171	Private Submitter	S
172	Private Submitter (FS*)	S
173	Private Submitter (FS*)	S
174	Private Submitter (FS*)	S
175	Private Submitter	S
176	Private Submitter (FS*)	S
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178	Private Submitter	S
179	Private Submitter	S
180	Private Submitter	S
181	Wildlife Preservation Society of Queensland	S
182	Private Submitter	S
183	Private Submitter	S
184	Department of National Parks, Recreation, Sport and Racing	S
185	Wildlife Preservation Society of Queensland - NQ BRANCH	S
186	Private Submitter	S

ID Number	Submitter Name	Commonwealth (C) / State (S)
187	Private Submitter (FS*)	S
188	Private Submitter	S
189	Private Submitter (FS*)	S
190	Private Submitter (FS*)	S
191	Townsville City Council	S
192	Townsville Local Marine Advisory Committee	S
193	Private Submitter (FS*)	S
194	Private Submitter (FS*)	S
195	Private Submitter (FS*)	S
196	Department of Education, Training and Employment	S
197	Private Submitter (FS*)	S
198	Private Submitter (FS*)	S
199	Queensland Tourism Industry Council	S
200	Alliance to Save Hinchinbrook Inc.	S
201	Private Submitter	S
202	Private Submitter (FS*)	S
203	Private Submitter	S
204	Private Submitter (FS*)	S
205	Queensland Health Department	S
206	Queensland Police	S
207	Major Projects Office & Government Land and Asset Management	S
208	Townsville Chamber of Commerce	S
209	Private Submitter	S
210	Queensland Fire and Rescue Service - State Community Safety Operations Branch	S
211	Department of Housing and Public Works	S
212	Private Submitter (FS*)	S
213	Private Submitter	S
214	Department of Transport and Main Roads	S
215	Mackay Conservation Group	S
216	Private Submitter	S
217	Department of Natural Resources and Mines - Planning Services North	S
218	IRC Pty Ltd	S
219	NQ Dry Tropics	S
220	WWF Australia	S
221	Townsville Enterprise Limited	S
222	Private Submitter (FS*)	S
223	Private Submitter (FS*)	S
224	Private Submitter (FS*)	S

ID Number	Submitter Name	Commonwealth (C) / State (S)
225	Private Submitter (FS*)	S
226	Department of Environment and Heritage Protection	S
227	Private Submitter (FS*)	S
228	Private Submitter (FS*)	S
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242	Australian Coral Reef Society	S
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246	Private Submitter (FS*)	S
247	Skills Queensland	S
248	Mount Isa to Townsville Economic Development Zone Inc. (MITEZ)	S
249	Private Submitter (FS*)	S
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254	Queensland Conservation Council	S
255	Powerlink	S
256	Private Submitter (FS*)	S
257	Private Submitter (FS*)	C
258	Private Submitter	C
259	Aquascene Tours and Charters	C
260	Private Submitter (FS*)	C
261	Australian Coral Reef Society	C
262	Private Submitter	C

ID Number	Submitter Name	Commonwealth (C) / State (S)
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267	Private Submitter (FS*)	C
268	BirdLife Townsville	C
269	Private Submitter (FS*)	C
270	Blackwood Corporation Limited	C
271	Private Submitter	C
272	Private Submitter	C
273	Private Submitter (FS*)	C
274	Private Submitter	C
275	Private Submitter (FS*)	C
276	Private Submitter (FS*)	C
277	Private Submitter (FS*)	C
278	Private Submitter	C
279	Private Submitter	C
280	Butterfly House Graphic Design	C
281	Private Submitter	C
282	Private Submitter	C
283	Private Submitter	C
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ID Number	Submitter Name	Commonwealth (C) / State (S)
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302	Private Submitter	C
303	Private Submitter (FS*)	C
304	Private Submitter	C
305	Private Submitter	C
306	Private Submitter (FS*)	C
307	Private Submitter	C
308	Environmental Defenders Office	C
309	Private Submitter	C
310	Private Submitter (FS*)	C
311	Private Submitter (FS*)	C
312	Foodworks Magnetic Island	C
313	Private Submitter	C
314	Private Submitter	C
315	Private Submitter	C
316	Private Submitter	C
317	Private Submitter (FS*)	C
318	Private Submitter	C
319	Greenpeace Australia	C
320	Private Submitter (FS*)	C
321	Private Submitter (FS*)	C
322	Private Submitter	C
323	Private Submitter	C
324	Private Submitter (FS*)	C
325	Private Submitter (FS*)	C
326	Private Submitter	C
327	Private Submitter	C
328	Private Submitter (FS*)	C
329	Private Submitter	C
330	Private Submitter	C
331	Private Submitter (FS*)	C
332	Private Submitter	C
333	Private Submitter (FS*)	C
334	Private Submitter	C
335	Private Submitter	C
336	Private Submitter (FS*)	C
337	Private Submitter	C
338	Private Submitter	C

ID Number	Submitter Name	Commonwealth (C) / State (S)
339	Private Submitter	C
340	Private Submitter	C
341	Private Submitter (FS*)	C
342	Private Submitter	C
343	Private Submitter	C
344	Private Submitter (FS*)	C
345	Legal Centre	C
346	Private Submitter (FS*)	C
347	Private Submitter	C
348	Private Submitter	C
349	Magnetic Island Community Development Association Heritage Infrastructure and Planning Group (MICDA)	C
350	Magnetic Island Nature Care Association Inc.(MINCA)	C
351	Private Submitter	C
352	Private Submitter	C
353	Private Submitter (FS*)	C
354	Private Submitter (FS*)	C
355	Private Submitter (FS*)	C
356	Private Submitter	C
357	Private Submitter (FS*)	C
358	Private Submitter (FS*)	C
359	Private Submitter (FS*)	C
360	Private Submitter (FS*)	C
361	Private Submitter (FS*)	C
362	Private Submitter (FS*)	C
363	Private Submitter (FS*)	C
364	Private Submitter (FS*)	C
365	Private Submitter	C
366	Private Submitter	C
367	Private Submitter	C
368	North Queensland Conservation Council (NQCC)	C
369	North Queensland Wildlife Care	C
370	Private Submitter (FS*)	C
371	Private Submitter	C
372	Private Submitter	C
373	Private Submitter (FS*)	C
374	Private Submitter (FS*)	C
375	Private Submitter	C
376	Private Submitter	C

ID Number	Submitter Name	Commonwealth (C) / State (S)
377	Private Submitter	C
378	Picnic Bay Surf Life Saving Club	C
379	Private Submitter (FS*)	C
380	Private Submitter	C
381	Private Submitter (FS*)	C
382	Private Submitter (FS*)	C
383	Queensland Conservation Council	C
384	Private Submitter	C
385	Private Submitter	C
386	Private Submitter (FS*)	C
387	Private Submitter	C
388	Private Submitter	C
389	Private Submitter	C
390	Private Submitter (FS*)	C
391	Private Submitter (FS*)	C
392	Private Submitter (FS*)	C
393	Private Submitter (FS*)	C
394	Private Submitter (FS*)	C
395	Private Submitter	C
396	Private Submitter	C
397	Private Submitter (FS*)	C
398	Private Submitter	C
399	Private Submitter	C
400	Private Submitter	C
401	Private Submitter (FS*)	C
402	Private Submitter (FS*)	C
403	Private Submitter	C
404	Private Submitter (FS*)	C
405	Private Submitter (FS*)	C
406	Private Submitter (FS*)	C
407	Private Submitter	C
408	Private Submitter	C
409	Private Submitter (FS*)	C
410	Private Submitter (FS*)	C
411	Private Submitter (FS*)	C
412	Private Submitter (FS*)	C
413	Private Submitter (FS*)	C
414	Townsville Chamber of Commerce	C

ID Number	Submitter Name	Commonwealth (C) / State (S)
415	Private Submitter	C
416	Townsville Local Marine Advisory Committee	C
417	Private Submitter (FS*)	C
418	Private Submitter	C
419	Private Submitter (FS*)	C
420	Private Submitter	C
421	Private Submitter (FS*)	C
422	Private Submitter (FS*)	C
423	Private Submitter (FS*)	C
424	Wildlife Preservation Society of Queensland	C
425	Wildlife Preservation Society of Queensland - Townsville Branch	C
426	Private Submitter (FS*)	C
427	Private Submitter (FS*)	C
428	Private Submitter (FS*)	C
429	Private Submitter (FS*)	C
430	Private Submitter (FS*)	C
431	Private Submitter (FS*)	C
432	Private Submitter (FS*)	C
433	Private Submitter (FS*)	C
434	Private Submitter (FS*)	C
435	Great Barrier Reef Marine Park Authority (GBRMPA)	C

* Form Letter Submission - FS

Submission Reference Table

Submitter Number	Submitter Name	Section(s) of AEIS Report
1	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.2.4, 21.2.3
2	Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA)	1.0, 2.0, 15.2.1
3	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10, 11.2.1, 15.2.5, 21.2.1, 21.2.3, 21.2.5, 21.2.6
4	Department of Energy and Water Supply	Department noted no comments
5	Private Submitter	1.0, 2.0, 5.2.10, 15.2.2, 15.2.3
6	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10
7	Private Submitter	1.0, 2.0, 5.3.4, 8.3.4, 11.3.4
8	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.3, 5.2.10, 5.2.11
9	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.3, 5.2.9, 5.2.10, 6.2.4, 6.2.8, 7.2.1, 7.3, 8.2.11, 10.2.2, 13.2.1, 13.2.2, 15.2.6, 21.2.6, 21.2.7, 25.2
10	Department of State Development, Infrastructure and Planning - Strategy and Governance	Department noted no comments
11	Private Submitter	1.0, 2.0, 6.2.4, 8.2.5, 15.2.3, 21.2.3
12	Private Submitter	1.0, 2.0, 8.2.5
13	Department of Tourism, Major Events, Small Business and the Commonwealth Games	Department noted no comments
14	Private Submitter	1.0, 2.0, 8.2.5, 21.2.6
15	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.2.4, 6.3.4, 8.2.5
16	Private Submitter	1.0, 2.0, 2.3, 2.4, 15.2.4, 15.2.5
17	Private Submitter	1.0, 2.0, 6.2.4, 6.2.6, 8.2.5
18	Private Submitter	1.0, 2.0, 21.2.5, 21.2.6, 21.2.7
19	Legal Centre	1.0, 2.0, 15.2.4, 21.2.6
20	Private Submitter	1.0, 2.0, 6.2.6, 8.2.5, 21.2.1, 21.2.5, 21.2.6
21	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.8, 6.3.4, 8.2.5, 8.3.4
22	Private Submitter	1.0, 2.0, 5.2.10, 5.2.11, 8.2.3, 9.2.1, 9.2.2, 9.2.3
23	Private Submitter	1.0, 2.0, 8.3.4, 21.2.1, 21.2.5, 21.2.6
24	Private Submitter	1.0, 2.0, 5.2.2, 5.2.10, 6.2.3, 8.2.5, 8.3.4, 15.2.3, 21.2.6, 25.2
25	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.4, 8.3.4
26	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10
27	Private Submitter	1.0, 2.0
28	Private Submitter	1.0, 2.0, 21.2.6
29	Regional Services - Department of State Development, Infrastructure and Planning	1.0, 2.0, 3.2.1, 3.2.3, 21.2.1, 21.2.5
30	Department of Justice and Attorney-General - Hazardous Industries and Chemicals Branch, Work Health and Safety QLD	1.0, 2.0, 3.2.2, 22.2.2, 22.2.3, 24.2.3, Appendix C3 - Errata List
31	Private Submitter	1.0, 2.0, 8.2.7, 21.2.7
32	Private Submitter	1.0, 2.0, 6.2.4, 8.3.4, 21.2.6, 21.2.7
33	Department of Economic Development Queensland (DSDIP)	Department noted no comments
34	Private Submitter	1.0, 2.0, 2.3, 21.2.6
35	Private Submitter	1.0, 2.0, 6.3.4, 8.2.5, 21.2.6
36	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.3.4, 8.2.5, 8.3.4
37	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.3.4, 8.2.5, 8.3.4
38	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
39	Private Submitter (FS*)	1.0, 2.0, 2.3, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
40	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10, 17.2.1, 21.2.1
41	Private Submitter	1.0, 2.0, 5.2.10
42	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
43	Private Submitter	1.0, 2.0, 21.2.6, 21.2.7
44	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
45	Department of Agriculture and Fisheries	1.0, 2.0, 3.2.3, 3.2.4, 5.2.5, 8.2.3, 8.2.12, 9.2.4, 27.2.1, 27.2.5
46	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
47	Private Submitter	1.0, 2.0, 2.3, 5.2.8, 6.3.4, 8.3.4
48	Private Submitter (FS*)	1.0, 2.0, 2.3, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.3, 8.2.5, 8.2.6, 8.2.7, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
49	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
50	Private Submitter	1.0, 2.0, 2.3, 25.2
51	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
52	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
53	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
54	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
55	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
56	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
57	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
58	Private Submitter	1.0, 2.0, 2.3, 5.2.8, 6.2.4, 6.2.6, 8.2.5, 8.3.4
59	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
60	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
61	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
62	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
63	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
64	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
65	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
66	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
67	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
68	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
69	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
70	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
71	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
72	Private Submitter (FS*)	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 6.2.8, 7.2.1, 8.2.3, 8.2.5, 8.2.7, 8.3.4, 8.2.10, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.3, 21.2.4, 21.2.5, 21.2.6, 21.2.7, 25.2, 28.2.2
73	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
74	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
75	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
76	Private Submitter	1.0, 2.0
77	Private Submitter	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.6, 15.2.5, 21.2.1, 21.2.6
78	Private Submitter	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.6, 15.2.5, 21.2.1, 21.2.6
79	Private Submitter	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.6, 15.2.5, 21.2.1, 21.2.6
80	Private Submitter	1.0, 2.0, 5.2.2, 5.2.10, 5.2.11, 6.2.4, 8.2.3, 8.2.5, 8.2.7, 8.2.12, 8.2.13, 8.3.4, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.6, 25.2
81	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.3, 8.2.5, 8.2.6, 8.2.7, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2, 26.2
82	North Queensland Wildlife Care	1.0, 2.0, 8.2.3, 8.2.4, 8.2.6, 8.2.7, 8.3.4, 25.2, 26.2
83	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
84	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
85	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
86	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
87	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
88	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
89	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
90	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
91	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
92	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
93	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
94	Private Submitter	1.0, 2.0, 6.3.4, 15.2.4, 21.2.6, 21.2.7
95	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
96	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 21.2.6
97	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
98	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
99	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
100	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
101	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
102	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
103	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
104	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
105	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
106	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
107	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
108	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
109	Private Submitter	1.0, 2.0, 3.2.5, 3.2.6, 5.2.3, 5.2.10, 7.2.4, 8.2.1, 8.2.5, 8.2.13, 28.2.2, 28.2.3
110	Private Submitter	1.0, 2.0, 8.3.4, 11.2.1
111	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
112	Private Submitter	1.0, 2.0, 6.2.6, 6.2.8, 21.2.1
113	Private Submitter	1.0, 2.0, 6.2.4, 8.2.5, 11.2.1
114	Private Submitter	1.0, 2.0
115	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
116	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
117	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
118	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
119	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.3.4, 28.2.1

Submitter Number	Submitter Name	Section(s) of AEIS Report
120	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
121	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
122	Private Submitter	1.0, 2.0, 6.3.4, 28.2.1
123	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
124	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
125	Private Submitter	1.0, 2.0, 6.3.4, 28.2.1
126	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
127	Foodworks Magnetic Island	1.0, 2.0, 6.2.6, 6.3.4, 15.2.4, 21.2.1, 21.2.6
128	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
129	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
130	Private Submitter	1.0, 2.0, 2.3, 11.2.1
131	Private Submitter	1.0, 2.0, 2.3, 5.2.8, 8.2.5, 8.2.6, 8.2.7, 13.2.1, 13.2.2, 15.2.4, 19.2.4, 21.2.6, 21.2.7
132	Private Submitter	1.0, 2.0, 10.2.1, 13.2.1
133	BirdLife Townsville	1.0, 2.0, 9.2.1, 9.2.2, 9.2.3, 9.3, 12.2.1, 12.2.2
134	Private Submitter	1.0, 2.0, 5.2.10, 6.2.4, 8.2.7, 8.2.13
135	Private Submitter	1.0, 2.0, 6.3.4, 28.2.1
136	Private Submitter	1.0, 2.0, 2.3, 2.4, 8.2.5, 21.2.3, 21.2.6, 21.2.7
137	Magnetic Island Community Development Association (MICDA)	1.0, 2.0, 2.3, 2.4, 5.2.10, 8.2.5, 8.2.13, 21.2.1, 21.2.2, 21.2.4, 21.2.6, 21.2.7
138	Private Submitter	1.0, 2.0, 15.2.3, 21.2.3
139	Private Submitter	1.0, 2.0, 2.3, 5.2.10, 6.2.4, 8.2.5, 8.2.6, 21.2.2, 21.2.6, 21.2.7, 25.2
140	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
141	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
142	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
143	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
144	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
145	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
146	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
147	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
148	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
149	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
150	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
151	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
152	Private Submitter	1.0, 2.0, 6.3.4, 28.2.1
153	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
154	Private Submitter	1.0, 2.0, 2.3, 5.2.2, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.7, 15.2.5, 15.2.6, 21.2.1, 21.2.6
155	Private Submitter	1.0, 2.0, 8.3.4, 11.2.1
156	Private Submitter	1.0, 2.0
157	Private Submitter	1.0, 2.0, 2.3, 2.4, 11.2.1, 21.2.7
158	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
159	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
160	Private Submitter	1.0, 2.0, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 21.2.7, 25.2
161	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
162	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
163	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.5, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
164	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
165	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
166	Magnetic Island Nature Care Association (MINCA)	1.0, 2.0, 5.2.2, 5.2.3, 5.2.10, 6.2.4, 6.2.5, 6.2.8, 7.2.4, 8.2.3, 8.2.4, 8.2.5, 8.2.7, 8.2.9, 8.2.13, 8.3.4, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.6, 21.2.7, 25.2, 27.2.1, 27.2.5, 28.2.2
167	Private Submitter	1.0, 2.0
168	Private Submitter	1.0, 2.0, 28.2.12
169	Private Submitter	1.0, 2.0, 5.2.2, 6.3.4
170	North Queensland Conservation Council (NQCC)	1.0, 2.0, 2.3, 2.4, 3.2.5, 3.2.6, 5.2.2, 5.2.3, 6.2.2, 6.2.3, 6.2.5, 7.2.4, 8.2.1, 8.2.8, 8.3.4, 9.3, 12.3, 19.2.1, 19.2.4, 21.2.3, 21.2.7, 25.2, 27.2.1, 27.2.5, 28.2.1, 28.2.2, 28.2.3
171	Private Submitter	1.0, 2.0, 11.2.1
172	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
173	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
174	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
175	Private Submitter	1.0, 2.0, 6.2.4, 8.2.5, 8.3.4, 15.2.4
176	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
177	Private Submitter	1.0, 2.0, 6.2.3, 8.2.5, 8.3, 9.2.1, 9.2.2, 9.2.3, 9.3, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
178	Private Submitter	1.0, 2.0, 5.2.2, 5.2.10, 6.2.4, 8.2.2, 8.2.3, 8.2.7, 8.2.13, 8.3.4, 15.2.3, 15.2.4, 15.2.5, 21.2.6, 25.2
179	Private Submitter	1.0, 2.0, 8.2.5
180	Private Submitter	1.0, 2.0, 21.2.6
181	Wildlife Preservation Society of Queensland	1.0, 2.0, 2.3, 5.2.2, 6.3.4, 8.2.3, 20.2.2, 21.2.6, 25.2, 26.2, 27.2.1
182	Private Submitter	1.0, 2.0, 8.2.13
183	Private Submitter	1.0, 2.0, 5.2.10, 8.2.5, 8.3.4
184	Department of National Parks, Recreation, Sport and Racing	1.0, 2.0, 2.3, 2.4, 8.2.7, 8.2.8, 8.2.13, 25.2, 26.2, 27.2.1, 27.2.4, 27.2.6, 28.2.2, 28.2.4, 28.2.10
185	Wildlife Preservation Society of Queensland - NQ BRANCH	1.0, 2.0, 5.2.3, 8.2.3, 8.2.4, 8.2.7, 8.3.4, 11.2.1, 21.2.6, 21.2.7, 25.2
186	Private Submitter	1.0, 2.0, 5.2.2, 5.2.10, 5.2.11, 6.2.4, 8.2.3, 8.2.5, 8.2.7, 8.3.4, 15.2.3, 15.2.4, 15.2.5, 21.2.6, 25.2, 26.2
187	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
188	Private Submitter	1.0, 2.0, 5.2.3, 8.2.3, 13.2.1, 16.2.7, 22.2.3, 25.2, 26.2
189	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
190	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
191	Townsville City Council	1.0, 2.0, 5.2.6, 10.2.1, 11.2.1, 11.3.2, 12.2.1, 12.2.2, 12.2.6, 14.2.1, 15.2.1, 15.2.2, 15.2.5, 16.2.1, 16.2.2, 16.2.3, 16.2.4, 16.2.5, 16.2.6, 16.2.7, 19.2.1, 19.2.3, 19.2.5, 21.2.1, 21.2.2, 21.2.5, 22.2.1
192	Townsville Local Marine Advisory Committee	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.10, 6.2.3, 6.2.4, 7.2.1, 7.2.2, 7.2.4, 8.2.3, 8.2.6, 11.2.1, 12.2.2, 12.2.4, 15.2.3, 15.2.4, 15.2.5, 15.2.6, 19.2.5, 21.2.3, 25.2, 27.2.7
193	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
194	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
195	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
196	Department of Education, Training and Employment	1.0, 2.0, 16.3.2
197	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
198	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
199	Queensland Tourism Industry Council	1.0, 2.0, 2.3, 5.2.10, 5.3.4, 6.3.4, 8.3.4, 20.2.2, 21.2.3, 21.2.6, 21.2.7, 25.2, 28.2.5, 28.2.13, 28.2.14, 28.2.15

Submitter Number	Submitter Name	Section(s) of AEIS Report
200	Alliance to Save Hinchinbrook Inc.	1.0, 2.0, 2.3, 2.4, 3.2.5, 3.2.6, 3.2.7, 5.2.2, 5.2.3, 5.2.9, 5.2.10, 6.2.5, 6.2.6, 6.2.8, 6.3.4, 7.2.3, 8.2.3, 8.2.4, 8.2.5, 8.2.8, 8.3.4, 11.2.1, 11.2.2, 12.2.4, 19.2.1, 19.2.2, 19.2.4, 19.2.5, 21.2.5, 21.2.6, 21.2.7, 25.2, 27.2.1, 27.2.4, 28.2.2
201	Private Submitter	1.0, 2.0, 2.3, 2.4, 3.2.6, 3.2.7, 6.3.4, 7.2.1, 7.2.3, 8.2.3
202	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
203	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10, 8.2.3, 21.2.4, 28.2.1
204	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.5, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
205	Queensland Health Department	1.0, 2.0, 9.2.4, 11.3.4, 12.2.2, 12.2.4, 12.2.5, 12.3, 28.2.7
206	Queensland Police	Noted no comments
207	Major Projects Office & Government Land and Asset Management	Noted no comments
208	Townsville Chamber of Commerce	1.0, 2.0
209	Private Submitter	1.0, 2.0, 5.2.3
210	Queensland Fire and Rescue Service - State Community Safety Operations Branch	1.0, 2.0, 24.2.1, 24.2.2, 28.2.8
211	Department of Housing and Public Works	Department noted no comments
212	Private Submitter (FS*)	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
213	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.3.4, 8.2.5
214	Department of Transport and Main Roads	1.0, 2.0, 4.2.1, 16.2.1, 16.2.2, 16.2.3, 16.2.4, 20.2.1, 20.2.3, 20.2.4, 20.2.5, 20.2.6, 20.2.7, 27.2.6, 28.2.10, 28.2.13, 28.2.14, 28.2.15, 28.2.16, 28.2.17
215	Mackay Conservation Group	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.3, 5.2.7, 6.2.4, 6.3.4, 15.2.3, 15.2.4, 15.2.5, 21.2.2, 21.2.5, 21.2.6, 21.2.7, 25.2, 27.2.1
216	Private Submitter	1.0, 2.0, 8.2.7, 8.3.4
217	Department of Natural Resources and Mines - Planning Services North	1.0, 2.0, 3.2.4, 3.2.5, 3.2.7, 5.2.4
218	IRC Pty Ltd	1.0, 2.0
219	NQ Dry Tropics	1.0, 2.0, 2.3, 3.2.8, 4.3, 5.3.4, 6.2.3, 6.2.4, 6.2.5, 6.3, 7.2.3, 7.3, 8.2.3, 8.2.5, 8.2.11, 8.2.13, 8.2.14, 9.2.2, 10.2.1, 10.2.2, 21.2.7, 25.2, 27.2.1, 27.2.3, 28.2.11
220	WWF Australia	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.7, 5.2.8, 6.2.2, 6.2.5, 8.2.1, 21.2.1, 21.2.2, 21.2.3, 21.2.4, 21.2.5, 21.2.6, 25.2, 28.2.1, 28.2.2
221	Townsville Enterprise Limited	1.0, 2.0, 15.2.3, 15.2.4, 21.2.6
222	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
223	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
224	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
225	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
226	Department of Environment and Heritage Protection	1.0, 2.0, 2.4, 3.2.1, 3.2.5, 3.2.7, 4.2.1, 4.2.2, 5.2.7, 6.2.1, 6.2.2, 6.2.3, 6.2.6, 7.2.2, 8.2.6, 8.2.7, 8.2.8, 10.2.2, 11.2.1, 11.2.2, 11.2.3, 11.3.4, 12.2.3, 12.2.5, 14.2.2, 18.2.1, 27.2.1, 27.2.2, 27.2.4, 27.2.7, 28.2.1, 28.2.2, 28.2.6, 28.3
227	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
228	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
229	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
230	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
231	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
232	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
233	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
234	Private Submitter	1.0, 2.0, 5.2.2, 6.3.4, 8.3.4, 28.2.1
235	Private Submitter	1.0, 2.0, 15.2.3, 15.2.4, 21.2.6
236	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
237	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
238	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
239	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
240	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
241	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
242	Australian Coral Reef Society	1.0, 2.0, 2.3, 2.4, 3.2.5, 3.2.6, 5.2.3, 5.2.10, 7.2.4, 8.2.1, 25.2, 28.2.2, 28.2.3
243	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
244	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
245	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
246	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
247	Skills Queensland	1.0, 2.0
248	Mount Isa to Townsville Economic Development Zone Inc. (MITEZ)	1.0, 2.0
249	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
250	Private Submitter	1.0, 2.0, 8.2.5, 15.2.5, 15.2.6

Submitter Number	Submitter Name	Section(s) of AEIS Report
251	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 6.3.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
252	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
253	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
254	Queensland Conservation Council	1.0, 2.0, 2.3, 2.4, 7.2.3, 8.3.4, 19.2.1, 19.2.4, 21.2.1, 21.2.2, 21.2.4, 21.2.6, 21.2.7, 25.2, 27.2.1
255	Powerlink	1.0, 2.0, 28.2.9
256	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
257	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
258	Private Submitter	1.0, 2.0, 22.2.2, 22.2.3, 23.2.1
259	Aquascene Tours and Charters	1.0, 2.0, 2.3, 6.2.4, 6.3.4, 8.3.3, 15.2.4, 15.2.6
260	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
261	Australian Coral Reef Society	1.0, 2.0, 2.3, 2.4, 3.2.5, 3.2.6, 5.2.3, 5.2.10, 7.2.4, 8.2.1, 25.2, 28.2.2, 28.2.3
262	Private Submitter	1.0, 2.0
263	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
264	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
265	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
266	Private Submitter	1.0, 2.0, 2.3, 2.4, 21.2.5, 21.2.6, 21.2.7, 28.2.6
267	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
268	BirdLife Townsville	1.0, 2.0, 9.2.1, 9.2.2, 9.2.3, 9.3, 12.2.1, 12.2.2
269	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
270	Blackwood Corporation Limited	1.0, 2.0
271	Private Submitter	1.0, 2.0, 5.2.2
272	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4
273	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
274	Private Submitter	1.0, 2.0, 5.2.10, 8.2.3, 9.2.1, 9.2.2, 9.2.3
275	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.6, 21.2.7, 25.2
276	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.5, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
277	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

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278	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.3, 5.2.9, 5.2.10, 6.2.4, 6.2.8, 7.2.1, 7.3, 8.2.11, 10.2.2, 13.2.1, 13.2.2, 15.2.6, 21.2.6, 21.2.7, 25.2
279	Private Submitter	1.0, 2.0
280	Butterfly House Graphic Design	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
281	Private Submitter	1.0, 2.0, 6.2.4, 6.2.6, 8.2.5
282	Private Submitter	1.0, 2.0, 5.2.2, 5.2.4, 8.3.4
283	Private Submitter	1.0, 2.0, 5.2.3, 5.2.8, 6.3.4, 20.2.2, 20.2.5, 20.2.6, 20.2.7, 21.2.6, 21.2.7
284	Private Submitter	1.0, 2.0, 21.2.1, 21.2.2, 21.2.3, 21.2.4, 28.2.2
285	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
286	Private Submitter	1.0, 2.0, 2.3, 2.4
287	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
288	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
289	Private Submitter	1.0, 2.0, 6.2.6
290	Private Submitter	1.0, 2.0, 8.2.5, 21.2.6, 21.2.7
291	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
292	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
293	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
294	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
295	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
296	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
297	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
298	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.3, 21.2.6, 25.2, 27.2.1
299	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
300	Private Submitter	1.0, 2.0, 8.2.7, 8.3.4
301	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
302	Private Submitter	1.0, 2.0, 6.2.4, 8.2.5, 15.2.3, 21.2.3
303	Private Submitter (FS*)	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
304	Private Submitter	1.0, 2.0, 2.3, 2.4, 3.2.6, 3.2.7, 6.3.4, 7.2.1, 7.2.3, 8.2.3
305	Private Submitter	1.0, 2.0
306	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
307	Private Submitter	1.0, 2.0, 6.3.4, 28.2.1
308	Environmental Defenders Office	1.0, 2.0, 3.2.3, 8.2.7, 8.3.4, 25.2

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309	Private Submitter	1.0, 2.0, 3.2.5, 3.2.6, 5.2.3, 5.2.10, 7.2.4, 8.2.1, 8.2.5, 8.2.13, 28.2.2, 28.2.3
310	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
311	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
312	Foodworks Magnetic Island	1.0, 2.0, 6.2.6, 6.3.4, 15.2.4, 21.2.1, 21.2.6
313	Private Submitter	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.2, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
314	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.3.4, 6.3.4, 8.3.4
315	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.3.4, 6.3.4, 8.3.4, 21.2.6, 21.2.7
316	Private Submitter	1.0, 2.0, 8.3.4
317	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
318	Private Submitter	1.0, 2.0, 8.3.4
319	Greenpeace Australia	1.0, 2.0, 2.3, 2.4, 3.2.6, 8.2.1, 21.2.5, 21.2.6, 21.2.7, 25.2, 27.2.4, 28.2.1, 28.2.3
320	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
321	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
322	Private Submitter	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 6.2.8, 7.2.1, 8.2.3, 8.2.5, 8.2.7, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.3, 21.2.4, 21.2.5, 21.2.6, 21.2.7, 25.2, 28.2.2
323	Private Submitter	1.0, 2.0
324	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
325	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
326	Private Submitter	1.0, 2.0, 2.3, 2.4
327	Private Submitter	1.0, 2.0, 2.3, 2.4, 8.2.7, 11.2.1, 11.3.4, 15.2.4, 15.2.5, 15.2.6, 21.2.1, 21.2.2, 21.2.4, 25.2, 28.2
328	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
329	Private Submitter	1.0, 2.0, 2.3, 2.4, 8.2.5, 21.2.3, 21.2.6, 21.2.7
330	Private Submitter	1.0, 2.0, 5.2.3, 8.2.2, 22.2.3, 25.2, 26.2
331	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
332	Private Submitter	1.0, 2.0, 8.2.3
333	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
334	Private Submitter	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.6, 15.2.5, 21.2.1, 21.2.6
335	Private Submitter	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 6.2.4, 6.2.6, 8.2.5, 8.2.6, 15.2.5, 21.2.1, 21.2.6
336	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
337	Private Submitter	1.0, 2.0, 11.2.1

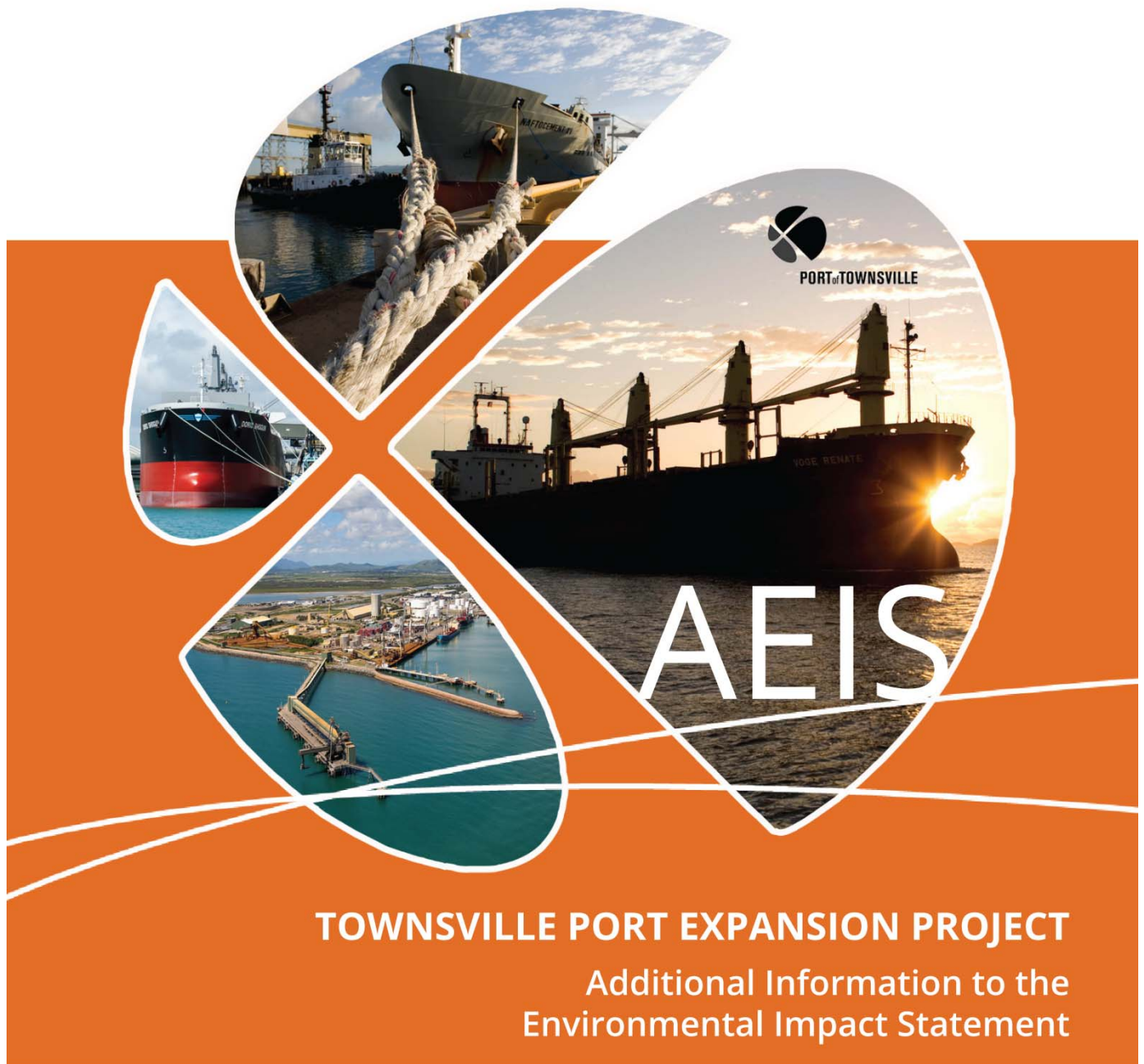
Submitter Number	Submitter Name	Section(s) of AEIS Report
338	Private Submitter	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
339	Private Submitter	1.0, 2.0, 5.2.2, 5.2.10, 6.2.4, 8.2.3, 8.2.5, 8.2.7, 8.2.12, 8.2.13, 8.3.4, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.6, 25.2
340	Private Submitter	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.3, 8.2.5, 8.2.6, 8.2.7, 8.2.10, 8.3.4, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
341	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
342	Private Submitter	1.0, 2.0
343	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
344	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
345	Legal Centre	1.0, 2.0, 15.2.4, 21.2.6
346	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
347	Private Submitter	1.0, 2.0, 8.2.5
348	Private Submitter	1.0, 2.0, 5.2.3, 5.2.7, 6.2.4, 6.3.4, 8.2.7
349	Magnetic Island Community Development Association Heritage Infrastructure and Planning Group (MICDA)	1.0, 2.0, 2.3, 2.4, 5.2.10, 8.2.5, 8.2.13, 21.2.1, 21.2.2, 21.2.4, 21.2.6, 21.2.7
350	Magnetic Island Nature Care Association Inc.(MINCA)	1.0, 2.0, 5.2.3, 6.2.4, 7.2.3, 8.2.3, 8.2.4, 8.2.5, 8.2.6, 8.2.7, 8.3.4, 21.2.2, 21.2.3, 25.2
351	Private Submitter	1.0, 2.0, 2.3, 2.4
352	Private Submitter	1.0, 2.0, 2.3, 2.4
353	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.3, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 7.2.1, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
354	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 6.2.8, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
355	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
356	Private Submitter	1.0, 2.0, 6.2.6, 8.2.5, 21.2.1, 21.2.5, 21.2.6
357	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
358	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
359	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
360	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
361	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.5, 21.2.6, 21.2.7, 25.2
362	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
363	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
364	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
365	Private Submitter	1.0, 2.0, 12.2.1
366	Private Submitter	1.0, 2.0, 12.2.1
367	Private Submitter	1.0, 2.0, 6.2.6
368	North Queensland Conservation Council (NQCC)	1.0, 2.0, 2.3, 2.4, 3.2.5, 3.2.6, 5.2.2, 5.2.3, 6.2.2, 6.2.3, 6.2.5, 7.2.4, 8.2.1, 8.2.8, 8.3.4, 9.3, 12.3, 19.2.1, 19.2.4, 21.2.3, 21.2.7, 25.2, 27.2.1, 27.2.5, 28.2.1, 28.2.2, 28.2.3
369	North Queensland Wildlife Care	1.0, 2.0, 8.2.3, 8.2.4, 8.2.6, 8.2.7, 8.3.4, 25.2, 26.2
370	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
371	Private Submitter	1.0, 2.0, 2.3, 15.2.3, 21.2.6, 21.2.7, 25.2
372	Private Submitter	1.0, 2.0, 2.3, 2.4, 15.2.4, 15.2.5
373	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
374	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
375	Private Submitter	1.0, 2.0, 2.3, 2.4, 21.2.5, 21.2.7
376	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
377	Private Submitter	1.0, 2.0, 5.2.10, 8.2.5, 8.3.4
378	Picnic Bay Surf Life Saving Club	1.0, 2.0, 5.2.5, 5.2.6, 6.2.7, 8.3.4, 15.2.6
379	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
380	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 21.2.6
381	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
382	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.1, 21.2.2, 21.2.5, 21.2.6, 25.2
383	Queensland Conservation Council	1.0, 2.0, 7.2.3, 8.3.4, 19.2.1, 19.2.4, 21.2.1, 21.2.2, 21.2.4, 21.2.7, 25.2, 27.2.1
384	Private Submitter	1.0, 2.0
385	Private Submitter	1.0, 2.0
386	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
387	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.8, 6.3.4, 8.2.5, 8.3.4
388	Private Submitter	1.0, 2.0, 2.3, 2.4, 5.2.10, 17.2.1, 21.2.1
389	Private Submitter	1.0, 2.0, 8.2.5
390	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
391	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
392	Private Submitter (FS*)	1.0, 2.0, 5.2.3, 7.2.1, 21.2.1, 21.2.5
393	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
394	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
395	Private Submitter	1.0, 2.0, 15.2.3, 21.2.3
396	Private Submitter	1.0, 2.0, 2.3, 2.4, 6.2.4, 21.2.3

Submitter Number	Submitter Name	Section(s) of AEIS Report
397	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.3, 8.2.7, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
398	Private Submitter	1.0, 2.0, 6.3.4
399	Private Submitter	1.0, 2.0
400	Private Submitter	1.0, 2.0, 6.2.4, 8.2.5, 8.2.7
401	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
402	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
403	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 28.2.1
404	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
405	Private Submitter (FS*)	1.0, 2.0, 5.2.10, 6.2.4, 8.2.5, 25.2, 26.2
406	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
407	Private Submitter	1.0, 2.0, 2.3, 6.2.4, 8.2.5
408	Private Submitter	1.0, 2.0, 8.3.4, 21.2.1, 21.2.2, 21.2.4, 21.2.5, 21.2.6, 21.2.7
409	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
410	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
411	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
412	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 21.2.7, 25.2
413	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.3, 21.2.6, 25.2
414	Townsville Chamber of Commerce	1.0, 2.0
415	Private Submitter	1.0, 2.0, 6.3.4, 8.3.4, 12.2.1
416	Townsville Local Marine Advisory Committee	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.10, 6.2.3, 6.2.4, 7.2.1, 7.2.2, 7.2.4, 8.2.3, 8.2.6, 11.2.1, 12.2.2, 12.2.4, 15.2.3, 15.2.4, 15.2.5, 15.2.6, 19.2.5, 21.2.3, 25.2, 27.2.7
417	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
418	Private Submitter	1.0, 2.0, 2.3, 21.2.1, 21.2.2
419	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 8.2.13, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
420	Private Submitter	1.0, 2.0, 2.3
421	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
422	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2, 26.2
423	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
424	Wildlife Preservation Society of Queensland	1.0, 2.0, 6.3.4, 8.2.13, 8.3.4, 25.2

Submitter Number	Submitter Name	Section(s) of AEIS Report
425	Wildlife Preservation Society of Queensland - Townsville Branch	1.0, 2.0, 5.2.3, 8.3.4, 11.2.1
426	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 21.2.7, 25.2
427	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
428	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
429	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
430	Private Submitter (FS*)	1.0, 2.0, 2.3, 2.4, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
431	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.3, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
432	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
433	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
434	Private Submitter (FS*)	1.0, 2.0, 5.2.2, 5.2.4, 5.2.7, 5.2.10, 6.2.4, 8.2.10, 15.2.3, 15.2.4, 21.2.2, 21.2.6, 25.2
435	Great Barrier Reef Marine Park Authority (GBRMPA)	1.0, 2.0, 2.3, 2.4, 3.3.5, 5.2.1, 5.2.3, 5.2.5, 5.2.10, 5.3.4, 6.2.1, 6.2.3, 6.2.4, 6.3.4, 8.2.6, 8.2.7, 8.2.13, 8.3.4, 10.2.1, 10.2.2, 14.2.1, 21.2.2, 21.2.3, 21.2.4, 25.2, 26.2, 27.2.1, 27.2.6, 28.2.12

* Form Letter Submission - FS



APPENDIX C2

Changes to Legislation



Appendix C2 - Summary of Legislative and Policy Changes

Table 1 summarises the legislation and policy changes that may potentially affect the PEP either strategically, as part of the Terms of Reference / EIS Guidelines for the EIS, or during its detailed design, construction or operational phases. This table groups the changes according to Commonwealth, State and local jurisdictions and refers to the relevant legislation or policy change, the summarised changes and PEP context as well as the sections of the AEIS that the changes most readily apply to. Legislation may include Acts and Regulations. A reference to a 'Policy' can include a reference to any non-statutory Commonwealth, State or local government document, a statutory local planning scheme and any strategy, plan, guideline or the like.

Table 1 Summary of Legislative and Policy Changes

Legislation/Policy	Summarised Change	Summarised PEP Context
Commonwealth		
<i>Clean Energy Act 2011</i> (Repealed)	This Act was repealed on 17 July 2014 as a result of the Commonwealth government's aim to replace the previous government's carbon pricing mechanism with a Direct Action Plan including an Emissions Reduction Fund initiative.	The PEP and Port are unlikely to be directly affected by changes in indirect costs from a carbon price or other Direct Action Plan initiatives.
CS FP 001-1995 Fire emergency response (Standards Australia, 1995)	Withdrawn. 28 Aug 2013.	This Australian Standard is no longer relevant and will not apply to the PEP detailed design stage. The withdrawal of the Standard does not affect this stage of the PEP.
Department of Defence White Paper	The 2016 Australian Defence White Paper identifies investment in national defence infrastructure – including the Army, Navy and Air Force bases in northern Australia, including Townsville as a focus of the White Paper.	The Port of Townsville provides a fuel link (and other cargo) to Defence assets in Townsville, which include Lavarack Barracks, RAAF Base Townsville and the Townsville High Range Training Area.
White Paper on Developing Northern Australia	The White Paper acknowledges that the prohibition of sea based disposal of capital dredge material from the proposed port expansion means that significant additional funding will be required to allow the expansion to progress.	The PEP is identified in the Commonwealth government White Paper on Developing Northern Australia as projected infrastructure to accommodate forecast growth in trade and to address current capacity constraints.
Great Barrier Reef Marine Park Regulation 1983	A new regulation under the Great Barrier Reef Marine Park Regulations 1983 (Cth) was introduced on 2 June 2015 which sets out to prevent the placement of capital dredge material in the Marine Park. Specifically, the regulation prevents the Great Barrier Reef Marine Park Authority (GBRMPA) from granting permission for placement of capital dredge material in the Marine Park.	No immediate effect on the PEP. The revised design no longer requires sea placement of dredged material.
Handbook 203:3006 Environmental risk management – principles and processes (HB203:2012)	Handbook 203:3006 Environmental risk management – principles and processes (HB203:2006) is superseded by HB 203:2012.	Detailed environmental risk management principles are to be applied at the design and operational stages for the PEP and will be considered accordingly. The Handbook details do not affect the current stage of the PEP.
Leading Practice: Port Master Planning – Approaches and Future Opportunities	Recommends best-practice port master planning principles and processes. Supports the National Ports Strategy which has identified the need for more effective long term port planning.	Does not directly affect this stage of the PEP but is likely to be significant in helping to guide other expected State legislation for master planning of Priority Port Development Areas which are expected to include the Port of Townsville. Port master plans represent a separate aspect of land use and other issues

Legislation/Policy	Summarised Change	Summarised PEP Context
		management of port areas and do not affect the impact assessment process contained in the PEP EIS. The PEP has been informed by earlier non-statutory master planning undertaken by the Port which is expected to beneficially position the Port for the preparation of any new master plan.
<i>Maritime Transport and Offshore Facilities Security Act 2003</i>	Amendments to the Act affect operational matters relating to the appointment of Australian Maritime Safety Authority inspectors and surveyors and meanings that relate to overseas voyages.	There are no impacts on the PEP or need for further impact assessment.
National Counter-Terrorism Plan (NCTC, 2005), Revised Edition	The current edition is now the National Counter-Terrorism Plan (NCTC, 2012). A new edition has been released since the 2005 Edition refer to in the Chapter. 3 rd Edition 2012. The revised edition outlines the contemporary framework for the coordination of counter-terrorism threat measures amongst agencies, largely based on the previous edition.	The revised edition of the National Counter-Terrorism Plan does not affect this stage of the PEP or result in a need for any additional impact assessment. Any specific design consideration intended to help manage terrorism threats are matters that would be incorporated during the detailed design stage and would be consistent with the standards that apply at the time. The construction phase of the PEP is to be managed in accordance with relevant security protocols that apply at the time including any that may relate to the minimisation of terrorism threats. The revised Plan has no impact on the PEP at this stage and does not result in a need for any additional impact assessment.
<i>National Greenhouse and Energy Reporting Act 2007</i>	The repeal of the <i>Clean Energy Act 2011</i> had no effect on the obligations of corporations to report emissions to the Clean Energy Regulator.	The reporting obligation has no effect on this stage of the PEP. Emission reporting obligations associated with future operational stages of the PEP are likely to be more related to specific uses on reclaimed land and not the PEP itself.
National Infrastructure Plan	The plan details major infrastructure reforms over the next 50 years including providing greater certainty for ports and freight networks.	The PEP is consistent with the National Infrastructure Plan. No further impact assessment is required.
National Ports Strategy	The Strategy provides a coordinated planning strategy driving the development of efficient, sustainable ports and related freight logistics for Australia's growth. Implementation of the national action plan is expected through complementary State legislation and/or implementation plans.	There are no direct impacts on the PEP as implementation of the Strategy is expected through State legislation/implementation plans. The PEP is consistent with the objectives and proposed actions of the Strategy.
Regional Development Australia Townsville and North West Regional Road Map	The Regional Road map provides a strategic plan for the development of the region which includes port investment and access to markets.	The PEP is consistent with the scope of the Regional Road Map. No additional impact assessment is required.
EPBC Act Referral guidelines for the Outstanding Universal Value (OUV) of the Great Barrier Reef (GBR) World Heritage Area (WHA)	The Guidelines outline that OUV is the key reference point for the protection and management of world heritage properties and it the general idea of the World Heritage Convention. Attributes that contribute to the OUV of the GBRWHA are identified in the Statement of Outstanding Universal Value which was prepared retrospectively to capture the values of the property at the time of listing in 1981.	Since the EIS was released there has been substantial further guidance provided about the OUV of the GBR including finalisation of the EPBC Act referral guidelines published by the Commonwealth government Department of the Environment. The guidelines have been used in the re-assessment of the Project in the Outstanding Universal Values section.

Legislation/Policy	Summarised Change	Summarised PEP Context
Joint Commonwealth/State of Queensland		
Commonwealth Government Great Barrier Reef Region Strategic Assessment Report	Comprehensive assessment of MNES and OUV affecting the GBRWHA and Wet Tropics World Heritage Area. Includes protected flora and fauna likely to be within the area affected by the PEP. Has specific consideration for the impact of dredging within the GBRWHA.	The Strategic Assessment helps to clarify matters of OUV associated with the GBR and the associated assessment context. The Strategic Assessment recognises the strategic importance of priority port development areas along the Queensland coast and the need to limit any further dredging activity within the GBR to these locations. The Strategic Assessment does not change any MNES or OUV affecting the PEP. The PEP and Port are compatible with the intent of the Strategic Assessment and its implementation documents including the Program Report and the Draft Reef 2050 Long-Term Sustainability Plan. The Plan provides recommendations for future changes to administrative processes and the introduction of additional guidelines and practices for users of the GBR to maximise the protection of MNES and the OUV of the GBRWHA. The implementation of the Plan is expected to primarily affect the further approval processes for the PEP in terms of clarifying assessment criteria, performance outcomes for development within the GBRWHA and procedures for ongoing operational requirements. The Plan does not affect the PEP in terms of any required changes to the concept design for the purposes of the EIS or the impacts assessments that have been undertaken.
Great Barrier Reef Region Strategic Assessment Program Report	Outlines the 25 year program for the protection and management of the GBR including relevant MNES. The Program addresses administrative management requirements for the Reef, largely as administered by GBRMPA as well as improvements to environmental regulation to make processes and requirements clearer. Greater emphasis on supporting recovery and managing for resilience as well as strengthening protection of heritage values. Greater focus on engagement, knowledge, innovation and integration, adaptive management and implementation, and more effective operation of the permission system.	
Reef 2050 Long-Term Sustainability Plan	Provides an outcomes framework for the implementation of findings of the Strategic Assessment. The outcomes framework of the draft Sustainability Plan is based on seven key themes - water quality, biodiversity, ecosystem health, economic benefits, heritage, community benefits and governance. Each theme has an outcome, objectives, targets and actions.	
State of Queensland		
Coastal Management Plan 2014	The Coastal Management Plan is a non-statutory plan that provides policies and coastal management outcomes for non assessable development (i.e. coastal management issues for assessable development are considered under the State Planning Policy and State Development Assessment Provisions). The policies and outcomes are intended for use by all land managers who are or are planning to undertake activities within the coastal zone.	The PEP is consistent with the general coastal management outcomes affecting public accessible land. The Plan has removed the need to consider scenic amenity issues associated with coastal development, including for the PEP. Detailed outcomes are expected to be accounted for as part of the detailed design and construction phases of the PEP. No additional impact assessment is considered necessary resulting from the Coastal Management Plan.
Coastal Protection and Management Act 1995	The Coastal Protection and Management Act 1995, apart from regulating tidal and other works in terms of effects on and by coastal processes, also requires a resource entitlement for any large amounts of quarried material from within tidal areas. This includes dredge material that is likely to be used for reclamations such as the PEP.	The requirement for resource entitlement to access and use dredge material is an administrative process that is required prior to taking of the material and is usually obtained before lodgement of a development application for the works. The requirement does not affect the PEP or require any additional impact assessment at this stage of the Project.

Legislation/Policy	Summarised Change	Summarised PEP Context
<i>Economic Development Act 2012</i>	This is a new act that was introduced to highlight the importance of economic development to Queensland's prosperity. The Act provides a new Ministerial role and powers to declare special Priority Development Areas (PDAs) that are intended to provide for expedited integrated planning of key economic areas. The Act specifies the preparation of separate development schemes for PDAs which determine development outside the provisions of the <i>Sustainable Planning Act 2009</i> (SPA).	The identification of the Townsville PDA has no direct effect on the PEP or requires any additional impact assessment as part of this AEIS. The PEP as an integral part of the Port is expected to be consistent with planned development for the PDA.
<i>Environmental Protection Regulation 2008</i>	<i>Environmental Protection (Waste Management) Regulation 2000</i> was repealed on 29 August 2014. A number of provisions from the regulation were retained to maintain an appropriate level of management proportionate to the risk associated with waste. Amendments were made to the <i>Environmental Protection Regulation 2008</i> to give effect to the transfer of retained provisions from the expiring regulation in relation to waste tracking.	The PEP will be consistent with the amendments regarding waste.
<i>Environmental Protection (Water) Policy 2009</i>	Schedule 1 of the <i>Environmental Protection (Water) Policy 2009</i> has been updated to include the <i>Ross River Basin and Magnetic Island Plan (Basin No. 118)</i> .	Implications from this document include zones of high ecological value around Magnetic Island and the eastern region of Cleveland Bay, which entails 'no change' to water quality. This document also includes more stringent turbidity and Water Quality Objections expressed as 20 th , 50 th and 80 th percentiles. The PEP impact assessment does not rely on assessment against WQOs, this change in WQOs for the study area does not affect the outcomes of the impact assessment in the EIS or the AEIS.
<i>Environmental Offsets Act 2014, Environmental Offsets Regulation 2014</i> and Queensland Environmental Offsets Policy 2014, Version 1.1	The <i>Environmental Offsets Act 2014</i> coordinates the delivery of offsets across jurisdictions and provides a single point of truth for offsets in Queensland. The associated <i>Environmental Offset Regulation 2014</i> provides details of the prescribed activities regulated under existing legislation and prescribed environmental matter to which the Act applies. The Queensland Environmental Offsets Policy Version 1.1 replaced version 1.0 which provides a single, consistent, whole-of-government policy for the assessment of offset proposals to satisfy offset conditions.	The PEP will be consistent with the <i>Environmental Offsets Act 2014</i> and subsequent legislation.
<i>Forestry Act 1959</i>	The <i>Forestry Act 1959</i> has become of greater relevance to the PEP due to the need for quarry material from off-site sources. Such sources are required to have a Sales Permit for the extraction of material and its subsequent use.	Inclusion of the Sales Permit provisions of the Act do not affect the PEP or require any additional impact assessment at this stage of the Project.
Governing for Growth: Economic Strategy and Action Plan	Establishes pro-growth policies for business development in Queensland. Seeks to reduce red-tape barriers to business including streamlining major project approvals. Fosters economic growth and resilience as key principles. Recognises the importance of supply chains and the use of State Development Areas to promote development.	The Port is identified as being important as a key part of the Mount Isa to Townsville supply chain and in facilitating economic growth for Queensland. The Plan does not materially affect the PEP and does not result in a need for the PEP to be modified or for any additional impact assessment to be undertaken.

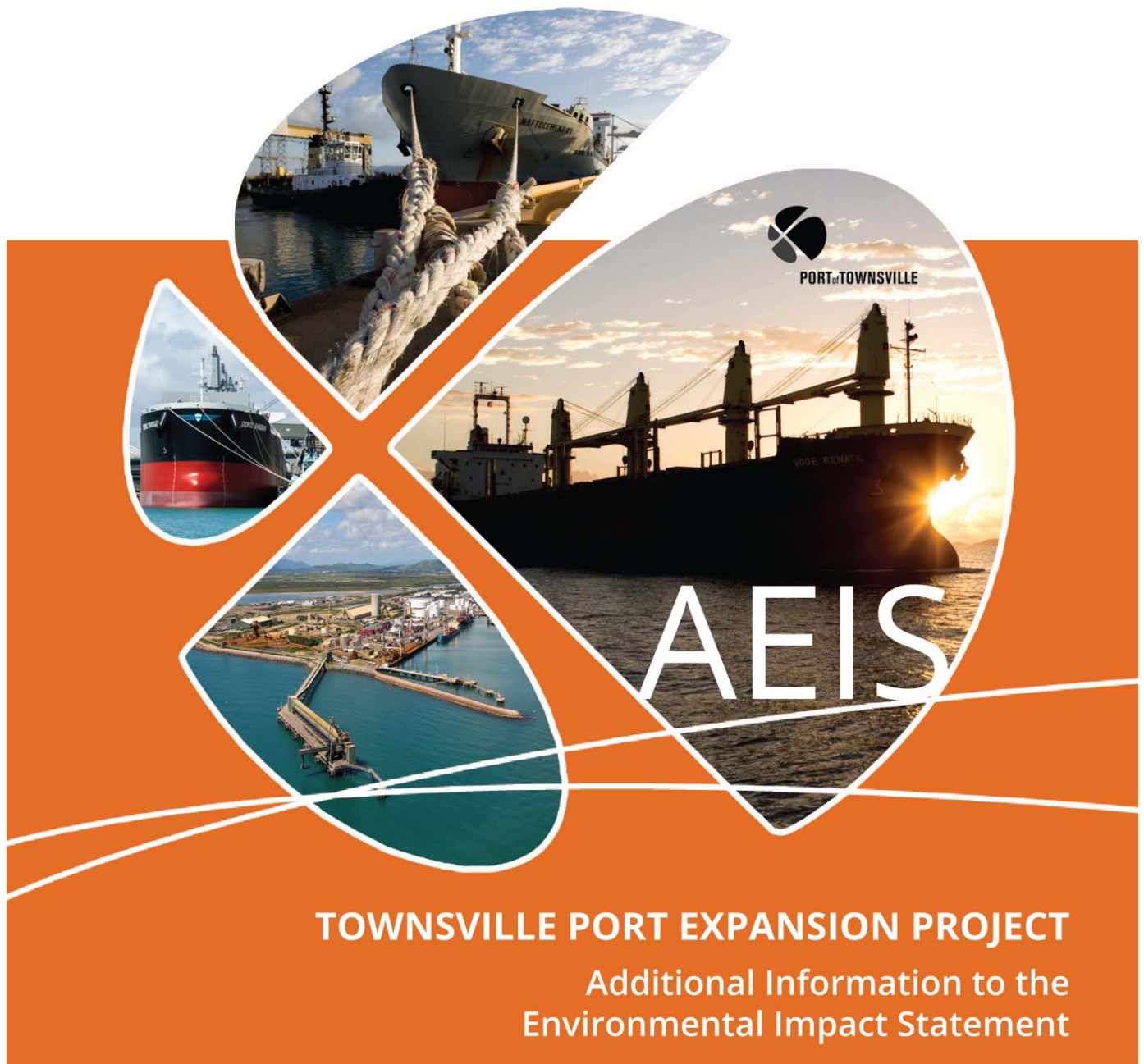
Legislation/Policy	Summarised Change	Summarised PEP Context
Great Barrier Reef Coastal Zone Strategic Assessment	This forms the State's component towards the Joint Commonwealth and Queensland Strategic Assessment of the Great Barrier Reef World Heritage Area. The recommendations of the State have formed parts of the Commonwealth's Strategic Assessment Program and the draft 2050 – Long term Sustainability Plan.	The overall strategic assessment recognises the need for better regulation of port development along the coast and minimisation of dredging within the GBR other than for recognised strategic Priority Port Development Areas. The PEP is to form a part of one of the intended Priority Port Development Areas (i.e. the Port of Townsville). The need for dredging has been limited to the area for the berths and improvements to the existing channel to the Port to accommodate larger capacity shipping. The Coastal Zone Strategic Assessment does not result in the need for any further modification of the PEP or any additional impact assessment.
Infrastructure for Economic Development	This is the State government's statement outlining how it is to plan and prioritise major economic infrastructure projects including through increasing opportunities for private sector involvement allowing for redistribution of government funds to other priorities.	The statement has no direct effect on the PEP concept design or assessment of environmental impacts. Potential greater reliance on private sector funding is a matter which will first require appropriate government policy decisions to be made regarding the Port. In the absence of any such definitive policy framework, no further impact assessment of the economic implications of this aspect is considered practicable or necessary at this stage.
InfrastructureQ Directions Statement	The Statement foreshadows the preparation of a State-wide Infrastructure Plan including prioritised infrastructure for economic growth. InfrastructureQ is also expected to largely replace the repealed <i>Queensland Infrastructure Plan</i> that was referred to in the PEP EIS.	The Statement does not provide specific policy detail and does not indicate anything adverse regarding the Port's continued status as important strategic infrastructure for North Queensland. The Statement does not result in a need for the PEP to be modified or for any additional assessment to be undertaken.
Moving Freight Strategy	The Moving Freight Strategy details a 10 year strategy for the strengthen the State's transport network for freight, including a modal shift to rail and shipping for bulk goods handling and transport. The Strategy supersedes the previous directions of the <i>Northern Economic Triangle infrastructure Plan 2007-2012</i> .	The PEP is designed to be consistent with the prioritisation of the the Port of Townsville as a main shipping centre for Queensland which is directly linked to road and rail. The Policy does not result in a need to modify the PEP or require any additional impact assessment to be undertaken.
<i>Nature Conservation Act 1992</i>	The <i>Nature Conservation Act 1992</i> and its related legislation was amended to simplify permit requirements for protected flora and fauna. The <i>Nature Conservation (Wildlife) Regulation 2006</i> lists threatened species of Queensland and is revised regularly.	The legislative changes do not change the effect on the PEP or require any additional impact assessment at this stage of the Project.
Planning and Development Bill	This forms the consultation basis for the proposed new Planning and Development Act. Reforms include the simplification of levels of assessment and public notification requirements.	The Planning and Development Act, once enacted, is likely to have noticeable procedural impacts on PEP in terms of obtaining further development approvals. The proposed changes to the planning framework do not adversely affect the PEP or require any additional detailed impact assessment.
Queensland Agriculture Strategy: A 2040 Vision to Double Agricultural Production	The Plan sets out the 2040 vision for agriculture, fisheries and forestry. Ports are recognised as an important supply chain aspect for agricultural growth.	The PEP is consistent with the overall policy direction of the Strategy. The Strategy does not result in a need for the PEP to be modified or for any additional assessment to be undertaken.

Legislation/Policy	Summarised Change	Summarised PEP Context
Queensland Counter-Terrorism Strategy 2013	The Strategy outlines the State's vision for the safeguarding of the Queensland community through effective and collaborative arrangements to counter terrorism and its consequences. The Strategy is a high level commitment to ensure that appropriate plans and agency coordination is in place to provide an effective counter-terrorism framework.	The Strategy provides a commitment to ensure that an appropriate State counter-terrorism framework is in place. The Strategy does not directly affect specific PEP design, construction or operational aspects and does not require any modification to the PEP or any additional or revised impact assessment.
Queensland Department of Transport and Main Roads document <i>Road Traffic Noise Management Code of Practice 2008</i>	<i>Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise 2013</i> .	The calculation methodology, noise goals and applicability are unchanged for the purposes of this AEIS.
Queensland Plan	The Queensland Plan provides an over-arching State vision for next 30 years. Establishes goals and targets for Queensland's economic development, its growth and future prosperity.	There are no required modifications to the PEP or need for additional impact assessment as a result of the introduction of the Queensland Plan.
Queensland Ports Strategy	The Strategy recognises the importance of Queensland shipping ports in the facilitation of economic development for the State and their significance in regional supply chains. The Strategy recognises the need for: - concentration of port activity into five key Priority Port Development Areas (PPDAs) which includes the Port of Townsville - integrated master planning for PPDAs - assessment of cumulative impacts of development on MNES and OUV of Great Barrier Reef.	The PEP will form an integral part of the Port and is able to be incorporated within any future master plan. Cumulative impacts of the proposed PEP have been assessed in the PEP EIS and this AEIS.
Queensland Reformed Development Assessment Process	This represents the proposed replacement of the IDAS process under SPA. The process proposes to reduce the statutory timeframes and number of steps to enable quicker activation of appropriate development. Details of the process are not yet available to review and may be included within a Regulation.	This is an administrative process that will apply to the processing of development applications. It is not yet known how this process is expected to directly apply to port development. Any impending changes are unlikely to influence the PEP or require any additional impact assessment as part of this AEIS.
Queensland State Land Tenure Review	Policy level assessment for possible improvements to the State land tenure system through: - investment certainty for leaseholders - providing greater flexibility for local governments - streamlined regulatory environment May lead to legislative changes and revised specific amended or new procedures. Changes are yet to be announced.	Changes are as yet unknown. No immediate effect on the progress of the PEP. The PEP is situated on State land. Any changes to the State land legislation are expected to apply to the PEP which will be required to proceed consistently with such changes. There are no new impacts that affect the PEP due to any proposed land tenure changes at this stage.
RegionsQ	The Policy recognises the importance of regional growth in Queensland in order to build economic resilience. This policy document has also largely replaced the repealed <i>Queensland Regionalisation Strategy</i> that was referred to in the original PEP EIS and the regional objectives for Townsville in the document 'A Second capital for Queensland - Townsville Futures Plan' that was referred to in the PEP EIS.	The PEP is intended to help strengthen the Port's capacity as a general cargo port both in terms of the diversity and tonnage of products that it is able to handle as economic activity within the North Queensland Region grows. The Policy does not result in a need for any modification to the PEP or additional impact assessment.

Legislation/Policy	Summarised Change	Summarised PEP Context
ResourcesQ	The policy highlights mineral resources as a continuing priority for economic development in Queensland, including the North West Mineral province which is directly linked to the Port of Townsville to facilitate minerals exports. While being a state-wide plan, ResourcesQ effectively replaces the <i>Northern Economic Triangle Infrastructure Plan 2007-2012</i> in terms of strategic directions for the region's resource development.	The PEP is an integral part in helping to facilitate export growth of minerals, including from the North West Minerals Province. The PEP is consistent with the intent of ResourcesQ and does not require modification or any additional impact assessment as a result of the introduction of the policy.
Sea Freight Action Plan	The Plan is yet to be announced and is expected to examine whether there is a greater need for marine transport connection as an integral part of the State's transport network including the expanded use of containerisation for shipping.	The PEP is consistent with the intention to expand the Port's overall capacity to handle a range of general cargo including freeing up existing berths for general cargo shipping. The proposed plan is not expected to result in any need for the PEP to be modified or any additional impact assessment to be undertaken.
<i>State Development and Public Works Organisation Act 1971</i>	The SDPWO Act has been amended to redefine 'significant projects' as coordinated projects and to allow the Coordinator General to decide whether such projects require a formal EIS or a more simplified Impact Assessment Report. Changes also enable the Coordinator General to determine whether formal public consultation is required for those projects that do not require an EIS.	The changes do not directly affect the current PEP as the project's assessment is already defined by specific terms of reference from the Coordinator General and from the Commonwealth Department of Environment, both of which have required a formal EIS.
State Development Assessment Provisions	Introduces code assessment provisions for State assessable development, including referral matters under Schedule 7 of the SP Regulation. Code provisions are contained within specific modules which also constitute State interests.	No direct impact on the PEP at this stage of the Project. State Development Assessment Provisions (SDAP) matters are to be considered in detail as part of any future development applications under the current provisions of SPA. The PEP is generally consistent with the objectives and overall outcomes of the relevant SDAP Modules.
State Disaster Management Plan 2013-2014, prepared in accordance with Disaster Management Act 2003	An update of the Plan was provided in 2013 prepared in accordance with the Disaster Management Act 2003. The changes reflect machinery of government changes due to the 2012 State Election, outcomes of the Queensland Floods Commission Inquiry and Police Safety Review outcomes.	The updated changes of the Plan do not affect the PEP or require any additional impact assessment.
State Planning Policy	Repeal of previous SPPs; replaced by a single new SPP which identifies relevant State interests	The SPP provides clarification and rationalisation of key State interests much of which has been based on the repealed SPPs which were assessed in detail in the PEP EIS. The SPP identifies specific performance outcomes and acceptable outcomes that did not previously exist for matters of State interest, many of which are based on earlier SPP objectives and outcomes which have been assessed in detail in the PEP EIS. The SPP does not require any modification to the PEP or require any additional impact assessment.
State Planning Regulatory Provisions	Repeal of Coastal Planning State Planning Regulatory Provisions.	There are no significant impacts on the PEP or a need for additional impact assessment.

Legislation/Policy	Summarised Change	Summarised PEP Context
Statutory Port Master Planning Guidelines	Statutory master planning guidelines are proposed for integrated port planning of key Queensland ports under the Queensland Ports Strategy.	The PEP has been the result of earlier detailed port master planning for the Port of Townsville. Scope will exist for detailed PEP design planning to be incorporated into a statutory master plan when required. The proposed master planning provisions do not impact on this stage of the PEP or require any additional impact assessment.
Strengthening Queensland's Supply Chains 2013-2015	This is an industry council led report which recognises the need to strengthen the operational integrity and efficiency of supply chains including ports by managing encroachments and more effective port planning. The recommendations have largely been incorporated into the Queensland Ports Strategy.	The PEP is designed to minimise the risk of encroachment from other incompatible development and is of a proposed form and functionality that is based on earlier detailed master planning investigations for the overall Port. The Report does not result in a need for modification to the PEP or any additional or revised impact assessment.
<i>Sustainable Ports Development Act 2015</i>	The <i>Sustainable Ports Development Act 2015</i> commenced on 20 November 2015. The purpose of the Act is to provide protection of the Great Barrier Reef World Heritage Area through managing port related development.	The Act prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park, unless it is for a priority port and in accordance with that port's Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.
<i>Sustainable Planning Act 2009</i>	Changes to the Act related to administrative requirements regarding the relationship of the Act to other acts, relationship of other state statutory instruments and other revised administrative processes. There were no specific changes directed towards development that may be associated with ports or port-related activity.	SPA provides the over-arching legislative planning context for land use management associated with the Port's activity. This includes the proposed development of the PEP. There are no direct impacts on the PEP from the changes to SPA in terms of its concept design or the EIS that has been prepared and this AEIS.
Sustainable Planning Regulation 2009	Changes to the SP Regulation formed a part of the State government's Planning Reform package intended to streamline planning processes within Queensland and are intended to act as a precursor to planned introduction of a new Planning and Development Act by 2015. Changes to the SP Regulation have included: ▪ introduction of single state referral agency (SARA) ▪ revised fewer state assessable development triggers ▪ revised fewer referral triggers ▪ new State assessment fees ▪ additional self-assessment provisions for some forms of State assessable development.	The changes to the Regulation do not require any changes to the PEP or any significant additional impact assessments. The changes since the PEP EIS was finalised primarily reduce the number of State assessable development and referral triggers that are likely to apply to the PEP when the Project is at the detailed design stage including any specific development approvals that may apply under the current planning legislation. It is noted that the changes that have been identified in the AEIS are expected to be superseded once the new Planning and Development Act is enacted by State parliament with detailed regulatory provisions which have as yet been unavailable for the AEIS assessment.
Townsville Priority Development Area	Townsville Prioty Port Development Area (PDA) is a PDA that has been declared under the provisions of the <i>Economic Development Act 2012</i> . The Townsville PDA covers much of the Ross Creek location and affects non-strategic port land held by the Port of Townsville. Declaration of PPDAs is likely to be included either within an expected Ports Act or an accompanying Regulation.	The Townsville PDA does not directly affect the Port of Townsville Strategic Port land or the PEP; however, it is likely that the PDA could impact Port operations, or future port activities related to non strategic port land. The full implications are currently unclear as the PDA is still under development.

Legislation/Policy	Summarised Change	Summarised PEP Context
Townsville State Development Area Development Opportunities Strategy	The Strategy provides greater strategic context for the use of Townsville State Development Area land. The Strategy continues to recognise and facilitate complementary development between the Port and the State Development Area, particularly where there is a need for port dependent industrial land which cannot be facilitated on Strategic Port Land.	Changes to the Strategy do not affect the PEP or require any additional impact assessment to that which was provided in the PEP EIS.
Local		
Townsville City Developer Contributions	Revised developer contributions have been resolved by the Council which include scope for State government contributions to strategic infrastructure provision.	The Port's existing arrangements for infrastructure contributions to Council to be negotiated through formal Infrastructure Agreements are not changed. The determination of detailed trunk infrastructure requirements is a matter for the detailed approval stages and does not require any modification to the PEP or additional impact assessment at this stage.
Townsville City Economic Development Plan 2013-2017	The Plan highlights economic development priorities identified by the Townsville City Council which include growth in port operations.	The PEP is consistent with the Economic Development Plan and is also likely to leverage other opportunities for increased employment and business that are regarded as priorities for the area. The Plan does not require any change to the PEP or any additional impact assessment.
Townsville City Plan 2014	The Townsville City Plan 2014 provides the locally based land use planning framework for Townsville, including the identification of a preferred Strategic Framework for future development, zones for preferred development, levels of development assessment and key social and environmental constraints. The City Plan supports high scenic amenity outcomes.	Land use planning approvals within the Port's strategic port land are not affected by the Planning Scheme. The Port is recognised as a strategic centre as part of the Planning Scheme and adjacent development is intended to be compatible with port activity. The PEP does not adversely affect the land use planning intent of the Planning Scheme and does not require any modification or additional impact assessment.



APPENDIX C3

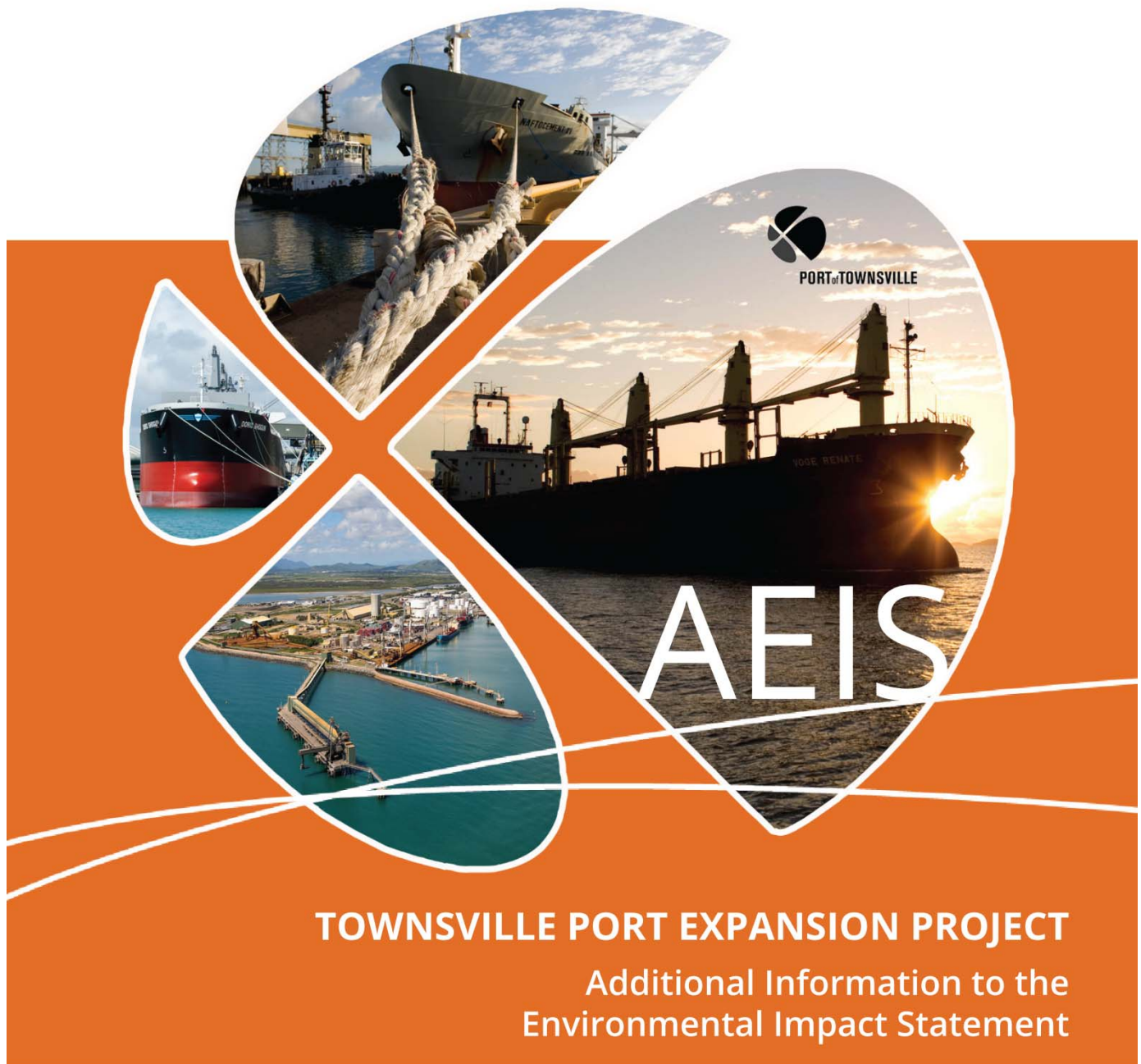
Errata List



Errata List

Section	Page No.	Erratum
B4.3.1	Page 162	Table B.4.1 modified as per the following: 'tick' added in the cell corresponding to "ANZECC (2000)b" and Aquatic Ecosystems" - row added "NHMRC (2008)" and 'tick' moved from the "ANZECC (2000)b" row for "Primary Recreation" and "Secondary Recreation" down into the "NHMRC (2008)" row.
B4.3.1	Page 162 and 163	Tables B.4.1 and B.4.2 modified as follows: - Footnote in Table B.4.1 and B.4.2 modified to "Queensland Water Quality Guidelines 2009, prepared by the Environmental Protection Agency Department of Environment and Resource Management, Queensland government". - In Table B.4.2, Ammonia trigger level amended from 910 ug/L to 460 ug/L as per Batley & Simpson (2009) Development of guidelines for ammonia in estuarine and marine water systems. Marine Pollution Bulletin, 58 (2009), pp. 1472-1476. - In Table B.4.2, the following amendments are made: - The recreational guideline value for Cadmium of 50 µg/L should be replaced with the aquatic ecosystem trigger value of 0.7 µg/L - The toxicity trigger value for mercury should be 0.1 µg/L instead of 0.004 µg/L - The toxicity trigger value for nickel should be 7 µg/L instead of 70 µg/L - In Table B.4.2, a footnote should be added that for substances known to be bioaccumulating in marine environments (i.e. cadmium, mercury and nickel), it is the 99% species protection level and not the 95% species protection level that becomes the default trigger value (as per ANZECC/ARMCANZ).
B4.3.2.13	Page 175 and 177 'Photosynthetically Active Radiation (PAR)'	Section B4.3.2.13 of the EIS is amended as follows (insertion of underlined text and deletion where struck through): - Page 177, paragraph 2, sentence2: <i>"In this equation, E(s) is the PAR at the water surface and E(z) is the PAR at a depth of z. <u>PAR levels at the surface were obtained from the Australian Institute of Marine Science data centre.</u>"</i> - Page 175, paragraph 1 sentence 2: <i>"BMT WBM (2009) measured PAR at the seabed as part of their monitoring campaign during October 2008 to May 2009 as reported in Section B4.4.4 for TSS. <u>PAR levels at the surface were obtained from the Australian Institute of Marine Science data centre.</u>"</i>
B.4.4.3.1	Page 190, paragraph 1 under 'potential impact'	The following text is deleted "While there are no set water quality guidelines for sediment porewater; previous dredging-related assessments elsewhere (URS, 2008; Hydrobiology, 2003a; BMT WBM, 2008) were required to assess porewater (and elutriate) concentrations with acute toxicity trigger values (TTVs) associated with water column as outlined in the ANZECC/ARMCANZ (2000)) guidelines." Text replaced with "The ANZECC/ARMCANZ (2000) aquatic ecosystem protection trigger values are the appropriate water quality guidelines to assess sediment porewater."
B.4.4.3.1	Page 190, paragraph 2 under 'potential impact'	Text amended as follows: "For ammonia, the TTV varies according to pH, thus assuming a pH of 8.0 and 95% protection of species for 'slightly to moderately' disturbed systems, the TTV for ammonia is 0.9146 mg/L (ANZECC & ARMCANZ, 2000 Batley and Simpson. 2009)."

Section	Page No.	Erratum
B6	Entire	All references to declared FHAs affecting/regulating net fishing and trawling to be replaced with "legal fishing is allowed in declared FHAs".
B.6.2.1	Page 262	<i>Marine Parks Act 2004</i> included in the list of relevant State legislation as impacts from dredging have the potential to affect the State Marine Park.
B.8.3.3	Page 428	Foot notes missing from Table B.8.3.3.
B.10.4.3.2	Page 474	"night-time" should instead be "day-time".
B11	Entire	The EIS used an incorrect emissions factor for diesel fuel. The AEIS used the correct emissions factor as published in the National Greenhouse Accounts Factors (August 2015).
B.13.3.3.3	Page 539	Indigenous Populations' should be referred to as 'Aboriginal and Torres Strait Islander'.
B.17.4.3 / Table B.17.18	Page 689	Missing information on Viewpoint 10. Medium sensitivity, moderate (noticeable) magnitude of change, moderate (adverse) significance. Also Included in Section 19.0 Scenic Amenity of the AEIS.
B.18.3.3	Page 710	Incorrect reference to the length of the inner route from Tropic of Capricorn to the Torres Straits should be "is in excess of 900nm", not the stated "300 miles".
B.20.5.1	Page 779 / Table B.20.4	Chemical Hazards' should read: ▪ "Work Health and Safety Regulation 2011 ▪ Chapter 7 - Hazardous Chemical ▪ Chapter 8 – Asbestos ▪ Part 4.8 - Dive Work ▪ Chapter 9 - Major Hazard Facilities".
Section 16	Page 213	The EIS calculated two person trips for light vehicle traffic movements. This has been amended in the AEIS. The revised AEIS comparison of typical peak light vehicle traffic movements (Figure 16.2) is based on single person trips as directed by DTMR.



APPENDIX C4

References



- ABS. (2006). *Community Profiles*. Retrieved 07 27, 2012, from Commonwealth of Australia (Australian Bureau of Statistics):
<http://www.abs.gov.au/websitedbs/censushome.nsf/home/communityprofiles?opendocument&navpos=230>
- ABS. (2011). *2011 Census of Population and Housing Basic Community Profile: Magnetic Island*. Canberra: Commonwealth of Australia (Australian Bureau of Statistics).
- ABS. (2012b, 08 06). *National Regional Profile 2006-2010*. Retrieved 10 10, 2012, from Commonwealth of Australia (Australian Bureau of Statistics):
<http://www.ausstats.abs.gov.au/ausstats/nrmaps.nsf/NEW+GmapPages/national+regional+profile>
- Access Economics Pty Ltd. (2007). *Measuring the Economic and Financial Value of the Great Barrier Reef Marine Park, 2005-2006*. Townsville: Great Barrier Reef Marine Park Authority.
- AEC Group Limited. (2009). *Townsville North Queensland; Tourism Opportunity Plan*. Townsville: State of Queensland (Tourism Queensland, Townsville Enterprise, Townsville North Queensland) .
- AEC. (2011). *Cairns - Townsville Experiences - Audit Report*. n.s: AEC Group Ltd.
- AECOM (2014). Consideration of the PEP Design Refinement on wave climate at the Port of Townsville. Report prepared for Port of Townsville Ltd, October 2014.
- AECOM. (2012). *Light Impacts of Migratory Waders*. Perth.
- AECOM. (2012a). *Townsville Port Expansion Project, Obtrusive Light Study*. Brisbane.
- Amos, K., Alexander, J., Horn, A., Pocock, G., & Fieldings, C. (2004). Supply limited sediment transport in a high-discharge event of the tropical Burdekin River, North Queensland, Australia. *Sedimentology*, 51, 145-162.
- Anderson C, Battershill C, Carter RM, Cruz-Motta JJ, Doherty G, Ericson G, Evans-Illidge E, Haynes D, Hesse A, Jones GB, Larcombe P, Lough J, Neil K, Orpin A, Reichelt-Brushett AJ, Ridd P, Roche M, Veitch V (2002) Cleveland Bay, Townsville, Queensland Australia. Status Report. Cleveland Bay Consortium, Townsville.
- Anthony, K., Dambacher, J., Walshe, T., & Beeden, R. (2013). *A framework for understanding cumulative impacts, supporting environmental decision and informing resilience-based management of the Great Barrier Reef World Heritage Area*. Townsville : Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- Australian Bureau of Statistics. (2012a). *Australian National Accounts: State Accounts, 2011-12, Cat. No. 5209.055.001, September*. Canberra: Commonwealth of Australia (Australian Bureau of Statistics).
- Australian Bureau of Statistics. (2012b). *Australian National Accounts: State Account, 2011-12. Cat. No. 5220.0, November*. Canberra: Commonwealth of Australia (Australian Bureau of Statistics).
- Australian Government and Queensland Government. (2015). *Reef 2050 Long-Term Sustainability Plan*. Australian Government & Queensland Government.
- Awramik SM (1971) Precambrian columnar stromatolite diversity: Reflection of Metazoan Appearance. *Science* 174: 825-827. [DOI:10.1126/science.174.4011.825]
- Ayling, A. &, & Ceccarelli, D. (1991). The Impact of Dredge Spoil Dumping on Fringing Coral Reefs Around Facing Island. *Sea Research*.
- Ayling, A.M. and A.L. Ayling. (1998). *The Effect of the Daintree River Flood Plume in Snapper Island Coral Reefs*. A Report to the Great Barrier Reef Marine Park Authority.
- Ayukai, T., & Wolanski, E. (1993). Importance of biologically mediated removal of fine sediments from the Fly River plume, Papua New Guinea. *Estuarine Coastal and Shelf Science*, 44, 629-639.
- Barnes, J. (1966). The crown-of-thorns starfish as a destroyer of coral. *Australian Natural History*, 15, 257-61.
- Batley, G., & Simpson, S. (2009). Development of guidelines for ammonia in estuarine and marine water systems.

Marine Pollution Bulletin, pp. pp. 1472-1476.

Beasley I, Robertson, KM, Arnold, P (2005). Description of a new dolphin: The Australian snubfin dolphin *Orcaella heinsohni* sp.n. (Cetacea, Delphinidae). *Marine Mammal Science*. 21(3):365-400.

Bell, P., Elmetri, I., & Lapointe, B. (2014). *Evidence of Large-Scale Chronic Eutrophication in the Great Barrier Reef: Quantification of Chlorophyll a Thresholds for sustaining Coral Reef Communities*. The Royal Swedish Academy of Sciences 2013.

Belperio, A. (1983). Terrigenous sedimentation in the central Great Barrier Reef lagoon: a model from the Burdekin region. *Journal of Australian Geology & Geophysics*, 8, 179-190.

Berkelamans, R., De'ath, G., Kininmonth, S., & Skirving, W. (2004). A comparison of the 1998 and 2002 coral bleaching events on the Great Barrier Reef; spatial correlation, patterns and predictions. *Coral Reefs*, 23:74-83.

BITRE. (2013). *Australian bulk ports*. Canberra: Commonwealth of Australia (Department of Infrastructure and Transport; Bureau of Infrastructure, Transport and Regional Economics).

BITRE. (2013). *Maritime Australia's Bulk Ports*. Canberra: Commonwealth of Australia (Department of Infrastructure and Transport).

Blake, D.R., Rowland, F.S., 1988. Continuing Worldwide Increase in Tropospheric Methane, 1978 to 1987. *Science* 239, 1129-1131.

BMT WBM (2013). *Assessment of Maintenance Dredging Impacts in Cleveland Bay*. Report prepared for Port of Townsville Limited.

BMT WBM (2014). *Assessment of Maintenance Dredging for 10 Year Permit*. Report prepared for Port of Townsville Limited.

Bongaerts, P., Frade, P., Ogier, J., Hay, K., Van Bleijswijk, J., Englebert, N., *et al.* (2013). Sharing the slope: depth partitioning of agariciid corals and associated symbiodinium across shallow and mesophotic habitats (2-60 m) on a caribbean reef. *Bmc Evolutionary Biology*, 13.

Bongaerts, P., T, R., Sampayo, E., & Hoegh-Guldberg, o. (2010). Assessing the 'deep reef refugia' hypothesis: focus on Caribbean reefs. *Coral Reefs* 29, 309-327.

Brandon, D., & Price, R. (2007). *Summary of Available Guidance and Best Practices for Determining Suitability of Dredged Material for Beneficial Uses*. US Army Corps of Engineers, Engineer Research and Development Centre.

Brodie, J. W. (2013). *2013 Scientific Consensus Statement: Land use impacts on Great Barrier Reef water quality and ecosystem condition*. The State of Queensland.

Brodie, J., Fabricius, K., De'ath, G., & Okaji, K. (2005). Are increased nutrient inputs responsible for more outbreaks of crown-of-thorns starfish? An appraisal of the evidence. *Marine Pollution Bulletin* 51, 266-278.

Brodie, J., Waterhouse, J., Schaffelke, B., Koon, F., Thorburn, P., Rolfe, J., *et al.* (2013). *2013 Scientific Consensus Statement*. Brisbane: The State of Queensland, Reef Water Quality Protection Plan Secretariat.

Browne, N. (2012). Spatial and temporal variations in coral growth on an inshore turbid reef subjected to multiple disturbances. *Marine Environmental Research* 77, 71-83.

Browne, N., Smithers, S., & Perry, C. (2010). Geomorphology and community structure of Middle Reef, central Great Barrier Reef, Australia: an inner-shelf turbid zone reef subject to episodic mortality events. 683-689.

Browning, L, Bailey, K (2006). Current Methodologies and Best Practices for Preparing Port Emission Inventories. 15th International Emission Inventory Conference

Bureau of Transport Economics. (2000). *Regional Impacts on Ports, Report 101*. Canberra: Commonwealth of Australia (Bureau of Transport Economics).

Bureau of Transport Economics. (2001a). *Regional Impact on the Port of Gladstone, Working Paper 46*. Canberra:

Commonwealth of Australia (Bureau of Transport Economics).

Bureau of Transport Economics. (2001b). *Regional Impacts of the Port of Mackay, Working Paper 47*. Canberra: Commonwealth of Australia (Bureau of Transport Economics).

C&R Consulting (2007) Townsville ocean terminal nature conservation report: baseline study of impacts of the Townsville ocean terminal on ecological characteristics of Cleveland Bay. Technical Appendix to the Townsville Ocean Terminal Project - Environmental Impact Statement (Final). City Pacific Limited, Townsville.

C&R Consulting. (2007). *Townsville Ocean Terminal Nature Conservation Report: Baseline Study of Impacts of the Townsville Ocean Terminal on Ecological Characteristics of Cleveland Bay*. Townsville: C&R Consulting for City Pacific Limited.

Campbell SJ, McKenzie LJ (2004) Flood related loss and recovery of intertidal seagrass meadows in southern Queensland. *Australia Estuarine, Coastal and Shelf Science* 60: 477-490.

Campbell, S. &. (2004). Flood related loss and recovery of intertidal seagrass meadows in southern Queensland, Australia. *Estuarine, Coastal and Shelf Science* 60, 477-490.

Carr, L., & Mendelsohn, R. (2003). Valuing coral reefs: a travel cost analysis of the Great Barrier Reef. *AMBIO:J.Human Environ.* 32, 353 - 357.

Carrigan, A., & Puotinen, M. (2014). Tropical cyclone cooling combats region-wide coral bleaching. *Global Change Biology*, 20 (5), 1604-1613.

Carter, R., Johnson, D., & Hooper, K. (1993). Episodic post-glacial sea level rise and the sedimentary evolution of a tropical continental embayment (Cleveland Bay, Great Barrier Reef shelf, Australia). *Australian Journal of Earth Sciences: An international Geoscience Journal of Geological Society of Australia*, 40:3, 229-255.

Cicerone, R.J., Oremland, R.S., 1988. Biogeochemical aspects of atmospheric methane. *Global Biogeochemical Cycles* 2, 299-327.

Coles R, McKenzie L, Campbell S (2003) The seagrasses of Eastern Australia, in Green, E.P. and Frederick, T.S. (eds), *World Atlas of Seagrasses*, UNEP World Conservation Monitoring Centre, Cambridge.

Collier, C., & Waycott, M. (2010). *Light intensity and water temperature are drivers of change in seagrasses of the Great Barrier Reef*. Cairns: Annual Conference of the Marine and Tropical Sciences Research Facility.

Connell, J., Hughes, T., & Wallace, C. (1997). A 30 Year Study on Coral Abundance, Recruitment, and disturbance at several scales in space and time. *Ecological Monographs* 67(4), 461-488.

Connolly, E., Norman, D., & West, T. (2012). *Small Business: An Economic Overview (Small Business Round Table)*. n.s: Australian Bureau of Statistics (ABS).

Context Pty Ltd. (2013). *Defining the Aesthetic Values of the Great Barrier Reef*. Canberra: Commonwealth of Australia (Department of Sustainability, Environment, Water, Population and Communities).

Cooper, T.F., Ridd, P.V., Ulstrup, K.E., Humphrey, C., Slivkoff, M., Fabricius, K.E., 2008. *Temporal dynamics in coral bioindicators for water quality on coastal coral reefs of the Great Barrier Reef*. *Mar. Fresh. Res.* 59, 703-716.

CPL. (2007). *Townsville Ocean Terminal Project - Environmental Impact Statement (Final)*. Townsville: City Pacific Limited.

Cruz-Motta JJ (2000). Effects of dumping of dredged material of Townsville Port on the soft-bottom benthic community of Cleveland Bay. James Cook University report to the Townsville Port Authority.

Cruz-Motta JJ, Collins J (2004). Impacts of dredged material disposal on a tropical softbottom benthic assemblage. *Marine Pollution Bulletin* 48: 270-280

Davies JN, McKenna SA, Jarvis JC, Carter AB, Rasheed MA (2013). Port of Townsville Annual Monitoring and Baseline Survey: October 2013. James Cook University Publication, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), Cairns, 52 pp.

- DCILGPS. (2000). *Townsville-Thuringowa Strategy Plan*. Townsville: State of Queensland (Department of Communication and Information, Local Government, Planning and Sport).
- De Jonge, V., De Jong, D., & van Katwijk, M. (2011). Disturbance and the dynamics of coral cover on the Great Barrier Reef (1995-2009). *PLOS One*.
- De Weille, J., & Ray, A. (1974). The Optimum Port Capacity. *Journal of Transport Economics and Policy*, 244-259.
- De'ath G and Fabricius KE (2008) Water quality of the Great Barrier Reef: distributions, effects on reef biota and trigger values for conservation of ecosystem health. Final Report to the Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science, Townsville. 100 pp.
- Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., (2014). Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.
- De'Ath, G., Fabricius, K., Sweatman, H., & Puotinen, M. (2012). The 27-year decline of coral cover on the Great Barrier Reef and its causes. *PNAS*.
- DEC. (2005). Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Department of Environment and Conservation (NSW), Sydney.
- DEEDI. (2011). *Coastal Habitat Resources Information System (CHRIS)*. State of Queensland (Department of Employment, Economic Development, and Innovation).
- DEHP (2014) Queensland Environment Offsets Policy Significant Residual Impact Guideline (Nature Conservation Act 1992, Environment protection Act 1994, Marine Parks Act 2004). State of Queensland, Department of Environment and Heritage Protection.
- DEHP. (2011). *Queensland Coastal Plan; State Planning Policy 3/11 Guideline: Coastal Protection*. Brisbane: State of Queensland (Department of Environment and Heritage Protection).
- DEHP. (2012). *Environmental Protection (Water) Policy 2009; Draft Ross River Basin Environmental Values and Water Quality Objectives*. State of Queensland (Department of Environment and Heritage Protection).
- DEHP. (2014). *Coastal Management Plan*. n.s: State of Queensland (Department of Environment and Heritage Protection).
- DEHP. (2014). *Contaminated land assessment guideline*. Brisbane: State of Queensland (Department of Environment and Heritage Protection).
- Dekker, R., Bloemhof, J., & Mallidis, I. (2012). Operations research for green logistics - an overview of aspects, issues, contributions and challenges. *European Journal of Operation Research* 219, 671–679.
- Department of Natural Resources and Mines. (2002). *Guidance on the Assessment of Tangible Flood Damages*. Queensland Government.
- Department of the Environment (2016). Species Profile and Threats Database. Accessed 27/09/2016. <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
- Department of the Environment (2013) Matters of Environmental Significance – Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act. Commonwealth of Australia, Department of the Environment, Canberra.
- DERM. (1993). *Queensland Heritage Register Listing Description for Castle Hill*. Retrieved 07 12, 2011, from State of Queensland (Department of Environment and Resource Management): <http://www.epa.qld.gov.au/chims/placeDetail.html?siteId=15982>
- DERM. (2006a). *Magnetic Island National Park*. Retrieved 12 7, 2011, from State of Queensland (Department of Environment and Resource Management): <http://www.derm.qld.gov.au/parks/magnetic-island/about.html>
- DERM. (2006b). *Queensland Heritage Register Listing Description for the Rocks Guest House*. Retrieved 07 12, 2011, from State of Queensland (Department of Environment and Resource Management):

<http://www.epa.qld.gov.au/chims/placeDetail.html;jsessionid=0a10032330d88c552d6d70054b4ba258b24fe296e1cd.e34NaN8SbNyKci0MaheOaheMchuMe6fznA5Pp7ftolbGmkTy?siteId=19505> (accessed 12/07/2011).

DeVantier, L., De'ath, G., Done, T., Turak, E., & Fabricius, K. (2006). Species richness and community structure of reef-building corals on the near shore Great Barrier Reef. *Coral Reefs*, 25, 329-340.

Devlin, M., McKinna, L., Alvarez-Romero, J., Petus, C., Aboot, B., Harkness, P., et al. (2012). Exposure to riverine plumes in the Great Barrier Reef. Risk Assessment by Mapping Plume extent and composition using remote sensing. *Marine Pollution Bulletin*, 224-235.

DHI in Chevron (2010). *Appendix N3 – Tolerance Limits Report for the Draft Environmental Impact Statement for the Proposed Wheatstone Project*.

DI. (2007). *South East Queensland Regional Plan including Implementation Guideline Number 8*. Brisbane: State of Queensland (Office of Urban Management, Department of Infrastructure).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DOE. (2013). *The Revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*. Canberra: Commonwealth of Australia (Department of Environment; Council of Australian Governments Standing Council of Environment and Water National Water Reform Thematic Oversight Group).

DoE. (2014). *EPBC Act referral guidelines for the Outstanding Universal Value of the Great Barrier Reef World Heritage Area*. Commonwealth of Australia (Department of the Environment).

Done, T. (1992). Effects of tropical cyclone waves on ecological and geomorphological structures on the Great Barrier Reef. *Continental Shelf Research* 12, 859-872.

Done, T., Ayling, A., & Van Woesik, R. (1991). *Broadscale survey of impacts of Cyclone Ivor on coral reefs*. Townsville, Australia: Unpublished report for the Great Barrier Reef Marine Park Authority.

Douvere, F. &. (2012). *Mission Report. Reactive Monitoring Mission to Great Barrier Reef (Australia) 6th to 14th March 2012*. UNESCP World Heritage Centre - ICUN.

DSDIP. (2013). *Great Barrier Reef, Coastal Zone Strategic Assessment 2013*. Brisbane: State of Queensland, Department of State Development, Infrastructure and Planning.

DSDIP. (2014). *Great Barrier Reef coastal zone strategic assessment, Supplementary Report*. Brisbane: State of Queensland, Department of State Development, Infrastructure and Planning.

DSDIP. (2014). *Queensland Ports Strategy*. Brisbane: State of Queensland (Department of State Development, Infrastructure and Planning).

DSDIP. (2014a). *Queensland Ports Strategy*. Brisbane: State of Queensland, The Department of State Development,

Infrastructure and Planning.

DSDIP. (2014a). *Queensland Ports Strategy*. Brisbane: State of Queensland, The Department of State Development, Infrastructure and Planning.

DSEWPac. (2013). *The Interim Guidelines on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area – for Proponents of Actions*.

DSEWPac. (2013a). *Interim Guidelines on the Outstanding Universal Value of the Great Barrier Reef World Heritage Area - For Proponents of Actions*. Canberra: Commonwealth of Australia (Department of Sustainability, Environment, Water, Population and Communities).

DSEWPac. (2014). *Great Barrier Reef Region Strategic Assessment*. DSEWPac.

DTMR. (2001). *Townsville-Thuringowa Intergrated Regional Transport Plan*. Townsville: State of Queensland (Department of Transport and Main Roads).

Econsearch. (2009). *Port of Port Kembla Economic Impact Study*. n.s: Econsearch, prepared for Port Kembla Port Corporation.

Endean, R. (1982). Crown-of-thorns starfish on the Great Barrier Reef. *Endeavour*, 6, 10.

EPHC. (2010). *Draft National Windfarm Development Guidelines*. Environment Protection and Heritage Council.

Erftemeijer, P. &. (2006). Environmental impacts of dredging on seagrass: A review. *Marine Pollution Bulletin* 52, 1553-1572.

Erftemeijer, P.L.A., Lewis, R.R.R. (2006) Environmental Impacts of dredging on seagrasses: a review. *Marine Pollution Bulletin* 52: 1553-1572.

Erftemeijer, P.L.A., Riegl, B., Hoeksema, B.W., Todd P.A. (2012) Environmental impacts of dredging and other sediment disturbances on corals: a review. *Marine Pollution Bulletin* 64: 1737–1765.

Fabricius, K. (2009). *Patterns in hard coral diversity and cover on inshore reefs of the GBR*. Commonwealth of Australia (Australian Institute of Marine Science).

Fabricius, K., De'ath, G., Puotinen, M., Done, T., Cooper, T., & Burgess, S. (2008). Disturbance Gradients on Inshore and Offshore Coral Reefs Caused by a Severe Tropical Cyclone. *Limnology and Oceanography*, Volume 53, No. 2, 690-704.

Fabricius, K., Okaji, K., & De'ath, G. (2010). Three lines of evidence to link outbreaks of the crown-of-thorns seastar *Acanthaster planci* to the release of larval food limitation. *Coral Reefs*, 29, 593 - 605.

Farabegoli E, Perri MC, Posenato R (2007). Environmental and biotic changes across the Permian–Triassic boundary in western Tethys: The Bulla parastratotype, Italy. *Global and Planetary Change*, 55: 109-135.

Fourgeaud, P. (2000). *Measuring Port Performance*. The World Bank Group.

Furnas, M., Schaffelke, B., & McKinnon, A. (2014). *Selective Evidence of Eutrophication in the Great Barrier Reef: Comment on Bell et al. (2014)*. Royal Swedish Academy of Sciences 2013.

GBRMPA (2010) Water quality guidelines for the Great Barrier Reef Marine Park 2010. Revised Edition 2010. Published by the Great Barrier Reef Marine Park Authority.

GBRMPA (2012). The use of Hydrodynamic Numerical Modelling for Dredging Projects in the Great Barrier Reef Marine Park, August 2012.

GBRMPA. (2011). *Impacts of Tropical Cyclone Yasi on the Great Barrier Reef*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).

GBRMPA. (2012). *Informing the outlook for Great Barrier Reef coastal ecosystems*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).

- GBRMPA. (2012). *Protecting the reef bioregions in the Great Barrier Reef Marine Park and World Heritage Area*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- GBRMPA. (2014). *Great Barrier Reef Outlook Report 2014*. Townsville: Commonwealth of Australia, Great Barrier Reef Marine Park Authority.
- GBRMPA. (2014). *Great Barrier Reef Outlook Report*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- GBRMPA. (2014). *Great Barrier Reef Region Strategic Assessment; Strategic Assessment Report*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- GBRMPA. (2014). *Great Barrier Reef Region Strategic Assessment; Strategic Assessment Report*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- GBRMPA. (2014). *Great Barrier Reef Region Strategic Assessment; Strategic Assessment Report*. Townsville: Commonwealth of Australia (Great Barrier Reef Marine Park Authority).
- Geochemical Assessments (2013). *Sampling and Analysis Plan Implementation Report Addendum*. Report prepared for Port of Townsville Limited (POTL)
- GHD (2008a). *Townsville Port Authority Long Term Dredging and Disposal Management Plan Report*. Prepared for the Port of Townsville Limited by GHD Pty Ltd., Gladstone.
- GHD (2009) Townsville Marine Precinct Project Environment Impact Statement. Report prepared for Port of Townsville Corporation.
- GHD (2011) Port of Townsville Limited Report for Port Expansion – Benthic Ecology and Fisheries Resources Report. October 2011. Report prepared for Port of Townsville Corporation.
- GHD (2012) Port of Townsville Limited Report for Port Expansion Project: Marine Megafauna. Prepared for the Port of Townsville Limited by GHD, Queensland.
- GHD. (2011). *Townsville City Council; Strategic Planning Studies Scenic Amenity Study*. Brisbane: GHD.
- Gibbs, M. (2009). Resilience: What is it and what does it mean for marine policymakers?
- Gibbs, M. T. (2006). Assessing the risk of an aquaculture development on shore birds using a Bayesian belief model. *Human and Ecological Risk Assessment*, 13. 156-179.
- Gilmour JP, Cooper TF, Fabricius KE and Smith LD (2006) Early warning indicators of change in corals and coral communities responding to anthropogenic stressors in the Pilbara, Western Australia. Environmental Protection Authority, Western Australia. 100 p.
- Glynn, P., & Colgan, M. (1992). Sporadic Disturbances in Fluctuating Coral Reef Environments: El Niño and Coral Reef Development in the Eastern Pacific. *Integrative & Comparative Biology* 32, 707-718.
- Glynn, P., & D'Croz, L. (1990). Experimental evidence for high temperature stress as the cause of El-Nino coincidence coral mortality. *Coral Reefs*, 181-191.
- Glynn, P., & De Weerd, W. (1991). Elimination of Two Reef-Building Hydrocorals Following the 1982-83 El Nino Warming Event. *Science*, Volume 253.
- Golder (2008b). *Offshore Geotechnical Investigation and Acid Sulfate Soils Investigation*. Prepared for Port of Townsville Limited by Golder Associates, Townsville.
- Great Barrier Reef Marine Park Authority. (2011). *Extreme weather on the Great Barrier Reef*. Townsville, Queensland: GBRMPA.
- Great Barrier Reef Marine Park Authority. (2014). *Great Barrier Reef Region Strategic Assessment: Strategic Assessment Report*. GBRMPA.

- Haapkyla, J., Melbourne-Thomas, J., Flavell, M., & Willis, B. (2013). Disease outbreaks, bleaching and a cyclone drive changes in coral assemblages on an inshore reef of the Great Barrier Reef. *Coral Reefs*, 815-824.
- Hazel, J., & Gyuris, E. (2006). Vessel-related mortality of sea turtles in Queensland, Australia. *Wildlife Research*, 33, 149-154.
- Heinsohn, G. E. 1979. Biology of small cetaceans in north Queensland Waters. The Great Barrier Reef Marine Park Authority, Townsville, Queensland.
- Hickey, C., Martin, M., & NIWA. (2009). *A review of nitrate toxicity to freshwater aquatic species. Environment Canterbury. Report No. R09/57.* <http://ecan.govt.nz/publications/Reports/report-review-nitrate-toxicity-freshwater-aquatic-species-000609-web.pdf>. Christchurch: National Institute of Water & Atmospheric Research Ltd (NIWA). Client Report: HAM2009-099. <http://ecan.govt.nz/publications/Reports/report-review-nitrate-toxicity-freshwater-aquatic-species-000609-web.pdf>.
- Hoegh-Guldberg, O. (1999). The impact of increased concentrations of ammonium and phosphate on coral growth and survivorship under field conditions. *Journal Experimental Marine Biology and Ecology*.
- Holles S, Simpson S, Radford A, Berten L, Lecchini D (2013) Boat noise disrupts orientation behaviour in a coral reef fish. *Marine Ecology Progress Series* 485, 295-300.
- Hough-Guldberg, O. (2011). *Coral reef ecosystems and anthropogenic climate change*. Reg Environ Change.
- HSQA (CSIRO, 2005) or Simpson, S.L., Batley, G.E., Chariton, A.A., Stauber, J.L, King, C.K., Chapman, J.C., Hyne, R.V., Gale, S.A., Roach, A.C. and Maher, W.A. (2005). Handbook of Sediment Quality Assessment. Commonwealth Scientific and Industrial Research Organisation (CSIRO). Bangor, NSW.
<http://www.csiro.au/en/Outcomes/Environment/Population-Sustainability/Handbook-sediment-quality-assessment.aspx>.
- Hydrobiology (2003). *Testing of Townsville inner harbour (Non-Berth Areas) Sediments for Sea Disposal Suitability – Bioavailability and Ecotoxicity Testing of Swing Basin and Silt Trench Sediment*.
- Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage. (2013). *Operational Guidelines for the Implementation of the World Heritage Convention*. Paris: UNESCO World Heritage Centre.
- Intergovernmental Panel on Climate Change. (2013). *The Physical Science Basis. Contribution of the Working Group I to the Fifth Assessment*. Cambridge University Press.
- JCU. (2011a). *Magnetic Island Visitor Survey: Locals vs Tourists*. Townsville: James Cook University (JCU) (School of Business), DEEDI, SeaLink QLD and Townsville City Council.
- Johnson, J., Brando, V., Devlin, M., Kennedy, K., McKenzie, L., & Morris, S. (2011). *Reef Rescue Marine Monitoring Program: 2009/2010 Synthesis Report*. Cairns: Reef and Rainforest Research Centre Consortium, for Great Barrier Reef Marine Park Authority (Reef and Rainforest Research Centre Limited).
- Johnston, D., & Searle, D. (1984). Post-glacial seismic stratigraphy, central Great Barrier Reef, Australia. *Sedimentology*, 31, 335-352.
- Jokiel, P., & Coles, S. (1990). Response of Hawaiian and other Indo-Pacific reef corals to elevated reef temperatures. *Coral Reefs*, 155-162.
- Jones, A., & Berkelmans, R. (2014). Flood Impacts in Keppel Bay, Southern Great Barrier Reef in the Aftermath of Cyclonic Rainfall. *PLOS ONE* 9(1).
- Joo, M., Raymond, M., McNeil, V., Huggins, R., Turner, R., & Choy, S. (2012). Estimates of sediment and nutrient loads in 10 major catchments draining to the Great Barrier Reef during 2006 - 2009. *Marine Pollution Bulletin*, 65, 150-166.
- Knowlton, N., & Jackson, J. (2008). Shifting Baselines, Local Impacts, and Global Change on Coral Reefs. *PLOS Biology*.
- KPMG. (2000). *Economic and Financial Values of the Great Barrier Reef Marine Park*. Townsville, QLD: Great Barrier

Reef Marine Park Authority.

Kragt, M., Roeneling, P., & Ruji, S. (2006). Effects of Great Barrier Reef degradation on recreational demand: a contingent behaviour approach. *The Fondazione Eni Enrico Mattei Note di Lavoro Series Index*.

Kroon, F., Kuhnert, M., Henderson, B., Wilkinson, S., Henderson, A., Abbot, B., *et al.* (2012). River loads of suspended solids, nitrogen and phosphorus and herbicides delivered to the Great Barrier Reef Lagoon. *Marine Pollution Bulletin*, 167-181.

Kroon, F., Kuhnert, K., Henderson, B., Wilkinson, S., Kinsey-Henderson, A., Brodie, J. and Turner, R. (2012). River loads of suspended solids, nitrogen, phosphorus and herbicides delivered to the Great Barrier Reef lagoon. *Marine Pollution Bulletin* 65: 167-181. doi:10.1016/j.marpolbul.2011.10.018

Kroon, F., Kuhnert, K., Henderson, B., Wilkinson, S., Kinsey-Henderson, A., Brodie, J., *et al.* (2012). River loads of suspended solids, nitrogen, phosphorus and herbicides delivered to the Great Barrier Reef lagoon. *Marine Pollution Bulletin* (65), 16.

Lambeck, A., & Woolfe, K. (2000). Composition and textural variability along the 10m isobath, Great Barrier Reef; evidence for pervasive northward sediment transport. *Australian Journal of Earth Sciences*, 47, 327-335.

Larcombe P. and Ridd P.V. (1994) *Data Interpretation*. In *Townsville Port Authority Capital Dredging Works 1993: Environmental Monitoring Programme* (Eds: Benson L.J., Goldsworthy P.M., Butler I.R. and Oliver, J.) pp 165-194. Townsville Port Authority

Larcombe, P., & Carter, R. (1998). Sequence architecture during the Holocene transgression: an example from the Great Barrier Reef shelf, Australia. *Marine Geology* 117, 97-121.

Larcombe, P., & Carter, R. (2004). Cyclone pumping, sediment partitioning and the development of the Great Barrier Reef shelf system: a review. *Quaternary Science Reviews* 23, 107-135.

Larcombe, P., & Woolfe, K. (1999). Terrigenous sediments as influences upon Holocene nearshore coral reefs, central Great Barrier Reef, Australia. *Australian Journal of Earth Sciences*, 46, 141-154.

Larcombe, P., Ridd, P., Prytz, A., & Wilson, B. (1995). Factors Controlling suspended sediment on inner-shelf coral reefs. *Coral Reefs* 14, 42, 163-171.

Lecchini, D., Carassou, L., Frederich, B., Nakamura, Y., Mills, S., *et al.* (2011). Effects of alternate reef states on coral reef habitat associations. *Environ Biol Fish*.

Lewis, S., Brodie, J., McCulloch, M., Mallela, J., Jupiter, S., William, S., *et al.* (2012). An assessment of an environmental gradient using coral geochemical records, Whitsunday Island, Great Barrier Reef Australia. *Marine Pollution Bulletin*, 306-319.

Lewis, S., Olley, J., Furuichi, T., Sharma, A., & Burton, J. (2014). Complex sediment deposition history on a wide continental shelf: Implications for the calculation of accumulation rates on the Great Barrier Reef. *Earth and Planetary Science Letters* (393), 146-158.

LI & IEMA. (2002). *The Guidelines for Landscape and Visual Impact Assessment*. UK: The Landscape Institute & Institute of Environmental Management and Assessment.

LI & IEMA. (2013). *The Guidelines for Landscape and Visual Impact Assessment (Third Edition)*. The Landscape Institute & Institute of Environmental Management and Assessment.

Loomis, J., & Santiago, L. (2013). Economic Valuation of Beach Quality Improvements Comparing Incremental Attribute Values Estimated from Two Stated Preference Valuation Methods. *Coastal Management*. 41:1, 75-86.

Lou, J., & Ridd, P. V. (1997). Modelling of Suspended Sediment Transport in Coastal Areas Under Waves and Currents. *Estuarine, Coastal and Shelf Science* 45, pp. 1-16.

Lourey, M., Ryan, D., & Miller, I. (2000). Rates of decline and recovery of coral cover on reefs impacted by, recovering from and unaffected by crown-of-thorns starfish *Acanthaster planci*: a regional perspective of the Great Barrier Reef. *Marine Ecology Progress Series, Volume 196*, 179-186.

- Ludescher, C. (1997). *Fisheries Resources between Bowen and Tully - An Inventory*. Townsville: James Cook University, for the Townsville Zonal Advisory Committee and Queensland Fisheries Management Authority.
- Lukoschek, V., Cross, P., Torda, G., Zimmerman, R., & Willis, B. (2013). The importance of Coral Larval Recruitment for the Recovery of Reefs Impacted by Cyclone Yasi in the Central Great Barrier Reef. *PLOS ONE*, Issue 6.
- Macdonald R. K., Ridd P. V., Whinney J. C., Larcombe P., Neoil D. T. (2013). *Towards environmental management of water turbidity within open coastal waters of the Great Barrier Reef*. Marine Pollution Bulletin 74.
- Marshall, P., & Baird, A. (2000). Bleaching of corals on the Great Barrier Reef: Differential susceptibilities among taxa. *Coral Reefs*, 19, 155-163.
- Martin Soberon, A. (2012). The Capacity in Container Port Terminals . *UNCTAD; Ad Hoc Expert Meeting on Assessing Port Performance*. Geneva, Switzerland: UNCTAD.
- Maunsell AECOM. (2007). *Port of Townsville Master Plan*.
- Maunsell AECOM. (2009). *Townsville Port Expansion, Preliminary Engineering and Environment Study*. Brisbane: Port of Townsville Limited.
- Maxwell, W. (1968). Atlas of the Great Barrier Reef. *Elsevier, Amsterdam*.
- McArthur, C., Ferry, R., & Proni, J. (2002). *Development of Guidelines for Dredged Material Disposal Based on Abiotic Determinants of Coral Reef Community Structure*. In: Dredging 2002 Key Technologies for Global Prosperity, 3rd Specialty Conference on Dredging and Dredged Material Disposal. Orlando Florida: American Society of Civil Engineers.
http://www.aoml.noaa.gov/themes/CoastalRegional/projects/FACE/McArthur_MiamiODMDS_Guidelines_Dredged_Material_Disposal_2002.pdf.
- McCartney, B. (2005). *Ship Channel Design and Operation*. n.s: American Society of Civil Engineers No. 107.
- McIntyre, C. (1996). The Holocene sedimentary facies of Cleveland Bay, Townsville, Great Barrier Reef shelf. *Great Barrier Reef terrigenous sediment flux and human impacts, Second Edition (Larcombe, P; Woolfe, K.J; Purdon, R.G eds) CRC Reef Research Centre, Reef Symposium Proceedings, Townsville, Australia*, 104-107.
- McKenna, S., & Rasheed, M. (2011). *Port of Townsville Long-term Seagrass Monitoring*. Cairns: Commonwealth of Australia (Department of Employment, Economic Development and Innovation).
- McKenna, S., & Rasheed, M. (2012). *Port of Townsville Long-term Seagrass Monitoring*. Cairns: DEEDI Publication. Fisheries Queensland.
- McKenzie, L. J. (2014). Disturbance influences the invasion of a seagrass into an existing meadow. *Marine Pollution Bulletin* 86, 186-196.
- McKergow, L. A., Prosser, I. P., Hughes, A. O., & Brodie, J. (2005). Sources of sediment to the Great Barrier Reef World Heritage Area. *Marine Pollution Bulletin* 51, pp. 200-211.
- MSQ. (2013). *Port Procedures and Information for Shipping*. Townsville : Maritime Safety Queensland (MSQ).
- NAGD (DEWHA, 2009). National Assessment Guidelines for Dredging (NAGD), Department of the Environment, Water, Heritage and the Arts (DEWHA). Australian Government, Canberra:
<http://www.environment.gov.au/coasts/pollution/dumping/publications/pubs/guidelines09.pdf>.
- National Pollutant Inventory (NPI) (2012). Emission estimation technique manual for mining (Version 3.1). Canberra: Commonwealth of Australia Department of Sustainability, Environment, Water, Population and Communities (DSEWPC).
- Nebel, S., Portera, J., & Kingsford, R. (2008). Long-term trends of shorebird populations in eastern Australia and impacts of freshwater extraction. *Biological Conservation*, Vol. 141 (4), 971-980.
- Neil KM, Sheaves J, Cruz JJ, Hoedt FH, Choat JH (2001). Port Baseline Surveys and Surveys for introduced Marine

Pests: the Port of Townsville Final Report. CRC Reef Research Centre and JCU Marine Biology and Aquaculture report to the Townsville Port Authority.

Nias, R. (2011) A case for legal protection – the Australian snubfin dolphin. Prepared by TierraMar Consulting for WWF-Australia, Brisbane.

Nott, J., & Hayne, M. (2001). High frequency of 'super-cyclones' along the Great Barrier Reef over the past 5,000 years. *Nature*, Volume 413, 508-512.

O'Brien, M., & Ramsay, J. (1991). *Assessing aesthetic values of landscapes for the Register of National Estate. A discussion paper*. Australian Heritage Commission.

OESR. (2012a). *Queensland Regional Profiles*. Retrieved 10 10, 2012, from State of Queensland (Office of Economic and Statistical Research): <http://statistics.oesr.qld.gov.au/qld-regional-profiles>

Orpin, A., & Ridd, P. (2012). Exposure of inshore corals to suspend sediments due to wave suspension and river plumes in the central Great Barrier Reef: A reappraisal. *Continental Shelf Research*, 47, 55-67.

Orpin, A., & Ridd, P. (2012). Exposure of inshore corals to suspend sediments due to wave-resuspension and river plumes in the central Great Barrier Reef: A reappraisal. *Continental Shelf Research* 47, 55-67.

Orpin, A., Brunskill, G., Zagorskis, I., & Woolfe, K. (2004). Patterns of mixed siliciclastic-carbonate sedimentation adjacent to a large dry-tropics river on the Great Barrier Reef shelf, Australia. *Australian Journal of Earth Sciences*, 51, 665-683.

Orpin, A., Ridd, P., & Stewart, L. (1999). Assessment of the relative importance of major sediment transport mechanisms in the central Great Barrier Reef lagoon. *Australian Journal of Earth Sciences*, 46, 883-896.

Orpin, A., Ridd, P., Thomas, S., Anthony, K., Marshall, P., Oliver, J. (2004). *Natural turbidity variability and weather forecasts in risk management of anthropogenic sediment discharge near sensitive environments*. Marine Pollution Bulletin 49.

Orth R J, Harwell MC, Inglis GJ (2006). Ecology of seagrass seeds and seagrass dispersal processes, in Larkum, A. W. D. Orth, R. J. and Duarte, C. M. (eds). Springer, Netherlands. Seagrasses: Biology, Ecology, and Conservation.

Osborne, K., Dolman, A., Burgess, S., & Johns, K. (2011). Disturbance and the Dynamics of Coral Cover on the Great Barrier Reef (1995-2009). *PLOS ONE* 6(3).

Oxford Economics. (2009). *Valuing the effects of Great Barrier Reef Bleaching*. Great Barrier Reef Foundation.

Pandolfi, J., Connolly, S., Marshall, D., & Cohen, A. (2011). Protecting Coral Reef Futures Under Global Warming and Ocean Acidification. *Science*, 333.

Parra GJ, Corkeron PJ, Marsh H (2006) Population sizes, site fidelity and residence patterns of Australian snubfin and Indo-Pacific humpback dolphins: Implications for conservation. *Biol Conserv* 129: 167-180.

Parra, G.J. 2006. Resource partitioning in sympatric delphinids: space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. *Journal of Animal Ecology* 75:862-874.

Passow, U. S. (2001). The origin of transparent exopolymer particles (TEP) and their role in the sedimentation of particulate matter. *Continental Shelf Research* 21, 327-346.

Paton, D., Ziembicki, M., Owen, P., & Heddle, C. (2000, 37). Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. *The Stilt*, 46.

Peverell SC, Pillans RD (2004). Determining feasibility of acoustic tag attachment and documenting short-term movement in *Pristis zijsron* Bleeker, 1851. Report for the National Oceans Office. 18.

Poiner Ian, C. C. (1993). *Effects of Cyclones on seagrass Communities and penaeid prawn stocks of the Gulf of Carpentaria*. Cleveland, Queensland: CSIRO Division of Fisheries.

Port of Townsville Limited. (2013). *Port of Townsville Land Use Plan*. Townsville: Queensland Government.

- Port of Townsville Limited. (2013). *Port of Townsville Land Use Plan*. Townsville: Queensland Government.
- POTL (2013) Long Term Dredging and Disposal Management Plan for Port of Townsville: Final Report.
- POTL. (2008 - 2013). *Annual Reports*. Retrieved 2014, from Port of Townsville Limited (POTL): <http://www.townsville-port.com.au/about-the-port/news-room/annual-reports>
- POTL. (2013). *Port of Townsville Land Use Plan*. Townsville: Queensland Government, Port of Townsville Limited.
- POTL. (2013). *Trade Statistics*. Retrieved 2014, from Port of Townsville Limited (POTL): <http://www.townsville-port.com.au/business-with-the-port/performance/trade-statistics>
- Prayaga, P., Rolfe, J., & Stockl, N. (2010). The value of recreational fishing in the Great Barrier Reef, Australia: a pooled revealed preference and contingent behaviour model. *Mar. Policy*, 34, 244-251.
- Preen, A., Lee Long, W., & Coles, R. (1995). Flood and cyclone related loss, and partial recovery, of more than 1000 km² pf seagrass in Hervey Bay, Queensland, Australia. *Aquatic Botany* 52, 3 - 17.
- Pringle, A.W. (1989) The History of Dredging in Cleveland Bay, Queensland and Its Effect on Sediment Movement and on the Growth of Mangroves, Corals and Seagrass. Prepared by the Great Barrier Reef Marine Park Authority for the Townsville Port Authority.
- Puotinen, M. (1994). Designing effective monitoring programs for the Great Barrier Reef Marine Park, Australia. *Coastal Management Journal*, 22, 391-398.
- Puotinen, M. (2004). Mapping tropical cyclone disturbance of the Great Barrier Reef. *Journal of the Australian Map Circle Inc.*, 31-42.
- Puotinen, M. (2004). Tropical Cyclones in the Great Barrier Reef, Australia, 1910-1999: a First Step Towards Characterising the Disturbance Regime. *Australian Geographical Studies*, 378-392.
- Puotinen, M. (2007). Modelling the risk of cyclone wave damage to coral reefs using GIS: a case study of the Great Barrier Reef 1969-2003. *International Journal of Geographical Information Science*, 97-120.
- Puotinen, M., Done, T., & Shelly, W. (1997). An atlas of tropical cyclones in the Great Barrier Reef Region, 1969-1997. *CRC Reef Research Centre, Technical Report No. 19*, Townsville.
- QPWS. (2011, July). *Queensland Parks and Wildlife Service*. Retrieved November 12, 2014, from Magnetic Island Map : <http://www.npsr.qld.gov.au/parks/magnetic-island/pdf/magnetic-island-map.pdf>
- QTT. (2014). *Queensland Regional Database*. Retrieved 09 18, 2014, from State of Queensland (Queensland Treasury and Trade, Queensland Government Statisticians Office): <http://www.qgso.qld.gov.au/products/qld-regional-database/qld-regional-database/index.php>
- Queensland Government. (2007). *South East Queensland Regional Plan 2005–2026 Implementation Guideline No. 8 Identifying and protecting scenic amenity values*. Brisbane: Department of Infrastructure.
- Queensland Government. (2013). *Townsville State Development Area, Development Scheme*. Brisbane: Queensland Government.
- QWQG (DERM, 2009). Queensland Water Quality Guidelines (QWQG). Version 3 September 2009. Department of Environment and Resource Management (DERM), Queensland Government, Brisbane: http://www.ehp.qld.gov.au/water/guidelines/queensland_water_quality_guidelines_2009.html.
- Rasheed, M. M. (2014). Contrasting recovery of shallow and deep water seagrass communities following climate associated losses in tropical north Queensland, Australia. *Marine Pollution Bulletin* 83, 491-499.
- Rasheed, M., & Taylor, H. (2008). *Port of Townsville Seagrass Baseline Survey Report Cairns Harbour and Trinity Inlet - September 2011*. Cairns: Commonwealth of Australia (Department of Employment, Economic Development and Innovation).
- Reeves, R.R., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten,

- E., Smith, B.D., Wang, J.Y. & Zhou, K. 2008. *Orcaella heinsohni*. The IUCN Red List of Threatened Species 2008: e.T136315A4273414. <http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T136315A4273414.en>. Downloaded on 15 February 2016.
- Rolfe, J., & Windle, J. (2011). Using auction mechanisms to reveal costs for water quality improvements in Great Barrier Reef catchments in Australia. *Agricultural Water Management*, 98(4), 493-501.
- Ross, G.J.B. (2006). Review of the Conservation Status of Australia's Smaller Whales and Dolphins. Page(s) 124. [Online]. Report to the Australian Department of the Environment and Heritage, Canberra. Available from: <http://www.environment.gov.au/resource/review-conservation-status-australias-smaller-whales-and-dolphins>.
- Russell, M (2001) Spawning aggregations of reef fishes on the Great Barrier Reef: implications for management. Great Barrier Reef Marine Park Authority, Townsville, Australia. 37 pp.
- Rustomji, P. B. (2009). Flood variability east of Australia's Great Dividing Range. *Journal of Hydrology* 374, 196-208.
- Sachithanandam, V. M. (2014). Assessment of Cyclone Lehar's impact on seagrass meadows in Ross and Smith Islands, North Andaman. *Nat Hazards* 72, 1253-1258.
- Sandstrom, M. (1988). Aliphatic hydrocarbons in surface sediments from the North Queensland coast and Great Barrier Reef: Effects of tropical cyclone Winifred. *Org. Geochem, Vol. 12, No. 5*, 445-454.
- Scheltinga DM, Heydon L. (2005). Report on the condition of estuarine, coastal and marine resources of the Burdekin Dry Tropics region. Report to the Burdekin Dry Tropics Board, Townsville.
- Schroeder, T., Devlin, M., Brando, V., Dekker, A., Brodie, J., L.A. C., *et al.* (2012). Inter-annual variability of wet season freshwater plume extent into the Great Barrier Reef lagoon on satellite coastal ocean colour observations. *Marine Pollution Bulletin* 65, 210-233.
- Sealink Queensland. (2014). *Market Research*. Retrieved 09 18, 2014, from Sealink Queensland: http://www.sealinkqld.com.au/about_us/market_research.php
- Shakhova, N., Semiletov, I., Salyuk, A., Yusupov, V., Kosmach, D., Gustafsson, O., 2010. Extensive methane venting to the atmosphere from sediments of the East Siberian Arctic Shelf. *Science* 327, 1246-1250.
- Shiba T, Shioi Y, Takamiya K-I, Sutton DC, Wilkinson CR. (1991). Distribution and physiology of aerobic bacteria containing bacteriochlorophyll a on the east and west coasts of Australia. *Applied and Environmental Microbiology* 1991;57: 295-300.
- Simpson, S., Batley, G., & Chariton, A. (2010, Revised July). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. *CSIRO Land and Water Science Report Series: 08/07 - August, 2008, ISSN: 1834-6618*.
- Sinclair Knight. (1991). *Draft Impact Assessment Study - Eastern Harbour Expansion*. Townsville: Prepared by Sinclair Knight & Partners Ptd Ltd for Townsville Port Authority.
- SKM, 2007. Bulk Liquids Berth No. 2 – Port Botany. Air Quality Impact Assessment.
- SKM. (1994). *Port Plan Review - Cape Cleveland Comparision 1994*.
- SKM. (2013). *Improved Dredge Material Management for the Great Barrier Reef Region; Appendix A*. Sinclair Knight Merz (SKM).
- Slabbekoorn H, Bouton N, van Opzeeland I, Coers A, ten Cate C, Popper A (2010) A noisy spring: the impact of globally rising underwater sound levels on fish. *Trends in Ecology and Evolution* 25, 219-427.
- SNH & CA. (2006). *Topic Paper 6: Techniques and Criteria for Judging Capacity and Sensitivity*. UK: Scottish Natural Heritage (SNH) & Countryside Agency (CA).
- Stafford-Smith, M., & Veron, J. (1992). *Survey of control and potential impact reefs for reactive Monitoring of Townsville Port Expansion dredging project*. Townsville: For Townsville Port Authority.
- Stoeckl, N., Hicks, C., Mills, M., Fabricius, K., Esparon, M., Kroon, F., *et al.* (2011). The Economic Value of ecosystem services in the Great Barrier Reef: our state of knowledge. *Annals of the New York Academy of Sciences*.

- Taylor, B., & Goldingay, R. (2004). Wildlife road-kills on three major roads in north-eastern NSW. *Wildlife Research*, 83-91.
- TCC. (2005). *Townsville City Plan (amendment no. 6)*. Townsville: Townsville City Council.
- TCC. (2010b). *The Strand*. Retrieved 07 12, 2011, from Townsville City Council (TCC): <http://www.townsville.qld.gov.au/facilities/strand/Pages/default.aspx>
- TCC. (2014). *Townsville City Plan*. Townsville: Townsville City Council.
- TCC. (2014). *Townsville City Plan*. Townsville: Townsville City Council.
- TCC. (2014). *Townsville City Plan*. Townsville: Townsville City Council.
- TFPT. (2011). *Townsville Futures Plan; a second capital for Queensland*. Townsville: State of Queensland (Department of Local Government and Planning) & Townsville Futures Plan Taskforce (TFPT).
- The Hon. Greg Hunt MP, M. f. (2015, January 24). Orders given to ban dumping of capital dredge material in Marine Park. *Media Release*. Australia: Commonwealth of Australia.
- The State of Queensland. (2013). *Great Barrier Reef Coastal Zone Strategic Assessment 2013 - Strategic Assessment Report*. Brisbane: Department of State Development, Infrastructure and Planning.
- Thompson, A., & Dolman, A. (2010). *Coral Bleaching: one disturbance too many for near-shore reefs of the Great Barrier Reef*. Coral Reefs, 29.
- Thompson, A., Costello, P., Davidson, J., Schaffelke, B., Uthicke, S., & Liddy, M. (2013). *Reef Rescue Marine Monitoring Program Report of AIMS Activities - Inshore coral reef monitoring 2012*. Townsville: Report for Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science.
- Thompson, A.; Lønborg, C.; Costello, P.; Davidson, J.; Logan, M.; Furnas, M.; Gunn, K.; Liddy, M.; Skuza, M.; Uthicke, S.; Wright, M.; Zagorskis, I.; Schaffelke, B. (2014) Marine Monitoring Program: Annual report of AIMS activities 2013 to 2014. Inshore water quality and coral reef monitoring
- TNQ. (2012). *Destination Tourism Strategy 2016-2016*. Townsville: State of Queensland (Townsville North Queensland).
- Townsville City Council. (2013). *Townsville City Economic Development Plan*. Townsville: Townsville City Council.
- TPA. (1996). *Land Use Plan*. Townsville: Townsville Port Authority.
- TPA. (1999). *Townsville Port Development Plan*.
- TSSC. (2001). *Little Tern (western Pacific) (Sterna albigrons sinensis)*. Canebrera: Commonwealth of Australia (Department of the Environment; Threatened Species Scientific Committee).
- United States Environmental Protection Agency (USEPA) (1998). AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Chapter 11.9: Western Surface Coal Mining.
- Unsworth, R., McKenna, S., & Rasheed, M. (2010). *Port of Townsville long-term seagrass monitoring*. Cairns: QPI&F Publication PR09-4330.
- URS (2008). *Sediment Quality Assessment – 2008 inner harbour and Berth 11 Pocket: Maintenance Dredging Programme*. Report to the Port of Townsville.
- URS (2010). *Sampling and Analysis Plan Report – 2010 Berth 12 Capital Dredging Programme*. Prepared for Port of Townsville Ltd. by URS, Sydney.
- Van Woesik, R., Ayling, A., & Mapstone, B. (1991). Impact of Tropical Cyclone 'Ivor' on the Great Barrier Reef, Australia. *Journal of Coastal Research, Volume 7, No. 2*, 551-557.

- Veron, J. (2008). *A reef in Time: The Great Barrier Reef from beginning to end*. Belkna Press / Havard University Press.
- Veron, J. (2011). Ocean Acidification and Coral Reefs: An Emerging Big Picture. *Diversity*, 262-274.
- Wachenfeld, D., Oliver, J., & Morrissey, J. (1998). *State of the Great Barrier Reef World Heritage Area*. Australia: Great Barrier Reef Marine Park Authority.
- Walker, T. (1981). Seasonal salinity variations in Cleveland Bay, northern Queensland. *Australian Journal of Marine and Freshwater Research* 32 (1), pp. 143-149.
- Way, A. (1987). *Post-Glacial stratigraphy of upstart bay, off the burdekin river north queensland*. Townsville: James Cook University (MSc thesis, Unpublished).
- Waycott, M., Longstaff, B., & Mellors, J. (2005). Seagrass population dynamics and water quality in the Great Barrier Reef Region; a review and future research directions. *Marine Pollution Bulletin* 51, 343-350.
- Western Australia Environmental Protection Authority (WA EPA) (2011). *Environmental Assessment Guideline for Marine Dredging Proposals*.
- Whiticar, M.J., 1999. Carbon and hydrogen isotope systematics of bacterial formation and oxidation of methane. *Chemical Geology* 161, 291-314.
- Wielgus, J., Glassom, D., & Fishelson, L. (2003). Long-term persistence of low coral cover and abundance on a disturbed coral reef flat in the northern Red Sea. *J. Exp. Mar. Biol. Ecol.* 297, 31-41.
- Wilkinson, C., Linden, C., Cesar, H., Hodgson, G., Rubens, J., & Strong, A. (1999). Ecological and socio-economic impacts of 1998 coral mortality in the Indian Ocean: an ENSO impact and a warning of future change. *Ambio*, 188-196.
- Windle, J., & Rolfe, J. (2005). Assessing non-use values for environmental protection of an estuary in a Great Barrier Reef catchment. *Aust. J. Environm. Manage.* 12, 147-155.
- Winter, A., Apeldoorn, R., Bruckner, A., Williams, E., & Goenaga, C. (1998). Sea surface temperature and coral reef bleaching cycle of La Parguera Puerto Rico (northeastern Caribbean Sea). *Coral Reefs*, 377-382.
- Wisshak, M., Schonberg, C., Form, A., & Freiwalk, A. (2012). Ocean Acidification Accelerates Reef Bioerosion. *PLOS ONE*, 1-9.
- Wooldridge, S. (2009). Water quality and coral bleaching thresholds: Formalising the linkage for the inshore reefs of the Great Barrier Reef, Australia. *Marine Pollution Bulletin*, 745-751.
- Woolfe, K., & Larcombe, P. (1998). Terrigenous sediment accumulation as a regional control upon the distribution of reef carbonates. *Camoin, G.F, Davies, P.J (eds.) Reefs and Carbonate Platforms in the Pacific and Indian Oceans. IAS Special Publication No. 25*, 295-310.
- Woolsey, E., Bainbridge, J., Kingsford, M., & Byrne, M. (2012). Impacts of cyclone hamish at One Tree Reef: intergrating environmental benthic habitat data. *Mar Biol* 159, 793-803.
- World Heritage Committee. (2014). *Decisions Adopted by the World Heritage Committee at its 38th Session (Doha, 2014)*. UNESCO.
- WWL. (2014). *Widening the oceans*. Retrieved 2014, from Wallenius Wilhelmsen Logistics (WWL): <http://www.2wglobal.com/news-and-insights/articles/features/Widening-the-oceans/#.VHUdWouUfls>
- Yara, Y., Fujii, M., Yamano, H., & Yamanaka, Y. (2014). Projected coral bleaching in response to future sea surface temperature rises and the uncertainties among climate models. *Hydrobiologia*, 19-29.