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Queensland Government

DEPARTMENT OF STATE DEVELOPMENT

Marine Ecology Technical Report

Abbot Point Growth Gateway Project

301001-01956-00-EN-REP-0007 – Rev 2

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Level 3, 80 Albert Street
Brisbane
QLD 4000
Australia
Telephone: +61 7 3221 7444
Facsimile: +61 7 3221 7791
www.worleyparsons.com
ABN 61 001 279 812

WorleyParsons Consulting

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DEPARTMENT OF STATE DEVELOPMENT
MARINE ECOLOGY TECHNICAL REPORT
ABBOT POINT GROWTH GATEWAY PROJECT

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ACRONYMS AND ABBREVIATIONS

Abbreviation/Acronym	Description
ANZECC	Australian and New Zealand Environment and Conservation Council
APGG	Abbot Point Growth Gateway
APSDA	Abbot Point State Development Area
AQIS	Australian Quarantine and Inspection Services
ASS	Acid Sulfate Soils
AASS	Actual Acid Sulfate Soils
ASSMP	Acid Sulfate Soils Management Plan
BOD	Biological Oxygen Demand
BOM	Bureau of Meteorology
BPP	Benthic Primary Producers
BTEX	Benzene, Toluene, Ethylbezene and Xylenes
CIA	Cumulative Impact Assessment
CSD	Cutter Suction Dredge
DAFF	Department of Agriculture, Fisheries and Forestry
DEEDI	Department of Employment, Economic Development and Innovation (former)
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resource Management
DMCP	Dredged Material Containment Ponds
DMMA	Dredged Material Management Area
DNRM	Department of Natural Resources and Mines
DO	Dissolved Oxygen
DoE	Department of Environment
DPA	Dugong Protection Areas
DSD	Department of State Development
DSEWPC	Department of Sustainability, Environment, Water, Populations and Communities
DTMR	Department of Transport and Main Roads

Abbreviation/Acronym	Description
EAG no. 7	Western Australian (WA) EPA Guideline *Environmental Assessment Guideline for Marine Dredging Proposals*
EAM	Environmental Assessment and Management
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Environmentally Relevant Activity
FHA	Fish Habitat Area
FM Act	*Fisheries Management Act 1994*
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
IDF	Intensity, Duration and Frequency
IMS	Introduced Marine Species
IUCN	International Union for Conservation of Nature
LAT	Lowest Astronomical Tide
LBMA	Light based management approach
LOR	Limit of Reporting
MCF	Multi Cargo Facility
MCU	Material Change of Use
MNES	Matters of National Environmental Significance
MOF	Material Offloading Facility
MSDS	Material Data Safety Sheets
MSQ	Maritime Safety Queensland
NAGD	National Assessment Guidelines for Dredging
NC Act	Queensland *Nature Conservation Act 1992*
NEPC	National Environmental Protection Council
NEPM	National Environment Protection Measure

Abbreviation/Acronym	Description
NODGM	National Ocean Disposal Guidelines for Dredged Material
NQBP	North Queensland Bulk Port
NTU	Nephelometric Turbidity Units
OCP	Organochlorine pesticide
OPP	Organophosphate Pesticides
PASS	Potential Acid Sulfate Soils
PAH	Polyaromatic Hydrocarbons
PAR	Photosynthetic Active Radiation
PCB	Polychlorinated Biphenyls
PER	Public Environment Report
PQL	Practical Quantification Limit
PMMST	Protected Matters Search Tool
PTS	Permanent Threshold Shift
PWC	Personal Water Craft
QASSIT	Queensland Acid Sulfate Soils Investigation Team
QWQG	Queensland Water Quality Guidelines
RAM	Range Dependent Acoustic Model
RHDHV	Royal Haskoning DHV
SAP	Sediment Analysis Plan
SARA	State Assessment and Referral Agency
SEL	Sound Exposure Level
SI	Surface Irradiance
SP Act	*Sustainable Planning Act 2009*
SPL	Sound Pressure Level
TAA	Total Actual Acidity
T0	Terminal 0
T1	Terminal 1
T2	Terminal 2
TBT	Tributyltin
TC	Tropical Cyclone

Abbreviation/Acronym	Description
TO Act	*Transport Operations (Marine Pollution) Act 1995* (QLD)
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TropWATER	The Centre for Tropical Water & Aquatic Ecosystem Research
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Sediments
TTS	Temporary Threshold Shift
UCL	Upper Confidence Level
WQ	Water Quality

1. INTRODUCTION

1.1 Background

The Abbot Point Growth Gateway Project (the Project) is proposed by the Queensland Government Department of State Development (DSD) to support the development of the already approved Terminal 0 (T0) Project at the Port of Abbot Point through undertaking capital dredging to provide sea access for this terminal. The Project includes:

- Construction of onshore dredged material containment ponds (DMCPs) within the area previously allocated for the development of Terminal 2 (T2) and adjoining industrial land
- Capital dredging of approximately 1.1 million m^3 *in-situ* (Mm^3) of previously undisturbed seabed for new berth pockets and ship apron areas required to support the development of T0
- Relocation of the dredged material to the DMCPs and offshore discharge of return water
- Ongoing management of the dredged material including its removal, treatment and beneficial reuse within the port area and the Abbot Point State Development Area (APSDA), where appropriate.

1.2 Legislative framework

1.2.1 Australian Government

The Project was referred by the DSD to the Australian Government Department of Environment (DoE) on 15 April 2015 for a determination as to whether the Project requires assessment as a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Project was determined to be a controlled action to be assessed by preliminary documentation with the relevant controlling provisions (the Matters of National Environmental Significance (MNES)) being:

- World Heritage properties (section 12 and 15A)
- National Heritage places (sections 15B and 15C)
- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A)
- Commonwealth Marine Area (sections 23 and 24A)
- Great Barrier Reef Marine Park (GBRMP) (sections 24B and 24C)

1.2.2 Queensland Government

The Project triggers a number of Queensland Government approvals under the Sustainable Planning Act 2009 (SP Act), the APSDA Development Scheme and other legislation. The following key approvals are triggered by the Project:

- Development Approval by North Queensland Bulk Ports (NQBP) as Assessment Manager for Operational Work within Strategic Port Land and by the Department of Infrastructure Local Government and Planning (DILGP) (as State Assessment and Referral Agency - SARA) as concurrence agency supported by technical advice agencies. This approval includes:
    - Operational work that is tidal works: the proposed dredging and land placement activities are considered tidal works under the SP Act because they occur in tidal waters.
    - Operational work that is the removal, damage or destruction of marine plants: the proposed dredging will cause removal of seagrass, which is classed as marine plants under the Fisheries Act 1994.
    - Approval from Maritime Safety Queensland (MSQ), ensuring the proposed works are carried out safely, without undue restrictions on maritime traffic, professional and recreational fishing activities.
    - Environmental Authority to carry out an Environmentally Relevant Activity (ERA) 16(1)(b), being dredging more than 1,000,000t in a year, and associated Material Change of Use (MCU) for an ERA.
- Development Approval by DILGP as Assessment Manager for Operational Work in coastal waters outside Strategic Port Land, supported by the Department of Agriculture and Fisheries. This approval covers operational work that is the removal, damage or destruction of marine plants (i.e. seagrass).
- MCU under the APSDA Development Scheme, including approval for self-assessable operational work, which is granted by the Coordinator-General, as follows:
    - Assessment against the APSDA Development Scheme assessment criteria.
    - Clearing of remnant vegetation. The dredged material transport and return water pipelines intersect an area of mapped remnant vegetation. This section of the MCU application is assessed by the Department of Natural Resources and Mines (DNRM) as referral entity.
    - Approved Traffic Impact Assessment covering the Bruce Highway/Abbot Point Road intersection and rail crossings. The road traffic generated by the Project may generate additional traffic and increased risks that must be assessed and

managed. This section of the MCU application is assessed by the Department of Transport and Main Roads (DTMR) as referral entity.

- Use of Aurizon railway crossings. The road traffic generated by the Project may have some impacts on three railway crossings managed by Aurizon.
- Approval of development by NQBP on land owned in freehold.
- High impacts earthworks in a Wetland Protection Area. Small sections of the DMCP embankment southern wall encroach on the Caley Valley Wetland Protection Area and must therefore be assessed for their potential impacts on the wetland. This section of the MCU application is assessed by the Department of Environment and Heritage Protection (DEHP) as referral entity.

- Permit to tamper with animal breeding places. The land disturbance caused by the construction of the ponds may remove fauna breeding places as defined under the Nature Conservation (Wildlife Management) Regulation 2006. This permit application is assessed by DEHP.

1.3 Scope of report

This report primarily addresses the marine ecology related information requirements to address the *Guidelines for an Environmental Impact Statement to Undertake Capital Dredging, Onshore Placement and Reuse of Dredged Material at Abbot Point, 25km North of Bowen, North Queensland (EPBC 2015/7467)* (DoE, 2015).

The report outlines the assessment methodology used, describes the existing environment and potential impacts of the Project and provides a detailed impact assessment along with mitigation and management measures for matters relevant to marine ecology. The report specifically addresses potential impacts on the MNES of marine listed threatened species and communities, marine listed migratory species, Commonwealth marine area and the GBRMP. Marine ecology matters relevant to the Great Barrier Reef World Heritage Area (GBRWHA) are discussed, although potential impacts on this MNES that are not relevant to marine ecology are not discussed in this report. This report does not address potential consequential and cumulative impacts associated with the Project.

The report also addresses matters relevant to approvals under Queensland Government legislation as described above.

2. METHODOLOGY

This section describes the methodology applied for the description of existing environment and assessment of potential impacts relevant to the Project. The existing environment is described in terms of water quality, sediment characteristics, habitat and marine fauna. The description of existing environment relies on extensive existing information on the Abbot Point region and includes the following studies:

- Bell, I. (2003). Turtle population dynamics in the Hay Point, Abbot Point and Lucinda Port areas. Prepared for Ports Corporation of Queensland Ltd.
- BHP Billiton Ltd (BHBP) (2011a). Abbot Point Coal Terminal 2 Project, EPBC referral, Attachment C - Marine Environment, October 2011
- CDM Smith (2013a). Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging Public Environment Report Supplementary Report (EPBC 2011/6213/GBRMPA G34897.1). Prepared for North Queensland Bulk Ports Corporation, May 2013
- CDM Smith (2013b). Abbot Point Coal Terminal 0 EIS, Appendix B11 - Marine Turtle Nesting Surveys, Abbot Beach. Prepared for Adani Mining Pty Ltd, February 2013
- Chartrand, K.M., Ralph, P.J., Petrou, K. and Rasheed, M.A. (2012). Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program. DAFF, Publication. Fisheries Queensland, Cairns 126 pp.
- Chartrand, K., Sinutok, S., Szabo, M., Norman, L., Rasheed, M.A., and Ralph, P.J. (2014). Final Report: Deepwater Seagrass Dynamics - Laboratory-Based Assessments of Light and Temperature Thresholds for Halophila spp., Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication, James Cook University, Cairns, 26 pp.
- Ecological Australia and Open Lines (2013). Abbot Point Cumulative Impact Assessment. Prepared for the Abbot Point Working Group, February 2013
- Ecowise Environmental (2004). Assessment of the status of marine sediments at Abbot Point. Prepared for the NCA Project, Xstrata Limited
- GHD (2008). Benthic Baseline Assessment Report: Baseline Environmental Monitoring for Port of Abbot Point. Prepared for Abbot Point Multi Cargo Facility Environmental Impact Statement, June 2008
- GHD (2009a). Report for Proposed Multi Cargo Facility, Abbot Point: Preliminary Sediment Quality Assessment. Prepared for Ports Corporation of QLD
- GHD (2009b). Port of Abbot Point X110 Apron and Berth Capital Dredging: Sediment Sampling and Analysis Program. Prepared for Ports Corporation of QLD

- GHD (2009c). Abbot Point Coal Terminal X110 Expansion Draft Voluntary Environmental Assessment, October 2009. Prepared for NQBP
- GHD (2009d). Marine Ecology Benthic Survey Report: Proposed Abbot Point Multi Cargo Facility EIS, September 2009. Prepared for NQBP
- GHD (2009e). Baseline Marine Fauna Report, Port of Abbot Point Baseline Monitoring. Prepared for North Queensland Bulk Ports Corporation, September 2009
- GHD (2009f). Megafauna Assessment Report: Proposed Abbot Point Multi Cargo Facility EIS, December 2009. Prepared for NQBP
- GHD (2010). Proposed Abbot Point Multi Cargo Facility Environmental Impact Statement. Report for North Queensland Bulk Ports Corporation, May 2010
- GHD (2012a). Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report. Prepared for North Queensland Bulk Ports Corporation, July 2012
- GHD (2012b). Abbot Point, Terminals 0, 2 and 3 Capital Dredging Project Hydrodynamic and Sediment Transport Analysis. Prepared for North Queensland Bulk Ports Corporation, July 2012
- GHD (2012c). Abbot Point Cumulative Impact Assessment, Technical Report Marine Water Quality. Prepared for the Abbot Point Working Group, August 2012
- GHD (2012d). Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging, Public Environment Report, (EPBC 2011/6213/GBRMPA G34897.1). Prepared for North Queensland Bulk Ports Corporation, December 2012
- Hof, C and Bell, I. (2014). Determining the spatial distribution and densities of marine turtle nesting and predator activity in the northern Great Barrier Reef, Queensland. Final Report to WWF-Australia and Threatened Species Unit, Department of Environment and Heritage Protection
- McCauley, R., Maggi, A., Duncan, A., Salgado-Kent, C., Parnum, I. and Erbe, C. (2012). Underwater Noise Prediction from Port Development at Abbot Point, QLD. Prepared for Abbot Point Working Group (APWG) by Centre for Marine Science & Technology R201218, Curtin University Perth, Western Australia
- McKenna, S.A., Rasheed, M.A., Unsworth, RKF and Chartrand, KM (2008). Port of Abbot Point seagrass baseline surveys-wet and dry season 2008. Prepared for North Queensland Bulk Ports Corporation
- McKenna, S.A. and Rasheed, M.A. (2011). Port of Abbot Point Long-Term Seagrass Monitoring: Interim Report 2008-2011, DEEDI Publication. Fisheries Queensland, Cairns, 52 pp.

- McKenna, S.A. and Rasheed, M.A. (2013). Port of Abbot Point Long-Term Seagrass Monitoring: Annual Report 2011-2012. Report No. 13/02 for North Queensland Bulk Ports Corporation, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), James Cook University
- McKenna, S.A. and Rasheed, M.A. (2014). Port of Abbot Point Long-Term Seagrass Monitoring: Annual Report 2012-2013. Report No. 13/44,prepared for North Queensland Bulk Ports Corporation, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), James Cook University
- McKenna, S.A., Chartrand, K.M., Jarvis, J.C., Carter A.B. and Rasheed, M.A. (2015). Port of Abbot Point - Initial light thresholds for modelling impacts to seagrass from the Abbot Point Growth Gateway Project, JCU Publication, Centre for Tropical Water & Aquatic Ecosystem Research, Cairns, 18 pp.
- Ottaway, J.R., Andrews, J.S., Burdon-Jones, C., Hammond, L.S., Roberts, C.R. and Saalfeld, W.K. (1989). Marine environmental impacts of construction of an off-shore coal-loading facility at Abbot Point, Queensland, Department of Marine Biology, School of Biological Sciences, James Cook University, Townsville
- Rasheed, M.A., Thomas, R. and McKenna, S.A. (2005). Port of Abbot Point seagrass, algae and benthic macroinvertebrate community survey – March 2005, DPI&F Information Series Q105044, DPI&F, Cairns
- SMEC (2012). Abbot Point Water Quality Assessment: T0, T2, T3 and MCF. Prepared for North Queensland Bulk Ports, May 17 2012, Rev 1.0
- Unsworth, R., McKenna, S. and Rasheed, M. (2010). Seasonal Dynamics, Productivity and Resilience of Seagrass at the Port of Abbot Point: 2008-2010.Prepared for North Queensland Bulk Ports Corporation
- WBM Oceanics Australia (WBM) (2005). Sampling and Analysis Plan for Capital Dredging Material – Port of Abbot Point. Prepared for Ports Corporation of Queensland, June 2005. WBM, Brisbane
- WBM Oceanics Australia (WBM) (2006). Abbot Point Coal Terminal, Stage 3 expansion, Environmental Impact Statement. Prepared for Ports Corporation Queensland
- Worley Parsons (2007). Port of Abbot Point: Sediment Quality Assessment Report (305/15503/02), December 2007
- WorleyParsons (2014). Abbot Point Baseline Water Quality Monitoring Report. Prepared for North Queensland Bulk Ports. 132pp.

2.1 Marine water quality

2.1.1 Previous studies

A summary of the previous water quality monitoring programs and the parameters measured is outlined in Table 2-1.

Eight sedentary water quality loggers were deployed at Abbot Point as part of a previous baseline study undertaken between April 2008 and June 2009 (GHD, 2010). The selection of monitoring sites was based on available knowledge at the time of program development, in conjunction with an aim to achieve suitable spatial variation for the program's intent. Site selection therefore considered areas of sensitive habitat and hydrodynamic modelling, and was completed in consultation with the Great Barrier Reef Marine Park Authority (GBRMPA) and TropWATER (formerly DAFF and the Department of Employment Economic Development and Innovation - DEEDI).

In 2011, six water quality loggers were redeployed at Abbot Point in areas of known, or potential, seagrass habitat – three at coastal and three at inshore locations (WorleyParsons, 2014). For both coastal and inshore locations, one logger was deployed in proximity to the existing facilities, one deployed to the west and one deployed to the east of the existing facilities. The two remaining loggers were deployed in deepwater locations to the east and west of the existing facilities (Figure 2-1).

Between February 2013 and June 2014 an additional baseline marine water quality monitoring program (WorleyParsons, 2014) was implemented.

The monitoring program was developed for implementation over a period of 16 months and was designed with three key principles in mind:

- The sites selected could be used throughout all dredging Project phases (baseline, impact and long-term ambient monitoring) providing consistency of data collected
- The program would be robust enough to be easily adapted for any additional future works at Abbot Point such as maintenance dredging (if required) or further expansions of existing infrastructure or dredging areas
- The program would consider the location and nature of surrounding point and diffuse sources that influence water quality, the various sensitive receiving environments of the area, and seasonal and/or diurnal effects.

The program was implemented over a period of 16 months from February 2013 to June 2014 at a total of 14 sites as follows:

- *In-situ* permanent water quality loggers were established at seven sites (Figure 2-1). Loggers were deployed at an additional two sites from April to June 2014 and monitored parameters such as turbidity, photosynthetic active radiation (PAR), sedimentation rate, conductivity, temperature, dissolved oxygen (DO) and pH

- Depth profiling was undertaken monthly at each of the 14 locations for turbidity, DO, conductivity, temperature, pH and depth (pressure)
- Periodic sampling (monthly) of surface waters was undertaken at 14 sites to examine the seasonal variation (and presence or absence) in the concentrations of a full suite of analytes such as dissolved metals, nutrients, herbicides and pesticides.

A summary of the key findings from these water quality programs is outlined in Section 3.5.

Table 2-1 Summary of Abbot Point Water Quality Monitoring Programs

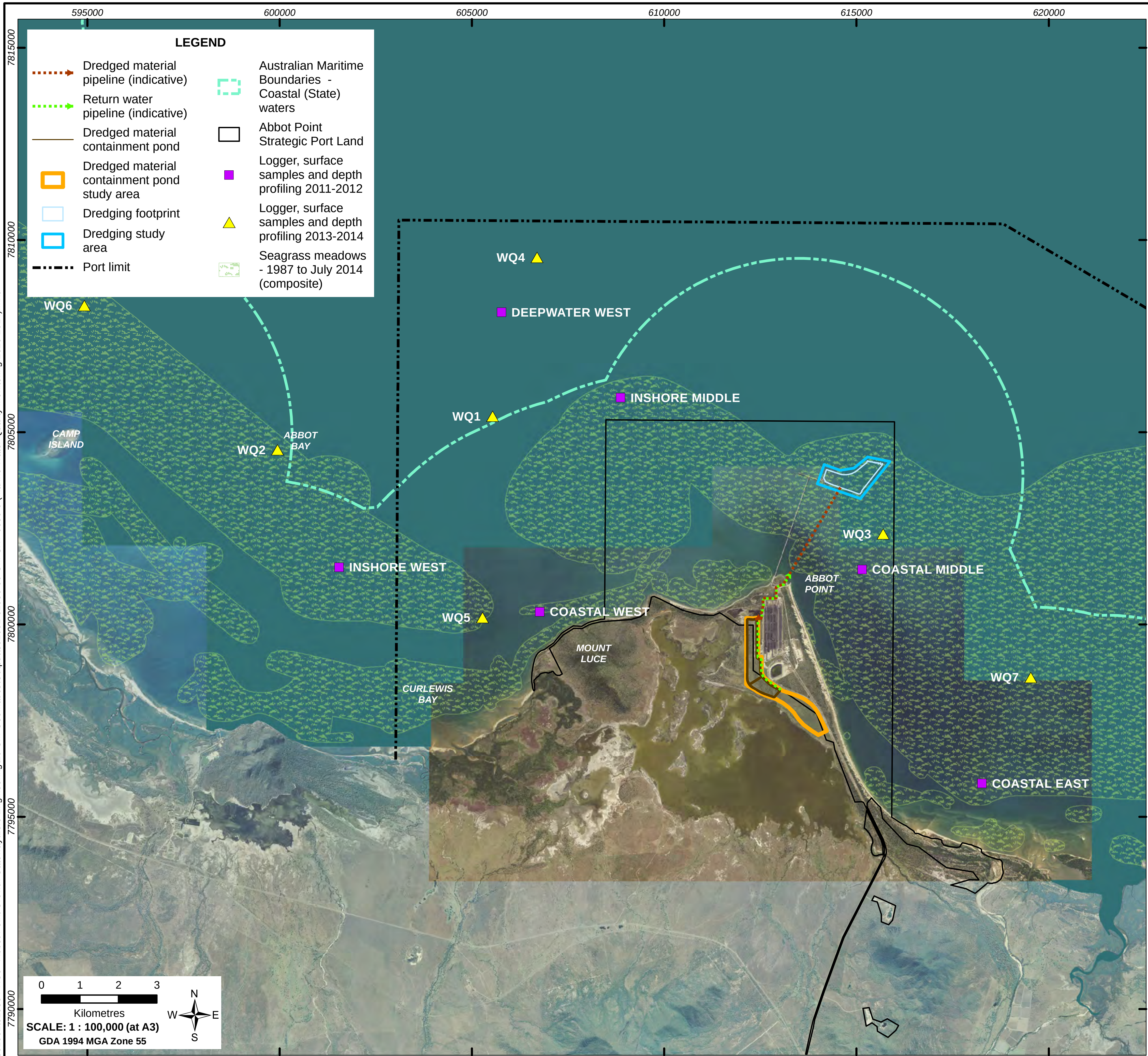
Component	Previous	Previous	Most Recent
Monitoring Period	April 2008 to June 2009	November 2011 to September 2012	February 2013 to May 2014
Permanent logger stations	Eight locations	Six locations	Seven locations
Continuously logged parameters (at seabed)	• Turbidity • Light (PAR) • Sediment deposition • Water pressure	• Turbidity • Light (PAR) • Sediment deposition • Water pressure	• Turbidity • Light (PAR) • Sediment deposition • pH • Temperature • Salinity and Electrical conductivity
Laboratory samples	Monthly (13 sampling events) at eight locations	Monthly (8 sampling events) at six locations	Monthly (12 sampling events) at 141 locations
Laboratory analytes (at sea surface)	• Total Suspended Sediment (TSS) • Chlorophyll a • Oxides of nitrogen • Total nitrogen (N) and total phosphorus (P)	• TSS • Chlorophyll a • Oxides of nitrogen (N) • Total nitrogen (N) and total phosphorus (P) • Total and dissolved metals • TPH and TBT • PAH	• TSS • Chlorophyll a • pH • Biological Oxygen Demand (BOD) • Ultra trace nutrients2 • Potassium and Sulphur • Ultra trace dissolved and total metals3

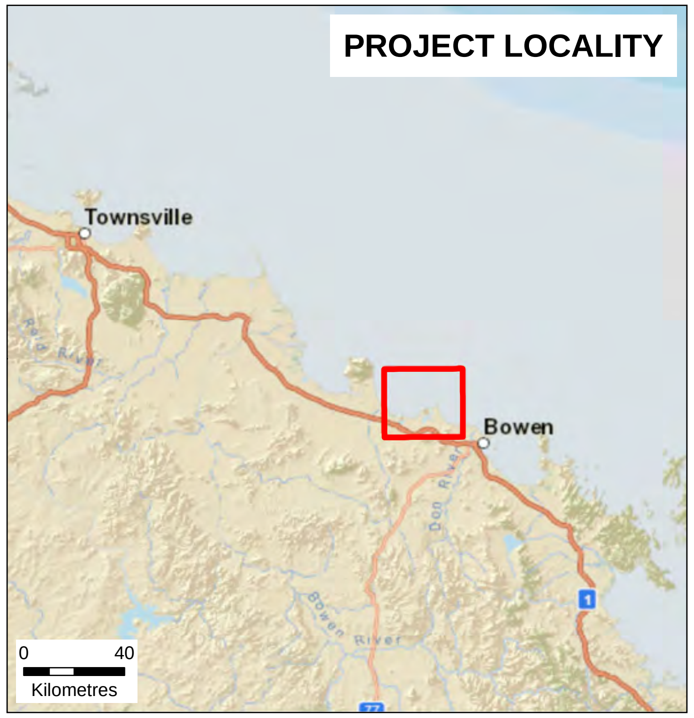
Component	Previous	Previous	Most Recent
			• BTEX • PAH • TPH • OC/OP Pesticides • Phenoxyacid herbicides • Herbicides by LCMSMS • E. coli, Faecal coliforms, Enterococci
Manual *in-situ* measurements	Monthly at eight locations (including surface, middle and seabed records)		Monthly at 14 locations (including surface, middle and seabed records)

[1] Not all analytes were measured at every site. Seven sites were the full suite, 3 sites the full suite minus Potassium, Sulphur and Phenoxyacid herbicides, 4 sites TSS, pH and BOD only.

[2] Includes Ammonia, Nitrite, Nitrate, Phosphate, Total N and Total P.

[3] Includes Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se and Zn.





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 -
http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 2-1
Marine Water Quality Monitoring Sites
2010 - 2014

Figure: 301001-01956-00-GM-SKT-0050 | Rev: 0

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2.1.2 Applicable guidelines for fresh and marine water quality

The primary focus of the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines for fresh and marine water quality (ANZECC, 2000) is to provide guideline values (numbers) or descriptive statements for a number of water quality indicators for the protection of aquatic ecosystems and human uses of waters (e.g. primary recreational, secondary recreational, visual amenity, etc.). Whilst the ANZECC guidelines provide extensive default guideline values, it is strongly recommended that regional guidelines be used where applicable or that site-specific guidelines be developed as necessary. Under the ANZECC (2000) aquatic ecosystem guidelines, there are three ecosystem conditions that apply:

- High conservation/ecological value systems
- Slightly to moderately disturbed systems
- Highly disturbed systems.

For the purposes of describing water quality, the Port of Abbot Point can be described as 'slightly to moderately' disturbed due to the effects of its historical use as an industrial port over the past 30 years, as well as consideration of other land use factors in the catchments.

The Queensland Water Quality Guidelines (QWQG) (DERM, 2009) are focused on a more regional scale and are intended to address guideline values that are specific to Queensland regions and the water types. The QWQG provide the framework for deriving and implementing more locally relevant guidelines for waters in Queensland. QWQG apply in marine waters as defined as *"the three nautical-mile limit of Queensland waters."* The primary aim of these guidelines is for protection of aquatic ecosystems in Queensland.

The GBRMPA has prepared water quality guidelines for the GBRMP with trigger levels for specific pollutants (GBRMPA, 2010). The guidelines focus on sediments, nutrients and pesticides as the main catchment runoff pollutants that affect water quality reaching the Great Barrier Reef (GBR). The guideline values adopted from this document are those listed as open coastal (Central Coast).

The principal guidelines for the open coastal inshore areas in Abbot Bay are those outlined below:

- Table 3.4.1 of the ANZECC 2000 guidelines for 'slightly to moderately' disturbed ecosystems at the 95% and 99% species protection levels
- Table 3.3.4 of the ANZECC 2000 guidelines for physical and chemical stressors (open coastal) and Table 3.3.5 for turbidity
- Table 3.2.1b of the QWQG for marine waters (Open Coastal) in the Central Coast Queensland Region (DERM 2009)

- Water Quality Guidelines for the GBRMP (GBRMPA 2010) for 95% and 99% species protection (Open Coastal).

Baseline water quality data is compared against these guidelines where applicable.

2.2 Sediment characterisation

Sediment characterisation studies have been undertaken at the Port of Abbot Point since 2004, for capital and maintenance dredging projects. Findings of these numerous studies were summarised in the Abbot Point T0, T2 and T3 capital dredging project Public Environment Report (PER), and are outlined in Section 3.1.1.

All field studies were undertaken in accordance with, and assessed against:

- National Ocean Disposal Guidelines for Dredged Material (NODGDM) (for studies undertaken before 2009)
- National Assessment Guidelines for Dredging (NAGD) (Commonwealth of Australia 2009)
- Guidelines for the Assessment and Management of Contaminated Land in Queensland Environmental or Health Investigation Levels (DoE, 2008) (for studies undertaken before 2013)
- National Environmental Protection Council (NEPC) (1999) National Environmental Protection (Assessment of Site Contamination) Measure (amended 2013)
- Ahern, C.R, Ahern, M.R, and Powell, B, (QASSIT) (1998). Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland – Version 4.0, Department of Natural Resources and Mines, Brisbane.

The NODGDM and NAGD provide a national framework to assess the placement of dredged material offshore. The contaminated land guidelines are a Queensland Government set of guidelines for managing contaminated land. These guidelines provide frameworks to assess and manage the placement or reuse of potentially contaminated sediments and soils and were superseded due to the release of the amended NEMP in 2013. ASS assessments were completed in general accordance with the Guidelines for Sampling and Analysis of Lowland ASS in Queensland (Ahern, 1998).

The most recent sediment study was undertaken for the Abbot Point T0, T2 and T3 capital dredging Project in 2012 (GHD, 2012a). Sediment samples were collected at 69 locations across the Project's approved T0, T2 and T3 dredging footprint. Samples were collected in accordance with NAGD and approved by GBRMPA (GHD, 2012a). The findings of this study are outlined in Section 3.1.1.

Sediment characterisation for ASS has been completed with reference to offshore and onshore placement options. ASS are soils that contain metal sulfides that, when oxidised can produce sulfuric acid. Investigations are required when potential ASS (PASS) is being disturbed and exposed to oxygen. Soil or sediment that remains waterlogged or undisturbed is considered low risk, but excavation or dredging of PASS increases the risk of Actual ASS (AASS) occurring.

ASS investigations were undertaken for the Abbot Point multi cargo facility Project, adjacent to the proposed Project, the X80/X110 expansion Project (area of T3) (GHD, 2010) and the now superseded dredged material management areas (DMMAs) (Golder, 2014).

Golder and Associates was commissioned to undertake an ASS investigation of the DMCP footprint in June 2015 (Golder, 2015a). The field and laboratory results do not indicate the presence of Actual ASS (AASS) and PASS within the upper 5m across the proposed DMCP site. Excavation below 5m is not proposed. Limited groundwater sampling conducted during the ASS investigations generally indicates a relatively stable and neutral environment with a high buffering capacity. Test results do not indicate that groundwater has been affected by historical oxidation of sulfides although; relatively high levels of aluminium and iron have been detected in some groundwater samples. Groundwater dewatering outside of the DMCPs will not be required to construct the DMCPs and therefore monitoring and possible treatment of groundwater is not proposed.

Potential impacts associated with ASS have been considered in the development of this document. These potential impacts, along with potential mitigation measures are described in further detail in the Preliminary Acid Sulfate Soils Management Plan (Preliminary ASSMP) for the DMCPs (Golder, 2015b), provided in Volume 3 Appendix M of the EIS.

2.3 Impact assessment

Due to the actions associated with the dredging of the T0 berths and apron area and associated return water from the DMCPs there will be potential direct and offsite impacts on the marine ecology (and marine habitat) in the vicinity of these activities. The Project has potential to impact:

- The water and sediment quality conditions that influence the marine biodiversity of Abbot Point and the surrounding waters
- Marine ecology including benthic biodiversity, seagrasses and dependent species including marine fauna that may be MNES.

The impact assessment methodology used in this report drew on and is guided by a number of guidelines and standards, and reflects the output of a number of technical assessments. These include:

- The Project EIS Guidelines
- A risk assessment process
- Habitat assessment
- Underwater noise assessment

- Significant Impact Guidelines.

2.3.1 Project EIS guidelines

The impact assessment undertaken addresses the EIS guidelines developed for the Project by the Australian Government DoE (2015).

2.3.2 Risk assessment

A risk assessment approach has been applied to assess potential environmental impacts associated with the Abbot Point Growth Gateway Project. The approach (Figure 2-2) is primarily based on the International Standard *ISO 31000:2009: Risk Management – Principles and Guidelines* and draws on a number of guidelines and standards to assist in conducting risk identification and assessment for the EIS:

- AS/NZS ISO 31000-2009 Risk management – principles and guidelines
- Handbook 436-2004 – Risk management guidelines
- Handbook 89:2012 – Risk management guidelines on risk assessment techniques
- GBRMP Environmental Assessment and Management (EAM) Risk Management Framework
- Department of Environment Matters of National Environmental Significance – Significant Impact Guidelines 1.1 (2013).

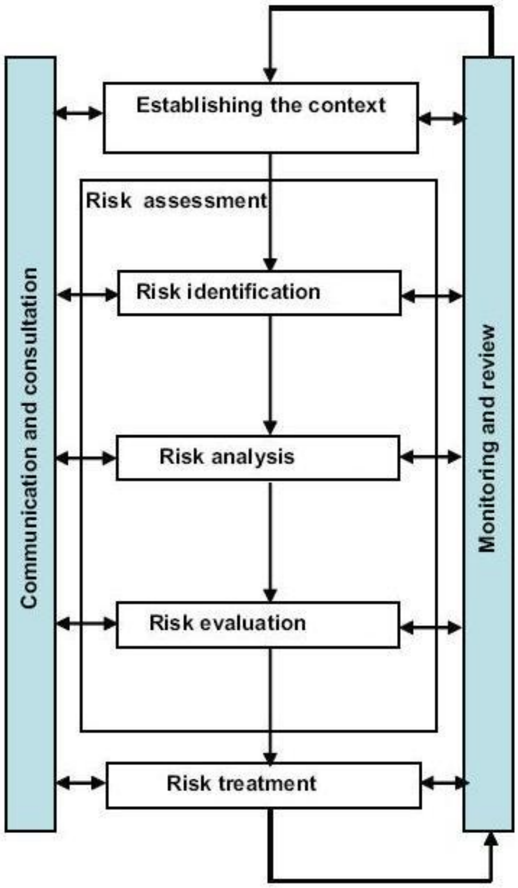


Figure 2-2 Risk Management Process (Source: AS/NZS ISO 31000 2009)

The process involves the following key steps:

Context establishment – Confirm the project description, its environmental setting, policy and regulatory context, stakeholders that may be potentially affected by the project activities or interested in the environmental impacts of the proposal and stakeholder values associated with the environmental setting.

Risk identification – Risks are systematically identified by linking them to project phases, project activities, technical assessment areas and controlling provisions (MNES). This step informs the technical assessment in relation to the potential impacts and allows incorporation of the evaluation of the impacts/risks and their mitigation measures in the respective assessments. It needs to be noted that the assessed environmental risk ratings, are not a direct reflection of the level of risk to the nominated MNES. However, they are relevant for consideration in the subsequent assessment of project impacts to nominated MNES.

Risk analysis and evaluation – Project-specific risk matrix (Figure 2-2), consequence and likelihood descriptors (Table 2-2 and Table 2-3) are developed. The environmental consequence considers direct and offsite impacts, short and long-term, temporary and irreversible impacts for the Project's lifecycle. The magnitudes of the potential environmental impacts are derived from the analysis of the amount and type of change and the sensitivity of the receiving environment. Based on the consequence of the risk and the likelihood of the risk occurring, risks are rated (e.g. extreme, high, moderate, low) and prioritised to identify risks that require additional mitigation measures to reduce their risk ratings to levels that are tolerable and as low as reasonable practicable.

Risk treatment/mitigation – Mitigation measures are identified to reduce the potential for consequences occurring, or to reduce their severity if they do occur. Risks are re-rated (residual risk) taking into consideration the adequacy and effectiveness of the mitigation measures.

Table 2-2 Consequence Definition for the Marine Ecology Impact Assessment

	Insignificant	Minor	Moderate	Major	Severe
Marine Ecology	Minor degradation of habitat and/or increased disturbance leading to a small and/or short-term reduction in habitat use by fauna/flora, at a local scale. No disturbance of threatened ecological communities or species. Recovery expected to occur over a period of months.	Minor degradation of important habitat and/or increased disturbance leading to a small and/or short-term reduction in habitat use by fauna/flora at a local scale, including threatened or migratory species. Minimal disturbance of threatened ecological communities or species. Recovery expected to occur over a period of one year.	Degradation of important habitat and/or increased disturbance leading to a reduction in habitat use by fauna/flora at a local or regional scale, including threatened and migratory species. Minor disturbance of threatened ecological communities or species. Recovery expected to occur over a period of one to three years.	Degradation of important habitat and/or increased disturbance leading to a temporary and substantial reduction in habitat use by fauna/flora at a regional scale, including threatened and migratory species. Moderate disturbance of threatened ecological communities or species. Recovery expected to occur over a period of five years.	Degradation of important habitat and/or increased disturbance leading to a substantial reduction in habitat use by fauna/flora at a regional scale, including threatened and migratory species. Major disturbance of threatened ecological communities or species. Recovery unlikely to occur completely, or to occur over a period of 10+ years.

Table 2-3 Likelihood Definition

Likelihood of Impact Occurring	Definition
Almost Certain	• It is known that the impact will occur, or • 95 – 100% chance of occurring
Likely	• Impact is likely to occur on this Project, or • 71 – 95% chance of occurring
Moderate	• Impact has occurred on a similar Project, or • 31 – 70% chance of occurring
Unlikely	• Given current practices and procedures, this impact is unlikely to occur on this Project, or • 5 – 30% chance of occurring
Rare	• Highly unlikely to occur on this Project, or • 0 – 5% chance of occurring

INCREASING LIKELIHOOD		INCREASING CONSEQUENCE: 1 Insignificant	2 Minor	3 Moderate	4 Major	5 Severe
	A Almost certain	Moderate	Moderate	High	Extreme	Extreme
	B Likely	Moderate	Moderate	High	High	Extreme
	C Moderate	Low	Moderate	High	High	Extreme
	D Unlikely	Low	Low	Moderate	Moderate	High
	E Rare	Low	Low	Moderate	Moderate	Moderate

Figure 2-3 Risk Matrix

A summary of the risk register is included in Section 6.6.

2.3.3 Habitat impact assessment

Assessments of the potential impact of dredging activity on benthic communities and habitats commonly refer to the Western Australian (WA) EPA Guideline *Environmental Assessment Guideline for Marine Dredging Proposals (EAG7)* (EPA, 2011). The EAG7 provides a spatially-based zonation scheme for proponents to use as a common basis to describe the predicted extent, severity and duration of impacts associated with their dredging proposals.

EAG7 is "*...designed to ensure that the predicted extent, severity and duration of impacts to benthic habitats associated with significant dredging activities....are presented in a clear and consistent manner.*"

The assessment framework is designed to provide an approach for generating and presenting predictions of the likely range of environmental impacts. The predictions are then utilised to recommend conditions and the types and locations of environmental monitoring and the management strategies for meeting these conditions. The guidelines can be viewed at http://www.epa.wa.gov.au/Policies_guidelines/EAGs/Pages/EAG7.aspx.

This framework has been applied to assess the potential impacts to the marine habitat from the dredging and return waters and to delineate zones of impact.

2.3.3.1 DIRECT AND OFFSITE IMPACTS

The definitions of direct and offsite impacts in this report are as follows:

Direct impacts occur predominantly within and immediately adjacent to infrastructure footprints where dredges excavate the seabed. Direct impacts typically involve ***irreversible*** loss of benthic habitats and communities, where ***irreversible*** is defined as "*lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less"* (EPA, 2009).

Offsite impacts arise from effects of dredge-generated sediments and generally extend over areas surrounding infrastructure footprints and dredging sites and occur when sediment deposition rates and/or elevated turbidity exceed the natural tolerance or threshold levels of benthic organisms exposed to those pressures. These offsite effects of dredge-generated sediments may restrict or inhibit key ecological processes such as photosynthesis and cause impacts that range in severity and duration from irreversible to readily-reversible.

2.3.3.2 DESCRIBING IMPACT PREDICTIONS

The EAG7 describes a spatially-based zonation scheme for proponents to use as a common basis to describe the predicted extent, severity and duration of impacts associated with their dredging proposals. The scheme consists of three zones that represent different levels of impact.

The ***zone of high impact*** includes the areas defined by the project infrastructure (direct removal or smothering) and the areas in which elevated TSS, sedimentation or sediment deposition levels are such that they cause the total mortality of benthic organisms that inhabit these areas and recovery of the more sensitive organisms is not likely to occur within five years of the impact. In this area, the impacts to the benthic organisms are predicted to be ***irreversible.*** The term irreversible is defined in accordance with EPA (2011) as *"…lacking a capacity to or recover to a state resembling that prior to being impacted within a time frame of five years or less."*

The ***zone of moderate impact*** includes areas in which sustained levels of TSS, sedimentation or sediment deposition are such that they cause sub-lethal impacts to benthic organisms that inhabit the areas. Sub-lethal impacts include impacts such as bleaching, partial mortality and impacts to the health of the organism that may include a reduction in the ability of that organism to grow and reproduce as it normally would. The organisms in this zone are expected to recover within five years of the impact.

The ***zone of influence*** is the area in which changes in water quality due to the dredging and dredged material relocation operations are predicted to occur, but these changes will not result in a detectable impact on benthic biota. This zone will most likely encompass a large area, but at any given time the actual dredging plume will only be restricted to a very small proportion of this area.

2.3.3.3 Modelling approach

Detailed numerical modelling of the dredging and return water activities was undertaken by Royal Haskoning DHV (RHDHV) and is reported in the Abbot Point Growth Gateway Project: Numerical Modelling Report (RHDHV, 2015).

Three dimensional modelling was undertaken using three separate years selected from the last 20 years (RHDHV, 2015). The three separate years were chosen so as to encompass the range of climatic and oceanographic variability in a given year. The three years represented a strong El Nino event (1997) a strong La Nina event (2011) and a neutral year (2007).

Results of the modelling indicate that the plume resulting from the dredging and onshore placement activities is smaller and less intense than for the dredging associated with the offshore placement outlined in previous modelling reports which addressed offshore placement (GHD, 2012b). This difference is attributed to the different dredge type and activity proposed for the Project releasing substantially less mass of material into the environment when compared with the dredge approach proposed for offshore placement.

The 95th percentile plots of all yearly modelling scenarios were investigated to identify the differences between the background forcing bought about by the different scenarios.

The area of TSS greater than 2.5mg/L due to the dredging is largest in 2007, the neutral ENSO year and smallest in the strong La Nina year. The difference is due to different Metocean conditions (specifically the winds and waves) experienced in these years. The neutral year was subject to the lowest wind and wave energy out of the three years while the La Nina was subject to the highest wind and wave energy.

Higher wind and wave energy results in higher current speeds and increased re-suspension which causes the sediment released by dredging and return water operations to be transported further from the source. The increase in transport results in a reduction in the TSS concentrations as it becomes diluted by being transported over a large area. As a result the material is transported away from the main plume extent and the TSS concentration is more rapidly reduced and therefore the percentile plots do not show such large plume extent.

Based on this interrogation of the 95th percentile plots the neutral ENSO year is when the largest area of concentrations above 2.5mg/L occurs. **The 2007 neutral year represents the worst-case scenario for the impacts to the marine habitat and thus the thresholds developed in the following sections will apply to this year only for both seasons.**

The model simulations were then split into two seasons; the dry season period from 1 May to 31 October and the wet season period from 1 November to 30 April. For the assessment of the potential impact on benthic light availability for seagrasses the model simulations were split in to two seasons, the seagrass growing season (1 July to 31 December) and the senescence season (1 January to 31 July).

The TSS in the water column varies depending upon the depth. The TSS concentrations are much higher in the near seabed layer compared to the other modelled layer (Table 2-4). **The results presented are solely representative of the seabed layer and are presented as the worst-case.**

Table 2-4 Variation in TSS concentrations through the water column at a site 200m away from the dredging area at model data extraction point D02

Model Layer	Median TSS (mg/L)	Mean TSS (mg/L)	Max TSS (mg/L)
Surface	0.8	1.5	12.1
Mid	4.4	5.4	22.3
Bed	13.9	16.1	79.2

2.3.3.4 Dredging Durations

The size of the dredging vessel that will undertake the T0 dredging is not known at this stage, although it is likely that it will be either a large or medium sized dredge. The dredge rates and therefore the dredge duration will vary depending on the vessel size. For a large vessel the dredge rates are higher and the duration is expected to be approximately 6 weeks, while for a medium vessel the rates are lower and as such the duration is expected to be approximately 13 weeks.

To assess the impact from the onshore placement of dredged material using a large compared to a medium sized dredging vessel, additional numerical modelling sensitivity testing simulations were undertaken by RHDHV (2015). The results of these interrogations indicate:

- The shorter dredge duration of approximately 6 weeks, which assumes a large dredging vessel, results in increased TSS concentration impacts compared to the longer dredge duration of approximately 13 weeks, which assumes a medium sized dredging vessel. Both dredge durations show similar impacts in terms of sedimentation rates and impacts to benthic PAR, with some variability resulting due to the variable metocean conditions from the difference in dredge duration.
- However, this metocean variability will be captured by the stochastic modelling approach regardless of which dredge duration is adopted. Therefore, adopting the shorter dredge duration of approximately 6 weeks for the stochastic modelling represents the worst-case scenario in terms of the intensity and extent of potential impacts. As a result, the modelling detailed in this report is based on the shorter dredge duration of approximately 6 weeks.

2.3.3.5 HYDRODYNAMIC MODELLING OUTPUTS

A number of model outputs are presented to provide an understanding of the spatial and temporal patterns of the dredging plume TSS, bed sedimentation (gross and net), light attenuation and benthic light (PAR) availability. These will include:

- Percentile TSS and sediment deposition outputs (median, 80th and 95th)
- Time series plots from a number of extraction point located at or near sensitive receptors including coral reefs and the Catalina plane wreck site (see Marine Protected Areas (MPAs) Figure 3-3)
- Bed thickness plots
- Benthic light availability plots
- Weekly instantaneous snapshot plots of the surface dredging plume.

Percentile plots do not show an actual dredging plume at any point in time, they are duration-based plots which show statistical summaries of the dredging plume dispersion over the entire dredging period.

95th percentile plots represent conditions that would be expected for 5% of the dredging campaign. The use of 95th percentile outputs reflect, conservatively, conditions which could occur at most on three days (not necessarily consecutively) during the dredging campaign and may be considered as a worst-case scenario.

The 80th percentile outputs represent conditions that would be expected for 20% of the dredging campaign. The use of the 80th percentile represents an upper value of an indicator which may cause an impact.

50th percentile outputs, from modelled scenarios, are reported to enable comparison with site median values; the recommended comparative statistic against guidelines for turbidity (ANZECC, 2000). It is considered that 50th percentile results are more likely to represent conditions that could have ecological relevance, representing conditions for at least half the total dredging campaign. However, for 50% of the time, plumes may exceed the predicted spatial extent of the 50th percentile plots.

Only 95th percentile and 80th percentile outputs have been included in this report to represent spatial impact as a result of the Project. The median or 50th percentile plots show very little in terms of the spatial extent of the plume data.

Time history plots have been produced for TSS, bed thickness and daily deposition to demonstrate the variation at varying extraction points over the entire period of simulation. These plots assist interpretation of the variable nature of plumes over the duration of the dredging campaign and provide a means of determining the intensity of the impact over the duration of the dredging.

Bed thickness maps have been produced for several of the scenarios to spatially illustrate the depth of bed sedimentation as a result of plumes from dredging and material relocation. Bed sedimentation maps visually depict the spatial extent and intensity of bed sedimentation expected from the proposed dredging.

Light availability plots have been produced based on the percentage of surface irradiance, which is a key parameter to predict potential impacts from suspended dredged material on benthic primary producers (BPP) in the project area.

2.3.3.6 MODELLING THE THRESHOLDS

To assess the potential impacts of the dredging and return water, several plots will be presented which outline the zones of impact (high and moderate) and the area of influence associated with these activities. These will be developed after the application of thresholds associated with the particular parameter in question and show the spatial extent of the impact zones, while also allowing for a quantitative assessment of the areas that will likely be impacted and associated loss in hectares of particular habitats. These plots will include zonation maps of:

- Sedimentation/deposition daily rates
- Bed thickness
- Intensity, Duration and Frequency (IDF) of TSS
- Benthic light availability based on % Surface Irradiance (SI).

2.3.3.7 DEVELOPING THRESHOLDS

The direct impacts to the marine habitat of the Abbot Point environment are related to the physical removal of the seabed during dredging. The offsite impacts include those associated with the generation of plumes during dredging and returning waters and include:

- Changes in water quality conditions associated with increases in turbidity and TSS loads in the water column at both the area to be dredged and return water area
- Deposition of mobilised sediments and changes in bed thickness from settlement of suspended sediments within the plume
- Light attenuation associated with plumes in the water column.

Additional offsite impacts to intertidal and subtidal areas will include the laying of pipelines to support the pumping of the dredged and the positioning of the return water pipeline infrastructure. The offsite impacts associated with temporary pipeline infrastructure are likely to be very short-term.

The impact assessment requires the development of thresholds which can be applied to the hydrodynamic modelling outputs to produce zones of ‘pressure’ or zones of cascading impact. The development of the thresholds relies heavily on existing information on the benthic habitats and organisms currently existing in the intertidal and subtidal environments surrounding Abbot Point, their relative susceptibility to increases in suspended sediments in the water column, along with their sensitivity to reductions in benthic light availability and the level of sedimentation bought about by the Project development.

Once the ecologically relevant thresholds are developed, the areas of zones are overlaid onto the benthic habitat maps and estimates of irreversible and recoverable losses (zone of moderate impacts) of particular habitats can be measured.

2.3.3.8 Sedimentation and bed thickness thresholds

The sedimentation rate determines the rate of sediment that falls onto the substrate in a given area. The sediment may then be re-suspended during the tidal cycle and land elsewhere. In some areas the sediment remains and forms a layer on the surface of the substrate. These areas may either experience a very high sedimentation rate where the rate of re-suspension is less than the rate of deposition, or the area may be located in a sediment ‘sink’ where bathymetry, proximity of reefs and islands, currents, winds and wave combine to create an area of low energy where sediments may sink and collect.

Marine organisms have physiological or behavioural methods of dealing with sediments that settle on or around them, ranging from avoidance (such as fish, marine mammals and sea turtles) to tolerance and clearing of clogged pores (such as filter feeders). Above certain thresholds, small changes in net sedimentation rates may adversely affect organisms, resulting in stress and eventually mortality, particularly for sessile organisms or those confined to specific territories.

The majority of observed detrimental impacts of dredging relate to high sedimentation (e.g. Marsalek 1981; Brown *et al.* 1990, 2002). The deposition of sediment from a dredging plume is likely to be on a smaller spatial scale compared to any changes in the water quality induced by a dredging plume. This is primarily because the heavier particles in the plume will fall out of the water column relatively close to the site where the dredge is working, or where dredged material is disposed. Fine particles (typically those <75µm), on the other hand, often travel large distances in the water column until eventually settling wherever local conditions (waves and currents) are sufficiently calm. These particles may be re-suspended again (repeatedly) if local conditions (waves and currents) change. Consequently, the modes of impact and the receptors affected by sedimentation are often different when compared to impacts induced by reduced light or suspended sediments. It is therefore appropriate that sedimentation be considered separately for the interrogations of the dredging plume modelling output and separate thresholds for the process of sedimentation are developed.

Modelled differences in bed thickness and daily net sedimentation rates are used to inform potential impacts by two methods:

- Considering sedimentation data from extraction points near and far from dredging operations and at sensitive receptor sites
- Application of sedimentation thresholds to the modelled output to quantify potential zones of high and moderate impact as well as areas of influence.

Sedimentation rate thresholds for seagrass are sourced from the literature and from applicable guidelines.

Critical net sedimentation thresholds for seagrass species previously observed at Abbot Point (*Cymodocea rotundata*, *Cymodocea serrulata* and *Halophila ovalis*) range from 15–130mm/annum (Erftemeijer and Lewis, 2006). This is relatively consistent with the general findings of Vermaat *et al.* (1997) who concluded that sedimentation rates of 2 to13cm (or 20 to130mm) per year are able to be tolerated depending on the species. Given that ambient net deposition rates across the Abbot Point region are not well understood, a conservative approach to considering potential impacts from smothering has been adopted.

In recognition that there would be a baseline level of deposition/erosion, a 10mm critical threshold above background has been adopted for assessing potential impacts of sedimentation on potential seagrass habitat at Abbot Point.

Potential impacts from deposition are also compared to the GBRMPA Guideline (GBRMPA, 2010) for the protection of corals to provide context to the changes predicted from the Project. The GBRMP guideline level for maximum daily sediment deposition (15mg/cm^2 daily) and yearly sedimentation rate (3mg/cm^2/day) has been developed for the protection of corals, which are more sensitive to sediment deposition than seagrass and other macrobenthic organisms (Fabricius and Wolanski, 2000). Comparison of predicted increases in deposition with this guideline level is considered to be a very conservative approach to examining potential impacts to non-coral communities and the duration of the guideline level is for a year which is eight times longer than the modelled period of dredging

The GBRMPA guideline values for maximum daily sediment deposition of 15mg/cm^2/day and yearly (in this case define as the duration of dredging) sedimentation rate of 3mg/cm^2/day are applied to model outputs to delineate the zone of moderate impacts, worst-case scenario.

2.3.3.9 TOTAL SUSPENDED SOLID THRESHOLDS

One of the most robust and repeatable water quality measurements is the TSS concentration measurement. This measure is critical in dredging plume modelling. The common models used for predictions of plume behaviour work on the basis of particles measured as concentrations of TSS moving over varying spatial and temporal scales in response to the activities of dredging and dredged placement and the prevailing metocean conditions.

The accurate measurement of TSS relies upon laboratory analysis of water samples. This means there are severe logistical and economic constraints in the use of this method for the assay of water quality over large spatial scales in both baseline and reactive monitoring programs. TSS is used to characterise the behaviour of particles in modelling of dredging plume behaviour. The use of water quality thresholds based on turbidity requires an understanding of the locally relevant relationship/s between TSS and Nephelometric Turbidity Units (NTU) in order to use the baseline and reactive monitoring datasets (NTU) to predict the potential impact of the dredging plume (TSS) upon the environment. Therefore the development of the thresholds for modelling interrogations typically hinges upon the development of a reliable relationship between TSS and turbidity.

2.3.3.10 Turbidity thresholds

The measurement of turbidity is relevant to benthic organism health in that increased turbidity influences the light attenuation characteristics of the water column, and therefore influences the amount of PAR available to primary producers. Turbidity also reflects the level of TSS within the water column, although the relationship between the two parameters can vary widely depending on the nature of the particles constituting suspended sediment. Turbidity (measured as NTU) is a widely utilised parameter, particularly for the reactive monitoring of dredging plume impacts on water quality, because of its impact on a biologically important physical parameter - light. The measurement of turbidity is also favoured because with modern instrumentation it is easily and robustly measured simultaneously at many sites (multiple loggers deployed), continuously (entire dredging program), over varying small temporal scales from seconds to days.

As the measurement of turbidity can be influenced by changes in particle size, the relationships between turbidity, light attenuation and TSS can vary widely.

The approach used to develop thresholds is based on the methods outlined in McArthur *et al.* (2002). Using this approach requires the interrogation of baseline TSS data to calculate the IDF of particular TSS events. The IDF of the upper range of TSS events is then chosen which may represent the upper limits of what a benthic community is accustomed. IDF events above this ‘threshold’ are deemed to be potentially outside the natural boundaries and may be the cause of sub-lethal or lethal responses in that benthic community. The more baseline TSS data available, the more accurate measure of ambient IDF of TSS events or thresholds can be ascertained.

The turbidity measurements from the last two water quality baseline studies (described in Section 2.1) are interrogated to come up with the IDF of a number of events. The sites chosen for this interrogation are located in close proximity to existing seagrass communities. IDF turbidity values from the combined dataset include WQ7, Coastal East, WQ3, Coastal Middle and Inshore Middle data (Figure 2-1). These baseline water quality monitoring sites are located near the nearshore/deepwater seagrass meadows identified by TropWATER (McKenna and Rasheed, 2014).

Only the TSS/NTU data from the daylight period (6am to 6pm) is used to develop thresholds. The levels of TSS are related to the amount of benthic light available for BPP. At night the TSS in the water column cannot impact on the light availability because there is not light available. Because the primary benthic habitat in the Abbot Point region is seagrass, which relies on light, this approach is appropriate. A one month time period was utilised to formulate the period of occurrence (frequency) of TSS intensities. The durations of the specific TSS events examined are 2 hours, 5 hours and 10 hours. The results of these investigations are summarised in Table 2-5. Turbidity data has been converted to TSS via the conversion factor outlined in Section2.3.3

The ***zone of influence*** is the area in which changes in water quality due to the dredging and dredged relocation operations are predicted to occur, but these changes will not result in a detectable impact on benthic biota. This zone will most likely encompass a large area, but at any given time the actual dredging plume will only be restricted to a very small proportion of this area. The zone of influence for this assessment is defined for any instance where the bottom surface layer TSS concentration in a given model cell exceed 5mg/L at any time for a 1 hour duration.

The zone of moderate impact is based on elevated TSS in the water column that exceeds the naturally occurring TSS events which are discerned from the baseline water quality data. The zone of moderate impact includes short events of low TSS (median) occurring on many occasions and short events of high TSS values (95th percentile) on a few occasions (see IDF curves Figure 2-4).

The ***zone of high impact*** is defined as the areas to be dredged only. The seagrass habitat in these areas will be removed and impacts will be 'irreversible'.

Based on this assessment the zone of influence and the zone of moderate impact are delineated by the values of IDF outlined in Table 2-5.

Table 2-5 Descriptions of the zones based on IDF curves for baseline TSS data collected from Abbot Point water quality monitoring sites

Season	Zone of Influence			Zone of Moderate Impact			
	Intensity	Duration	Frequency[2]	Metric	Intensity[1]	Duration	Frequency[2]
WET	>5mg/L	1 hr	once	Median	2.61mg/L	5 hrs	18 times
				95th %ile	14.5mg/L	5 hrs	3 times
DRY	>5mg/L	1 hr	once	Median	1.45mg/L	5 hrs	24 times
				95th %ile	12.62mg/L	5 hrs	2 times

[1] TSS = 1.45 x NTU

[2] Note the Frequency values in the IDF curves are for four weeks, the values here have been scaled up to the length of the dredging campaign (~ six weeks).

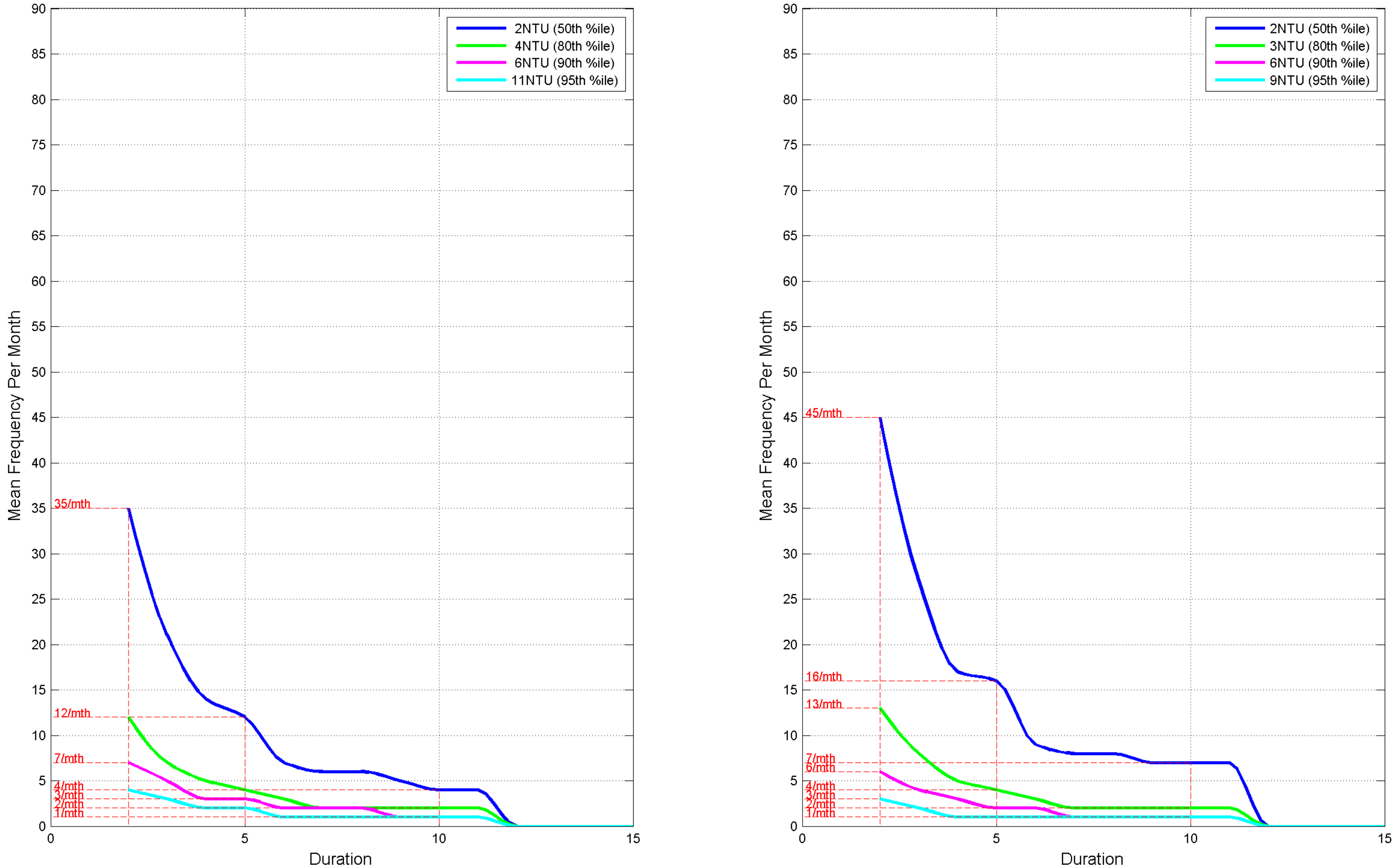


Figure 2-4 IDF *turbidity* curves, wet season = left graph and dry season = right graph

2.3.3.11 Relationship between NTU and TSS

Typically, *in-situ* seawater clarity is measured using turbidity probes. The hydrodynamic modelling outputs are typically in TSS in mg/L. The conversion of turbidity data to TSS data is a vital component which connects the baseline measurements of turbidity to the development of TSS thresholds which are in turn used to interrogate the hydrodynamic modelling outputs.

For a number of monitoring programs at Abbot Point and Hay Point the relationship has been ascertained using laboratory experiments which use sediment collected from specific sites. A summary of the results is outlined in Table 2-6. An example of the laboratory methods used to establish the site-specific relationship between TSS and NTU is as follows:

An instrument is placed in a large container (50L) in darkness and the output is read on a computer attached to the logger. Seawater is used to fill the container. Sediment from one of the study sites is added to a small container of salt water and agitated. The water-sediment slurry is then added to the large container which is stirred with a small submerged pump. A water sample is taken and analysed for TSS using standard laboratory techniques. Typically six different concentrations of sediment are used for each site. TSS is then plotted against the NTU reading from the logger for each of the different sediment concentrations and a linear correlation between NTU and TSS is calculated. For the results to be considered reliable, the correlation must typically have an R^2 value of equal to or greater than 0.9, with the NTU to TSS multiplication factor between 0.8 and 5.

For the development of TSS thresholds for this Project a median value of 1.45 is used to convert the turbidity intensity measured to TSS. This incorporates all information gathered on the relationship between TSS and NTU available.

Table 2-6 The range of conversion factors from TSS to NTU from a range of projects

Program	Location or Sites	Conversion Factor (CF) (TSS = CF x NTU)
Abbot Point PER (GHD, 2012)	WQ1	0.48
	WQ2	2.42
	WQ3	1.94
	WQ4	1.96
	WQ5	2.10
	WQ6	1.34
	WQ7	2.33
	WQ8	1.41

Program	Location or Sites	Conversion Factor (CF) (TSS = CF x NTU)
Abbot Point Alternative Dredged relocation ground investigations in 2014	AP2	1.21
	PER ground	1.61
	PER ground	0.98
Departure path and Apron Capital Dredging (Trimarchi and Keane 2007)	Hay Point area	2.20
Hay Point Maintenance Dredging 2010 (Worley Parsons 2010)	Victor Island	1.45
	Slade Point	1.36
Hay Point X3 Capital Dredging (BMA, 2011)	Within plume	1.91
Dudgeon Point Coal Terminal EIS (DPCT)	Dalrymple Bay	1.28
	Dungeon Point (inshore)	1.74
	Old Ground	3.10
	Victor Islet	0.62
	Round Top Island	1.31
Australian Institute of Marine Science (Schaffelke *et al.* 2008)	GBR wide	1.30
Median		1.45
Mean		1.62

2.3.3.12 Light attenuation

A BPP such as seagrass relies on sunlight to photosynthesise and therefore grow and reproduce. The amount of PAR which reaches the seagrass communities on the seabed is influenced by the amount of particles in the water column in which the light passes. Any suspended solids in the water column will reduce the amount of light reaching the seabed by the process of absorption or reflection; this light is said to be attenuated (Kirk 1994). At certain depths the attenuation is such that no PAR reaches the seabed. Increased suspended solid loads in the water column due to dredging activities will add to the background levels of light attenuation causing a further reduction in light reaching the BPP at certain depths. To account for the light attenuation through the water column the best metric to use is depth averaged TSS rather than the bottom layer TSS.

The potential effects on the underwater light climate from suspended particles derived from dredging and return water are investigated for this Project. The objective is to estimate the change in the light attenuation from dredging activities related to background information on light attenuation collected when there are no dredging activities being undertaken.

The seagrasses likely to be impacted by turbid plumes from the dredging activities are the deeper water communities which are dominated by *Halophila* species. The nearshore communities dominated by *Halodule uninervis* are likely to be impacted by the returning water discharges.

Site-specific preliminary light requirements for Abbot Point seagrasses were developed by the Centre for Tropical Water and Aquatic Ecosystem Health JCU Seagrass Ecology Group TropWATER (McKenna *et al.,* 2015) for the Project. The methods used to develop the light requirements thresholds were:

1. A review of the range of species-specific light requirements from existing literature as well as data from ongoing studies to establish likely ranges of light required for the species of concern
2. Analysis of *in-situ* data on light and seagrass change collected at Abbot Point between August 2013 and May 2015
3. Examination of how the literature and ongoing study derived values fit with the recorded light history and occurrence of seagrass at the Abbot Point monitoring sites.

By using benthic PAR data collected by TropWATER at seagrass monitoring sites over the last two years, and surface PAR measured from the Bureau of Meteorology (BOM) weather station at Abbot Point, the two seagrass communities (inshore and offshore) are examined separately in terms of their light requirements based on the changes in light attenuation during dredging (McKenna *et al*., 2015). Based on these assessments TropWATER recommend the following light based thresholds be used:

1. For the offshore areas of deep water *Halophila* species the modelling threshold is 1.5mol/m^2/day over a rolling seven day average
2. For the shallow inshore areas potentially affected by outfall discharges (dominated by *Halodule uninervis*) the modelling threshold is 3.5mol/m^2/day over a rolling 14 day average.

TropWATER recommended adapting a more conservative value of 5mol/m^2/day over a rolling seven day rolling average for the coastal seagrass community for any management criteria.

2.3.3.13 Modelling Light Requirements

The following procedure was used to assess the impacts of suspended dredged material at the dredge head and return water on the light attenuation through the water column.

From July 2013 to April 2015 the benthic PAR at the seabed from six locations (see Figure 3-12) was measured using upward facing PAR instruments deployed by TropWATER as part of the ongoing seagrass monitoring program.

Daily totals of PAR in units of mol/m^2/day were calculated at each site for days when entire daily datasets were available. During the same period and on all days where daily benthic PAR was available, daily totals of solar irradiance values (MJ/m^2/s) captured at the BOM weather station at Abbot Point were downloaded. Light attenuation coefficients (K_d) could then be calculated for each seagrass monitoring site.

PAR measurements from instruments placed on land at the NQBP compound at Abbot Point were compared to the solar radiation values measured at the BOM weather station at Abbot Point. The relationship between daily solar exposure (MJ/m^2) and daily PAR (mol/m^2/day) is significant (R^2=0.8759), linear and a conversion factor of 2.1 was used to convert the solar exposure to daily PAR (Figure 2-5).

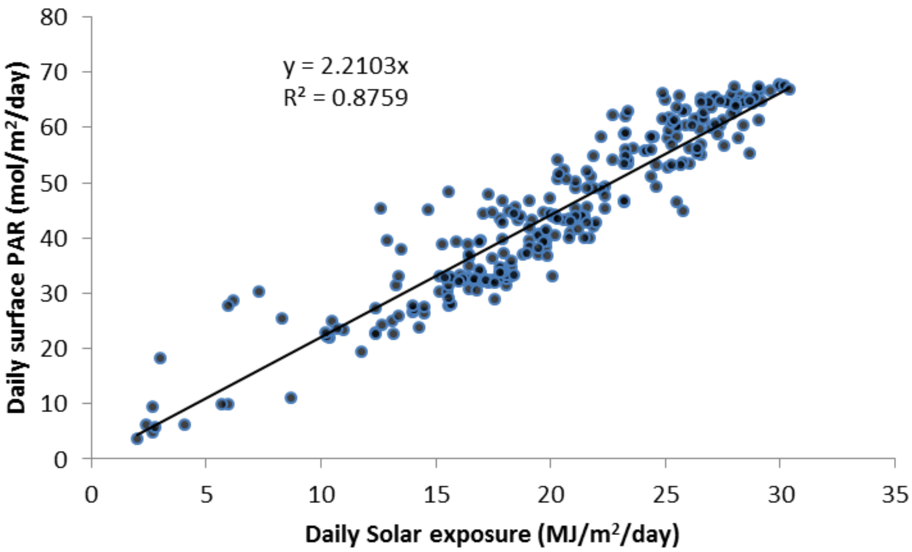


Figure 2-5 Daily PAR at NQBP compound compared to daily solar exposure at BOM weather station

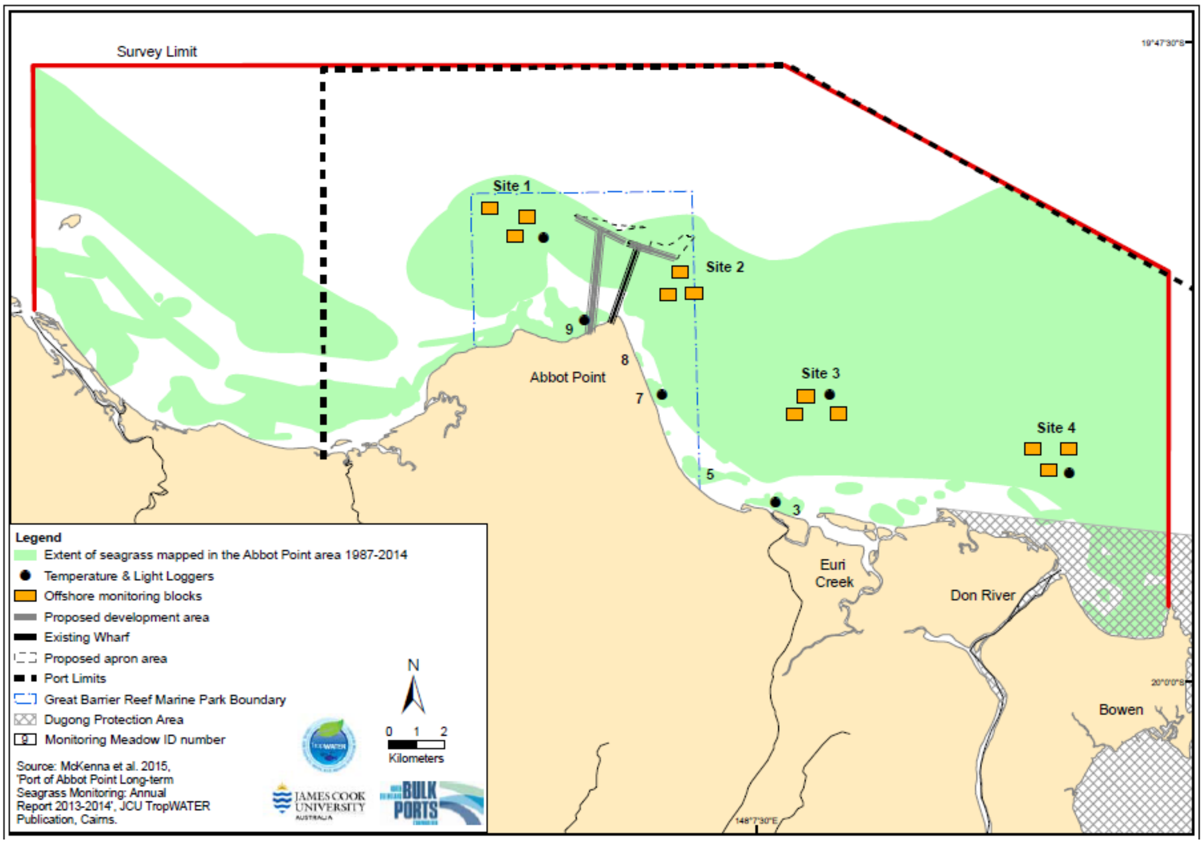


Figure 2-6 Coastal meadows and monitoring sites (reproduced from McKenna *et al.* 2015)

The data was separated into growing (1 July to 31 December) and senescence (1 January to 31 June) seasons and the minimum, maximum 5th, 10th, 20th, 50th, and 80th percentile and average light attenuation coefficient (k_d) at each site for each season was calculated using a rearrangement of the equation describing the Beer-Lambert Law as follows:

$$K_d = ln(I_z/I_0)/z$$

Where I_z is the daily PAR measured at the seabed and I_0 is the daily surface PAR measured at the Abbot Point weather station and corrected for 7% surface reflectance (Kirk, 1994), and z is the mean water depth above the logger in meters at each site.

The k_d values from the growing season are only used to interrogate the hydrodynamic modelling outputs and then to predict potential impacts on the nearshore and offshore seagrass communities due to a reduction in the benthic light caused by the dredging and returning waters.

To remain consistent with the data used to develop light requirements (McKenna *et al.*, 2015) only the PAR data from August 2013 onwards was used to calculate baseline k_d. This is because only one logger was deployed at each site before this time. Using the period when dual loggers were available at each site allowed for a higher level of confidence in the light data as any potential and non-obvious erroneous data could be removed, and relationships between light and seagrass biomass could be interrogated with confidence.

In addition, only irradiance data from offshore sites 3 and 4 and inshore site 7 were used. Inshore site 3 was excluded as it was deemed outside the area likely to be affected by dredging. Inshore site 9 was also excluded as it has not had any significant amounts of *H. uninervis* recorded at the site since light loggers were deployed and therefore would not provide evidence of light that supports this species' growth. Offshore site 1 was excluded because it is located on a shallow shoal (Clark shoal) which is traditionally dominated by *H. uninervis* and not considered to be a true deep water site. *Halodule uninervis* has not been present at the site consistently since Tropical Cyclone (TC) Yasi and therefore would not provide evidence of light that supports this species' growth.

The k_d metric which best described the range of measured PAR data at the inshore was the median K_d. To arrive at this conclusion the 20^{th} percentile and median kd at the nearshore site was used to back calculate to provide a benthic daily PAR value. These values were then compared (plotted) to the entire dataset of benthic PAR collected at nearshore site 7 (Figure 2-7).

The median PAR value appears to represent the most reliable metric which equates closest to the light requirements of the nearshore seagrasses (3.5mol/m^2/day) and the predicted light contour for the median k_d encompasses the known distribution of this community (see Figure 6-20). The offshore seagrass community at Abbot Point is very sensitive to changes in benthic light; the outer boundary of the offshore seagrass distribution expands and contracts depending on a given light regime in a particular year. The minimum k_d metric was used in the modelling exercise to delineate areas of potential impacts due to benthic light climate changes in offshore areas due to additional (above background) sediments released into the water column during dredging. The offshore k_d minimum baseline contour corresponds best with the known distribution of offshore seagrass.

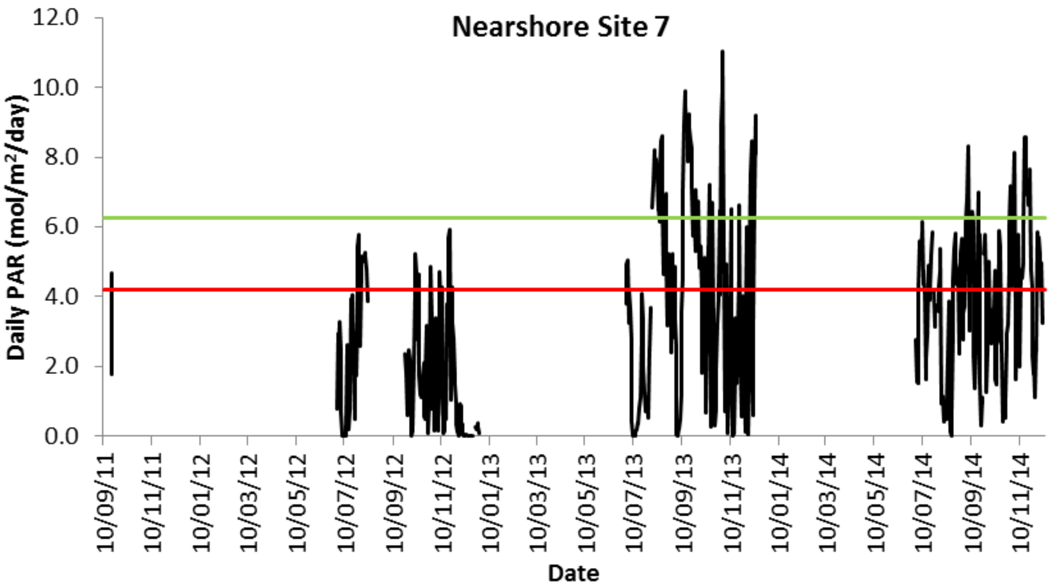


Figure 2-7 Daily PAR data from nearshore site 7, reference lines represent median PAR (red) and 20th percentile PAR (green)

Depending on when the dredging occurs, the background PAR attenuation coefficients during a particular season will increase from the introduction of suspended sediments from the dredging and return water operations. To account for this, the cumulative light attenuation coefficient for each seagrass community will be the sum of the background attenuation (kgrowing) plus the attenuation caused by additional suspended sediments (kdredge). kdredge is assumed to be 0.025/m per 1mg/L of TSS at a particular location. The relationship between TSS and kdredge has been measured in pre-dredging laboratory experiments using local sediments at a number of locations where dredging has occurred and range between 0.0237 (Environmetrics Australia 2007) to 0.018 (MScience 2012).

The % Surface Irradiance (SI) can be calculated for the background conditions for each season by rearrangement of the Beer-Lambert Law as follows:

$$\%SI = I_z/I_0 = e^{-kz}$$

To estimate the impact on light attenuation and %SI at the seabed of each mg/l of TSS at each grid cell in the numerical model the following equation is used.

$$\%SI = I_z/I_0 = e^{-(kwet\ or\ kdry\ +\ 0.025*TSS\ value)z}$$

In summary the hydrodynamic modelling was interrogated to produce areas of offsite impact due to changes in light requirements by:

1. Using the nearshore data for k_d (median) from data collected at site 7 by TropWATER to predict baseline k_d contours for nearshore seagrass communities. This was then used to calculate baseline %SI using the depth contours from the model and then baseline benthic PAR was calculated based on the surface PAR values.
2. Using offshore data for k_d (minimum) from data collected at meadow 3 and 4 by TropWATER to predict baseline k_d contours for offshore seagrass communities. This was then used to calculate baseline %SI using the depth contours from the model and then baseline benthic PAR was calculated based on the surface PAR values.
3. Splitting the analysis into growing (1 July to 31 December) and senescence (1 January to 30 June) seasons for nearshore and offshore seagrass light requirements.
4. Using the growing season data only.
5. Calculating kdredge, %SI and benthic PAR with the modelled **depth averaged** TSS for every model timestep. The 14 day rolling median benthic PAR for baseline plus dredging was then calculated throughout the model simulation to identify when the nearshore PAR is reduced below 3.5mol/m2/day for the 14 day rolling median. Areas were this value is triggered were identified to produce a zone of moderate impact.
6. Calculating kdredge, %SI and benthic PAR with the modelled TSS for every modelled timestep. The 7 day rolling median benthic PAR for baseline plus dredging was then calculated throughout the model simulation to identify when the nearshore PAR is reduced below1.5mol/m^2/day for a 7 day rolling median. Areas were this value is triggered were identified to produce a zone of moderate impact.
7. Using the 2007 El Nino forcing scenario only (worst case).

Based on this process:

The zone of moderate impact on nearshore seagrass habitat is defined as the area (in hectares) of change between the baseline PAR value contour of 3.5mol/m^2/day average and the dredging PAR value contour of 3.5mol/m^2/day (over a rolling 14 day), where seagrass habitat exists.

The zone of moderate impact on offshore seagrass habitat is defined as the area (in hectares) of change between the baseline PAR value contour of 1.5mol/m^2/day average and the dredging PAR value contour of 1.5mol/m^2/day (over a rolling 7 day), where seagrass habitat exists.

The health of the seagrass community after 7 days (offshore) and 14 days (nearshore) of low light climate (below the thresholds) may be compromised. However total mortality and significant declines will only occur if there is an extended period (several days or weeks) of low benthic light (below the light requirements) beyond the stipulated durations.

2.3.4 Underwater noise

To assess the potential impacts of noise from the Project on threatened and migratory species, a separate study was undertaken – namely the Abbot Point Gateway Growth Project Underwater Noise Impact Assessment (SLR, 2015a). This assessment contains a detailed methodology of the study.

A literature review was undertaken and included research of the relationship between noise and marine fauna, potential noise impacts on marine fauna, relevant noise assessment criteria, noise emitted from dredging (including its spectral and temporal variations) and an assessment of the existing noise environment.

To assess the quantitative link between marine noise and impacts on marine fauna, noise exposure criteria were used. These criteria were developed by Southall *et al.* (2007) based on various sound types (e.g. pulse vs. non pulse) and a review of literature on marine mammal hearing and physiological and behavioural responses. The most relevant assessment parameters (i.e. sound exposure level (SEL) and sound pressure level (SPL)) were selected based on the assumption that marine noise associated with dredging and supporting vessels is likely to be low emissions and continuous in nature. Criteria are included in Table 2-7.

Table 2-7 Dredging Noise Impact Assessment Criteria

Permanent Hearing Threshold Shift (PTS) or Physical Injury	Temporary Hearing Threshold Shift (TTS)	Behavioural Response
SEL, dB re 1 µPa²·s (Within a 24-hour period)	**SEL, dB re 1 µPa²·s (Within a 24-hour period)**	**SPL, dB re 1 µPa RMS**
215	195	120

Underwater noise propagation modelling (which predicts the sound loss between a noise source and a receiver) was undertaken to predict existing received noise levels in the surrounding waters. The Range Dependent Acoustic Model (RAM) (Jensen *et al*., 2000), which is based on parabolic equations, was used to predict the transmission of the noise from dredging and vessel activities. The propagation modelling was undertaken along 36 tracks originating from the source location with an increment of 10 degrees and a maximum range of 30km, at the one-third octave bands from 16Hz to 4kHz. This model requires input of various environmental parameters including bathymetry, sound speed profile and seabed properties, which were investigated prior to modelling.

Predicted zones of impact define the environmental footprint of the noise generating activities and indicate the possible areas of noise impacts on marine fauna species, either behaviourally or physiologically. The predicted zones of impact from noise associated with dredging were determined by comparing the predicted received noise levels (based on noise propagation modelling) and the noise impact assessment criteria in Table 2-7.

Based on the information obtained through the literature review and the results of the noise propagation modelling, an assessment of the potential noise impacts from the Project on marine fauna was then undertaken.

2.3.5 Listed threatened and migratory marine species

2.3.5.1 Overview

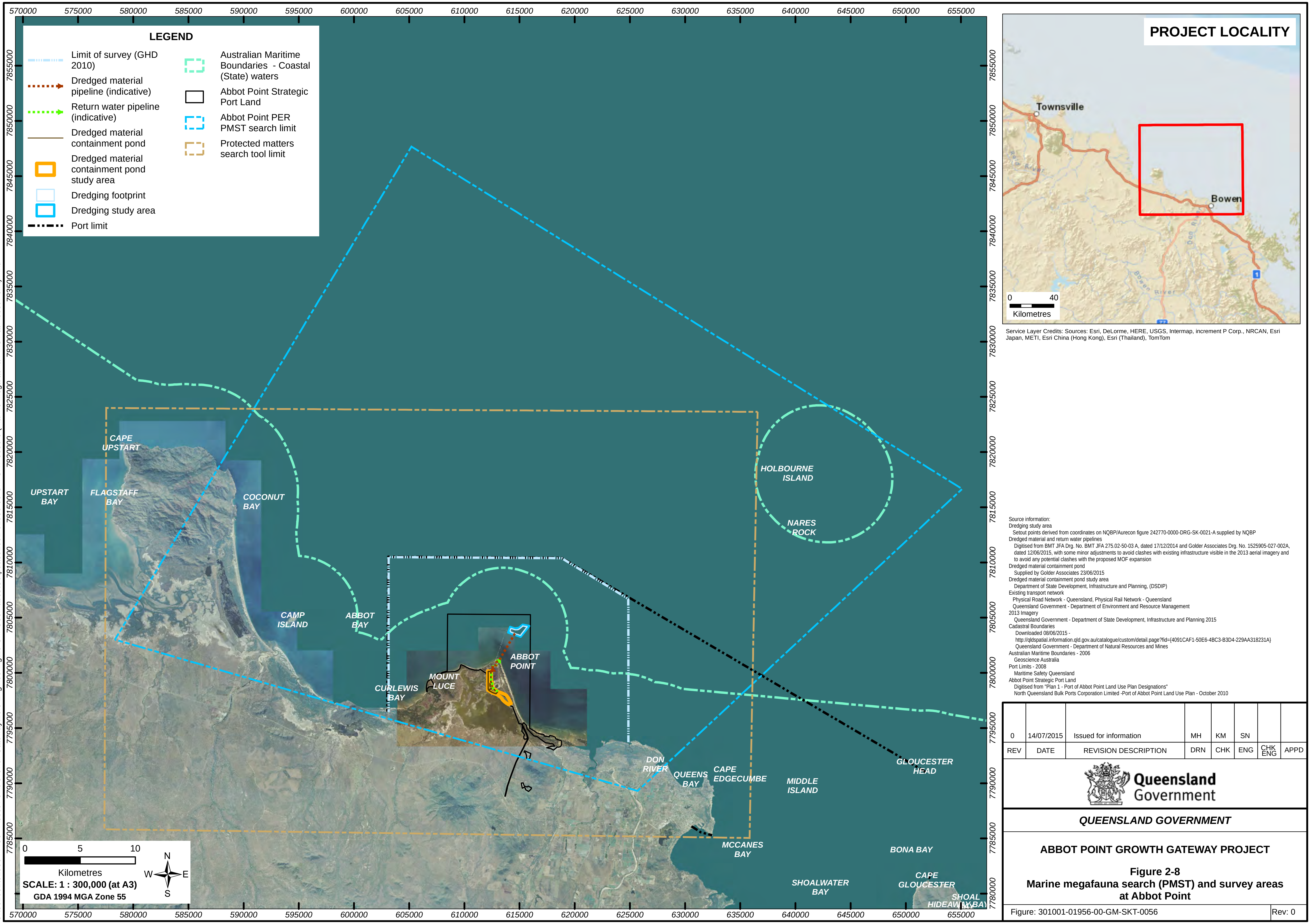
The marine species of conservation significance that would potentially be impacted by this Project were assessed using the following methodology:

- Identification of species listed as 'threatened' or 'migratory' under the EPBC Act within a specific area related to the project area through the DoE's 'Protected Matters Search Tool (PMST)' (Appendix 1 EPBC Act Protected Matters Report)
- Identification of species listed as 'threatened' or 'near threatened' under the *Queensland Nature Conservation Act 1992*
- A review of previous studies and published literature
- An assessment of the likelihood of occurrence of each of the EPBC Act listed threatened or migratory species using the definitions in Table 2-8
- A risk assessment approach to assess potential impacts associated with the Project
- Outlining the potential impacts for each species, or group of species relating to the Project
- Undertaking an impact assessment on each of the threatened or migratory listed species categorised as 'known (to occur)', 'likely to occur' or 'potentially occurring' using the significant impact criteria in the Significant Impact Guidelines 1.1 (DoE, 2013) (Table 2-9)
- Outlining mitigation and measurement measures for any potential impacts.

The coordinates for the PMST boundary were determined based on the project area, including the dredging footprint, proposed return water pipe location, predicted zone of high Impact, zone of moderate impact and zone of influence as determined by modelling of predicted dredging plumes (EPA, 2011). The EAG7 methodology is outlined in Section 2.3.3.The coordinates for the PMST boundary are presented in Table 2-8 and Figure 2-8.

Table 2-8 Protected Matters Search Tool boundary coordinates

Longitude	Latitude
-20.0266	148.2988
-20.0228	147.7398
-19.6779	147.7398
-19.6779	148.3029
-19.6779	148.3029
-20.0266	148.2988



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 - http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

REV	DATE	REVISION DESCRIPTION	DRN	CHK	ENG	CHK ENG	APPD
0	14/07/2015	Issued for information	MH	KM	SN		

Queensland Government

QUEENSLAND GOVERNMENT

ABBOT POINT GROWTH GATEWAY PROJECT

Figure 2-8
Marine megafauna search (PMST) and survey areas at Abbot Point

Figure: 301001-01956-00-GM-SKT-0056 | Rev: 0

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Compiled by BRISBANE GEOMATICS

The likelihood of occurrence of marine fauna of conservation significance (listed under the EPBC Act) in the vicinity of the project area was assessed for each identified species, based on the criteria described in Table 2-9. The assessment took into account:

- Results of field surveys undertaken within the vicinity of the Port of Abbot Point and existing data for the region more broadly
- The habitat requirements and known distribution of species and ecological communities
- Professional judgment of the authors.

An assessment of the likelihood of occurrence of potential impacts of dredging and onshore placement for each of the species identified in the PMST as 'known to occur', 'likely to occur' or 'potentially occurring' is presented in Sections 4 and 6.7.

Table 2-9 Likelihood of occurrence definition from DoE (2013)

Likelihood of Occurrence	Definition	Supporting Description
Known	The species has been observed on the site	Species has been recorded during recent field surveys in or in close proximity to the project area
Likely	A medium to high probability that a species occurs on the site	Species has been recorded from desktop search extent (although has not been detected during recent surveys of the project area) and suitable habitat is present in the project footprint
Potentially occurring	Suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur	Species has not been recorded from desktop search extent although species' distribution incorporates the project area and potentially suitable habitat occurs in the project area, or Species has been recorded from desktop search extent and suitable habitat is generally lacking from the project area.
Unlikely to occur	A very low to low probability that a species occurs on the site	Species has not been recorded from desktop search extent and suitable habitat is lacking from the project area and/or Current known distribution does not encompass the project footprint and suitable habitat is lacking from the project area and/or Records regarding the existence of the species at the

Likelihood of Occurrence	Definition	Supporting Description
		project area are historic or based on predictive modelling only and suitable habitat is lacking from the project area
Highly unlikely	Habitat on the site and in the vicinity is unsuitable for the species.	Species has not been recorded from desktop search extent and current known distribution does not encompass the project area and suitable habitat for the species does not occur in or adjacent the project area or Species distribution in the area is based on predictive modelling only and suitable habitat for the species does not occur in or adjacent the project area Species is considered locally or regionally extinct or well outside the species known range.

2.3.5.2 Assessment of impacts

The assessment of potential impact of the Project to MNES refers to the Australian Government guideline *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DoE, 2013). Significant impact criteria relevant to the assessment of potential impacts to listed threatened and migratory marine species are described in Table 2-10.

Table 2-10 Significant impact criteria for endangered, vulnerable and migratory species (DoE 2013)

Critically Endangered and Endangered Species
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will: • Lead to a long-term decrease in the size of a population • Reduce the area of occupancy of the species • Fragment an existing population into two or more populations • Adversely affect habitat critical to the survival of a species • Disrupt the breeding cycle of a population • Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent

that the species is likely to decline

- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

Vulnerable species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere substantially with the recovery of the species.

Migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- 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
- 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
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an

ecologically significant proportion of the population of a migratory species.

The guideline defines key concepts which are relevant to the impact assessment associated with EPBC Act listed threatened species and listed migratory species including:

- A population of a species
- An invasive species
- Habitat critical to the survival of a species or ecological community
- An important population of a species
- Important habitat for a migratory species
- An ecologically significant proportion
- A population of a migratory species.

The definition for each of these concepts per the guideline (DoE ,2013) is provided in Table 2-11.

Table 2-11 Significant impact guidelines, key concepts (DoE, 2013)

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to: • A geographically distinct regional population, or collection of local populations • A population, or collection of local populations, that occurs within a particular bioregion.
An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • For activities such as foraging, breeding, roosting, or dispersal • For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • To maintain genetic diversity and long-term evolutionary development

- For the reintroduction of populations or recovery of the species or ecological community.
- Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

An area of 'important habitat' for a migratory species is:

a) 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

b) Habitat that is of critical importance to the species at particular life-cycle stages, and/or

c) Habitat utilised by a migratory species which is at the limit of the species range, and/or

d) Habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

2.3.6 Great Barrier Reef Marine Park

The Significant Impact Guidelines (DoE, 2013) identify the criteria for determining the likelihood of a significant impact on the GBRMP. An action is likely to have a significant impact on the environment of the GBRMP if there is a real chance or possibility that the action will:

- Modify, destroy, fragment, isolate or disturb an important, substantial, sensitive or vulnerable area of habitat or ecosystem component such that an adverse impact on marine ecosystem health, functioning or integrity in the GBRMP results
- Have a substantial adverse effect on a population of a species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological health or integrity or social amenity or human health
- Result in a known or potential pest species being introduced or becoming established in the GBRMP
- Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, or social amenity or human health may be adversely affected
- Have a substantial adverse impact on heritage values of the GBRMP, including damage or destruction of an historic shipwreck.

Potential impacts on recognised GBRMP values within the project area are discussed in Section 6.8.

2.3.7 Commonwealth marine areas

The Significant Impact Guidelines (DoE, 2013) identify criteria for determining the likelihood of a significant impact on a Commonwealth marine area. An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:

- Result in a known or potential pest species becoming established in the Commonwealth marine area
- Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results
- Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health

- Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected
- Have a substantial adverse impact on heritage values of the Commonwealth marine areas, including damage or destruction of an historic shipwreck.

Potential Project related impacts on Commonwealth marine areas are discussed in Section 6.9.

3. EXISTING ENVIRONMENT

3.1 Extreme weather events

Significant weather events, such as tropical cyclones and flooding, have had a prominent effect on Abbot Point and the surrounding area in recent years. From an ecological perspective these events are particularly relevant to water quality and benthic habitats. Extreme weather events that have taken place since March 2009 are listed in Table 3-1. These events correlate with seagrass and water quality data discussed in Section 3.6 and Section 3.5 respectively.

Table 3-1 Extreme weather events at Abbot Point and Bowen – March 2009 to October 2014

Date	Event	Location
March 2009	TC Hamish (category 5)	125km off the coast at Bowen
February 2010	Flooding	Don River, approximately 7km south of Abbot Point
March 2010	TC Ului (category 3)	Airlie Beach, south of Bowen
December 2010	Wettest December on record for Queensland.	Widespread and significant flooding
January 2011	TC Anthony (category 2)	Crossed the coast at Bowen
January/February 2011	Severe TC Yasi (category 5)	Mission Beach, north of Bowen
March 2011	Highest rainfall on record at Bowen with extensive and prolonged flooding of Don River	Bowen and Don River
January 2013	TC Oswald (category 1)	Large parts of the Queensland coast
January 2014	TC Dylan (category 2)	Crossed the coats 35km east of Bowen (BOM, 2014)
April 2014	TC Ita (category 1)	Crossed near Bowen (110mm of rain recorded in Bowen in one hour) (BOM 2014)

TC = Tropical cyclone

3.1.1 Water Quality and extreme events

Water quality monitoring at seven offshore sites was undertaken between February 2013 and June 2014 (see Section 3.5 for details). During this deployment two cyclones impacted the Abbot Point area:

- TC Dylan was a category 2 cyclone when it crossed the coastline 35km to the east of Bowen on 31 January 2014; and
- TC Ita was a category 1 cyclone when it tracked along the coastline from Townsville to Bowen on 13 April 2014.

Discussion on the impacts to water quality in the region is in Section 3.5 -*Summary of Physicochemical Parameters*. Further analysis of the water quality data (in particular TSS) in comparison to the TSS produced during the dredging operations is discussed in RHDHV (2015) and in Section 6.2.1.

3.2 Sediment characterisation and ASS

The sediment properties of the Port of Abbot Point have been analysed since 2004 for capital and maintenance dredging projects relating to the port. The previous sediment studies, including the 2012 investigation in the dredging footprints for T0, T2 and T3 were summarised in the Abbot Point T0, T2 and T3 capital dredging project PER (GHD, 2012b). All sediment investigations undertaken prior to the Abbot Point Growth Gateway Project are summarised in Table 3-2. The sampling locations for studies undertaken between 2005 and 2009 are presented in Figure 3-1.

Table 3-2 Summary of previous investigations in the dredging footprints and surrounding area

Project	Chemical Results	Physical Results	Reference
Assessment of the Status of Marine Sediments at Abbot Point	Mean concentrations of metals and metalloids were lower than NOGDM screening levels and the Guidelines for the Assessment and Management of Contaminated Land in Queensland Environmental Investigation Levels (DoE, 1998)	Not provided	Ecowise Environmental (2004)
X50 Capital Dredging SAP Implementation	Mean heavy metals, metalloids and PAH concentrations were less than the NODGDM screening levels. Nutrients (total nitrogen and total phosphorus) were comparable with background concentrations. The 95% upper confidence limit (UCL) of normalised TBT in the proposed new berth area was initially greater than the NODGDM screening level (5µg Sn/g). Further testing subsequently decreased the 95% UCL to less than the screening level. Pore water and elutriate concentrations were less than the ANZECC Guidelines 95% species protection level (ANZECC, 2000). The sediments were assessed as suitable for unconfined ocean disposal in accordance with the NODGDM.	Mainly silty sands to 0.5m with underlying stiff clays	WBM (2005)
Sediment Quality Assessment Report for Capital and Maintenance Dredging	Results from surface sediment sampling and analysis for capital or maintenance dredging of berth 1 and 2 and apron and depositional areas adjacent to berth 2 indicated that the mean concentrations for heavy metals and metalloids were less than the NODGDM screening levels. The 95% UCL for normalised TBT at berth 1 and the adjacent depositional area was greater than the NODGDM screening level (5µg Sn/g). Elutriate testing for TBT demonstrated that relevant ANZECC (2000) water quality values could be achieved with additional dilution. Pore water TBT concentrations were less than the laboratory limit of reporting (LOR) making it unlikely that TBT is bioavailable. The sediments of berth 1 and the depositional and apron areas adjacent to berth 2 were assessed as suitable for unconfined ocean disposal in accordance with the NODGDM.	Not provided	WorleyParsons (2007)
Preliminary Sediment Quality Assessment for Proposed Multi Cargo Facility, Abbot Point	Results from the sampling and analysis of sediments within the proposed multi-cargo facility (MCF) footprint indicated that all contaminant concentrations in sediment samples were less than the contaminant investigation thresholds for offshore and onshore placement. Depending on the analyte being assessed and the guidelines available, sediments were analysed against the Guidelines for the Assessment and Management of Contaminated Land in Queensland Environmental Investigation Levels (DoE 1999) or Health Investigation Levels (HIL), (NEPC 1999). The ASS assessment indicated that PASS were present, but with the natural buffering capacity of the sediment, there were no neutralisation requirements if sediments were dredged and used for land reclamation purposes.	Particle size distribution of sediment consisted mainly of medium to coarse-grained sands and fine gravels	GHD (2009a) GHD (2010)
Port of Abbot Point X110 Apron and Berth Capital Dredging Sediment SAP Implementation	The sediment sampling and analysis results for the X110 apron and berth capital dredging Project, including the Abbot Point offshore relocation area, indicated that heavy metals and metalloids, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), benzene, ethylbenzene, toluene and xylenes (BTEX), organochlorine pesticides (OCPs), organophosphorous pesticides (OPP) were less than the NAGD screening levels. Although individual results for normalised TBT were greater than the NAGD screening levels, the 95% UCL was less than the NAGD screening level. The sediments were considered suitable for unconfined offshore ocean disposal.		GHD (2009c)

Sources: Ecowise Environmental (2004), WBM (2005), WorleyParsons (2007), GHD (2009a), GHD (2009c), GHD (2010), GHD (2012b).

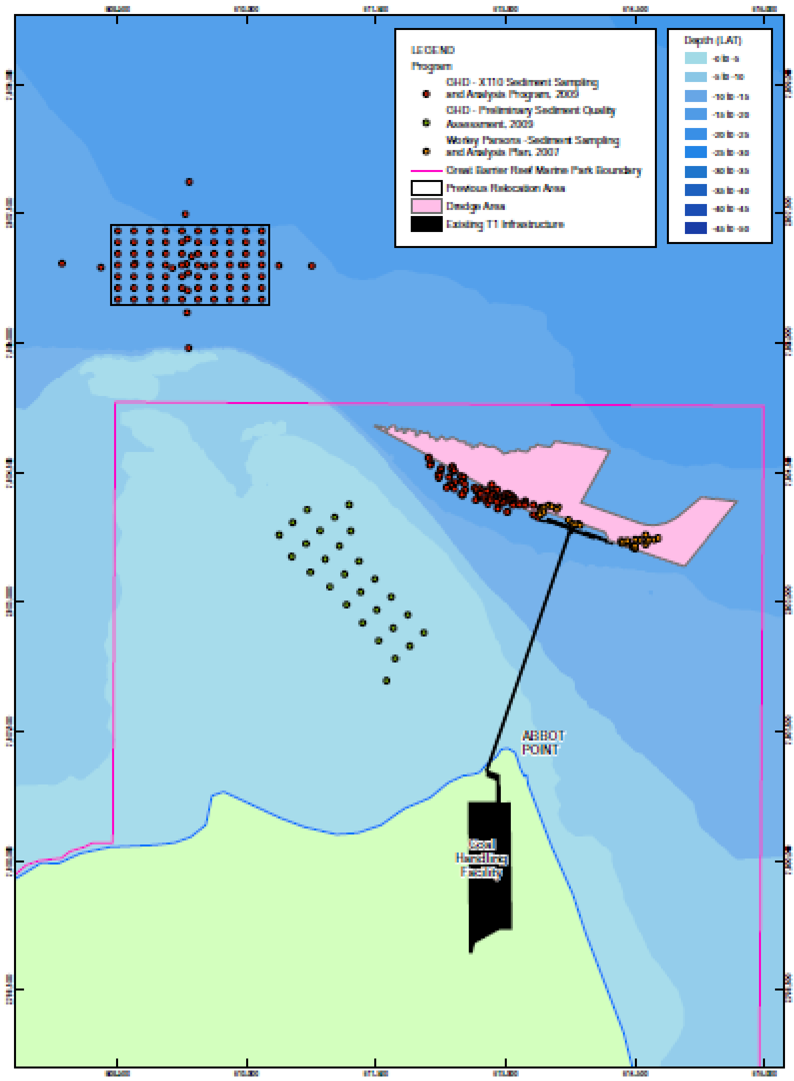


Figure 3-1 Sediment sampling locations at Abbot Point 2005 to 2009 (dredging area indicates T0, T2 and T3 approved dredging area). Source: GHD (2012a)

The sediment characterisation undertaken for the Abbot Point T0, T2 and T3 capital dredging project in 2012 considered the area of dredging proposed for the Abbot Point Growth Gateway Project (T0). The T2 and T3 dredging footprints, for which sediment characterisation was also undertaken, is not included within the footprint of the Abbot Point Growth Gateway Project (Figure 3-2).

Sediment characterisation (including ASS) of the dredging footprints was originally assessed and approved under NAGD (Commonwealth of Australia, 2009) and the material was assessed as suitable for offshore placement.

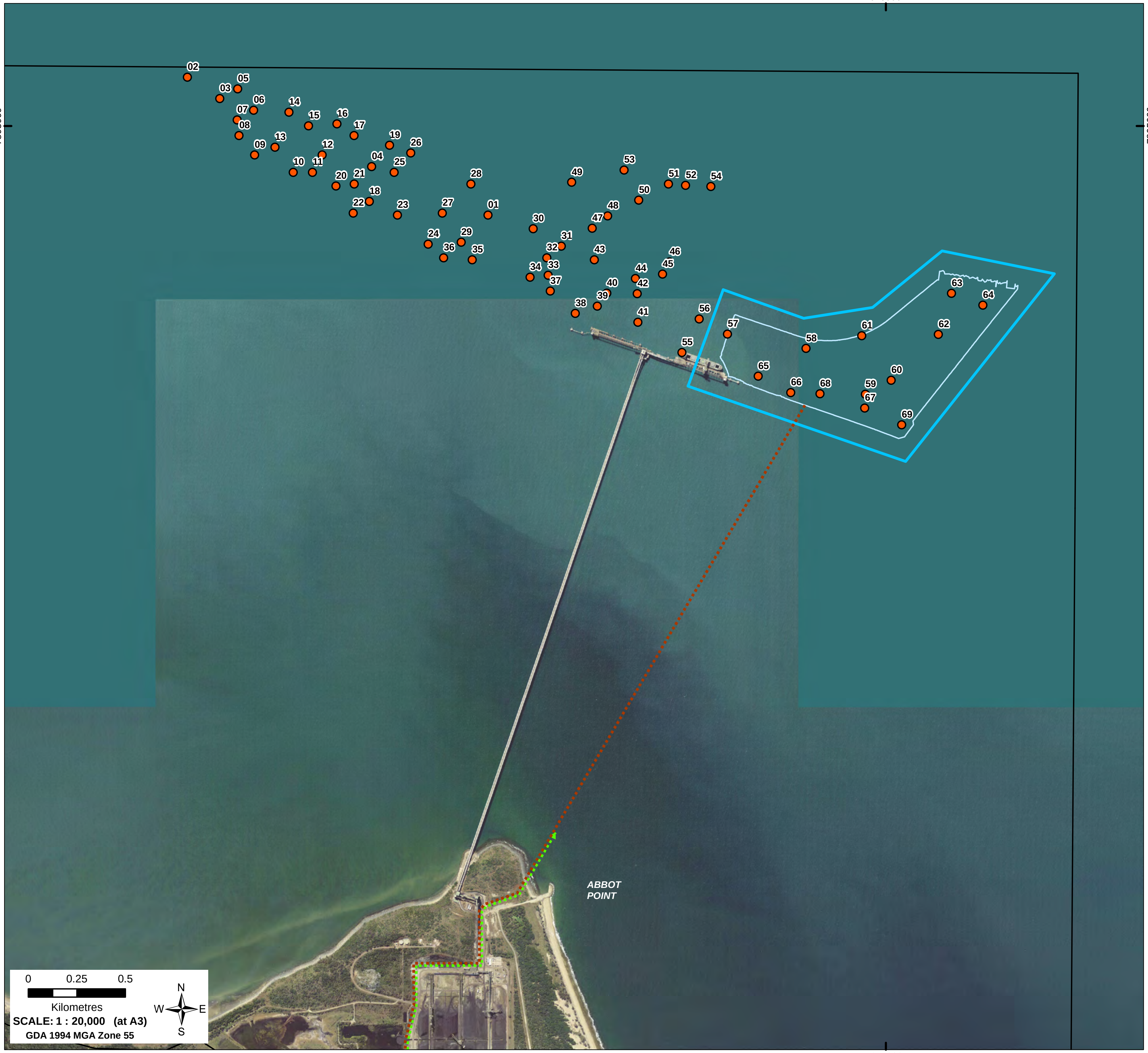
All TPHs, BTEX, pesticides (OCPs and OPPs), PCBs and total cyanide had concentrations less than the NAGD screening levels and the laboratory practical quantitation limits (PQL), indicating there are no anthropogenic sources of these contaminants within the dredging footprint.

All heavy metal and metalloid concentrations had 95% UCLs less than the NAGD screening levels and NEPM (1999) EILs and HIL A Guidelines (where applicable). Results indicated that there is negligible variability in heavy metal and metalloid concentrations within the dredging area, as different depth intervals contained similar concentrations.

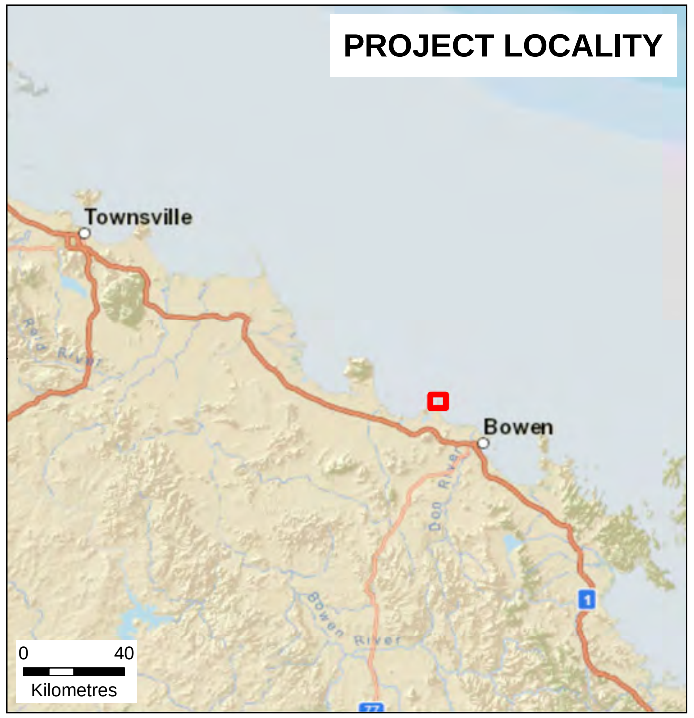
The 95% UCL tributyltin (TBT) was less than the NAGD screening level. TBT concentrations in two samples [normalised to 1% total organic carbon (TOC)] from the dredging area were greater than the NAGD screening level; however, these samples were in the T2 dredging area, which is not included in the proposed dredging.

ASS analysis on sediments within the dredging area showed that the potential acidity (SCr) exceeded the QASSIT (1998) action criterion in 92% of samples. However, total actual acidity (TAA) results were less than the PQL for all samples, and the acid neutralising capacity (by back titration) ranged between 0.3%S and 18.5%S. Therefore, although results were greater than the QASSIT (1998) action criteria (demonstrating that sulfur is present in the soil), the potential acid neutralising capacity of the soil exceeds the acid generating potential. Due to the excess neutralising capacity in all samples, there is no requirement for liming of the dredged material if it undergoes oxidisation. Oxidisation may occur if the dredged material is relocated onshore and used within reclamation activities. If the dredged material was to be oxidised, monitoring of ASS would be required and the implementation of management measures would potentially be required to minimise risks to the environment.

The sediments were found to be relatively homogenous in the 0 to 0.5m depth interval, with less sand recorded in the T0 dredging footprint than in the T2 and T3 footprints. As depth increases to the deepest intervals between 3 and 4.5m, clay and silt content increased and sand content decreased. Across the dredging footprint, sand (0.06-2mm) was the predominant sediment type (54%), with high percentages of silt (2μm) and clay (<2μm) recorded (19% and 20% respectively).



PROJECT LOCALITY



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

LEGEND

- Dredged material pipeline (indicative)
- Return water pipeline (indicative)
- Dredging footprint
- Dredging study area
- Marine sediment sampling locations
- Australian Maritime Boundaries - Coastal (State) waters
- Abbot Point Strategic Port Land

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 -
http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 3-2
Sediment sampling locations in T0, T2 and T3 approved dredge footprint. Source GHD (2012a)

Figure: 301001-01956-00-GM-SKT-0051 | Rev: 0

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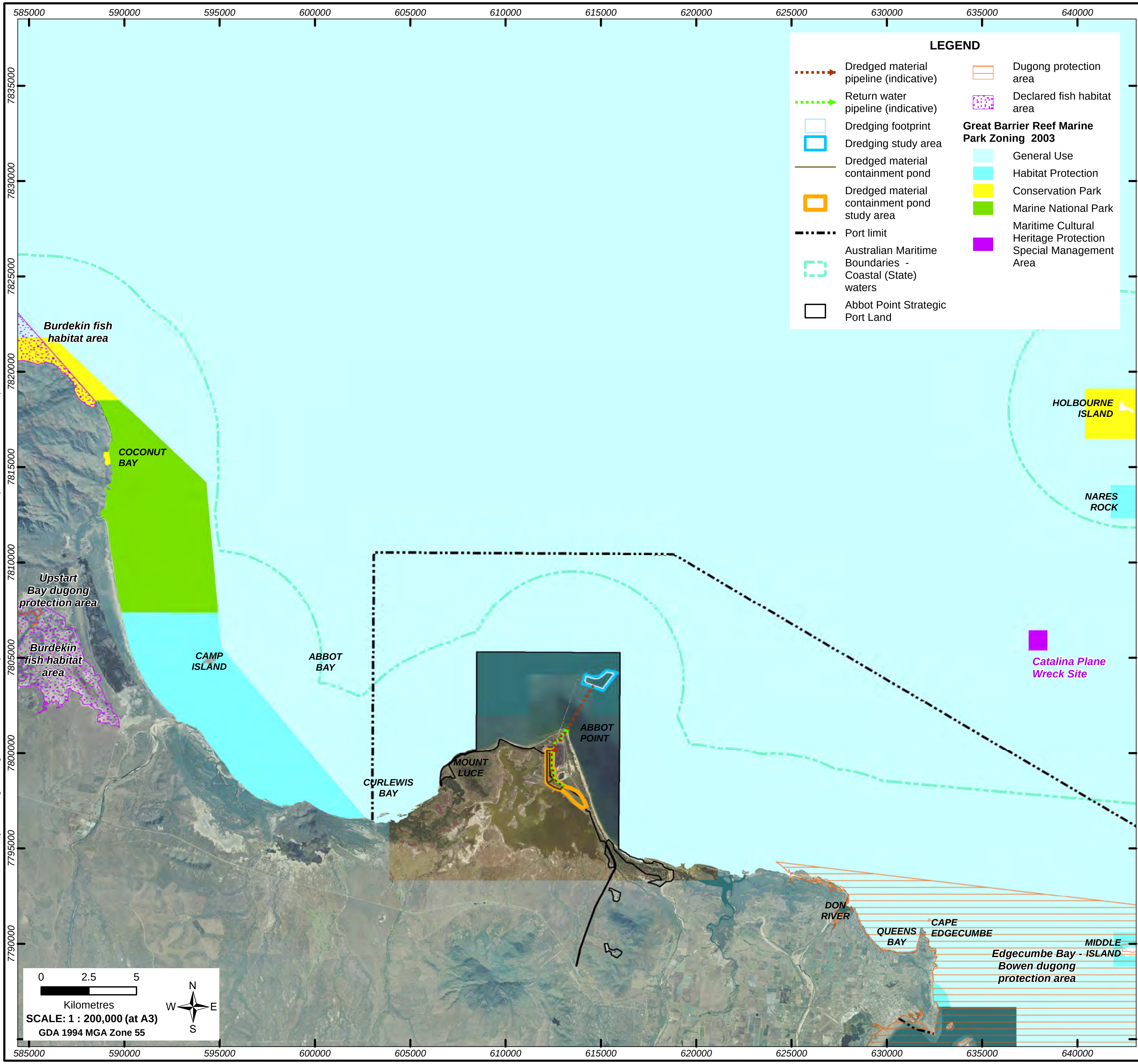
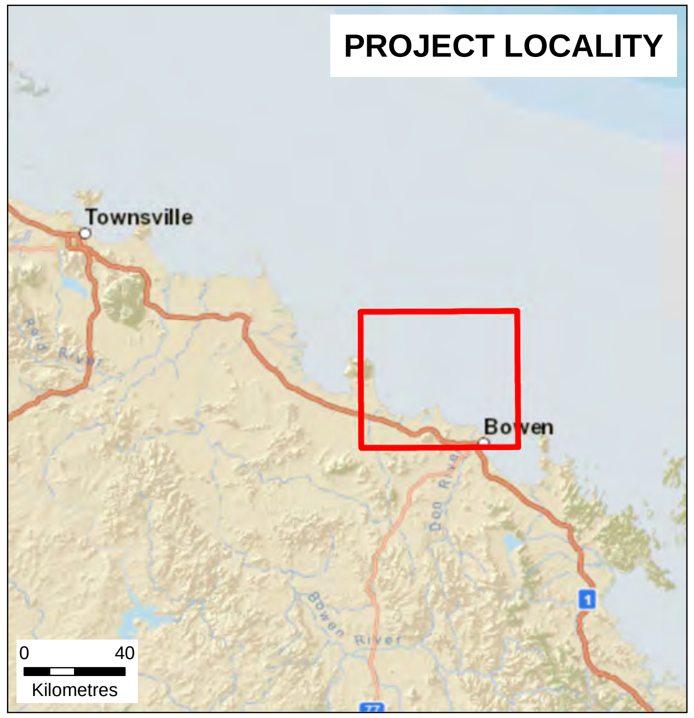
Compiled by BRISBANE GEOMATICS

3.3 Protected areas

The offshore Project activities are proposed to be undertaken within the GBRWHA. The majority of the marine environment at Abbot Point is characterised by open seabed habitat with highly variable water depths including shoals and channels. This habitat supports small patches of benthic macroinvertebrate communities and low diversity seagrass beds and rocky reefs (see Section 3.6). No reef complexes of high biodiversity have been identified within the port limits. The proposed Action will only take place within port limits. To the east and west of the port limits, habitats of conservation and biodiversity significance are recognised to include (refer to Figure 3-3):

- GBRWHA, GBRMP and the Great Barrier Reef Coast Marine Park
- Commonwealth marine areas
- Dugong Protected Areas (DPA)
- Fish Habitat Areas (FHA)
- Cape Upstart Marine National Park Zone
- Holbourne Island Conservation Park Zone
- Nares Rock and Camp Island Habitat Protection Zones
- Catalina Plane Wreck – Maritime Cultural Heritage Protection Area.





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 - http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010
Fish Habitat Areas
Queensland Government - Department of Agriculture, Fisheries and Forestry
Dugong Protection Areas - 2002
Queensland Government - Department of Primary Industries and Fisheries
Great Barrier Reef Marine Park Zoning 2003
Commonwealth of Australia - Great Barrier Reef Marine Park Authority 2012
Maritime Cultural Heritage Protection Special Management Area in the Bowen Region
Location plotted from coordinates on figure:http://www.gbrmpa.gov.au/__data/assets/image/0005/230981/130921a_BowenCatalina_A24-24SMA_MediaMap.jpg
http://www.gbrmpa.gov.au/zoning-permits-and-plans/special-management-areas/protecting-our-maritime-cultural-heritage

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0	14/07/2015	Issued for information	KM	SN			

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 3-3
Marine Protected Areas in the vicinity of Abbot Point

Figure: 301001-01956-00-GM-SKT-0048 | Rev: 0

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3.3.1 Great Barrier Reef Marine Park

The GBRMP encompasses approximately 345,400km^2 and is a multiple-use area in which a wide range of activities and uses are allowed, including extractive industries. A multiple-use zoning system has been implemented with the aim of minimising impacts and conflicts through providing high levels of protection for specific areas. Zoning designations provide for management and protection of the values of the GBRMP. In designated zones of the GBRMP activities including shipping, aquaculture, tourism and research (among others) are allowed to occur in a controlled manner. The General Use Zone provides for reasonable use of the GBRMP while still allowing for conservation of these areas. Information on each zone presented forthwith are sourced online at http://www.gbrmpa.gov.au/visit-the-reef/zoning/zoning-guide-to-using-the-marine-park/interpreting-zones

As outlined in the Significant Impact Guidelines 1.1 (DoE 2013), an action will require approval under the EPBC Act if:

a) The action is taken in the GBRMP and the action has, will have, or is likely to have a significant impact on the environment, or

b) The action is taken outside the GBRMP and the action has, will have, or is likely to have a significant impact on the environment in the GBRMP.

An action is likely to have a significant impact on the environment of the GBRMP if there is a real chance or possibility that the action will:

a) Modify, destroy, fragment, isolate or disturb an important, substantial, sensitive or vulnerable area of habitat or ecosystem component such that an adverse impact on marine ecosystem health, functioning or integrity in the GBRMP results

b) Have a substantial adverse effect on a population of a species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution

c) Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological health or integrity or social amenity or human health

d) Result in a known or potential pest species being introduced or becoming established in the GBRMP

e) Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, or social amenity or human health may be adversely affected, or

f) Have a substantial adverse impact on heritage values of the GBRMP, including damage or destruction of an historic shipwreck.

The Project has been assessed against the significance criteria outlined above and the results are outlined in Section 6.8.

The Outlook Report 2014

In terms of the current environmental health of the GBRMP, The Outlook Report 2014 (GBRMPA, 2014) assessed the current condition of the all ecosystems within the region (including mangroves, seagrass, coral reefs and open ocean), all aspects of the region's heritage values (including world heritage, outstanding universal and cultural values and historic places) and their links with other environmental, social and economic values. The Outlook Report 2014 also examined pressures facing the GBR, current responses to these pressures and the likely future outlook for the region's values.

Assessments of ecosystem health and biodiversity in the Outlook Report 2014 indicate that the GBR as a whole retains the values and qualities contributing to its Outstanding Universal Value as recognised in its listing as a world heritage property. The northern third of the GBR region has good water quality and its ecosystems are believed to be in good condition. However, key habitats, species and ecosystem processes in the central and southern inshore area of the GBR continue to deteriorate, particularly inshore seagrass meadows and coral reefs. The greatest risks to the GBR have not changed since the Outlook Report 2009. Climate change, poor water quality from land-based run-off, coastal development and some impacts of fishing were identified as the major threats to the future vitality and resilience of the GBR in the Outlook Report 2014.

The Outlook Report 2014 summarises that the impacts of port operations to the marine environment include: clearing and modifying coastal habitats; disturbance, displacement, dredging, offshore placement and re-suspension of dredged material; injury and death of wildlife; chemical and oil spills; some contribution to marine debris; altered light regimes; diminished aesthetic values; and air and noise pollution.

The Outlook Report 2014 also highlights that the specific impacts of dredging and port infrastructure construction are well documented and most severe at the dredging site, but that some impacts (such as turbidity, sedimentation, noise and disruption of fish habitats) may occur at a distance from dredging and offshore placement of dredged material. Localised impacts of dredging, such as seabed disturbance, transport or re-suspension of contaminants, alteration of sediment movement and changes in coastal processes can, however, be severe. Burial or smothering of plants and animals on the seafloor, degradation of water quality and loss and modification of habitats are highlighted as the major direct impacts of dredging and offshore placement of dredged material.

These specific impacts of dredging highlighted in The Outlook Report are discussed in detail in Section 6.

The Dredge Synthesis Report

In response to increasing interest from government, industry and the wider community in port development and specifically dredging within and adjacent to the GBR region an independent panel have authored the *Synthesis of current knowledge of the biophysical impacts of dredging and disposal on the Great Barrier Reef (2015)*. This review was commissioned by the Australian Institute of Marine Science and the GBRMPA to assess the available information relating to the effects of dredging activities in the GBR region. As such, this report provides an independent synthesis of the current knowledge of the effects of dredging and offshore placement of dredged material on the physico-chemical environment and the biological values of GBRWHA (World Heritage Area), as assessed by the panel.

The report was largely completed in late 2014; however, changes to the report were made to take into account changes in the publicly available forecasts of dredged volumes and offshore placement locations given Federal and Queensland Government commitments to ban the offshore placement of capital dredged material in the GBR region. In November 2014, the Federal Minister for the Environment committed to a ban on the placement of capital dredged material in the GBRMP (which forms 99% of the GBRWHA). In February 2015, the new Queensland Government committed to legislate to restrict capital dredging to existing port facilities (within the regulated port limits of Gladstone, Hay Point/Mackay, Abbot Point and Townsville), and to prohibit the sea-based placement of capital dredged material. The revised Synthesis Report accounts for this change in Government policy.

The panel summarise the potential impacts of dredging as:

- Seabed removal by excavation during dredging: Dredging is generally carried out in soft-sediment habitats, sometimes supporting seagrass, and do not involve the excavation of coral reefs. The area directly affected is generally only a small proportion of the relevant habitat, though the effect is severe within the footprint and could be significant regionally; however, overall the ecological significance of direct removal to the GBR is considered small.
- Changes to bathymetry and hydrodynamics: Changes localised and sufficiently predictable via modelling.
- Increased artificial lighting and underwater noise: Dredging may have significant impacts on marine species, though it is difficult to distinguish to what extent.
- Release of fine sediments: Dredging plumes can be significant increasing turbidity, sedimentation and reducing light availability to marine organisms. Extent and duration of plumes may have been underestimated in previous assessments.
- Potential contributions to chronic suspended sediment: Sediments dispersed from dredging plumes may be resuspended and transported to contribute to a long-term chronic increase in fine suspended sediment concentrations in the inshore GBR. The extent to which this occurs compared to background levels and impacts on marine life

was not agreed on by the panel. Dredging may provide a significant contribution to inshore fine sediments compared to river inputs, though this is reduced by onshore placement of dredged material.

These specific impacts of dredging and the returning waters as highlighted in the Dredge Synthesis Report are discussed in detail in Section 6.

3.3.2 Commonwealth marine areas

The Commonwealth marine area is any part of the sea, including the waters, seabed and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State waters. It is generally defined as the area extending from 3 to 200 nautical miles from the mainland coastline.

Within Queensland, the Commonwealth marine area overlaps with the boundaries of the GBRMP and the GBRWHA (refer to Figure 3-3). For this Project and at Abbot Point the values of the GBRMP are equivalent to those of the Commonwealth marine area. For specific detail on the extent of the Commonwealth marine areas in relation to the GBRMP boundaries please refer to the following website:
http://www.environment.gov.au/topics/marine/marine-reserves

An action will require approval if:

a) The action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or

b) The action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area.

An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:

a) Result in a known or potential pest species becoming established in the Commonwealth marine area

b) Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results

c) Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution

d) Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health

e) Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or

f) Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

The Project has been assessed against the significance criteria outlined above and the results are outlined in Section 6.9.

3.3.3 Dugong and fish protection areas

Abbot Point is located between two DPAs: 'Dugong Sanctuary A' at Upstart Bay (44km north-west of Abbot Point) and 'Dugong Sanctuary B' at Edgecumbe Bay (35km south-east of Abbot Point). The embayments in Upstart Bay and in Edgecombe Bay adjacent to the DPAs are designated as FHAs (refer to Figure 3-3).

3.3.4 Conservation and habitat protection zones

Holbourne Island is the most northerly National Park island in the Whitsundays and is located 31km from the T0 dredging area (refer Figure 3-3). The park's diverse vegetation ranges from grassland and stunted shrubs on the hillsides to vine thickets on the foreshores. A small forest of Pisonia trees occurs near the shore, which is unusual because this forest type usually occurs on coral cays, not continental islands. Holbourne Island National Park is a major nesting site for Green and Flatback Turtles and is an important breeding habitat for several bird species. The Holbourne Conservation Park (Yellow) Zone that surrounds the Island allows for increased protection and conservation of areas of the Marine Park, while providing opportunities for reasonable use and enjoyment including limited extractive use. Most extractive activities are allowed in a Conservation Park (Yellow) Zone with additional restrictions for most fishing activities.

The marine waters surrounding Nares Rock and Camp Island are classified as Habitat Protection Zones (refer to Figure 3-3). The Habitat Protection (Dark Blue) Zone provides for the conservation of areas of the GBRMP by protecting and managing sensitive habitats and ensuring they are generally free from potentially damaging activities. Trawling is not permitted in the Habitat Protection (Dark Blue) Zone. Nares Rock is located 30km east of the T0 dredging area. Camp Island is located 20km to the west of the T0 dredging area. The Habitat Protection (Dark Blue) Zone continues to provide for reasonable use of areas and makes up about 28% of the GBRMP.

A Marine National Park Zone is located on the eastern side of Cape Upstart 27km from the T0 dredging area (refer to Figure 3-3. The Marine National Park (Green) Zone is a 'no-take' area and extractive activities like fishing or collecting are not allowed without a permit. Anyone can enter a Marine National Park (Green) Zone and participate in activities such as boating, swimming, snorkelling and sailing. Travelling through a Marine National Park (Green) Zone with fish on board is also allowed (it is only an offence to fish in a Marine National Park (Green) Zone). Fishing gear, such as rods with attached hooks, must be stowed inboard the boat or in rod holders. All fishing apparatus must be out of the water.

Anchoring is also allowed in a Marine National Park (Green) Zone; however, in high use and sensitive areas, use of a mooring may be necessary or there may be a no anchoring area defined by buoys. Commercial fishing dories must be attached to a mother vessel at all times whilst in a Marine National Park (Green) Zone. The Marine National Park (Green) Zone makes up about 33% of the GBRMP.

3.3.5 Catalina plane wreck

In April 2015 the Australian Government announced that the RAAF World War II Catalina aircraft wreck located in the GBRMP off Bowen will be protected under new management measures (see location of wreck in Figure 3-3). Special management areas – or buffer zones – will be placed around the Catalina wreck. Under these new measures, fishing and anchoring will not be allowed within a 1km^2 area that encompasses the crash site and diving will be restricted.

The new management area is designed to protect maritime cultural heritage in the Marine Park. The Catalina is an example of the iconic Catalina or 'Black Cats' which were active in the western Pacific during World War II for long range bombing, reconnaissance and rescuing allied personnel. The decision to provide greater protection for the Catalina wreck was prompted by direct requests from the relatives of the servicemen who died. Divers will be able to access the two sites under a GBRMPA permit, for example, to clean away entangled anchors or fishing equipment, or to conduct monitoring or research.

Since this announcement the new management areas surrounding the Catalina Plane wreck have been enacted. Specific details on the location of the Maritime Cultural Heritage Protection Special Management Area in the Bowen Region can be found at http://www.gbrmpa.gov.au/zoning-permits-and-plans/special-management-areas/protecting-our-maritime-cultural-heritage

The Catalina plane wreck is located 24km to the east of the T0 dredging area.

3.4 Key environmental values

The key environmental values of the marine environment of the project area include:

- Diversity of inshore marine habitats including seagrass, soft bottom habitats, beaches and estuarine areas
- Presence of marine species, many of which are threatened and/or migratory
- Presence of higher order predators, e.g. sharks and dolphins indicating functioning food webs.

3.5 Marine water quality

3.5.1 Water quality monitoring programs 2009 -2012

As outlined in the Abbot Point PER (GHD, 2012), the marine water quality at Abbot Point is influenced by coastal (currents and waves) and fluvial processes (discharges from coastal rivers and creeks), as well as weather conditions. These processes contribute to significant temporal, and particularly seasonal, variations in water quality. A high degree of seasonality in rainfall in the Abbot Point region influences fluctuations in turbidity, TSS and salinity, whereby increased runoff and freshwater inputs result in increased suspended solids in the water column and reduced salinity. Observed peaks in turbidity tended to coincide with months when heavy rainfall was recorded, although occasionally peaks in turbidity coincided with high wind speeds and the localised re-suspension of sediments.

Nutrient parameters also showed seasonal variability as a result of seasonal variation in fluvial inputs. Higher records of total nitrogen and phosphorus were reported during the dry season, which, similar to turbidity, are often linked to periods of strong winds and localised re-suspension of nutrients. The degree of spatial variation in water quality conditions at Abbot Point was considerably less than the temporal variation. This suggests that the coastal waters of Abbot Point are well mixed under non-flood conditions, which is consistent with other coastal waters of the GBR.

A number of parameters were outside relevant water quality guidelines, which consistently included TSS, nutrients and DO and, at a lesser frequency, chlorophyll a and pH during the wet season. These results indicate that the waters of Abbot Point exhibit elevated levels of these parameters, particularly during the wet season when high rainfall and runoff increase inputs of nutrients and terrigenous sediments, with implications for biological processes. This indicates that site-specific guidelines would be more applicable for the Abbot Point area in order to incorporate seasonality, coastal processes and fluvial influences specific to the area.

3.5.2 Water quality monitoring program February 2013 - June 2014

The results of the most recent baseline water quality monitoring program are presented in full in WorleyParsons' (2014) *Abbot Point Baseline Water Quality Monitoring Report*. A summary of the results are presented in the following sections.

3.5.2.1 PERMANENT DATALOGGERS

At seven sites *in-situ* permanent telemetry dataloggers were installed on the seabed in February 2013 and removed in July 2014. Each logger was configured to measured temperature (^{0}C), electrical conductivity (EC) (mS/cm), salinity (ppt), DO (%sat and mg/L), pH, turbidity (NTU) and PAR (µE/cm^2/sec). Three sediment traps were attached to the outer frame to measure gross sedimentation between service events.

The analysis of results described in this section is focused on identification of differences in temperature, conductivity, salinity, pH, turbidity and daily PAR between sites. Changes in all parameters are also examined in a seasonal context, i.e. wet season (being November to April) versus dry season (being May to October).

Results derived from the dataloggers are presented as box plots of the data (Figure 3-4 to Figure 3-11) which examine trends across sites and between seasons.

For each parameter, the data is presented as box plots which highlight the median (central line in the bar), 80th percentile and 20th percentile range. The whiskers represent the non-outlier range.

Two graphs are presented for each parameter:

1. All data for all sites for each parameter ordered from the shallowest site (WQ5) on the left to the deepest site (WQ4) on the right
2. All data at each site grouped for the wet season (light grey bars on the left) and dry season (dark grey bars on the right).

The summary statistics for each parameter at each site for the entire data collection period are presented in Table 3-3. Where applicable, reference lines are added to the plots indicating the upper and lower limit guidelines from the QWQG (DERM, 2009 - Table 3.2.1.b).

For the seasonal plots, the light grey bars represent the wet season data and the dark grey bars represent the dry season. The whiskers represent the non-outlier range.

3.5.2.2 Sea Temperatures

The overall median sea temperature was 26.34^{0}C, ranging from a median of 27.40^{0}C in the wet season to 22.68^{0}C in the dry season (Table 3-3). The median sea temperature varied considerably with depth and ranged between 27.08^{0}C at WQ1 to 25.46^{0}C at WQ6 (Table 3-3 and Figure 3-4). There was considerable temperature variation between seasons; the wet season characterised by median temperatures between 27^{0}C and 28 ^{0}C at all sites compared to the dry season where temperatures ranged between 22^{0}C and 23^{0}C (Table 3-3 and Figure 3-4). The maximum temperature of 30.00^{0}C was recorded during the wet season at WQ5 (the shallowest site) and the lowest temperature of 20.41^{0}C recorded at WQ7 (second shallowest site) during the dry season (Table 3-3).

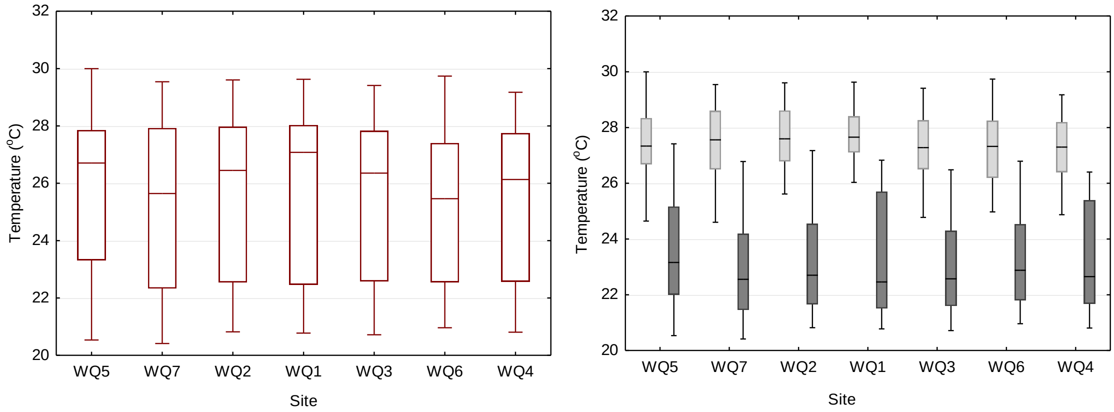


Figure 3-4 Median sea temperatures (⁰C) at each site (left graph) and per season (right graph)

3.5.2.3 ELECTRICAL CONDUCTIVITY (MS/CM)

All EC data is standardised to 25⁰C as per Hayashi (2004). This removes the influence of temperature on the data and allows comparisons with the conductivity of the sea water at a given time. There is a strong correlation between EC and salinity.

Median EC across all sites was 52.68mS/cm and varies within a small range between 52.29mS/cm at WQ7 to 53.28mS/cm at WQ1 (Table 3-3 and Figure 3-5). The EC is generally highest in the wet season at all sites except WQ7 and WQ6 which showed the reverse pattern (Table 3-3 and Figure 3-5). The highest EC of 55.32mS/cm was recorded at WQ1 in the wet season, the lowest was 50.25mS/cm at WQ7 (Table 3-3 and Figure 3-5).

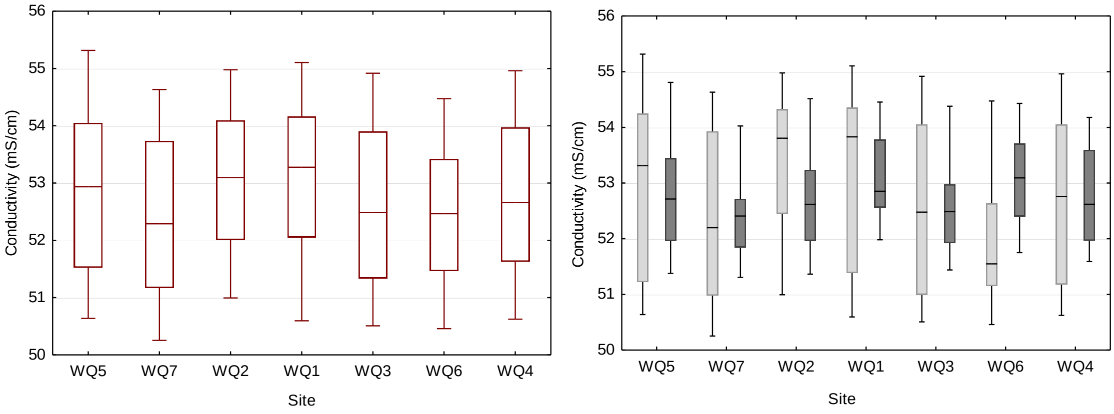


Figure 3-5 Median conductivity (mS/cm) at each site (left graph) and at each site per season (right graph)

3.5.2.4 SALINITY (PPT)

Median salinity across all sites was 34.75ppt, ranging from 34.72ppt in the dry season to 34.96ppt in the wet (Table 3-3). The lowest salinity of 32.85ppt was recorded at WQ7 during the wet season and the highest was 36.53ppt at WQ5 also during the wet season (Table 3-3 and Figure 3-6). Salinity was highly variable in the wet season months; there was no consistent pattern in the intensity of salinity between seasons (Figure 3-6).

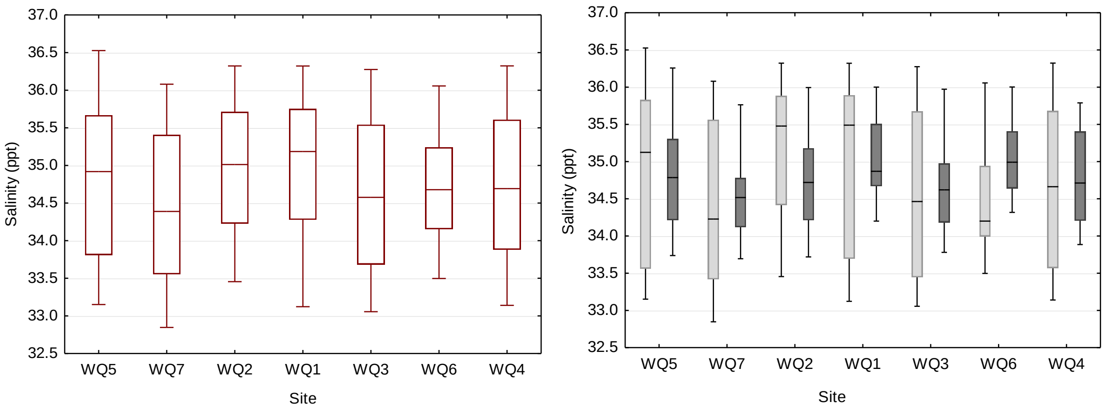


Figure 3-6 Median salinity (ppt) at each site (left graph) and at each site per season (right graph)

3.5.2.5 DISSOLVED OXYGEN (%SAT)

Median DO (%sat) across all sites was 91.73%, ranging from 88.82% in the wet season to 96.51% in the dry season (Table 3-3). The lowest DO (%sat) was 75.00% recorded at a number of sites during both seasons and the highest of 119.40% was recorded at WQ7 during the dry season (Table 3-3 and Figure 3-7). The DO (%sat) was generally lower in the wet season compared to the dry season at all sites except WQ5 (Figure 3-7). The median DO (%sat) was outside the lower and upper guideline limits for open coastal environments at most sites except at WQ7 and WQ1(Figure 3-7).

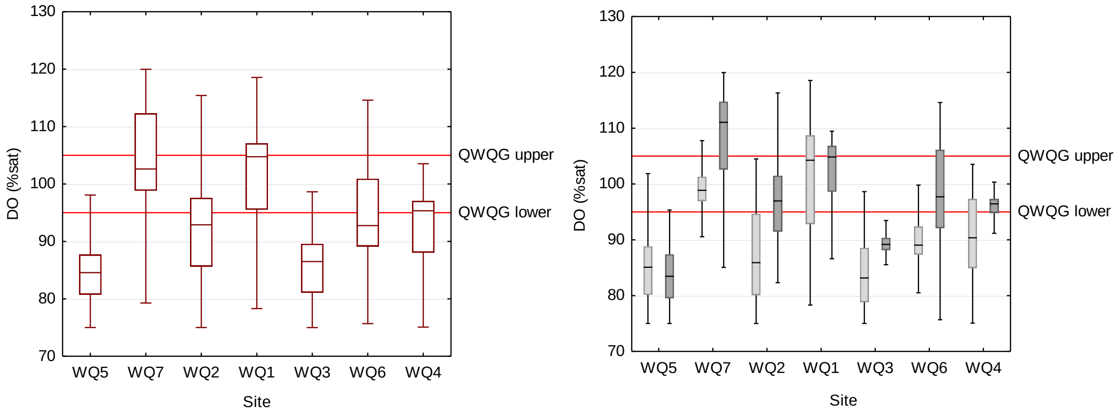
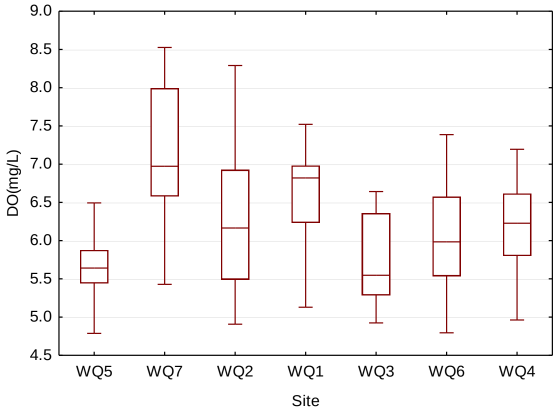


Figure 3-7 Median DO (%sat) at each site (left graph) and at each site per season (right graph) (upper and lower QWQG referenced)

3.5.2.6 Dissolved Oxygen (mg/L)

The values of DO (mg/L) are very closely related to the DO (%sat) measurements and follow the same patterns as this parameter. Median DO (mg/L) across all sites was 6.15mg/L ranging from 5.69mg/L in the wet season to 6.63mg/L in the dry season (Table 3-3). The lowest DO (mg/L) was 4.66mg/L recorded at WQ5 during the wet season and the highest of 8.53mg/L recorded at WQ7 during the dry season (Table 3-3 and Figure 3-8). The DO (mg/L) was generally lower in the wet season compared to the dry season at all sites except WQ1 (Figure 3-8).



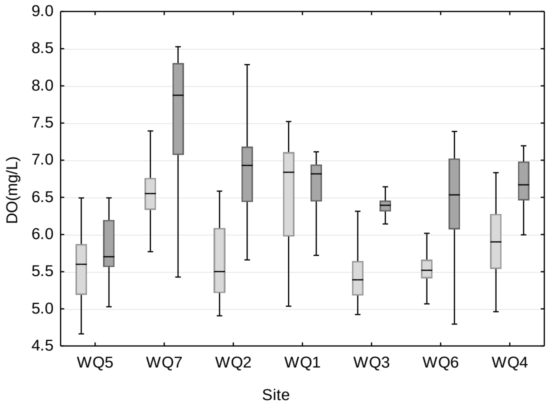


Figure 3-8 Median DO (mg/L) at each site (left graph) and at each site per season (right graph)

3.5.2.7 pH

Median pH across all sites was 8.20, ranging from 8.15 in the wet season to 8.23 in the dry season (Table 3-3). The lowest pH of 7.03 was recorded at WQ7 during the dry season and the highest pH of 8.94 was recorded at WQ1 also during the dry season (Table 3-3 and Figure 3-9). The pH was generally lower in the wet season compared to the dry season at most sites except WQ7, WQ3 and WQ4 (Figure 3-9). The overall median pH at each site was within the lower and upper guideline limits for open coastal environments at all sites except WQ7. Variations in pH between the two seasons meant the median pH values at some sites were outside the upper or lower guideline boundaries (Figure 3-9). The pH at WQ7 was consistently below the lower guideline value of 8.10.

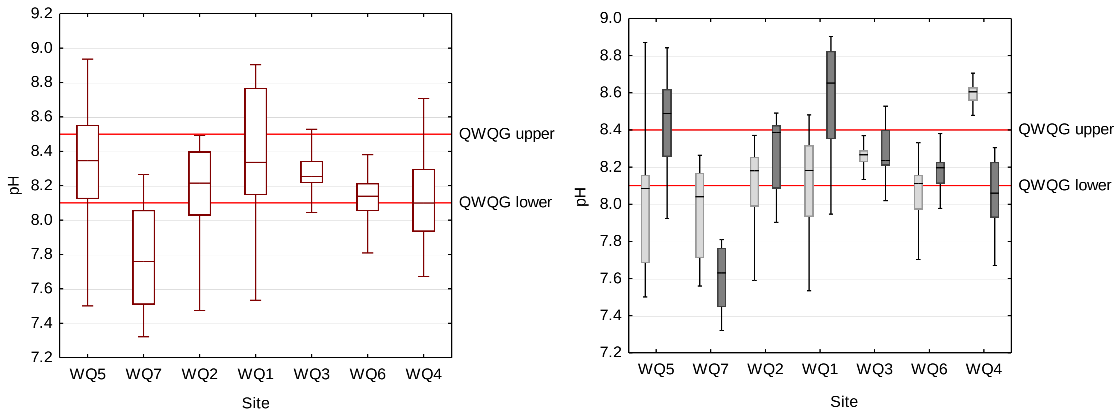


Figure 3-9 Median pH at each site (left graph) and at each site per season (right graph) (upper and lower QWQG referenced)

3.5.2.8 Turbidity

Median turbidity (NTU) across all sites was 2.27 (3.3mg/L using conversion factor see Section 2.3.3.11), ranging from 2.07 (3mg/L) in the dry season to 2.47(3.6mg/L) in the wet season (Table 3-3). The lowest turbidity of 0.00 was recorded at all sites during both seasons; the highest turbidity of 654.00 was recorded at WQ6 during the wet season (Table 3-3 and Figure 3-10). The turbidity was generally higher in the wet season compared to the dry season at all sites except WQ1 (Figure 3-10). The overall median turbidity was above the QWQG (open coastal) guideline value of 1NTU at all sites during all seasons (Figure 3-10).

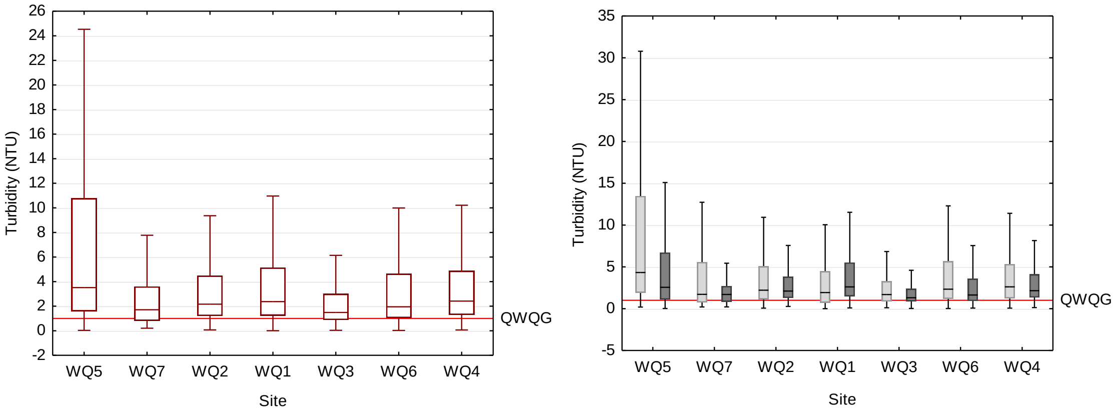


Figure 3-10 Median turbidity (NTU) at each site (left graph) and at each site per season (right graph) (QWQG referenced)

3.5.2.9 DAILY PAR (MOL/M^2/DAY)

Median daily PAR across all sites was 0.39mol/m^2/day, ranging from 0.38mol/m^2/day in the dry season to 0.40mol/m^2/day in the wet season (Table 3-3). The lowest daily PAR of 0.00mol/m^2/day was recorded at all sites during both seasons; the highest daily PAR of 9.67mol/m^2/day was recorded at WQ7 during the wet season (Table 3-3 and Figure 3-11). The daily PAR was generally higher in the wet season compared to the dry season at most sites except WQ3 (Figure 3-11). Daily PAR was generally higher in the shallow waters compared to the deeper waters, the exception is the shallowest site (WQ5) which generally has low light all year around (Figure 3-11).

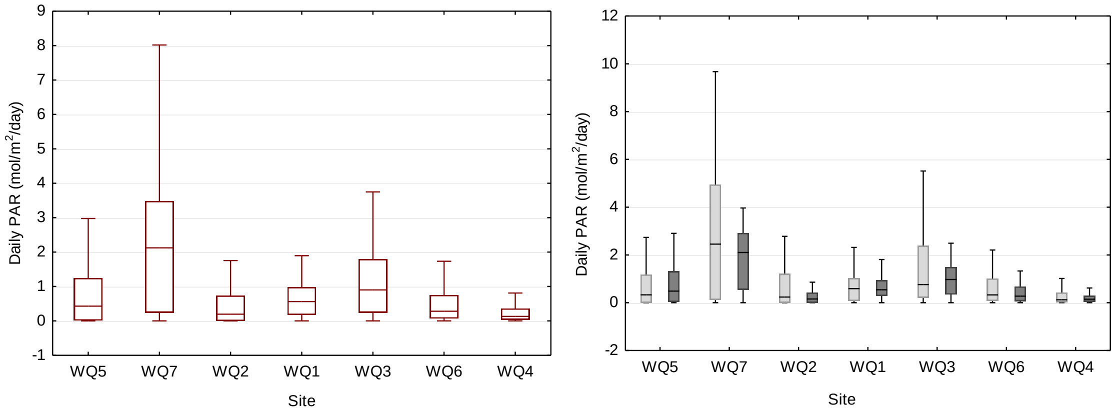


Figure 3-11 Median daily PAR (mol/m²/day) at each site (left graph) and at each site per season (right graph)

3.5.3 Summary of Physicochemical Parameters

The main driver of water quality in marine waters surrounding Abbot Point during the 16 months of sampling was the passage of the two cyclones, TC 'Dylan' on 31 January 2014 and TC 'Ita' on 13 April 2014. The elevated wave height and winds and the associated flooding rains that each cyclone caused brought about the largest changes in all measured parameters during a period either side of the events. During cyclone 'Dylan' the impacts on turbidity and daily benthic light availability were the most profound. The intensity of the impacts was generally related to the depth, with shallower sites having the largest overall changes in temperature, salinity, pH, turbidity and benthic light compared to the deeper sites. The total loss of benthic light due to elevated suspended solids in the water column from cyclonic influences often extended for over 10 days.

The downward changes in sea temperatures, salinity and pH which were triggered by the cyclones persisted for several weeks before returning to pre-cyclone values.

Periodic increases in wind and waves due to the passage of storms also influenced all measured parameters. The shallower sites were again highly influenced by the increases in suspended sediments in the water column due to these events.

A summary of the impacts to water quality of dredging compared to the impacts on water quality during cyclonic events is discussed in detail in RHDHV (2015) and Section 6.2.7.

Wet seasons compared to dry seasons were characterised by higher sea temperatures, lower pH and DO and higher suspended solid concentrations (measured as turbidity). Sites located closest to freshwater inputs from local creeks and rivers exhibited the largest changes in salinities in the wet season. These sites also experienced the lowest pH values and largest ranges of DO concentrations.

Daily benthic light availability (measured as PAR) was higher in the wet season compared to the dry season; the increases in turbidity during the wet season that work to reduce PAR on the seabed are offset by the longer days and more intense sunlight available to benthic organisms in this season. Daily PAR was generally higher in the shallow waters compared to the deeper waters; the exception is the shallowest site (WQ5) which generally has low light all year around. This could be related to the elevated turbidity this site experiences throughout the entire year which serves to lower the benthic light regime perhaps on a daily tidal cycle. In addition, the gross sedimentation measured using sediment traps was the highest at this site. Similar relationships between sedimentation rates, elevated turbidity and low light environments are evident at WQ1 and WQ4.

Season	Parameter	Unit	Count	Mean	Median	Min	Max	Percentile - 20th	Percentile - 80th	Standard Deviation	Standard Error
COMBINED	Wind Speed (offshore)	km/h	11545	24.38	24.26	0.27	73.54	15.50	33.04	9.82	0.09
	Tide Elevation	m LAT	68927	1.83	1.80	-0.03	4.15	1.19	2.47	0.69	0.00
	Significant Wave Height	m	22160	0.56	0.53	0.06	3.81	0.29	0.80	0.28	0.00
	Rainfall	mm/day	1187	2.13	0.00	0.00	267.40	0.00	0.00	10.58	0.31
	River Discharge	ML/day	33052	735.80	6.79	0.00	208184.74	0.00	124.01	6482.72	35.66
	Temperature	°C	61415	25.59	26.34	20.41	30.00	22.60	27.83	2.52	0.01
	Electrical Conductivity	mS/cm	60958	52.74	52.68	50.25	55.32	51.59	53.96	1.16	0.00
	Salinity	ppt	62141	34.75	34.75	32.85	36.53	33.99	35.60	0.83	0.00
	Dissolved Oxygen	% sat	46281	92.93	91.73	75.00	119.97	84.79	100.48	9.29	0.04
	Dissolved Oxygen	mg/L	46131	6.19	6.15	4.66	8.53	5.51	6.86	0.73	0.00
	pH	pH units	42482	8.16	8.20	7.03	8.94	7.96	8.38	0.30	0.00
	Turbidity	NTU	73584	6.10	2.27	0.00	654.00	1.13	6.24	14.33	0.05
	PAR	µE/m2/s	59027	9.32	0.00	0.00	415.91	0.00	9.17	25.82	0.11
	PAR	µE/m2/day	2167	0.80	0.39	0.00	9.67	0.05	1.30	1.11	0.02
WET	Wind Speed (offshore)	km/h	6481	25.06	25.29	0.27	73.54	16.03	33.23	10.02	0.12
	Tide Elevation	m LAT	38544	1.86	1.84	-0.02	4.15	1.22	2.51	0.69	0.00
	Significant Wave Height	m	12038	0.59	0.58	0.06	3.81	0.32	0.82	0.29	0.00
	Rainfall	mm/day	658	3.48	0.00	0.00	267.40	0.00	1.20	13.90	0.54
	River Discharge	ML/day	19568	1217.42	9.28	0.00	208184.74	0.18	197.21	8391.26	59.99
	Temperature	°C	34644	27.47	27.40	24.60	30.00	26.66	28.36	1.04	0.01
	Electrical Conductivity	mS/cm	34582	52.75	52.93	50.25	55.32	51.16	54.14	1.40	0.01
	Salinity	ppt	34954	34.74	34.96	32.85	36.53	33.59	35.74	1.00	0.01
	pH	% sat	18762	8.11	8.15	7.03	8.94	7.95	8.28	0.24	0.00
	Dissolved Oxygen	mg/L	26289	90.07	88.82	75.01	119.97	83.08	97.22	8.36	0.05
	Dissolved Oxygen	pH units	26186	5.83	5.69	4.66	8.24	5.37	6.28	0.56	0.00
	Turbidity	NTU	41277	6.90	2.47	0.00	654.00	1.14	6.83	15.28	0.08
	PAR	µE/m2/s	31376	10.43	0.00	0.00	415.91	0.00	9.63	29.58	0.17
	PAR	µE/m2/day	1031	0.93	0.40	0.00	9.67	0.03	1.48	1.36	0.04
DRY	Wind Speed (offshore)	km/h	5064	23.51	22.74	0.33	47.72	14.81	32.70	9.50	0.13
	Tide Elevation	m LAT	30383	1.79	1.76	-0.03	3.64	1.16	2.42	0.68	0.00
	Significant Wave Height	m	10122	0.52	0.47	0.06	1.52	0.26	0.77	0.27	0.00
	Rainfall	mm/day	529	0.45	0.00	0.00	26.40	0.00	0.00	2.38	0.10
	River Discharge	ML/day	13484	36.86	3.80	0.00	304.23	0.00	57.91	66.27	0.57
	Temperature	°C	26771	23.16	22.68	20.41	27.42	21.66	24.67	1.62	0.01
	Electrical Conductivity	mS/cm	26376	52.73	52.64	51.31	54.81	51.98	53.44	0.75	0.00
	Salinity	ppt	27187	34.78	34.72	33.69	36.26	34.22	35.29	0.54	0.00
	Dissolved Oxygen	% sat	19992	96.68	96.51	75.00	119.97	89.06	105.41	9.11	0.06
	Dissolved Oxygen	mg/L	19945	6.67	6.63	4.79	8.53	6.19	7.05	0.66	0.00
	pH	pH units	23720	8.20	8.23	7.32	8.90	7.99	8.44	0.34	0.00
	Turbidity	NTU	32307	5.08	2.07	0.03	258.53	1.12	5.44	12.95	0.07
	PAR	µE/m2/s	27651	8.05	0.00	0.00	280.96	0.00	8.66	20.67	0.12
	PAR	µE/m2/day	1136	0.69	0.38	0.00	3.97	0.07	1.21	0.81	0.02

Table 3-3 Basic statistics (combined data and seasonal data) for all parameters during the data logger deployment period

3.5.3.1 DEPTH PROFILING

The depth profiling program was aimed at identifying differences in physico-chemical conditions through the water column and to allow for comparison with data collected by the permanent dataloggers. For example, physico-chemical conditions may differ near the surface compared to mid-water or near the seabed, due to the mixing and wave action toward the surface or near shore currents at the seabed.

The water temperatures, DO and pH at the sea surface were generally higher than mid-water and at the seabed. The water was generally more turbid closer to the seabed. Salinity varied little between the different depths measured.

3.5.3.2 WATER SURFACE TESTING

The water surface testing program was designed to test for temporal and spatial differences in the water chemistry across a range of monitoring sites.

The program was specifically designed to test for a range of analytes which were known to exist in local sources which may also be found in the adjoining marine environment. Examples of potential inputs are herbicides, pesticides, pathogens, nutrients and chlorophyll a from the Don River and the Caley Valley Wetland overflow along with elevated nutrients, pH and Chlorophyll a from the Good Fortune Bay Aquaculture Farm. Port operations may also act as an input for elevated dissolved metals (copper and zinc) sulfur, PAH's and TPH's in the marine environment.

The pH values ranged from 7.8 pH units to 8.3 pH units, with the median pH value being 8.2 pH units across all sites. Across seasons pH was generally higher during the wet season compared to the dry season but always within guideline values during both seasons.

TSS was generally higher and more variable during the wet season compared to the dry season and on or just above guideline values. Sampling trips always occurred during good weather, and as such values of TSS are skewed to the lower end.

Biochemical Oxygen Demand (BOD) was not present in concentrations above the LOR (2mg/L) for all samples with the exception of one sample. There are no available water quality guidelines for BOD comparisons.

3.5.3.3 TOTAL AMMONIA, NITROGEN, PHOSPHOROUS

Total Ammonia was generally higher and more variable during the wet season compared to the dry season. Combined data for both seasons were on or slightly below the guideline values. Total Nitrogen was generally higher during the wet season compared to the dry season; Total Nitrogen was most variable during the dry season and below the guideline values. Total Phosphorus was generally higher and more variable in the dry season compared to the wet season and generally well below the guideline values.

3.5.3.4 DISSOLVED AND TOTAL POTASSIUM, SULFUR AND CHLOROPHYLL A

Dissolved and Total Potassium concentrations were higher in the wet season compared to the dry season. Sulfur concentrations were higher in the wet season compared to the dry season. Sulfur concentrations were similar across sites and followed a similar temporal trend. Chlorophyll a concentrations were higher and more variable in the wet season compared to the dry season; median concentrations during both seasons were above the GBRPMA Guidelines. Chlorophyll a concentrations were similar across all sites.

3.5.3.5 DISSOLVED AND TOTAL METALS

Most dissolved concentrations of metals were similar between seasons with the exception of Aluminium which had much higher (two to four times) concentrations in the dry season compared to the wet season.

For all samples, the concentrations of dissolved Cadmium, Chromium, Lead, Mercury, Nickel, Cobalt and Zinc were all below the detection limits (LOR) or below the applicable Guidelines where guidelines were available. Concentrations of dissolved Copper were above Guidelines on occasion at specific sites.

Dissolved Copper and dissolved Zinc were detected at low concentrations during previous water quality monitoring in the Caley Valley Wetland (GHD, 2012). The existing port operations were also flagged as a potential source of elevated dissolved Copper and Zinc concentrations. The elevations of dissolved Copper measured offshore during the baseline program were not limited to areas adjacent to the wetland or port facilities (e.g. WQ5), rather they are spread throughout the region including at offshore sites (WQ8) situated >25km from the wetland outlet and >15km from the Port. The ANZECC 95% species protection guideline value for dissolved Zinc was not exceeded during the baseline surveys.

For all samples, the concentrations of Total Cadmium, Lead, Mercury, Nickel, Cobalt and Zinc were all below the detection limits (LOR) or below the applicable guidelines where guidelines were available. The concentrations of three metals, Chromium and Copper were above guidelines on occasion at specific sites. Mean Total Chromium concentrations were above the ANZECC 95% species protection value at WQ5 on one occasion.

As with the dissolved metal analysis, the highest concentrations of Copper which exceeded the ANZECC Guideline value for 95% species protection were observed at a number of sites spread through the area.

3.5.3.6 HYDROCARBONS, PESTICIDES AND HERBICIDES

PAHs, TPHs and BTEX were not present in concentrations higher than the LOR for all samples. Therefore, there were no samples that had hydrocarbon concentrations that exceeded applicable water quality guidelines.

OCs, OPs and Multiresidual Pesticides were not present in concentrations higher than the LOR for the majority of samples. No samples had pesticide or herbicide concentrations that exceeded applicable water quality guidelines. Prometryn was detected in a sample collected from monitoring site WQ11 during the August 2013 trip while Diuron was detected in samples collected from monitoring sites WQ11 and WQ12 during the February field trip.

3.5.3.7 Pathogens

There were no seasonal variations in the concentrations of *E. coli* or faecal coliforms. The highest concentration of faecal coliforms was measured at the site closest to the Euri Creek/Don River mouth during April 2014. Concentrations of Enterococci were elevated at a number of sites on occasion. The site closest to the Don River/Euri Creek recorded the highest concentrations in February 2014. There was very little variation in Enterococci between seasons.

3.6 Marine habitat

3.6.1 Seagrass

Seagrasses grow on sandy or muddy substrates in water depths where enough light can penetrate the water column to allow the plants to photosynthesise. Depending on water quality and clarity this can be a minimum of 2m up to a maximum of 47m (Kirkman, 1997). Seagrasses are an important nursery habitat for some commercial fish and crustacean species and play an important role in stabilising sediments with their rhizome and root systems (Kirkman, 1997). In tropical areas seagrasses are the primary food source for dugongs and an important food source for Green Turtles.

Seagrass mapping has been undertaken at Abbot Point since 1987 (Rasheed *et al.,* 2005, McKenna *et al*., 2008, Unsworth *et al*., 2010, McKenna and Rasheed, 2014). A composite map of seagrass distribution between 1987 and 2013 has been produced to ascertain where seagrass is present or has been present historically (considered to be potential seagrass habitat) (Figure 3-12). In 2008, a detailed study was undertaken to map more than 20,000ha of deepwater and coastal seagrass communities within the Port of Abbot Point during the wet season and the dry season. These baseline studies were used to establish long-term monitoring sites and inform future development options that would have minimal impact on seagrass communities (McKenna and Rasheed, 2011). Following severe weather events in 2010 to 2013 (Section 3.1) seagrasses within the broader port limits were remapped (McKenna and Rasheed, 2014).

Long-term monitoring sites have been monitored quarterly between 2008 and 2014, providing important temporal and spatial site specific information on seagrasses at Abbot Point. Current monitoring locations are presented in Figure 3-12. Additional mapping of seagrass communities within the proposed dredging footprint and immediate surrounds was undertaken on 11 December 2014. The results of these surveys and all other surveys of the T0 footprint since 2008 are represented in Figure 3-13, and discussed in the following section.

Images of the typical seagrass communities observed during the September 2013 surveys within the dredging footprint and seagrass communities in nearshore areas are displayed as insets on Figure 3-12. In the dredging footprint (top three images) the images represent the dominant open substrate, sparse seagrass meadow (1% cover), light seagrass meadow (1-5%). The more prolific nearshore shallow water seagrass meadow is represented by the image at the bottom of the figure.

Of the 14 species of seagrass found in Queensland, seven species have been consistently identified within the port limits during surveys being:

- *Cymodocea serrulata*
- *Cymodocea rotundata*
- *Halodule uninervis*
- *Zostera capricorni*
- *Halophila decipiens*
- *Halophila ovalis*
- *Halophila spinulosa.*

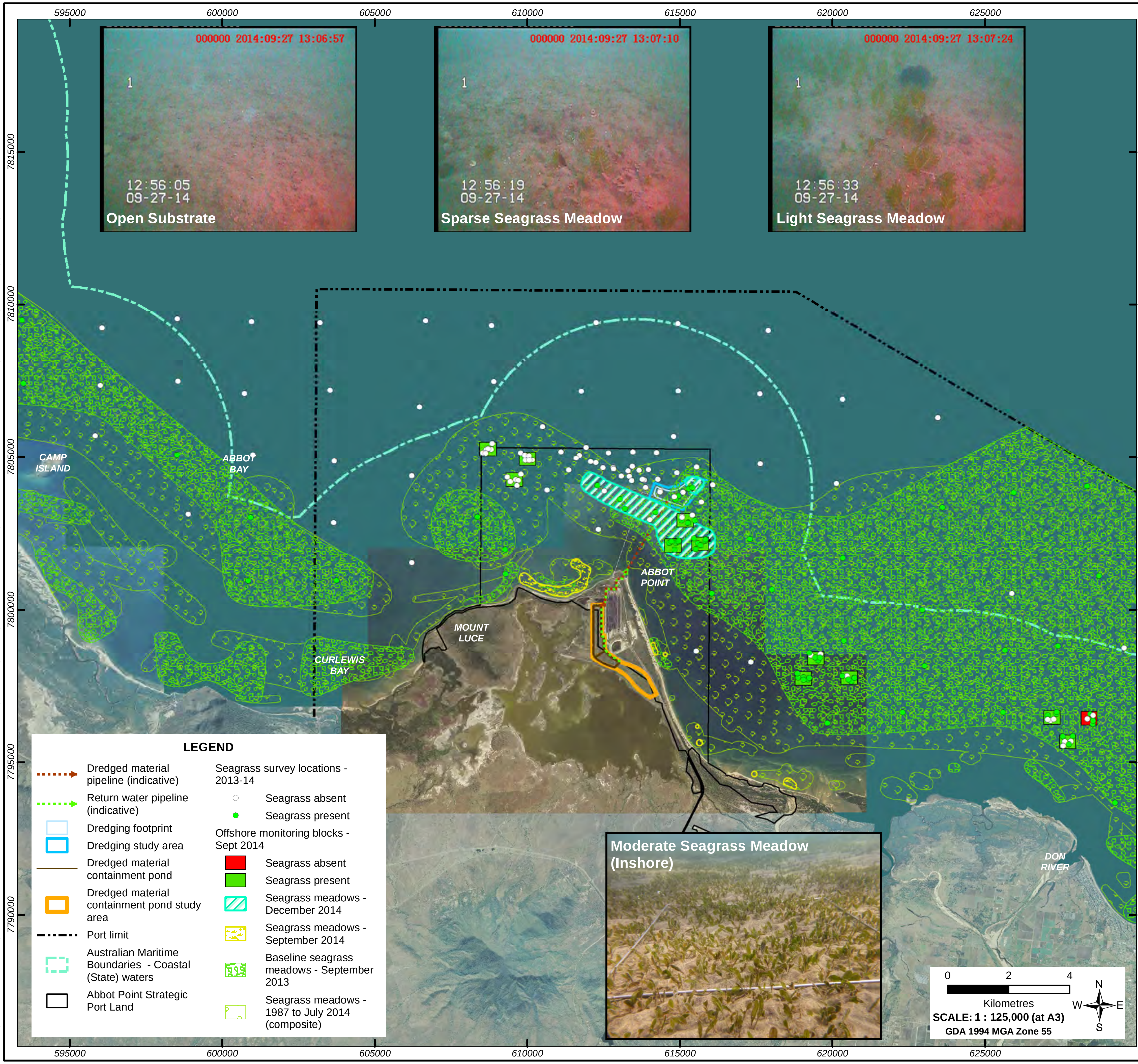
These occur as meadows containing mixed species which are transient and patchy in distribution. *H. spinulosa* dominates deepwater areas and *H. uninervis* dominates inshore areas. These species are colonising species and are typically well represented outside the port limits. The seagrasses at Abbot Point are considered to be highly dynamic, based on long-term monitoring and influenced by extreme weather events and the seasons (McKenna and Rasheed, 2011). During their 2008 to 2011 monitoring, MacKenna and Rasheed (2011) reported that seagrass is minimal at the end of the wet season and at its highest density and distribution during the end of spring/beginning of summer.

Major declines in seagrass density and biomass at Abbot Point and other long-term monitoring locations in Queensland have occurred since November 2010, attributed to extreme weather events. The total extent of all seagrass meadows in the broader Abbot Point area declined by 60% between the 2008 and 2013 wet season surveys. However, by the 2013 dry season survey, the total meadow area had increased again to be similar to the 2008 dry season (McKenna and Rasheed, 2014).

The broader scale baseline surveys in 2013 have found meadows of the key inshore species *H. uninervis* and *Zostera muellerinear* that could provide a means of recovery for Abbot Point meadows through dispersal of seeds and other propagules.

Coastal meadows have demonstrated strong differences between meadow types and species in their capacity to recover following disturbance events. Long-term monitoring indicated coastal areas dominated by *H. uninervis*, which uses asexual reproduction and has high light requirements, are more susceptible to longer term impacts than deepwater meadows dominated by *H. spinulosa*, which uses a combination of asexual and sexual reproduction (McKenna and Rasheed, 2011). However, remapping of the broader area in 2013 found meadows of *H. uninervis* and *Z. muellerinear* near to Abbot Point that could provide a means of recovery for Abbot Point meadows through dispersal of seeds and other propagules, should there be any impacts at Abbot Point. Deepwater seagrass meadows showed some recovery following the extreme weather events in 2011, but then declined following TC Oswald in 2013 (McKenna and Rasheed, 2014).

In December 2014, seagrass was found in the north-eastern section of the apron dredging area, and in a larger area on the inside of the current wharves, encompassing offshore monitoring site 2 (Figure 3-12 and Figure Figure 3-13). Seagrass in the apron footprint consisted of a light cover of *H. decipiens*, while seagrass in the surrounding areas consisted of a light cover of *H. decipiens, H. ovalis and H. spinulosa*. The deep water seagrass showed physical signs of senescing, which can be typical for this time of year. Conducting the survey this late in the year may have missed the seasonal peak in seagrass abundance and distribution at Abbot Point which occurs between September and late November/early December. Coastal seagrass around Abbot Point continued its 2014 trend of recovery. In December 201, no seagrass was found in the proposed berth pocket (and batter slope) dredging area.



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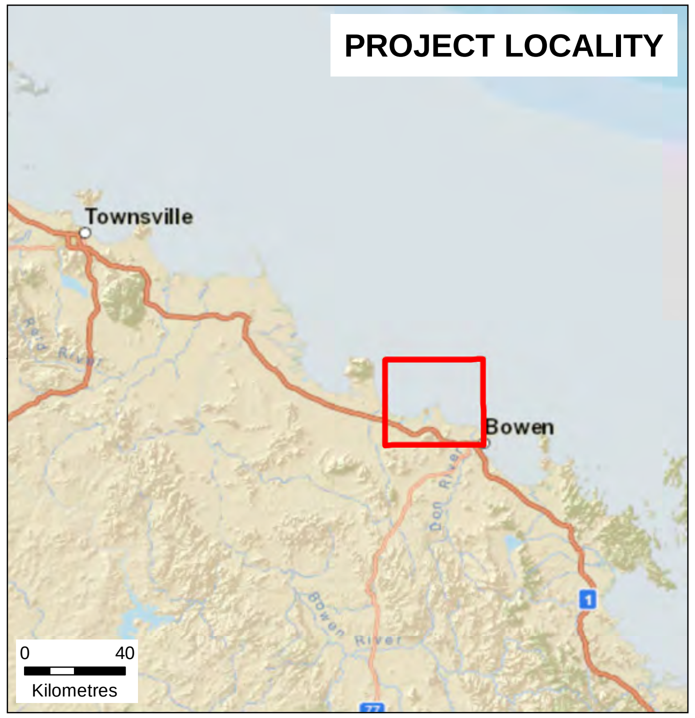

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Seagrass monitoring and survey data
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Figure 3-12
Seagrass monitoring locations and distribution
2013 - 2014

Figure: 301001-01956-00-GM-SKT-0053 | Rev: 0

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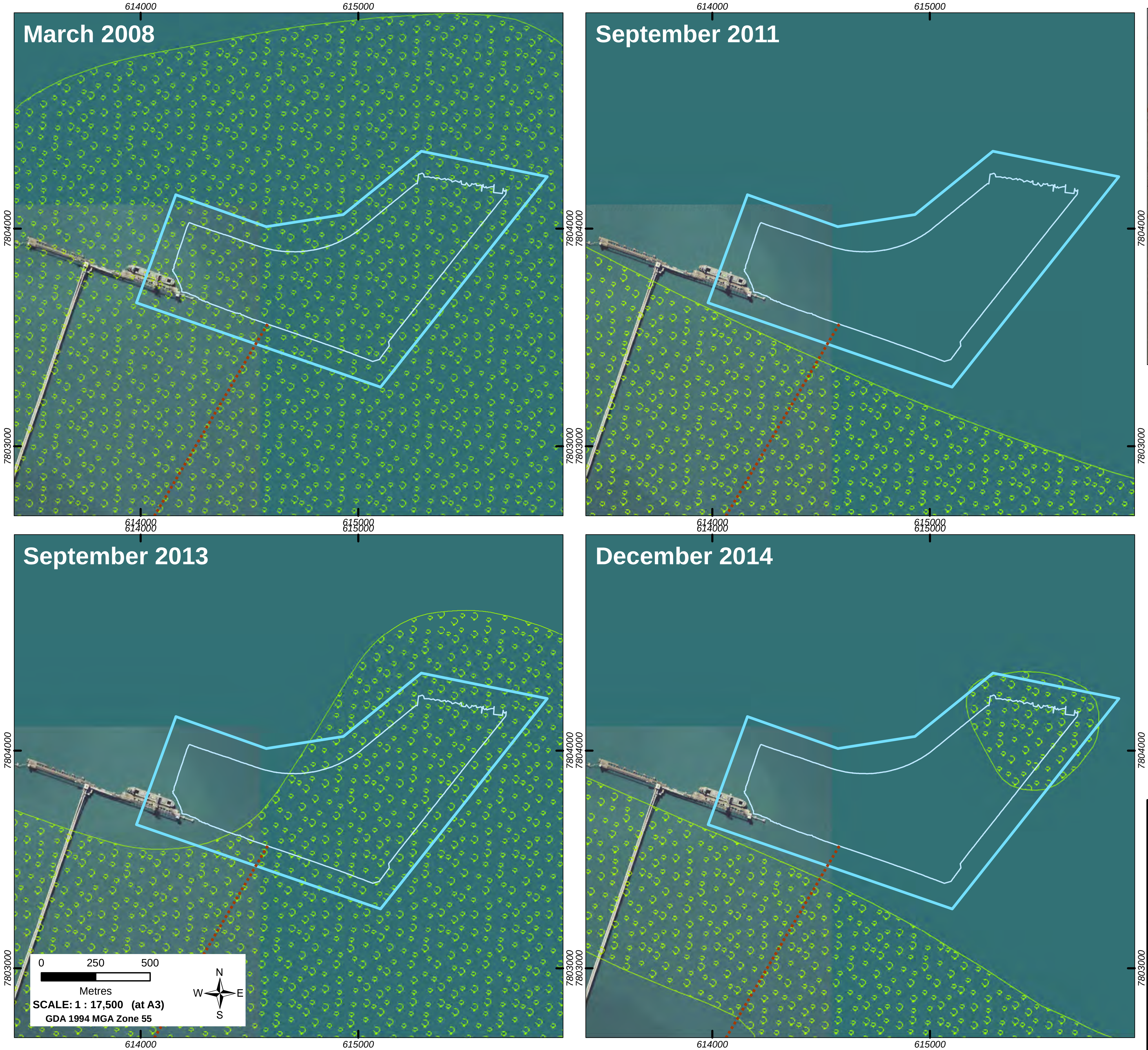

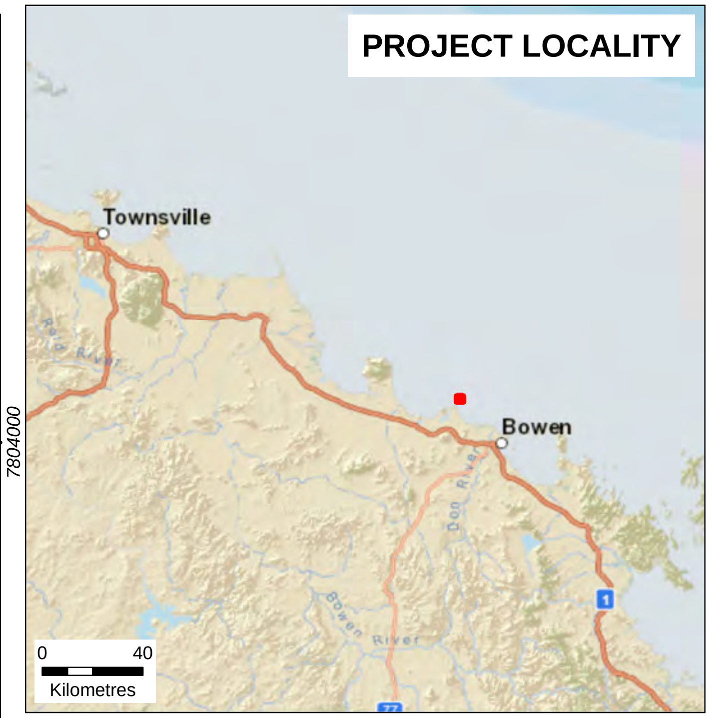

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LEGEND

- Dredging footprint
- Dredging referral area
- Abbot Point Strategic Port Land
- Seagrass habitat 1-5% cover

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Figure 3-13
Historical seagrass habitat in the proposed T0 dredging footprint and surrounds

Figure: 301001-01956-00-GM-SKT-0075 | Rev: 0

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3.6.2 Macroalgal communities

Macroalgal communities at Abbot Point have been identified as widespread but patchy in distribution and typically with low percentage cover. A survey in 2005 observed algae communities as covering approximately half of the area surveyed, but with mostly less than 5% cover.

During surveys within the port limits, GHD (2009c) detected algae in association with small patches of hard substrate, which were scattered across the area. Macroalgae recorded included:

- Nine green algae (phylum *Chlorophyta*)
- Four brown algae (phylum *Phaeophyta*)
- Seven red algae (phylum *Rhodophyta*).

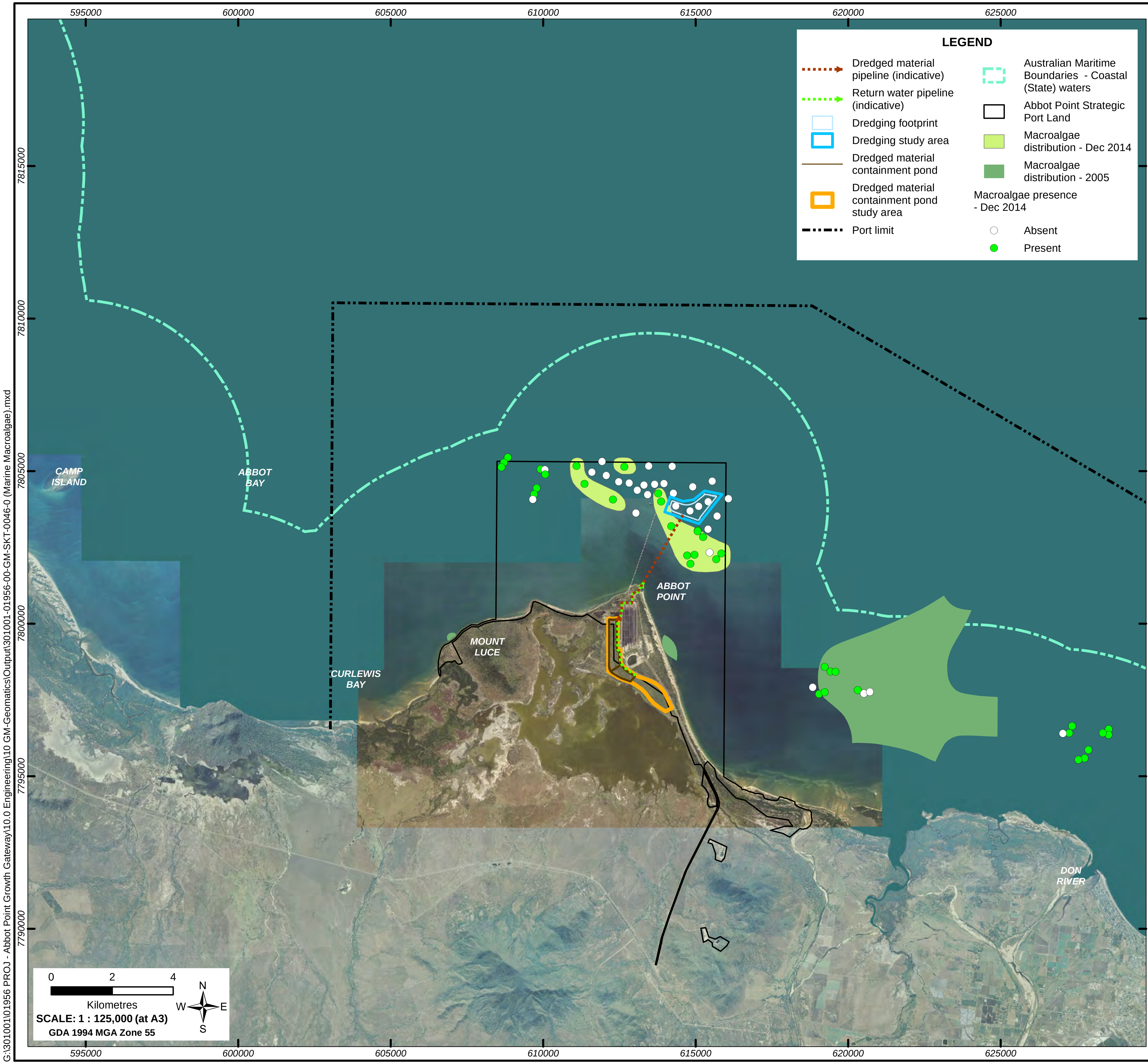
The most commonly occurring alg*ae were Chondria spp., Peyssonnelia spp., Chaetomorpha spp., Acetabularia spp.*, *Laurencia spp*. and a red filamentous alga. The distribution of macroalgal taxa was generally consistent between sites surveyed. The macroalgae observed were usually associated with small patches of hard substrates such as shell grit.

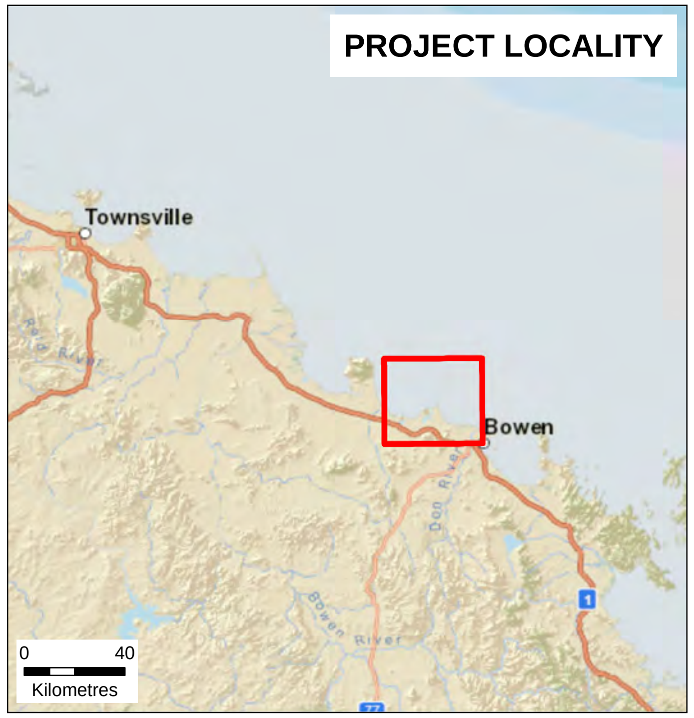
Findings indicate temporal variability in the presence of species as well, with a shift in species composition observed between the 2005 and 2009 surveys. The long-term algal communities are not assessed as part of the long-term seagrass monitoring at Abbot Point because it is considered patchy and ephemeral.

It is noted that a high abundance of red and green algae has been previously recorded on the rocky reef habitat located adjacent to the Abbot Point beach (Rasheed *et al*., 2005).

Twelve macroalgal taxa were observed within the broader project area beyond the port limits surveyed for the Abbot Point PER using video transect surveys (BMT WBM, 2012). Three species of *Halimeda* were recorded, with species distribution corresponding to the distribution of low mud content substrates. Other unidentified green, red and brown algae were present in association with the *Halimeda spp*., in particular crustose coralline algae, which became more abundant with proximity to reef (BMT WBM, 2012). The algae community distribution from habitat surveys in the Abbot Point area is represented in Figure 3-14.

The most recent surveys of macroalgae in the proposed dredging footprint and immediate surrounds were undertaken by TropWATER in December 2014. The preliminary results are presented in Figure 3-14 and indicate that no macroalgae was present within the dredging footprint, macroalgae was found in areas surrounding the footprint and in offshore monitoring sites 1 and 2 Figure 3-14. Macroalgae near the dredging footprint occurred as light sparse patches, while in the surrounding areas, algae cover tended to be higher in abundance and distribution. The dominant macroalgae were species of *Caulerpa* and *Halimeda*. Red macroalgae were also found in some trawls.





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Macroalgae survey - December 2014
TropWATER (Centre for Tropical Water & Aquatic Ecosystem Research) - James Cook University
Macroalgae survey - 2005
North Queensland Bulk Ports

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Figure 3-14
Algae community distribution at Abbot Point
(Source: GHD 2009c)

Figure: 301001-01956-00-GM-SKT-0046 | Rev: 0

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Benthic macroinvertebrates including coral communities

Benthic macroinvertebrate assemblages in Abbot Point are low in both diversity and abundance (GHD, 2012a). Spatial and temporal heterogeneity is typical of these macroinvertebrate communities. The seafloor is open and provides little habitat structure for benthic macroinvertebrates resulting in patchy distributions (GHD, 2012a). Cnidarians (soft and hard corals, jelly fish, anemones and hydrozoans) have been recorded throughout the Abbot Point area in very low densities (<10% coverage when recorded) (GHD, 2009d).

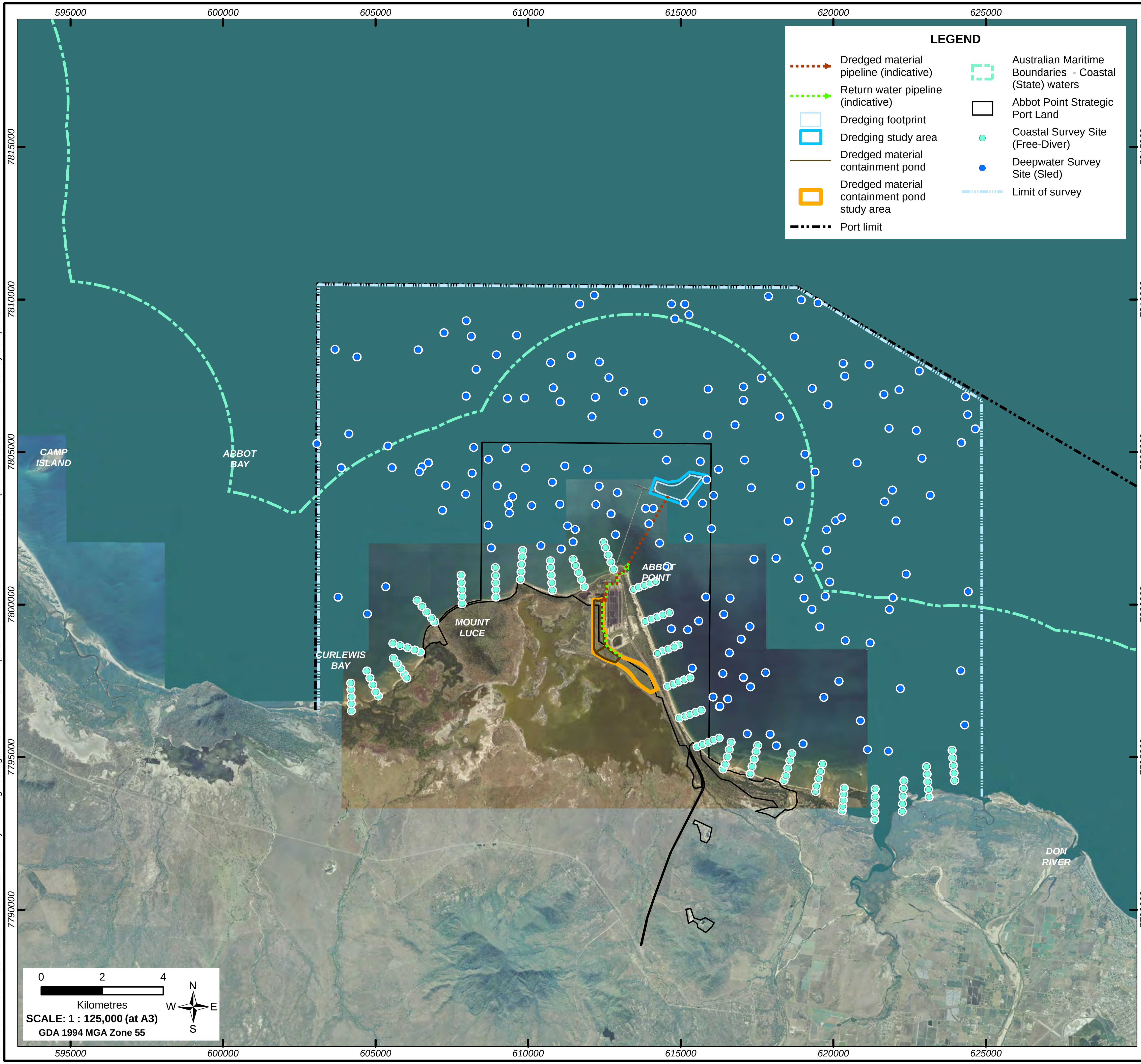
Further afield, more extensive hard and soft coral communities can be found growing on rocky outcrops surrounding Nares Rock and Camp Island. The most extensive coral communities are found offshore at Holbourne Island (for more detail and actual locations see Section 3.3 and Figure 3-3).

Ecological surveys in 2012 identified soft corals, hydroids, hard corals, anemones and one sea pen. Hard corals recorded within the PER project area consisted of individual fungid corals (BMT WBM, 2012). A similar species composition was recorded at sandy inshore locations that are consistent with the PER project area habitat (GHD, 2008, 2009d). These areas supported soft corals, sea pens, sub-massive corals, massive corals and mushroom corals. All corals observed were very small in size (<1cm to 30cm), often occurred as single coral and were very sparsely distributed across the PER project area (less than one coral per ha). Sea pens were the most frequently occurring taxa, and are considered common within soft-sediment tropical benthic systems. Mushroom corals were the second most common coral taxa and are also commonly found along the inshore coastal systems of Queensland (GHD 2008, 2009d).

The majority of the Abbot Point area can be classified as open substrate with a low density (1 to 10%) cover of benthic macroinvertebrates. No areas of high density and very few areas of medium density coverage were found occurring in Abbot Point. The distribution of benthic macroinvertebrates across the PER project area was patchy and varied both spatially and temporally (GHD 2008, 2009d).

Previously, GHD (2009d) have observed sedentary benthic macroinvertebrates during surveys of the Port Limits. Ascidians were the most abundant, followed by echinoderms, molluscs, polychaetes and small crustaceans, concentrated around isolated patches of rubble and rock where other organisms grow.

Although the dominant benthic species reported from Abbot Point have changed since a JCU survey 25 years ago, the spatial findings of the earlier work are consistent with recent studies. This demonstrates that the patchy distribution of low diversity benthic communities at Abbot Point is a persistent condition of this area, despite recent meteorological disturbances and previous dredging works. This infers these assemblages are resilient to large scale and targeted benthic disturbance activities. Benthic survey sites are presented in Figure 3-15. Benthic macroinvertebrate densities in the Abbot Point area from the 2009 surveys are presented in Figure 3-16.



PROJECT LOCALITY

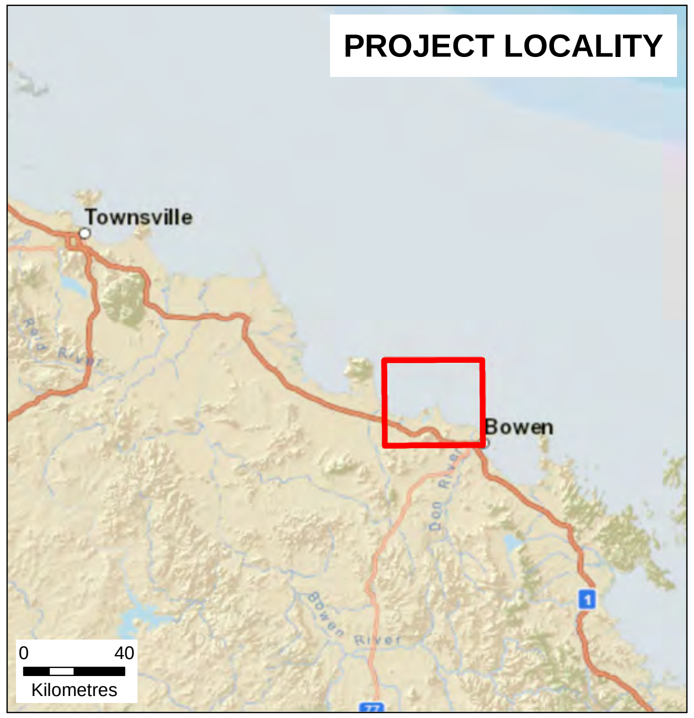


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Figure 3-15
Marine macroinvertebrate survey sites
(Source: GHD 2009d)

Figure: 301001-01956-00-GM-SKT-0041 | Rev: 0

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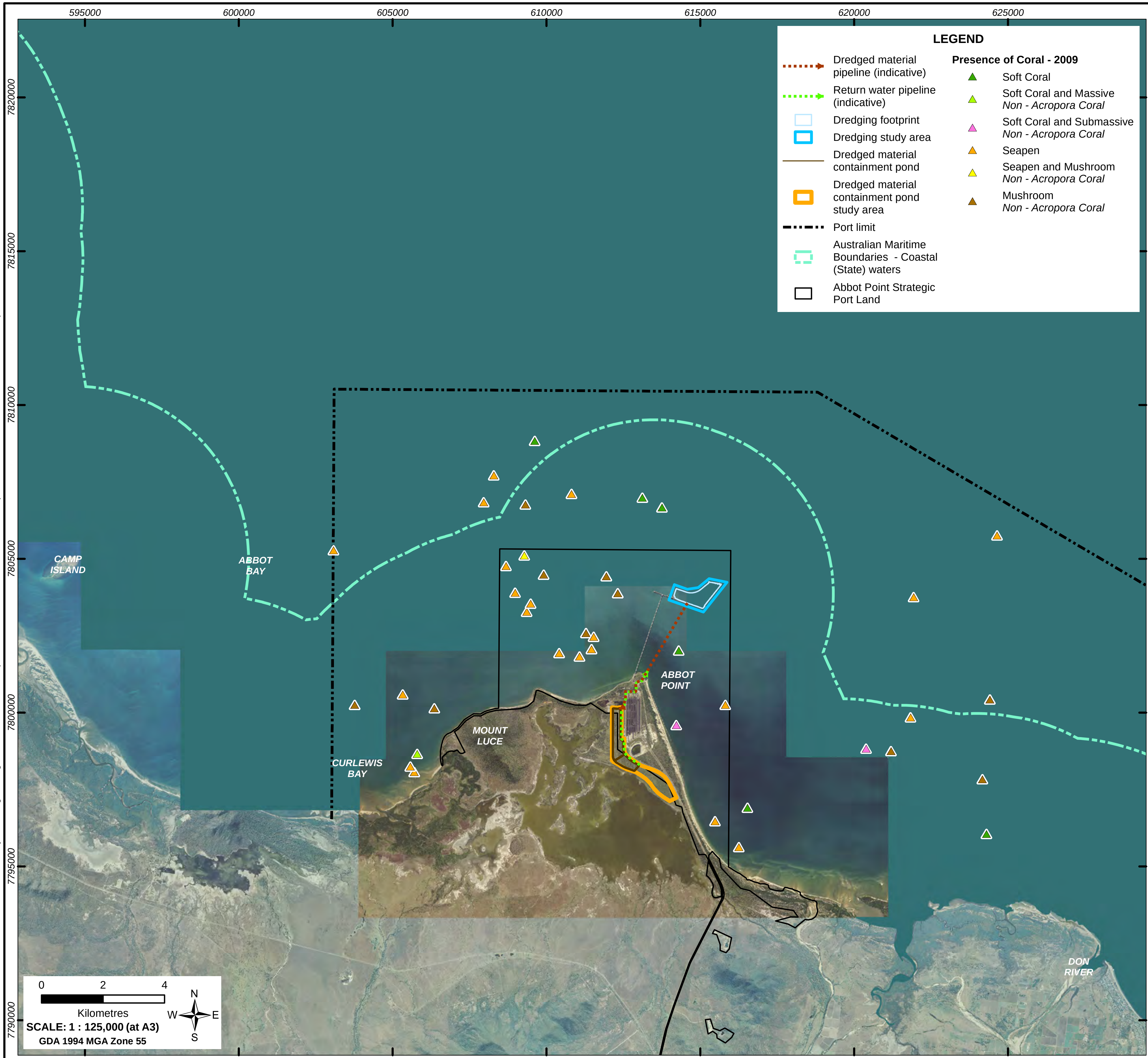

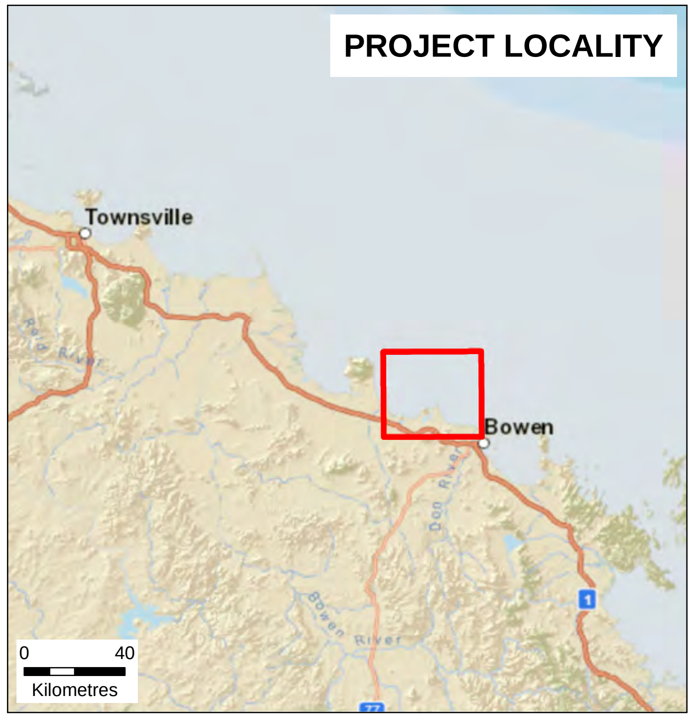

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 3-16
Macro invertebrate distributions at Abbot Point
(Source: GHD 2009d)

Figure: 301001-01956-00-GM-SKT-0044 | Rev: 0

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4. MIGRATORY OR THREATENED MARINE SPECIES IN THE PROJECT STUDY AREA

4.1.1 Overview

The Protected Matters Search Tool identified 19 EPBC Act listed migratory or threatened marine fauna species that may occur in the project area and areas that may be impacted by the Project. These species have been categorised by likelihood of occurrence in the project area and areas that may be impacted by the Project.

If a species is 'known (to occur)', 'likely (to occur)', or 'potentially occurring' the level of species specific information (where available) has been increased to provide sufficient background information to properly assess the species against the relevant significant impact criteria. An assessment of the likelihood of occurrence of each of these species is summarised in Table 4-1. Only fauna listed as threatened or migratory under the EPBC Act have been assessed for potential impacts.

Table 4-1 Likelihood of occurrence of EPBC Act listed threatened or migratory marine species

Common Name Scientific Name	EPBC Act Status	Habitat Suitability and Distribution	Likelihood of Occurrence
Mammals			
Humpback whale *Megaptera novaeangliae*	V, M	Humpback whale adults and calves have been recorded within the vicinity of the project area (GHD, 2010), potentially using the area for resting on their southern migration from calving grounds. Presence in the area is seasonally high from August to October. The wider area is recognised as a biologically important area for breeding and calving (DoE, 2014b).	Known
Killer whale *Orcinus orca*	M	There have been no recorded sightings of killer whales within The project area during studies related to this Project or previous projects. Concentrations are reported in cooler waters in Tasmania, South Australia and Victoria (DoE, 2014c)	Highly Unlikely
Blue whale *Balaenoptera*	E, M	No previous records in the region. Blue whales are generally oceanic and migratory through Australian waters. There are several recognised	Highly Unlikely

Common Name Scientific Name	EPBC Act Status	Habitat Suitability and Distribution	Likelihood of Occurrence
musculus		feeding areas off the southern coasts of Victoria, South Australia and Western Australia (DoE, 2014d).	
Bryde's whale *Balaenoptera edeni*	M	Species data deficient on habitat suitability and distribution. There are no specific feeding or breeding grounds recorded in Australian coastal waters (DoE, 2014e).	Highly Unlikely
Indo-Pacific Humpback dolphin *Sousa chinensis*	M	112 Indo-Pacific Humpback dolphin sightings were recorded during surveys at Abbot Point. It is not known whether The project area supports breeding individuals as no calves or breeding behaviour has been observed within the area, and it is not known if the dolphins observed are residents or transients that occasionally use the area (DoE, 2014f).	Known
Australian Snubfin dolphin *Orcaella heinsohni*	M	20 Snubfin dolphin sightings were recorded during surveys at Abbot Point. It is not known whether the project area supports breeding individuals as no calves or breeding behaviour has been observed within the area, and it is not known if the dolphins observed are residents or transients that occasionally use the area (DoE, 2014g).	Known
Dugong *Dugong dugon*	M	Dugong adults, a juvenile and calves were observed in the project area during surveys at Abbot Point. The project area is a potential foraging area. Abbot Point was identified as an area of low conservation importance for dugongs in the Southern GBR (Grech & Marsh, 2007).	Known
Reptiles			
Green turtle *Chelonia mydas*	V	The most frequently recorded marine turtle species in the port limits and surrounding waters surveyed at Abbot Point (GHD, 2010). They have been found to have a high association with inshore rocky reefs that run parallel to Abbot Beach (Bell, 2003; CDM Smith, 2013). Beaches within the port area have been identified as	Known

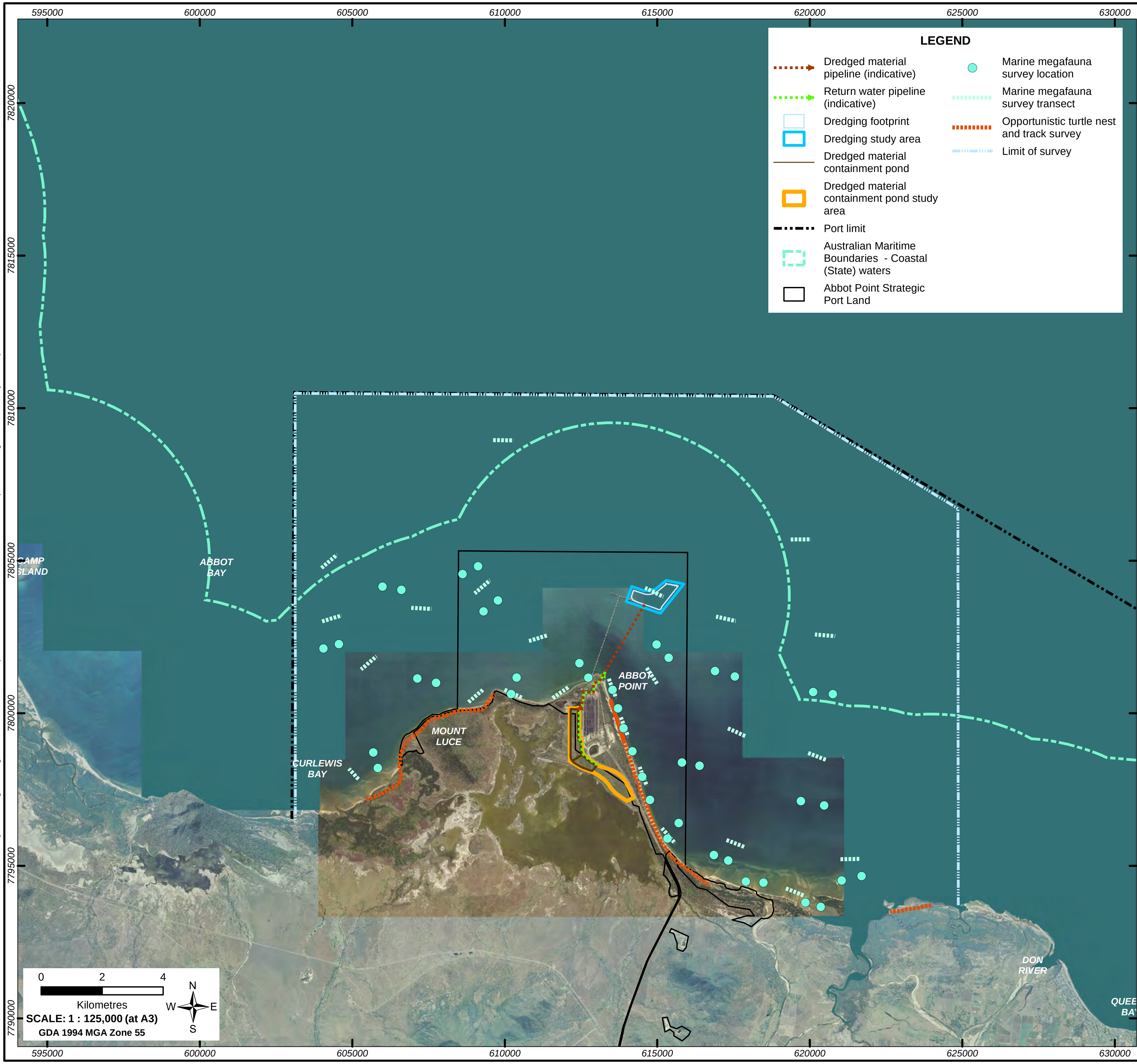
Common Name Scientific Name	EPBC Act Status	Habitat Suitability and Distribution	Likelihood of Occurrence
		supporting low density nesting habitat (Bell, 2003, GHD, 2010; CDM Smith, 2013; DoE, 2014h). Recent aerial surveys (Hof and Bell, 2014) indicate that the distribution of green turtle nesting stretches along the majority of the Whitsunday-Burdekin-Townsville coastline with higher density nesting occurring on mainland coastal beaches at Rita Island, Paradise Bay and Abbot Point.	
Flatback turtle *Natator depressus*	V	Flatback turtles typically utilise coastal tropical waters and soft bottom habitat (DoE, 2014i). Flatback turtles have been recorded within port limits in the vicinity of the project area and there is evidence of low density nesting habitat in the area (Bell, 2003; GHD 2010; CDM Smith, 2013). Are known to be associated with the rocky reef area that extends ~ 2.5km south of the existing Material Offloading Facility (MOF), just south of the existing wharf (CDM Smith, 2013). Recent aerial surveys (Hof and Bell, 2014) indicate that the distribution of green turtle nesting stretches along the majority of the Whitsunday-Burdekin-Townsville coastline with higher density nesting occurring on mainland coastal beaches at Rita Island, Paradise Bay and Abbot Point.	Known
Hawksbill turtle *Eretmochelys imbricate*	V	Hawksbill turtles have been recorded along the inshore rocky reefs that run parallel to Abbot Beach, as per Green Turtles (GHD, 2010). Typically utilise coastal tropical and sub-tropical species, foraging in tidal and sub-tidal coral and rocky reefs. Nesting is not known to occur in the area (DoE, 2014j).	Known

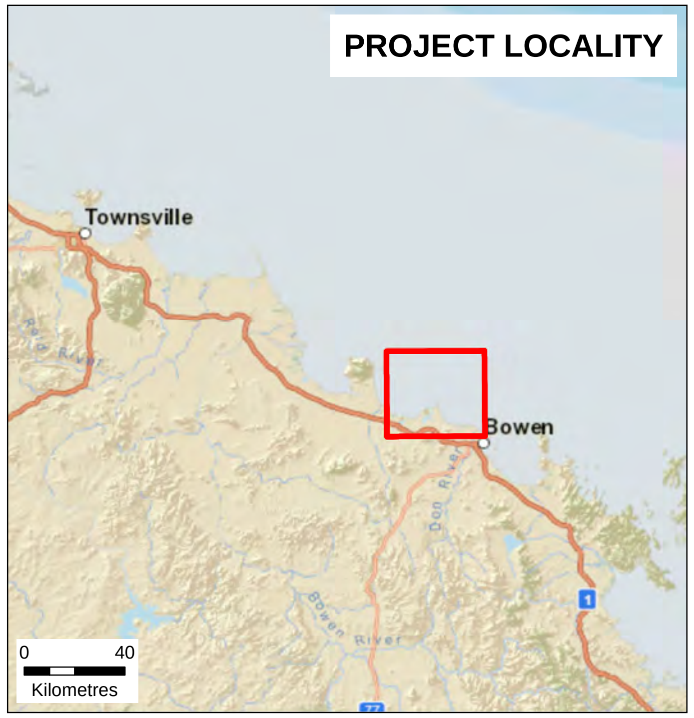
Common Name Scientific Name	EPBC Act Status	Habitat Suitability and Distribution	Likelihood of Occurrence
Loggerhead turtle *Caretta caretta*	E	Has been recorded within the port limits in the vicinity of the project area (GHD, 2010). Are known to be associated with the rocky reef area that extends ~2.5km south of the MOF (CDM Smith, 2013). Typically inhabits open waters with either soft or hard substrates, including rocky and coral reefs, muddy bays, sandflats, estuaries and seagrass meadows. There are no nesting beaches within the project area and no habitat critical to the species survival (DoE, 2014k).	Known
Olive Ridley turtle *Lepidochelys olivacea*	E	Coastal tropical waters, soft bottomed habitats feeding predominantly on gastropods and bivalves. They have been recorded in the area; however sightings are rare (Bell, 2003). Nesting is not known to occur in the area (DoE, 2014l).	Known
Leatherback turtle *Dermochelys coriacea*	E	There are no known records of Leatherback turtles occurring in the area. Suitable foraging habitat is present in the waters offshore of Abbot Point; however, Leatherback turtles are rarely found in Queensland and have not been recorded to have nested in eastern Australia since 1996. Leatherbacks are a largely pelagic species. Nesting is not known to occur in the area (Limpus 2009b, GHD, 2010, DoE, 2014m).	Unlikely
Saltwater crocodile *Crocodylus porosus*	M	One individual was recorded by within the Abbot Point area but the species has not been historically recorded in the area (GHD, 2012). Evidence of a Saltwater crocodile was found on the downstream section of Goodbye Creek on the eastern side of the Caley Valley Wetland (BMT WBM, 2012). The limited habitat within the project area is not considered important habitat for this species.	Known
Sharks and Rays			
Great White shark *Carcharodon*	V	Suitable habitat may be present within the Project rea, however the closest identified aggregation area, considered the most	Highly Unlikely

Common Name Scientific Name	EPBC Act Status	Habitat Suitability and Distribution	Likelihood of Occurrence
carcharias		northernmost for the species is offshore from Rockhampton, approximately 550km south of the project area (DoE 2014n).	
Mackerel shark *Lamna nasus*	M	The Mackerel shark has not been previously recorded during surveys of Abbot Point. There is little information available on the distribution of the species in Queensland. Foraging habitat is predominately in pelagic environments (DoE 2014o).	Highly Unlikely
Whale shark *Rhincodon typus*	V	The Whale shark has not previously been recorded within the waters of Abbot Point. The species is known from Queensland waters (DoE 2014p), however there are no aggregation areas near the project area.	Highly Unlikely
Green sawfish *Pristis zijsron*	V	Not recorded in the project area. Historically, the habitat utilised by *Pristis zijsron* includes predominantly large tropical river systems, as the species has only been captured in muddy tidal rivers and estuaries (DoE 2014q). Most recent capture is from the Mackay region (approximately 200 km to the south of Abbot Point), approximately two years ago.	Highly Unlikely
Giant manta ray *Manta birostris*	M	Two Giant manta rays were opportunistically recorded during the marine megafauna surveys that occurred from 2008 – 2009. However, the project area is not considered an aggregation site or an area that contains breeding or important feeding areas for the manta ray (GHD, 2012). Giant manta rays are generally associated with offshore reefs and islands (DoE, 2014r).	Known

The survey sites for marine megafauna are presented in Figure 4-1. The results of the megafauna surveys as identified in the Abbot Point PER is presented below (Figure 4-2).

The methods used to survey these communities and the results are detailed in Section 3.2 of the Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging Project (GHD, 2012d) and in GHD (2009f), Megafauna Assessment Report: Proposed Abbot Point Multi Cargo Facility EIS, December 2009.





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Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
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Australian Maritime Boundaries - 2006
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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 4-1
Marine megafauna survey locations
(Source: GHD 2009f)

Figure: 301001-01956-00-GM-SKT-0055 | Rev: 0

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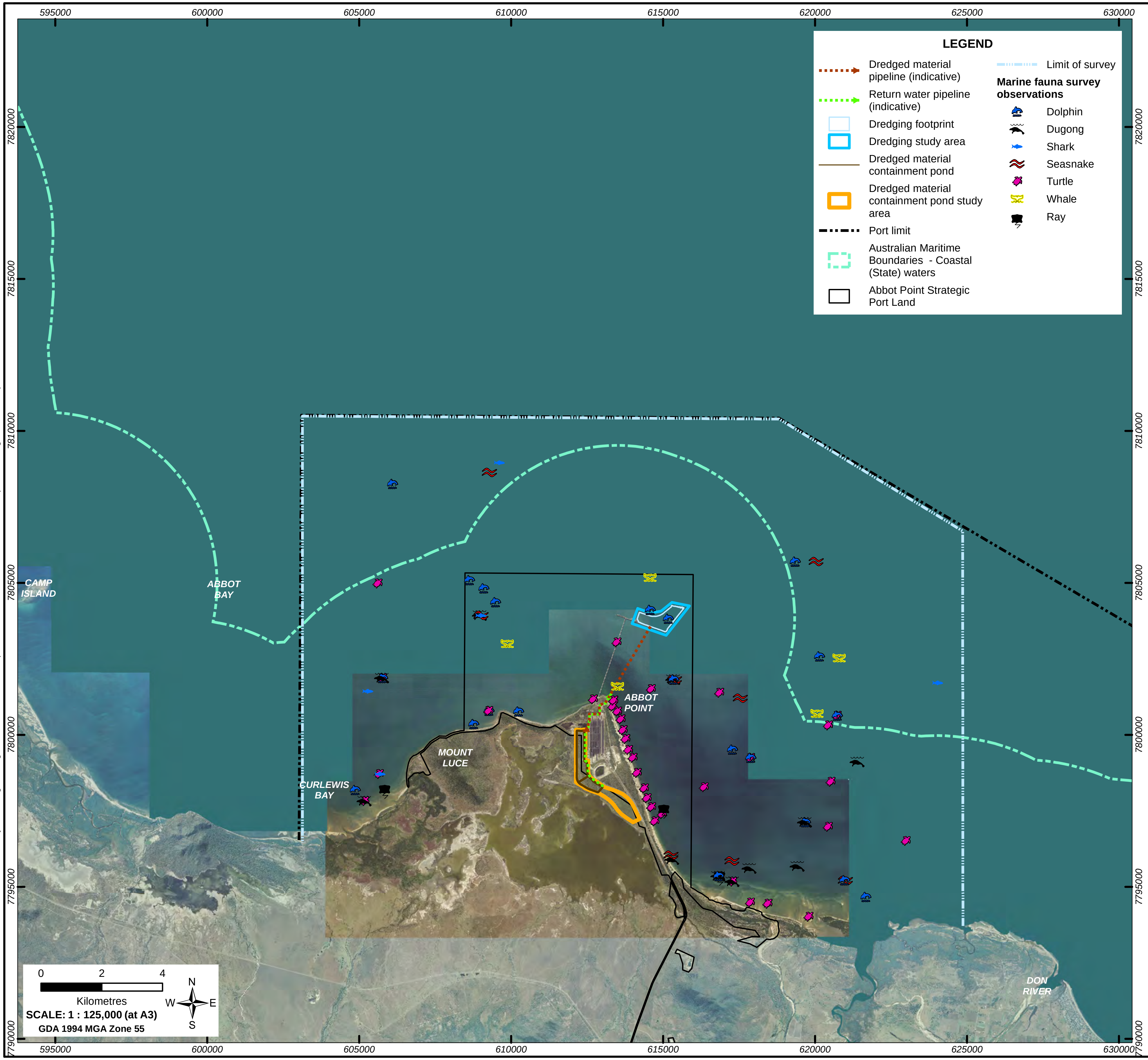

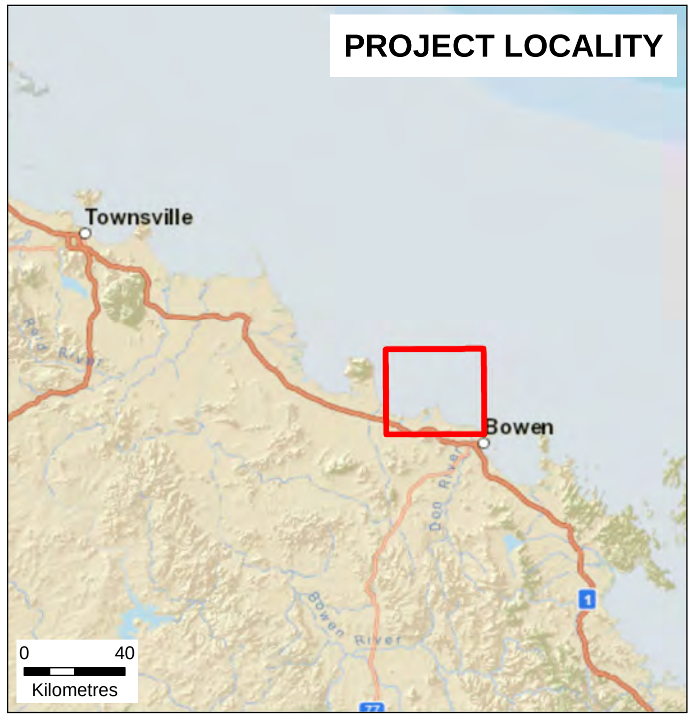

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 4-2
Marine megafauna recorded at Abbot Point
(Source: GHD 2009f)

Figure: 301001-01956-00-GM-SKT-0054 | Rev: 0

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4.1.2 Whales

4.1.2.1 Humpback Whale

The Humpback Whale (*Megaptera novaeangliae*) is listed as 'least concern' under the International Union for Conservation of Nature (IUCN) Red List of threatened species, and as 'vulnerable' under both the Queensland *Nature Conservation Act 1992* (NC Act) and the EPBC Act.

The Humpback Whale is a moderately large baleen whale. The species is distributed almost worldwide, but with apparent geographical segregation. In Australia there are two migratory populations of Humpback Whales, a west coast and an east coast population. The east coast population of Humpback Whales is increasing at a rate of approximately 10% a year (Noad *et al.*, 2011), and is currently estimated to contain approximately 15,000 whales.

Australian Humpback Whales migrate from their Southern Ocean summer feeding grounds northwards to tropical calving grounds from June to August, and return south to the feeding areas from September to November. Peak migration through the study area is July (northward) and mid-September-October (southward). The GBR provides breeding and resting grounds for Humpback Whales. Known aggregation areas occur along the east coast, with core breeding and calving areas on the GBR, resting areas in the Whitsundays, the Swain Reefs complex, Bell Cay, and the Palm Island Group, Hervey Bay and Moreton Bay (DEH, 2005a; Smith *et al.*, 2012). Despite decades of research, the width of the migratory corridor is unknown and the exact area of the breeding grounds is unknown, especially for the east coast migratory population (DoE, 2014b). Along parts of the migratory route there are narrow corridors and bottlenecks resulting from physical and other barriers (such as islands and reefs) where the majority of the population passes close to shore (e.g. within 30km of the coastline). For the east coast population, offshore of Moreton and North Stradbroke Island is recognised as a migratory bottleneck (Figure 4-3).

A recent study by Smith *et al.* (2012) provided more detail on calving and resting areas of hHumpback Whales around the GBR. Based on observations, Smith et al. (2012) developed a predictive habitat spatial model for Humpback Whale habitat use. The model identified restricted ranges in water depths of 30 to 58m and sea surface temperatures between 21 and 23°C; and identified two core areas of higher probability of whale occurrence in the GBRMP, which correspond well with the movements of satellite tagged whales. The two core areas were: (1) offshore of Proserpine extending south to Mackay within the inner reef lagoon region, and (2) the Capricorn and Bunker groups of islands and reefs approximately 100km east of Gladstone (Figure 4-4). Smith *et al.* (2012) hypothesised that the first core area, off the coast of Mackay, is an important wintering area for Humpback Whales.

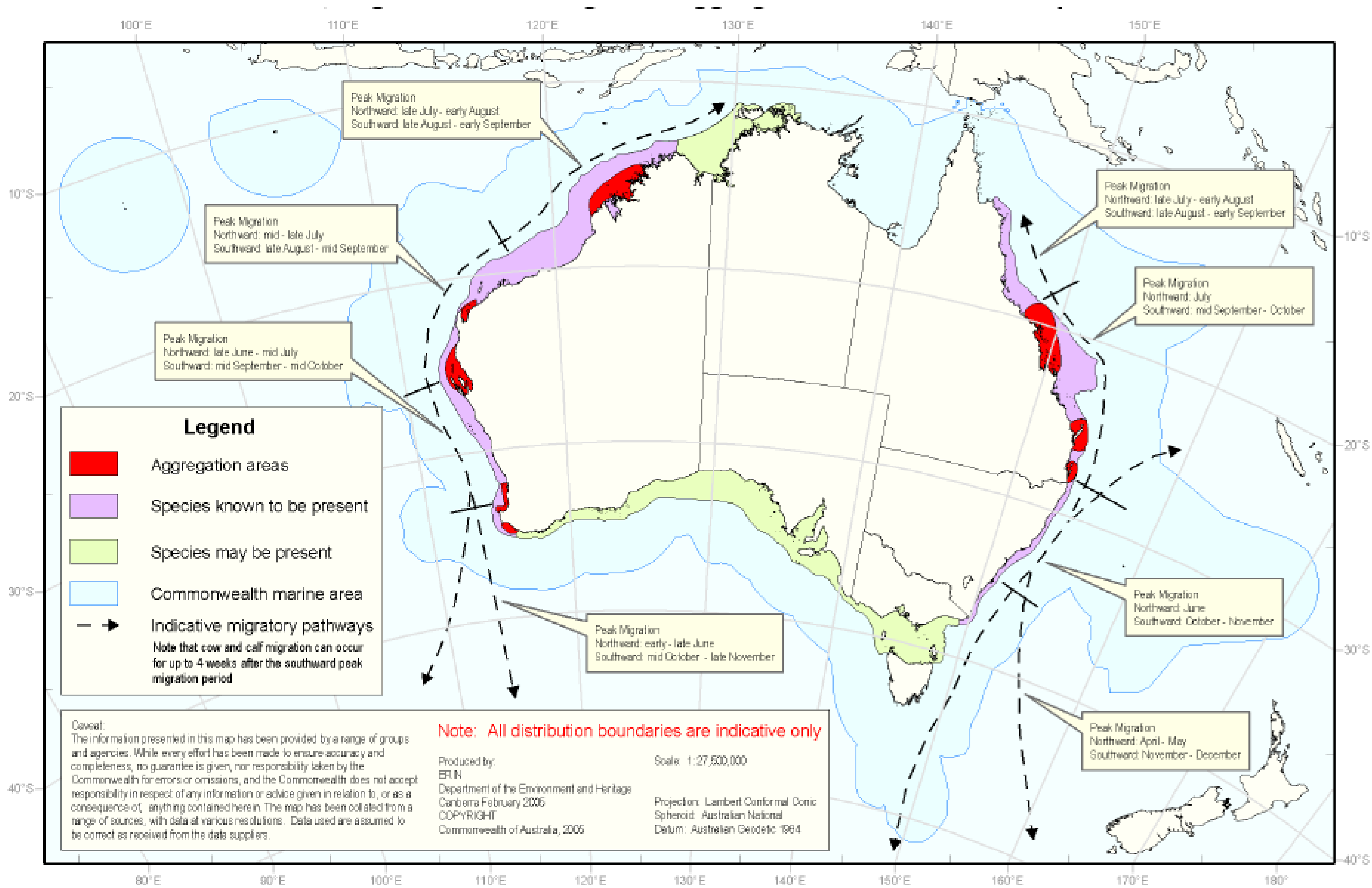


Figure 4-3 Distribution, migration and recognised aggregation areas of the humpback whale (Source: Commonwealth of Australia 2005)

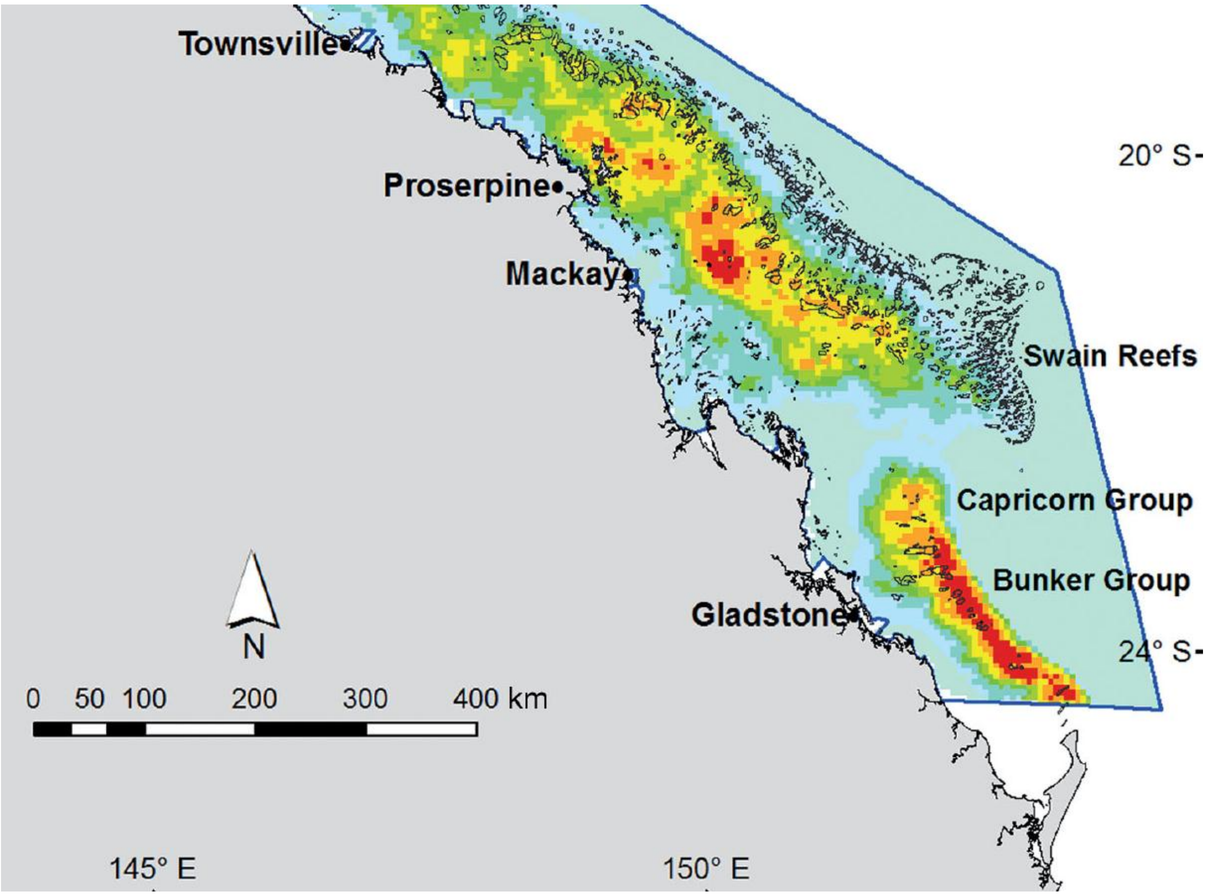


Figure 4-4 Model prediction of average environmental suitability for Humpback Whales in the Great Barrier Reef Marine Park for July and August 2003 to 2007. High probability of suitable habitat and occurrence of whales are indicated in dark red source: Smith et al. 2012

In addition to the assessments of Humpback Whale populations undertaken for the Humpback Whale Recovery Plan 2005 - 2010 (Commonwealth of Australia, 2005), the GBRMPA undertook vulnerability assessments on habitats, species and groups of species identified as being potentially ‘at-risk’ as part of the Great Barrier Reef Biodiversity Conservation Strategy, 2012 (GBRMPA, 2012). Humpback Whales are a species within the GBR that were identified as ‘at-risk’ and a vulnerability assessment for whales as a group has been developed. This assessment detailed concerns for Humpback Whales within the GBR and recommended management measures. Whales in the GBR received an assessment of ‘good’ with a vulnerability assessment of ‘low’ (GBRMPA, 2014).

Humpback Whales within the project area

The observations of Humpback Whales within Abbot Point only during September suggest a transitory, opportunistic use of this area as a resting habitat as they migrate south to their feeding grounds in the Antarctic. The protected coastline and variable water depths at Abbot Point may provide a refuge environment for some whales, however, others were observed to swim past the area (GHD, 2009e).

The Humpback Whale Recovery Plan provides an indicative map of aggregation areas for the species in Australia (Figure 4-3). Abbot Point is located towards the northern extent of an aggregation area which has been mapped for the Whitsunday region. However, the Recovery Plan notes that these boundaries are indicative only and there is inherent variability in the movement of the species. This, combined with the environmental suitability modelling, suggests that Abbot Point is not an important aggregation area and is not identified as such in the Humpback Whale Recovery Plan (Commonwealth of Australia, 2005) or the Smith *et al*. (2012) study.

Importance of Abbot Point Humpback Whale population and habitat

Abbot Point appears to provide a transitory area for some Humpback Whales migrating to and from their breeding grounds within the northern GBR. Known core aggregation areas for Humpback Whales closest to Abbot Point occur further south off the Mackay coast in the Whitsunday region and in Hervey Bay.

Based on the available information, it is considered unlikely that Abbot Point supports an important Humpback Whale population or habitat critical to the survival of Humpback Whales. While Abbot Point is located towards the northern extent of the aggregation area identified in the Whitsunday region (DoE, 2014b), these areas have been mapped to provide a broad indication of the extent of aggregation areas and the information available for Abbot Point is not suggestive of a significant or important aggregation area. The number of individuals observed within the project area (14) is very low considering the population estimate for the east coast population in 2010 was approximately 15,000 (Noad *et al*., 2011). Of the 14 individuals observed, only 4 (2 adults and 2 calves) were sighted within the shallow coastal waters of Clark Shoal. The relevance of Abbot Point to the Humpback whale is likely to be that of a migratory path north and south which supports opportunistic resting or feeding within the relative protection of its shallow coastal waters during the southern migration.

4.1.3 Inshore Dolphins

4.1.3.1 INDO-PACIFIC HUMPBACK DOLPHIN

The Indo-Pacific Humpback Dolphin (*Sousa chinensis*) is listed as 'near threatened' under the IUCN Red List of threatened species and the Queensland NC Act and 'migratory' under the EPBC Act.

The global range of the Indo-Pacific Humpback Dolphin extends through the Indo-Pacific region from eastern South Africa to northern Australia. Within Australia, the dolphins occur from the Queensland/New South Wales border, north through to Exmouth in Western Australia. Indications are that Australian populations are discrete and geographically localised (Parra *et al*., 2004). Regional population levels (e.g. Queensland) are likely to be in the thousands, but not as high as tens of thousands. The estimated extent of occurrence of the Indo-Pacific Humpback Dolphin in Queensland is approximately 122,000km^2 (DoE, 2014f).

Indo-Pacific Humpback Dolphins inhabit shallow coastal, estuarine, and occasionally riverine habitats, in tropical and subtropical regions. The species usually occurs close to the coast, generally in depths of less than 20m. Surveys conducted in 2005/6 in the far northern section of the GBRMP showed that most sightings of Indo-Pacific Humpback Dolphins occurred in waters less than 5km from land, 20km from the nearest river mouth, and in waters less than 15m deep (Parra *et al*., 2006). Indo-Pacific Humpback Dolphins appear to be present throughout the year off northern Queensland (Ross *et al*., 1994). However, stranding rates differ between various seasons (with peaks during the summer monsoon), which seems to indicate variable dolphin densities and possibly seasonally differing habitats.

In addition to the assessments of dolphins as a group undertaken for the Great Barrier Reef Outlook Report assessment (GBRMPA, 2009), GBRMPA undertook vulnerability assessments on habitats, species and groups of species identified as being potentially 'at-risk' as part of the Great Barrier Reef Biodiversity Conservation Strategy, 2012 (GBRMPA, 2012). Indo-Pacific Humpback Dolphins are a species within the GBR that were identified as 'at-risk' and a vulnerability assessment for inshore dolphins (Indo-Pacific Humpback and Australian Snubfin) has been developed. This assessment detailed concerns for inshore dolphins within the GBR and recommended management measures. Inshore dolphins in the GBR received an assessment of 'good' with a vulnerability assessment of 'high' (GBRMPA, 2014). DEHP have identified the Indo-Pacific Humpback Dolphin as a critical priority species under the DEHP Back-on-Track Biodiversity Action Plans.

4.1.3.2 AUSTRALIAN SNUBFIN DOLPHIN

The Australian Snubfin Dolphin (*Orcaella heinsohni*) is listed as 'near threatened' under the IUCN Red List of threatened species and the Queensland NC Act and 'migratory' under the EPBC Act 1999.

The Australian Snubfin Dolphin is likely to be endemic to Australian waters. There is only one record of the species outside Australia, being from Papua New Guinea (DoE, 2014g). In Australia, it is believed to be confined to northern coastal waters from Brisbane to Broome. The Australian Snubfin Dolphin usually inhabits shallow coastal waters less than 20m deep and is often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al.*, 1997; Jefferson, 2000; Parra, 2006). Within Australia, the dolphin species co-exists with coastal development, including extensive port facilities such as the Port of Brisbane and Cleveland Bay, Townsville (Hale *et al.*, 1998; Parra, 2006).

Studies of the Australian Snubfin Dolphin have found populations at Keppel Bay, Great Sandy Strait and in Cleveland Bay, Townsville. These sites each have estimated populations of between 100 and 150 individuals (GBRMPA, 2012). The information available for Cleveland Bay indicates that Australian Snubfin Dolphins are not permanent residents, but use the area regularly from year to year following a model of emigration and re-immigration. Individuals spend periods of days to a month or more in coastal waters of Cleveland Bay before leaving, for periods of over a month before re-entering. Home ranges and/or territories for this species appear to be large, as many of the identified individuals spent less than 30 days within the 310km² Cleveland Bay study area (Parra, 2006). Considering the length of coastline and area of suitable shallow habitat and the apparent occurrence of Australian Snubfin Dolphins in small localised groups, it is likely that mature Australian Snubfin Dolphins do not number more than 10,000 individuals (DoE, 2014g). There are no published studies to date to determine the extent of individual movement of these species between potential inshore habitats along the Queensland coast.

Australian Snubfin Dolphins are a species within the GBR that have been identified as 'at-risk' and a Vulnerability Assessment has been developed for this species in conjunction with the Indo-Pacific Humpback Dolphin. This assessment identifies the Australian Snubfin dolphin as having a 'high' vulnerability to known sources of pressures within the GBR. Like the Indo-Pacific Humpback Dolphin, the Australian Snubfin Dolphin maintains small populations in discrete home ranges which are geographically distinct. This, combined with their life history traits (e.g. long-lived, slow growth rate, late maturing and low reproduction rate) makes them particularly susceptible to any potential impacts.

Inshore Dolphins within the project area

Surveys for marine megafauna within the Abbot Point area were undertaken between 2008 and 2009 (GHD, 2009e). A total of 50 transects and 42 spot sites were surveyed over 9 months between June/July 2008 to June 2009. Surveys were not completed during January to March due to unsafe weather conditions.

Indo-Pacific Humpback and Snubfin Dolphins were observed in the waters offshore of Abbot Point during the survey. Key results from the survey included:

- 112 Indo-Pacific Humpback Dolphin sightings were recorded during survey months except for April and October. The highest frequency of observations occurred in May and September in water depths of between 4.5 and 19.5m.
- 20 Snubfin Dolphin sightings were recorded in June/July, September and October, in water depths between 9 and 13m.
- A mixed pod of Snubfin and Indo-Pacific Humpback Dolphin were recorded on one occasion.

It is not known whether the project area supports breeding individuals as no calves or breeding behaviour has been observed within the area, and it is not known if the dolphins observed are residents or transients that occasionally use the area.

Importance of Abbot Point inshore dolphin populations and habitat

There are no population estimates for either the Australian Snubfin or Indo-Pacific Humpback Dolphin within the project area, nor are there any confirmed national estimates for the two species. Studies of Queensland coastal locations (as discussed above) including Townsville, Gladstone/Port Alma and the Great Sandy Strait have indicated that:

- Populations of these species are generally small, usually with less than 100 individuals in any one location
- Recent studies indicate that these small populations can be relatively disconnected due to geographic isolation and genetic separation
- Studies indicate that both species show a level of site fidelity, with evidence of female philopatry in Indo-Pacific Humpback Dolphins
- There is currently very little published information on the scale of movement between habitats and between regions along the coast.

Detailed studies have not been undertaken within the project area to determine whether these population characteristics are also true for the Australian Snubfin and Indo-Pacific Humpback Dolphins observed at Abbot Point. In the absence of such information, a precautionary approach needs to be applied and populations of both dolphin species at Abbot Point need to be considered as potentially disconnected, small (<100) and potentially genetically distinct. The conservation importance of Australian Snubfin and Indo-Pacific Humpback Dolphins in a local context should therefore be considered as high.

The lack of regional and national population data for both species, however, makes it difficult to understand the importance of the population of Australian Snubfin and Indo-Pacific Dolphins in a broader context. In terms of the impact assessment of the Project on these species, it is assumed the population of Australian Snubfin and Indo-Pacific Dolphins at Abbot Point may be important and management and mitigation measures put in place will ensure the residual impact on these species from project activities is low.

4.1.4 Dugong

The Dugong (*Dugong dugon*) is listed as 'vulnerable' under the IUCN Red List of threatened species and the Queensland NC Act and 'migratory' under the EPBC Act.

Dugongs are long-lived (up to 70 years) with low reproductive output and are the only living species of the family Dugongidae in the world. After a gestation period of between 13 and 15 months, a female produces a single calf with calving intervals between three and seven years. Their slow breeding rate and long life span mean that Dugong are particularly susceptible to factors that threaten their survival, and population recovery, even when impacting processes are removed, is slow.

The Dugong is the only herbivorous mammal that is strictly marine and a seagrass community specialist. Dugong prefer to select seagrass species that are high in nitrogen concentration relative to available seagrass resources, and this is often the seagrass resources that are in the intertidal region (Sheppard *et al*., 2010).

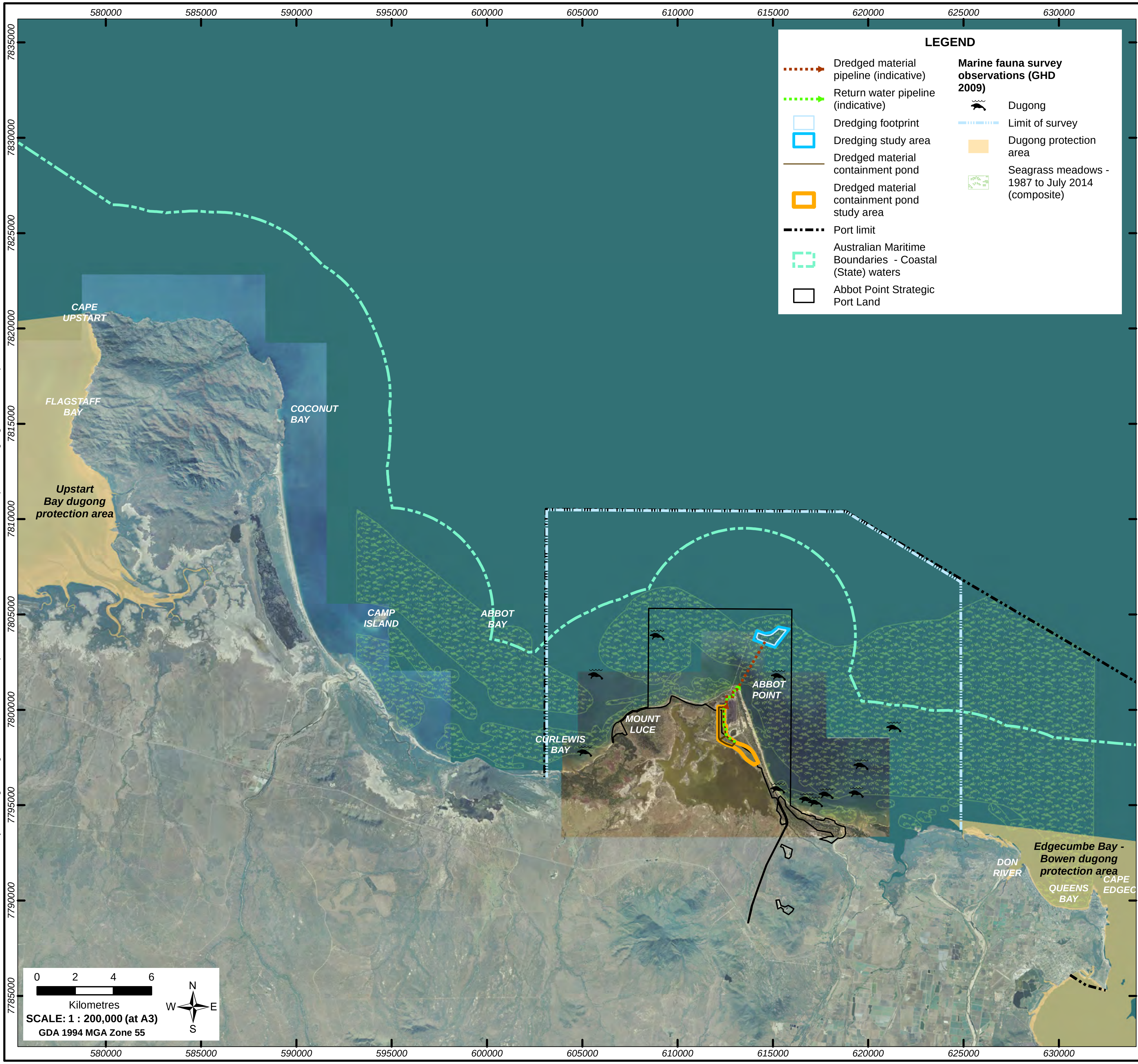
There is a significant and long-term decline in the population of Dugong along the Queensland urban coast (Dobbs *et al*., 2008). Dugong numbers in the Great Barrier Reef (GBR) along the urban coast of Queensland (area south of Cooktown) have fallen by 97% since the 1960s (Marsh and Lawler, 2001), however appear to now be stabilising (GBRMPA, 2009). Anthropogenic impacts on Dugong include: traditional hunting; incidental capture in large meshed commercial fishing nets; the shark control program; boat strike; and destruction of, and alienation from, seagrass habitat.

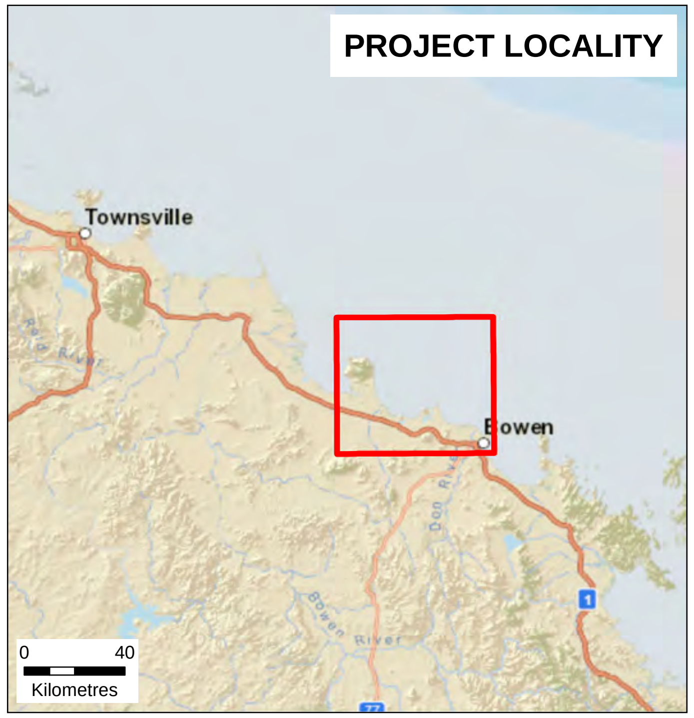
Sixteen DPAs are declared under the Queensland NC Act and as Special Management Areas under the *Great Barrier Reef Marine Park Regulations 1983* and the Great Barrier Reef Marine Park Zoning Plan 2003. The GBRMPA's primary management intent for Dugong conservation in the GBRMP is to facilitate the recovery of Dugong populations such that they fulfil their ecological role within the GBR ecosystem (GBRMPA 2007).

There are no specific Commonwealth recovery plans for the Dugong; however, the Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life (Commonwealth of Australia, 2009) applies. DEHP have identified the Dugong as a priority species under the DEHP Back-on-Track Biodiversity Action Plans.

Dugongs are a species within the GBR that were identified as 'at-risk' and a vulnerability assessment for dugongs has been developed. This assessment detailed concerns for dugongs within the GBR and recommended management measures. Dugongs in the GBR received an assessment of 'poor' with a vulnerability assessment of 'high' (GBRMPA, 2014).

Abbot Point is located between two DPAs: 'Dugong Sanctuary A' at Upstart Bay (44km north-west of Abbot Point) and 'Dugong Sanctuary B' at Edgecumbe Bay (35km south-east of Abbot Point) (Figure 4-5).





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Dugong Protection Areas - 2002
Queensland Government - Department of Primary Industries and Fisheries

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Figure 4-5
Dugongs observed at Abbot Point and Dugong Protection Areas

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Aerial surveys for Dugong were completed along the Queensland coast from Cape Upstart south to Edgecumbe Bay, inclusive of the Abbot Point area, between 1987 and 1999 (Marsh and Lawler, 2001) as part of broader systematic surveys of the GBRWHA. These surveys recorded estimates of 312 (1987), zero (1992) and 203 (1999) individuals in the area surrounding Abbot Point (GHD, 2012e). A Dugong population model was developed using the distribution and abundance data from the surveys to identify areas of high to low conservation value (Grech & Marsh, 2007). Abbot Point was identified as an area of low conservation value.

Aerial surveys of Upstart and Edgecumbe Bay between 1987 and 1999 recorded variable, but sometimes large population estimates of Dugong (Marsh et al. 1996). Population estimates ranged from:

- 19 ± 19 up to 171 ± 87 Dugong in Upstart Bay
- 20 ± 17 up to 205 ± 90 Dugong in Edgecumbe Bay.

Local populations of Dugongs in these areas are likely to have a variable abundance in relation to natural variations in seagrass distribution and health.

Dugongs within the project area

Surveys for marine megafauna within the Abbot Point area were undertaken between 2008 and 2009 (Figure 4-2) (GHD, 2009e). Results from the surveys included:

- Observations of 24 Dugongs including 16 adults, 1 juvenile and 3 calves
- Individuals were largely associated with seagrass meadows containing *H. uninervis* and *H. spinulosa*
- Individuals were observed in water depths between 2.5m and 14m throughout the waters of the existing port facilities
- Individuals were found to be present throughout most of the year (observed in June/July, August, September, October, December and April).

The presence of Dugongs within Abbot Point is likely to be strongly influenced by the abundance and health of seagrass meadows. Seagrass within the project area is naturally variable as a result of seasonal and inter-annual changes in environmental factors (i.e. rainfall, cyclonic events and flooding). A detailed description of the distribution and abundance of seagrass at Abbot Point is provided in Section 3.6.

Importance of Abbot Point dugong population and habitat

Abbot Point was identified as an area of low conservation importance for dugongs in the Southern GBR (Grech & Marsh, 2007). Other areas in the southern GBR are known to support more significant populations of Dugongs than Abbot Point including:

- Upstart Bay and Edgecumbe Bay to the north-west and south-east of Abbot Point support variable, but on occasion significant populations of Dugongs (>150 individuals) and are therefore considered to be of higher conservation value
- Cleveland Bay, located 140km to the north of Abbot Point, as identified by DoE (2014s) has recorded population estimates of up to 400 individuals during aerial surveys (Preen, 1999)
- Hervey Bay, over 750km to the south-east of Abbot Point, has recorded some of the largest population estimates in the southern GBR, with over 1,000 individuals recorded during aerial surveys.

Dugongs are known to travel short and long distances between food sources. The distance between the DPAs of Upstart Bay and Edgecumbe Bay is approximately 80km. There is potential for individuals to move between these areas in search of foraging habitat. It is likely that these individuals would use the seagrass habitat within Abbot Point and immediate surrounds for foraging. Abbot Point may therefore provide an opportunistic feeding area for dugongs as they travel between the two DPAs. Figure 4-5 illustrates the relationship between Dugong habitat values (seagrass beds), DPAs and between Upstart Bay and Edgecumbe Bay.

Given the available information, it is considered unlikely that the project area supports locally important Dugong habitat or an ecologically significant proportion of the dugong population in Australia. This conclusion is supported by the following factors:

- Abbot Point has been previously identified as an area of low conservation importance for Dugongs in the southern GBR, based on reef wide, long-term data (Grech & Marsh, 2007)
- Seagrass distribution and abundance is naturally highly variable in the project area, with the most recent surveys recording reduced areas (when compared to 2008) of low density, patchy areas of seagrass (McKenna and Rasheed, 2014), indicating seagrass abundance in the project area is not stable or currently present in high abundance
- Dugongs recorded in the project area are likely to be transient individuals, moving between the more important areas of Cape Upstart to the north and Edgecumbe Bay to the south and have, to date, not been recorded in significant abundances in the project area
- Abbot Point is not at the limit of the distribution range of dugongs along the east coast of Australia
- Abbot Point is not known to provide any critical breeding, feeding or resting habitat for Dugongs in the local or regional area.

4.1.5 Marine Turtles

4.1.5.1 Green Turtle

The Green Turtle (*Chelonia mydas*) is listed as 'endangered' under the IUCN Red List of threatened species, 'vulnerable' under the Queensland NC Act and 'vulnerable' and 'migratory' under the EPBC Act. DEHP have listed Green Turtles as a critical priority species under the DEHP Back-on-Track Biodiversity Action Plans (DEHP, 2014).

Green Turtles nest, forage and migrate across tropical northern Australia. They forage in shallow coastal areas, in particular on seagrass beds and they are likely to forage within the project area. They feed principally on seagrass and seaweeds although juveniles are also carnivorous. Green Turtles are found in tropical and subtropical waters throughout the world. It is estimated that globally there are approximately 88,520 nesting female turtles worldwide. DoE (2014h) identifies that the total Australian population of Green Turtles is estimated to be more than 70,000 individuals. It has been identified that within Australia there are seven separate breeding aggregations of Green Turtles (Bowen *et al*., 1992; Moritz *et al*., 2002; Dutton *et al*., 2002) as shown in Figure 4-6.

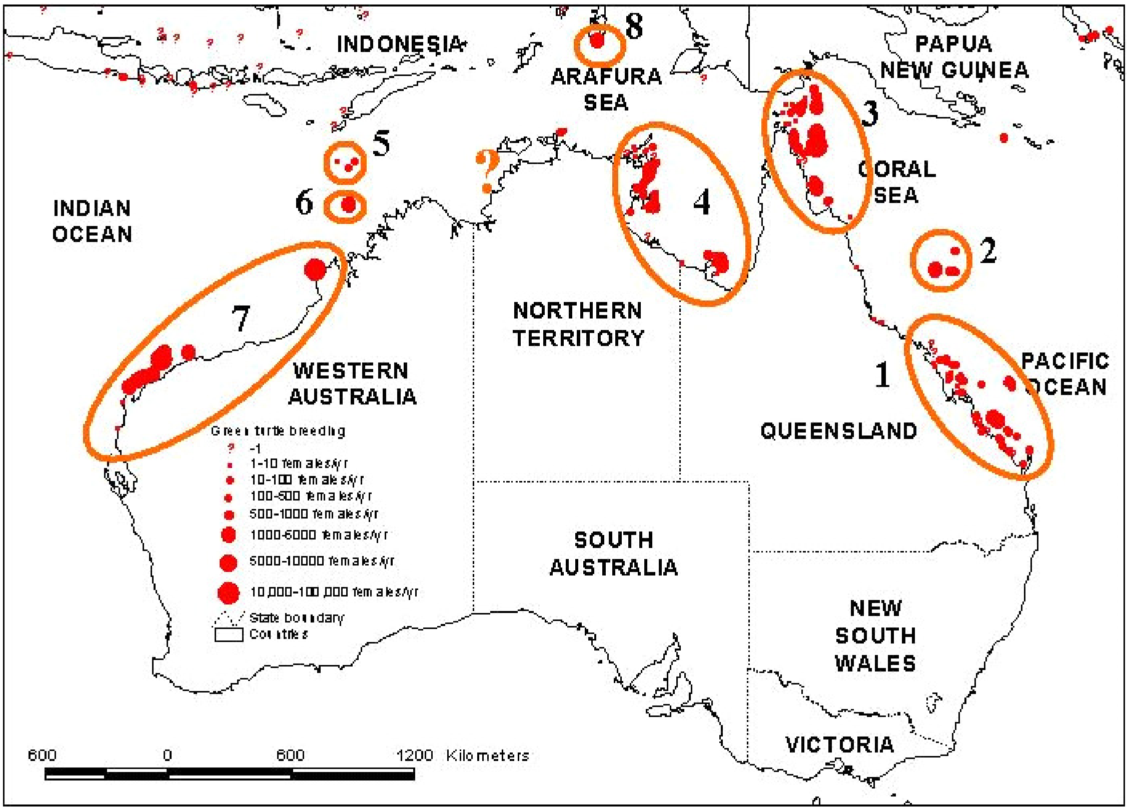


Figure 4-6 Genetically identifiable Australian breeding stocks of Green Turtles (source: Limpus 2008a)

The identified habitat critical for the survival of Green Turtles nearest to the project area is the Capricorn-Bunker Group islands, which are approximately 520km to the south of the existing Port of Abbot Point. This habitat is not listed on the EPBC Act Register of Critical Habitat, but rather is identified in the Marine Turtle Recovery Plan (Environment Australia, 2003). The Capricorn-Bunker Group is known to support natal and inter-nesting habitat. The description of this habitat includes all land above sea level in the Capricorn-Bunker Group including all waters within a 20km radius of that land (Environment Australia 2003).

Raine Island, which lies over 900km to the north of Abbot Point, supports the largest known marine turtle rookery in the world. Green Turtles nest on the island, and are part of the northern GBR genetic stock. The total number of turtles is variable between years, and can be as many as 131,000 (Limpus, 2008).

In a study for the Abbot Point PER the area between Bowen and Gloucester Island (approximately 25km to the southeast of Abbot Point) was noted as having a high abundance of marine turtles with Green Turtles observed to be abundant along the length of seagrass flats on the southwest side of Edgecumbe Bay.

Green Turtles within the Abbot Point area

Baseline and targeted turtle surveys have previously been undertaken within the Abbot Point area (Bell, 2003; GHD 2009; CDM Smith, 2013b; Hof & Bell, 2014).

A baseline turtle population dynamics study was undertaken in 2003 to identify areas of turtle nesting and foraging within Hay Point, Abbot Point and Lucinda Port areas (Bell, 2003). The twelve month study, including 336 search hours and one night of nesting turtle survey (for Abbot Point to Gloucester Island), identified the following results of relevance to the Abbot Point area:

- Three potential Green Turtle nesting tracks were recorded along the beach between Euri Creek and the existing coal loading facility at Abbot Point.
- Four Green Turtles (three juveniles and one adult) were caught and released in the creek systems and associated protected coastal flats from Euri Creek to the mouth of the Don River.
- Captured and released Green Turtles were in areas where low-density seagrass beds existed.
- A single adult Green Turtle was recorded approximately 150m offshore and adjacent to the Abbot Point coal loading facility.
- The Green Turtles identified in the Abbot Point port area are thought to be associated with the southern GBR genetic stock.
- More recent marine fauna surveys (GHD, 2009) observed turtles within the coastal waters of Abbot Point including 76 observations of Green Turtles within water depths of between 1.1m and 14.9m (Figure 4-2). No turtles were observed within the dredging footprint.
- Turtle nesting was also recorded in the area with a total of four tracks recorded in November and seven in December 2008. The tracks were not distinguishable between Flatback and Green Turtles.

CDM Smith (2013b) undertook surveys of turtle nesting sites over a walking transect extending for 6km south from the existing MOF located south of Abbot Point. The beach and adjacent foredunes were examined for nesting turtle tracks on 19/20 December 2012 and 29 January 2013. The suitability of beach habitat for turtle nesting was also determined. A summary of results is provided below:

- Evidence of limited marine turtle nesting was recorded in December 2012, with 11 sets of tracks recorded over the transect length
- Tracks were found at southern most extent of transect indication that nesting may occur further south of the survey area
- Three sets of tracks appeared to result in a successful nesting attempt

- Six tracks could be attributed to a specific species: five being Flatback Turtles and one being a Green Turtle
- Two examples of hatchling emergence were recorded but could not be attributed to a specific species
- The first tracks were located 2.2km south of the MOF and others within the stretch of beach 1.4km south of this
- No evidence of nesting or hatching emergence was recorded in January 2013, however ex-tropical cyclone Oswald occurred a week prior to the survey and may have impacted hatchling emergence through high inundation levels
- Both the December and January surveys indicated a concentration of marine turtles (including Green Turtles, Loggerhead Turtles and Flatback Turtles) associated with the rocky reef that extends ~2.5km south of the MOF. An indicative estimate of 16 to 25 turtles using this area was made.

Most recently, in December 2014, an aerial survey (using a Robinson 44 rotating wing aircraft (helicopter)) of turtle nesting track data and predator activity was undertaken over the Whitsunday-Burdekin-Townsville region (between Euri Creek and Magnetic Island)(Hof & Bell, 2014). Data were supported by ground-truthed nesting data collected by community groups. Key findings of the survey included:

- Flatback and Green Turtle nesting occurs along the majority of the Whitsunday-Burdekin-Townsville coastline
- Higher density nesting occurs on mainland coastal beaches including Rita Island (51 tracks), Paradise Bay (22 tracks) and Abbot Point (21 tracks) respectively
- Wunjunga Beach was found to support regionally high density nesting of Flatback Turtles
- A regional density of 185 Flatback and Green Turtle nesting attempt tracks were recorded, with the majority identified as Flatback Turtles
- Predator tracks (primarily pig) were identified on mainland coastal beaches at Abbot Bay, Abbot Point, eastern Cape Upstart, Rita Island, Bowling Green Bay/eastern coast of Cape Cleveland, AIMS beach and Paradise Bay
- Overlapping turtle nesting and predator activity indicative of ‘hot spots’ for further investigation included Rita Island, the eastern beaches of Cape Cleveland particularly Paradise Bay, Abbot Bay including Abbot Point.

Importance of Abbot Point Green Turtle population and habitat

Abbot Point has not been identified as a key nesting or inter-nesting area for Green Turtles. The Abbot Point area is not considered a major nesting rookery in Queensland and therefore is not critical to the survival of Green Turtle populations. Abbot Point is within the region considered by GBRMPA as a high priority foraging area (Upstart Bay to Midge Point) (Dobbs, 2007).

There is no known critical or important habitat for Green Turtles present within the project area or region, as defined in the Recovery Plan for marine turtles in Australia (Environment Australia, 2003).

Abbot Point is known to provide foraging and nesting habitat for Green Turtles. CDM Smith (2013b) identified the Abbot Point area as having "*nesting habitat suitable with appropriate beach access and access to the supra-littoral zone for marine turtles. Not a known turtle rookery but low density nesting previously recorded or highly likely*". During their surveys in December 2012/January 2013 they identified parts of the supra-littoral area which contained Coastal She-Oak as potentially compromising nesting success due to its extensive and dense root systems prohibiting digging. High abundances of Green Turtles have not previously been recorded in the area.

The level of nesting observed at Abbot Point for Green Turtles is considered to be 'low-density' when compared with other known turtle rookeries in Queensland, such as North-West Island which is known to support approximately 700 nesting Green Turtles (over a two-week period in 1999). Given that the nesting beach adjacent to Abbot Point is considered to be 'low density', it is not likely to be critical to the survival of Green turtle populations in Queensland. However, Bell (2003) states that the Abbot Point area provides an important mainland nesting habitat in North Queensland. It is likely to be ecologically important to individual turtles that return to this nesting beach in future as marine turtles show fidelity to their natal nesting beaches. In addition, these low density nesting areas may make important reproductive contributions, particularly if they produce a disproportionate number of female hatchlings compared to island beaches with higher nesting densities (CDM Smith, 2013b). At a regional scale, the Abbot Beach has been identified as low significance for Green Turtle nesting and medium significance for Flatback Turtle nesting (Hardy and Stoinescu, 2012). However, the site should be considered as locally important due to the points raised above.

Areas of seagrass and algal communities that occur within the inshore and offshore areas of Abbot Point provide foraging habitat for Green Turtles. The area is within a region identified as 'High Priority' foraging habitat for Green Turtles within the GBRMP. The region extends from Upstart Bay to Midge Point, and covers a total area of 765.9km^2 (Dobbs, 2007).

4.1.5.2 Flatback Turtle

The Flatback Turtle (*Natator depressus*) is listed as 'data deficient' under the IUCN Red List of threatened species, and as 'vulnerable' under the Queensland NC Act *2* and 'vulnerable' and 'migratory' under the EPBC Act.

The Flatback Turtle is endemic to Australia and all known breeding sites of this species occur only in Australia. It is found only in the tropical waters of northern Australia, Papua

New Guinea and Irian Jaya. Nesting locations occur from the Bundaberg region, north to northern Western Australia (Figure 4-7). The most significant breeding site is Crab Island in the western Torres Strait.

Within central Queensland, Limpus *et al.* (2002) identified key nesting areas between Repulse Bay and Broad Sound with the major breeding aggregations occurring on continental islands in inshore areas of the southern GBR at Peak, Wild Duck, Avoid and Curtis Islands (Limpus, 2007). On the mainland in the Mackay region, they identified low density nesting of flatback turtles (1 – 10 individuals) on mainland beaches (e.g. Hay Point Beach and Salonika Beach), with islands being more important regional nesting habitat. It is considered that trends in the number of flatback turtles nesting in eastern Australia have been stable for the past 30 years (GBRMPA, 2009).

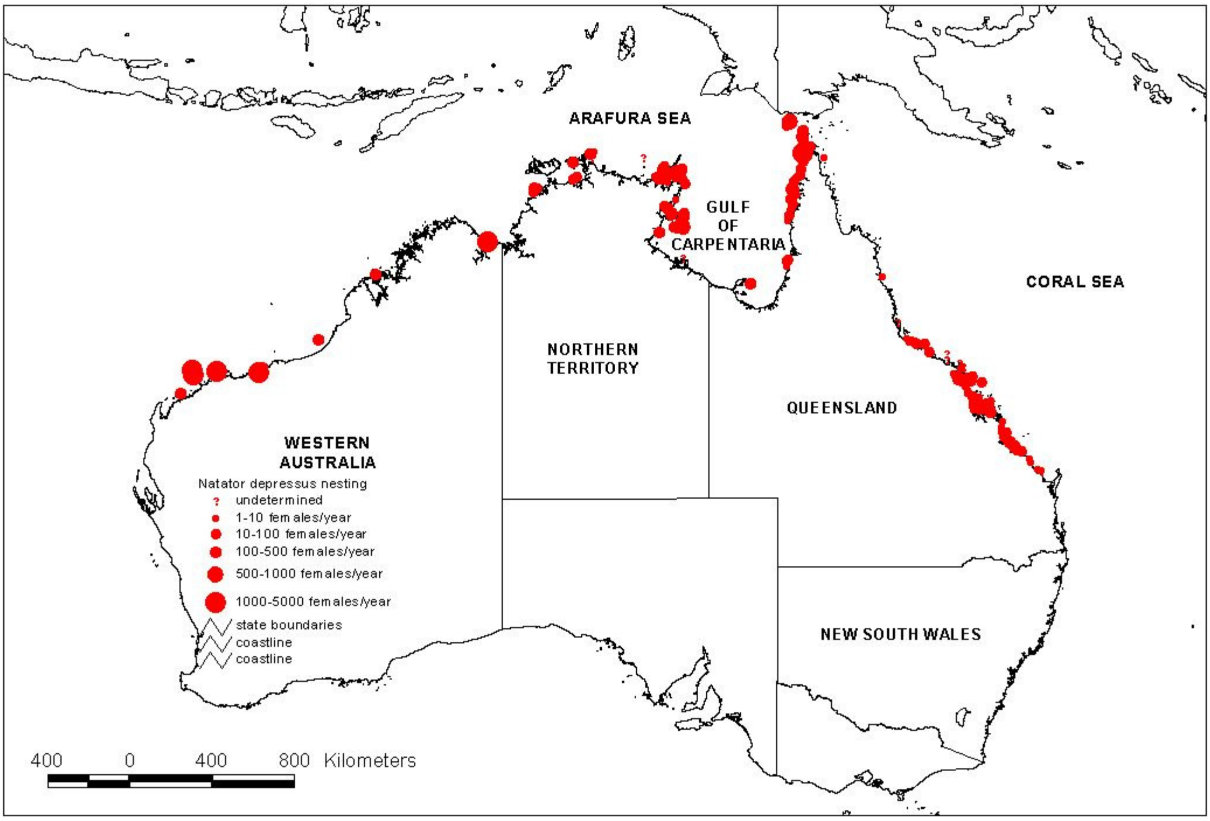


Figure 4-7 Distribution of Flatback Turtle nesting beaches (Source: Limpus 2007)

In eastern Queensland breeding is seasonal with nesting commencing in mid-October (Limpus, 2007). Nesting activity reaches a peak in late November - early December and ceases by about late January. Hatchlings emerge from nests during early December until about late March, with a peak of hatching in February. The Mackay and District Turtle Watch Association (2012) have identified that Flatback turtle nesting begins in the region in mid-October with hatchling emergence continuing until April.

Flatback turtles have a preference for shallow, soft-bottomed seabed habitats away from reefs. Flatback turtles are carnivorous and predominantly feed on epibenthic invertebrates including sea cucumbers and soft corals and are likely to feed in shallow soft sediment habitat in the Mackay region.

The total population size of the Flatback Turtle is currently estimated to be approximately 20,285 nesting females (Sea Turtle Conservancy, 2012a). There are four Australian stocks of Flatback Turtles, two of which inhabit Queensland and one of these inhabiting the Great Barrier Reef. The population on the GBR is known as the eastern Australian stock (GBRMPA, 2014).

Flatback Turtles within the Abbot Point area

Abbot Point has not been identified as a key nesting or inter-nesting area for Flatback turtles. However, evidence of Flatback Turtle use of the area has been recorded on numerous occasions.

Previously, Bell (2003) has undertaken marine turtle nesting and foraging surveys in the vicinity of port facilities at Hay Point, Abbot Point and Lucinda. The Mackay and District Turtle Watch Association (2012) have identified that approximately 30 to 100 Flatback Turtles nest annually across approximately 30 beaches in the Mackay region, each female laying approximately three times in a season.

A recent marine fauna survey (GHD, 2009) observed turtles within the coastal waters of Abbot Point, including 10 observations of Flatback Turtles within 1.2m and 12m. No turtles were observed within the dredging footprint (Figure 4-2). Turtle nesting was also recorded in the area with a total of four tracks recorded in November and seven in December 2008. The tracks were not distinguishable between Flatback and Green Turtles.

CDM Smith (2013b) undertook surveys of turtle nesting sites in December 2012/January 2013 over a walking transect extending for 6km south from the existing MOF located south of Abbot Point. Evidence of limited marine turtle nesting was recorded in December 2012, with 11 sets of tracks recorded over the transect length. Six tracks could be attributed to a specific species, with five of these being Flatback Turtles. Both the December and January surveys indicated a concentration of marine turtles (including Green Turtles, Loggerhead Turtles and Flatback Turtles) associated with the rocky reef that extends ~2.5km south of the MOF.

Hof and Bell (2014) undertook aerial surveys in December 2014 and reported that Flatback Turtle nesting occurs along the majority of the Whitsunday-Burdekin-Townsville coastline with higher density nesting on mainland coastal beaches including Rita Island (51 tracks), Paradise Bay (22 tracks) and Abbot Point (21 tracks) respectively. Wunjunga Beach was also found to support regionally high density nesting of Flatback Turtles. A regional density of 185 Flatback and Green Turtle nesting attempt tracks were recorded in this survey, with the majority identified as Flatback Turtles (Hof and Bell, 2014).

Importance of Abbot Point Flatback Turtle population and habitat

Flatback Turtles are known to nest in the Abbot Point area and are also likely to forage within the project area. There are no identified critical habitat areas for Flatback Turtles in Queensland (Environment Australia, 2003).

Nesting is known to occur along the Queensland coast between Bundaberg in the south and northwards to Torres Strait. The main nesting sites occur in the southern GBR at Peak, Wild Duck and Curtis Island (DoE, 2014i). The level of nesting observed at Abbot Point for Flatback Turtles is considered to be 'low-density' when compared with other known turtle rookeries in Queensland, such as Wild Duck Island known to support 20 nesting Flatback Turtles per night (during an average year). As the nesting beach adjacent to Abbot Point is considered to be 'low density', it is not likely to be important or critical to the survival of Flatback Turtles populations in Queensland, but is likely to be ecologically important to individual turtles that return to this nesting beach in future. At a regional scale, the Abbot Beach has been identified as for medium significance for Flatback Turtle nesting (Hardy and Stoinescu, 2012).

4.1.5.3 Hawksbill Turtle

The Hawksbill Turtle (*Eretmochelys imbricata*) is listed as 'critically endangered' under the IUCN Red List of threatened species, 'vulnerable' under the Queensland NC Act and 'vulnerable' and 'migratory' the EPBC Act. DEHP have Hawksbill turtles as a critical priority species under the DEHP Back-on-Track Biodiversity Action Plans (DEHP, 2014).

Hawksbill Turtles are found in tropical, subtropical and temperate waters worldwide. Nesting is mainly confined to tropical beaches. There are no concise estimates of global Hawksbill Turtle population numbers; however, Australia holds the largest breeding populations of Hawksbill Turtles in the world. Within Australia, there are two genetically separate sub-populations: one in the northern GBR, Torres Strait and Arnhem Land; and the other on the Northwest Shelf of Western Australia (Limpus, 2009a) (Figure 4-8).

The northern GBR, particularly Milman Island and the inner GBR cays north from Cape Grenville (approximately 900km north of the project area), are considered to be important foraging grounds and juvenile habitat. The Sea Turtle Conservancy estimates there are approximately 22,900 nesting females worldwide. Approximately 4,000 females nest in Queensland each year (DoE, 2014j).

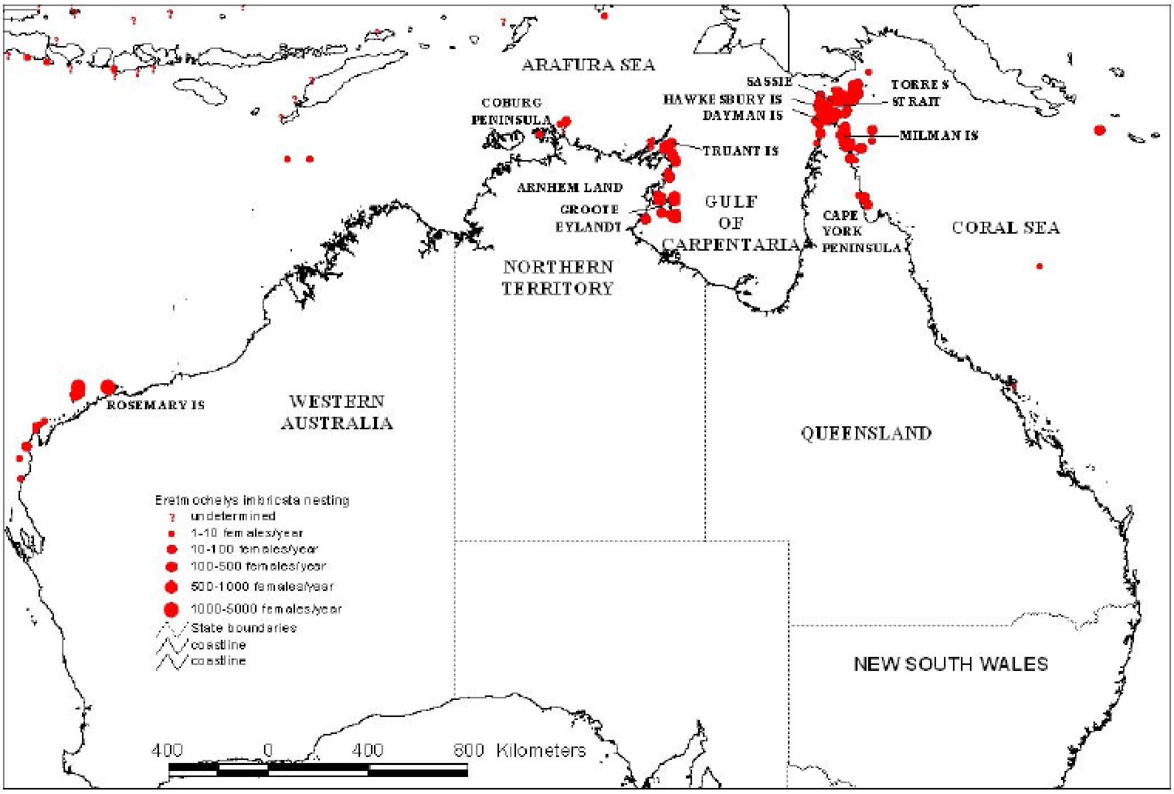


Figure 4-8 Distribution of Hawksbill Turtle nesting beaches in Australia (source: Limpus 2009a)

Hawksbill Turtles within the Abbot Point area

Previous marine fauna surveys undertaken at Abbot Point (GHD, 2009) observed turtles within the coastal waters of Abbot Point (Figure 4-2) including 3 observations of Hawksbill Turtles within water depths of 3m. No turtles were observed in the dredging footprint.

Importance of Abbot Point Hawksbill Turtle population and habitat

There is no known critical or important habitat (as defined in the Recovery Plan for Marine Turtles in Australia, Environment Australia, 2003) for Hawksbill Turtles present within the project area or region. There is no known nesting in the area. No nesting activity is recorded from the Abbot Point region and only one Hawksbill Turtle nesting event has been recorded in the last 70 years in the GBR south of Princess Charlotte Bay (Limpus, 2009a).

The Hawksbill turtle may potentially use the project area for foraging. Areas of seagrass and algal communities that occur within the inshore and offshore areas of Abbot Point provide foraging habitat for Hawksbill Turtles.

4.1.5.4 LOGGERHEAD TURTLE

The Loggerhead Turtle (*Caretta caretta*) is listed as 'endangered' under the IUCN Red List of threatened species, and the Queensland NC Act and 'endangered' and 'migratory' under the EPBC Act. DEHP have Loggerhead Turtles as a critical priority species under the DEHP Back-on-Track Biodiversity Action Plans (DEHP, 2014).

Loggerhead Turtles are widely distributed on a global scale in warm temperate and subtropical oceans (Weishampel *et al.*, 2004). In Australia, Loggerhead Turtles occur in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia (Limpus *et al.*, 1992). Loggerhead Turtles choose a wide variety of tidal and sub-tidal habitat as feeding areas and individual animals show fidelity to both their foraging and breeding areas (Limpus, 2008b). Loggerhead Turtles are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from nearshore to depths of 55m (Plotkin *et al,.* 1993).

There are no concise estimates of global population or annual nesting female numbers for the Loggerhead Turtle; however, the Sea Turtle Conservancy estimates the population of nesting females to be 44,560 globally. The Loggerhead Turtle is considered to comprise of two distinct genetic stocks in Australia — the eastern Australian genetic stock and the western Australian genetic stock. The major rookeries for the eastern Australian stock are on the mainland coast in the Bundaberg region, islands within the Capricorn Bunker group and islands of the Swain Reefs, with minor breeding on the mainland from Bustard Head to the Sunshine Coast. The nearest of these nesting areas to Abbot Point is the Capricorn-Bunker Group islands, which are approximately 520km to the south of the existing Port of Abbot Point (Limpus, 2008b) (Figure 4-9).

The DoE (2014k) database identifies that in the year 2000 it was estimated that there were 500 nesting females per year in the eastern Australian stock. Adult females comprise approximately 20% of the population, which would indicate a total population of approximately 2,500 individuals in the eastern Australian genetic stock. In the Capricorn Bunker Island group there are approximately 10 – 150 nesting females per year. Since the 1970s it is estimated that the number of females nesting annually has decreased by approximately 50 to 80% (Limpus, 2008b). For example, the number of loggerhead turtles nesting at Wreck Island in the Capricorn Bunker group decreased by 86% from 1977 to 2000. The eastern Australian loggerhead turtle stock is showing increases in abundance (GBRMPA, 2014).

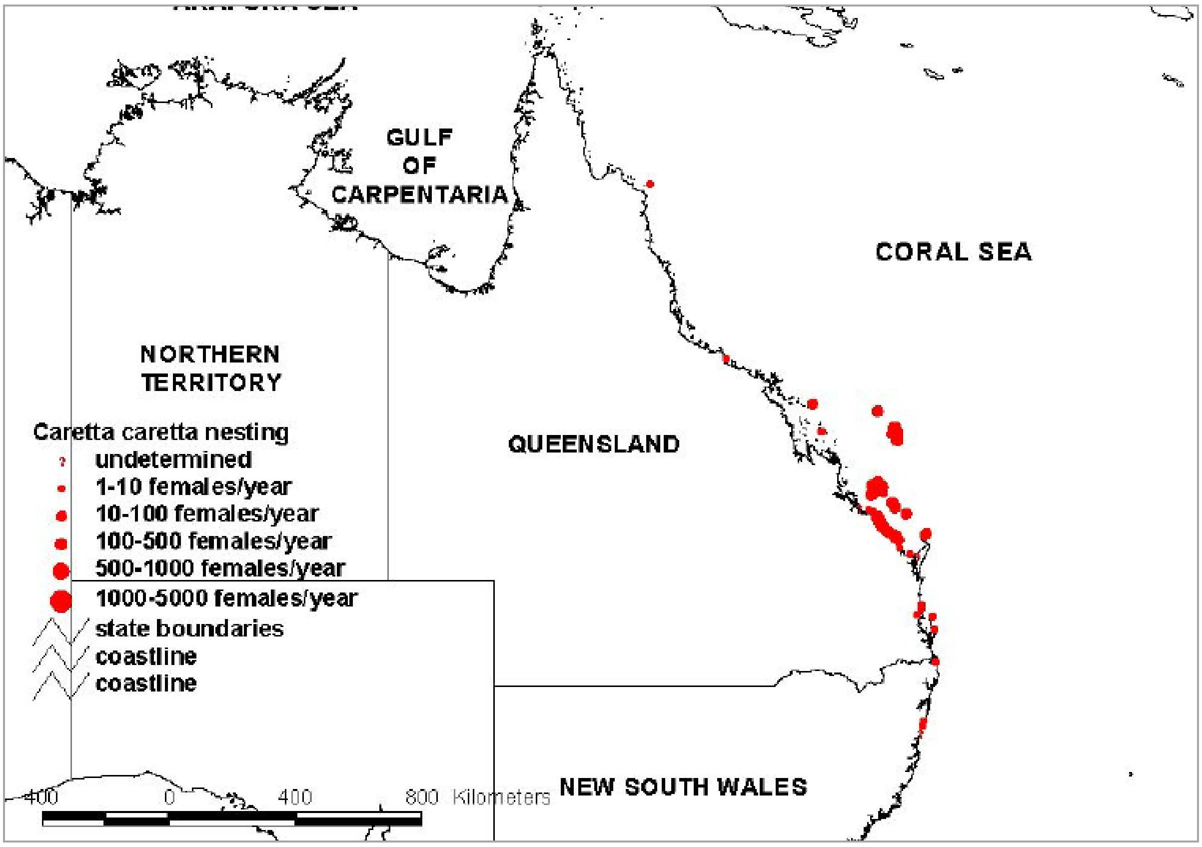


Figure 4-9 Distribution of Loggerhead Turtle nesting sites in eastern Australia (source: Limpus 2008b)

Loggerhead Turtles within the Abbot Point area

There is suitable foraging habitat for Loggerhead Turtles present in the waters offshore of Abbot Point. Two Loggerhead Turtle adults were observed in waters surrounding the existing Port of Abbot Point during December 2008, between 3 and 10m depth (Figure 4-2) (GHD, 2009e). CDM Smith (2013b) has also reported Loggerhead Turtles to be associated with the rocky reef that extends ~2.5km south of the MOF.

The importance of the Abbot Point Loggerhead Turtle population and habitat are discussed with the Olive Ridley Turtles below.

4.1.5.5 Olive Ridley Turtle

The Olive Ridley Turtle (*Lepidochelys olivacea*) is listed as 'vulnerable' under the IUCN Red List of threatened species, 'endangered' the Queensland NC Act 'endangered' and 'migratory' under the EPBC Act. DEHP have Olive Ridley Turtles as a critical priority species under the DEHP Back-on-Track Biodiversity Action Plans (DEHP, 2014).

The Olive Ridley Turtle nests throughout tropical waters and migrates through tropical and sub-tropical areas of the world. The largest nesting population occurs on the east coast of India, with over 100,000 turtles nesting annually. They generally inhabit shallow un-vegetated coastal waters where they feed on gastropod molluscs and crabs and are rarely recorded living within coral reef habitat or seagrass flats (Limpus, 2008c).

DoE (2014l) identifies two studies that estimate global annual nesting populations to be 852,000 and 2,000,000 respectively. Detailed information on the size of nesting and foraging populations in Australia is unknown, although the nesting population is estimated to be a few thousand. On the east coast of Australia, the GBR is known to provide a substantial part of the foraging habitat for Olive Ridley Turtles. There are no known nesting areas on the east coast of Australia (Limpus, 2008c) (Figure 4-10).

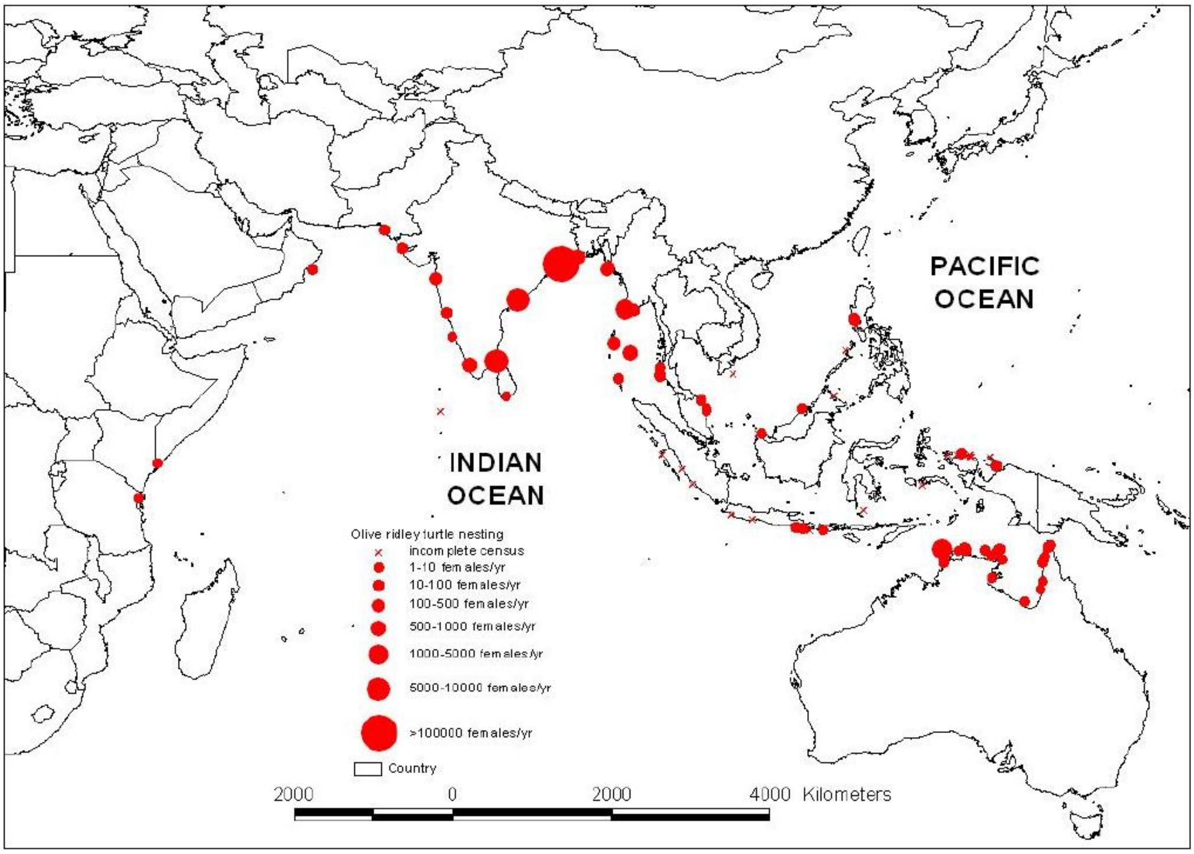


Figure 4-10 Distribution of Olive Ridley Turtle breeding sites in the Indian Ocean – Western Pacific (Source: Limpus, 2008c)

Although there are major nesting aggregations in other parts of the world, there are no dense nesting aggregations of Olive Ridley Turtles in Australia. Within Australia nests occur at low densities along the north-western Cape York Peninsula, the Gulf of Carpentaria, and the Arnhem Land Coast through to the northern shelf of Western Australia. It is not known if there is any genetic subdivision in the Australian population (DoE, 2014l).

The Olive Ridley Turtle is the most numerous of all marine turtles, although the global population is estimated to have decreased by 28 to 32% over 20 years (Albreu-Grobois & Plotkin, 2008). Within the South-east Pacific many populations have declined significantly due to continuing over-harvest of eggs. There are no data to indicate a change in population size in Australia.

Olive Ridley Turtles within the Abbot Point area

Olive Ridley Turtles have previously been confirmed to be present at Abbot Point, although sightings of this species in the GBRMP are rare (GHD, 2012e, GBRMPA, 2014). The importance of Abbot Point to the Olive Ridley Turtle population and habitat are discussed with Loggerhead Turtles below.

Importance of Abbot Point to Loggerhead and Olive Ridley Turtle populations and habitat

Abbot Point has not been identified as an area of high conservation importance for Loggerhead or Olive Ridley Turtles in the GBR and the area is not considered to represent habitat critical to the survival of any of these three species. This is due to:

- The very low number of Loggerhead and Olive Ridley Turtles sighted in the area
- Absence of any nesting activity for these species in the area.

There are no known nesting records for any of these three turtle species in the Abbot Point area. Existing records for these three endangered turtle species indicate that the coastal and offshore waters near Abbot Point support only small numbers of foraging individuals of Loggerhead and Olive Ridley Turtles. The project area is not listed under the breeding areas considered critical for any of these species under the Recovery Plan for Marine Turtles in Australia (Environment Australia, 2003).

Marine turtles are a group of species within the GBR that were identified as 'at-risk' and a vulnerability assessment for marine turtles has been developed. This assessment detailed concerns for marine turtles within the GBR and recommended management measures.

4.1.6 Rays

4.1.6.1 GIANT MANTA RAY

The Giant Manta Ray (*Manta birostris*) is listed as 'vulnerable' under the IUCN Red List of threatened species, and as 'migratory' under the EPBC Act.

The Giant Manta Ray is the largest of all rays reaching at least 6.7m across the disc. The lobes at the front of the head assist in directing water flow to the gaping mouth, to filter plankton using specialised gill plates when feeding (CDM, 2013a).

The Giant Manta Ray lives in tropical, marine waters worldwide. In Australia it is recorded from south-western Western Australia, around the tropical north of the country and south to the southern coast of New South Wales (Australian Museum, 2014). The Giant Manta Ray is commonly encountered in small groups, near the surface around offshore islands and reefs, with individuals occasionally being observed in sandy bottom areas and seagrass beds.

Giant manta rays within the project area and importance of Abbot Point giant manta rays population and habitat.

Two Giant Manta Rays were opportunistically recorded during the marine megafauna surveys that occurred at Abbot Point from 2008 – 2009 (Figure 4-2). These were observed to be feeding over relatively shallow habitats of 2.6m to 7m depth. However, the project area is not considered an aggregation site or an area that contains breeding of important feeding areas for the Manta Ray.

5. POTENTIAL IMPACTS

The Project is proposed by the Queensland Government (DSD) to support the development of the already approved T0 Project at the Port of Abbot Point through undertaking capital dredging to provide sea access for this terminal. The Project includes:

- Construction of onshore DMCPs within the area previously allocated for the development of T2 and adjoining industrial land
- Capital dredging of approximately 1.1Mm^3 *in-situ* of previously undisturbed seabed for new berth pockets and ship apron areas required to support the development of T0
- Relocation of the dredged material to the DMCPs and offshore discharge of return water
- Ongoing management of the dredged material including its removal, treatment and beneficial reuse within the port area and the Abbot Point State Development Area, where appropriate.
- Booster pump station located 1km offshore anchored in place
- Up to 3km of sunken dredged material water pipeline up to 1.0m to 1.2m in diameter lain onto the seabed
- Up to 1.km of floating dredged material pipeline up to 1.0 to 1.2m in diameter that connect to the CSD dredge and booster stations
- 300m of return water pipelines (two pipelines lain side by side) up to 1.0 - 1.2m each in diameter laid onto the seabed

Key potential impacts to the marine environment associated with the Project include:

- Impacts associated with the potential mobilisation of ASS from PASS in the dredged material
- Water quality decline from the suspended sediments from dredging and dredge return waters
- Reduction in benthic PAR due to increases in suspended sediments from dredging and dredge return waters
- Impacts to marine fauna associated with underwater noise
- Impacts to marine fauna associated with vessel collision
- Habitat loss or degradation caused by dredging of the seafloor and an increase in turbidity and TSS from the dredging plume
- Impacts of artificial lighting on nesting of marine turtles

- Introduction of marine pests.

Each of these potential impacts is described further below. Water quality decline and associated habitat loss or degradation caused by dredging and return water discharge are considered to be the potential impacts of most significance for the Project. As such these impacts are treated in more detail than other potential impacts.

5.1 Potential acid sulphate soils

Potential environmental impacts relating to dredged material and the associated mitigation and management measures were discussed in the PER (GHD, 2012b). Potential impacts of onshore placement of the dredged material may include oxidisation of PASS and subsequent mobilisation of ASS and associated contaminants during returning waters from the DMCP.

The management and mitigation measures for these potential impacts are discussed in Section 6.1.

5.2 Suspended sediments from dredging and return waters

The Abbot Point Cumulative Impact Assessment (CIA) (GHD, 2012e) provides a summary of potential effects from high sediment concentrations and marine water quality impacts on key marine ecological groups. This summary is reproduced in below Table 5-1.

Table 5-1 Key Ecological Groups and the potential effects

Key Marine Ecological Groups	Potential Effect
Marine pelagic environments and plankton communities	Potential reduced productivity due to light limitation
Seagrass communities	Prolonged low light conditions result in reduced growth and mortality
	High rates of sedimentation can result in burial
	Low levels of sedimentation (and associated increase in nutrients) can enhance productivity in some species
Rocky shores, reefs and coral communities	Prolonged low light conditions result in reduced growth and increased mortality of corals and algae
	High rates of sedimentation can result in burial of sessile flora and fauna and reef habitats
Beaches and dunes	Possible changes to invertebrates, but threshold sensitivities are

Key Marine Ecological Groups	Potential Effect
	unknown
Marine subtidal soft sediment habitats and marine impacts	High levels of sediment can result in stress to filter-feeders and changes to community structure
	High rates of sedimentation can result in burial of sessile flora and fauna
	Potential increase in abundance of some benthic fauna in response to increased food resources
Mangrove forests	Very high levels of sedimentation can cause burial of pneumatophores and changes to substrates
Shorebirds and seabirds	High levels of suspended sediment can interfere with locating prey for piscivores
	Loss of intertidal benthic fauna could result in changes of feeding patterns, and temporary avoidance of affected areas
Fish	High levels of suspended sediment can interfere with locating prey, and alter the movement patterns of larval fish
	Loss of seagrass could represent a loss of nursery habitat for many shellfish and fish species, and the avoidance of affected areas
	Loss of benthic fauna could result in changes to feeding patterns
Dugongs	Loss of seagrass could represent a loss of feeding habitat, and the avoidance of affected areas
	Dugong feeding patterns are not directly affected by high concentrations of suspended sediments, but are temporarily affected if seagrass is impacted
Marine Turtles	High levels of suspended sediment can interfere with locating prey
	Loss of seagrass and algae could represent a loss of food resources for green turtles, and avoidance of affected areas
	Loss or alteration of benthic faunal assemblages could result in changes to feeding patterns, and avoidance of affected areas
Cetaceans	Loss or alteration of benthic faunal assemblages could result in changes

Key Marine Ecological Groups	Potential Effect
(dolphins and whales)	to feeding patterns, and avoidance of affected areas

Based on the calculations outlined in Royal Haskoning DHV (2015) the total mass of fine sediment (<63μm, 40% of all sediments to be dredged) released into the marine environment from dredging and return water is approximately 15,900 tonnes. The majority of this mass was suspended by the dredging activity (cutter head), with 780 tonnes resulting from the return water discharge. The majority of the fine sand and coarse silts will settle out in close proximity to the operations. The fine silts and clays may disperse further afield.

Bainbridge et al (2012) measured the variation along a salinity gradient and distance from the coast of TSS concentrations and sediment particle size composition for the Burdekin River during ***peak discharge*** conditions in December 2010. This study found the fraction of sediments that travelled >3.5km were the fine silts and clay fraction only. The majority of the coarser silts and sands dropped out of suspension within 3.5km of the river mouth.

This is consistent with the relevant offset requirement for the previous approval for the dredging of T0, T2and T3 and offshore placement (EPBC2011/6213), which required offsetting in relation to fine sediments defined as *Fine Sediments are clay and fine silts <15.6μm, being the fractions that would be potentially available for resuspension.*

The fraction of fine sediment <15.6μm (fine silt and clay) in the sediment to be dredging of T0 represents 25% of all available sediment. This fraction of sediment will disperse the furthest from the cutter head.

Based on this definition, the total mass of fine silt and clay which enters the marine environment from the cutter head and return water discharge is approximately 9,938 tonnes.

5.3 Underwater noise

The generation of underwater noise from dredging activities has the potential to displace marine megafauna from critical habitat and interrupt critical behaviours. The main source of underwater noise source relating to this Project that may impact on marine fauna is the dredging vessel which emits a continuous source of noise compared to an activity like piling, which emits pulses of sound.

Impacts of noise on marine mammals may be behavioural or physiological. Behavioural impacts include changes in vocalisation, resting, diving and breathing patterns, changes in mother-infant relationships, masking of biologically important sounds (including those for communication and social interaction) and avoidance of the noise sources (McCauley *et al*., 2012). Physiological effects of underwater noise are more associated with the auditory system and can cause a reduction in the animal's hearing sensitivity, or an increase in hearing threshold. Physiological impacts can also include non-auditory secondary effects associated with other systems including the vestibular system, reproductive system, nervous system, liver or organs with high levels of dissolved gas concentrations and gas filled spaces.

The potential impacts of underwater noise on whales, cetaceans and marine reptiles are described in Section 6.3 and Section 6.7

5.4 Vessel collision

Vessel movements associated with this Project have some potential to impact marine fauna of conservation significance by increasing the possibility of collisions between vessels and fauna. Vessel collision with marine fauna can lead to fauna injury or death.

Fauna that surface to breath, (e.g. whales, dolphins, turtles and dugongs), are slow moving (turtles and dugongs), or utilise shallow habitats for critical behaviours such as foraging, feeding, breeding or nesting (turtles and dugongs) are considered more at risk from vessel collision. A key determinant in the potential for collisions between vessels and marine megafauna is the speed of the vessel, with high speed vessels (e.g. power boats and jet skis) causing more marine fauna injuries and mortalities than low speed vessels (Hodgson and Marsh, 2007).

Cutter suction dredgers (CSDs) are anchored during dredging and move at slow speeds to reposition, either with self-propulsion or the use of tug boats. Support vessels, which are smaller and able to plane on the water, have a higher risk of negative interactions with marine fauna. The use of additional vessels has been reduced with the elimination of offshore placement. The potential likelihood of fauna colliding with vessels for each species or group of species of conservation significance is discussed in Section 6.

5.5 Dredging water quality and habitat impacts

Habitat loss or modification can be caused by direct or offsite impacts of dredging and return waters. The direct impact of this Project is the removal of habitat from within the dredging footprint, while offsite impacts may include a decline in water quality associated with dredging activities and return waters and/or a decline in habitat area caused by smothering or other degradation of habitats.

The majority of the marine environment at Abbot Point is characterised by open seabed habitat. This habitat supports small patches of benthic macroinvertebrate communities (see Section 3). No coral reef complexes of high biodiversity have been identified with the Port limits. The nearest fringing reefs are at Camp Island, Holbourne Island and Nares Rock (see Section 3.3 and Figure 3-3). The known coral spawning period at Abbot Point is generally after the full moon in November, inshore reefs can also spawn in late October and December depending upon the environmental conditions. Coral communities and the breeding of these communities (spawning) are unlikely to be impacted upon by the dredging using a cutter type dredge and onshore placement.

Based on surveys by TropWATER since 1987 to July 2014 the primary sensitive receptor (and habitat) which is likely to be impacted upon by the dredging activities in the Abbot Point area is seagrass.

In terms of marine habitat, the potential impacts from the Project are focused on the seagrass habitat loss only and are discussed in Section 6.2.

The impacts of habitat loss and modification are discussed for each species or group of species in Section 6.7 with potential mitigation and management measures outlined in Section 8.

5.6 Impacts of artificial lighting on marine turtles

Nesting of marine turtles including Green Turtles and Flatback Turtles on the coastal beaches near to Abbot Point has been recorded. Nesting generally occurs between the high water mark and foredune. Marine turtles show high site fidelity to nesting beaches and return to nest on their natal beaches with a high degree of precision (Limpus *et al*., 1984). Artificial lighting/light pollution (e.g. from the proposed facility) can result in avoidance of nesting beaches by marine turtles and can impact on the ability of hatchlings to orientate after leaving the nest (Witherington and Martin, 1996; Limpus, 2008a). Lighting cues are known to be critical in allowing hatchlings to find their way from the nest to the ocean (i.e. to lighter areas in the absence of artificial lighting). Increased hatchling mortality from disorientation, heat exhaustion or increased levels of predation on hatchlings may result (Limpus, 2008). In effect, avoidance of beaches with artificial lighting results in habitat loss (Witherington and Martin, 1996).

5.7 Introduced marine species

Introduced Marine Species (IMS) are species translocated to regions outside their natural range, typically by the passage of vessels nationally and internationally. Where these species present a threat to human health or environmental and economic values, they are termed a 'pest'. Outbreaks of marine pests are a possible risk at ports trading with international clients.

Translocation of marine pests may occur via:

- Ballast water - used to control the trim and draft of a vessel
- Fouling - encrusting organisms via fouling of vessels (e.g. hulls, propellers, intake grates etc.)

- Other - accidental or intentional releases from the aquarium industry.

More detail on the potential impacts of IMS during the Project related activities is discussed in Section 6.5. Proposed mitigation measures are outlined in Section 8.1.3.

6. IMPACT ASSESSMENT

6.1 Potential acid sulphate soils

Sediment samples were collected at 12 locations across the Project's approved dredging footprint in T0, in accordance with NAGD (Commonwealth of Australia, 2009). Although the investigation was not consistent with QASSIT guidelines, it was approved by the GBRMPA (GHD, 2012). The outcomes of this investigation were:

- Marine sediment profiles were generally comprised of about 2m of loose/soft sands, clayey sands and sandy clays overlying alluvial deposits of firm to very stiff sandy clays.
- Laboratory testing indicated the marine sediments were PASS with a neutralising capacity greater than the acid generating capacity, likely due to the presence of shell and other calcareous materials throughout the sediment. Therefore, these marine sediments are self – neutralising.
- The PASS sediments do not pose a risk to the marine environment during dredging as they will remain saturated. However, the composition of the dredged material placed onshore will change as a result of settling. The separation of fine material and dewatering may result in an increased risk of ASS. These risks and mitigation measures are addressed in the Acid Sulphate Soil Management Plan (ASSMP) (Golder 2015b). The management of other environmental risks (such as turbidity, elevated sedimentation etc.) associated with the dredging activities will be addressed under a separate outline Dredging Management Plan.

6.2 Marine habitat impact assessment

6.2.1 Suspended sediments from dredging and return waters

6.2.1.1 Surface Plume Snap Shots

The predicted bed layer concentrations of TSS and sedimentation rates are used to assess the potential impacts of these parameters on the marine habitat and are considered a worst case scenario. To envisage what the actual plume will look like on the surface whilst the dredging is underway, the modelled surface layer 95th percentile concentration of TSS one week, three weeks and five weeks after commencement, along with one week after the completion of dredging, is presented in this section. These snap shots represent a time period of one hour.

TSS concentrations are predicted to be less than 10mg/L except for directly adjacent to the dredging area. It is highly unlikely that such low surface layer TSS concentrations would result in a clearly defined visual plume (see Figure 6-1). Only values above 20mg/L are likely to be visible in the water column, close to the dredging operations.

A very conservative approach is used in these snap shot presentations. Water samples collected and sent for analysis at the laboratory for TSS generally have a LOR value for TSS of 2mg/L. TSS concentration contours for the snap shots begin at the 3mg/L level of concentration. This value of TSS represents a turbidity value of 2NTU (based on the TSS to NTU conversion factor described in Section 2.3.3) in the water column. Such small concentrations are unlikely to be visible (refer to Figure 6-1)

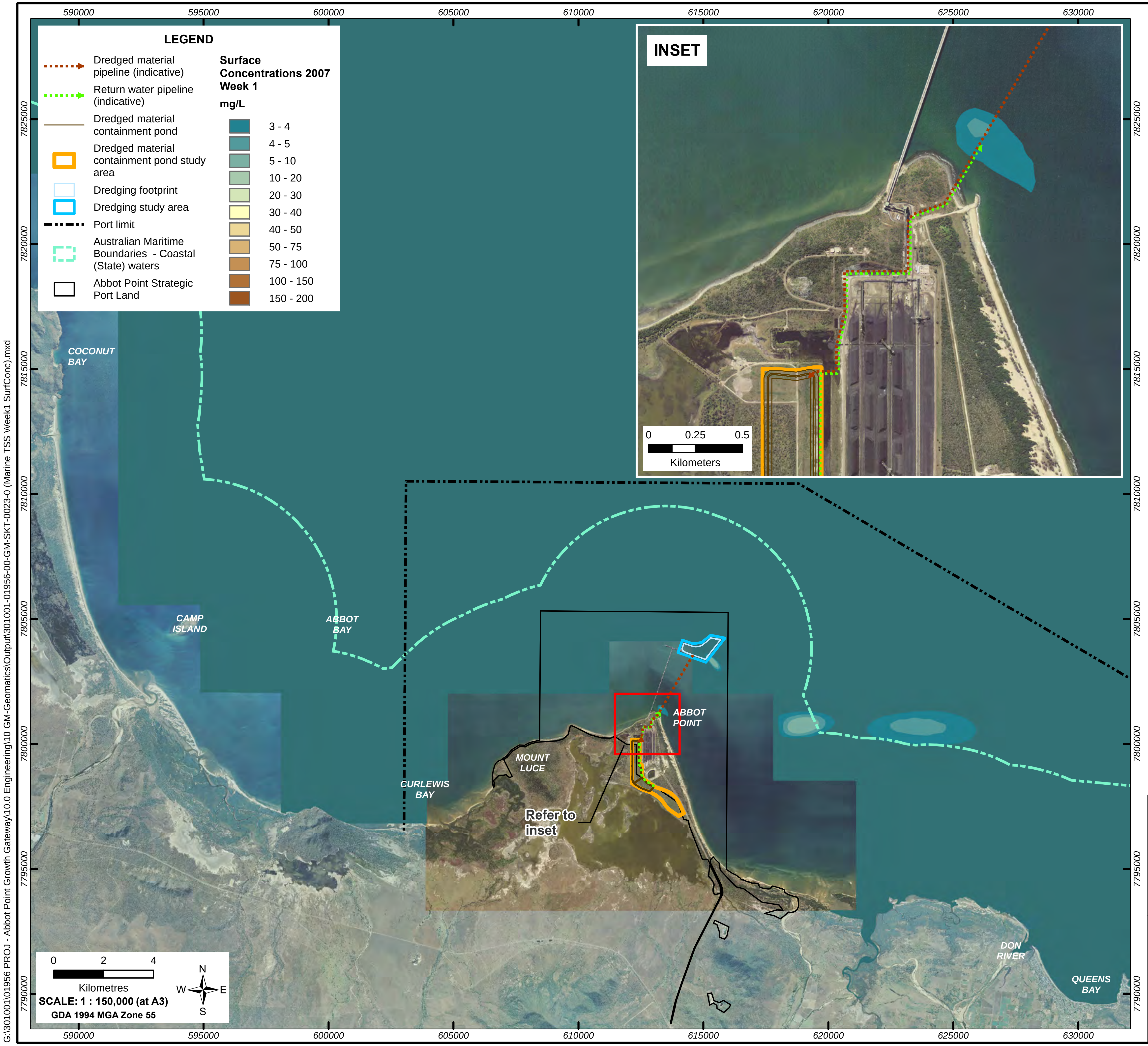
At the end of week one of dredging and return water operation the extent of the 3mg/L scattered plume in the surface layer extends to the 11km to the south-east (Figure 6-2). No concentration >5mg/L are predicted to occur in the surface layer. A small plume <400m to the south-east of <5mg/L may be seen emanating from the return water location (see inset Figure 6-2)

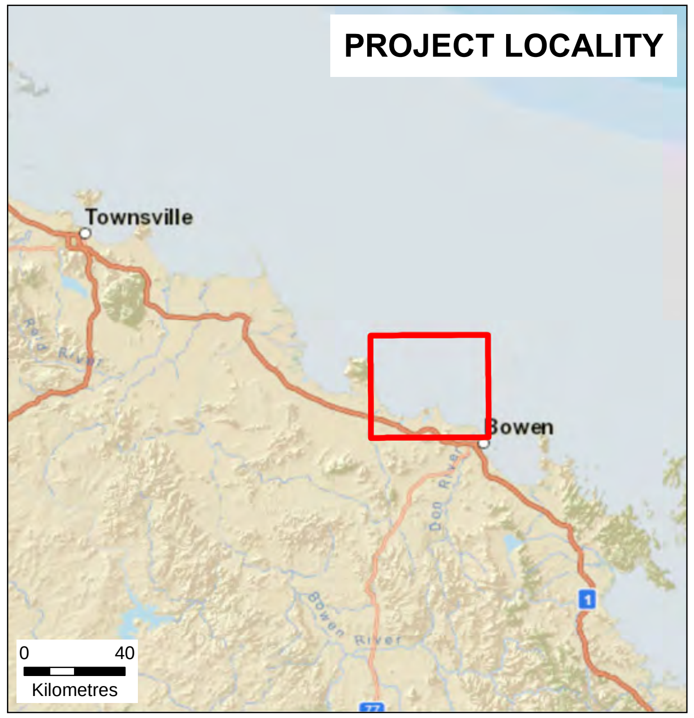
At the end of week three of dredging and return water operation the extent of the 3mg/L plume in the surface layer extends to the 6km to the north-west beyond the T0 dredging area (Figure 6-3). TSS concentrations between 5 and 10mg/L are predicted to occur in the surface layer in the vicinity of the dredge extending 2km to the north-west. No plume is predicted to be visible emanating from the return water location (see inset Figure 6-3).

At the end of week five of dredging and return water operation the extent of the >3mg/L scattered plume in the surface layer extends to the 14km to the north-west (Figure 6-4) and in the immediate vicinity of the dredge. No plume is predicted to be visible emanating from the return water location (see inset Figure 6-4).

One week after the dredging campaign no surface layer TSS concentrations at the dredging footprint or return water are predicted to occur (Figure 6-5).

Figure 6-1 Examples of a range of TSS concentrations (photo courtesy of RHDHV)





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

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Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
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Dredged material containment pond
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Dredged material containment pond study area
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Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
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Figure 6-2
TSS surface concentrations - Week 1

Figure: 301001-01956-00-GM-SKT-0023 | Rev: 0

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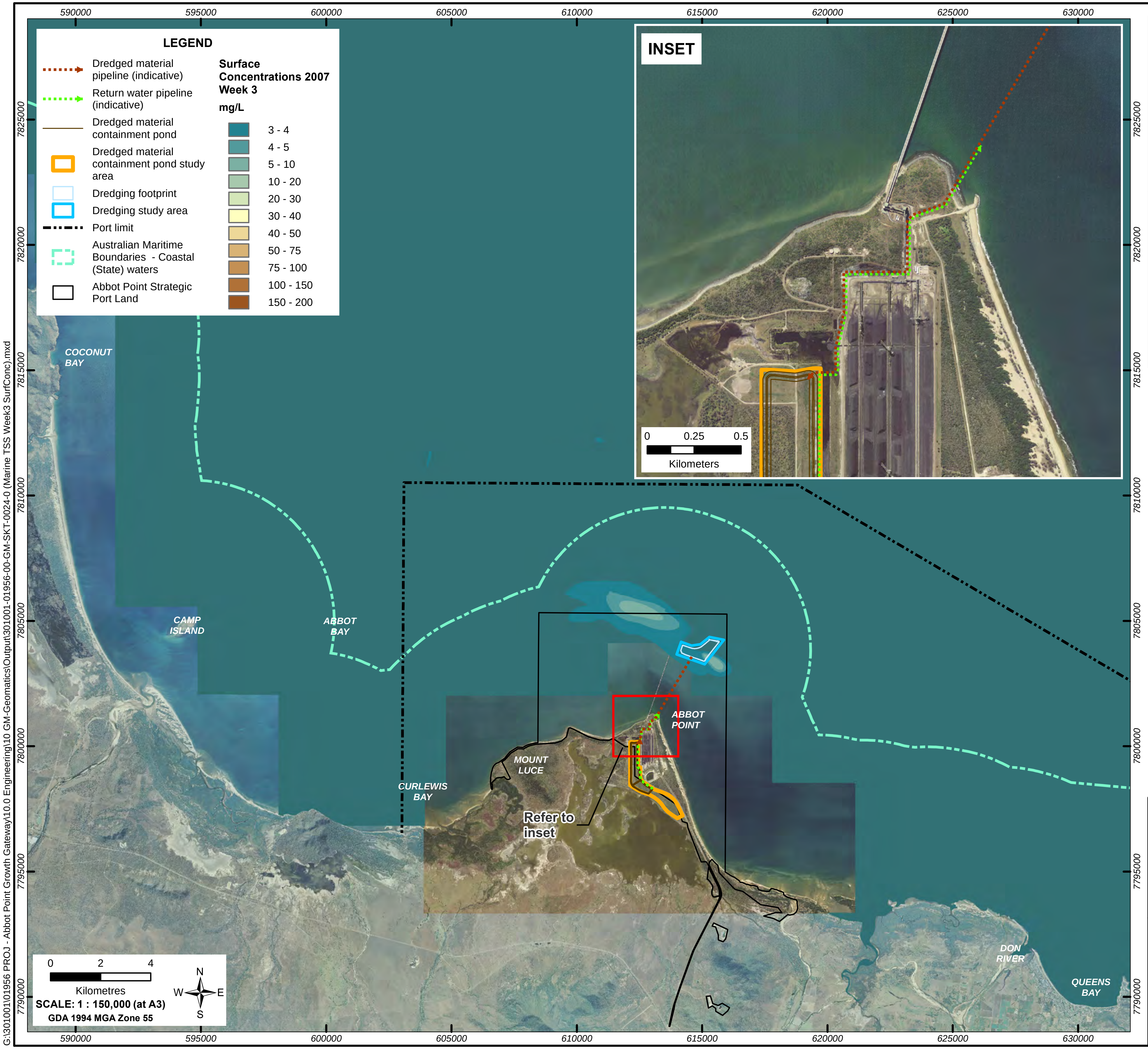

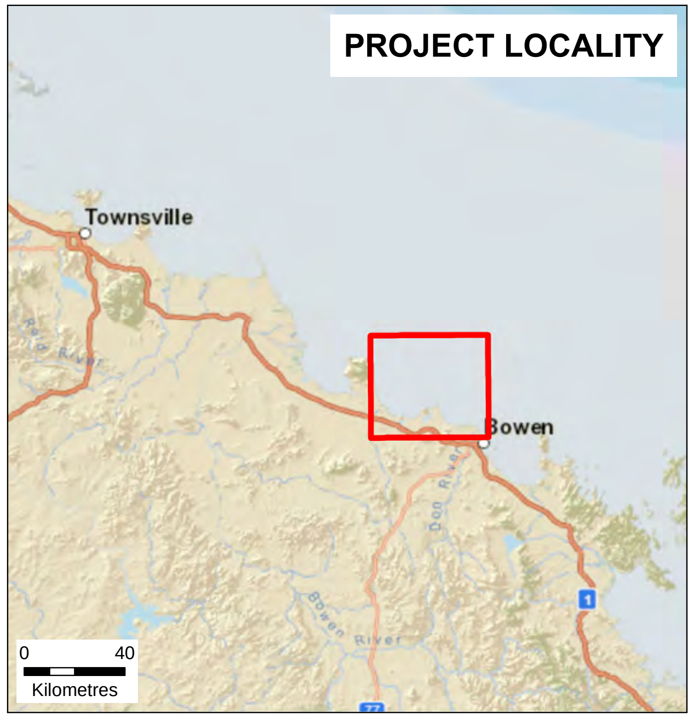

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Figure 6-3
TSS surface concentrations - Week 3

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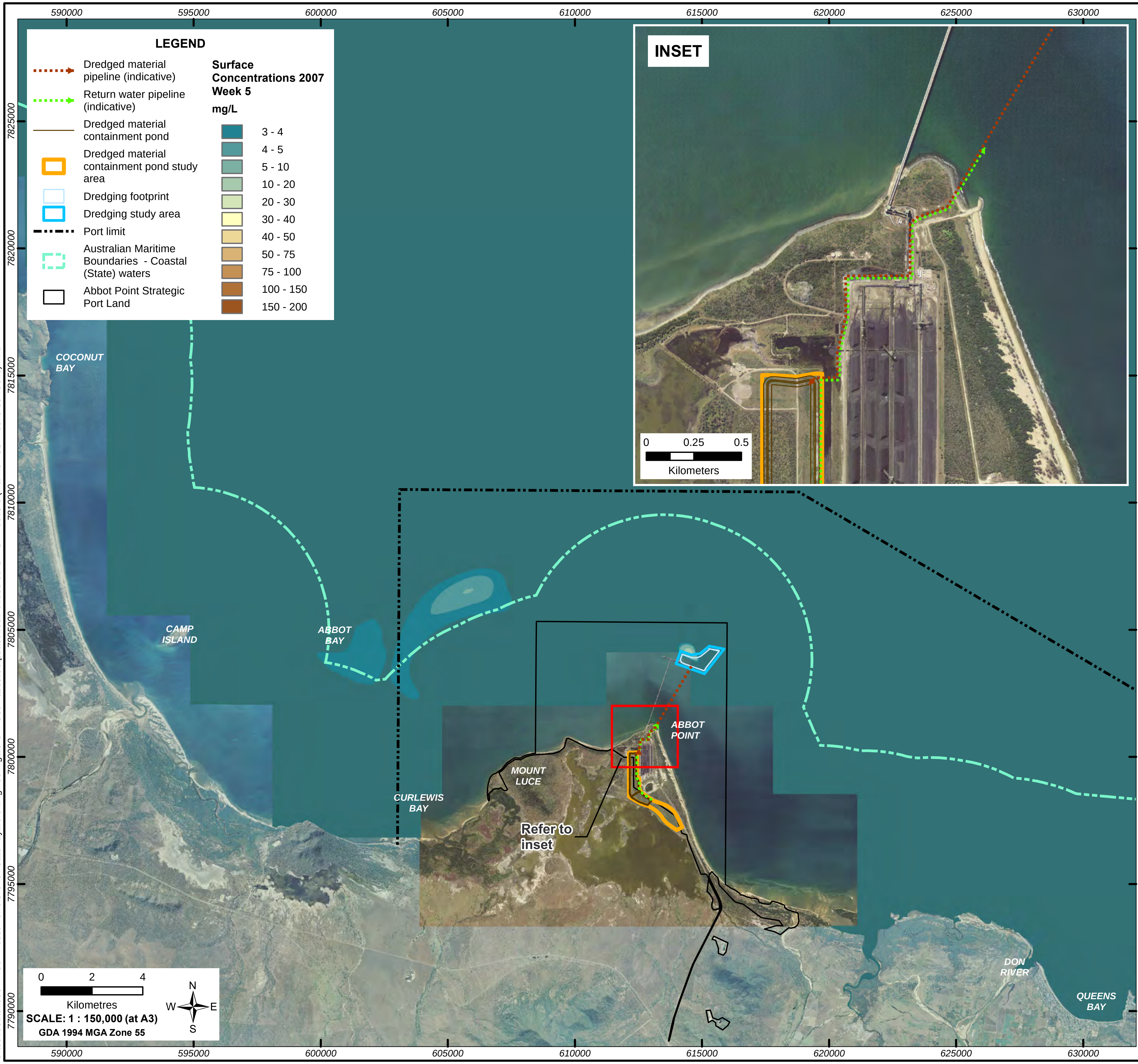

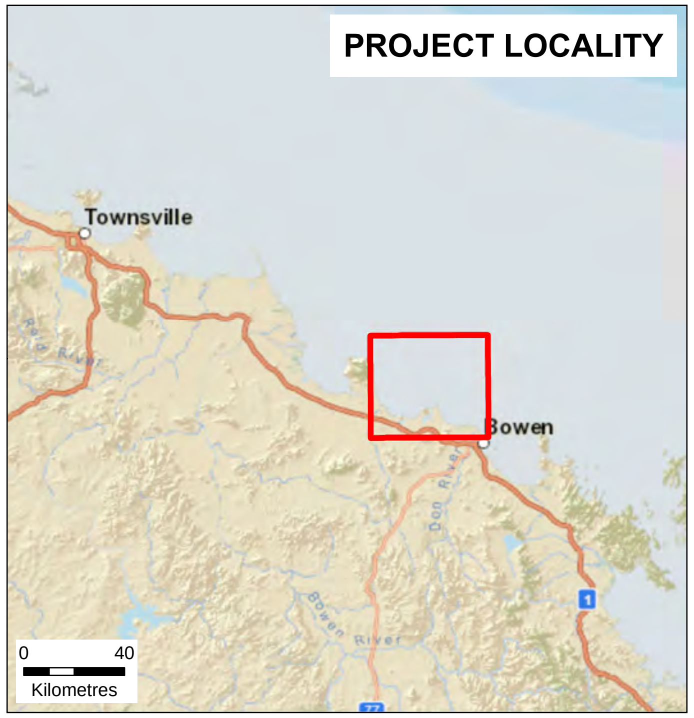

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Figure 6-4
TSS surface concentrations - Week 5

Figure: 301001-01956-00-GM-SKT-0025 | Rev: 0

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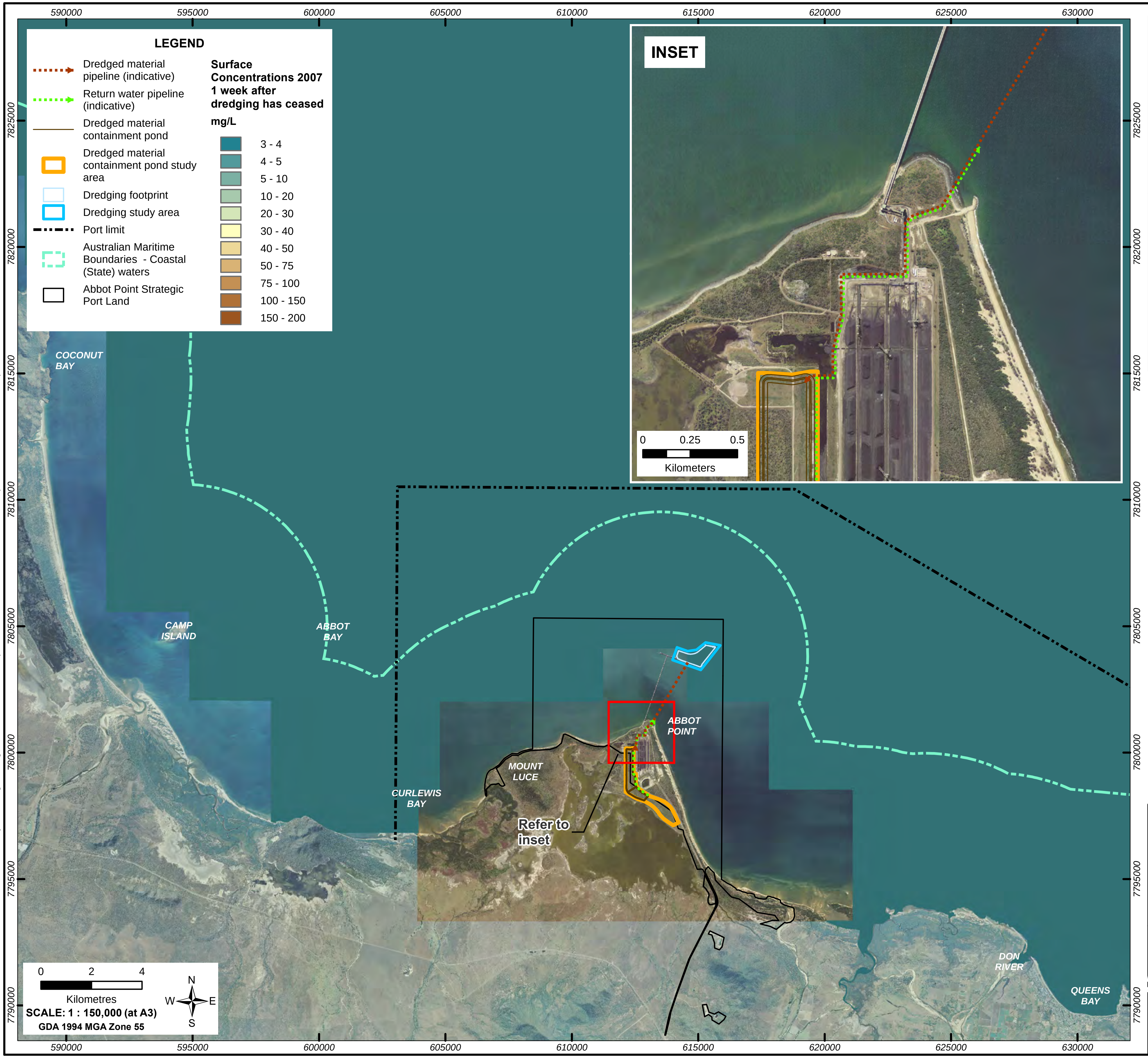

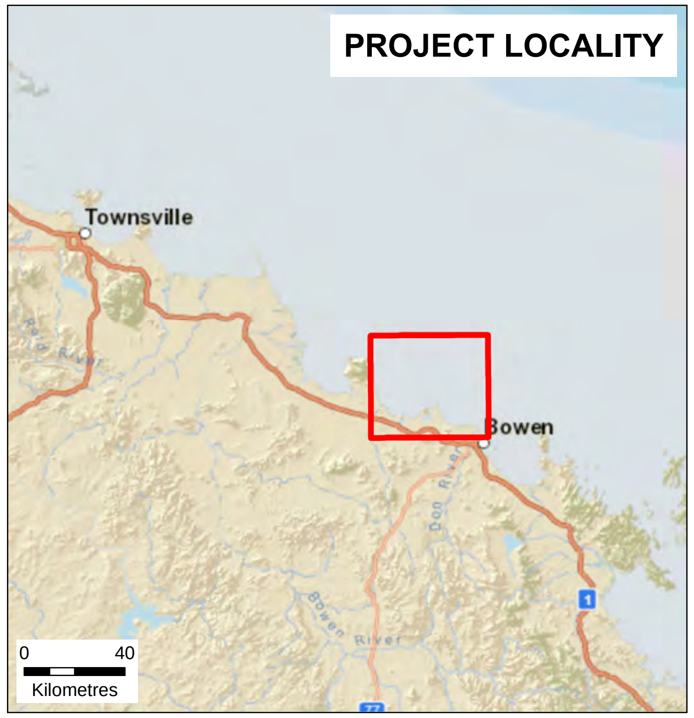

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-5
TSS surface concentrations
1 week after dredging has ceased

Figure: 301001-01956-00-GM-SKT-0026 | Rev: 0

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6.2.1.2 TSS Percentile Plots

Percentile plots do not show an actual dredging plume at any point in time. These plots are duration based plots which show statistical summaries of the dredging plume dispersion over the entire dredge period. The percentile plots show the value for which TSS throughout the dredging duration is less than, for a given percentage of the time. For example, the 95^{th} percentile shows the value throughout the dredging duration for which the TSS is below for 95% of the time. Median, 80^{th} and 95^{th} percentile plots are presented and discussed in the following section. Each plot contains an inset which allows for closer examination of the spatial extent of the TSS data from the return water locations and surrounds for each given percentile metric. The data representations of concentrations of TSS (mg/L) are for the modelled layer closest to the seabed only. This layer contains the highest concentrations of TSS of any layer and represents the 'worst case' scenario (as described in Section 2.3).

Median of 50^{th} percentile plots for the dredging period for the dry and wet season are presented in Figure 6-6 and Figure 6-7, respectively. These plots show the concentrations of elevated TSS for 50% of the time will be completely confined to the dredging area and immediate surrounds. At the return water location the concentrations >2mg/L will be confined to an area on the seabed within 100m of the return water for both seasons.

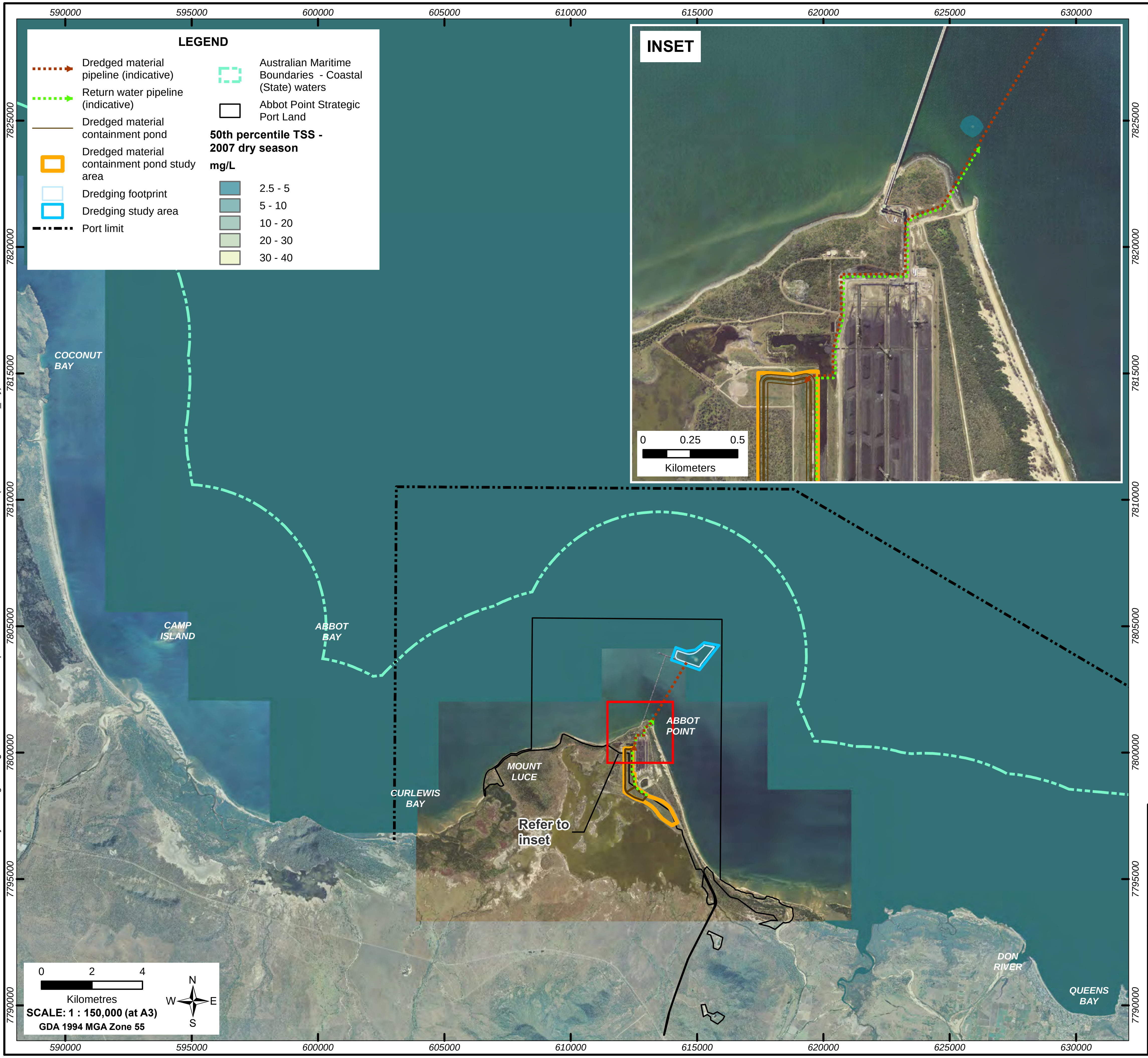
The 80^{th} percentile plots for the dry and wet season are presented in Figure 6-8 and Figure 6-9, respectively. The results show that the area impacted by the increased TSS >5mg/L is mainly localised to the dredging area in both season scenarios. In the dry season the concentrations of <5mg/L may be found in areas to the north-west from the dredging area for approximately 8km. In the wet season the extent of the predicted concentrations <5mg/L is reduced compared to the dry season down to a distance of 4.4km from the dredging area. At the return water location the concentrations >5mg/L are confined to an area on the seabed within 100m of the return water for both seasons. Seabed areas 350m to the north-west and 150m to the south-east of the return water may experience concentrations <5mg/L during the return water operation

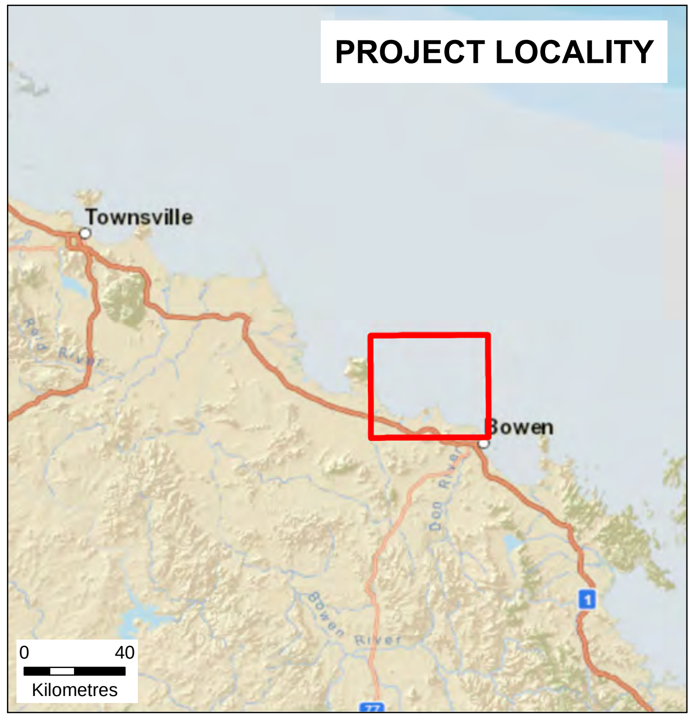
The 95^{th} percentile plots for the dry and wet seasons are presented in are presented in Figure 6-10 and Figure 6-11, respectively. During the dry season the areas where concentrations of TSS >5mg/L may be detected 5.3km beyond the dredging area to the north-west and 3km to the south-east. TSS concentrations of <5mg/L may be detected at the seabed 23km to the north-west toward Camp Island and 7.5km to the south-east. At the return water location the concentrations >5mg/L are confined to an area on the seabed within 100m of the return water for both seasons. Seabed areas 350m to the northwest and 150m to the south-east of the return water may experience concentrations <5mg/L during the return water operation.

Immediately adjacent to the return water location is the only area where the TSS resulting from the return water has been modelled to exceed 5mg/L. In the dry season the area with increased TSS of between 2 and 5mg/L resulting from the return water extends up to 2.5km to the south-west and 1.6km to the south-east of the returning water location. During the wet season the area with increased TSS of between 2 and 5mg/L resulting from the return water extends up to 2.2km to the south-west and 4.4km to the south-east of the returning water location.

The results show that there is little to no interaction between the suspended sediment plumes resulting from the dredging and the return water, the areas with increased TSS remain separate.

The predicted plume which may be visible at the sea surface is presented and discussed in section **6.2.1** (Figure 6-2 to Figure 6-5).





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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-6
TSS 50th percentile - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0017 | Rev: 0

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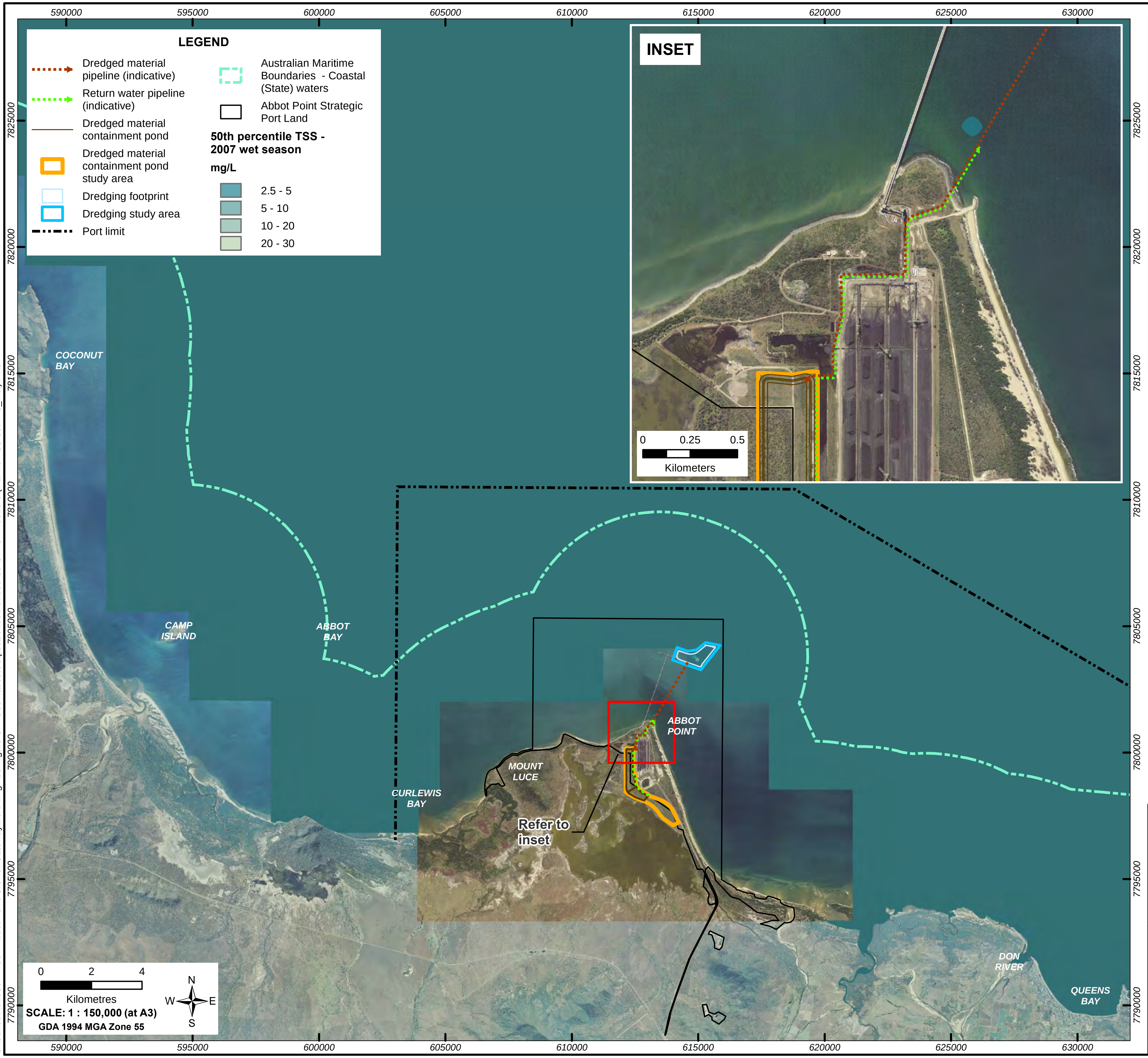

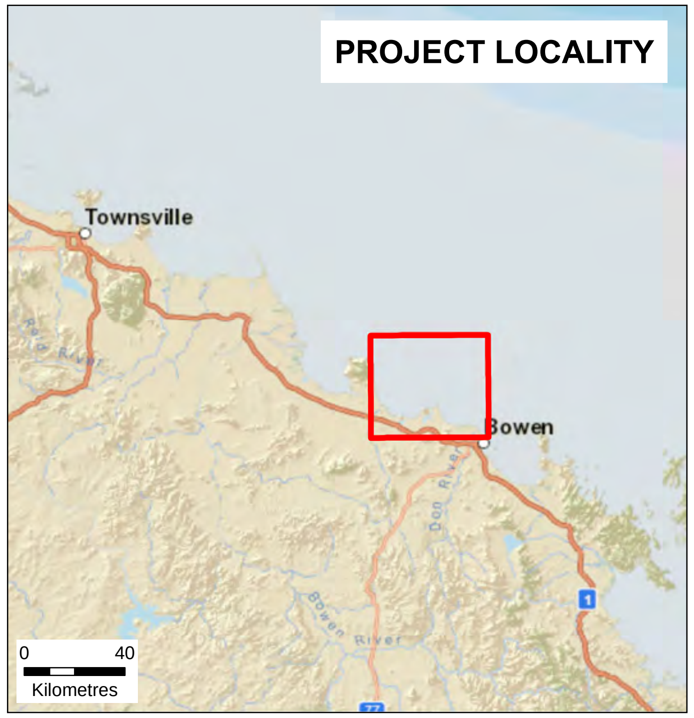

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-7
TSS 50th percentile - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0018 | Rev: 0

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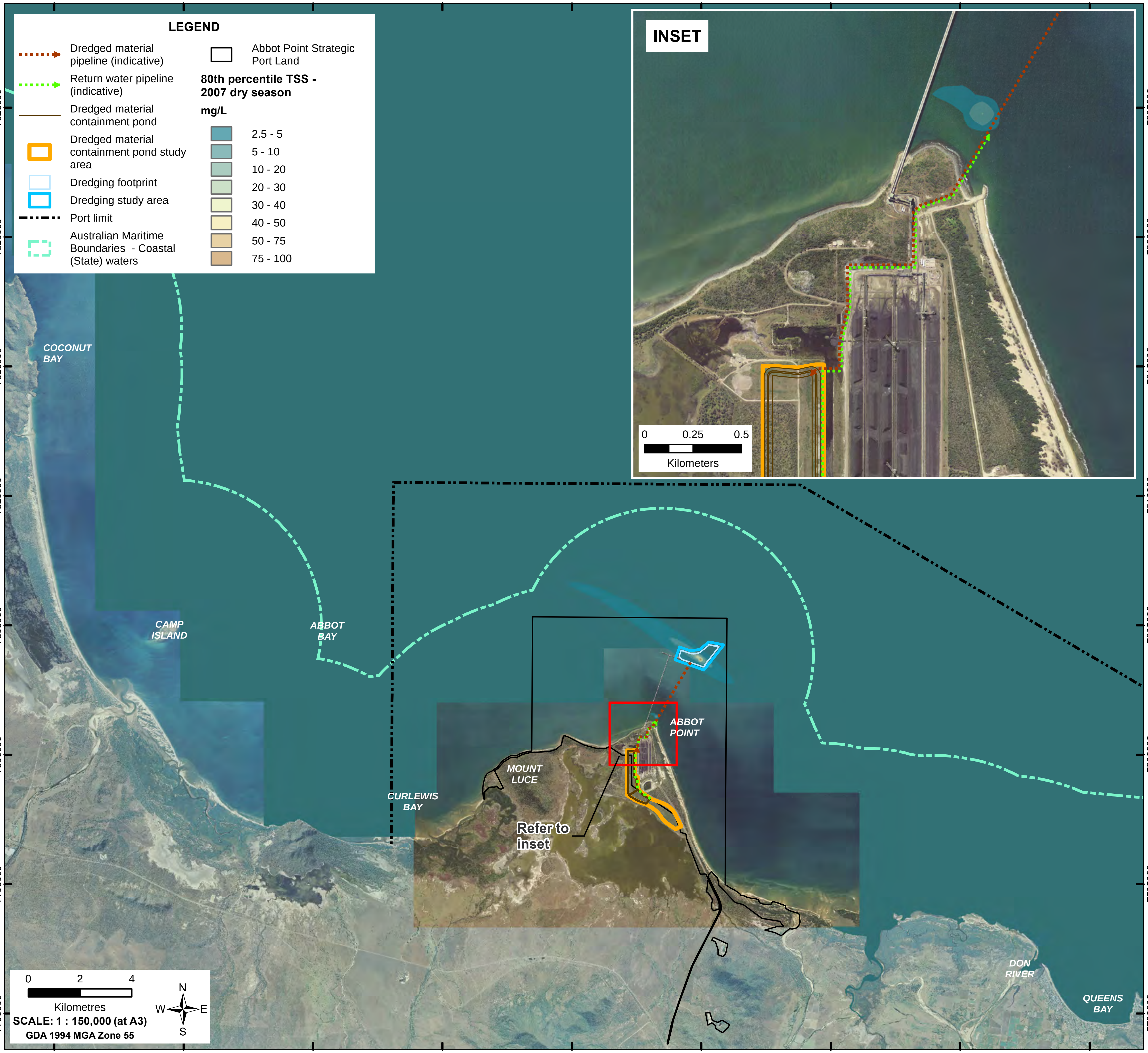

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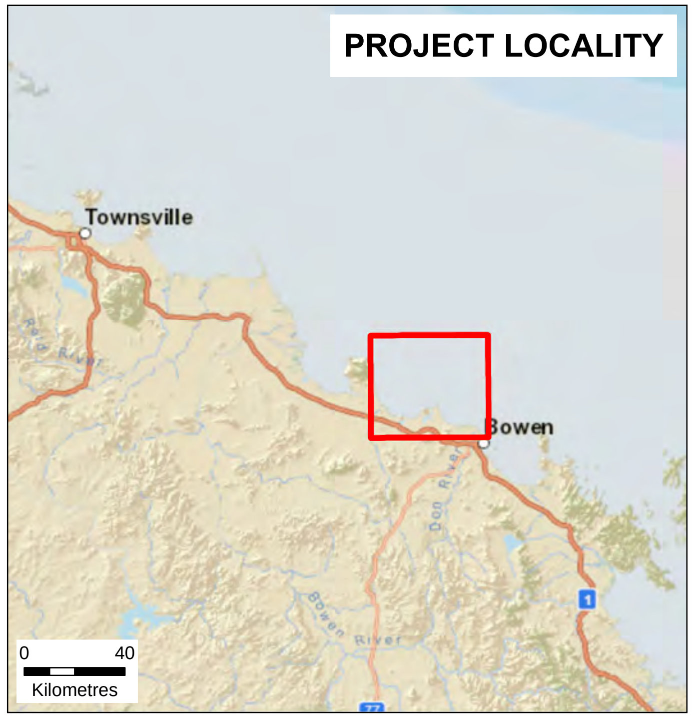
PROJECT LOCALITY



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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-8
TSS 80th percentile - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0019 | Rev: 0

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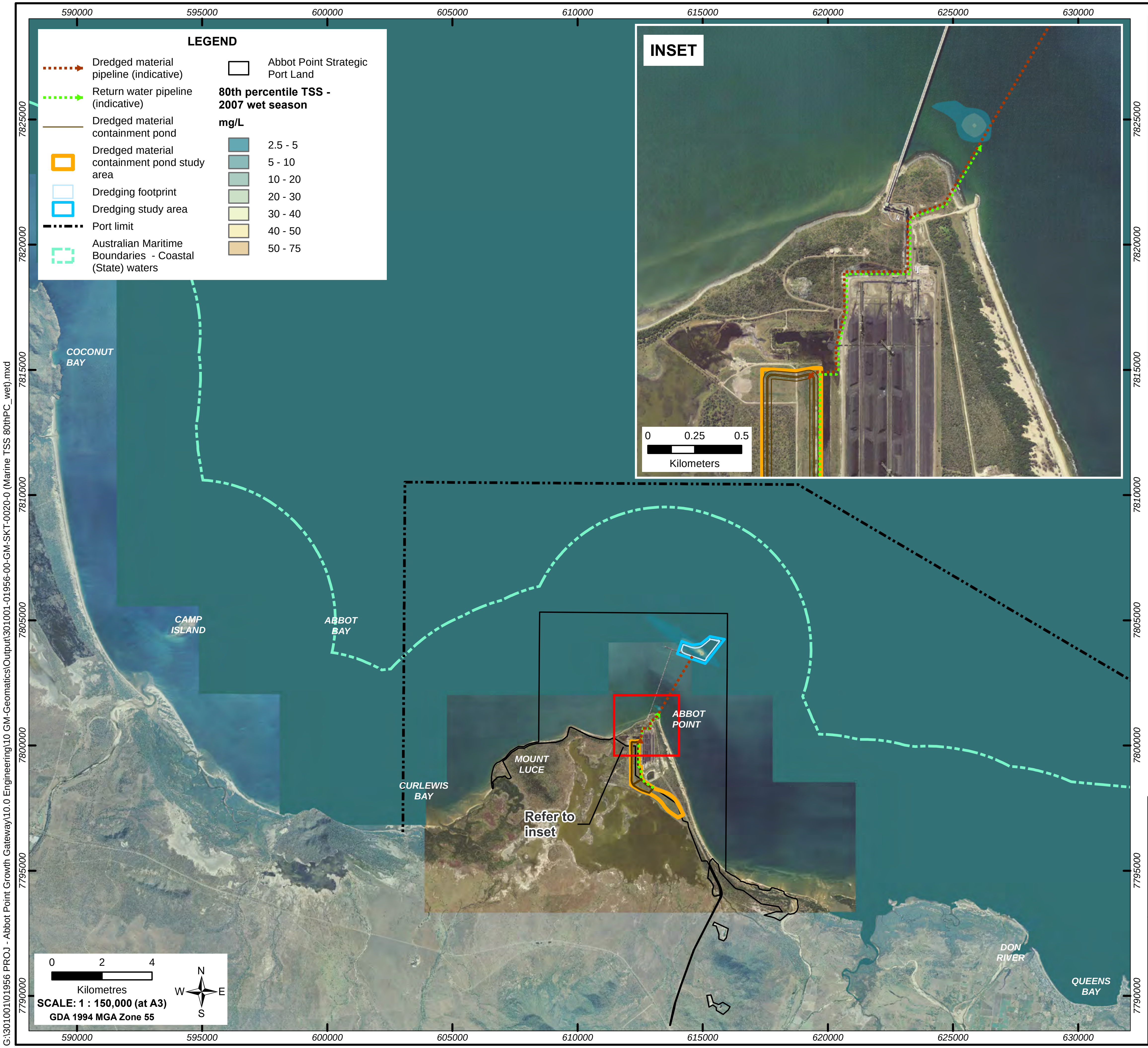

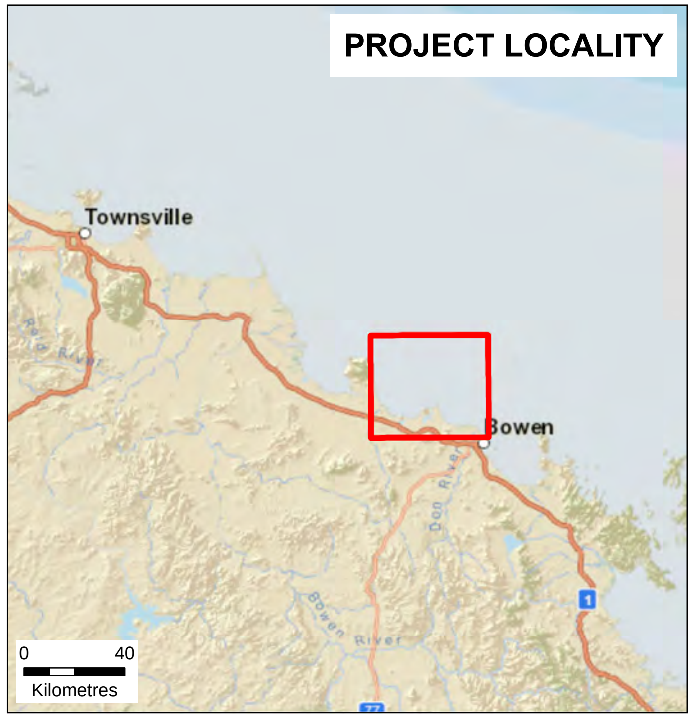

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-9
TSS 80th percentile - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0020 | Rev: 0

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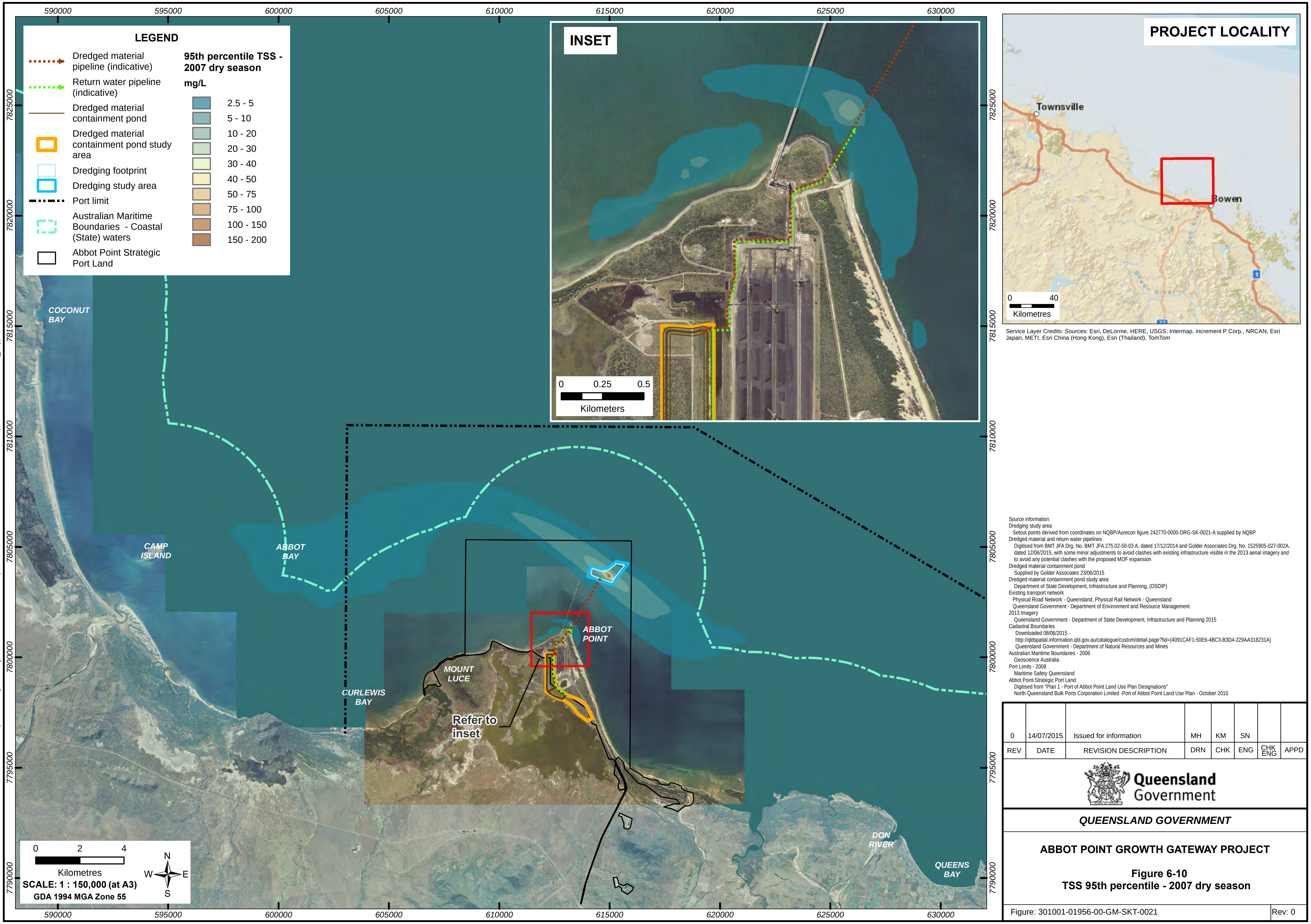

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-10
TSS 95th percentile - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0021 | Rev: 0

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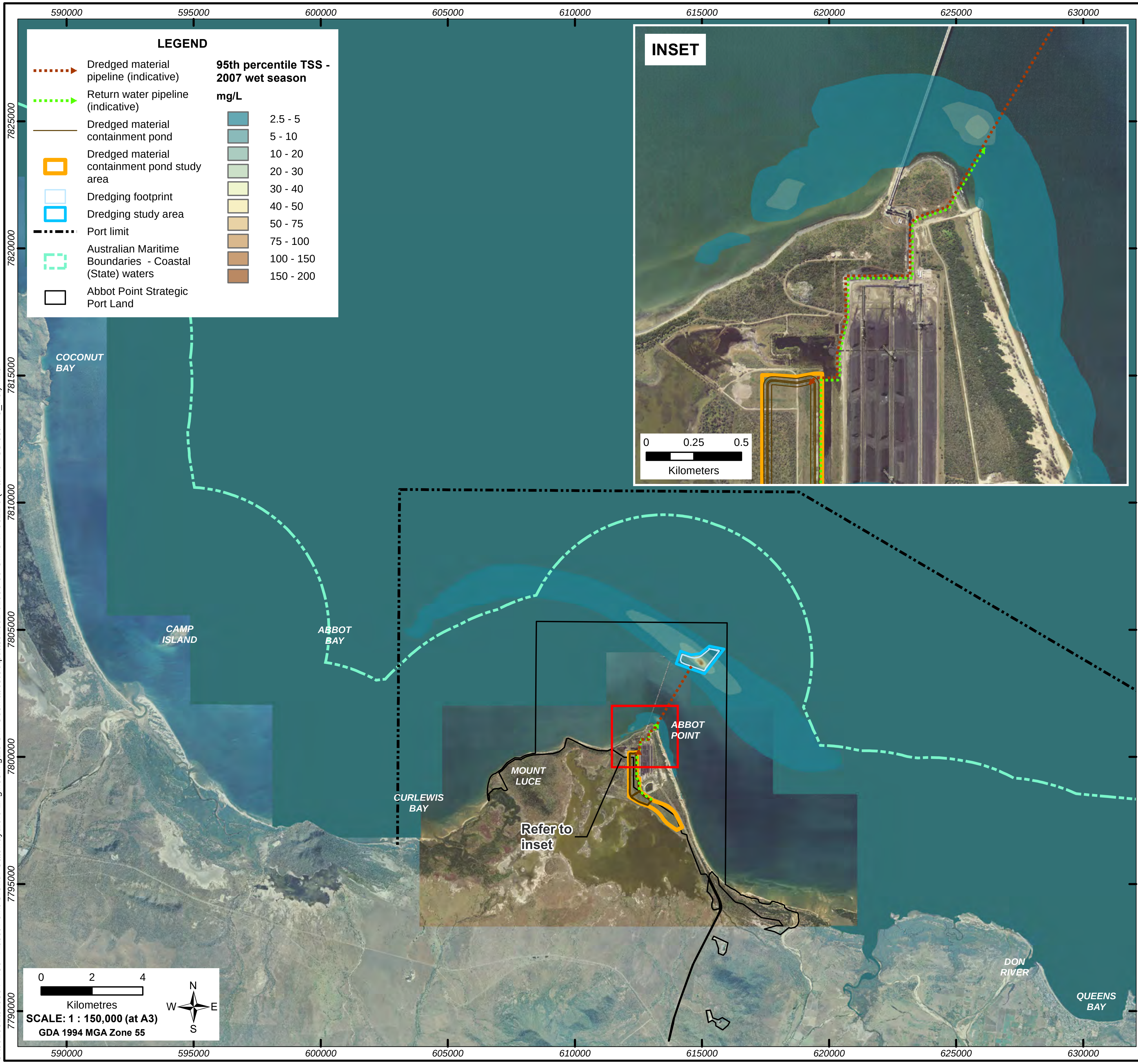

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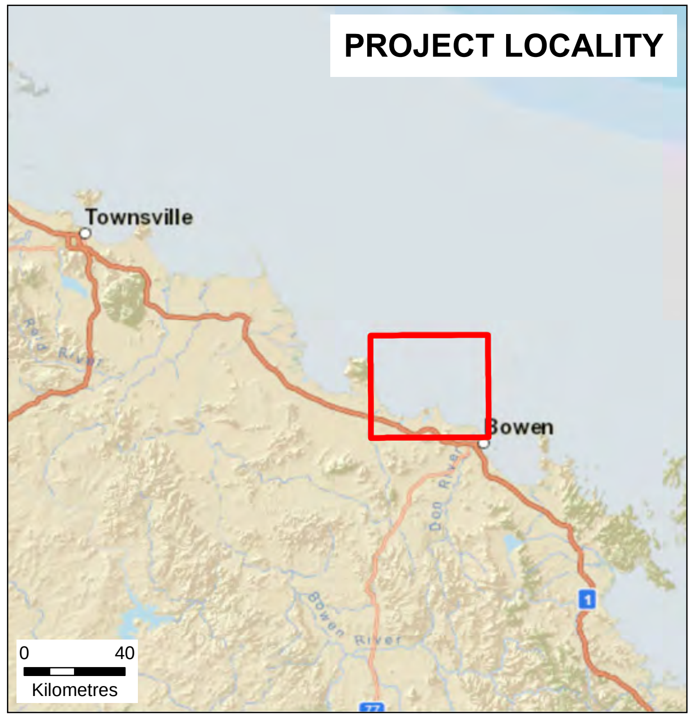

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-11
TSS 95th percentile - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0022 | Rev: 0

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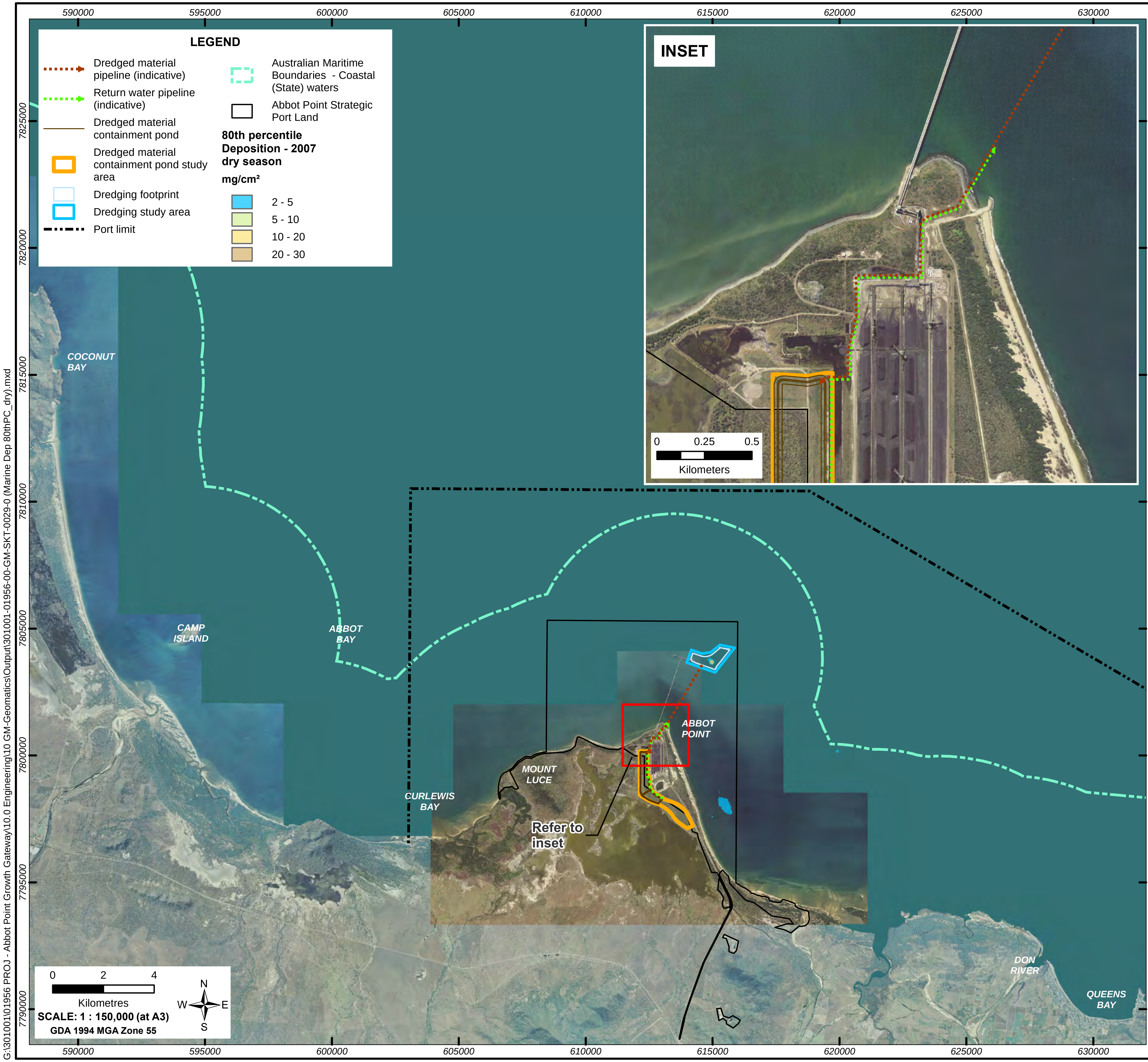
6.2.1.3 SEDIMENT DEPOSITION PERCENTILE PLOTS

The 50th percentile (median) plots for sediment deposition (mg/cm^2) show no extent of sedimentation data for this metric outside the dredging area and no sedimentation data for this metric at the return water site. The 80th percentile plots for sediment deposition (mg/cm^2) for both the dry and wet season are presented in Figure 6-12 and Figure 6-13, respectfully. Each plot contains an inset which allows for closer examination of the sedimentation data from the return water location and surrounds. The results show that the area impacted by the increased sedimentation >2mg/cm² is localised to the dredging area in both season scenarios. At the return water location no areas of sedimentation are predicted to occur based on examination of 80% of the data.

The 95th percentile plots for sediment deposition (mg/cm^2) for both the dry and wet season are presented in Figure 6-14 and Figure 6-15, respectfully. Each plot contains an inset which allows for closer examination of the TSS data from the return water locations and surrounds. The results show that the area impacted by the increased TSS >2mg/cm² is primarily localised to the dredging area in both season scenarios. At the return water location a small area of concentrations >5mg/cm² was predicted to occur 1.3km to the south-east of the return water location. To the south-west a larger area of sediment deposition of 20-30mg/cm² is predicted to occur approximately 1km for the return water location. The rates in these two locations were up to 10mg/cm²/day. This area is adjacent to the Abbot Point headland and is subject to occasional high rates of deposition due to both the metocean conditions and the local bathymetry.

Due to the sheltering effect of Clark Shoal and the Abbot Point headland this area is subject to relatively low wind and wave energy and is also relatively shallow. This results in material being deposited in this area at slack water, with the shallow bathymetry allowing more material to settle in a shorter period of time, and then re-suspending on the subsequent flood or ebb currents.



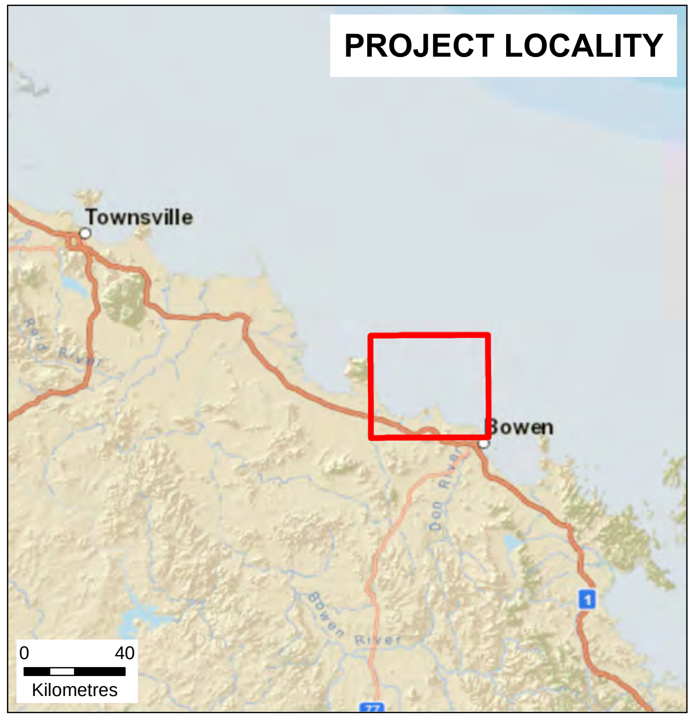


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Figure 6-12
Sediment deposition 80th percentile - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0029 | Rev: 0

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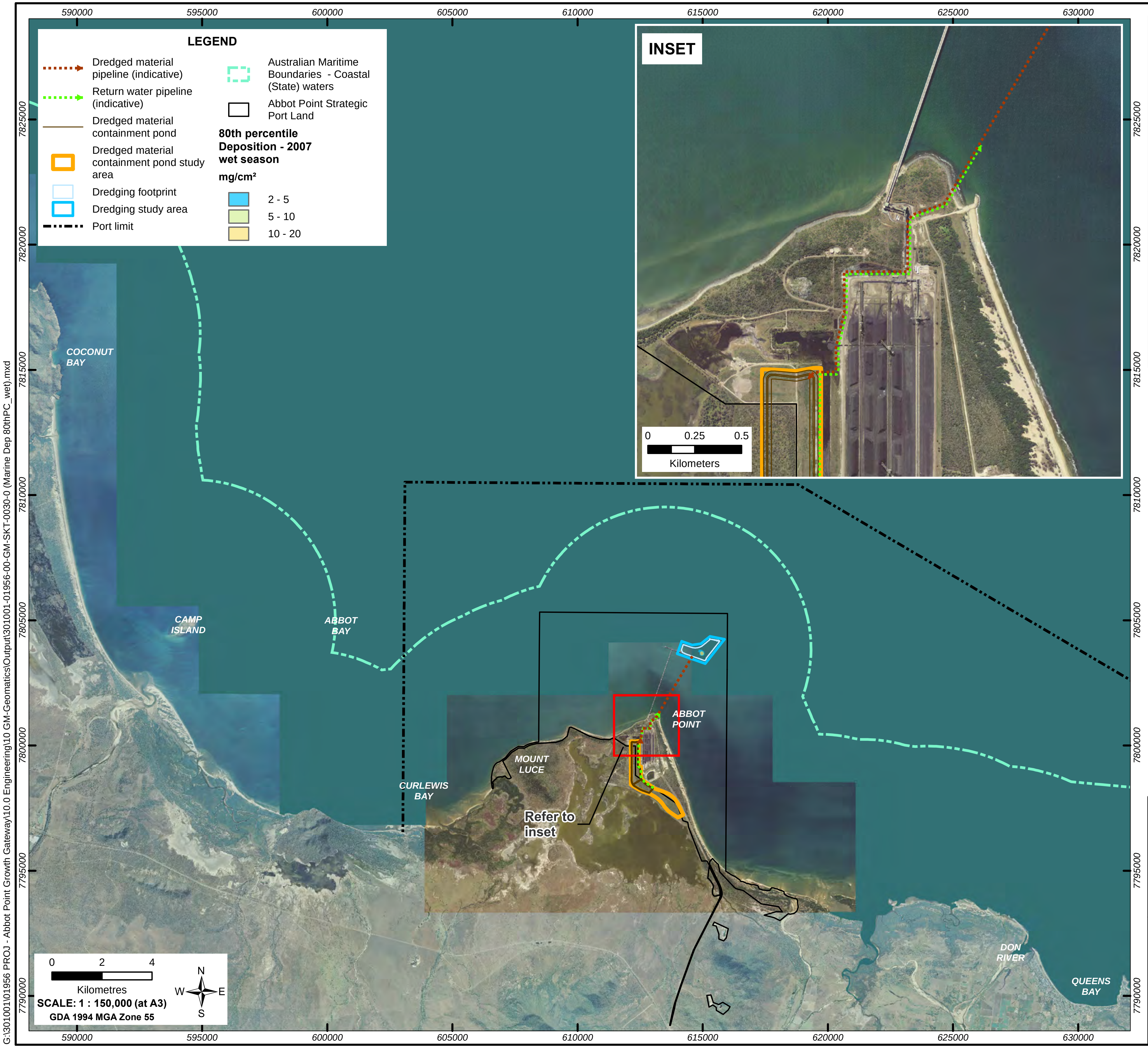

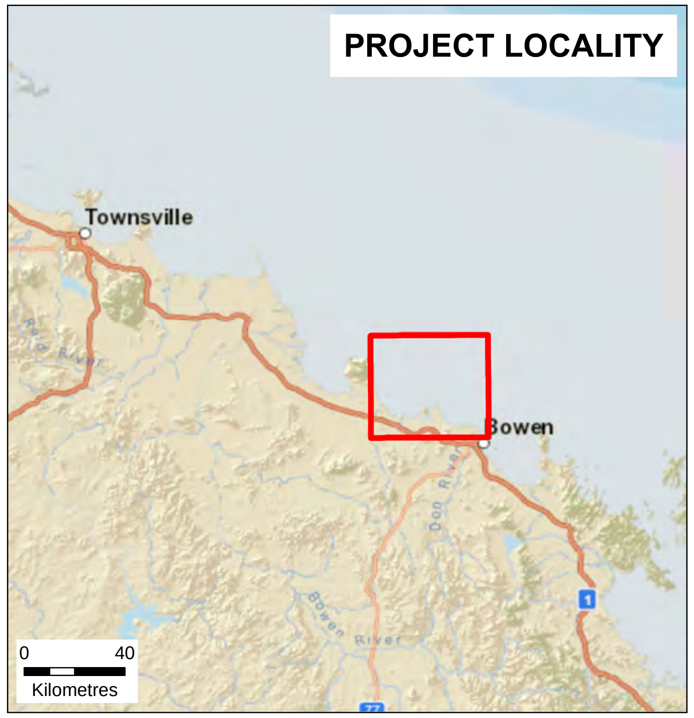

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-13
Sediment deposition 80th percentile - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0030 | Rev: 0

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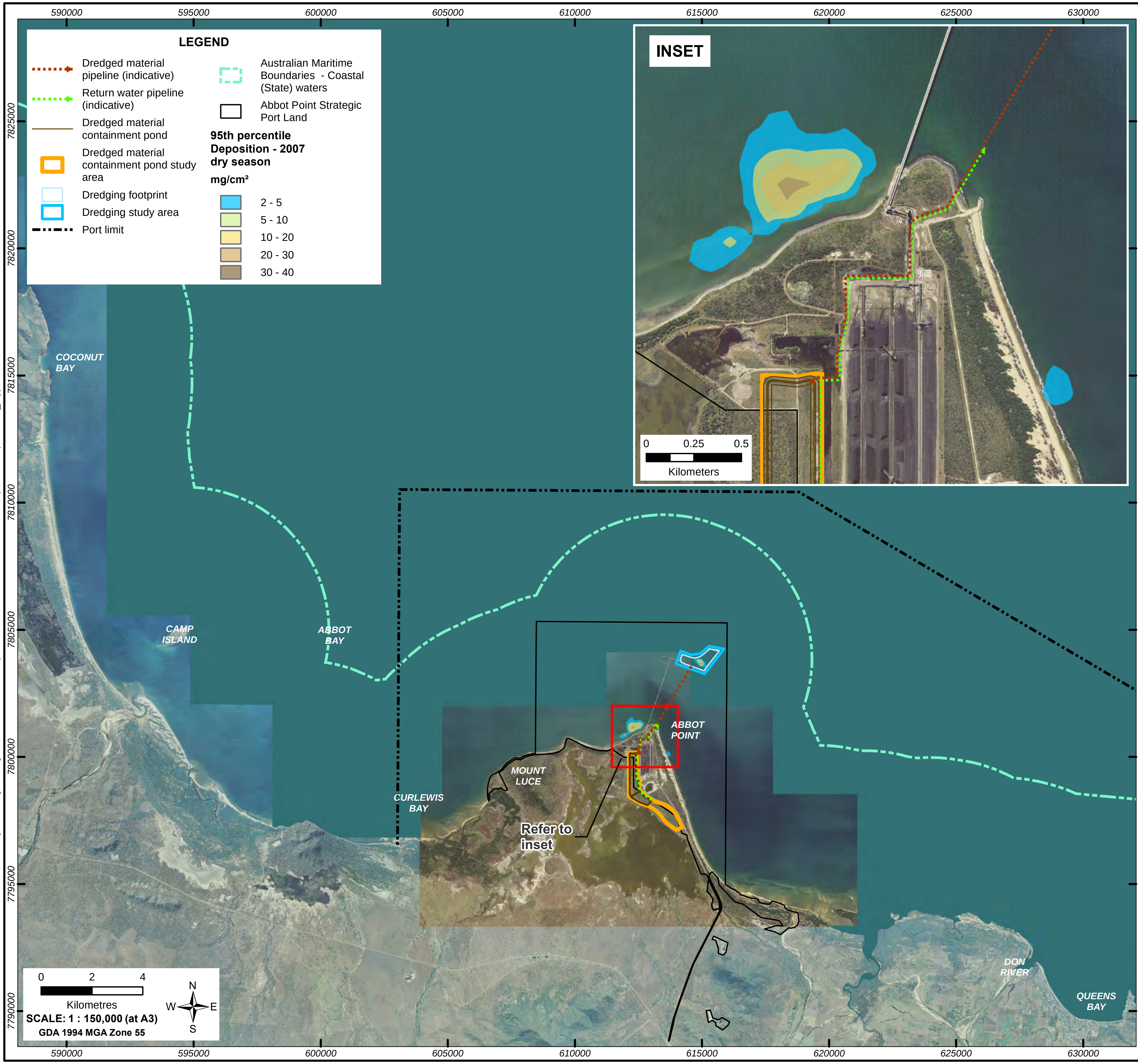

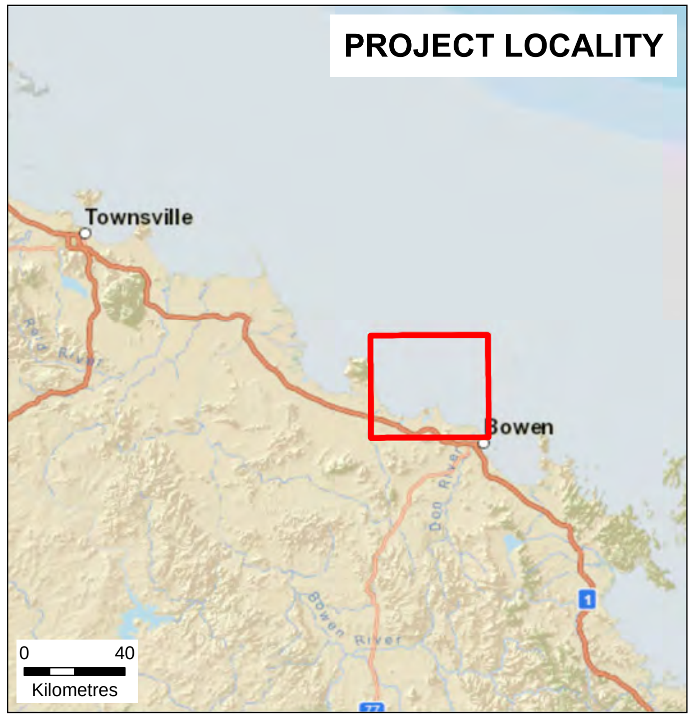

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-14
Sediment deposition 95th percentile - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0031 | Rev: 0

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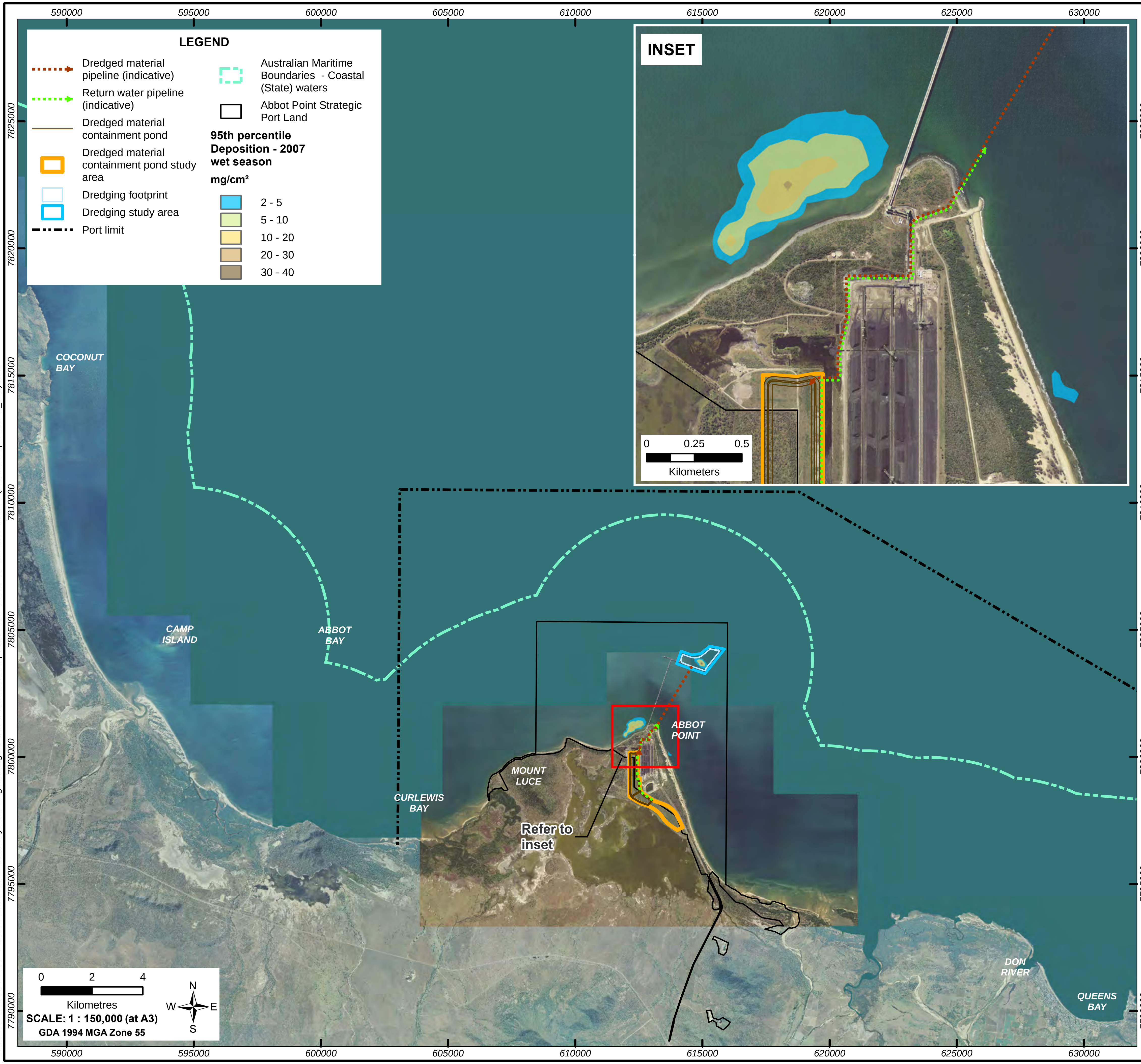

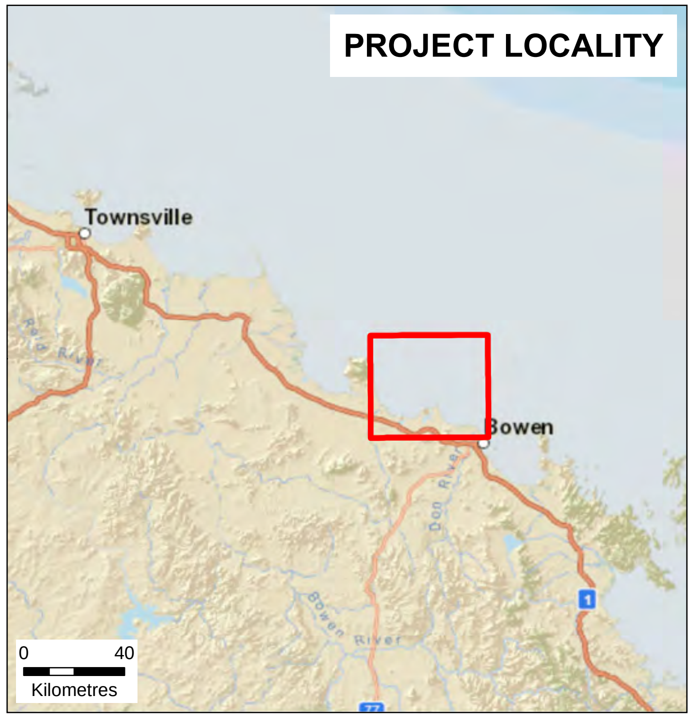

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-15
Sediment deposition 95th percentile - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0032 | Rev: 0

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6.2.2 Threshold plots TSS

The zones of Influence, moderate and high impact based on the IDF of TSS thresholds (as defined in section 2.3.3) for the dry and the wet seasons are presented in Figure 6-16 and Figure 6-17, respectively.

The zones are defined as:

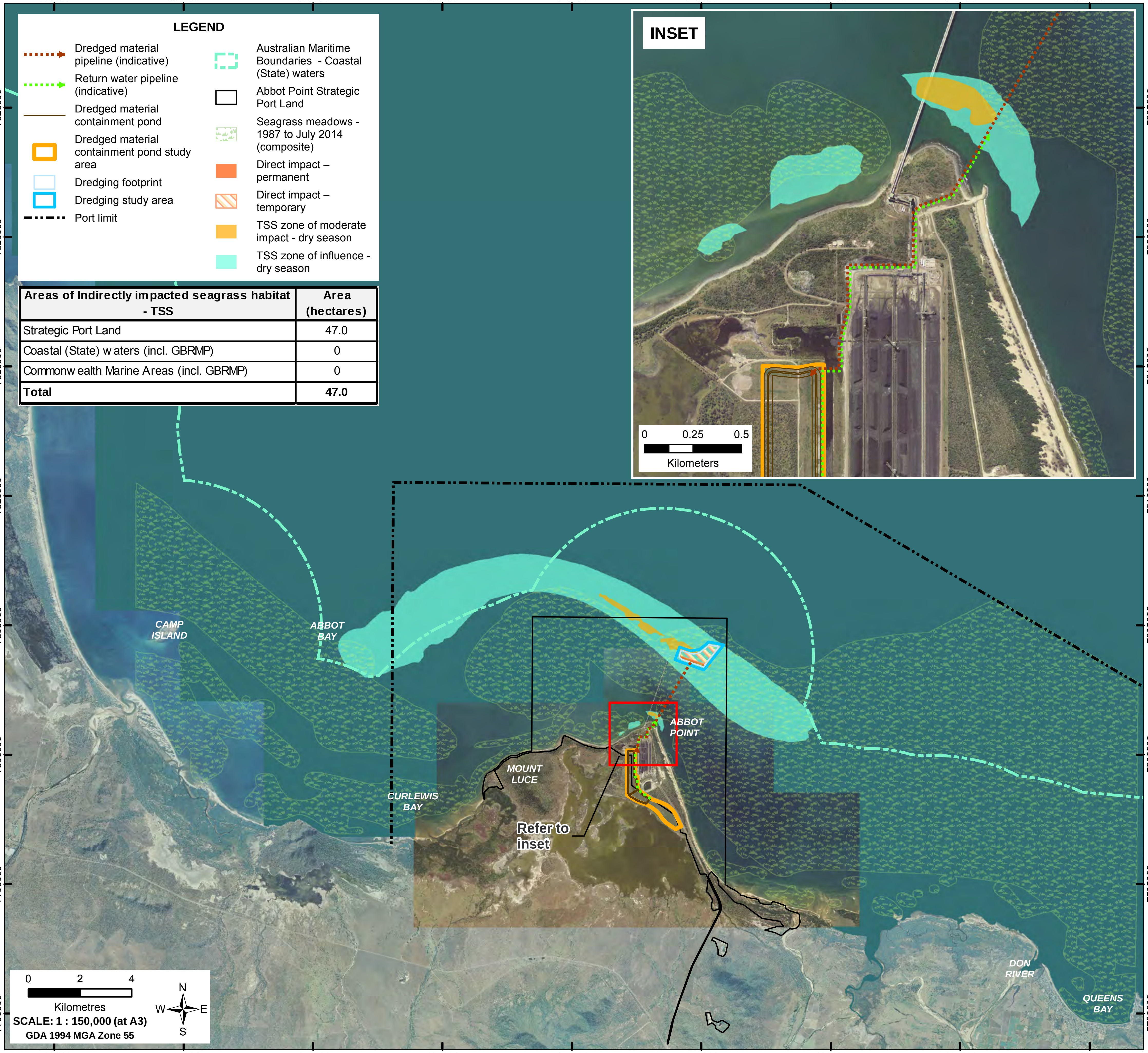
The ***zone of Influence*** for this assessment is defined as any instance where the bottom surface layer TSS concentration in a given model cell exceeds 5mg/L at any time for 1 hours duration.

The zone of influence in the dry season extends approximately 14km to the west and 5km to the east of the T0 dredging footprint. In the wet season this zone is reduced in area and extent, extending approximately 9km to the west and approximately 4km to the east.

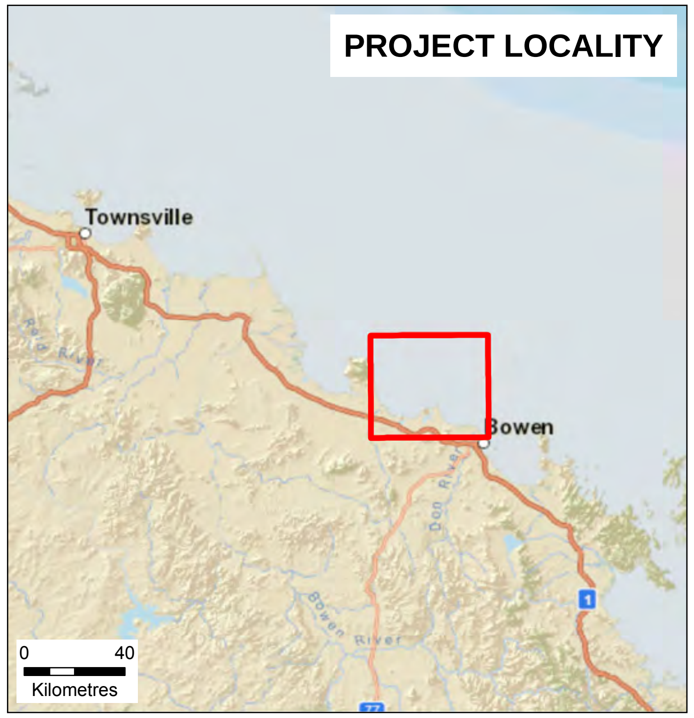
The zone of moderate impact encompasses areas were the benthic community will experience short events of low TSS (median) occurring on many occasions and short events of high TSS values (95th percentile) on a few occasions (see IDF curves in Section 2.3.3).

The zone of moderate impact in the dry season (Figure 6-16) due to dredging activities is larger than the wet season zone and extends approximately 4km to the north-west of the footprint. This represents an offsite impact on 46.7ha of potential seagrass habitat due to the dredging operations. The zone of moderate impact due to the returning water is a small area surrounding the return water itself and represents an offsite impact to 0.25ha of potential seagrass habitat.

The zone of moderate impact in the wet season (Figure 6-17) due to dredging activities is limited to the dredging footprint and a small area to the north-west of the footprint. This represents an offsite impact on 22.7ha of potential seagrass habitat due to the dredging operations. The zone of moderate impact due to the returning water is a small area surrounding the return water itself and represents an offsite impact to 0.22ha of potential seagrass habitat.



Areas of Indirectly impacted seagrass habitat - TSS	Area (hectares)
Strategic Port Land	47.0
Coastal (State) waters (incl. GBRMP)	0
Commonwealth Marine Areas (incl. GBRMP)	0
Total	**47.0**



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
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Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-16
TSS thresholds - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0027 | Rev: 0

G:\301001\01956 PROJ - Abbot Point Growth Gateway\10.0 Engineering\10 GM-Geomatics\Output\301001-01956-00-GM-SKT-0027-0 (Marine_TSS_Thresholds_dry).mxd

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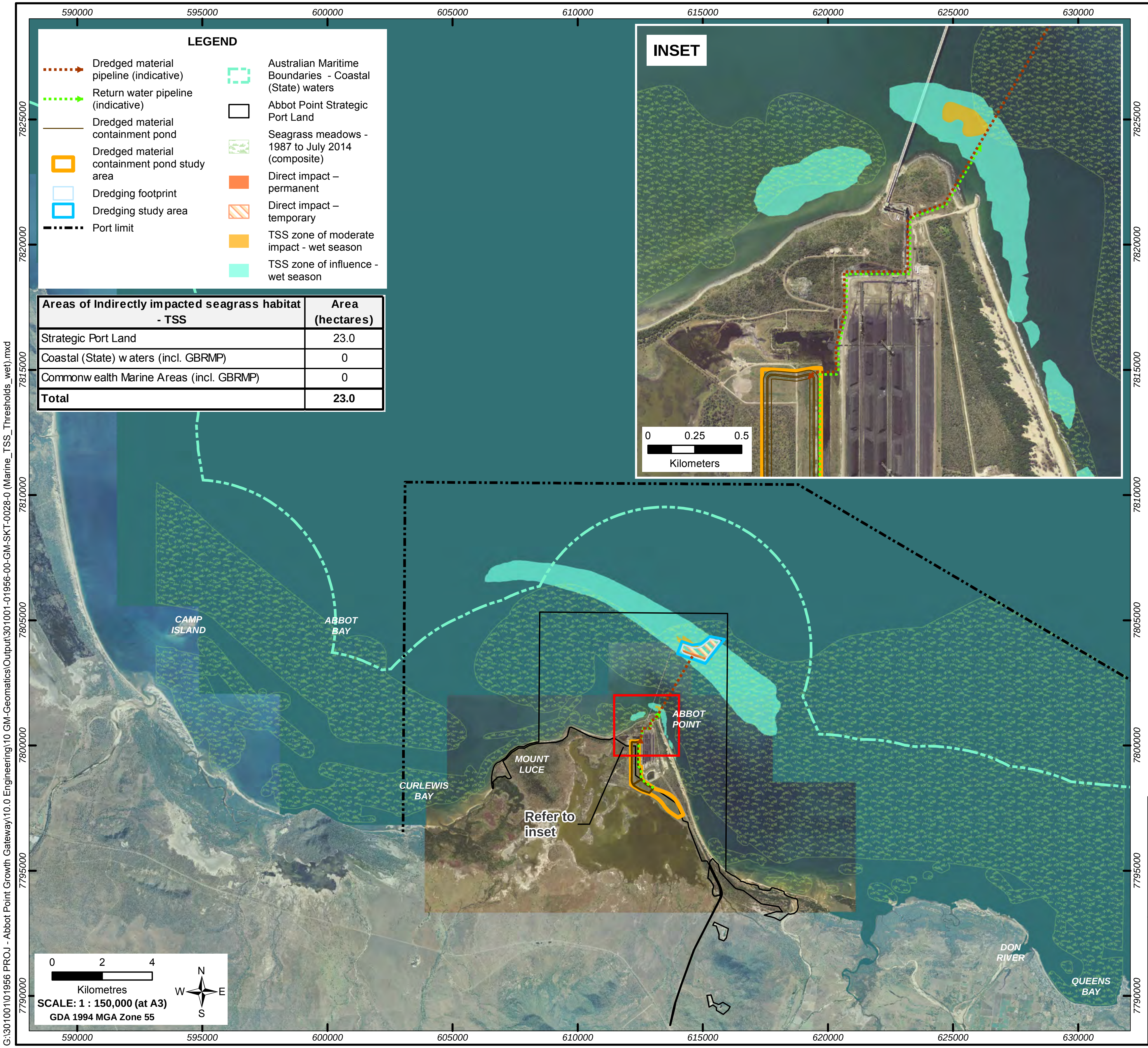
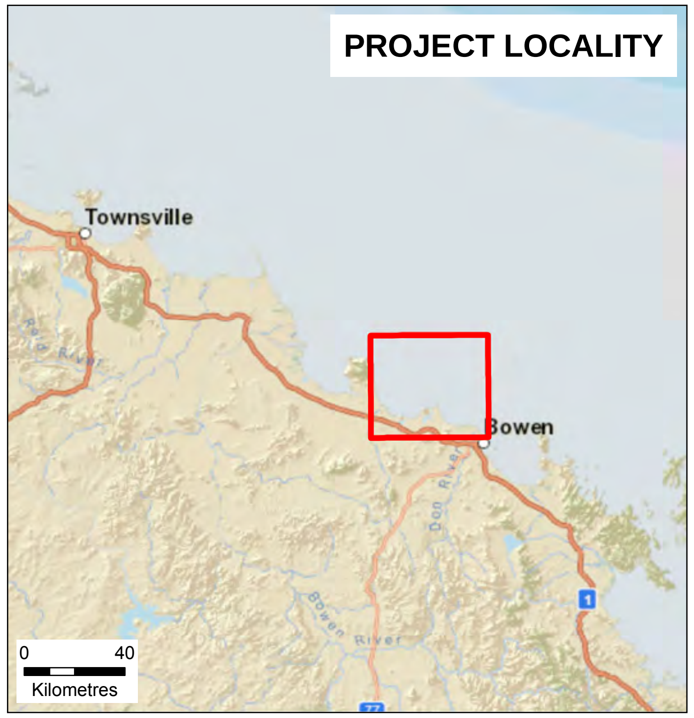


Areas of Indirectly impacted seagrass habitat - TSS	Area (hectares)
Strategic Port Land	23.0
Coastal (State) waters (incl. GBRMP)	0
Commonwealth Marine Areas (incl. GBRMP)	0
Total	**23.0**



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-17
TSS thresholds - 2007 wet season

Figure: 301001-01956-00-GM-SKT-0028 | Rev: 0

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6.2.3 Threshold plots sedimentation

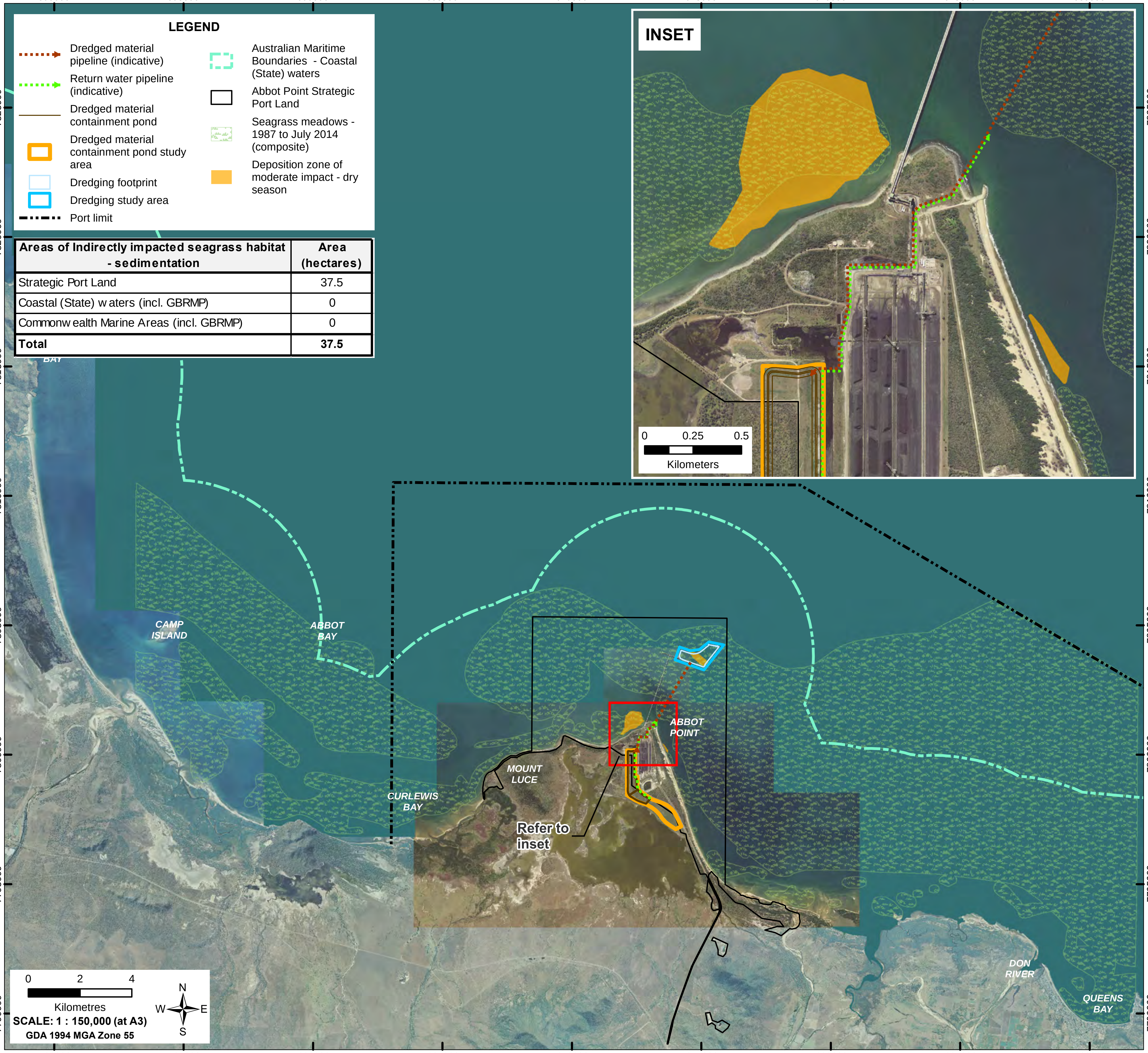
The GBRMPA (2010) water quality guideline trigger values for sedimentation (deposition) rates are a maximum mean annual sedimentation rate of 3mg/cm^2/day and a daily maximum of 15mg/cm^2/day. Sensitive receptors such as coral and seagrass communities within this zone are predicted to experience deposition conditions which may cause sub-lethal impacts only. These threshold values were applied to the model to predict the extent of a zone of moderate impact for both seasons.

The maximum mean annual sedimentation rate upper limit of 3mg/cm^2/day was applied across the period of the dredging campaign and not over the entire year; which represents a conservative approach to the application of this annual rate.

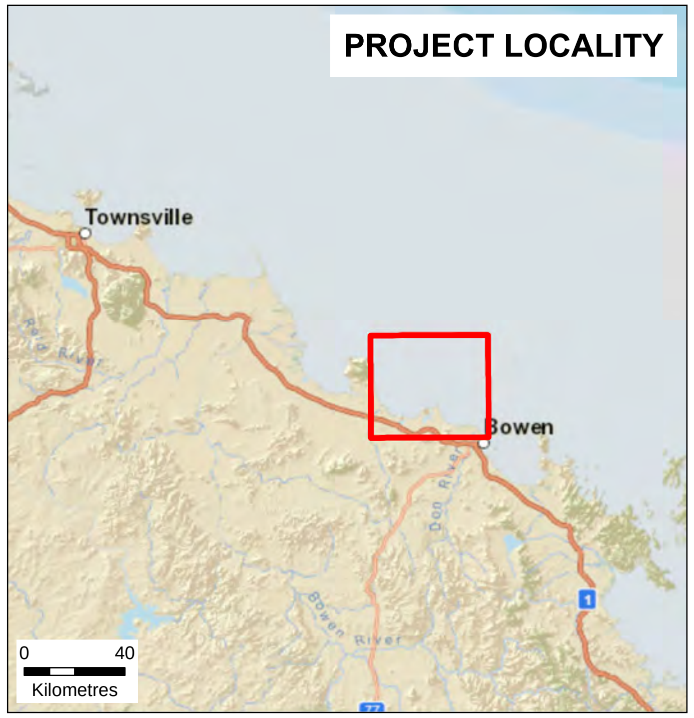
Based on these thresholds Figure 6-18 and Figure 6-19 show the zone of moderate impact based on the daily sedimentation rate and maximum daily sedimentation rate for the dry and wet season respectively.

In the dry season (Figure 6-18) the GBRMPA (2010) thresholds are exceeded within the dredging area. In the return water area there is a large zone of moderate impact extending 1.5km to the west of the returning water location, in the sheltered area adjacent to the Abbot Point headland and as per the TSS concentrations. A smaller zone of moderate impact is predicted to occur 1.2km to the south of the returning water location. The zones of moderate impact in the dry season intersect with known seagrass habitat and represent an offsite non-lethal impact to 4.16ha of seagrass habitat due to the dredging operations and 33.37ha due to the returning water operation.

In the wet season (Figure 6-19), the GBRMPA (2010) thresholds are only exceeded within the dredging area and in a 250m diameter patch 1.2km west of the returning water location in the sheltered area. The zone of moderate impact in the wet season is located almost entirely within known seagrass habitat and represents an offsite non-lethal impact to 5.11ha of seagrass habitat due to the dredging operations and 25.84ha due to the returning water operation.



Areas of Indirectly impacted seagrass habitat - sedimentation	Area (hectares)
Strategic Port Land	37.5
Coastal (State) w aters (incl. GBRMP)	0
Commonw ealth Marine Areas (incl. GBRMP)	0
Total	**37.5**



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
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Figure 6-18
Threshold deposition -
Dry season 2007

Figure: 301001-01956-00-GM-SKT-0033 | Rev: 0

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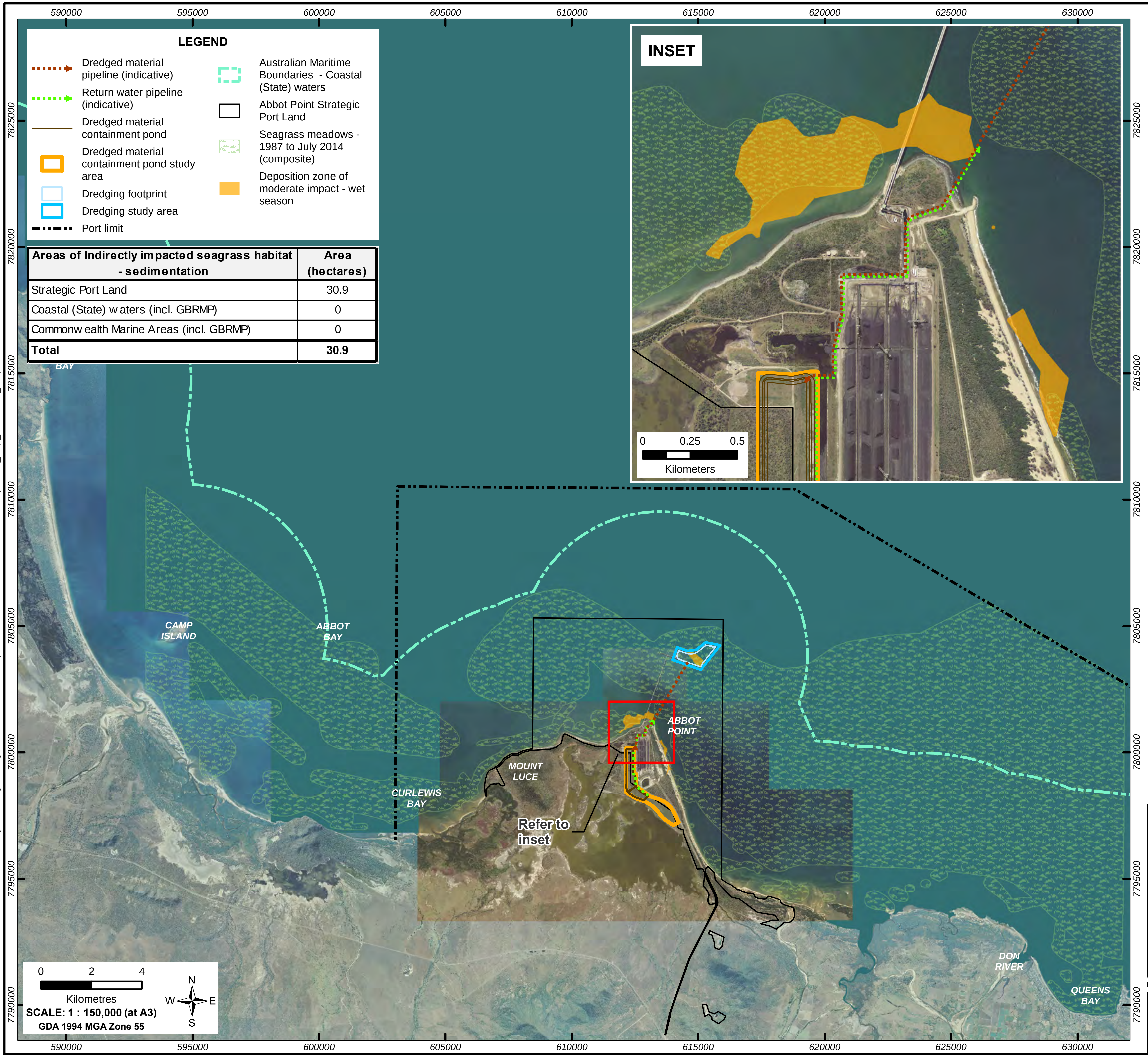
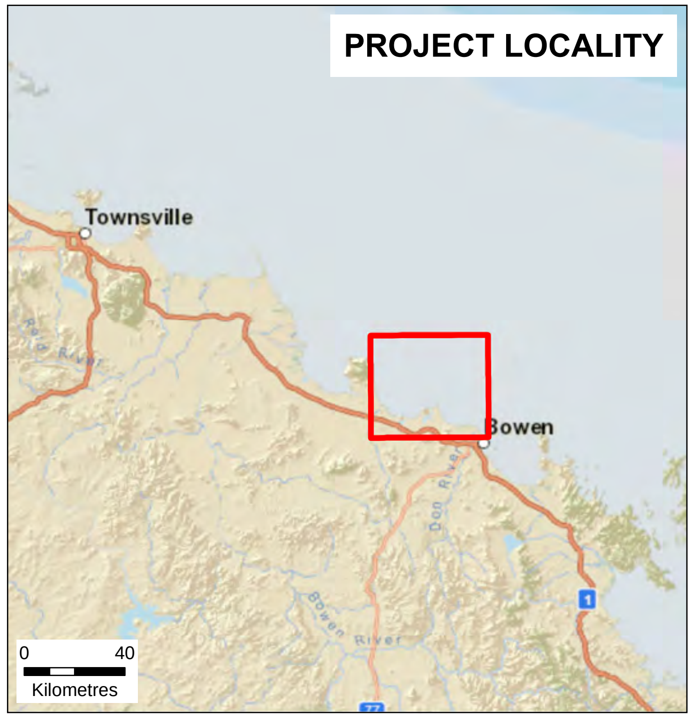


Areas of Indirectly impacted seagrass habitat - sedimentation	Area (hectares)
Strategic Port Land	30.9
Coastal (State) waters (incl. GBRMP)	0
Commonwealth Marine Areas (incl. GBRMP)	0
Total	**30.9**



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-19
Threshold deposition - Wet season 2007

Figure: 301001-01956-00-GM-SKT-0034 | Rev: 0

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6.2.4 Light requirement threshold plots

Baseline light availability contours and the change in contours during dredging for the seagrass growing seasons (for nearshore and offshore seagrasses) during the neutral scenario tear ('worst-case') are presented in Figure 6-20 and Figure 6-21 respectively. The plots also show the extent of seagrass habitat from surveys between 1987 and July 2014. The nearshore 3.5mol/m^2/day (Figure 6-20) and the offshore 1.5mol/m^2/day baseline contours (Figure 6-21) are represented as a blue line while the dredging 3.5mol/m^2/day and the 1.5mol/m^2/day contours are shown as a dotted blue line. The area of change between the dotted line and the solid line for each of the light requirement values interrogated is shaded orange and represents the zone of moderate impact where seagrass communities may suffer non-lethal offsite impacts during the Project.

The health of the seagrass community after 7 days (offshore) and 14 days (nearshore) of low light climate (below the thresholds) may be compromised. However total mortality and significant declines will only occur if there is an extended period (several days or weeks) of low benthic light (below the light requirements) beyond the stipulated durations.

The change in nearshore light climate due to elevated TSS from the returning waters in the seagrass growing season may result in the temporary impact (zone of moderate impact) to 8.9ha of potential seagrass habitat. The locations where the nearshore light climate contour changes is limited to small patches near the discharge point and further afield on Clarke Shoal and to the west of the discharge point (Figure 6-20).

The change in offshore light climate due to elevated TSS from the returning waters in the seagrass growing season may result in the temporary impact (zone of moderate impact) to 1181.46ha of potential seagrass habitat (Figure 6-21). The locations where the changes to the offshore light climate occur are primarily to the southeast up to 8km distant from the T0 dredging area.

The far-field changes in benthic light climate to the northwest are the result of the small elevations of TSS in the water column which are transported from the dredging activities over time. Model Extraction Point D12 (see Section 6.2.5) is located in the same direction (but not as far field) to the areas where the offshore contour is impacted upon. The time series data from this site is represented in Figure 6-46. The TSS concentrations fluctuate each day between 0.5mg/L and 2.5mg/L, toward the last 5 days of dredging however the TSS concentrations remain above 1mg/L and increase to over 3.5mg/L on some days.

The daily deposition data (Figure 6-46, second graph down) indicates the site also experiences large ranges of positive and negative deposition (deposition and re-suspension).

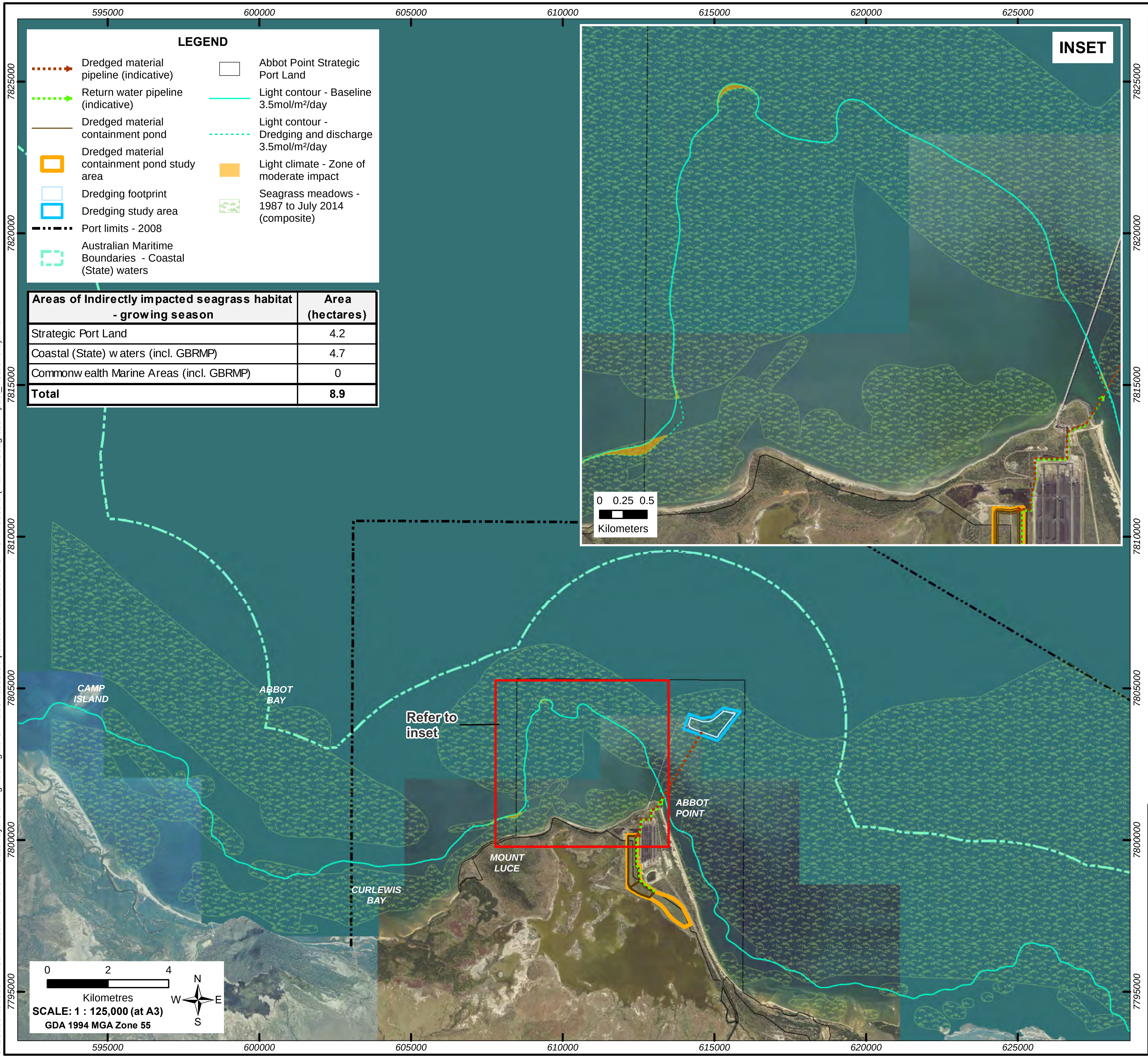
The zone of moderate impact due to changes in the seagrass light requirement in the growing season represents an offsite non-lethal temporary impact to 1181.5ha of offshore and 8.9ha of potential inshore seagrass habitat.

This represents an offsite impact on potential seagrass communities due to changes in the light climate at the seafloor in the seagrass growing season for a total of 1190.36ha.

The likely reasons why the baseline light climate for seagrass growth is inside the modelled extent of seagrass from all surveys 2008-2014 (Figure 6-21) are as follows:

- The light data used to create the present baseline contour was based on 2013 and 2014 growing/dry season light data only
- The light climate during this period (2013/2014 growing season) may be less that in earlier years meaning the extent of the seagrass growth in the offshore deeper areas may have extended further into the deeper regions because of a more favorable growing season light climate in previous years.
- The seagrass survey techniques used for the broader surveys of offshore seagrasses has a mapping precision of +/-100 -500m which would mean the modelled outer boundary of the seagrass extent maybe much closer in shore.
- The deeper water seagrasses community is accustomed to lower light climates and the seagrass light climate monitoring sites which are located nearer to shore (from which the estimates of light thresholds was established) in shallower water are an over estimate of the light requirements for the deeper seagrass communities.
- The use of a minimum kd value for modelling the baseline light requirement contour represents a very conservative approach when the 2013/2014 light data is considered; the minimum kd for the years which allowed the offshore seagrasses to grow into deeper water is likely to be much lower; meaning the baseline light requirement contour for offshore seagrasses would be in deeper water.
- In addition, the density and presence or absence of seagrass along the outer light requirement contour in depths between 10 and 15m deep varies between years and within years (seasonal).

Long-term monitoring has found that seagrass biomass and distribution at Abbot Point is generally lowest during the late senescence season (April/May) and greatest in the late growing season (October/November) (McKenna *et al*., 2014). Impacts resulting from light reductions during the senescence season are unlikely to be on the same magnitude as the impacts on seagrass due to a reduction in light climate during the growing season.



Areas of Indirectly impacted seagrass habitat - growing season	Area (hectares)
Strategic Port Land	4.2
Coastal (State) w aters (incl. GBRMP)	4.7
Commonw ealth Marine Areas (incl. GBRMP)	0
Total	**8.9**

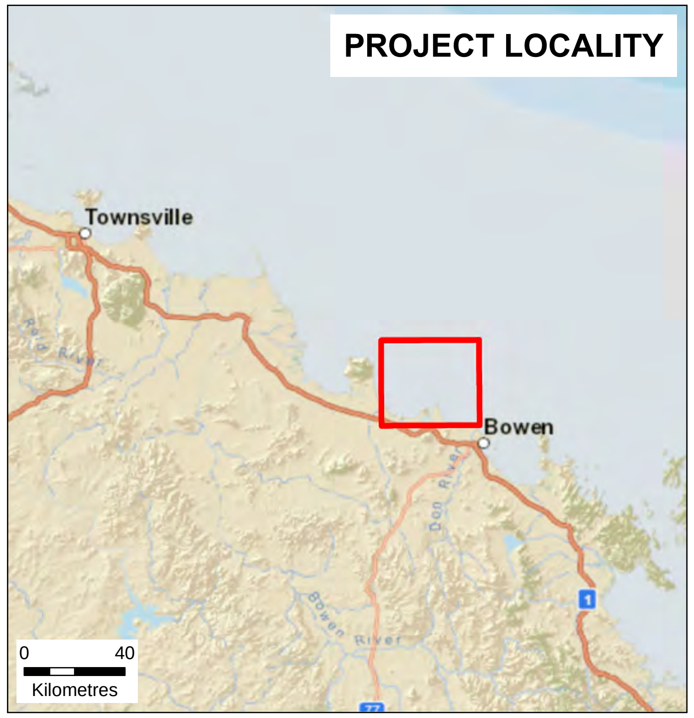


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Figure 6-20
Potential impacts to nearshore seagrass benthic light availability - Seagrass growing season

Figure: 301001-01956-00-GM-SKT-0038 | Rev: 0

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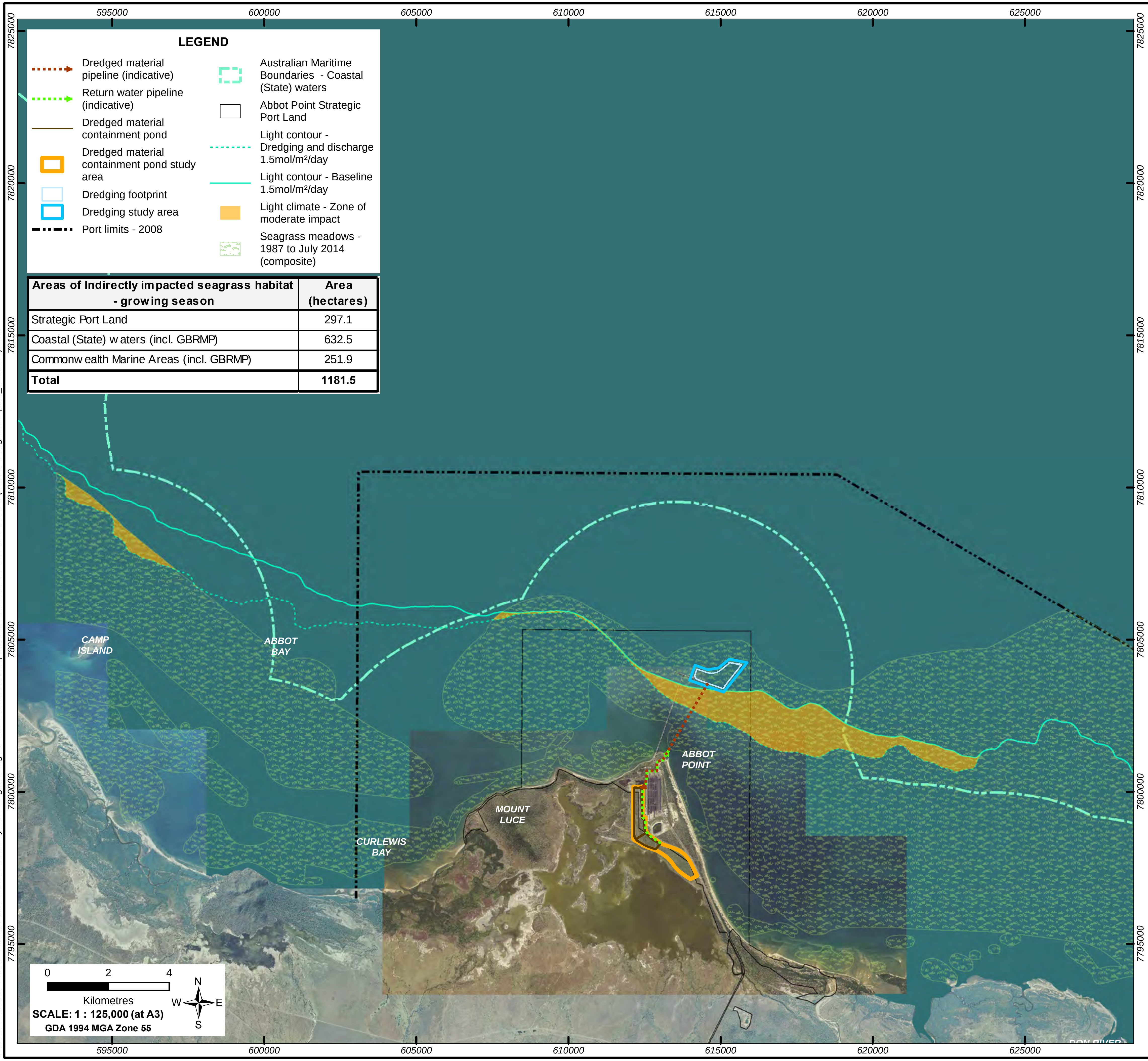

Areas of Indirectly impacted seagrass habitat - growing season	Area (hectares)
Strategic Port Land	297.1
Coastal (State) w aters (incl. GBRMP)	632.5
Commonw ealth Marine Areas (incl. GBRMP)	251.9
Total	**1181.5**

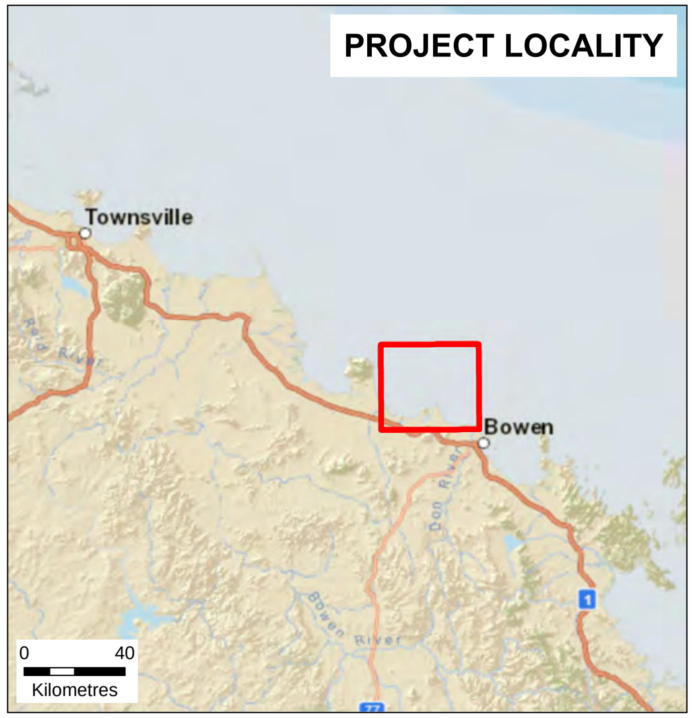

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Figure 6-21
Potential impacts to offshore seagrass benthic light availability - Seagrass growing season

Figure: 301001-01956-00-GM-SKT-0039 | Rev: 0

G:\301001\01956 PROJ - Abbot Point Growth Gateway\10.0 Engineering\10 GM-Geomatics\Output\301001-01956-00-GM-SKT-0039-0 (Marine SeagrassImpact_Offshore).mxd

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6.2.5 Extracted time series information

TSS, bed thickness and deposition rates data were extracted from the bottom layer of the model simulations at discrete locations (Figure 6-22). The data from these points provide more detailed information on the characteristics of the dredging plume and plume from the return water at different distances from the point source of impact. Several extraction points were also chosen to represent locations of sensitive receptor sites identified in surveys of the marine habitat. Additional sites representing the closest coral communities to the dredging activities and the Catalina plane wreck site are also added (see Marine Protected Areas Figure 3-3 and Figure 6-22). A summary of the extraction points and a brief description of each point are provided in Table 6-1.

Bed thickness data is cumulative from day to day and only drops when the sediment deposited is eroded away. In some areas the sediment builds up over a period hours then completely erodes away.

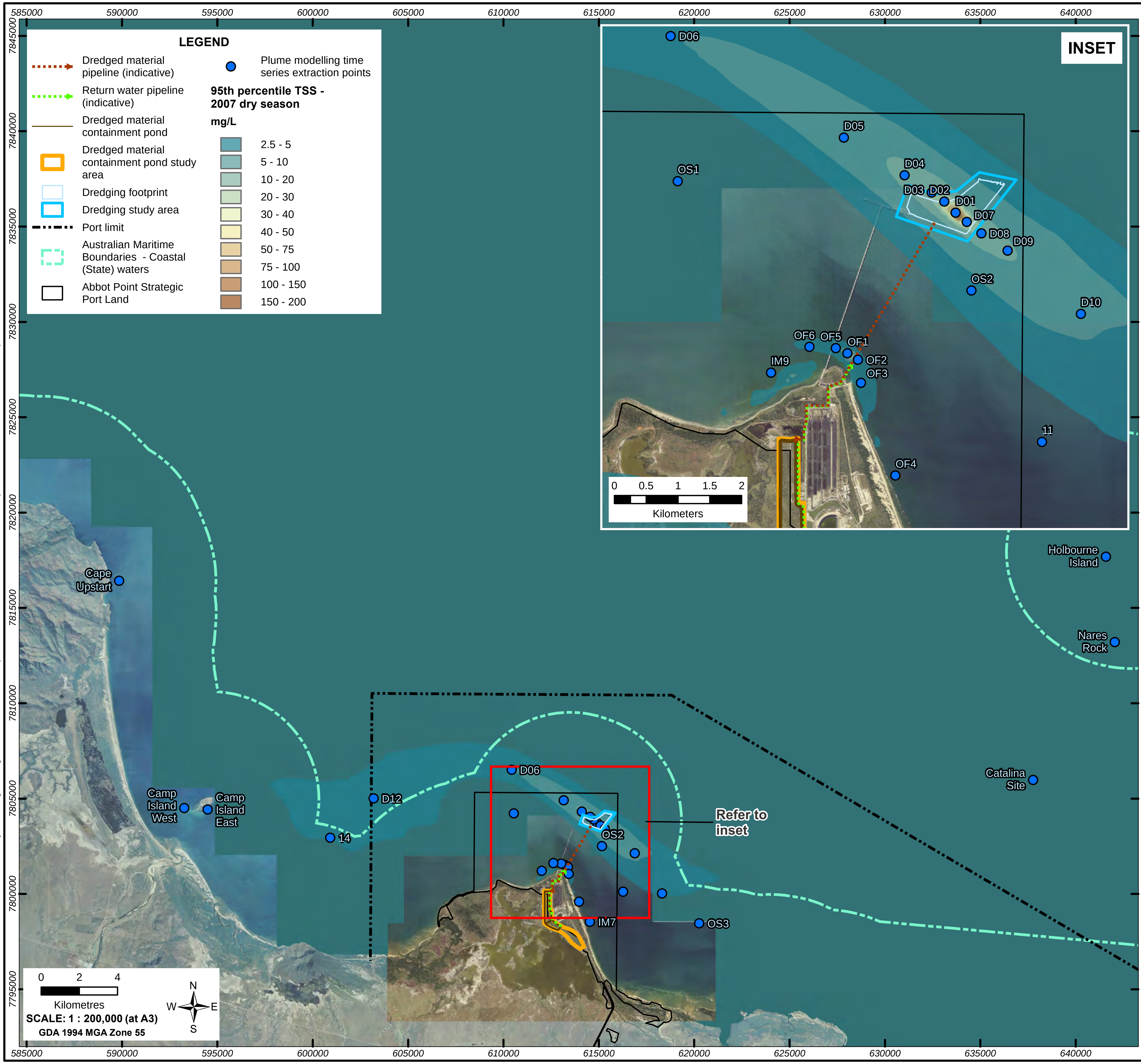
TSS data in the form of box plots represents summary data from the dry and wet seasons. The box is representative of the 20th (lower boundary) and the 80th (upper boundary) percentile data. The whiskers are representative of the 5th and 95th percentile values. The line across the box represents the median value across all data. Data from the baseline water quality monitoring sites is included in the box plot graphs for comparison. For the time series dredging data the points located within the dredging footprint (D01, D02 and D07) are removed. For the baseline data the data from Coastal West is removed as this data was from an area of very high TSS and represents an extreme baseline case. A box plot which represents the data from the dredging footprint extraction points (D01, D02 and D07) compared to all baseline water quality data including Coastal West is presented in Figure 6-49 for reference purposes only.

The locations of the model extraction points and the spatial extent of the 95th percentile TSS data for the dry season in 2007 are shown in Figure 6-22.

Table 6-1 Summary of the model extraction points (see also Figure 6-22)

Site	Location Description	Distance from Centre of T0 Dredging Footprint	Distance from Return Water Pipe	Northing	Easting
OS1	Offshore Seagrass Site 1	4.5 km W	3.8 km NW	610543.8	7804215.9
OS2	Offshore Seagrass Site 2	500 m SW	2.4 km N	614453.1	7803477.1
OS3	Offshore Seagrass Site 3	5.0 km S	5.3 km SE	620263.5	7798448.7
IM7	Inshore Seagrass Meadow 7	5.2 km S	3.3 km SE	614535.8	7798528.9
IM9	Inshore Seagrass Meadow 9	3.8 km W	1.2 km W	612012.7	7801201.5
OF1	Return water Site 1	2.8 km SW	~20 m	613215	7801506
OF2	Return water Site 2	2.9 km SW	200 m S	613381	7801404
OF3	Return water Site 3	3.1 km SW	500 m S	613428	7801043
OF4	Return water Site 4	4.2 km S	2 km S	613970	7799583
OF5	Return water Site 5	2.9 km SW	200 m W	613032	7801588
OF6	Return water Site 6	3.1 km SW	600 m W	612619	7801608
D01	Dredging Site 1	0 m	2.8 km NE	614917	7803720
D02	Dredging Site 2	250 m NW		614739	7803896
D03	Dredging Site 3	500 m NW		614541	7804036
D04	Dredging Site 4	1 km NW		614113	7804308
D05	Dredging Site 5	2 km NW		613159	7804900
D06	Dredging Site 6	5 km NW		610434	7806500
D07	Dredging Site 7	250 m SE		615093	7803575

D08	Dredging Site 8	500 m SE		615323	7803394
D09	Dredging Site 9	1 km SE		615735	7803123
D10	Dredging Site 10	2 km SE		616887	7802127
D11	Dredging Site 11	5 km SE		618319	7800020
D12	Dredging Site 12	12 km W		603200	7805000
11	Offshore seagrass East	4 km S	3.4 km SE	616275.4	7800111.7
14	Offshore seagrass West	14 km W	12.4 km W	600917.3	7802935.8
Cape Upstart	Marine Park near Cape Upstart	26.8 km NW	27.8 km NW	593266	7804496
Camp Is. East	Camp Island coral community	19.2 km W	19.0 km W	594497	7804421
Camp Is. West	Camp Island coral community	20.4 km W	20.2 km W	593266	7804496
Holbourne Is.	Holbourne island coral community	31.1 km ENE	32.6 km ENE	641589	7817673
Nares Rock	Nares Rock coral community	29.9 km ENE	31.1 km ENE	642053	7813195
Catalina Site	Catalina plane wreck Site	24.2 km E	24.9 km E	613573	7800574



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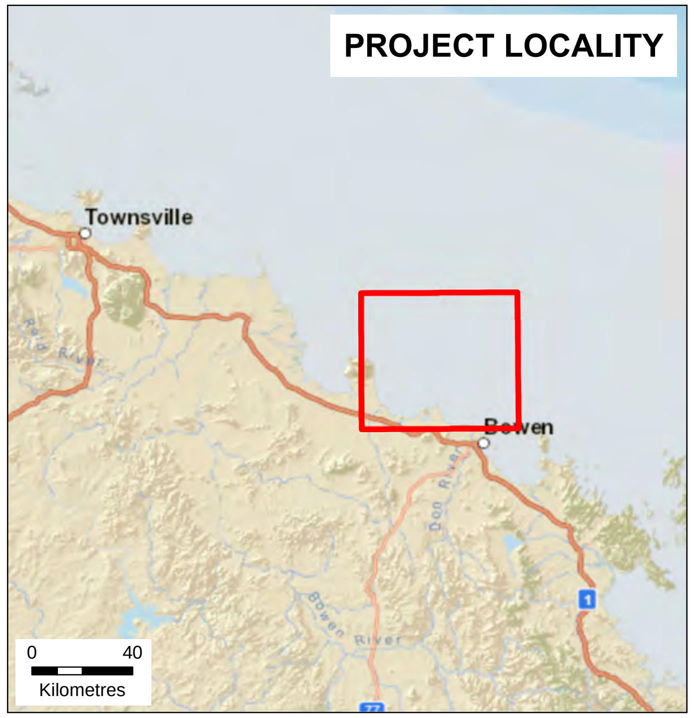

Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 -
http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

REV	DATE	REVISION DESCRIPTION	DRN	CHK	ENG	CHK ENG	APPD
0	14/07/2015	Issued for information	MH	KM	SN		

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Figure 6-22
Locations of plume modelling time series extraction points

Figure: 301001-01956-00-GM-SKT-0037 | Rev: 0

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Table 6-2 Summary statistics of time series TSS dredging and return water data from all extraction points

Site	Mean	Median	Minimum	Maximum	80th Percentile	95th Percentile
OS1	0.35	0.36	0.00	1.03	0.50	0.69
OS2	1.38	1.19	0.01	5.14	1.99	3.08
OS3	0.35	0.30	0.00	1.55	0.54	0.76
IM7	0.28	0.25	0.00	1.12	0.41	0.71
IM9	0.84	0.81	0.00	3.52	1.06	1.52
OF1	7.00	7.07	0.00	12.20	8.48	9.84
OF2	1.00	0.95	0.00	4.92	1.46	2.05
OF3	0.90	0.78	0.00	6.35	1.15	1.65
OF4	0.42	0.39	0.00	1.67	0.59	0.89
OF5	1.84	1.86	0.00	4.78	2.26	2.78
OF6	1.18	1.20	0.00	3.89	1.44	1.74
D01	53.85	55.21	0.54	159.28	94.76	127.03
D02	8.70	7.16	0.33	35.93	14.46	21.20
D03	5.98	4.82	0.42	23.53	9.26	14.56
D04	3.51	3.04	0.41	14.51	5.00	7.56
D05	2.32	2.12	0.34	7.46	3.12	4.63
D06	1.57	1.43	0.01	5.16	2.14	2.95
D07	8.44	5.80	0.00	42.11	14.36	24.88
D08	3.97	2.88	0.00	18.64	6.55	11.58

Site	Mean	Median	Minimum	Maximum	80th Percentile	95th Percentile
D09	2.32	1.92	0.00	10.76	3.60	6.18
D10	1.25	1.08	0.00	4.79	2.03	3.15
D11	0.60	0.51	0.00	2.78	0.99	1.40
D12	0.93	0.79	0.00	3.61	1.36	2.03
11	0.42	0.35	0.00	1.86	0.65	1.08
14	0.71	0.61	0.00	3.04	1.04	1.56

6.2.5.1 Offshore Seagrass Sites

Offshore seagrass site (OS2) is located 500m to the southwest of the centre of the T0 dredging footprint. The TSS, bed thickness and sediment deposition rates for the 40 days of dredging operations are presented in Figure 6-23. Maximum TSS concentrations were 5.14mg/L and the median value is 1.19mg/L. Bed thickness at this site is below 0.1mm throughout the dredging campaign. The TSS at OS1, located 4.5km to the west of T0, range between 0mg/L and 1.03mg/L and the median value is 0.36mg/L. The TSS at OS3, located 5km to the south of T0, range from 0mg/L to 1.55mg/L and the median value is 0.30mg/L. Compared to the background data the median and 80th percentile TSS concentrations predicted at each of the offshore seagrass sites will be well below the median and 80th percentile TSS concentrations measured at all baseline monitoring sites (Figure 6-26).

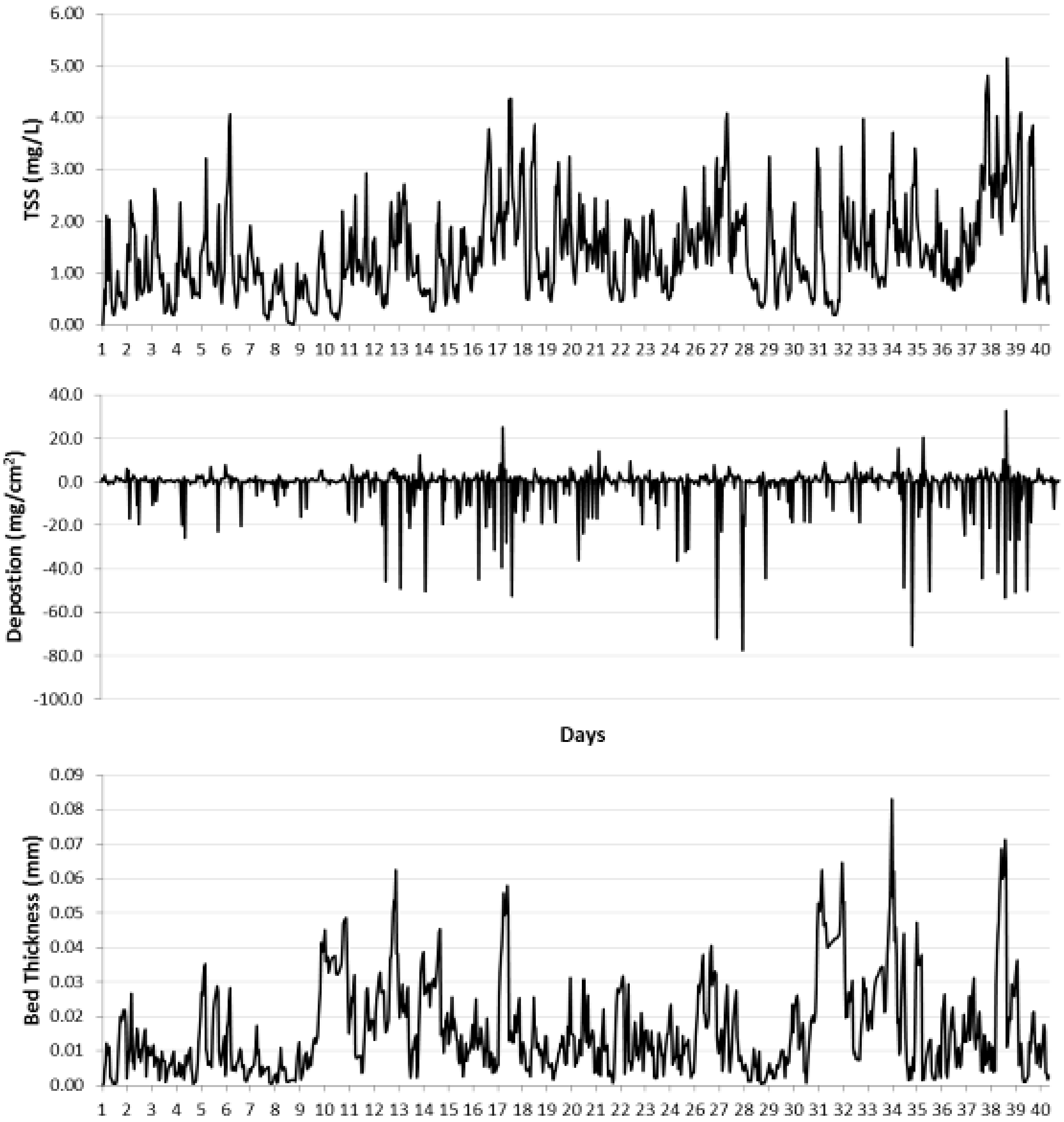


Figure 6-23 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OS2 during the dry season scenario only

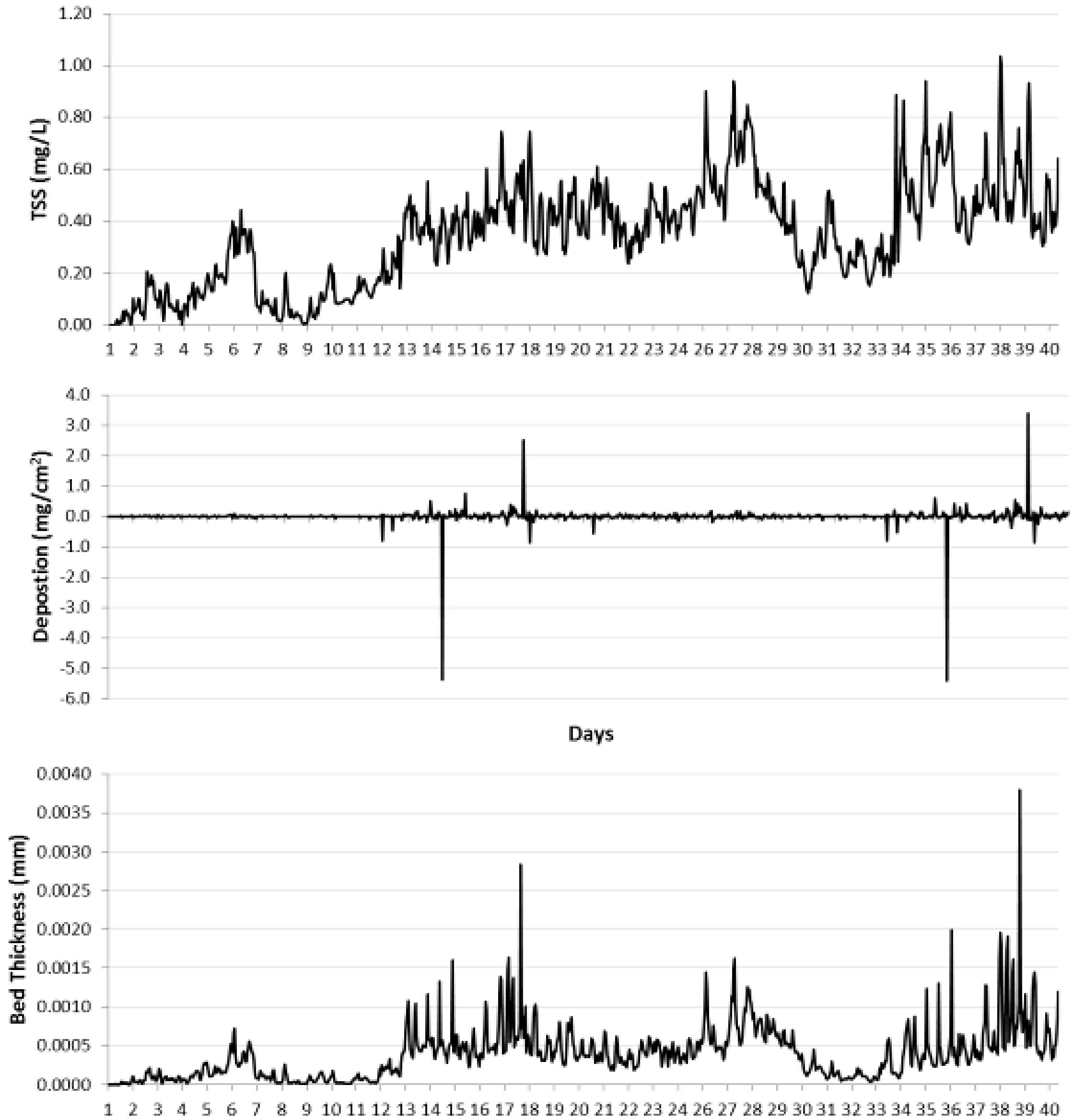


Figure 6-24 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point OS1 during the dry season scenario only

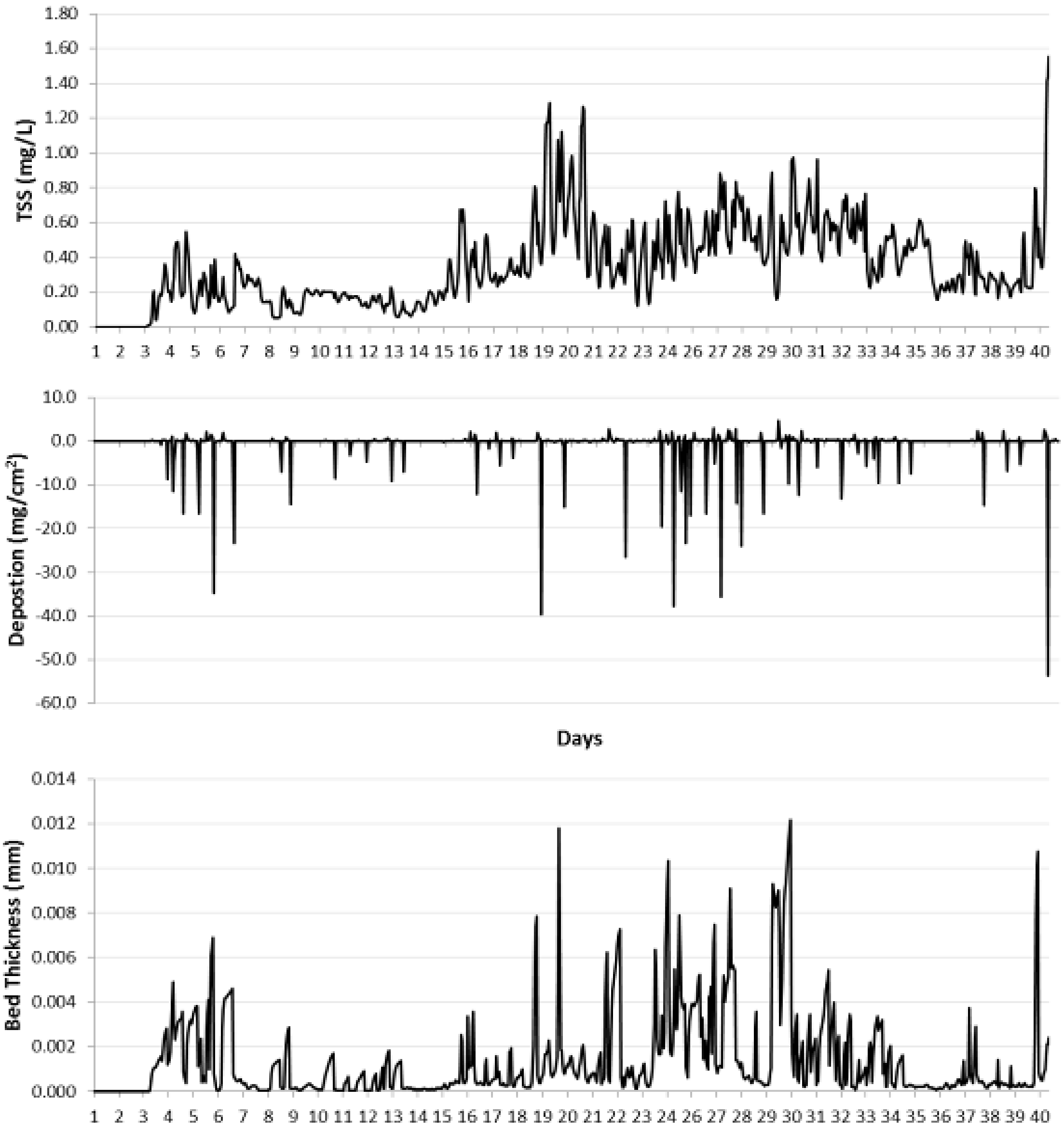


Figure 6-25 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point OS3 during the dry season scenario only

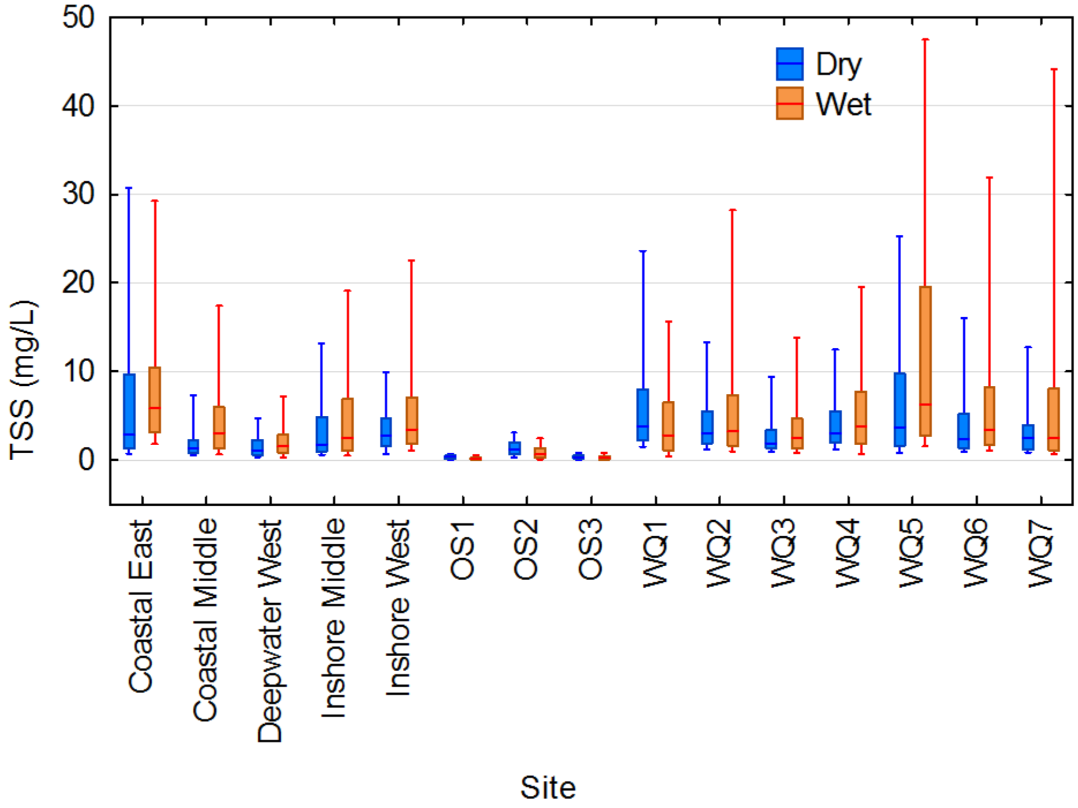


Figure 6-26 TSS Box plots for the dredging TSS time series data for all Offshore Seagrass monitoring Sites (OS1, OS2 and OS3) plus the background data from all baseline monitoring sites

6.2.5.2 Inshore Seagrass Meadows

The primary impacts to water quality at these sites will be driven by the dredge return waters. The dredging related plume is not expected to extend in this direction. Inshore seagrass meadow (IM7) is located 3.3km to the south-east of the return water. The TSS, bed thickness and sediment deposition rates for the 40 days of dredging operations are presented in Figure 6-27. TSS concentrations range from 0mg/l to 1.12mg/L while the median value is 0.25mg/L. Bed thickness at this site is below 0.004mm throughout the dredging campaign (Table 6-2). The TSS at Inshore Meadow 9 (IM9), located 1.2km to the west of the return water, ranged between 0mg/L and 3.52mg/L and the median value is 0.81mg/L (Table 6-2, Figure 6-28). Bed thickness is negligible and below 0.008mm at all times. Compared to the background data the median and 80th percentile TSS concentrations predicted at each of the inshore seagrass meadow monitoring sites will be well below those measured at all baseline monitoring sites (Figure 6-29).

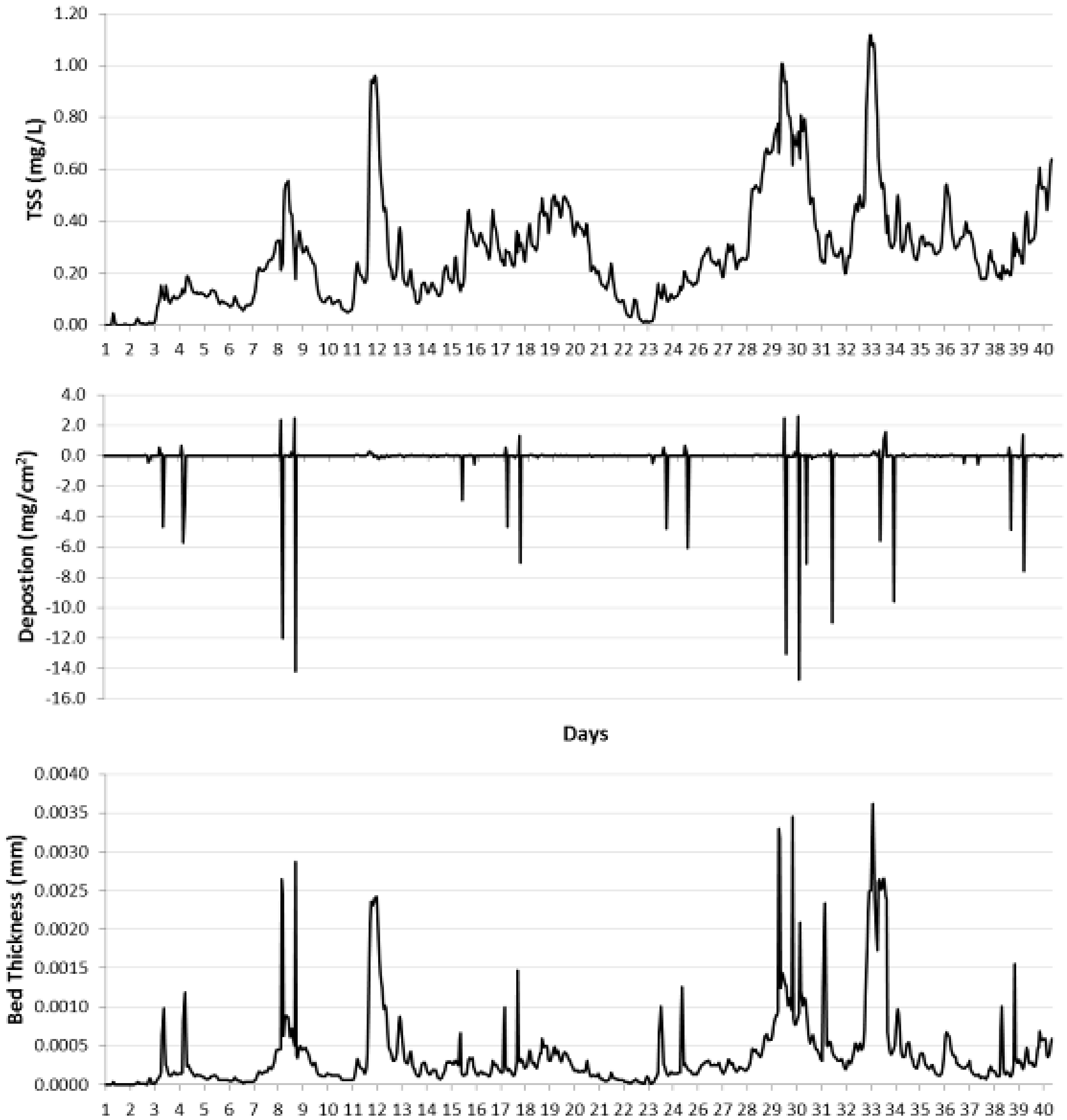


Figure 6-27 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point IM7 during the dry season scenario only

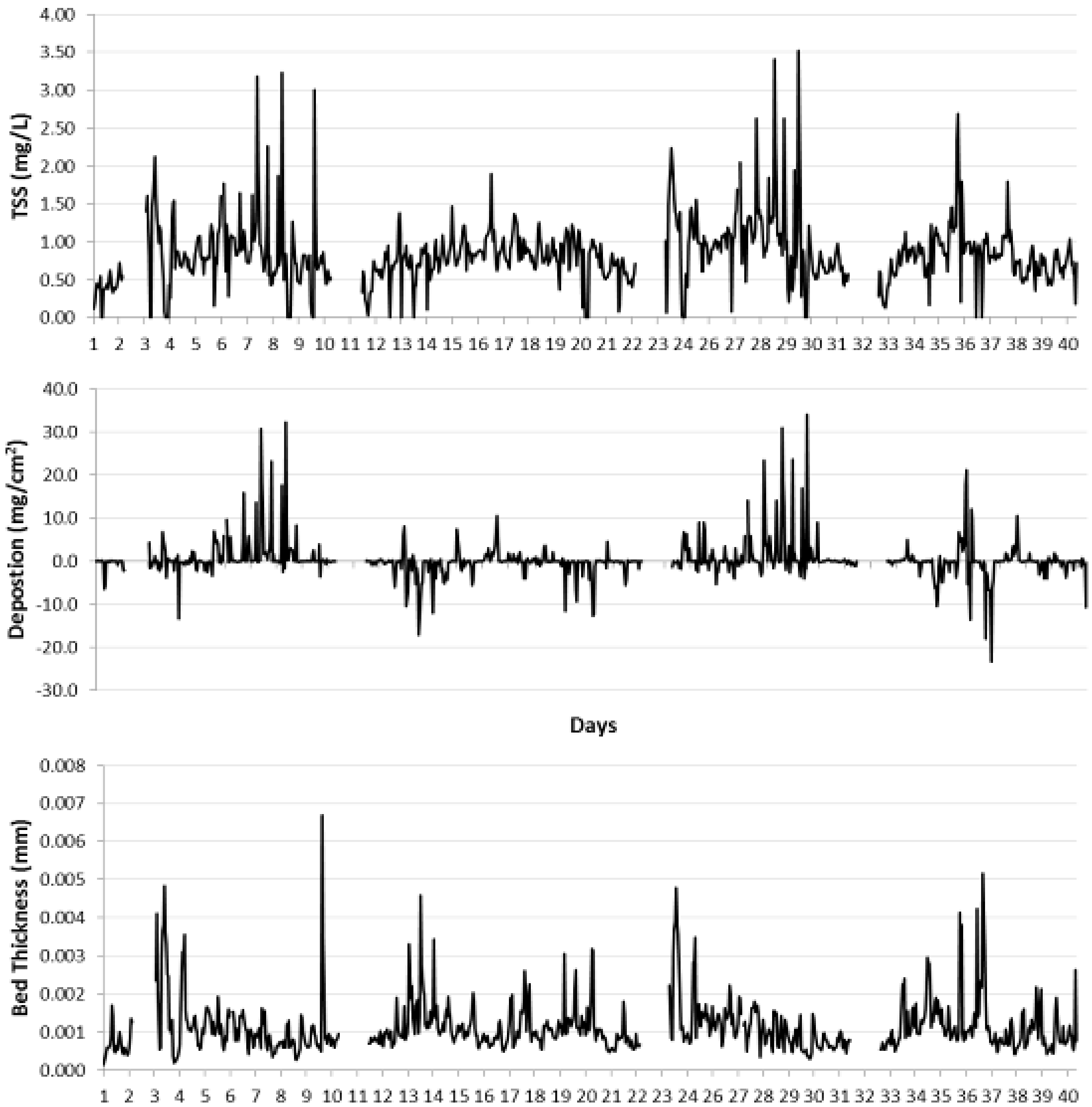


Figure 6-28 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point IM9 during the dry season scenario only

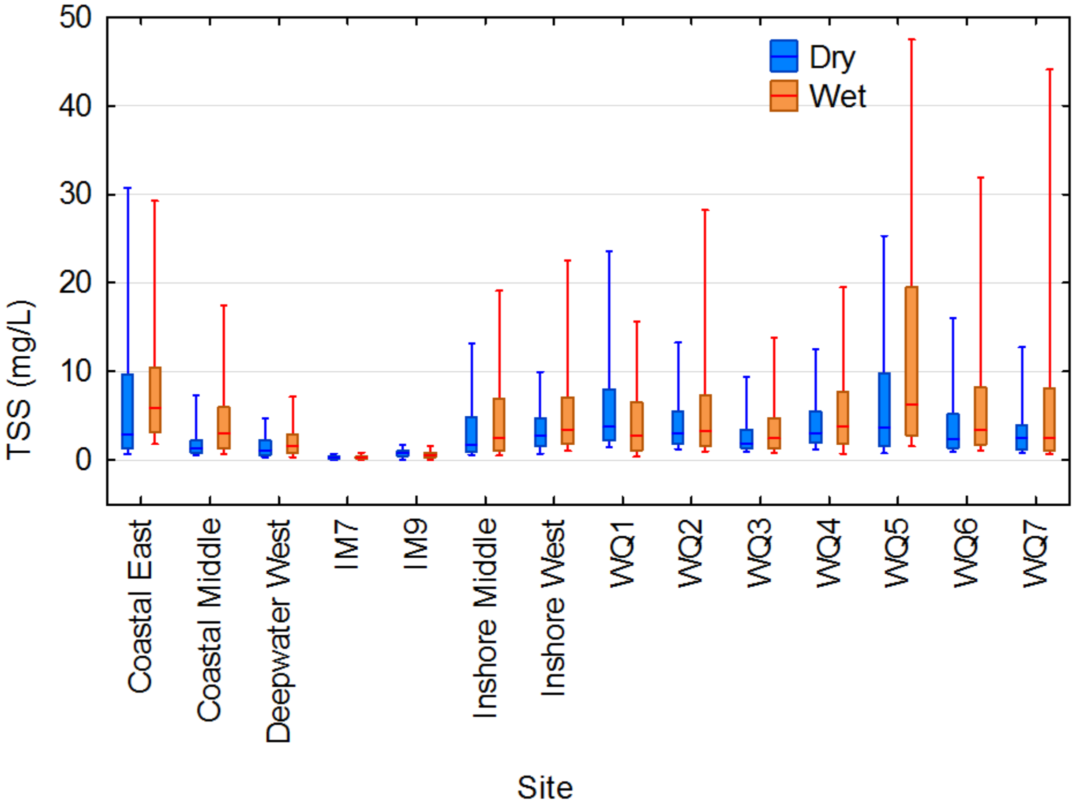


Figure 6-29 TSS Box plots for the dredging TSS time series data for two Inshore seagrass meadows monitoring sites (IM7 and IM9) plus the background data from all baseline monitoring sites

6.2.5.3 Return Water Extraction Points

Six return water extraction points were chosen at increasing distances from the point of return water discharge (see Table 6-2). The closest extraction point is OF1 located within 20m of the discharge point; the furthest extraction point is OF4 located 2km to the south of the discharge point.

Within 20m of the discharge the TSS concentrations (OF1) quickly dissipate and have a maximum concentration of 12.20mg/L and a median concentration of 7.07mg/L over the entire return water period (Table 6-2, Figure 6-30). The TSS concentrations fluctuate with tidal movement throughout the return water period. Very little sediment is deposited here and the bed thickness directly adjacent to the discharge point remains below 0.1mm.

Within 200m of the return water discharge point TSS concentrations reach a maximum of 4.92mg/L at OF2 and 4.78mg/L at OF5. Median TSS concentrations are 0.95mg/L and

1.86mg/L at OF2 and OF5 respectively (Table 6-2, OF2 - Figure 6-31, OF5 - Figure 6-34). Bed thickness at both these sites is <1mm.

Further from the discharge point at OF3, 500m to the south-west, the maximum TSS concentrations reach 6.35mg/L with a median of 0.78mg/L (Table 6-2, Figure 6-32. At OF6, located 600m to the west of the discharge point, maximum TSS concentrations reach 3.89mg/l, with a median of 1.20mg/L (Table 6-2, Figure 6-35. Bed thickness at both these sites is <1mm.

At OF4, located 2 km to the south of the return water discharge point, TSS concentrations peak at 1.67mg/L and the median is <0.5mg/L; predicted bed thickness values here very low and <1mm (Table 6-2, Figure 6-35).

Inshore seagrass site IM9 represents a time series extraction point at a distance of 1.2km to the west of the discharge point. The TSS at Inshore Meadow 9 (IM9) reaches a maximum of 3.52mg/L and the median value is 0.81mg/L (Table 6-2, Figure 6-28). Bed thickness is negligible and below 0.008mm at all times at this site.

Compared to the background data, the median TSS concentrations predicted at all return water sites, except OF1, will be below those measured at all baseline monitoring sites (Figure 6-36). At the return water discharge point the median TSS concentration are higher than those measured at monitoring sites in the region during the baseline monitoring programs.

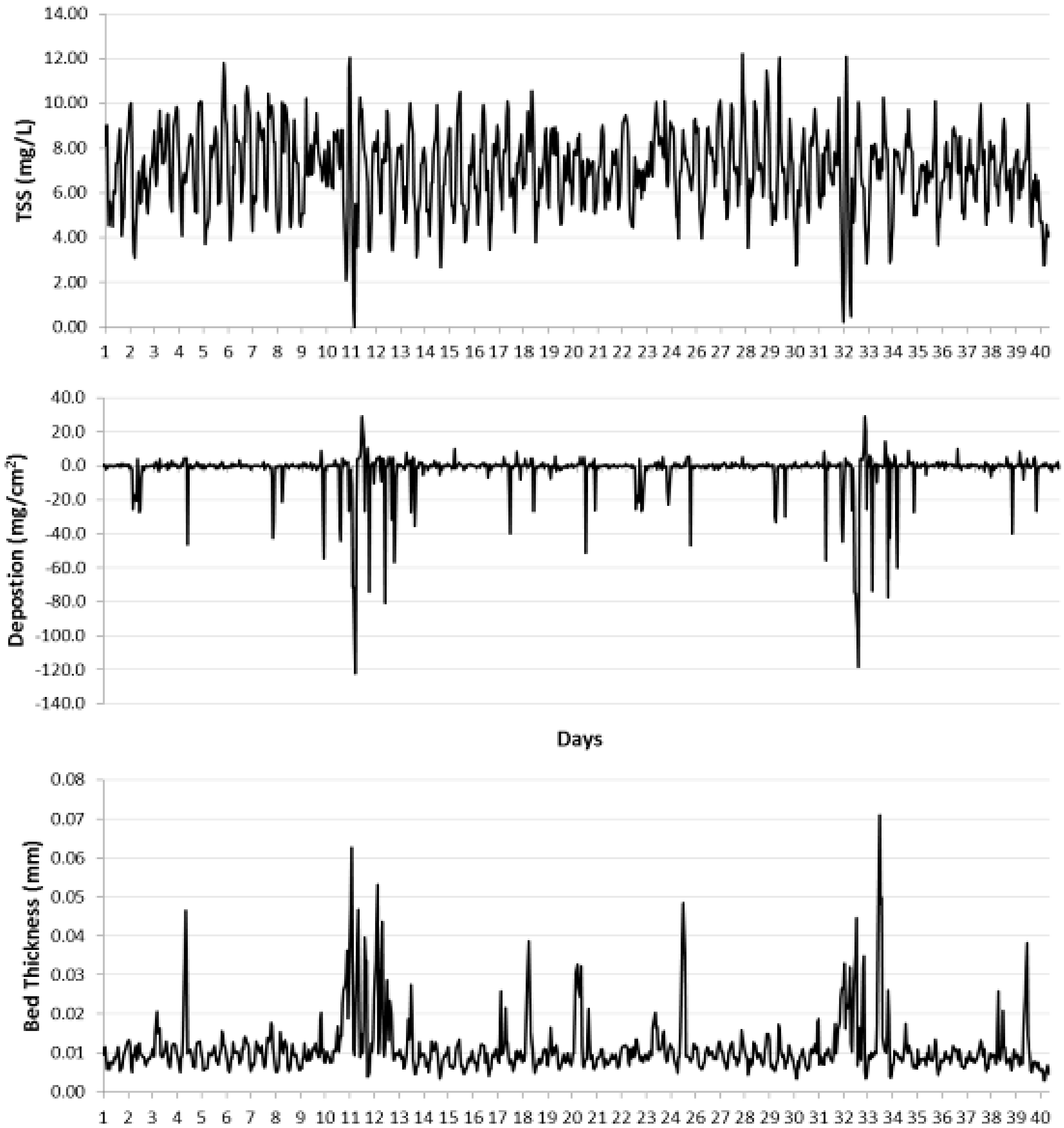


Figure 6-30 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OF1 during the dry season scenario only

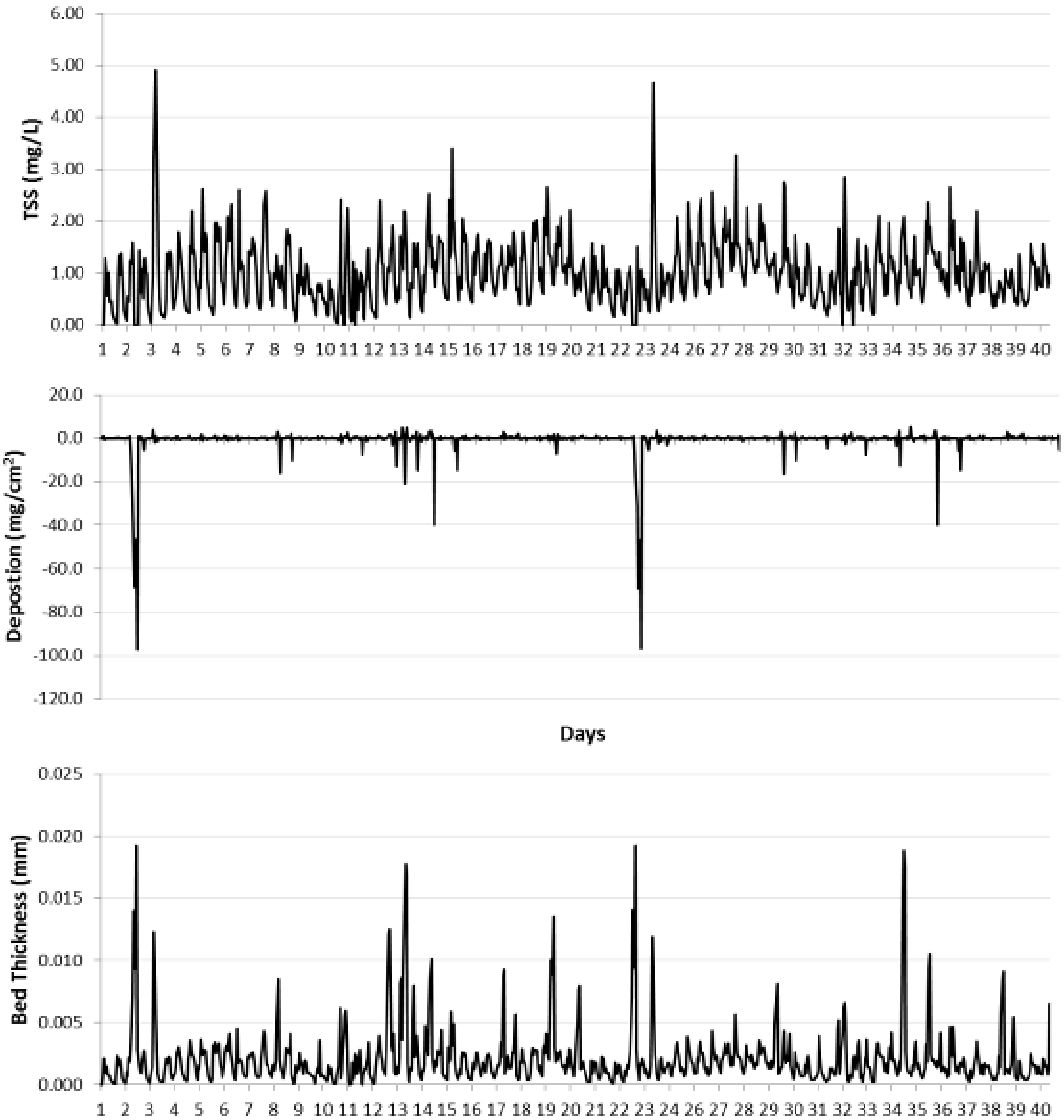


Figure 6-31 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OF2 during the dry season scenario only

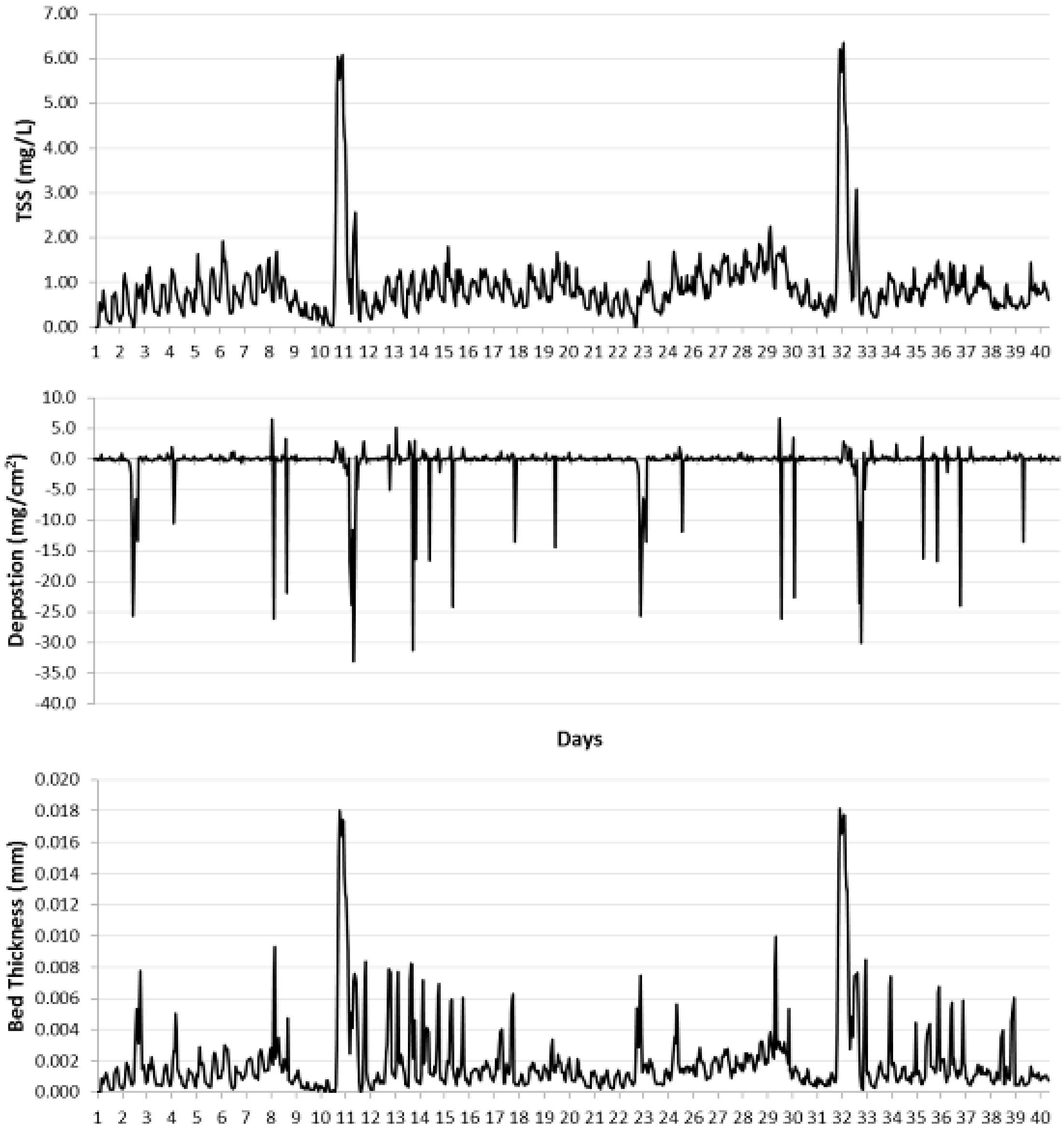


Figure 6-32 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OF3 during the dry season scenario only

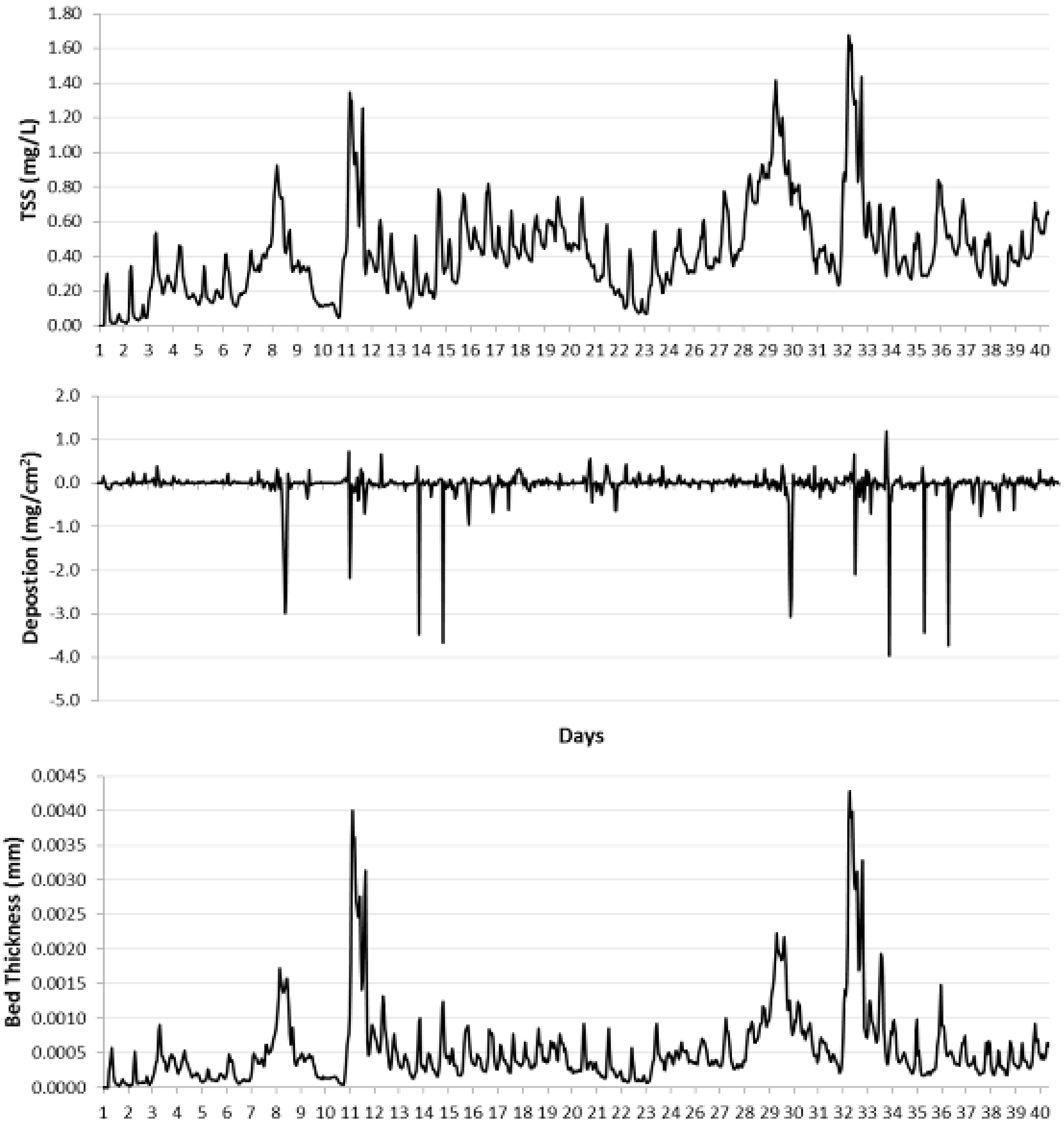


Figure 6-33 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OF4 during the dry season scenario only

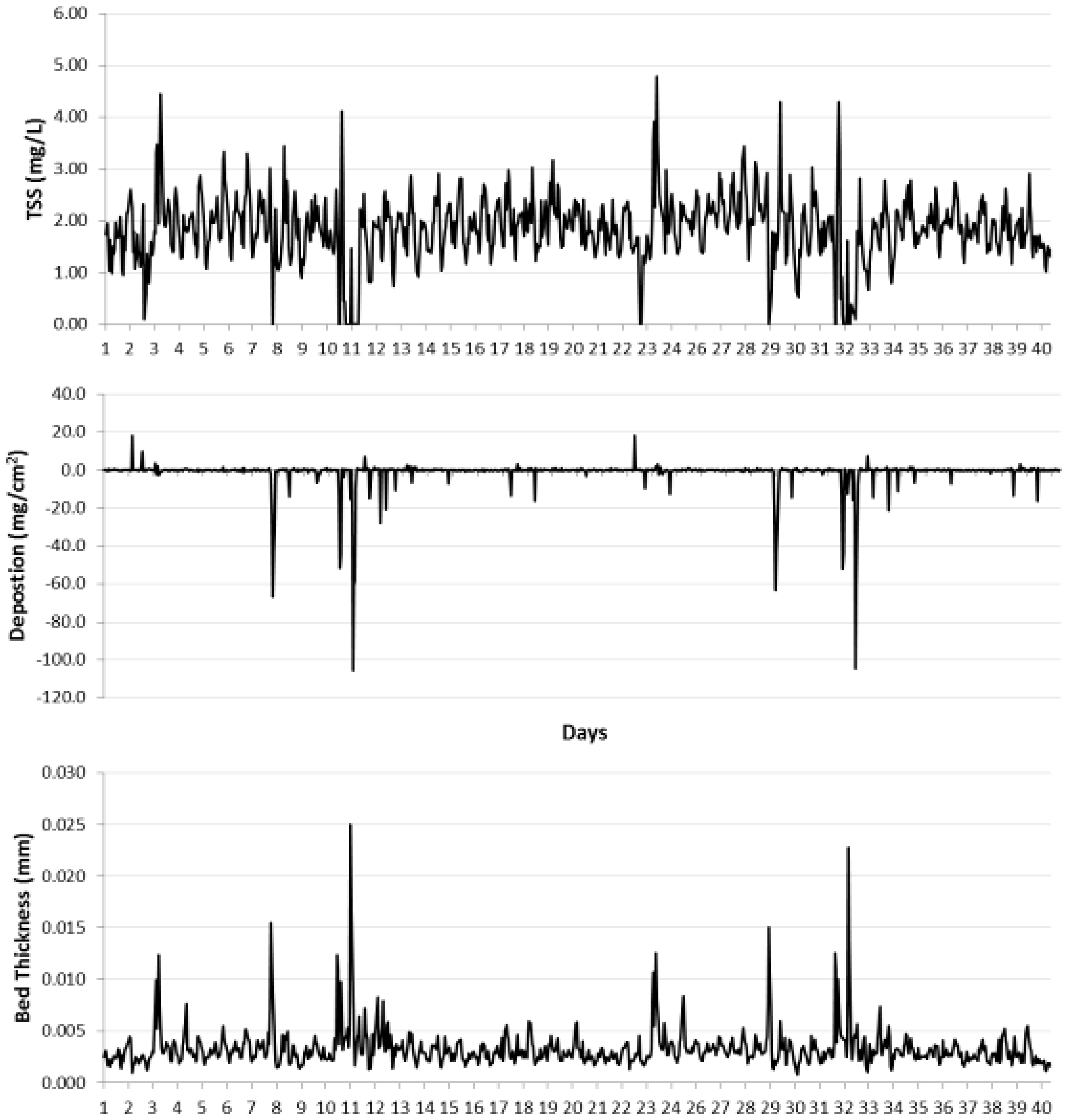


Figure 6-34 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point OF5 during the dry season scenario only

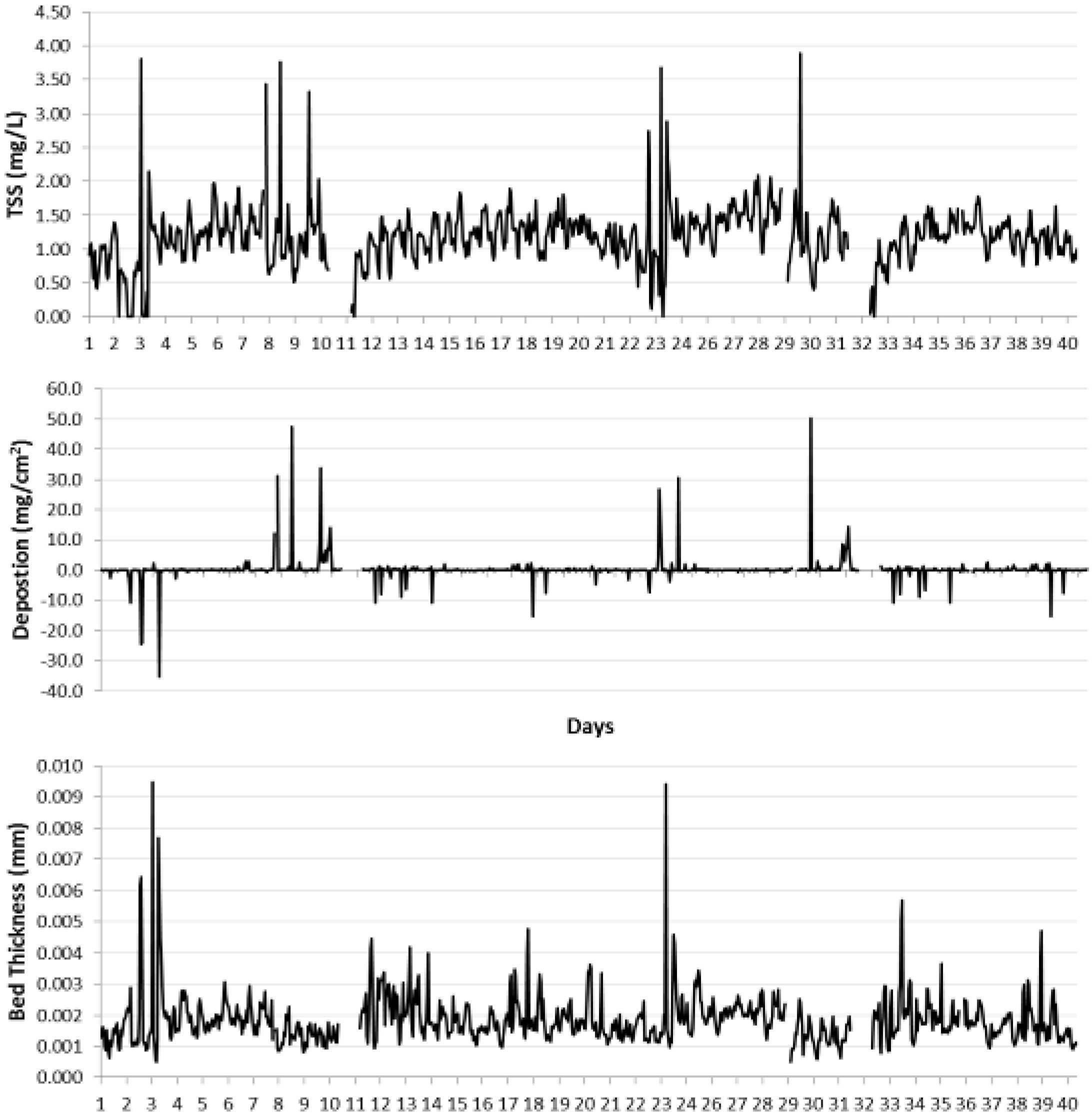


Figure 6-35 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point OF6 during the dry season scenario only

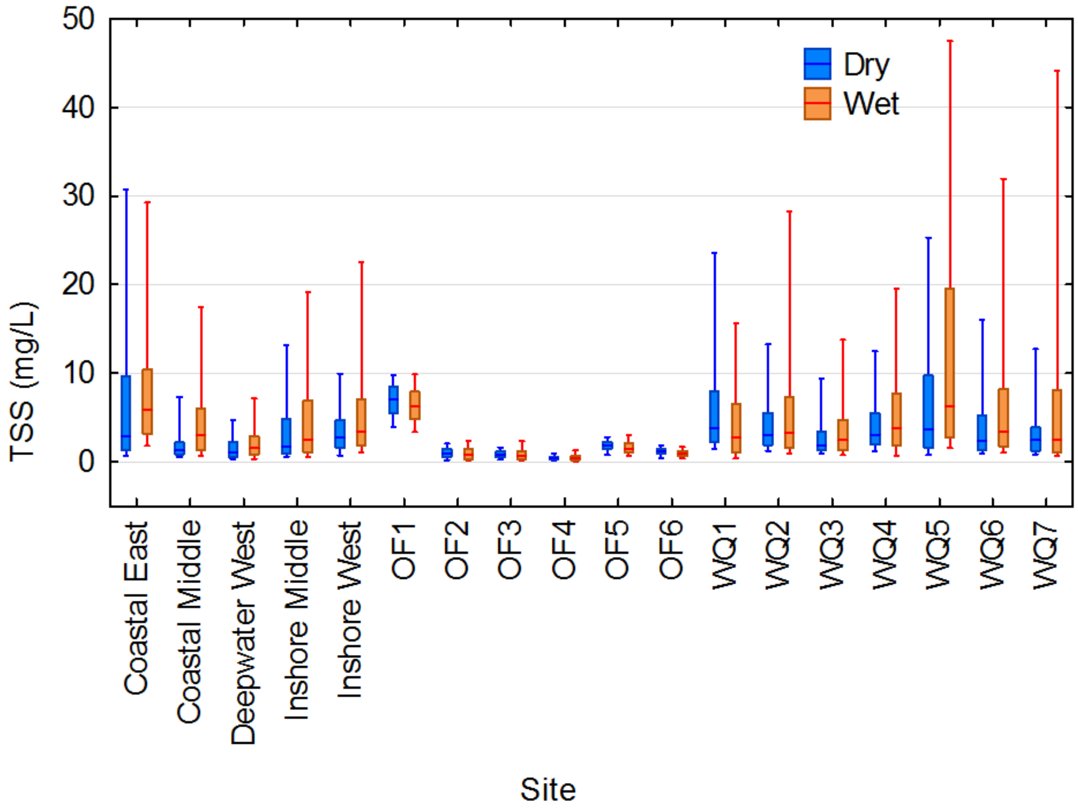


Figure 6-36 TSS Box plot for the dredging TSS time series data for the six Return water extraction points (OF1-OF6) plus the background data from all baseline monitoring sites

6.2.5.4 DREDGE RELATED EXTRACTION POINTS

Twelve extraction points from within the 95th percentile plume data extent were interrogated for the concentrations of TSS, bed thickness and sediment deposition. Only the results from six sites are presented below. Three sites in a north-west direction; 500m (D03 - Figure 6-37), 1km (D04 - Figure 6-38) and 2km (D05 - Figure 6-39) from the centre of the T0 dredging area and three sites in a south-east direction 500m (D08 - Figure 6-40), 1km (D09 - Figure 6-41) and 2km (D10 - Figure 6-42) from the centre of the T0 dredging footprint.

The plume is predicted to primarily travel in the north-west direction the TSS concentrations at extraction points in this direction generally have higher maximum TSS concentrations, higher median concentrations and higher bed thickness values.

Maximum TSS concentrations (Table 6-2) at D03, D04 and D05 are 23.53mg/L, 14.51mg/L and 7.46mg/L, respectively. In the opposite direction to the south-east the maximum TSS concentrations at D08, D09 and D10 are 18.64mg/L, 10.76mg/L and 4.79mg/L respectively. Median TSS concentrations (Table 6-2) at D03, D04 and D05 are 4.82mg/L, 3.04mg/L and 2.12mg/L, respectively. In the opposite direction to the south-east the maximum TSS concentrations at D08, D09 and D10 are 2.88mg/L, 1.92mg/L and 1.08mg/L respectively.

Bed thickness values throughout the dredging in the north-west direction (see relevant figures Figure 6-37 to Figure 6-42) at D03, D04 and D05 are <0.6mm, <0.25mm and <0.25mm, respectively. In the opposite direction bed thickness values at D08, D09 and D10 are <0.4mm, <0.18mm and <0.1mm respectively.

Compared to the background data, all of the dredge extraction point data is within the baseline data range (Figure 6-43). The predicted median TSS concentrations from the extraction points located approximately 500m from the centre of the T0 dredging area (D03 and D08), although elevated, are similar or below background TSS concentrations measured at many of the offshore baseline water quality sites.

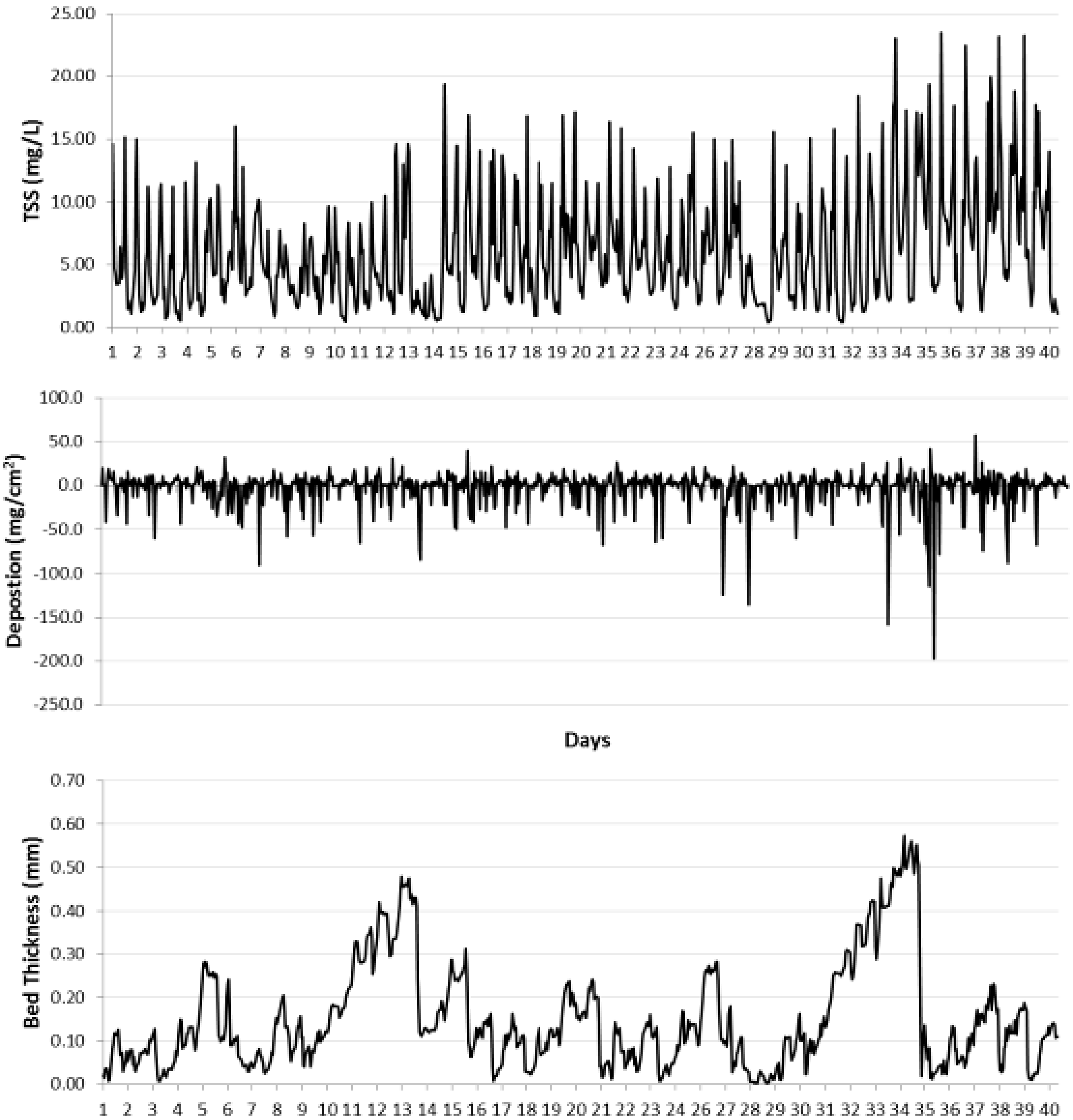


Figure 6-37 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point D03 during the dry season scenario only

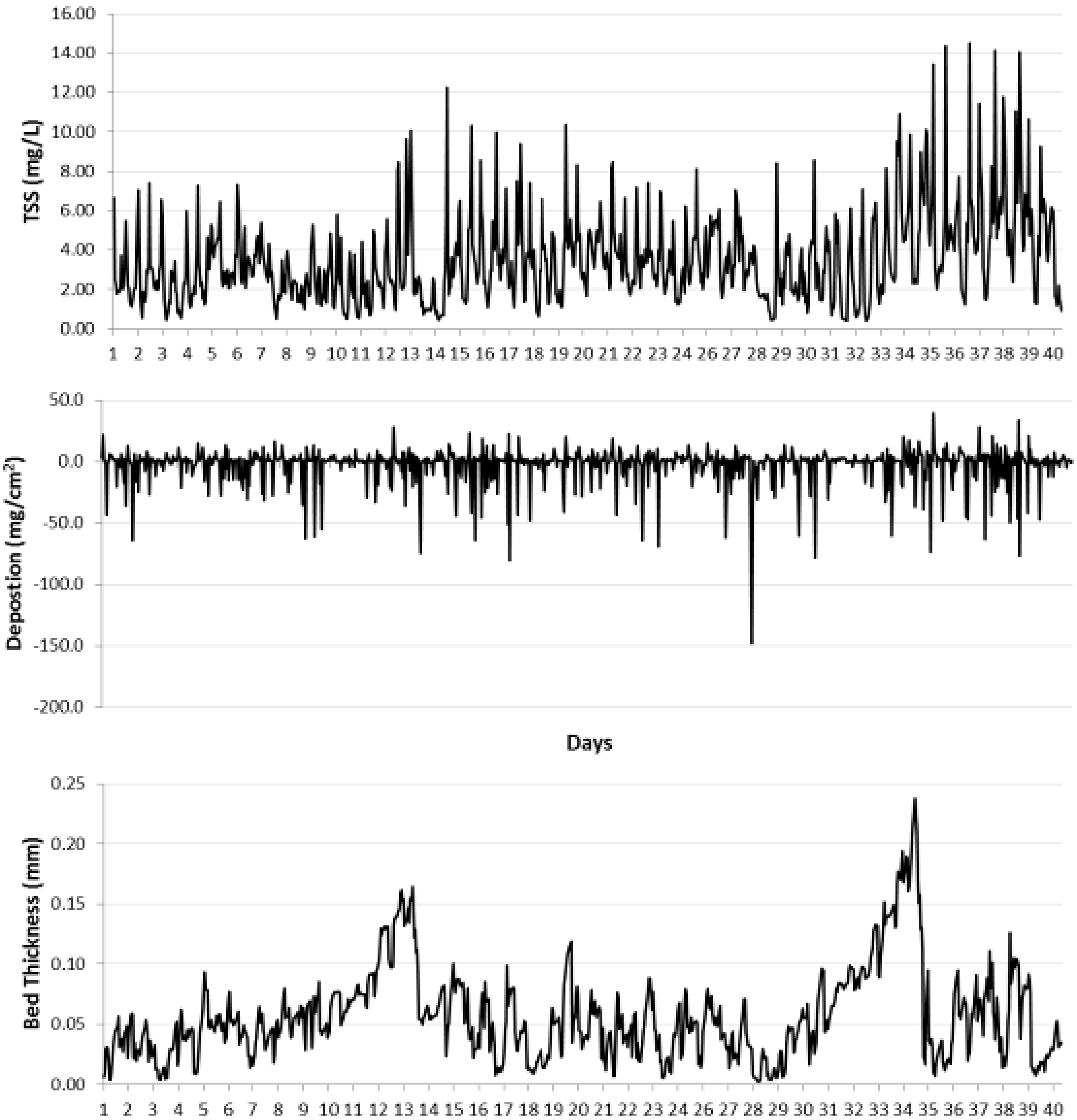


Figure 6-38 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point D04 during the dry season scenario only

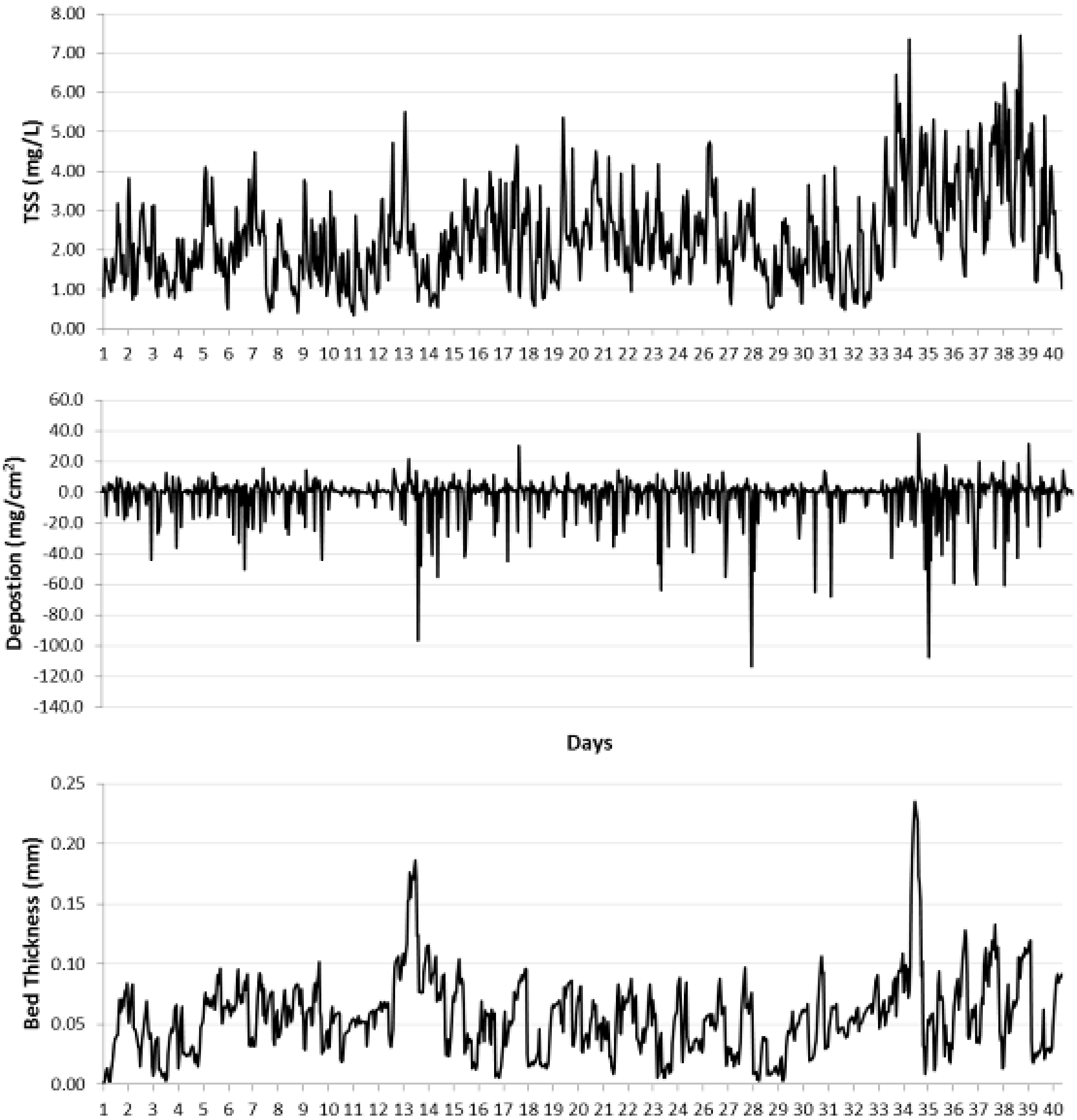


Figure 6-39 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point D05 during the dry season scenario only

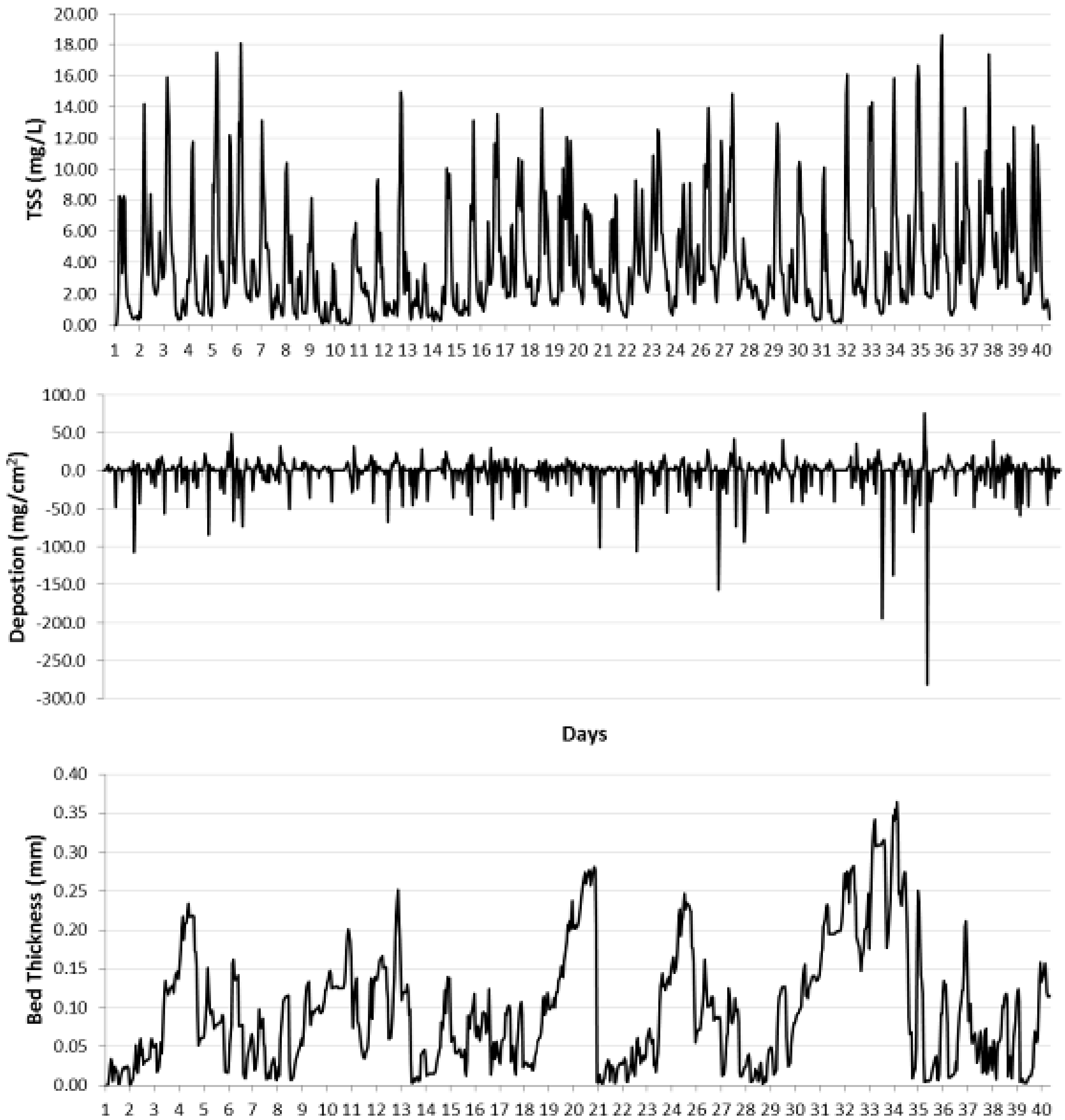


Figure 6-40 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point D08 during the dry season scenario only

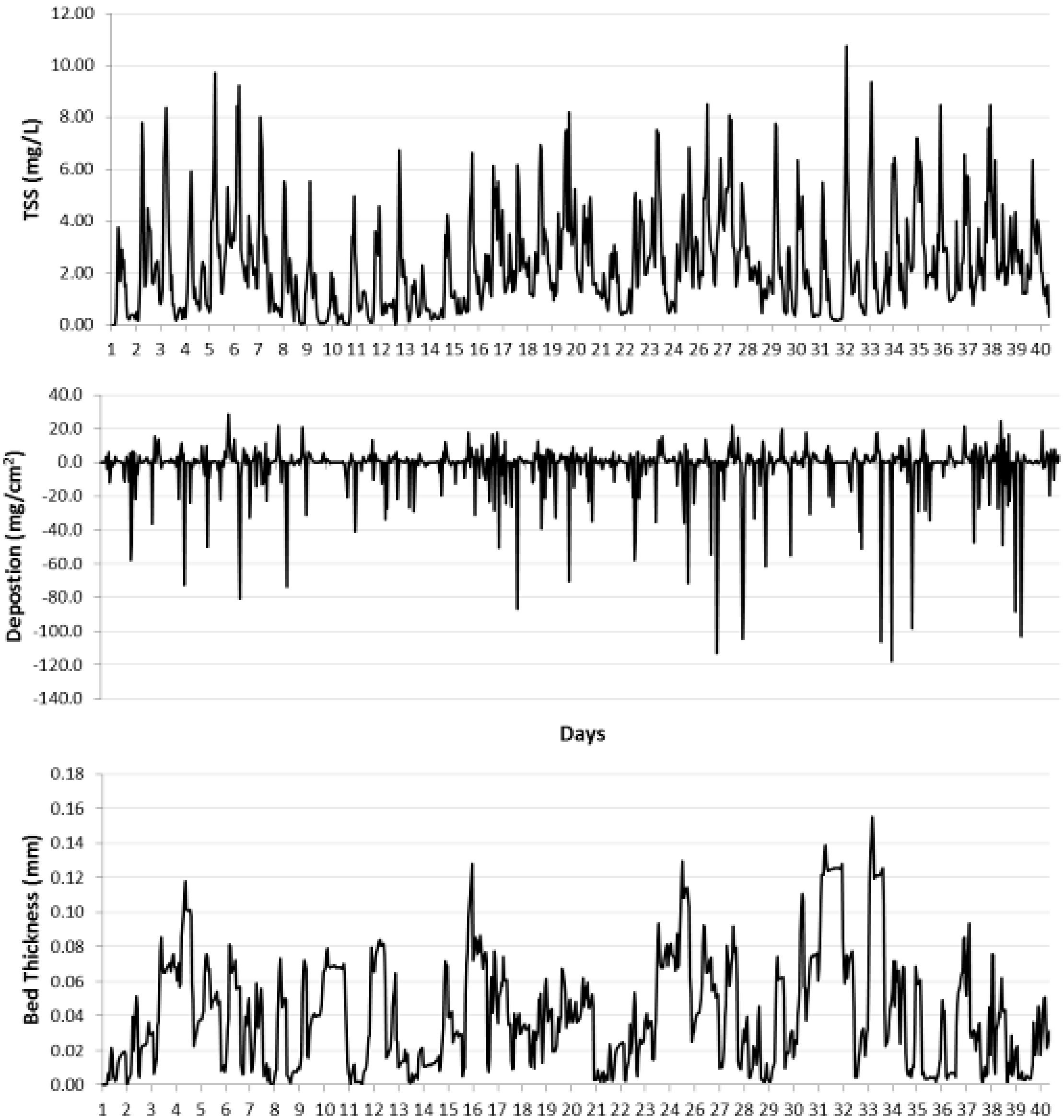


Figure 6-41 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point D09 during the dry season scenario only

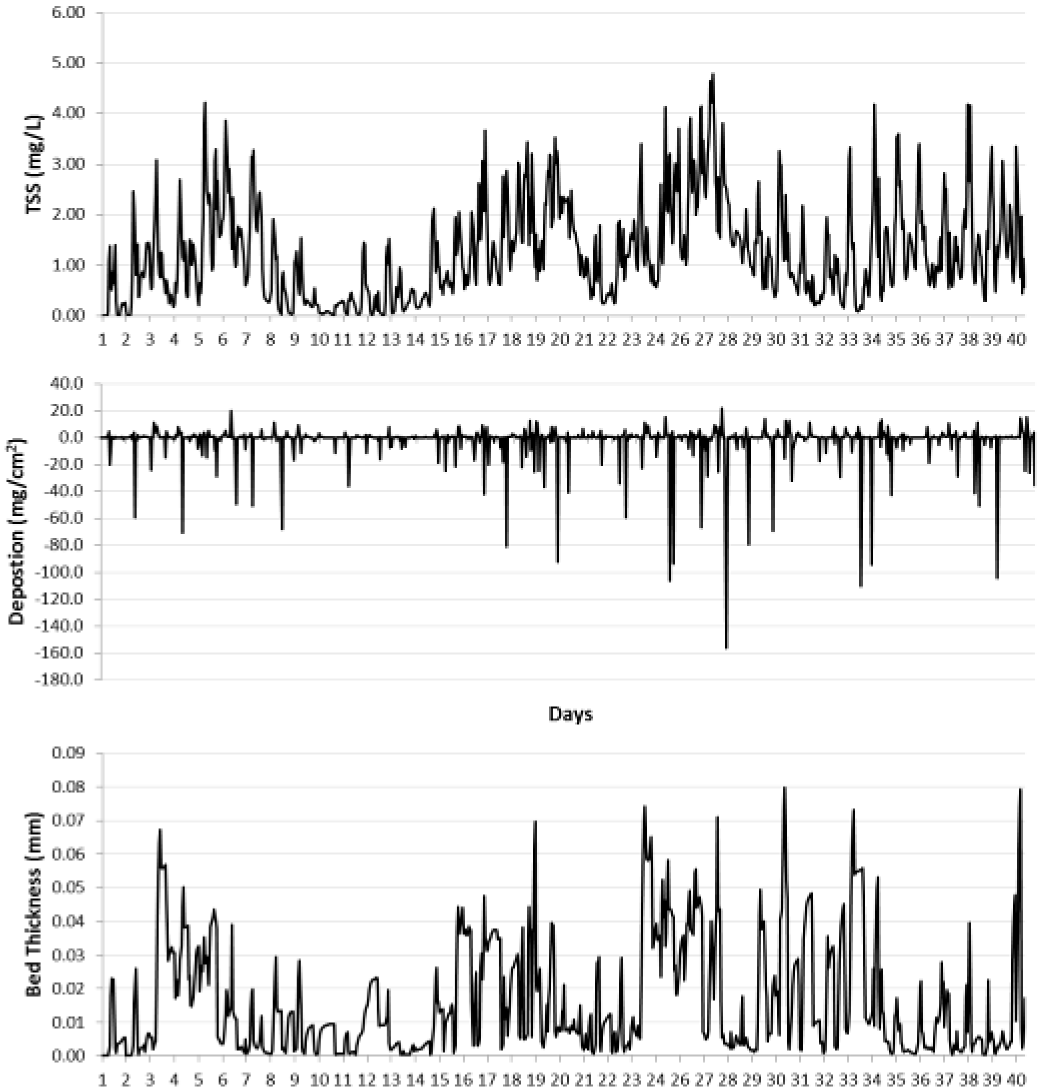


Figure 6-42 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point D010 during the dry season scenario only

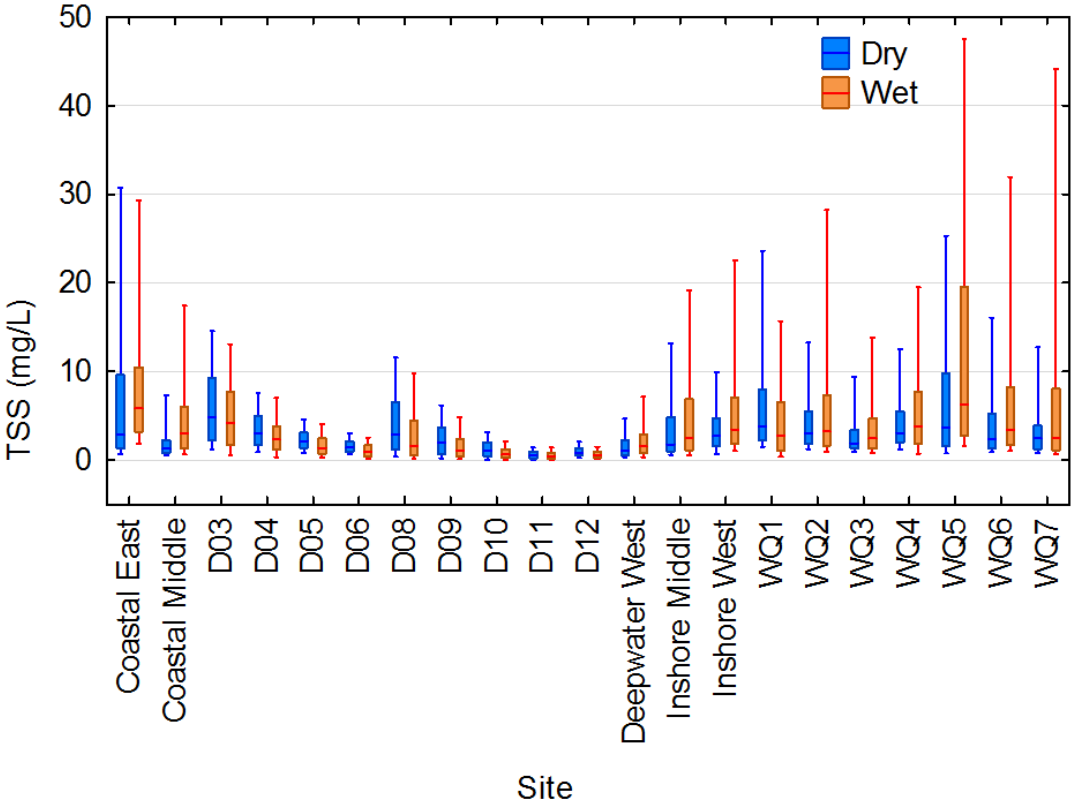


Figure 6-43 TSS Box plot for the dredging TSS time series data for the 6 Dredging plume extraction points (D03-06 and D08–12) plus the background data from all baseline monitoring sites

6.2.5.5 REFERENCE AND FAR-FIELD SITES

Four 'far-field' extraction points or reference sites were chosen which were outside or on the edge of the 95th percentile plume data extent outer boundary (Figure 6-22). From the centre of the T0 dredging area; Point 11 is located 4km to the South, D11 5km to the south-east, D12 located 12km to the west and Point 14 located 14km to the west (Table 6-1).

At Point 11 and D11 the TSS concentration peaks at 1.86mg/L and 2.78mg/L respectively and the median TSS concentrations at extraction point 11 and 14 are 0.35mg/L and 0.51mg/L respectively (Table 6-2, Figure 6-44, Figure 6-45). Bed thickness at these two sites is below 0.1mm.

At D12 and 14 the TSS concentration peaks at 3.61mg/L and 3.04mg/L respectively and the median TSS concentrations at D12 and 14 are 0.79mg/L and 0.61mg/L respectively (Table 6-2, Figure 6-44, Figure 6-45). Bed thickness at these two sites is below 0.1mm.

Compared to the background data the median TSS concentrations predicted at all reference sites will be below the medians measured at all baseline monitoring sites (Figure 6-48).

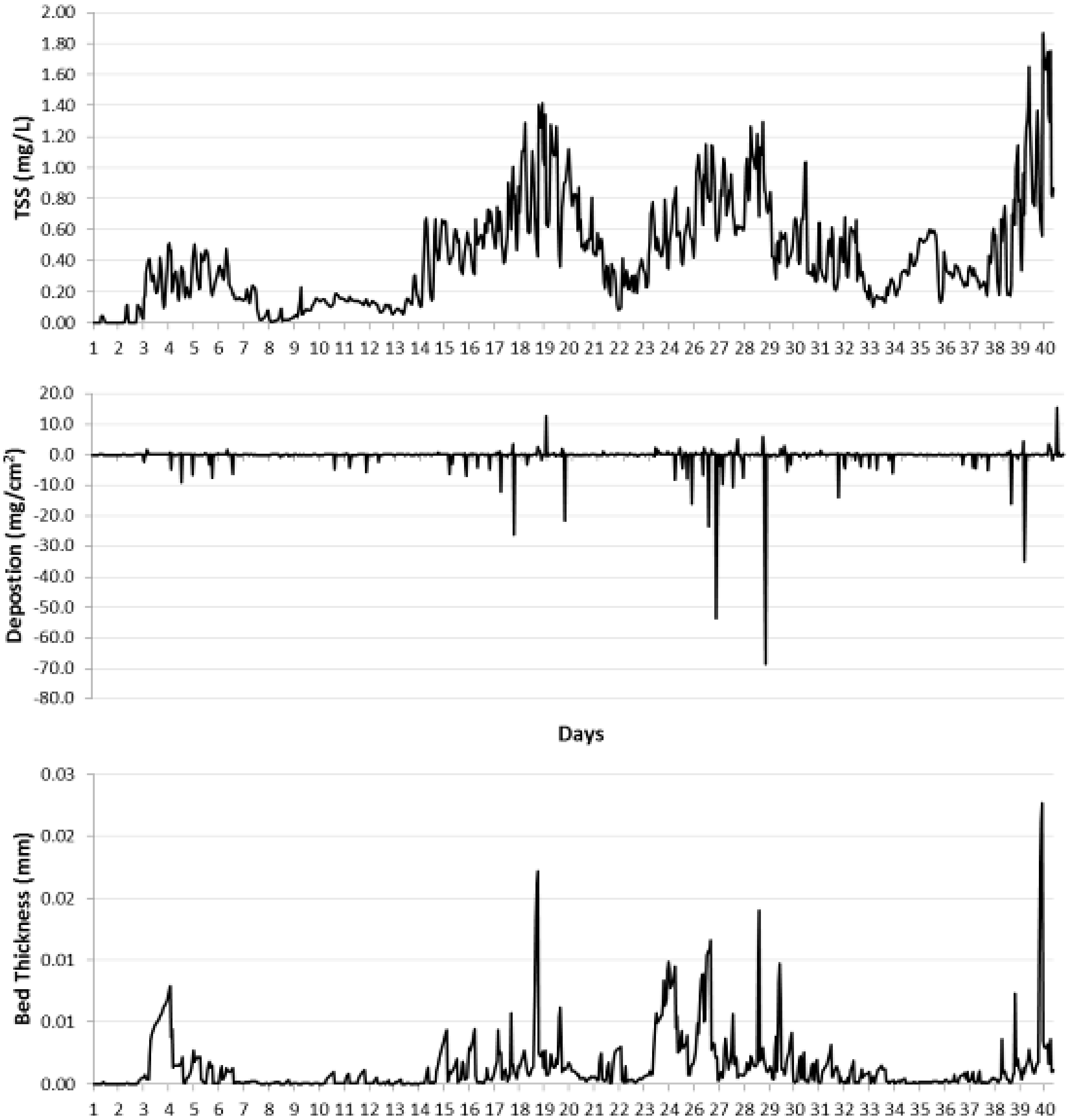


Figure 6-44 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point 11 during the dry season scenario only

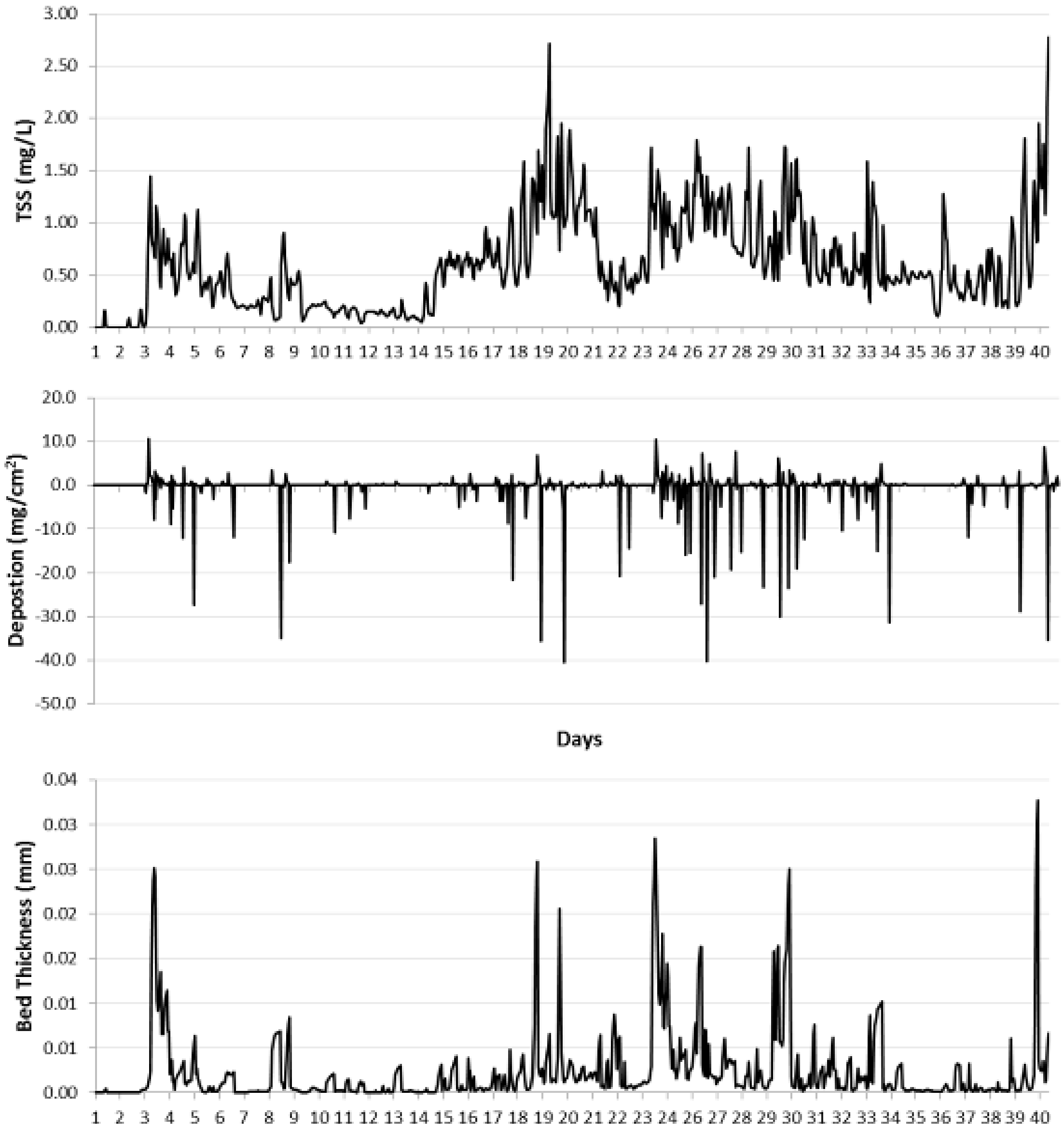


Figure 6-45 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point D11 during the dry season scenario only

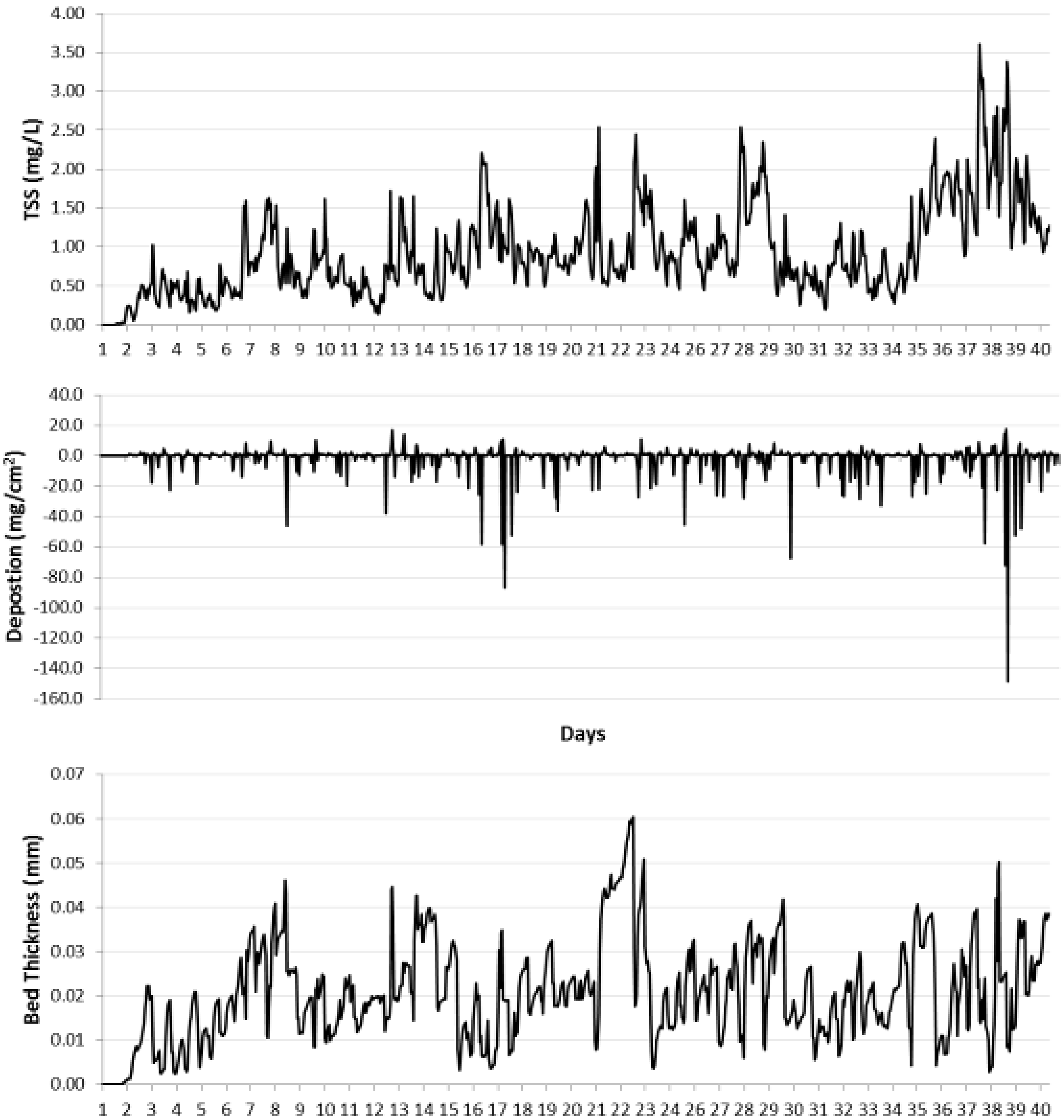


Figure 6-46 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point D12 during the dry season scenario only

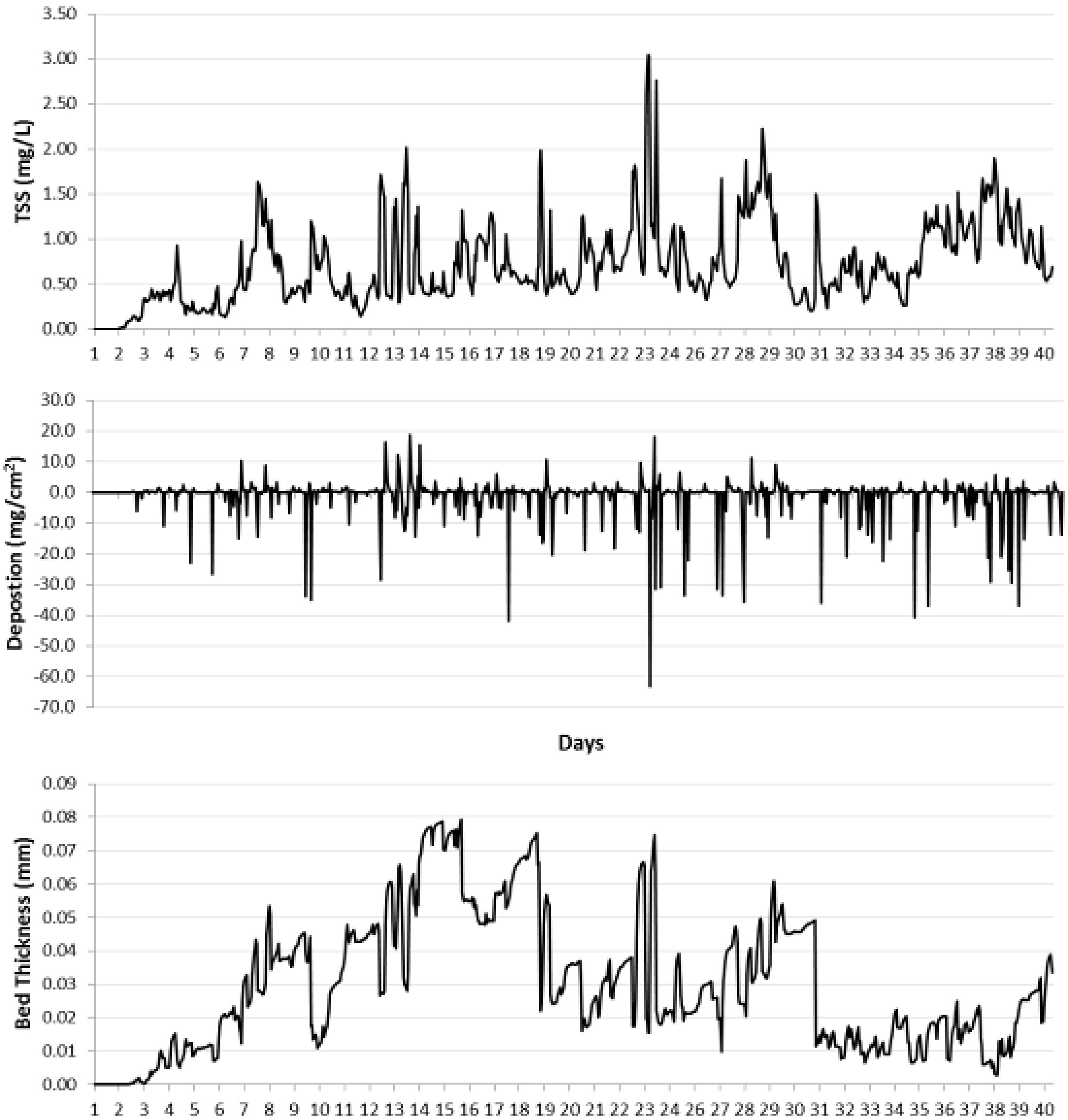


Figure 6-47 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point 14 during the dry season scenario only

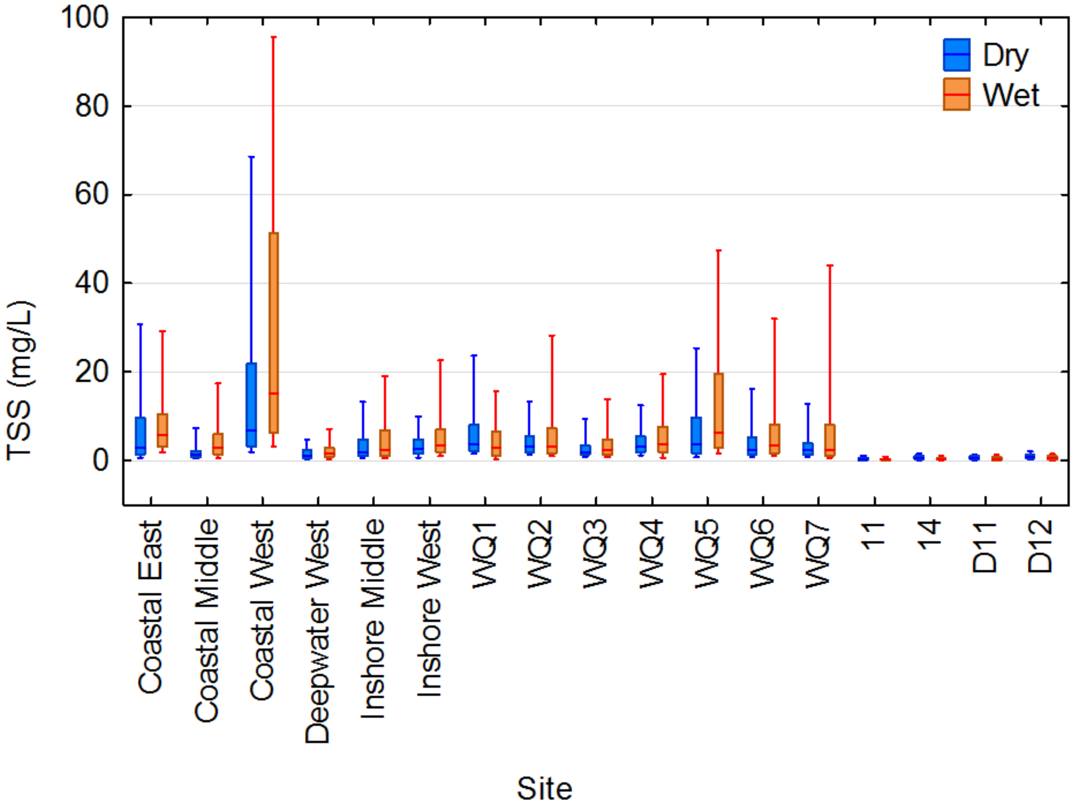


Figure 6-48 TSS Box plot for the dredging TSS time series data for the reference extraction points (11, 14, D11 and D12) plus the background data from all baseline monitoring sites.

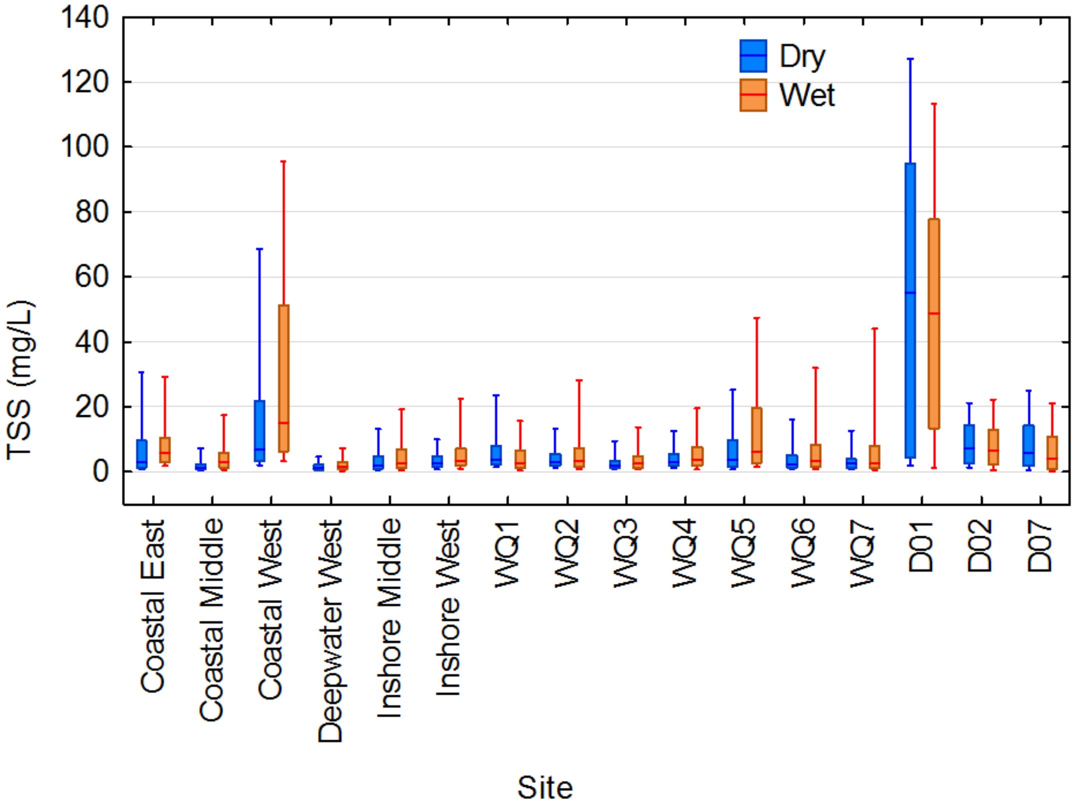


Figure 6-49 TSS Box plot for the dredging TSS time series data for the extraction points located within the dredging footprint (D01, D02 and D07) plus the background data from all baseline monitoring sites including Coastal West.

6.2.5.6 OTHER SENSITIVE RECEPTOR SITES

The closest coral communities to the T0 dredging area are found at Cape Upstart (27km away), Camp Island (20km away), Holbourne Island (31km away) and Nares Rock (30km away). Time series information was extracted from five coral community sites and the Catalina plane wreck site (located 24km from T0) to examine changes in TSS, sedimentation and bed thickness above background values at these locations for the dry season only, neutral year scenario (worst case). The locations of these points and the relative distance from the T0 dredging area and discharge point are provided in Table 6-1. The summary statistics for predicted TSS (mg/L), sedimentation rate (mg/cm2/hour) and bed thickness (mm) at each site are provided in Table 6-3 below.

Table 6-3 Summary statistics of time series TSS (mg/L) dredging and return water data from the coral reef and Catalina plane wreck extraction points

Site	Mean	Median	Minimum	Maximum	80th Percentile	95th Percentile
Cape Upstart	0.22	0.21	0.00	1.21	0.34	0.40
Camp Is. East	0.32	0.29	0.00	2.01	0.46	0.71
Camp Is. West	0.27	0.23	0.00	1.21	0.40	0.63
Holbourne Is.	0.00	0.00	0.00	0.00	0.00	0.00
Nares Rock	0.00	0.00	0.00	0.00	0.00	0.00
Catalina Site	0.01	0.00	0.00	0.22	0.02	0.08

Table 6-4 Summary statistics of time series bed thickness (mm) dredging and return water data from the coral reef and Catalina plane wreck extraction points

Site	Mean	Median	Minimum	Maximum	80th Percentile	95th Percentile
Cape Upstart	0.001	0.001	0.000	0.009	0.001	0.003
Camp Is. East	0.001	0.000	0.000	0.006	0.001	0.001
Camp Is. West	0.001	0.001	0.000	0.014	0.001	0.003
Holbourne Is.	0.000	0.000	0.000	0.000	0.000	0.000
Nares Rock	0.000	0.000	0.000	0.000	0.000	0.000
Catalina Site	0.000	0.000	0.000	0.008	0.000	0.001

The additional TSS due to the dredging activities at the seafloor at coral communities located at Cape Upstart, Camp Island East and Camp Island West ***on average*** are very similar (0.22mg/L, 0.32mg/L and 0.27mg/L respectively - Table 6-3). The model does predict slightly larger elevations of TSS above background for short periods. **Maximum** TSS at the seabed ranges from 1.21mg/L at Cape Upstart and Camp Island West (Figure 6-50 and Figure 6-51) to 2.01mg/L at Camp Island East (Figure 6-52). The amount of sediment that is predicted to settle on the seabed (**bed thickness**) at these sites is on average <0.001mm. A maximum of 0.014mm of sediment is predicted at Camp Island East (see summary statistics in Table 6-4, time series data in Figure 6-50 Figure 6-51 and Figure 6-52). The fine sediment that settles is quickly resuspended and eventually becomes entrained into the existing seabed sediments further afield.

The additional TSS due to the dredging activities at the seafloor at Nares Rock, Holbourne Island and the Catalina plane wreck site is very low or below zero (see summary statistics in Table 6-3). The model does however predict elevations of TSS above background for short periods at these sites reaching a maximum of 0.0014mg/L at Nares Rock (Figure 6-53), 0.00012mg/L at Holbourne Island (Figure 6-54) and 0.22mg/L at the Catalina Site (Figure 6-55). These elevations of TSS are so low as to not be distinguishable from background. Bed thickness of sediments at all of these sites are <0.01mm. The suspended fine sediments from the dredging are predicted to become entrained into the seabed sediments well before they reach these far field locations.

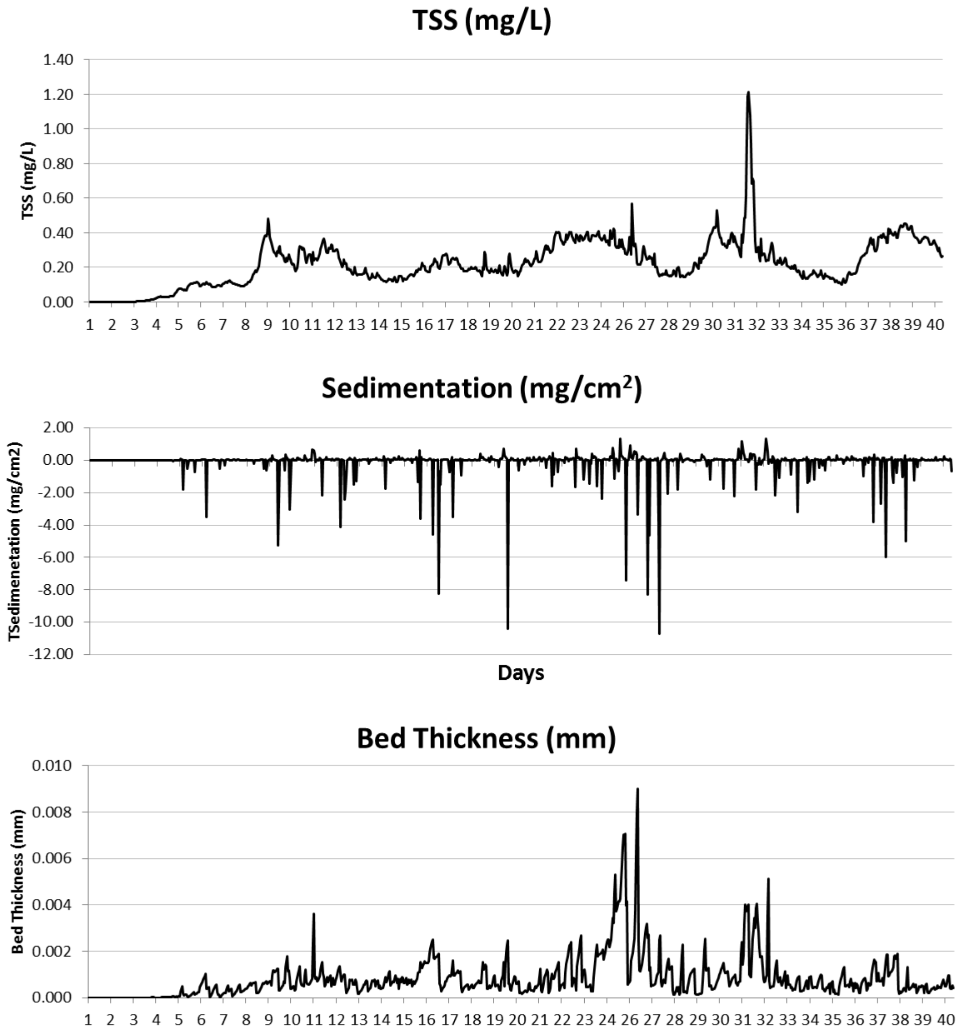


Figure 6-50 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point located at Cape Upstart during the dry season scenario only

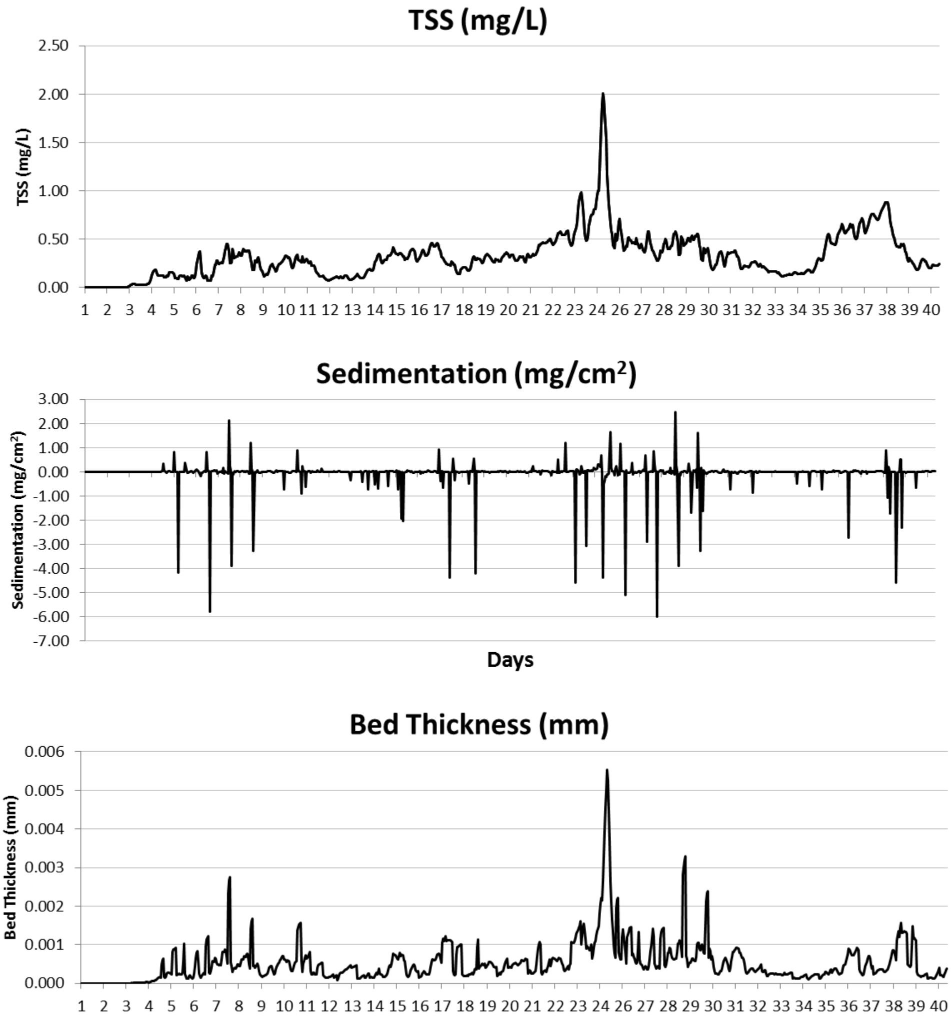


Figure 6-51 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point located at Camp Island East during the dry season scenario only

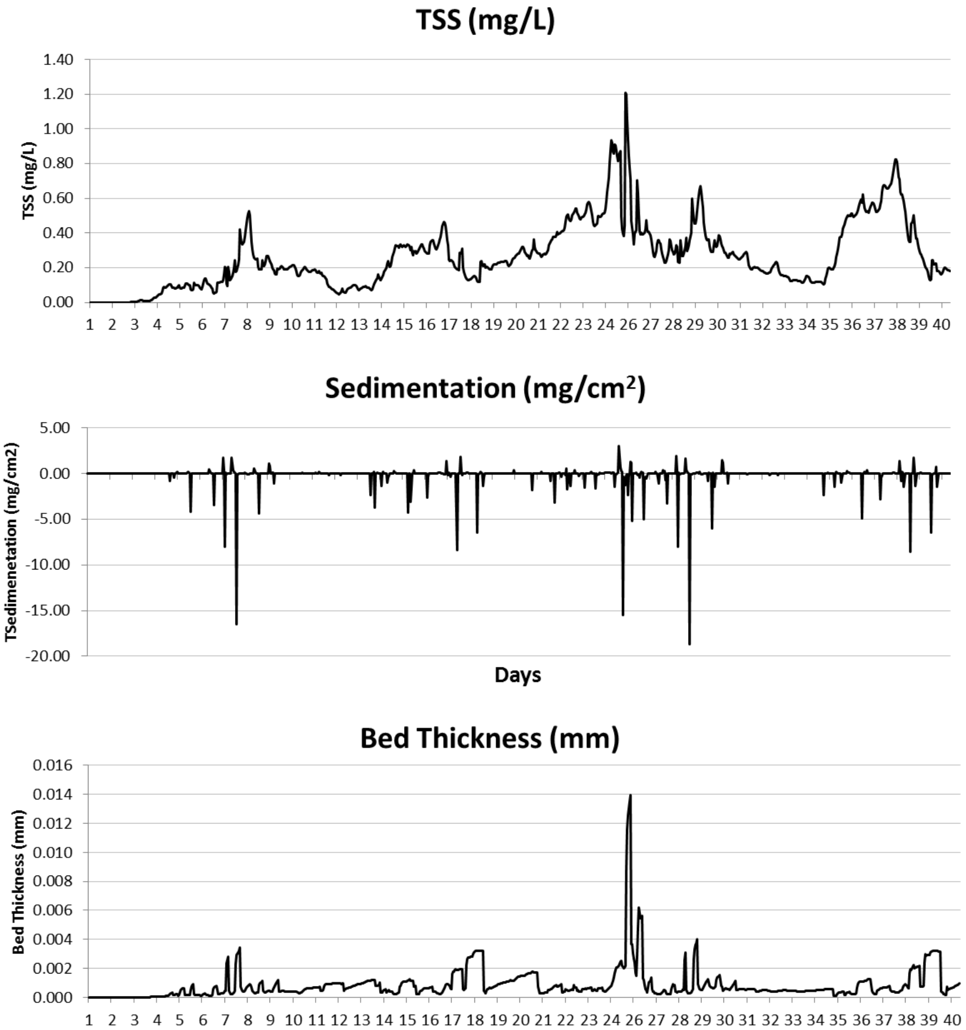


Figure 6-52 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm^2) from extraction point located at Camp Island West during the dry season scenario only

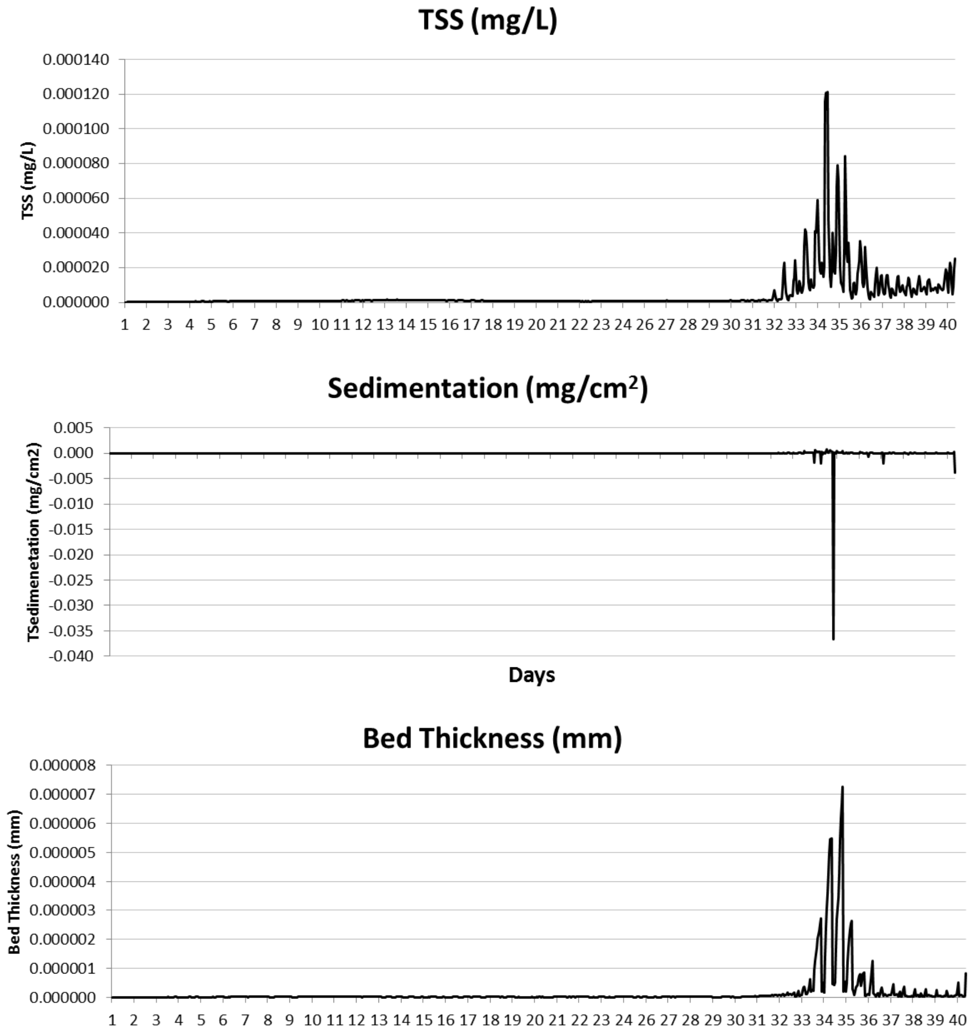


Figure 6-53 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point located at Holbourne Island during the dry season scenario only

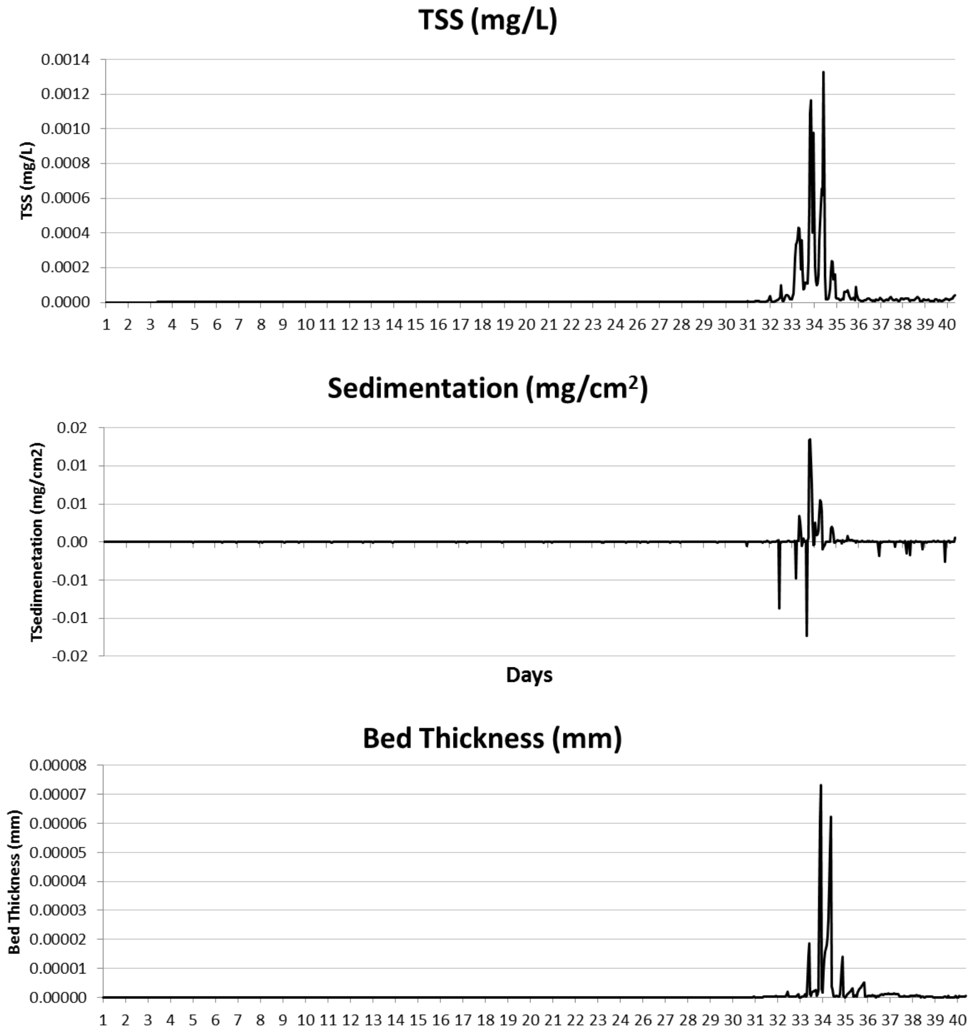


Figure 6-54 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm[2]) from extraction point located at Nares Rock during the dry season scenario only

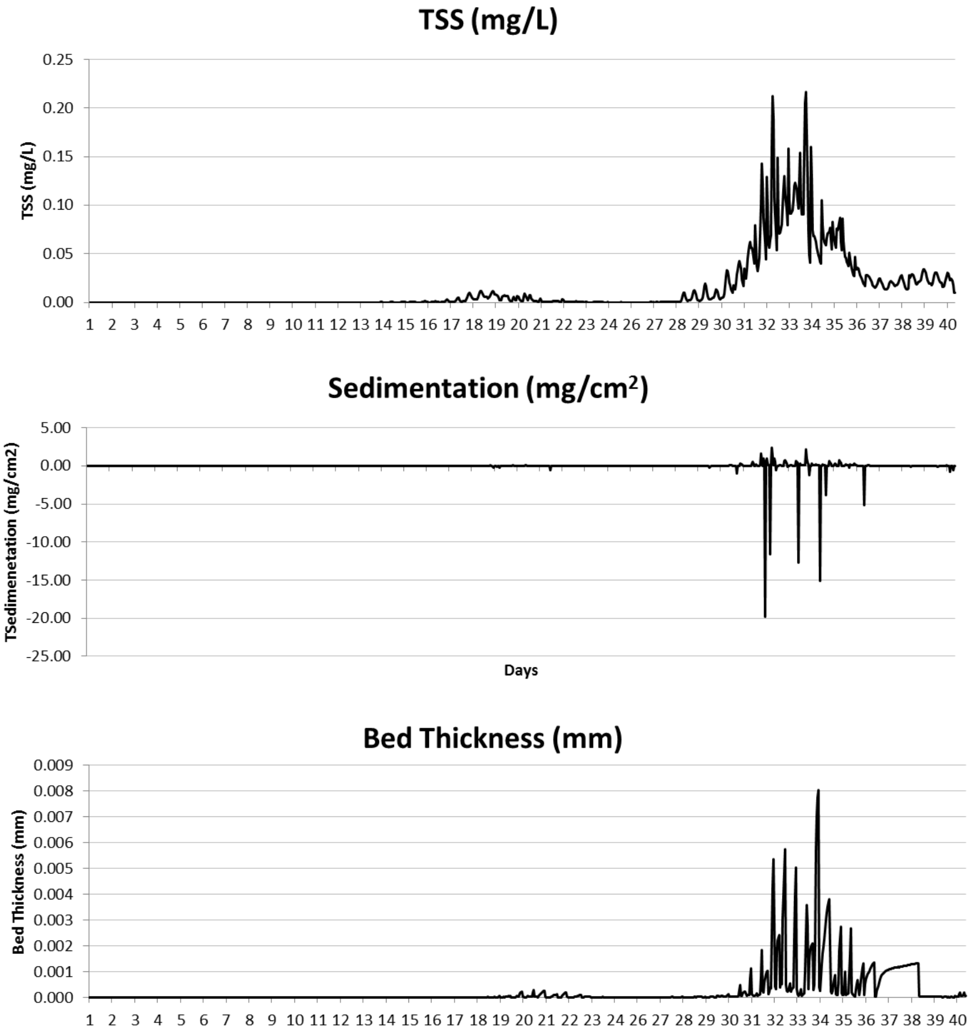


Figure 6-55 TSS (mg/L), bed thickness (mm) and sediment deposition (mg/cm²) from extraction point located at the Catalina plane wreck site during the dry season scenario only

6.2.6 Coral disease

A recent publication highlighted that dredging at Barrow Island (Gorgon Project) located offshore of North Western Australia may have caused elevated levels of coral disease in coral communities adjacent to the project (Pollock *et al.*, 2014). The Gorgon Project dredging program at Barrow Island involved the removal and dumping of approximately 7.6 million tons of marine sediment over an 18 month period from 19 May 2010 to 7 November 2011. The dredging occurred in close proximity to coral communities (<1km). The impacts to coral communities was limited to an area <10km from the impact site.

The Abbot Point Project involves the removal and placement on land of 1.1million tons of seabed sediment. There will be no placement of dredged material at sea. The dredging and discharge locations are located >19km from the nearest rocky coral reefs growing around Camp Island and >30km from Holbourne Island. The plumes associated with the dredging are not predicted to impact upon the health of these coral communities.

6.2.7 Cyclones, dredging and water quality

As detailed in RHDHV (2015) and in Section 3.5, TCs can result in short-term (in the order of days to weeks) increases in TSS (or turbidity) concentration due to the re-suspension of natural bed material. If a TC occurred during or immediately after the dredging at Abbot Point it is likely that re-suspension of any deposited material would occur. However, measured water quality data has shown that extensive re-suspension of the existing bed material also occurs during these extreme events, due to increased currents and wave activity, with TSS concentrations exceeding 100mg/l during the peak of the events. In addition, the measured data indicates that the natural re-suspension of the existing bed material occurs on a regional scale, likely influencing areas of hundreds of kilometres or more.

The modelling results have shown that the sediment released by the dredging activity and the return water discharge results in a small, local scale increase in suspended sediment and does not result in significant deposition at any location except for at the dredge location immediately after the dredging finishes (this material will then be subsequently re-suspended, dispersed and re-deposited).

Therefore, although re-suspension of any deposited dredged material is expected to occur during a TC it is not expected that this would result in an increase in the resultant TSS concentrations during the event or change any impacts of the suspended sediment on the environment. In addition, there is a significant difference in the spatial scale of any impacts resulting from the re-suspension of natural existing bed material during a TC which is regional compared to the re-suspension of deposited material released during the dredging which is local.

6.2.8 Previously proposed capital dredging projects

In December 2013, NQBP received EPBC Act approval (2011/6213) for capital dredging of T0, T2 and T3 and placement at sea for 3 million m^3 of dredged material. Approvals under the *Great Barrier Reef Marine Park Act 1975 (Cth)*, *Environment Protection (Sea Dumping) Act 1981* and necessary State approvals were received in January 2014.

The hydrodynamic modelling results of the 95%ile TSS concentrations outlined in the Abbot Point, T0, T2 and T3 Capital Dredging Public Environmental Report (GHD 2102d) and the Abbot Point Growth Gateway Project are both provided for comparison in Figure 6-56 and Figure 6-57, respectively.

The 95^{th} percentile plots represent conditions that would be expected for 5% of the dredging campaign. The use of 95^{th} percentile outputs may be considered as a worst case scenario. The lengths of the proposed dredging campaigns for both projects are similar (up to 12-13 weeks). The volumes of material differ between projects by some 1.9 million m^3.

The T0, T2 and T3 capital dredging project proposed using a TSHD and offshore placement of dredged material which would result in all dredged material entering the marine environment.

The hydrodynamic modelling results for the T0, T2 and T3 Capital Dredging indicate (Figure 6-56) the TSS concentrations were expected to decrease to between 10 and 25mg/L above background approximately 13km to the west of the dredging activities. The TSS concentrations were expected to decrease to between 5 and 10 mg/L above background approximately 19 km to the west of dredging activities.

The hydrodynamic modelling results for the Abbot Point Growth Gateway Project (Figure 6-57) indicate the 5mg/L seabed TSS concentrations during the dry season (worst case) may extend up to 4km to the north-west and 2km to the south-east of the T0 dredging area. The 5-10mg/L contour does not extend more than 1km beyond the T0 dredge footprint.

The capital dredging of T0, T2 and T3 and offshore disposal would have released more fine sediments into the marine environment in one day than the amount of fine sediment estimated to be released into the marine environment during the entire Abbot Point Growth Gateway Project dredging of T0 (refer Royal Haskoning DHV, 2015).

The impact assessment found (GHD 2012d) the dredging of T0, T2 and T3 and the offshore placement of dredged sediments are

> *…not likely to result in a significant impact on a listed threatened or marine migratory species. The Project is expected to have temporary and permanent impacts to the marine environment at Abbot Point. The assessment of the proposed Project has not identified any effects that would significantly impact on the values of any MNES.*

The impact on the marine environment and MNES of the dredging of T0 as part of the Abbot Point Gateway Growth Project will be substantially less than the impacts predicted for the approved T0, T2 and T3 capital dredging project.

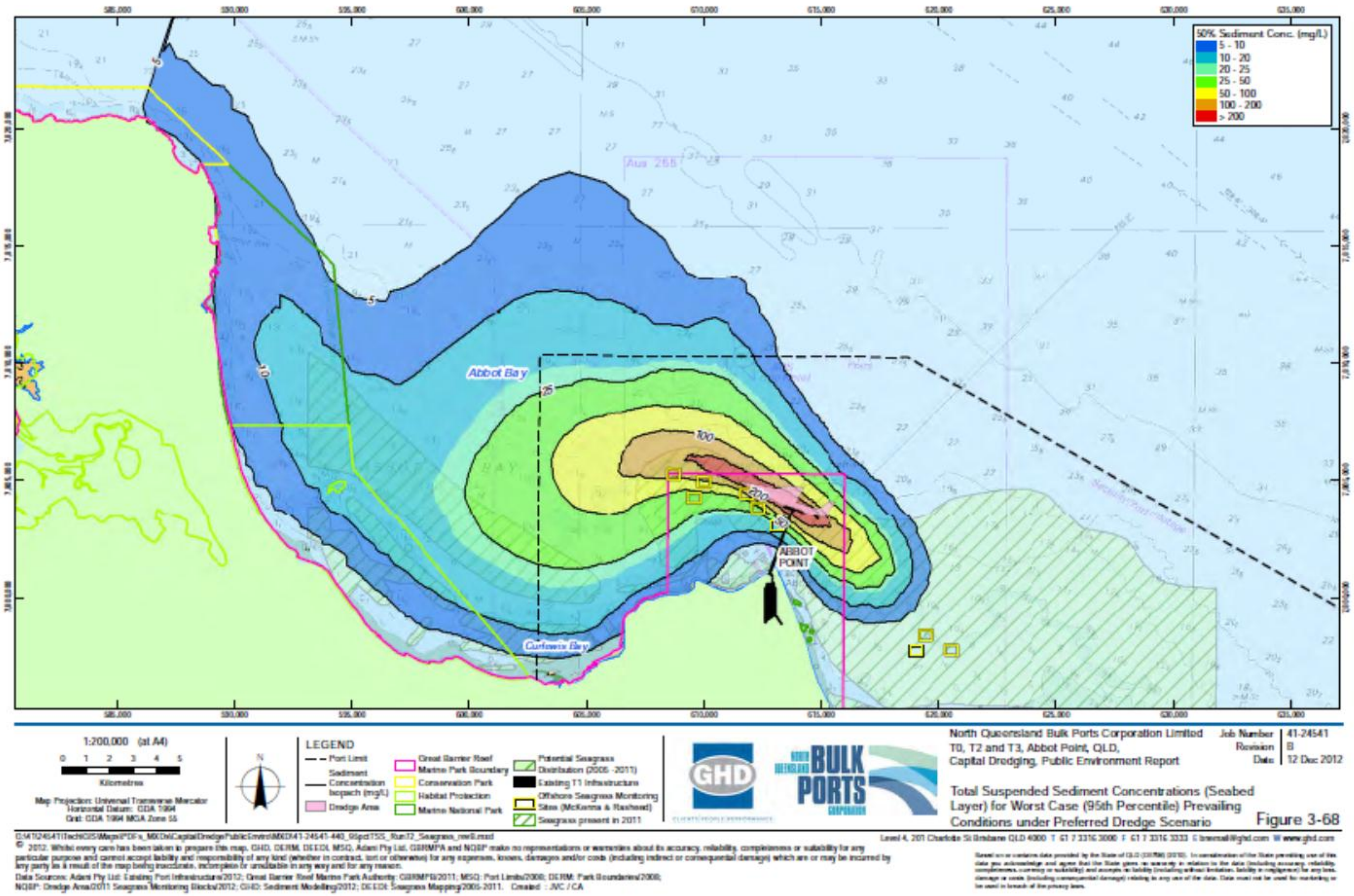
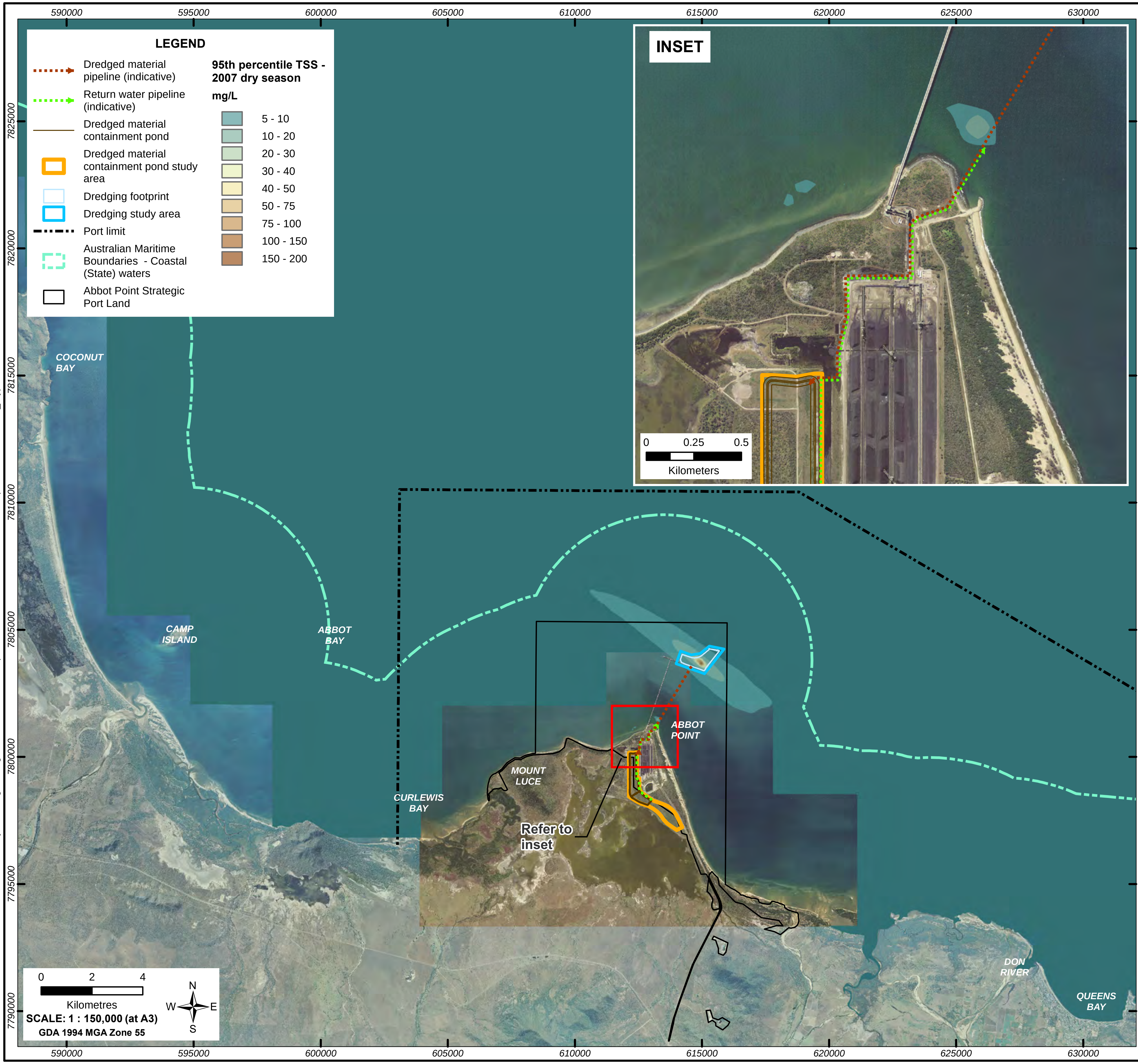
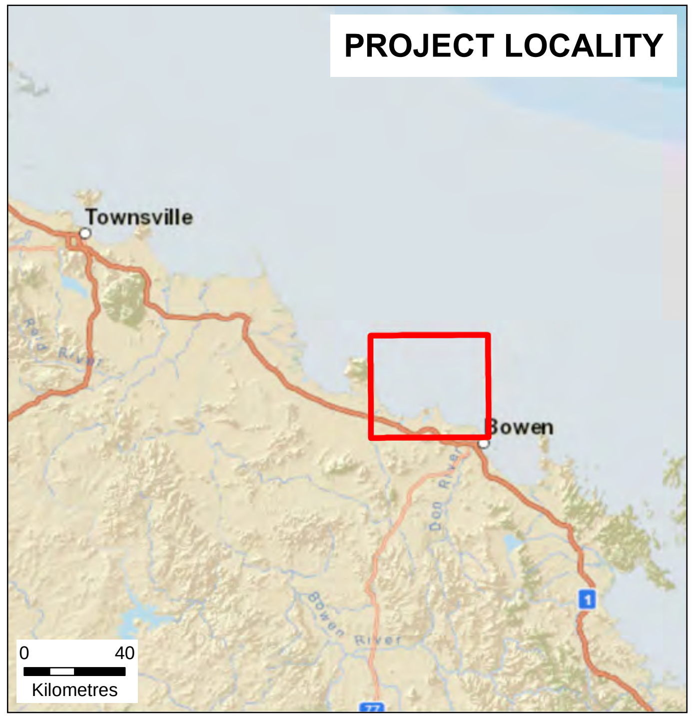


Figure 6-56 95th percentile TSS concentrations - T0, T2 and T3 capital dredging project (sourced from GHD 2012d)





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 -
http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-57
95th percentile TSS - 2007 dry season

Figure: 301001-01956-00-GM-SKT-0083 | Rev: 0

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6.2.9 Pipeline Corridor

The return water pipeline will cross the intertidal region near the Abbot Point headland to the north of the existing MOF (Figure 6-59). The dredged material pipeline will run parallel to the return water pipeline.

Both pipelines will traverse a rocky beach before entering the water, crossing a subtidal rocky reef habitat. A high abundance of red and green algae has been previously recorded on the rocky reef habitat in this area (Rasheed *et al.*, 2005). The impact of the pipelines on the macroalgae growing on the rocky reef habitat is expected to be temporary and confined to the width of the fixed pipelines plus a 0.5m buffer. The subtidal rocky habitat is not limited to this area and extends for several kilometres to the south of the MOF

Considering the extensive areas of this habitat that exist along this stretch of coastline any disruption to the foraging activity or impacts to food supply due to the temporary pipeline impacts is likely to be minimal.

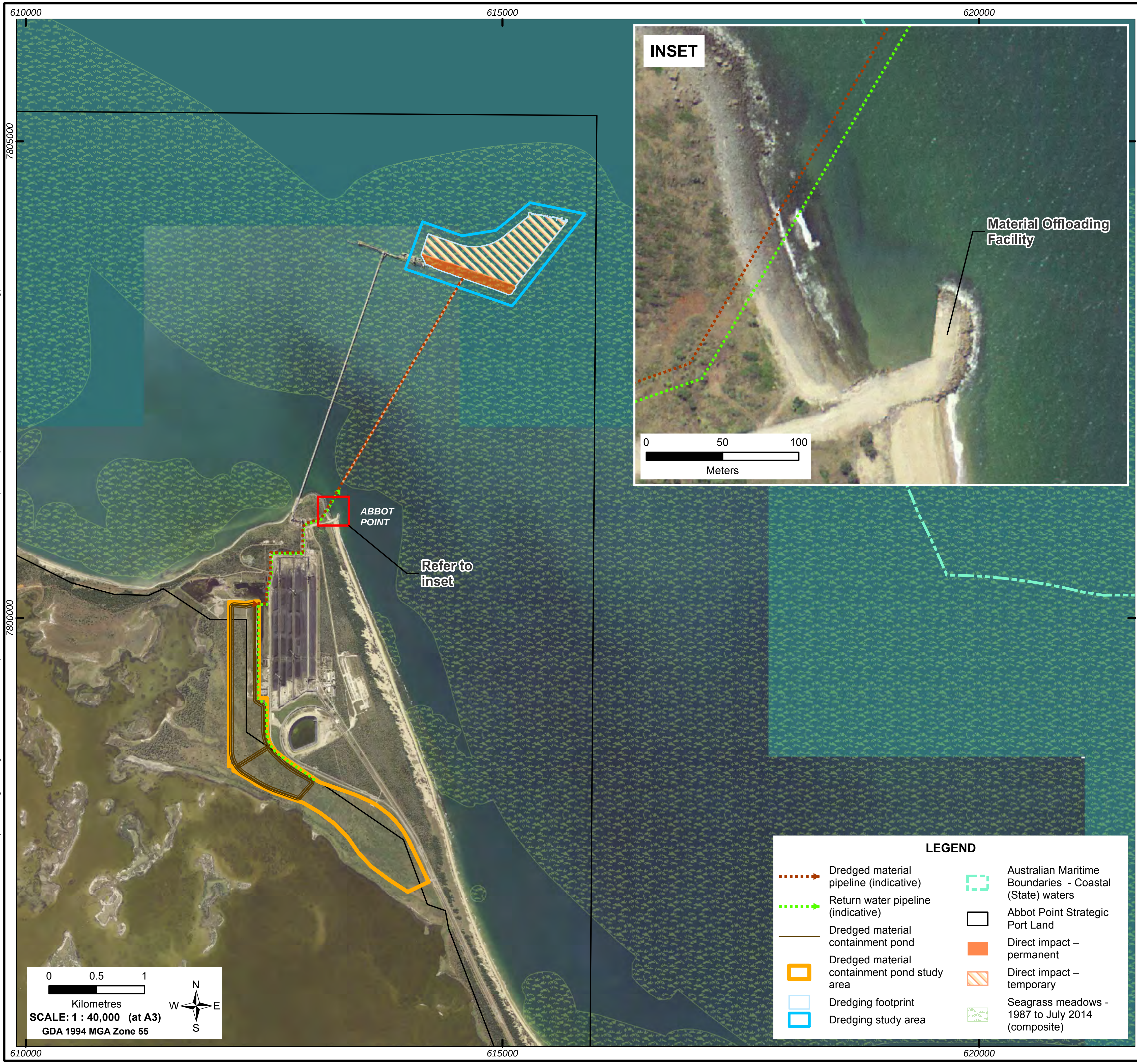
The beach environment where the pipelines will traverse is rocky and exposed and immediately offshore from the beach is a large rocky reef which extends from above the low tide water mark well into the subtidal region. The main concentrations of turtle nesting are known to occur on the preferred sandy beaches to the south of the MOF (refer Section 4.1.5).

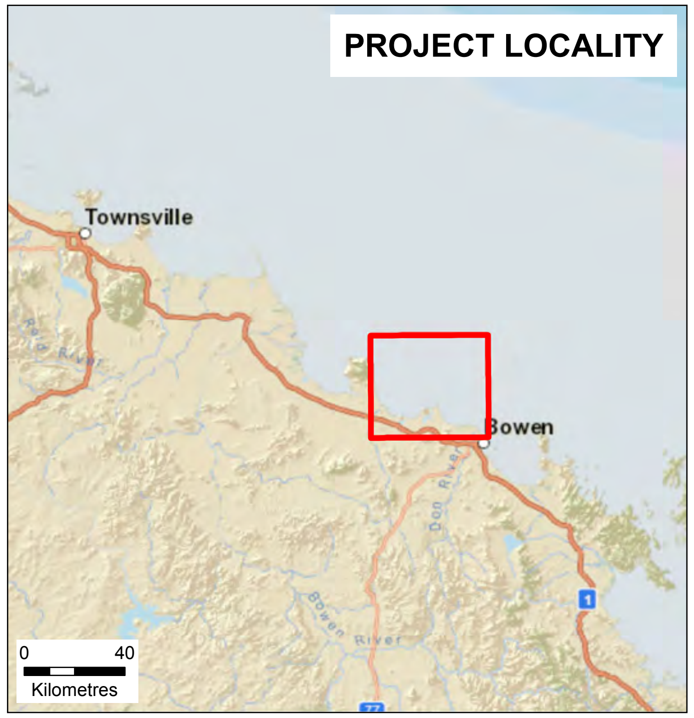
6.2.10 Temporary pipeline storage

The dredged material and return water pipeline will be fabricated by welding individual pipe lengths into a series of long ‘strings’.

Until required, pipe strings will be temporarily stored offshore in a sheltered location (e.g. adjacent the material offloading facility) either: as a submerged pipe string on the seafloor, or as a pipe floating string at a temporary secure anchorage (Figure 6-60). The area indicated on the figure is a 20m wide by 500m long, which is considered sufficient to store the pipeline required.

The location of the ‘storage’ area was chosen as to not impact upon seagrass habitat and is located 4-6m of water. The pipelines are likely to be stored in this area for several weeks before being connected together. No impacts to seagrass habitat will occur due to pipeline storage.





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
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http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
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North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-59
Pipeline infrastructure shoreline crossing

Figure: 301001-01956-00-GM-SKT-0081 | Rev: 0

G:\301001\01956 PROJ - Abbot Point Growth Gateway\10.0 Engineering\10 GM-Geomatics\Output\301001-01956-00-GM-SKT-0081-0 (Marine Pipeline infrastructure shoreline crossing).mxd

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Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
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Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
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Abbot Point Strategic Port Land
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North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010
Seagrass monitoring and survey data
TropWATER (Centre for Tropical Water & Aquatic Ecosystem Research) - James Cook University

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 6-60
Temporary pipeline storage location

Figure: 301001-01956-00-GM-SKT-0116 | Rev: 0

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6.2.11 Seagrass in the Apron Area

The seagrass habitat in the apron area will be dredged to a depth of -18.5m LAT. The current depth of the apron area ranges between -17.0m LAT to -18.5m LAT.

The dominant seagrass species recorded in the apron area is *Halophila.* (McKenna et al 2015). *Halophila* species are generally small bodied opportunistic seagrasses that exhibit fast growth habits, and are considered well adapted for recovery after disturbance events and are able to exploit resources under high light conditions, but are quick to disappear when light levels deteriorate (Longstaff et al. 1999; McMillan 1991; Hammerstrom et al. 2006; Ralph et al. 2007).

Seagrasses in the apron areas are likely to re-establish less than 5 years after the dredging. There are three potential issues related to the Project which will influence the potential for seagrass regrowth in the dredged apron area:

- Reduced benthic light availability due to deepening of the apron area
- Altered sediment characteristics of the seabed after dredging is complete
- Loss of seedbanks

Benthic light climate after dredging

The historical distribution of the offshore seagrass community which is dominated by deep water *Halophila* species extends seaward into depths of greater than -18.5m LAT (Figure 3-12 and Figure 3-13). The depth of the apron area once dredged will be no more than -18.5m LAT. The altered benthic light climate in the apron area does not preclude seagrass re-establishment.

Sediment Characteristics after dredging

The sediment characteristics of the seabed in the T0 apron area were characterised a part of the Abbot Point T0, T2 and T3 Capital Dredging PER (GHD 2012d). Specific details of the actual sediments in the T0, T2 and T3 berth and apron area are discussed in GHD (2012b). *Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report*. The samples of interest, when assessing the suitability of the sediments for seagrass re-establishment, were collected in the T0 apron area in 2012 (GHD 2012b) (Table 6-5 and Figure 6-60). Sampling sites SC55, 56 and 57 as shown in Figure 6-60 are located outside the proposed T0 dredging area.

All sediment cores collected in the apron area achieved depths greater than -18.5m LAT, below the required dredging depth of the T0 apron area. (Table 6-5). Descriptions of the sediments in the top 1 – 1.5m of the cores from the apron area provide information on the potential sediment characteristics of the resulting seabed once dredging of the apron areas is complete. Sediment descriptions in CAPITALS refer to the dominant sediment type in each core layer. Descriptions in bold represent the potential seabed characteristic after dredging is complete.

The sediment of the existing seabed contains various mixtures of sand, sit, clay, shell grit, whole shells and the consistency is generally wet and loose. The seabed once dredging of the apron is complete will not be unlike the current seabed except for slightly higher levels of clay; the consistency will remain wet and loose. In all cases, the stiff clay layer encountered at corer refusal is below the level of the proposed dredge depth.

Post dredging the texture and composition of the exposed seabed will revert to the previous texture and composition. A range of benthic organisms such as sea urchins, sea cucumbers, molluscs, polychaetes and crustaceans that forage, and burrow into sediments for food and shelter will quickly alter the seabed structure. Additional deposition and resuspension of layers of silts and sands onto the exposed seabed will occur during daily cycles and during more extreme events after dredging. It is likely that eventually seagrass will re-establish on the resultant seabed (over successive growing seasons), which will have the same or very similar characteristics as pre-dredging which was known to support seagrass.

Table 6-5 Sediment characterisation locations and sediment characteristics – T0 apron footprint (source GHD 2012b)

Sampling locations	Location description	Depth of water (m LAT)	Depth of core (m)	Final Core Depth (m LAT)	Dredging Depth (m LAT)	Core depth (m)	Sediment descriptions and characteristics
SC58	Apron	-18.4	1.3	-19.7	-18.5	0.0 - 0.5	**sandy SILT, with clay, low plasticity, grey, medium to coarse grained sands, trace fine to coarse grained shell grit, wet, loose. Whole shells present, trace whole shells (50mm)**
						0.5 – 1.0	sandy CLAY with shell grit, medium plasticity, dark green, coarse grained sands, shell fragments (400mm), wet, soft. Trace shell fragments
						1.3	Core refusal
SC59	Apron	-18.6	2.4	-21.0	-18.5	0.0 - 0.9	**silty SAND, with shell grit, grey, coarse sub-angular grained sands, fine to coarse grained shell grit, trace shell fragments (30 mm), wet, very loose. Whole shell present (50 mm).**
						0.9 – 1.25	sandy SILT. With shell grit, low plasticity, grey, fine to coarse grained sands, fine to coarse grained shell grit, trace shell fragments (20 mm), wet, loose.
						2.4	Core refusal
SC60	Apron	-17.6	0.9	-18.5	-18.5	0.0 – 0.1	SAND, With silt, grey, fine to medium grained sand, trace shell grit, trace clay content increasing with depth, wet, very loose. Clay lens, grey, soft to firm.
						0.1 – 0.3	SAND With shell grit, clay, grey, fine to coarse grain sand, fine to coarse grained shell grit, fine to medium gravel size shell grit pieces, trace shell fragments, wet, loose. Shell lens.
						0.3 – 0.9	**sandy CLAY With shell grit, low plasticity, grey, fine to medium grained sand, fine to coarse grained shell grit, trace fine gravel size shell grit pieces, trace shell fragments, wet to moist, soft, clay lenses throughout, soft to firm clay lenses. Clay content increasing.**
						1.0 – 1.25	sandy CLAY Low to medium plasticity, grey, fine to medium grained sands, trace fine to coarse grained shell grit, moist to wet, soft to firm, firmer clay lenses throughout. Clay content increasing.
						1.25 – 1.45	silty CLAY Medium to high plasticity, dark brown, trace fine to medium grained sands, moist, firm to stiff. Stiff clay lens.
						1.45	Corer refusal
SC61	Apron	-19.3	0.9	-20.2	-18.5	0.0 – 0.1	**sandy SILT Grey, fine to medium sub-angular grained sands, trace fine to coarse grained shell grit, wet, loose.**
						0.1 – 0.7	clayey SAND With shell grit, grey, fine to coarse sub-angular grained sands, well graded, fine to coarse grained shell grit, trace shell fragments (20-60 mm), wet, loose. Whole shells present (40-50 mm).
						0.7 – 0.9	CLAY With sand, high plasticity, dark grey mottled pale grey, fine to coarse grained sands, trace medium to coarse grained shell grit, moist, stiff.
						0.9	Core refusal

SC62	Apron	-18.4	1.5	-19.9	-18.5	0.0 – 0.1	silty SAND With shell grit, grey, fine to medium grained sands, trace clay, wet, loose, trace fine black particles.
						0.1 – 0.5	**sandy CLAY, low to medium plasticity, grey, fine to coarse grained sands, fine grained gravel size shell pieces, moist to wet, soft, clay and sand lenses throughout. Fine to medium grained sands.**
						0.5 – 0.9	SAND With shell grit, clay, grey, fine to coarse grained sands, fine to coarse grained shell grit, wet, loose.
						0.9 – 1.1	CLAY With sand, medium plasticity, grey, fine to coarse grained sands, trace shell grit, trace fine grained gravel, moist to wet, soft to firm.
						1.1 – 1.3	sandy CLAY With shell grit, moisture content greater than plasticity, grey, fine to medium grained sands, medium to coarse grained shell grit, wet, very soft.
						1.3 – 1.5	silty CLAY, Medium to high plasticity, dark grey-brown, trace fine to coarse grained sands, trace fine grained gravel, moist, firm to pale brown mottling present. Pale green-white, fine grained sands increasing with depth.
						1.5	Core refusal
SC63	Apron	-18.8	0.95	-19.75	-18.5	0.0 – 0.1	silty SAND With shell grit, grey, fine to medium grained sands, fine to coarse grained shell grit, wet, loose.
						0.1 – 0.3	**clayey SAND With shell grit, grey, fine to coarse grained sands, fine to medium grained gravel size shell grit, trace shell fragments, moist to wet, soft, soft to firm clay lenses throughout.**
						0.3 – 0.8	sandy CLAY With shell grit, low to medium plasticity, grey, fine to medium grained sands, fine grained gravel size shell grit, trace shell fragments, moist to wet, soft, soft to firm clay lenses throughout.
						0.8 – 0.95	silty CLAY Green-grey mottled black and white, trace fine to medium. Black and white mottling more prominent, moist, stiff.
						0.95	Corer refusal
SC64	Apron	-18.8	1.2	-20.0	-18.5	0.0 – 0.1	SAND With shell grit, fine to medium grained sands, fine to coarse grained shell grit, trace clay, wet, loose.
						0.1 – 0.4	**clayey SAND With shell grit, grey, fine to medium grained sands, fine to coarse grained shell grit, trace small shell fragments, trace fine grained gravel, moist to wet, soft, clay lenses throughout, sandy lenses throughout.**
						0.4 – 0.8	sandy CLAY With shell grit, low plasticity, grey, fine to medium grained sands, fine to coarse grained shell grit, trace shell fragments, moist to wet, soft to firm, clay lenses throughout, shell lenses throughout. Clay content increasing.
						0.8 – 1.2	sandy CLAY With shell grit, medium plasticity, grey, fine to medium grained sands, fine to coarse grained shell grit, trace shell fragments, trace whole shells, moist, firm, clay lenses throughout.
						1.2	Corer refusal

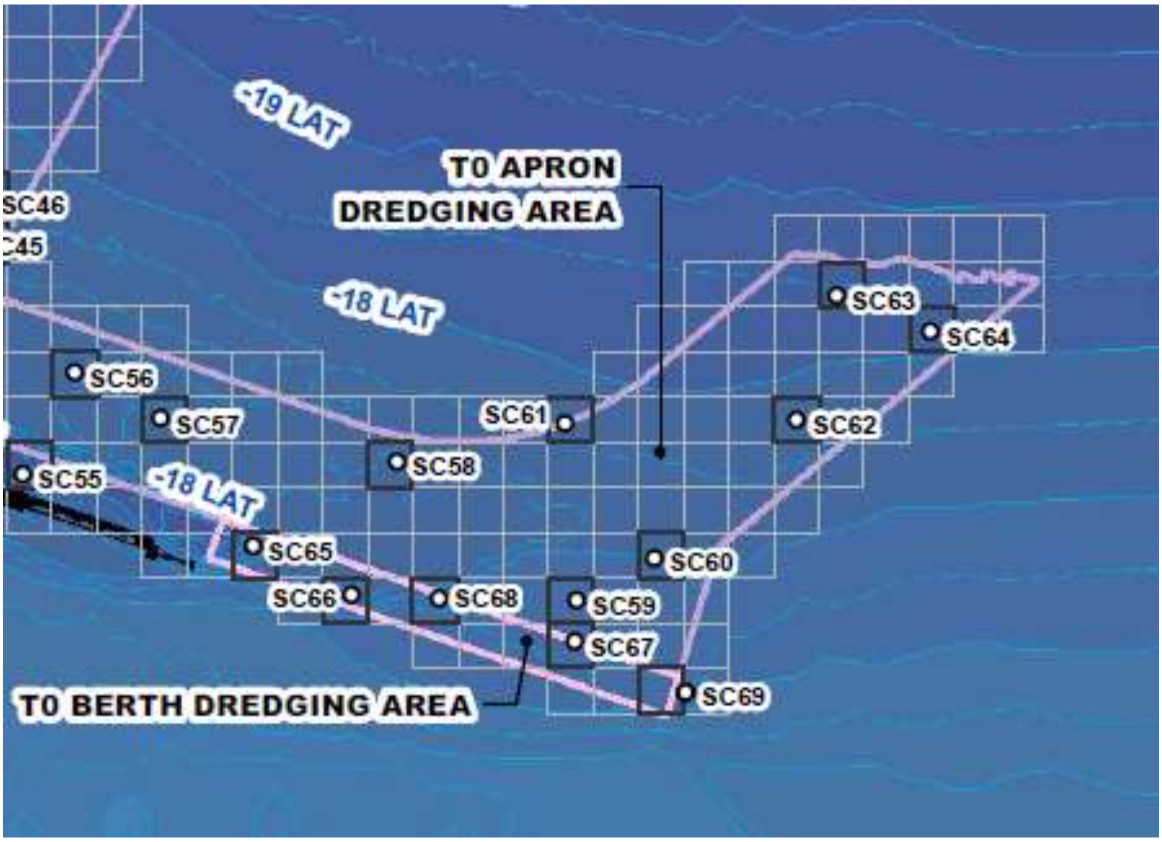


Figure 6-60 Extract from GHD (2012b) showing the sampling locations of interes

Seedbank loss

Halophila species typically produce large seed banks, (McMillan 1988; Hammerstrom et al. 2006) from which recovery can occur. The loss of the top 0.5 – 1.0m of seabed is likely will remove the existing seedbank.

The area surrounding the apron footprint from inside the current berths to 1km beyond the berths contains *Halophila* seagrass habitat and a well-established seedbank. There is a potential that these areas will supply enough seeds over several growing seasons to allow for the re-establishment seagrass and a viable seed bank.

Summary

The removal of sediment via dredging of the T0 apron area is unlikely to cause permanent loss of seagrass. The benthic light environment after dredging will not alter significantly from the existing light environment. Sediment characteristics of the resulting seabed immediately after dredging will not be unlike the current seabed sediment characteristics. After a short period (<4 growing seasons) via bioturbation and the deposition of local sediments the apron area seabed will be similar to the existing seabed and provide no obstacle to the re-establishment of a seagrass community. Transfer of seeds from the extensive seagrass community growing in surrounding habitat (and from far field habitat) is likely to occur over successive growing seasons.

Based on this assessment the loss of seagrass habitat in the apron area is highly likely to be temporary.

6.3 Underwater noise

An assessment of the potential impacts of underwater noise on marine fauna was undertaken (SLR, 2015a). On the basis of the information provided, this assessment has found that:

- Marine animals can only experience permanent hearing threshold shift (PTS) or temporary hearing threshold shift (TTS) impacts if they stay in close proximity to the noise sources (10m – 40m) with long exposure periods (up to more than 2 hours) which is considered an unrealistic scenario (see contour maps Figure 6-61).
- It is unlikely that the noise generated by the proposed dredging activities and associated supporting vessel movements will cause physical injuries or hearing damage (including PTS and/or TTS) to any assessed marine fauna species which have potential to occur in the study area.
- The proposed dredging activities and associated supporting vessel movements can potentially cause behavioural responses from assessed marine fauna species within a 3.0km range. However, the consequent disturbance is expected to be limited, considering the ecological characteristics of assessed marine fauna species, as well as the exiting ambient noise environment within the study area.
- The noise stress caused by the transfer vessel supporting the dredging operations which travels between Bowen and Abbot Point is only transient in nature and the consequent disturbance effect to the assessed marine fauna species is expected to be minimal.

On the basis of the results of this assessment study, no specific noise monitoring and/or mitigation measures were recommended.

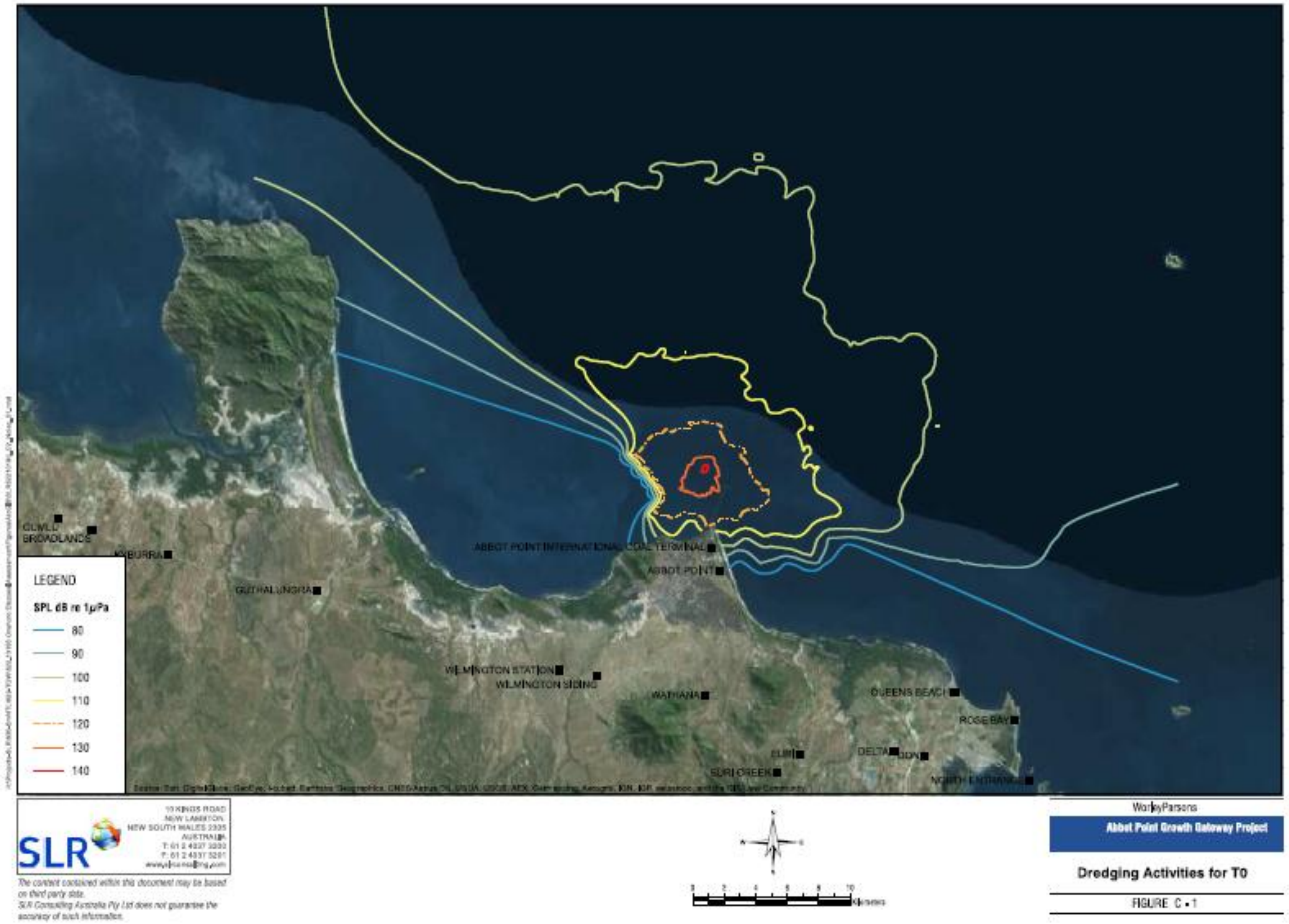


Figure 6-61 Underwater noise modelling prediction contours based on dredging activities (reproduced from SLR, 2015a)

6.4 Vessel collision

The pipeline establishment, dredging, placement and discharge of return water are not likely to result in mortality or injury to marine fauna. The CSD type dredge is stationary and no offshore placement of dredged material will occur. The key strategies for management and mitigation to avoid vessel collision with marine fauna are based on the following:

- Restrict CSD dredging to locations specified on approved drawings
- Visual monitoring for marine fauna in immediate vicinity of dredger
- Maintain site speed limits to minimise likelihood of animal strike when driving onsite
- Planing hull work vessels will be speed limited within the operational port area of the Port of Abbot Point, i.e. the area outside of the GBRMP.

Therefore it is unlikely that vessel collisions with marine fauna will occur.

6.5 Introduced marine species

A detailed risk assessment procedure, consistent with the *National System for the Prevention and Management of Marine Pest Incursions* Guidelines, will be implemented to deal with the risk associated with IMS. This procedure will be applied to all vessels and immersible equipment used for the dredging campaign to assess the risk of IMS. The risk assessment will be undertaken prior to the identified vessel and/or immersible equipment engaging in dredging and dredged material relocation activities. The objective of the risk assessment is to identify the individual level of IMS threat which a contracted vessel or its immersible equipment poses. This allows selection of the most appropriate vessels and immersible equipment and establishment of management measures to mitigate identified threats to an acceptable low level.

The three risk categories used in the risk assessment are:

1. Low: low likelihood of IMS – no additional management measures required
2. Uncertain: likelihood of IMS is not apparent – precautionary approach adopted, additional management measures required
3. High: identified as a potential risk – additional management measures required.

The key factors to be considered in the risk assessment include:

1. Vessel type
2. Inspection history
3. Presence and age of fouling control coating
4. Presence or absence of internal treatment systems

5. Internal treatment history
6. Previous climatic region(s) of operation
7. Stationary or slow periods of operation and climatic region
8. Type of vessel activity
9. Vessel desiccation period during mobilisation
10. Adherence to Australian Quarantine and Inspection Services (AQIS) ballast water requirements.

The outcomes of the risk assessment will determine whether or not an IMS vessel inspection is required prior to the vessel or immersible equipment mobilisation to site.

If these procedures are adhered to it is unlikely IMS will be introduced as a result of the Project activities.

6.6 Summary of Risk Assessment

A summary of the risks (before and after mitigation) of the activities associated with each phase of the project, dredge and return water pipeline installation, offshore dredging and return water discharging are outlined in Table 6-6. The register highlights the relevance of each activity (and associated risk) to MNES.

It needs to be noted that the assessed environmental risk ratings, are not a direct reflection of the level of risk to the nominated MNES. However, they are relevant for consideration in the subsequent assessment of project impacts to nominated MNES.

The residual risk category in Table 6-6 is used to assist in assessing the potential impacts relating to the Project for each EPBC Act listed threatened or migratory species that is known to occur, likely to occur or potentially occur using endangered, vulnerable or migratory criteria from the Significant Impact Criteria Guidelines 1.1 (DoE, 2013).

Table 6-6 Summary risk register

					MNES Relevance				
Project Activity	Risk	Initial Risk	Mitigation Measure	Residual Risk	Threated species and ecological communities	Migratory species	Great Barrier Reef World Heritage Property / National Heritage Place	The Great Barrier Reef Marine Park	Commonwealth marine areas
Project Phase – dredging and return water pipeline assembly and installation									
Boat Traffic	Injury / mortality of fauna	Low	Implement a Vessel Traffic Management Plan	Low	x	x	x		
Pipeline laying on seafloor	Direct removal of benthic ecology	Low	Proposed pipeline route intersects with only 0.43ha of potential seagrass habitat Pipeline anchored securely to seafloor	Low	x	x	x		
Pipeline installation	Introduction of marine pests and diseases	Low	A detailed risk assessment procedure consistent with the National System for the Prevention and Management of Marine Pest Incursions Guidelines will be implemented to deal with the risk associated with introduction of IMS.	Low	x	x	x	x	x
Pipeline installation	Displacement of fauna from habitat due to underwater noise	Low	Noise modelling undertaken based on the proposed dredge and support vessels predict no displacement of marine fauna in relation to dredging activities, pipeline installation underwater noise will be much less than the noise associated with dredging- no mitigation measures proposed	Low	x	x			
Project Phase – Offshore dredging									
Dredging	Injury / mortality of fauna due to dredging	Low	CSD is not mobile and slow moving. Visual monitoring for marine fauna in immediate vicinity of dredger. Implement a Vessel Traffic Management Plan	Low	x	x	x	x	x
Dredging	Direct removal of benthic ecology due to dredging activity	Low	Restrict dredging to locations specified on approved drawings.	Low	x	x	x		

Project Activity	Risk	Initial Risk	Mitigation Measure	Residual Risk	MNES Relevance: Threated species and ecological communities	Migratory species	Great Barrier Reef World Heritage Property / National Heritage Place	The Great Barrier Reef Marine Park	Commonwealth marine areas
Dredging	Smothering of benthic ecology in areas adjacent to dredging (sediment plume drift)	Low	Use of the CSD type dredger means sediment deposition is limited to areas within the dredging footprint and within 50-100m of the footprint. Bed thickness outside footprint is not sufficient to cause smothering of seagrass or other benthic organisms	Low	x	x	x		
Dredging	Mobilisation of sediment resulting in turbidity plumes potentially affecting light dependent species, filter feeders and having potential flow on effects to higher trophic groups	Medium	Use of CSD type dredger reduces mobilisation of fine sediment, dredging duration is limited (6-13 weeks). Implement a Receiving Environment Management Plan	Low	x	x	x	x	x
Dredging	Displacement of fauna from habitat due to underwater noise	Low	Noise modelling undertaken based on the proposed dredge and support vessels predict no displacement of marine fauna in relation to dredging activities - no mitigation measures proposed	Low	x	x	x	x	x
Dredging	Lighting impacts on marine fauna behaviour	Low	Light spill minimised, dredging occurring well offshore from nesting turtles and turtle hatching areas	Low	x	x	x	x	x
Dredging	Release of contaminants into the water (wastes / chemical spill from dredge or tender vessels)	Low	Implement waste and pollution management plans. Mitigation measures will include: All domestic, toxic, and hazardous wastes, oils and petroleum hydrocarbons, empty drums and other containers, and any other waste materials will be collected, handled, stored, and disposed of in accordance with existing Port of Abbot Point waste management policies and procedures. Any materials or objects dropped onto the seabed will be recovered.	Low	x	x	x	x	
Dredging	Introduction of marine pests and diseases	Low	A detailed risk assessment procedure consistent with the National System for the Prevention and Management of Marine Pest Incursions Guidelines will be implemented to deal with the risk associated with introduction of IMS.	Low	x	x	x	x	x

					MNES Relevance				
Project Activity	Risk	Initial Risk	Mitigation Measure	Residual Risk	Threated species and ecological communities	Migratory species	Great Barrier Reef World Heritage Property / National Heritage Place	The Great Barrier Reef Marine Park	Commonwealth marine areas
Dredging	Mobilisation of sediment resulting in changes to chemical signature of water (nutrients, pH, heavy metals and metalloids)	Low	The sediment released into the water column by the action of dredging are deemed suitable for offshore placement.	Low	x	x	x	x	x
Project Phase – Return water discharges									
Returning Water	Smothering of benthic ecology in areas adjacent to dredging (sediment plume drift)	Low	The fines sediments released are quickly dissipated and drift away from the discharge point. Sediments may collect in areas to the west of Abbot Point, however the predicted bed thickness is not considered sufficient to impact upon the benthic ecology (<5mm deep – see Section 6.2.5). Implement a Receiving Environment Management Plan	Low	x	x	x	x	
Returning Water	Mobilisation of sediment resulting in turbidity plumes potentially affecting light dependent species, filter feeders and having potential flow on effects to higher trophic groups	Low	The fines sediments released are quickly dissipated and drift away from the discharge point. Implement a Receiving Environment Management Plan	Low	x	x	x	x	
Returning Water	Mobilisation of sediment resulting in changes to chemical signature of water (nutrients, pH, heavy metals and metalloids)	Low	Implement an ASS Management Plan for the dredged sediments. Implement a Receiving Environment Management Plan, which includes monitoring sites for a range of chemical and physicochemical water quality parameters at nearby sensitive receptors beyond the discharge point	Low	x	x	x	x	

6.7 Impacts to threatened or migratory marine species

The impacts and potential impacts relating to the Project have been assessed for each EPBC Act listed threatened or migratory species that is 'known to occur',' likely to occur' or 'potentially occur' using endangered, vulnerable or migratory criteria from the Significant Impact Criteria Guidelines 1.1 (Section 2.3.5and Section 6.7 (DoE, 2013). The species assessed are listed in Table 6-7. Where possible a residual risk category (low/medium/high) as outlined in Table 6-6 in the section above is assigned to each significant impact criteria.

Table 6-7 EPBC Act listed species assessed against potential impacts

Common name (*Scientific name)*	EPBC Act status	Likelihood of occurrence
Mammals		
Humpback whale (*Megaptera novaeangliae)*	V, M	Known
Indo-Pacific Humpback dolphin (*Sousa chinensis)*	M	Known
Australian Snubfin dolphin (*Orcaella heinsohni)*	M	Known
Dugong (*Dugong dugon)*	M	Known
Reptiles		
Green turtle (*Chelonia mydas)*	V	Known
Flatback turtle (*Natator depressus)*	V	Known
Hawksbill turtle (*Eretmochelys imbricate)*	V	Known
Loggerhead turtle (*Caretta caretta)*	E	Known
Olive Ridley turtle (*Lepidochelys olivacea)*	E	Known
Sharks and Rays		
Giant manta ray (*Manta birostris)*	M	Known

6.7.1 Whales and cetaceans

6.7.1.1 Humpback whales

Significant impact criteria (vulnerable species)

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- **Lead to a long-term decrease in the size of an important population of a species**

No significant impact likely – Abbot Point is not recognised as supporting an important population of Humpback Whales. Dredging activities are temporary and short-term, relatively close to shore and the dredge is effectively stationary during operation (there will be no dredge movements to offshore dredged material relocation grounds) reducing the likelihood of vessel interactions with whales. The residual risk of boat strike is low.

- **Reduce the area of occupancy of an important population**

No significant impact likely - Humpback Whales migrate through the area and numbers are seasonally high between July and October. Mothers with calves have been observed resting in the area in low numbers and are thought to use the area opportunistically. The area is not known to support significant habitat for the species and is not identified as an aggregation or breeding area. Therefore, given the inshore location of the project area and the dredge methodology, it is considered unlikely that the Project will reduce the area of occupancy (particularly migration pathways) for Humpback Whales utilising the area.

Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project) are expected to be highly localised (<3km as a conservative estimation) and of short duration. PTS and TTS thresholds are highly localised (< 10m and between 10 to 60m respectively) and have long exposure times. It is unlikely that Humpback Whales would be within 60m of the stationary dredging operations.

Given the large distribution range of Humpback Whales and small area of the Project it is considered unlikely that underwater noise will have a measurable impact to individuals using the project area. The residual risk of underwater noise is low

- **Fragment an existing important population**

No significant impact likely - Humpback Whales are highly mobile and the Project would not create any barriers to the migration routes of individuals.

- **Disrupt the breeding cycle of an important population**

No significant impact likely – It is considered that Abbot Point does not support an important population. Humpback Whales migrate through the project area for the purposes of reaching their calving grounds and/or returning to feeding grounds after calving. The Project will not create any barriers to that migration.

- **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

No significant impact likely - The Project will not modify, destroy, remove, isolate or decrease the availability of habitat important to Humpback Whales. As discussed above, that area is not known to support habitat that is considered important to the survival of the species.

- **Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

No significant impact likely - It is considered unlikely that the Project will introduce an invasive species that will cause the species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests in low.

- **Introduce disease that may cause the species to decline**

No significant impact likely - It is considered unlikely that the Project will introduce a disease to the population that will cause the species to decline. Management measures will be in place that are consistent with the requirements of Australian legislation. The residual risk of the introduction of disease is low.

- **Interfere substantially with the recovery of the species**

No significant impact likely - The Project is unlikely to interfere with the recovery of the species, or the objectives or recovery actions outlined in the Humpback Whale Recovery Plan (Commonwealth of Australia, 2005). The east coast population is recovering at a rate of approximately 10% per annum. Activities associated with the Project are unlikely to have an impact on this recovery rate, and there are no barriers to the continued use of the area by Humpback Whales.

6.7.1.2 Indo-Pacific Humpback dolphins

Significant impact criteria (migratory species)

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- **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

No significant impact likely –Indo-Pacific Humpback Dolphins inhabit shallow coastal, estuarine, and occasionally riverine habitats, in tropical and subtropical regions. The species usually occurs close to the coast, generally in depths of less than 20m. Indo-Pacific Humpback Dolphins have been recorded in the project area, with 112 individuals recorded during the survey period. Dredging activities are temporary and short-term, and the dredge is effectively stationary during operation. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with Indo-Pacific Humpback Dolphins. The residual risk of boat strike is low.

Underwater noise levels predicted by the modelling may cause a behavioural response where the dolphins may move further away from activities. Due to the short-term nature of the Project activities, the impacts from the Project are not likely to cause a permanent relocation of the population The amount of potential seagrass habitat directly removed (10.5ha) is considered a minute proportion (<0.04%). of the total available potential seagrass habitat that exists in the Abbot Point region The residual risk of underwater noise is low

The direct and offsite impacts of this Project are not likely to modify, destroy or isolate an area of important habitat for Indo-Pacific Humpback Dolphins.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species**

No significant impact likely - It is considered unlikely that the Project will introduce an invasive species that will cause the species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests is low.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species**

No significant impact likely - Dredging activities are temporary and short-term; the dredge is effectively stationary during operation, restricted to the dredging areas offshore. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with Indo-Pacific Humpback Dolphins. The residual risk of boat strike is low.

Underwater noise levels predicted by the modelling may cause a behavioural response in close proximity of the dredging activities; dolphins may move further away from activities. Due to the short-term nature of the Project activities, the impacts from the Project are not likely to cause a serious disruption in the lifecycle of an ecologically significant proportion of the population of a migratory species. The residual risk of underwater noise is low.

6.7.1.3 Australian Snubfin dolphins

Significant impact criteria (migratory species)

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- **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**

The Australian Snubfin Dolphin usually inhabits shallow coastal waters less than 20m deep and is often associated with tidal riverine and estuarine systems, enclosed bays and coastal lagoons (Corkeron *et al*., 1997; Jefferson, 2000; Parra, 2006). Within Australia, the dolphin species co-exists with coastal development, including extensive port facilities such as the Port of Brisbane and Cleveland Bay, Townsville (Hale *et al*., 1998; Parra, 2006). The understanding of important habitat for the Australian Snubfin Dolphin indicates that they are very limited.

Australian snubfin dolphins have been recorded in the project area, with 20 individuals recorded during the survey period, found in areas with water depths of between 9 and13 m. The direct and offsite impacts of this Project are not likely to modify, destroy or isolate an area of important habitat for Australian Snubfin Dolphins. The amount of potential seagrass habitat directly removed (10.5ha) is considered a small proportion of the total available potential seagrass habitat that exists in the Abbot Point Region (<0.04%).

Declines in water quality caused by dredging and returning waters may affect these species at a highly localised level for a short duration. The residual risk of impacts to habitat and water quality is low.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species**

No significant impact likely - It is considered unlikely that the Project will introduce an invasive species that will cause the species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests is low.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species**

No significant impact likely – Dredging activities are temporary and short-term, the dredge is effectively stationary during operation. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with Australian Snubfin Dolphins. The residual risk of boat strike is low.

Underwater noise levels predicted by the modelling may cause a behavioural response where the dolphins move further away from activities. Literature suggests this species of dolphin can co-exist with coastal development, including extensive port facilities such as the Port of Brisbane and Cleveland Bay, Townsville (Hale *et al*., 1998; Parra, 2006). Due to the short-term nature of the Project activities the impacts from the Project are not likely to cause a serious disruption of the lifecycle of an ecologically significant proportion of the population of a migratory species. The residual risk of underwater noise is low.

6.7.1.4 DUGONG

- **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**

No significant impact likely - The Project will result in a permanent loss of 10.5ha of potential seagrass habitat within the dredged berth pocket. Which represents a minute (<0.04%) proportion of the total available potential seagrass habitat that exists in the Abbot Point Region. The area of potential seagrass habitat to be temporarily impacted by the Project is a small proportion (<4.4%) of that potentially available in Abbot Point. The residual risk of habitat loss is low. Dredging activities are temporary and short-term; the dredge is effectively stationary during operation. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with Dugongs. The residual risk of boat strike is low. Underwater noise levels predicted by the modelling may cause a behavioural response where Dugongs move further away from activities. The residual risk of underwater noise is low.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species**

No significant impact likely - It is considered unlikely that the Project will introduce an invasive species that will cause Dugong species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests is low.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species**

No significant impact likely - Abbot Point was identified as an area of low conservation importance for Dugongs in the southern GBR (Grech & Marsh, 2007). Other areas in the southern GBR are known to support more significant populations of Dugongs than Abbot Point. The closest area to support significant populations is 140km from the project area. Abbot Point is not known to provide any critical breeding, feeding or resting habitat for Dugongs in the local or regional area. The area of potential seagrass habitat to be temporarily impacted by the Project is a small proportion of that potentially available in Abbot Point. Seagrasses in the area are sparse and ephemeral. The residual risk of habitat loss is low.

Dredging activities are temporary and short-term; the dredge is effectively stationary during operation which reduces the potential for vessel strike. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with Dugong. The residual risk of boat strike is low.

Underwater noise levels predicted by the modelling may cause a behavioural response where Dugongs move further away from activities. The residual risk of underwater noise is low.

6.7.2 Marine turtles

6.7.2.1 Loggerhead and Olive Ridley turtles (Endangered)

Significant impact criteria (endangered species)	Loggerhead Turtle	Olive Ridley Turtle
Lead to a long-term decrease in the size of a population	**No significant impact likely** – Low numbers of Loggerhead Turtles have been recorded foraging and/or within the vicinity of the project area. There are no Loggerhead Turtle nesting sites known within the project area or its vicinity. Abbot Point has not been identified as an area of high conservation importance for Loggerhead Turtles as is not known to support an important population. As Loggerhead Turtles are widely	**No significant impact likely** – There are no dense nesting aggregations of Olive Ridley Turtles in Australia. Olive Ridley Turtles have previously been confirmed to be present at Abbot Point, although sightings of this species in the GBRMP are rare. Abbot Point has not been identified as an area of high conservation importance for Olive Ridley Turtles

Significant impact criteria (endangered species)	Loggerhead Turtle	Olive Ridley Turtle
	distributed and choose a wide variety of tidal and subtidal habitat as foraging areas, it is unlikely the short term and localised dredging activities associated with the Project will contribute to a decrease in the population size. The Project may have some short term, localised impacts on water quality during dredging and will only directly impact <0.04% of the available seagrass habitat in the area, these impacts are unlikely to cause a long-term decrease in the population. The residual risk of habitat loss is low. Vessel collision is not considered likely as the dredging vessel will be stationary during dredging, on site for a short period of time and turtles are highly mobile and able to avoid slow moving vessels. The residual risk of boat strike is low.	as is not known to support a population. The Project may have some short term, localised impacts on water quality (which may impact upon seagrass growth and survival) during dredging and will only directly impact <0.04% of the available seagrass habitat in the area, these impacts are unlikely to cause a long-term decrease in the population. The residual risk of habitat loss is low. Vessel collision is not considered likely as the dredging vessel will be stationary during dredging, on site for a short period of time and turtles are highly mobile and able to avoid slow moving vessels. The residual risk of boat strike is low.
Reduce the area of occupancy of the species	**No significant impact likely** - Low numbers of Loggerhead Turtles have been recorded foraging and/or within the vicinity of the project area. The project area is not known to support a population of Loggerhead Turtles.	**No significant impact likely** - The area is not known to support a population of Olive Ridley Turtles. Impacts, if any, to the species are expected to be short term and localised to the dredging area. Such impacts will not reduce the area of occupancy of the species. The Project may have some short term, localised impacts on water quality during dredging, to the small numbers that forage in the area, but these impacts are unlikely to cause a long-term decrease in the population. The Project will only have a direct

Significant impact criteria (endangered species)	Loggerhead Turtle	Olive Ridley Turtle
		impact on <0.04% of the available seagrass habitat in the area. These impacts are unlikely to cause a long-term decrease in the population. The residual risk of habitat loss is low
	No significant impact likely – The Project may have some short-term, localised impacts on water quality during dredging, to the small numbers of turtles that forage in the area, but these impacts are unlikely to cause a long-term decrease in Loggerhead or Olive Ridley Turtle populations. The Project will directly impact upon <0.04% of the available seagrass habitat in the area. Offsite impacts on seagrass communities will be temporary and recoverable. The residual risk of habitat loss is low. Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised. The maximum distance that may cause behavioural changes in megafauna is 3km (as a conservative estimation) and for a short duration PTS and TTS thresholds are highly localised (< 10m and between 10 to 60m respectively) and have long exposure times. Give the large distribution range of Loggerhead and Olive Ridley Turtles and the small area of the Project it is unlikely underwater noise will have a significant impact to individuals using the project area. The residual risk of underwater noise is low.	
Fragment an existing population into two or more populations	**No significant impact likely** - Marine turtles are highly mobile and the Project would not create any barriers to the movement of individuals.	
Adversely affect habitat critical to the survival of a species	**No significant impact likely** – The majority of foraging habitat (seagrass and bare sedimentary habitats) at Abbot Point is unlikely to be impacted by the Project. The seagrass habitat within the dredging footprints will be directly impacted by removal. The Project will have a direct impact on <0.04% of the available seagrass habitat in the region.	**No significant impact likely** - Foraging habitat (shallow rocky and coral reefs) is unlikely to be impacted by the Project. The widespread distribution of this species and lack of nesting areas in Abbot Point and eastern Australia make it unlikely individuals or populations will be significantly

Significant impact criteria (endangered species)	Loggerhead Turtle	Olive Ridley Turtle
	Considering the low number of Loggerhead Turtles observed at Abbot Point this seagrass removal is unlikely to have a significant impact. The residual risk of habitat loss is low. There is no Loggerhead Turtle population recorded as endemic to Abbot Point and no nesting activity or critical breeding areas for this species in the region.	impacted by the Project. There is no Olive Ridley Turtle population at Abbot Point.
Disrupt the breeding cycle of a population	**No significant impact likely** – The species is not known to nest in the Abbot Point region and therefore the Project is not considered to disrupt the breeding cycle of the population.	**No significant impact likely** - The species is not known to nest in the Abbot Point region and therefore the Project is not considered to disrupt the breeding cycle of the population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**No significant impact likely** – Abbot Point has not been identified as an area of high conservation importance for Loggerhead Turtles. Low numbers of Loggerhead Turtles have been recorded foraging and within the vicinity of the project area. There are no Loggerhead Turtle nesting sites known within the project area or its vicinity. The majority of foraging habitat (seagrass and bare sedimentary habitats) is unlikely to be impacted by the Project. Loggerhead Turtles forage on seagrass beds, among other benthic habitats. Removal of the seagrass in the dredging footprints may modify the foraging habitat within the dredging footprint. The Project will have a direct impact on <0.04% of the available seagrass habitat in the region. As Loggerhead Turtles are widely distributed and choose a variety of tidal and subtidal habitat as foraging areas, it is unlikely the small area of this direct impact will have	**No significant impact likely** - The area is not known to support a population of Olive Ridley Turtles. Offsite impacts will not reduce the availability of habitat to the species. The Project may have some short term, localised impacts on water quality during dredging, to the small numbers that forage in the area, but these impacts are unlikely to cause a long-term decrease in the population Foraging habitat (shallow rocky and coral reefs) is unlikely to be impacted by the Project.

Significant impact criteria (endangered species)	Loggerhead Turtle	Olive Ridley Turtle
	any impact that would cause the species to decline. The residual risk of habitat loss is low. The Project may have some short-term, localised impacts on water quality during dredging, to the small numbers that forage in the area, but these impacts are unlikely to cause a long-term decrease in the population. The residual risk to water quality is low.	
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	**No significant impact likely** - It is considered unlikely that the Project will introduce an invasive species that will cause Loggerhead or Olive Ridley species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests is low.	
Introduce disease that may cause the species to decline	**No significant impact likely** - It is considered unlikely that the Project will introduce a disease to the population that will cause Loggerhead or Olive Ridley species to decline. As per introduced species above, management measures will be in place that are consistent with the requirements of Australian legislation. The residual risk of the introduction of disease is low.	
Interfere with the recovery of the species	**No significant impact likely** - There is a recovery plan in place for marine turtles in Australia. Whilst the area supports some foraging habitat for both species, it is not considered critical habitat for the survival and recovery of either species. The Project will have a direct impact on upon <0.04% of the available seagrass habitat in the region. Habitat usage for foraging appears low and no nesting has been observed, particularly in comparison to other areas in the region. Based on these findings, the Project is not expected to interfere with the recovery of either species. The residual risk of habitat loss is low.	

6.7.2.2 Flatback, Green and Hawksbill turtles (Vulnerable listed)

Significant impact criteria (vulnerable species)	Flatback Turtle Green Turtle	Hawksbill Turtle
Lead to a long-term decrease in the size of an important population of a species	**No significant impact likely** - Low numbers of Flatback and Green Turtles have been recorded foraging and nesting within the project area, however the area is not known to support a regionally important population. The Project may have some short term localised impacts during dredging and returning water to the small numbers that forage in the area, but these impacts are unlikely to cause a long-term decrease in the population. Vessel collision is not considered likely as the dredging vessel will be stationary during dredging, on site for a short period of time and turtles are highly mobile and able to avoid slow moving vessels. The residual risk of boat strike is low.	**No significant impact likely** - Hawksbill Turtles have been recorded foraging in the project area, but do not nest in the area. Turtles occurring in the vicinity of the Project do not constitute a geographically distinct regional population or local population that occurs within a particular bioregion. The impacting processes are not of a sufficient scale or magnitude to lead to a long-term decrease in this species. Vessel collision is not considered likely as the dredging vessel will be stationary during dredging, on site for a short period of time and turtles are highly mobile and able to avoid slow moving vessels. The residual risk of boat strike is low.
Reduce the area of occupancy of an important population	**No significant impact likely** - Flatback and Green Turtles are widely distributed throughout the region and in tropical Australia. The Project would not reduce the area of occupancy of the species in any ecologically meaningful way. The Abbot Point area is not considered a major nesting rookery in Queensland, as the level of nesting is considered 'low density' and therefore is not critical to the survival of Green or Flatback Turtle populations. Abbot Point is within the region	**No significant impact likely** – There is no known critical or important habitat (as defined in the Recovery Plan for Marine Turtles in Australia, Commonwealth of Australia 2003) for Hawksbill Turtles present within the project area or region. There is no known nesting in the area. No nesting activity is recorded from the Abbot Point region and only one Hawksbill turtle nesting event has been recorded in the last 70 years in the GBR south of Princess Charlotte Bay (Limpus, 2009a). The Hawksbill Turtle may potentially

Significant impact criteria (vulnerable species)	Flatback Turtle	Green Turtle	Hawksbill Turtle
	considered by GBRMPA as a high priority foraging area for Green Turtles (Upstart Bay to Midge Point). Offsite impacts on water quality are expected to be short term and localised to the dredging area and returning water location. Such impacts will not reduce the area of occupancy of the species. The residual risk to water quality is low. Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised. The maximum distance that may cause behavioural changes in megafauna is <3km (as a conservative estimation) and for a short duration. PTS and TTS thresholds are highly localised (<10metres and between 10 to 60m respectively) and require long exposure times. Given the large distribution range of Flatback and Green Turtles and the small area of the Project it is unlikely underwater noise will have a significant impact to individuals using the project area. The residual risk of underwater noise is low. Impacts of lighting on nesting activities are expected to be small due to the low numbers of Green Turtles recorded to nest in this area. The residual risk of lighting is low.		use the project area for foraging. Areas of seagrass and algal communities that occur within the inshore and offshore areas of Abbot Point provide foraging habitat for Hawksbill turtles. The majority of foraging habitat (seagrass and algal communities) is unlikely to be impacted by the Project. The Project will have a direct impact on <0.04% of the available seagrass habitat in the region. Hawksbill Turtles forage on seagrass beds, among other benthic habitats. The residual risk of habitat loss is low.
Fragment an existing important population	**No significant impact likely** - Marine turtles are highly mobile and the Project would not create any barriers to the movement of individuals.		

Significant impact criteria (vulnerable species)	Flatback Turtle	Green Turtle	Hawksbill Turtle
Adversely affect habitat critical to the survival of a species	**No significant impact likely** – The seagrass habitat within the dredging footprints will be directly impacted by removal. The Project will have a direct impact on <0.04% of the available seagrass habitat in the region. Given the low number of Green and Flatback Turtles observed at Abbot Point this is unlikely to have a significant impact. The residual risk of habitat loss is low. There is no known critical or important habitat for Green Turtles present within the project area or region, as defined in the Recovery Plan for marine turtles in Australia (Commonwealth of Australia, 2003). Abbot Point is known to provide foraging and nesting habitat for Green Turtles. However, high abundances of Green Turtles have not previously been recorded in the area.		**No significant impact likely** - There is no known critical or important habitat for Hawksbill Turtles present within the project area or region.
Disrupt the breeding cycle of an important population	**No significant impact likely** – The Abbot Point area is not considered a major nesting rookery in Queensland, as the level of nesting is considered 'low density' and therefore is not critical to the survival of Green or Flatback Turtle populations. Green and Flatback Turtles nest annually on Abbot Point beach to the east of the existing terminal. The turtle nesting period is from early November to March. Peak hatching is triggered by temperature conditions and generally occurs in December and January. Dredging will occur over 3km to the north-west of Abbot Point beach where turtles are found to nest; any plume will not impact on the nesting beach area or surrounds. The use of a CSD will further reduce impacts as		**No significant impact likely** - This species is not known to nest in the Abbot Point region; the Project is not considered to disrupt the breeding cycle of the population.

Significant impact criteria (vulnerable species)	Flatback Turtle	Green Turtle	Hawksbill Turtle
	turtles are less likely to be caught (sucked) into the dredge head compare to the TSHD type dredge. Impacts due to lighting during the hatching season will be managed to ensure turtle hatchlings which emerge during December and January are not adversely impacted upon. The residual risk of lighting is low		
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**No significant impact likely** - Foraging and nesting habitat will be impacted (direct loss and disturbance) through modification and/or removal by the Projects development Project and dredging activities. Habitat in the project area Project is not generally considered as optimal in comparison with other areas in the region. It is considered that the direct impact from the Project on potential seagrass habitats (10.5ha) represents <0.04% of the available seagrass habitat in the Abbot Point region. This loss is unlikely be of sufficient scale to cause the species to decline, as other suitable (more optimal) habitat is available in the wider Abbot Point region to the north and south. The residual risk of habitat loss is low.		
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**No significant impact likely** - It is considered unlikely that the Project will introduce an invasive species that will cause turtle species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests is low.		
Introduce disease that may cause the species to decline	**No significant impact likely** - It is considered unlikely that the Project will introduce a disease to the population that will cause turtle species to decline. As per introduced species above, management measures will be in place that are consistent with the requirements of Australian legislation. The residual risk of the introduction of disease is low.		
Interfere substantially with the	**No significant impact likely** - There is a recovery plan in place for marine turtles in Australia. Whilst the area supports some foraging habitat for all three species, it is not considered critical habitat for the survival and recovery of any of these		

Significant impact criteria (vulnerable species)	Flatback Turtle	Green Turtle	Hawksbill Turtle
recovery of the species	species. Habitat usage for foraging appears low and no nesting has been observed, particularly in comparison to other areas in the region. The Project will have a direct impact on <0.04% of the available seagrass habitat in the region. Based on these findings, the Project is not expected to interfere with the recovery of any of the species. The residual risk of habitat loss is low.		

6.7.3 Sharks and rays

6.7.3.1 Giant Manta Ray (Manta birostris)

- **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**

No significant impact likely – The Giant Manta Ray is commonly encountered in small groups, near the surface around offshore islands and reefs in the pelagic environment feeding on plankton. Abbot Point is located in a nearshore turbid environment not likely to be an important feeding or aggregation area for Giant Manta Rays. The residual risk of habitat loss is low.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species**

No significant impact likely - It is considered unlikely that the Project will introduce an invasive species that will cause the species to decline. Relevant management measures will be in place, in accordance with Australian legislation, that minimise the likelihood of introduced species (e.g. from ballast water) being introduced into Australian waters. The residual risk of the introduction of marine pests or disease is low.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) or an ecologically significant proportion of the population of a migratory species**

No significant impact likely - Abbot Point is not an important feeding or aggregation area for Giant Manta Rays. Two Giant Manta Rays were observed opportunistically feeding during surveys in 2008 and 2009. This number is low, indicating this area is not an important area of habitat for Giant Manta Rays, which are more commonly found in the pelagic environment. Dredging activities will be temporary and short-term, and the dredge is effectively stationary during operation. There will be no dredge movements to offshore dredged material relocation grounds reducing the likelihood of vessel interactions with

Giant Manta Rays. The residual risk of boat strike is low.

Underwater noise levels predicted by the modelling may cause a behavioural response where the Giant Manta Rays may move further away from activities. The residual risk of underwater noise is low.

6.8 Impacts to the Great Barrier Reef Marine Park

Dredging associated with the Project will occur within the operational port limits, which are excised from, but adjacent to, the GBRMP (refer to Figure 3-3). As described in Section 3.6, the marine environment at Abbot Point is characterised by a heterogeneous habitat matrix, predominantly composed of soft sediment.

Project impacts assessed against each of the Significant Impact Criteria are outlined in Table 6-8. More detail on specific mitigation measures are provided in Section 8.

The project area does not represent unique or significant ecological value. Dredging and discharging activities are likely to result in temporary offsite impacts to the values of the GBRMP. The residual risks associated with each project phase and associated activities are outlined in Section 6.6 and Table 6-6. All residual risks are categorised as low.

Table 6-8 Significant Impact Criteria and potential impacts on the GBRMP

Significant Impact Criteria	Potential Project Impacts
Modify, destroy, fragment, isolate or disturb an important, substantial, sensitive or vulnerable area of habitat or ecosystem component such that an adverse impact on marine ecosystem health, functioning or integrity in the GBRMP results.	Dredging will occur outside the Marine Park and stochastic plume modelling (incorporating deep ocean current circulation) indicates that sediment migration will be highly localised from the dredge site and will not significantly affect the Marine Park. The proposed use of a CSD significantly reduces the extent of plume generated during dredging, with the majority of fine sediment being pumped ashore for settling and treatment. There will be no placement of dredged material in the Marine Park. Seagrass distribution and abundance is naturally highly variable in the Abbot Point area, with the most recent surveys recording reduced areas (when compared to 2008) of low density, patchy areas of seagrass (McKenna and Rasheed, 2014), indicating seagrass abundance in the Abbot Point area is not stable or currently present in high abundance Recent surveys found the seagrass communities growing in the dredging footprint area (which is

Significant Impact Criteria	Potential Project Impacts
	located outside the Marine Park) were low density and patchy. Based on this, the removal of 10.5ha of this seafloor is unlikely to have an adverse impact on marine ecosystem health, functioning or integrity. Potential offsite impacts to benthic communities as a result of Project activities are expected to be temporary and may extend into the Marine Park. Plume influences on light attenuation are considered comparable to observed inter-seasonal variability. As such, the effects of the plume on light availability are not predicted to result in detectable losses of seagrass or have detectable impacts on potential seagrass habitat. Elevated sedimentation is not predicted to occur outside the dredging footprint. Any temporary loss of potential seagrass habitat via offsite impacts is likely to be reflected only at the local scale on the basis that Abbot Point does not provide high value seagrass habitat.Benthic habitats within the project area are not considered to have any unique ecological values compared to other areas of the GBR or Abbot Point. The residual risks of project activities to the specific significant impact criteria are low.
Have a substantial adverse effect on a population of a species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution	Impacts to listed species are assessed in Section 6.7. No significant direct or offsite impacts to cetaceans or other species that occur in the GBRMP are expected to occur as a result of the Project.
Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological health or integrity or social amenity or human health,	The proposed dredging regime limits increases to sediment loads and associated water quality impacts. The returning waters will contain higher than natural levels of suspended solids. The sediments will quickly disperse. TSS concentrations within 100m of the discharge point (and well within the Port Limits outside the marine Park) will return to

Significant Impact Criteria	Potential Project Impacts
	natural levels as measures during baseline water quality studies. Air quality influences from the Project are restricted to emissions generated from dredger operation and these have been assessed as not having adverse impacts on local air quality. Dredging will occur within the restricted port limits and with the placement of material onshore, the likelihood of the proposed action impacting on other park users including the tourist and fishing industries in the area is low. The residual risks of Project activities to the specific significant impact criteria are low.
Result in a known or potential pest species being introduced or becoming established in the GBRMP.	Although highly unlikely, there is potential for invasive species to be introduced to the project area as a result of Project activities. The Project dredging vessel will adhere to the Australian mandatory ballast water reporting system. High risk ballast water exchange is not accepted within the Port of Abbot Point. Mandatory ballast water management arrangements are implemented by the AQIS. As result of adherence to these requirements, and additional requirements outlined in the outline Dredging Management Plan there is low to no risk that project activities will introduce marine pests to the GBRMP. The residual risks of Project activities to the specific significant impact criteria are low.
Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, or social amenity or human health may be adversely affected.	The primary input into the marine environment of returning waters will be elevated TSS. The returning suspended sediments are not expected to contain any organic chemicals, heavy metals or other potentially harmful chemicals. Surface waters in the vicinity of the discharge point will

Significant Impact Criteria	Potential Project Impacts
	be periodically tested for these chemicals as part of the discharge waters monitoring program (see DMP). No offshore placement will occur. Based on the marine sediment quality assessments undertaken in the dredging footprint, sediments realised into the marine environment from the action of the dredge cutter head are not expected to contain organic chemicals, heavy metals, or other potentially harmful chemicals. The residual risks of Project activities to the specific significant impact criteria are low.
Have a substantial adverse impact on heritage values of the GBRMP, including damage or destruction of an historic shipwreck.	The Project is not likely to directly or temporarily impact upon the GBRMP heritage values. Access to any historic ship wrecks would not be altered. The Project is therefore not likely to substantially adversely impact upon the heritage values held by the GBRMP. The Catalina Plane wreck located 32km from the T0 dredging footprint has been declared Maritime Cultural Heritage Protection Special Management Area. No impacts to this important site due to the Project are predicted The residual risks of Project activities to the specific significant impact criteria are low.

6.9 Impacts to Commonwealth marine areas

The Project dredging area and return pipeline is located outside the Commonwealth marine area. An assessment of the Project’s likely impacts on the significant impact criteria for the Commonwealth marine area is provided in Table 6-9. Direct impacts on the Commonwealth marine area will not occur, whilst offsite impacts could occur as a result of plume migration associated with the dredging and return water discharges. Mitigation measures are presented in Table 6-9 where appropriate. More detail on specific mitigation measures are details in Section 8.

Table 6-9 Significant Impact Criteria and the potential Project impacts on Commonwealth marine areas

Significant Impact Criteria	Potential Project Impacts to Commonwealth Marine Areas
Result in a known or potential pest species becoming established in the Commonwealth marine area.	Although highly unlikely, there is potential for invasive species to be introduced to the project area as a result of Project activities. The project dredging vessel will adhere to the Australian mandatory ballast water reporting system. High risk ballast water exchange is not accepted within the Port of Abbot Point. Mandatory ballast water management arrangements are implemented by the AQIS. As result of adherence to these requirements, and additional requirements in the outline Dredging Management Plan there is a low residual risk that project activities will introduce marine pests to the Commonwealth marine area. The residual risks of Project activities to the specific significant impact criteria are low.
Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results.	Dredging will occur outside the Commonwealth marine area and stochastic plume modelling (incorporating deep ocean current circulation) indicates that sediment migration will be highly localised from the dredge site and will not significantly affect the Commonwealth marine area. The proposed use of a cutter suction dredge significantly reduces the extent of plume generated during dredging, with the majority of fine sediment being pumped ashore for settling and treatment. There will be no placement of dredged material in the Commonwealth marine area. Seagrass distribution and abundance is naturally highly variable in the Abbot Point area, with the most recent surveys recording reduced areas (when compared to 2008) of low density, patchy areas of seagrass (McKenna and Rasheed, 2014),

Significant Impact Criteria	Potential Project Impacts to Commonwealth Marine Areas
	indicating seagrass abundance in the Abbot Point area is not stable or currently present in high abundance Recent surveys found the seagrass communities growing in the dredging footprint area (which is located outside the Commonwealth marine area) were low density and patchy. Based on this, the removal of 10.5ha of this seafloor is unlikely to have an adverse impact on marine ecosystem health, functioning or integrity. Potential offsite impacts to benthic communities as a result of Project activities are expected to be temporary and may extend into the Commonwealth marine area. Plume influences on light attenuation are considered comparable to observed inter-seasonal variability. As such, the effects of the plume on light availability are not predicted to result in detectable losses of seagrass or have detectable impacts on potential seagrass habitat. Elevated sedimentation is not predicted to occur outside the dredging footprint. Any temporary loss of potential seagrass habitat via offsite impacts is likely to be reflected only at the local scale on the basis that Abbot Point does not provide high value seagrass habitat.Benthic habitats within the project area are not considered to have any unique ecological values compared to other areas of the Commonwealth marine areas (GBR) or Abbot Point. The residual risks of project activities to the specific significant impact criteria are low.
Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution.	Impacts to listed species are assessed in Section 6.7. No significant direct or offsite impacts to cetaceans or other species that occur in the Commonwealth marine areas are expected to occur as a result of the Project.

Significant Impact Criteria	Potential Project Impacts to Commonwealth Marine Areas
Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health.	The proposed dredging regime limits increases to sediment loads and associated water quality impacts. The returning waters will contain higher than natural levels of suspended solids. The sediments will quickly disperse. TSS concentrations within 100m of the discharge point (and well within the Port Limits outside the Commonwealth marine area) will return to natural levels as measures during baseline water quality studies. Air quality influences from the Project are restricted to emissions generated from dredger operation and these have been assessed as not having adverse impacts on local air quality. Dredging will occur within the restricted port limits and with the placement of material onshore, the likelihood of the proposed action impacting on other users including the tourist and fishing industries in the commonwealth marine area is low. The residual risks of Project activities to the specific significant impact criteria are low.
Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.	The primary input into the marine environment of returning waters will be elevated TSS. The returning suspended sediments are not expected to contain any organic chemicals, heavy metals or other potentially harmful chemicals. Surface waters in the vicinity of the discharge point will be periodically tested for these chemicals as part of the discharge waters monitoring program (see DMP). No offshore placement will occur. Based on the marine sediment quality assessments undertaken in the dredging footprint, sediments realised into the marine environment from the action of the dredge cutter head are not expected to contain organic

Significant Impact Criteria	Potential Project Impacts to Commonwealth Marine Areas
	chemicals, heavy metals, or other potentially harmful chemicals. The residual risks of project activities to the specific significant impact criteria are low.
Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.	No heritage values have been identified within that part of the project area potentially affected by turbidity. The Catalina plane wreck is located 24km to the East of the T0 dredging area and is not expected to be influenced by the dredging and return water (see TSS, bed thickness and sedimentation time series plots for this location in Section 6.2.5.6)

7. SUMMARY OF IMPACTS

7.1 Benthic habitat

7.1.1 Direct losses

Direct impacts on benthic habitat will occur predominantly within and immediately adjacent to infrastructure footprints, where dredges excavate the seabed. Direct impacts typically involve ***irreversible*** loss of benthic habitats and communities, where *irreversible* is defined as *"lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less"* (EPA, 2011).

The habitat maps used to calculate the direct losses of seagrass habitat were created using composite results from TropWATER surveys of the project area from 1987 to 2014 (McKenna, 2014). If at any stage the habitat surveys found seagrass present, this particular habitat is deemed to be able to support seagrass and is accounted for in the direct loss calculations. This represents a very conservative approach in view of the ephemeral nature of the low density seagrass which grows in this area and surrounds in different years (see Figure 3-13).

The number of hectares of each Project component and the number of hectares of seagrass and habitat that will likely be directly impacted is summarised in Table 7-1.

7.1.1.1 BERTH POCKET AND BATTER SLOPES

Surveys over the last 20 years have shown that the seabed habitat in the berth pockets and batter slopes has supported areas of seagrass habitat. The ephemeral nature of the seagrass habitat in the T0 footprint and surrounds from surveys in 2008, 2001, 2013 and 2014 are shown in Figure 3-13. The seagrass habitat is known to extend into waters greater than -18.5m LAT. The percentage cover of the seagrass in this area when it occurs is of low density and between 1 and 5% cover.

Based on these surveys, the dredging of the berth pocket and batter slopes for T0 will directly impact on 10.5ha of potential seagrass habitat (Figure 7-1). The seagrass habitat in this area is not expected to recover within 5 years.

7.1.1.2 APRON AREA

Surveys over the last 20 years have shown that the seabed habitat in the apron areas has supported seagrass (Figure 3-13). The depth of the current apron area ranges between -17.0m LAT to -18.5m LAT. Seagrass is found in the deeper waters beyond -18.5 LAT, extending in a wide ark approximately 1km seaward of the proposed outer boundary of the T0 apron area (Figure 7-2). The dredging of the T0 apron area will remove 50.5ha of potential seagrass habitat. The seagrass habitat in this area is expected to recover within 5 years.

7.1.1.3 Pipeline infrastructure

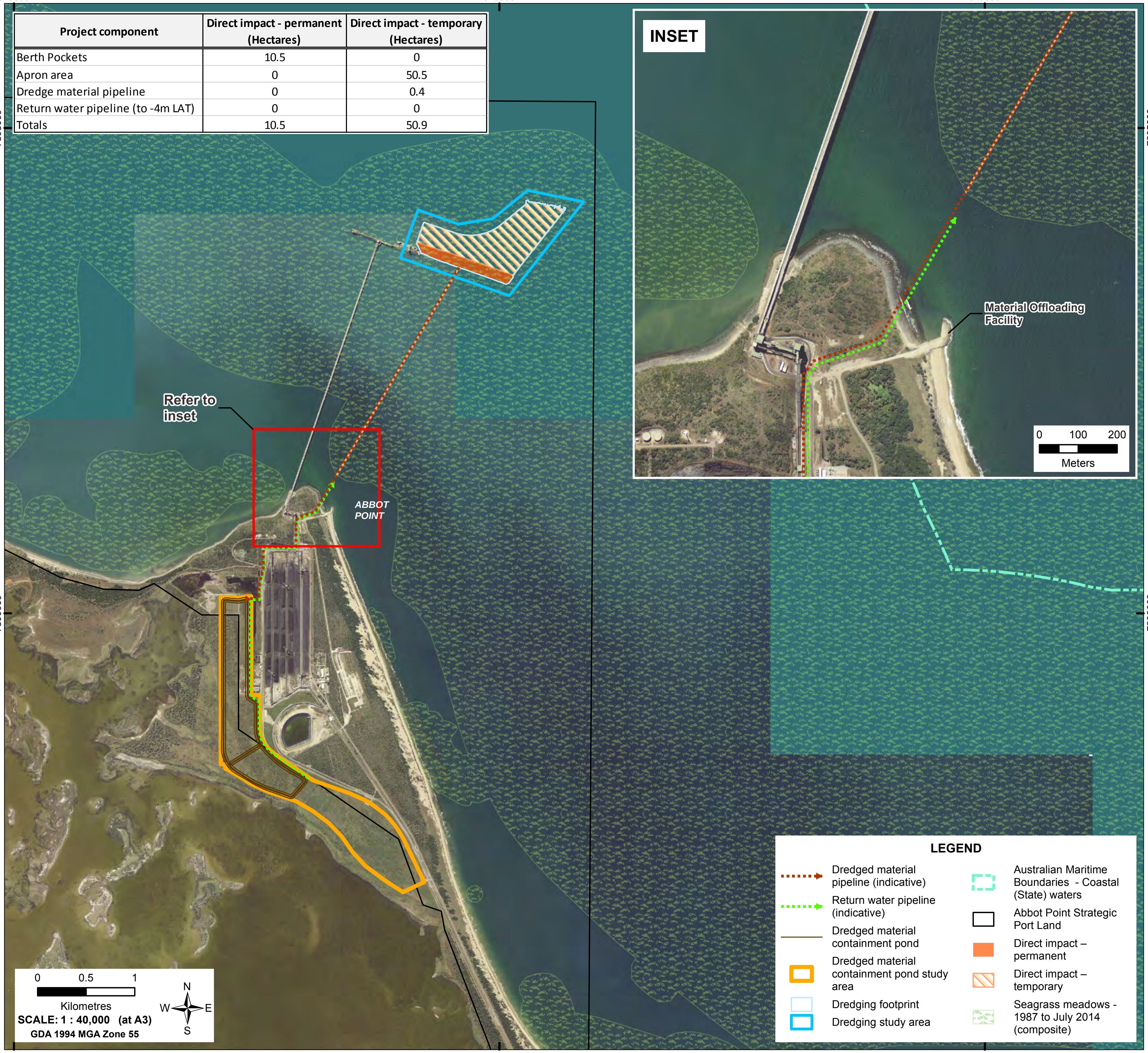
The pipeline diameter (delivery and return water) is assumed to be between 1.0 and 1.2m. A 0.5m buffer zone either side of the pipeline is assumed, which allows for some movement of the pipeline during operation.

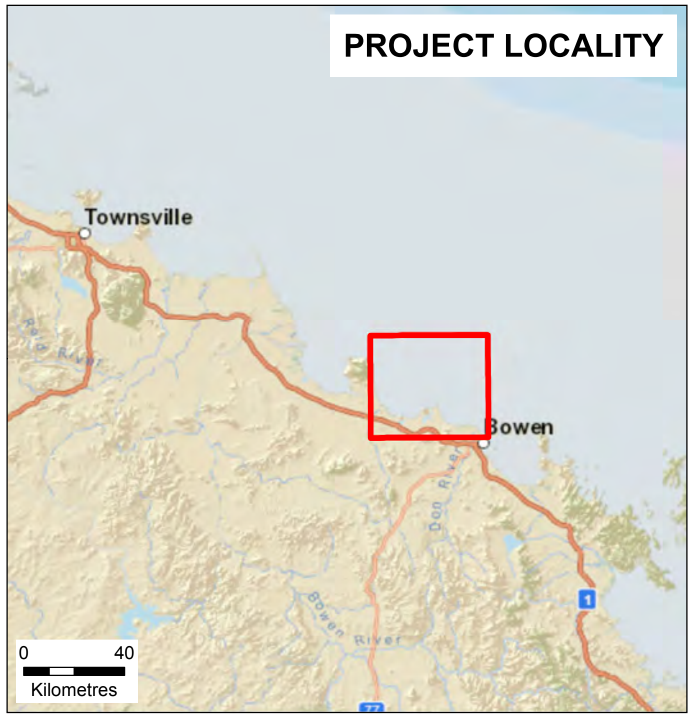
The laying of the dredged material delivery pipeline on the seabed between the Lowest Astronomical Tide (LAT) to the T0 dredging footprint will traverse across 0.43ha of potential seagrass habitat. The return water pipeline extends out to -4m LAT and crosses no areas found to have seagrass habitat. The loss of macroalgae growing on a rocky subtidal habitat in the pipeline corridor at the point of beach crossing will be temporary and likely to be minimal. The rocky habitat the macroalgae grows on will be quickly recolonised once the pipelines are removed. No impacts to the marine fauna (primarily turtles) that may utilise this region for foraging are predicted. The temporary storage of pipeline 'strings' offshore from the MOF will not result in any impacts to the seagrass habitat.

Total temporary losses of seagrass habitat during the seagrass growing season for the pipeline and return water pipeline represent 0.43ha of potential seagrass habitat (Figure 7-1).

Figure 7-1
Direct impacts – dredging and pipeline infrastructure

Project component	Direct impact - permanent (Hectares)	Direct impact - temporary (Hectares)
Berth Pockets	10.5	0
Apron area	0	50.5
Dredge material pipeline	0	0.4
Return water pipeline (to -4m LAT)	0	0
Totals	10.5	50.9





Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

LEGEND

- Dredged material pipeline (indicative)
- Return water pipeline (indicative)
- Dredged material containment pond
- Dredged material containment pond study area
- Dredging footprint
- Dredging study area
- Australian Maritime Boundaries - Coastal (State) waters
- Abbot Point Strategic Port Land
- Direct impact – permanent
- Direct impact – temporary
- Seagrass meadows - 1987 to July 2014 (composite)

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
Dredged material containment pond
Supplied by Golder Associates 23/06/2015
Dredged material containment pond study area
Department of State Development, Infrastructure and Planning, (DSDIP)
Existing transport network
Physical Road Network - Queensland, Physical Rail Network - Queensland
Queensland Government - Department of Environment and Resource Management
2013 Imagery
Queensland Government - Department of State Development, Infrastructure and Planning 2015
Cadastral Boundaries
Downloaded 08/06/2015 -
http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={4091CAF1-50E6-4BC3-B3D4-229AA318231A}
Queensland Government - Department of Natural Resources and Mines
Australian Maritime Boundaries - 2006
Geoscience Australia
Port Limits - 2008
Maritime Safety Queensland
Abbot Point Strategic Port Land
Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 7-1
Direct impacts – dredging and pipeline infrastructure

Figure: 301001-01956-00-GM-SKT-0040 | Rev: 0

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7.1.2 Offsite predicted losses

Offsite impacts arise from effects of dredge-generated sediments and generally extend over areas surrounding infrastructure footprints and dredging sites. These offsite impacts generally occur when sediment deposition rates and/or elevated turbidity exceed the natural tolerance or threshold levels of benthic organisms exposed to those pressures. The offsite effects of dredge-generated sediments may restrict or inhibit key ecological processes and cause impacts that range in severity and duration from irreversible to readily-reversible.

Zones of moderate impact are predicted for four water quality parameters; TSS, sedimentation, bed thickness and benthic light availability (refer to Figure 7-2). The total area of potential seagrass habitat mapped during the period 1987 to July 2014 in the Abbot Point region represents an area of 27,757.4ha. Offsite predicted losses in hectares of potential seagrass habitat are summarised in Table 7-1 and are based on very conservative assumptions that define the worst case. Offsite losses to seagrass habitat are only provided for during the growing season when the seagrass is present. If dredging occurs during the seagrass senescence season (January to June) there are no predicted offsite impacts to seagrass habitat due to elevated TSS, sedimentation or benthic light reduction.

7.1.2.1 Offsite predicted losses due to elevated TSS

Based on the TSS thresholds applied to the modelling outputs two zones of moderate impact are predicted to occur in the vicinity of the returning waters and the dredging footprint. During the dry season (seagrass growing season) the offsite impacts of elevated TSS concentrations at the dredging area and return water may potentially result in an offsite impact on 46.7ha and 0.3ha respectively - a total of 47.0ha.

7.1.2.2 Offsite Predicted losses due to elevated sedimentation rates

Based on the GBRMPA (2010) sedimentation thresholds applied to the modelling outputs two zones of moderate impact are predicted to occur in the vicinity of the return water point and the dredging footprint. During the dry season (seagrass growing season) the offsite impacts of elevated sedimentation rates at the dredging area and return water will result in an offsite impact on 4.2ha and 33.4ha respectively – a total of 37.5ha.

7.1.2.3 Offsite Predicted losses due to bed thickness

There are no losses of seagrass habitat predicted to occur based on the threshold bed thickness value of >10mm. The highest bed thickness found outside the T0 dredging area is predicted to occur in the vicinity of extraction point D02 and DO3 which recorded a maximum of 1.65mm and 0.7mm, respectively.

7.1.2.4 OFFSITE PREDICTED LOSSES DUE TO A REDUCTION IN BENTHIC LIGHT AVAILABILITY

The change in offshore light climate due to elevated TSS from the returning waters in the seagrass growing season may result in the temporary impact (zone of moderate impact) to 1181.5ha of potential seagrass habitat. The locations where the changes to the offshore baseline light climate due to elevated TSS from dredging are primarily to the southeast up to 8km distant from the T0 dredging area.

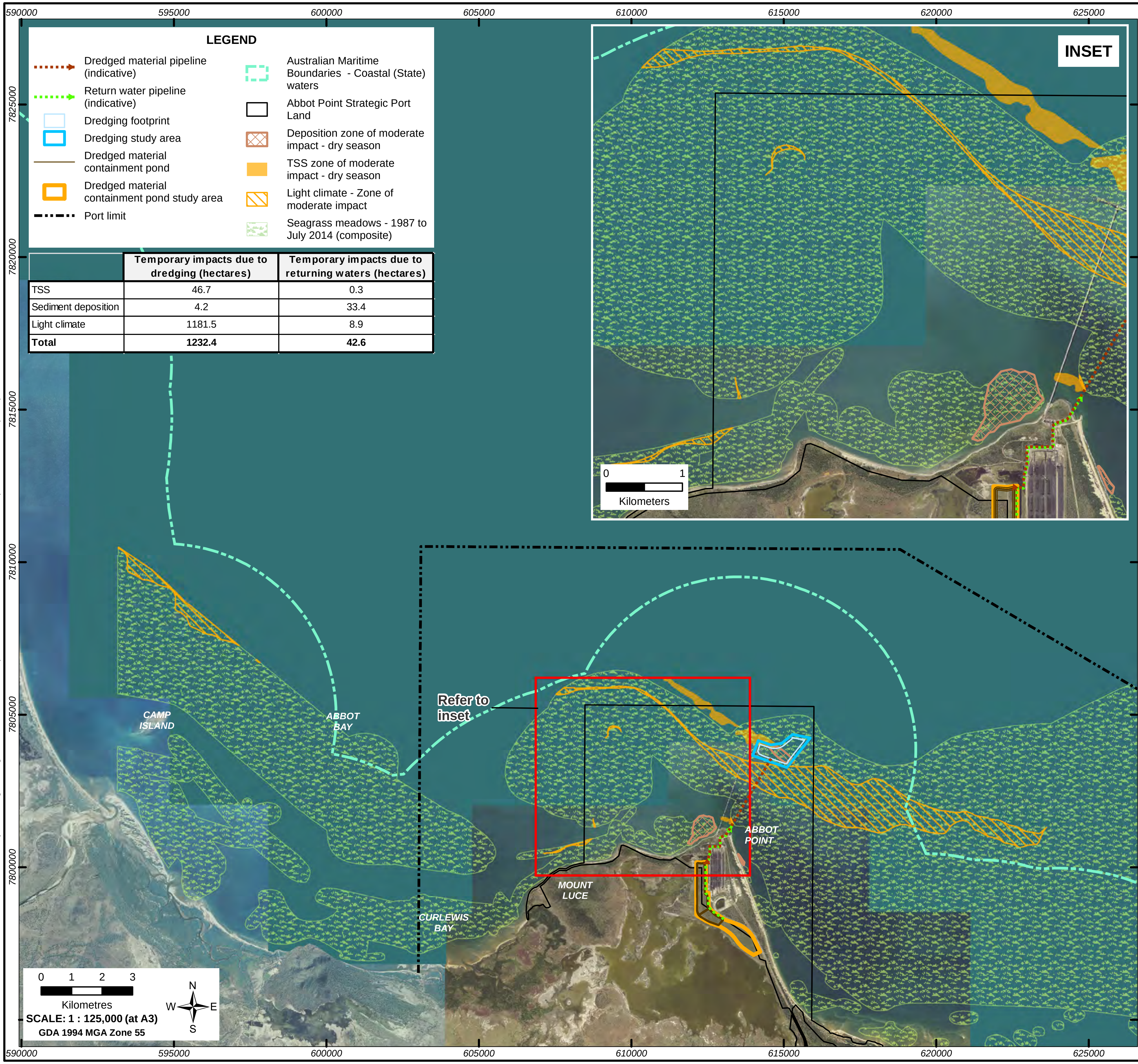
The zone of moderate impact due to changes in the seagrass light requirements in the growing season represents an offsite non-lethal temporary impact to 1181.5ha of offshore and 8.9ha of potential inshore seagrass habitat.

This represents an offsite impact on potential seagrass communities due to changes in the light climate at the seafloor in the seagrass growing season for a total of 1190.4ha. This represents <4.3% of the available seagrass habitat surveyed since 1987 that may be temporarily impacted during the dry season Project activities.

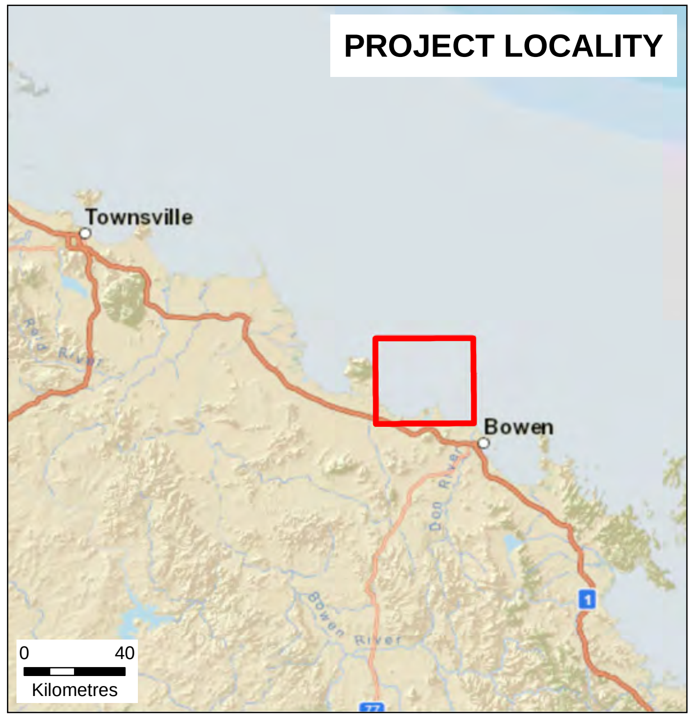
During the growing (dry) season, offsite temporary losses of potential seagrass habitat due to elevated TSS, sedimentation and benthic light reduction amount to a total of 1,274.87ha.

Long-term monitoring has found that seagrass biomass and distribution at Abbot Point is generally lowest during the late senescence season (April/May) and greatest in the late growing season (October/November) (McKenna *et al*., 2014). Impacts resulting from light reductions during the senescence season are unlikely to be on the same magnitude as the impacts on seagrass due to a reduction in light climate during the growing season.

During the senescence (wet) season, offsite temporary losses of potential seagrass habitat due to elevated TSS, sedimentation and benthic light reduction is likely to be much less than the loss predicted for the growing season.



	Temporary impacts due to dredging (hectares)	Temporary impacts due to returning waters (hectares)
TSS	46.7	0.3
Sediment deposition	4.2	33.4
Light climate	1181.5	8.9
Total	**1232.4**	**42.6**



Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

Source information:
Dredging study area
Setout points derived from coordinates on NQBP/Aurecon figure 242770-0000-DRG-SK-0021-A supplied by NQBP
Dredged material and return water pipelines
Digitised from BMT JFA Drg. No. BMT JFA 275.02-50-03 A, dated 17/12/2014 and Golder Associates Drg. No. 1525905-027-002A, dated 12/06/2015, with some minor adjustments to avoid clashes with existing infrastructure visible in the 2013 aerial imagery and to avoid any potential clashes with the proposed MOF expansion
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Digitised from "Plan 1 - Port of Abbot Point Land Use Plan Designations"
North Queensland Bulk Ports Corporation Limited -Port of Abbot Point Land Use Plan - October 2010
Seagrass monitoring and survey data
TropWATER (Centre for Tropical Water & Aquatic Ecosystem Research) - James Cook University

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ABBOT POINT GROWTH GATEWAY PROJECT

Figure 7-2
Offsite impacts due to project activities

Figure: 301001-01956-00-GM-SKT-0076 | Rev: 0

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Table 7-1 The areas of potential seagrass habitat in hectares predicted to be directly and temporarily impacted upon by a range of sources as a result Project activities

<table>
<tr><th rowspan="2">Potential Source of Impacts</th><th rowspan="2">Direct Impacts (ha)</th><th colspan="2">Temporary Offsite Impacts - dredging (ha)</th><th colspan="2">Temporary Offsite Impacts Return Water(ha)</th></tr>
<tr><th>Dry (growing)</th><th>Wet (senescence)</th><th>Dry (growing)</th><th>Wet (senescence)</th></tr>
<tr><td>Elevated TSS</td><td rowspan="4"></td><td>46.7</td><td>N/A</td><td>0.3</td><td>N/A</td></tr>
<tr><td>Sediment deposition</td><td>4.2</td><td>N/A</td><td>33.4</td><td>N/A</td></tr>
<tr><td>Bed thickness</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Benthic light loss</td><td>1181.5</td><td>N/A</td><td>8.9</td><td>N/A</td></tr>
<tr><td>Pipeline corridor</td><td>0.4 (temporary)</td><td colspan="4" rowspan="3"></td></tr>
<tr><td>Berth Pockets</td><td>10.5 (permanent)</td></tr>
<tr><td>Apron area</td><td>50.5 (temporary)</td></tr>
</table>

7.1.3 Summary of direct and offsite impacts to potential seagrass habitat

7.1.3.1 Actual Direct Impacts

The total area of potential seagrass habitat in waters surrounding Abbot Point mapped since 1987 represents is 27,757.4ha. Historically, the deepwater seagrass communities in the berth pockets and apron areas were described as sparse and ranging from 1 to 5% percentage cover (light cover category) of the seabed. The distribution of the seagrass habitat in more recent surveys (2013 and 2014) show the extent of the actual seagrass communities in the berth pocket that may be present during the Project execution is very low or non-existent (Figure 3-13).

Table 7-2 below outlines the areas of seagrass habitat which will be directly removed based on the historical surveys of the seagrass habitat in the dredging footprint from 1987-2014. Included in this table is the area of loss of the actual seagrass growing in the berth pockets when the range of measured percentage cover is taken into account.

Based on the historical surveys, which include all surveys; the area of actual seagrass which is directly removed equates to a lower limit of 0.1ha (if the percentage cover is 1%) and an upper value of 0.5ha (if the percentage cover is at the upper limit of 5%).

Pipeline infrastructure will only be in place temporarily (i.e. for 6 - 12 weeks) and the seagrass communities affected (directly but temporally) by this pipeline will recover within 5 years.

Table 7-2 Historical seagrass habitat survey results (ha) in the T0 dredging footprint area and the measured percentage cover of seagrass (December 2014)

Survey Period	Area of Seagrass Habitat in berth pockets (ha)	Percentage Cover of Actual Seagrass	
		Lower limit 1% cover	Upper limit 5% cover
Mapped seagrass habitat 1987 -2014	10.5	0.1	0.5
Mapped seagrass habitat September 2013	7.3	0.07	0.4
Mapped seagrass habitat December 2014	0.0	0.0	0.0

7.1.3.2 Offsite Predicted Impacts

Potential offsite impacts to benthic communities as a result of Project activities are expected to be temporary. Plume influences on light attenuation are considered comparable to observed inter-seasonal variability. As such, the effects of the plume on light availability are not predicted to result in detectable losses of seagrass or have detectable impacts on potential seagrass habitat.

Any temporary loss of potential seagrass habitat via offsite impacts is likely to be reflected only at the local scale on the basis that Abbot Point does not provide high value seagrass habitat. If the dredging occurs in the seagrass senescence season the impacts to the seagrass community will be greatly reduced.

7.2 Threatened or migratory marine species

The offshore environment at Abbot Point supports a number of marine species. Within this group of species a number are EPBC Act listed threatened and migratory marine species. The Protected Matters Search Tool identified nine EPBC Act listed threatened or migratory marine fauna species that may occur in the project area and areas that may be impacted by the Projects. These species have been categorised by likelihood of occurrence in the project area.

The offshore environment of Abbot Point is known to support, or have the potential to support:

- Humpback Whale (threatened and migratory)
- Two species of inshore dolphins (migratory)
- Dugong (migratory)
- Five species of marine turtle (threatened and migratory).

The activities associated with the Project have the potential to directly and temporarily impact upon these species. Direct impacts include habitat loss and fauna mortality; offsite impacts include:

- Marine water quality (refer to section 6.2 for detail)
- Habitat fragmentation or loss (refer to Section 6.2 and Section 7 for detail)
- Underwater noise (refer to Section 6.3 for detail)
- Vessel collision (refer to Section 6.4 for detail).
- Introduced marine species (refer to Section 6.5 for detail).

7.2.1 Humpback whales

7.2.1.1 Underwater Noise

Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised (<3km as a conservative estimation) and for a short duration. PTS and TTS thresholds are highly localised (<10m and between 10 to 60m respectively) and have long exposure times. It is unlikely that Humpback Whales will travel to within 60m of the dredging operations. Given the large distribution range of Humpback Whales and small area of the Project it is considered unlikely that underwater noise will have a measurable impact to individuals using the project area. The residual risk of project related underwater noise to this species is low.

7.2.1.2 Marine Water Quality

The use of a CSD dredger instead of a Trailing Suction Hopper Dredger (TSHD) has drastically reduced the amount of sediment entering the water column. No offshore placement of dredged material will occur, effectively reducing the amount of sediment entering the marine areas offshore from Abbot Point to only the fugitive sediment released during the actions of the CSD cutter head. The dredged material will be pumped to an onshore DMCP; therefore the marine water quality in the vicinity of the dredging area is unlikely to be impacted by the release of any potential contaminants from the small quantity of fugitive sediments released at the dredge cutter head.

Due to the operational nature of the CSD, changes in marine water quality from increases in suspended solids (see dry and wet season median TSS concentration data Figure 6-6 and Figure 6-7, respectively) and sedimentation (see dry and wet season 80th percentile sedimentation data Figure 6-12 and Figure 6-13, respectively) will be short lived and isolated primarily to within a 500m radius of the dredging operations. The changes in water quality near the return water discharge point are also localised and of short duration.

In comparison to the background TSS data collected from 2011 to 2014 (see Section 6.2.5), the predicted TSS concentrations due to the dredging and return waters are below the typical background in areas >200m from the dredging and >100m from the return water discharge point. The area to the west of the discharge point does appear to have elevated sedimentation (see dry Figure 6-18 and wet Figure 6-19) and TSS above the predicted thresholds (see TSS dry Figure 6-16 and wet Figure 6-17). Examination of the background data from near this location (monitoring site, Coastal West) shows this area is typically very turbid (see Figure 6-49) and predicted sedimentation and TSS from the return water is below the median background values measured since 2011.

There are large areas of comparable habitat within the Abbot Point region that will not experience impacts to water quality and these are accessible to this species.

The residual risk to this species because of Project related changes in water quality is low.

7.2.1.3 HABITAT FRAGMENTATION

The area is not known to support significant habitat for the species and is not identified as an aggregation or breeding area. Given the inshore location of the project area, it is unlikely that the Project will reduce the area of occupancy (particularly migration pathways) for Humpback Whales utilising the area (see Section 7.1 for more detail). The residual risk due to habitat loss (and fragmentation) due to Project related activities is low.

7.2.1.4 VESSEL COLLISON

Dredging activities are relatively close to shore and there will be no dredge movements to offshore dredged material relocation grounds, reducing the likelihood of vessel interactions with whales. The risk of fauna strike on this species is considered very low. Implementation of mitigation and management measures to manage potential impacts will be undertaken (see section 6.4 and Section8.1 for more detail). The residual impact on this species due to boat strike because of the Project is low.

Based on the impact assessment there is unlikely to be a significant impact upon this species. The residual impact of all Project activities on this species is low.

7.2.2 Inshore dolphins

7.2.2.1 Underwater Noise

Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised (<3km as a conservative estimation) and for a short duration. PTS and TTS thresholds are highly localised (<10m and between 10 to 60m respectively) and have long exposure times. It is considered unlikely that underwater noise will have a measurable impact to individuals using the project area. The residual risk of Project related underwater noise to this species is low.

7.2.2.2 Marine Water Quality

The use of a CSD dredger instead of a TSHD has drastically reduced the amount of fugitive sediment entering the water column. No offshore placement of dredged material will occur, effectively reducing the amount of fugitive sediment entering the marine areas offshore from Abbot Point to only the sediment released during the actions of the CSD cutter head. The dredged material will be pumped to an onshore DMCP therefore the marine water quality is unlikely to be impacted by the release of contaminants from the small quantity of sediments released at the dredge cutter head.

Due to the operational nature of the CSD, changes in marine water quality from increases in suspended solids (see dry and wet season median TSS concentration data - Figure 6-6 and Figure 6-7) and sedimentation (see dry and wet season 80th percentile sedimentation data (Figure 6-12 and Figure 6-13) will be short lived and isolated primarily to within a 500 m radius of the dredging operations. The changes in water quality near the return water discharge point are also localised and of short duration.

In comparison to the background TSS data collected from 2011 to 2014 (see Section 6.2.5), the predicted TSS concentrations due to the dredging and return waters are below the typical background in areas >200m from the dredging and >100m from the return water discharge point. The area to the west of the discharge point does appear to have elevated sedimentation (see dry Figure 6-18 and wet Figure 6-19) and TSS above the predicted thresholds (see TSS dry Figure 6-16 and wet Figure 6-17). Examination of the background data from near this location (monitoring site, Coastal West) shows this area is typically very turbid (see Figure 6-49) and predicted sedimentation and TSS from the return water is below the median background values measured since 2011.

There are large areas of comparable habitat within the Abbot Point region that will not experience impacts to water quality and these are accessible to these species. The residual risk to this species because of Project related changes in water quality is low.

7.2.2.3 Habitat Fragmentation or Loss

The direct and offsite impacts of this Project are not likely to modify, destroy or isolate an area of important habitat for inshore dolphins. The dredging will cause the direct loss of

10.5ha of potential seagrass habitat which represents <0.04% of the total available seagrass habitat in the Abbot Point area. Offsite impacts on seagrass habitat will temporarily impact upon <4.4% of the seagrass habitat in the area (see Section 7.1 for more detail). The residual risk due to habitat loss (and fragmentation) due to Project related activities is low.

7.2.2.4 Vessel Collison

Dredging activities are undertaken by a stationary dredge (CSD) and there will be no dredge movements to offshore dredged material relocation grounds, reducing the likelihood of vessel interactions with inshore dolphins. The risk of fauna strike on inshore dolphins is considered very low. Implementation of mitigation and management measures to manage potential impacts will be undertaken (see section 6.4 and Section 8.1 for more detail). The residual impact on this species due to boat strike because of the project is low.

Based on the impact assessment there is unlikely to be a significant impact upon this species. The residual impact of Project activities on this species is low.

7.2.3 Dugong

7.2.3.1 Underwater Noise

Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised (<3km as a conservative estimation) and for a short duration. Increased underwater noise may result in behavioural responses by Dugong foraging near the dredging operations. Foraging habitats are however not limited to areas surrounding the dredging. PTS and TTS thresholds are highly localised (<10m and between 10 to 60m respectively) and have long exposure times.

The level of impact from underwater noise is unlikely to result insignificant changes to the use of Abbot Point by these species. The residual risk of Project related underwater noise to this species is low.

7.2.3.2 Marine Water Quality

The use of a CSD dredger instead of a TSHD has drastically reduced the amount of fugitive sediment entering the water column. No offshore placement of dredged material will occur, effectively reducing the amount of fugitive sediment entering the marine areas offshore from Abbot Point to only the sediment released during the actions of the CSD cutter head. The dredged material will be pumped to an onshore DMCP therefore the marine water quality is unlikely to be impacted by the release of contaminants from the small quantity of sediments released at the dredge cutter head.

Due to the operational nature of the CSD, changes in marine water quality from increases in suspended solids (see dry and wet season median TSS concentration data - Figure 6-6 and Figure 6-7) and sedimentation (see dry and wet season 80th percentile sedimentation data Figure 6-12 and Figure 6-13) will be short lived and isolated primarily to within a 500m radius of the dredging operations. The changes in water quality near the return water discharge point are also localised and of short duration.

In comparison to the background TSS data collected from 2011 to 2014 (see Section 6.2.5), the predicted TSS concentrations due to the dredging and return waters are below the typical background in areas >200m from the dredging and >100m from the return water discharge point. The area to the west of the discharge point does appear to have elevated sedimentation (see dry Figure 6-18 and wet Figure 6-19) and TSS above the predicted thresholds (see TSS dry Figure 6-16 and wet Figure 6-17). Examination of the background data from near this location (monitoring site, Coastal West) shows this area is typically very turbid (see Figure 6-49) and predicted sedimentation and TSS from the return water is below the median background values measured since 2011.

There are large areas of comparable habitat within the Abbot Point region that will not experience impacts to water quality and these are accessible to this species. The residual risk to this species because of Project related changes in water quality is low

7.2.3.3 Habitat Fragmentation or Loss

The area of potential seagrass habitat to be temporarily impacted by the Project is a small proportion (<0.04%) of that potentially available in Abbot Point. Seagrasses in the area are considered sparse and ephemeral and utilised opportunistically by Dugong on their way to more extensive seagrass habitats to the North and South of Abbot Point (see Section 7.1 for more detail). The residual risk due to habitat loss (and fragmentation) due to Project related activities is low.

7.2.3.4 Vessel Collison

Dredging activities will be undertaken by a stationary dredge (CSD) and there will be no dredge movements to offshore dredged material relocation grounds, reducing the likelihood of vessel interactions with Dugongs. The risk of fauna strike on Dugongs is considered very low. Implementation of mitigation and management measures to manage potential impacts will be undertaken (see section 6.4 and Section8.1 for more detail). The residual impact on this species due to boat strike because of the Project is low.

Based on the impact assessment there is unlikely to be a significant impact upon this species. The residual impact of Project activities on this species is low.

7.2.4 Marine turtles

7.2.4.1 Underwater Noise

Predicted underwater noise levels from the dredging vessel (the loudest source of noise relating to the Project), are expected to be highly localised (<3km as a conservative estimation) and for a short duration. PTS and TTS thresholds are highly localised (<10m and between 10 to 60m respectively) and have long exposure times. Increased underwater noise may result in behavioural responses by marine turtles foraging near the dredging operations. Foraging habitats are not limited to areas surrounding the dredging. The level of residual impact from underwater noise is low and unlikely to result insignificant changes to the use of Abbot Point by these species.

7.2.4.2 MARINE WATER QUALITY

The use of a CSD dredger instead of a TSHD has drastically reduced the amount of sediment entering the water column. No offshore placement of dredged material will occur, effectively reducing the amount of sediment entering the marine areas offshore from Abbot Point to only the sediment released during the actions of the CSD cutter head. The dredged material will be pumped to an onshore DMCP therefore the marine water quality is unlikely to be impacted by the release of contaminants from the small quantity of sediments released at the dredge cutter head.

Due to the operational nature of the CSD, changes in marine water quality from increases in suspended solids (see dry and wet season median TSS concentration data - Figure 6-6 and Figure 6-7) and sedimentation (see dry and wet season 80th percentile sedimentation data Figure 6-12 and Figure 6-13) will be short lived and isolated primarily to within a 500 m radius of the dredging operations. The changes in water quality near the return water discharge point are also localised and of short duration.

In comparison to the background TSS data collected from 2011 to 2014 (see Section 6.2.5), the predicted TSS concentrations due to the dredging and return waters are below the typical background in areas >200m from the dredging and >100m from the return water discharge point. The area to the west of the discharge point does appear to have elevated sedimentation (see dry Figure 6-18 and wet Figure 6-19) and TSS above the predicted thresholds (see TSS dry Figure 6-16 and wet Figure 6-17). Examination of the background data from near this location (monitoring site, Coastal West) shows this area is typically very turbid (see Figure 6-49) and predicted sedimentation and TSS from the return water is below the median background values measured since 2011.

There are large areas of comparable habitat within the Abbot Point region that will not experience impacts to water quality and these are accessible to this species. The residual risk to this species because of Project related changes in water quality is low

7.2.4.3 HABITAT FRAGMENTATION OR LOSS

Sea turtles are known to utilise seagrass meadows. The Project will have a direct impact on <0.04% of the available seagrass habitat in the area. Offsite impacts on potential seagrass habitats are likely to occur on <4.4% of the available seagrass habitat in the Abbot Point area (see Section 7.1 for more detail). The residual risk due to habitat loss (and fragmentation) due to Project related activities is low.

7.2.4.4 VESSEL COLLISON

Dredging activities are undertaken by a stationary dredge (CSD) and there will be no dredge movements to offshore dredged material relocation grounds, reducing the likelihood of vessel interactions with turtles. The risk of fauna strike on marine turtles is considered very low. Implementation of mitigation and management measures to manage potential impacts will be undertaken (see section 6.4 and Section 8.1 for more detail). The residual impact on this species due to boat strike because of the project is low.

7.2.4.5 TURTLE NESTING

Green and Flatback Turtles nest annually on Abbot Point Beach to the east of the existing terminal. The turtle nesting period is from early November to March. Peak hatching is triggered by temperature conditions and generally occurs in December and January. Dredging will occur over 3km to the northwest of Abbot Point Beach where turtles are found to nest. The pipeline will traverse the rocky beach to the north of the MOF where turtles are not found to nest. The dredging plumes will not impact on the nesting beach area or surrounds. The use of a CSD will further reduce impacts as turtles are less likely to be caught (sucked) into the dredge head compare to the TSHD type dredge. Impacts due to lighting during the hatching season will be managed to ensure turtle hatchlings which emerge during December and January are not adversely impacted upon. The residual risk of lighting die to Project activities is low.

Based on the impact assessment there is unlikely to be a significant impact upon this species. The residual impact of Project activities on this species is low.

8. MITIGATION AND MANAGEMENT MEASURES

8.1 Environmental management strategies

8.1.1 Marine water quality

Key marine water quality issues relevant to the Project relate to dredging and return water causing suspension of fine sediments in the water column and associated impacts – turbid plumes, reduced photosynthetic capabilities and smothering. Suspension of material may occur at both the dredger head, at the discharge of return water to the sea, and through accidental release should a pipeline leak.

The strategy for management of marine water quality is provided in Table 8-1.

Table 8-1 Marine water quality management plan

Objectives	To minimise the impact of proposed works on marine water quality at the dredge, along the offshore pipeline length and at the discharge location.
Control Measures	Assemble pipeline with appropriate seals between sections. Maintain pipeline and fittings. Undertake all dredging with a CSD which limits the extent of turbidity generation. Develop relationship between turbidity and TSS. Ensure rolling seven day average 100mg/L TSS (or corresponding level for turbidity in units of NTU) discharge limit are met. Undertake all dredging within approved areas and apply adaptive management to the dredging operation as described in the draft marine water quality and seagrass monitoring plan (refer outline DMP)
Monitoring – Environmental Monitoring Consultant	Develop relationship between TSS and turbidity in the first week of discharging as per the following: On day 3, 5 and 7 of discharging collect one 10L sample from the discharging waters (immediately before the water enters the return water pipeline) every 30mins over a period of 2 hours (4 samples total per day). Test each sample immediately after collection as follows: • Ensure the sample is well mixed, then immediately measure the turbidity (as NTU) of the sample using a hand held nephelometer and note down the value, the date/time and

	sample number for the day • Ensure the sample is well mixed, then immediately transfer 2L of the discharge water into an appropriate clean container • Label the container with the date/time and sample number for the day • At the end of the day dispatch all four labelled samples from that day via overnight courier to a laboratory for analysis of TSS. As the laboratory results are available, compare (by way of a graph) the turbidity values for each sample against each of the corresponding laboratory derived TSS values to establish a relationship between TSS and turbidity. Based on this relationship calculate turbidity value in NTU which is equivalent to a TSS value of 100mg/L. Repeat the sampling once every week of discharging to ensure relationship between TSS and turbidity is stable. Sampling for turbidity (once the relationship between TSS and turbidity is established) will be undertaken at the DMCP weir-box daily until dredging ceases. Dissolved oxygen and pH testing of waters will be undertaken during discharge at the DMCP weir-box daily until dredging ceases, then daily until return water discharge ceases. Undertake receiving environment monitoring in accordance with the draft marine water quality and seagrass monitoring plan (refer outline DMP)
Monitoring – Dredging Contractor	Daily visual inspection of waters for turbidity plumes (including plume direction). Daily visual inspection of waters for any turbidity plumes in the vicinity of the offshore section of dredged material pipeline (for integrity checking). Daily visual inspection of waters for oil, grease, floating scum and litter.
Performance Indicators	No dredging outside approved areas. No leaks at joins between pipe components. No breaks in the pipeline. Full compliance with discharge criteria for water quality parameters.
Response	In the event compliance with discharge criteria is not met, a review of the receiving environment monitoring results is to be undertaken in consultation

	with regulators to discuss appropriate actions. In the event of a pipeline rupture cease dredging, inform Principal's Representative, identify the impacted area and undertake repairs.

8.1.2 Marine flora

The key issues regarding marine flora relate to direct impacts (removal) and offsite impacts such as the reduction in benthic light availability caused by dredging and return waters and laying of infrastructure on the seabed.

The strategy for management of marine flora is provided in Table 8-2.

Table 8-2 Marine flora management plan

Objectives	To minimise impacts on terrestrial and marine flora as a result of dredging and pipeline installation, maintenance and operation.
Control Measures	Pipeline corridor to be developed in existing cleared areas or degraded or less sensitive environmental areas where possible. The indicative pipeline locations will be selected and micro aligned to avoid SEVT and potential bird habitats where practicable. Only clear vegetation that is directly in the path of the pipeline, where there is no practical alternative.. Pre-clearance survey will be undertaken if it is determined that protected vegetation requires removal. Areas to be cleared will be surveyed in advance, marked-out and authorised by an appropriate person prior to clearing, to ensure no significant areas are inadvertently disturbed and no excessive clearing occurs. Trim terrestrial vegetation where possible rather than removing them. Restrict dredging and placement to locations specified on approved drawings. Clean all plant and equipment of mud, seeds and vegetation prior to use on the site. Controlling of weeds will be undertaken in areas where vegetation has been removed. Prevention of fire ignition and uncontrollable fires through appropriate measures, including fire arrestors on all earth-moving equipment. Overarching management strategies for weed and fire management will be incorporated to the DMP as relevant.

Monitoring	Identify any clearing or damage outside approved areas. Periodic monitoring of weeds will be undertaken in areas where vegetation has been removed. Undertake seagrass monitoring in accordance with the marine water quality and seagrass monitoring plan (refer to outline DMP)
Performance Indicators	No clearing outside approved areas. Dredging footprint is contained to the approved footprint. Seagrass monitoring completed in accordance with marine water quality and seagrass monitoring plan (refer to outline DMP)
Response	Unauthorised clearing – report to Principal's Representative. Undertake actions as directed by the Site Supervisor. Management response will to be applied according to the marine water quality and seagrass monitoring plan (refer to DMP)

8.1.3 Marine fauna

The pipeline establishment, dredging, placement and management of dredged material and discharge of return water are not likely to result in mortality or injury to marine or terrestrial fauna. Construction of the DMCP will occur as part of the Abbot Point Growth Gateway Project.

Some localised disturbance to fauna may occur through this Project. The strategy for management of marine and terrestrial fauna, including management of risk of introduced marine species, is provided in Table 8-3

Table 8-3 Fauna management plan

Objectives	To minimise habitat disturbance and prevent physical injury or mortality of fauna as a result of the works. To minimise potential for pest incursions associated with execution of the Project.
Control Measures	Restrict dredging to locations specified on approved drawings to minimise additional habitat disturbance. Restrict pipeline establishment onshore to areas that have been previously cleared as far as practicable. Visual observations for marine fauna during pipeline establishment. Visual observations of marine fauna in immediate vicinity of dredger. Locations of observed aggregations of marine fauna to be communicated to

	all vessels in the project area. Avoidance of aggregations of marine fauna where practicable. Vessels are to proceed with caution in areas where aggregations of marine fauna are observed. Planing hull work vessels[1] may be speed limited in the operational port area of the Port of Abbot Point, i.e. the area outside of the GBRMP. Implement a Vessel Traffic Management Plan. A detailed risk assessment procedure consistent with the *National System for the Prevention and Management of Marine Pest Incursions* Guidelines will be implemented to deal with the risk associated with introduction of introduced marine species (IMS). This procedure will be applied to all vessels and immersible equipment used for the dredging campaign to assess the risk of IMS introduction. The risk assessment will be undertaken prior to the identified vessel and/or immersible equipment engaging in dredging and dredged material placement activities. The objective of the risk assessment is to identify the individual level of IMS threat a contracted vessel or its immersible equipment poses. This allows selection of the most appropriate vessels and immersible equipment and establishment of management measures to mitigate identified threats to an acceptable low level. The three risk categories used in the risk assessment are: 1. Low: low likelihood of IMS – no additional management measures required 2. Uncertain: likelihood of IMS is not apparent – precautionary approach adopted, additional management measures required 3. High: identified as a potential risk – additional management measures required. The key factors to be considered in the risk assessment include: 1. Vessel type 2. Inspection history 3. Presence and age of fouling control coating 4. Presence or absence of internal treatment systems 5. Internal treatment history 6. Previous climatic region(s) of operation

[1] Planing vessels: Planing is defined by operation of a waterborne craft in which its weight is predominantly supported by hydraulic lift, rather than hydrostatic lift (buoyancy). Typically, a planing vessel is identifiable when it travels 'on top' of the water (planning mode) instead of 'in' the water (displacement modes. Examples of vessels capable of planing may include, a speed boat, personal water craft (PWC), aluminum dingy with outboard, and other high speed craft.

	7. Stationary or slow periods of operation and climatic region; 8. Type of vessel activity 9. Vessel desiccation period during mobilisation 10. Adherence to Australian Quarantine and Inspection Service (AQIS) ballast water requirements. The outcomes of the risk assessment will determine whether or not an IMS vessel inspection is required prior to the vessel or immersible equipment mobilisation to site. Personnel working on site will be made aware of threatened and migratory species to be encountered on site. Directional lighting will be used which is directly away from sensitive habitat.
Monitoring	Be alert for fauna movements in the areas of dredging and pipeline installation and operation. The vessel operator will record all marine fauna observed during pipeline installation.
Performance Indicators	No fauna injuries or mortality. No pest incursions associated with the project.
Response	Fauna injuries or deaths (dugong, turtles, whales and dolphins) will be reported to the Site Supervisor for referral to DEHP and DoE according to approval requirements.

8.1.4 Acid sulfate soils

Acid sulphate soils (ASS) assessments have targeted the T0 dredging area and the DMCPs.

A sediment study, undertaken for the Abbot Point T0, T2 and T3 capital dredging project in 2012 by GHD identified that marine sediments are potential acid sulphate soils (PASS) containing a natural neutralising capacity greater than the acid generating capacity, i.e. the sediments are self-neutralising. However, settling processes within the DMCP may change the composition of the dredged material and may reduce the neutralising capacity of the material.

Golder and Associates was commissioned to undertake an ASS investigation of the DMCP footprint (Golder, 2015a). The field and laboratory results do not indicate the presence of Actual ASS (AASS) and PASS within the upper 5m across the proposed DMCP site. Excavation below 5m is not proposed. Limited groundwater sampling conducted during the ASS investigations generally indicates a relatively stable and neutral environment with a high buffering capacity. Test results do not indicate that groundwater has been affected by historical oxidation of sulfides although; relatively high levels of aluminium and iron have been detected in some groundwater samples. Groundwater dewatering outside of the DMCPs will not be required to construct the DMCPs and therefore monitoring and possible treatment of groundwater is not proposed.

Potential impacts associated with ASS have been considered in the development of this document. These potential impacts, along with potential mitigation measures are described in further detail in the Preliminary Acid Sulfate Soils Management Plan (Preliminary ASSMP) for the DMCPs (Golder, 2015b), provided in Volume 3 Appendix M of the EIS.

The strategy for management of ASS is provided in Table 8-4

Table 8-4 Acid sulfate soil management

Objectives	To manage ASS appropriately to ensure the environmental values of the receiving environment are protected through all phases of the Project.
Control Measures	Implementation of the Preliminary ASSMP (Golder, 2015b). Control measures outlined in the plan have been divided into four phases namely, DMCP construction, placement of dredged material in the DCMP and returning water back to the ocean, management of dredged material in the DMCP after dredging and management for reuse. The first two phases are pertinent to the outline dredging management plan; control measures for these two phases are summarised below. DMCP Construction: • The inclusions of ASS identification training in construction inductions • Testing of possible ASS materials observed during construction • Contingency measures for lime neutralisation treatment of any confirmed ASS. Dredged material placement in DMCP and return water back to the ocean: • Laboratory testing of historical vibrocore samples from the Multi Cargo Facility offshore investigations • Strategies to be reviewed and updated if self-neutralising ASS is not confirmed • Lime guard layer to be placed over the base of the secondary pond • Phased characterisation/verification testing of dredged materials during placement by visual identification, field screening and subsequent laboratory testing, if warranted Groundwater quality monitoring surrounding the ponds Return water monitoring and management.
Monitoring – Environmental Monitoring Consultant	Implementation of groundwater monitoring Refer to marine water quality environmental management strategies (Section Table 8-1). Refer to marine water quality and seagrass monitoring plan for pH monitoring of marine water (refer to outline DMP) During DCMP construction, complete an ASS assessment on sediments during

	placement as per Procedure CP-A in the ASSMP (Golder, 2015b). During dredged material placement in DMCP complete an ASS assessment as per Procedure DS-A in the ASSMP (Golder, 2015b).
Performance Indicators	No generation of acidic soil conditions during the construction of the DMCPs or placement of the dredged material No impacts from ASS to environmental receptors Implementation of all ASS management measures
Response	If suspected ASS is encountered during the construction of the DMCPs follow procedure CP-B as outlined in the ASSMP. If the presence of ASS is confirmed treatment and verification is required refer to Procedure CP-B in the ASSMP. If during placement the dredged material is found to contain ASS follow Procedure DS-A as outlined in the ASSMP. If treatment is required refer to procedure PD-A in the ASSMP Additional advice can be obtained from the acid sulfate soils group (QASSIT) and DEHP.

8.1.5 Waste

The works to be undertaken can potentially release waste substances into surrounding environment. The strategy for managing these is provided in Table 8-5.

Table 8-5 Waste Management Plan

Objectives	To prevent the release of waste and other inappropriate substances as a result of the works.
Control Measures	Provide appropriate receptacles for each waste stream (recycling/general litter/waste). The Dredging Contractor will endeavour to minimise waste generation from equipment consumables, packaging, and the like. The Dredging Contractor will ensure that adequate toilet facilities are provided on the dredger and other vessels. All vessel related wastes, including grey water, will be legally disposed of. If there is a sewage treatment plant on board the dredger or any other vessels, it must comply with the *Transport Operations (Marine Pollution) Act 1995* (QLD). Solid waste will be transported to approved facilities outside the project area.

	Waste is to be minimised and segregated during mobilisation, installation, execution and demobilisation stages of the project. Fix all receptacles on the dredger and support vessels securely to the deck. Train staff on waste management requirements and instruct staff to use such receptacles. Empty receptacles at appropriate regular intervals and dispose of litter and waste offsite in accordance with approved guidelines. No burning of waste or other materials on site. All domestic, toxic, and hazardous wastes, oils and petroleum hydrocarbons, empty drums and other containers, and any other waste materials will be collected, handled, stored, and disposed of in accordance with existing Port of Abbot Point waste management policies and procedures.
Monitoring	Daily visual inspections of the works and storage areas. Daily visual inspection of pipeline and pumps for leakages and/or spills.
Performance Indicators	No unapproved release of substances. All waste materials are handled and disposed of in a safe and environmentally sound manner. With the exception of return water, no wastes from dredging plant and facilities are disposed of to the marine environment.
Response	Collect and dispose of litter.

8.1.6 Noise

There are no sensitive human receptors in the vicinity of the works; however, the works will occur in the vicinity of wetland habitats and coastal marine habitat, and the existing T1 operation. It is prudent to apply good practice to the management of noise which may locally modify animal behaviour. The results of the Underwater Noise Impact Assessment (SLR, 2015a) and Terrestrial Noise Impact Assessment (SLR, 2015b) found the project activities will cause minimal impacts to identified terrestrial and marine sensitive receptors. Based on these assessments, no noise monitoring (terrestrial or marine) is proposed.

The strategy for management of noise is provided in Table 8-6.

Table 8-6 Noise management plan

Objectives	To minimise the impact of proposed works on noise levels to fauna.

Control Measures	Maintain all vessels and plant in good condition. Shut down engines when not in operation. Exhaust mufflers are to be as per manufacturer's specifications. Adjustment of reversing alarms on plant to limit the acoustic range to the immediate danger area.
Monitoring	Undertake pre-start checks on all plant and vessels. No noise monitoring is proposed.
Performance Indicators	No excessive noise noted by Dredging Contractor Environment Officer or Environment Monitoring Consultant.
Response	Excessive noise noted in daily inspection – maintenance and/or replacement of faulty equipment.

8.1.7 Hazardous materials management and emergency preparedness

The works to be undertaken can potentially release hazardous substance into surrounding environment.

The strategy for management of release prevention and response to significant spills of these substances is provided in Table 8-7.

Table 8-7 Hazardous materials management and emergency management

Objectives	To prevent the release of hazardous substances as a result of the works.
Control Measures	**Hazardous Substances Management** Compliance with Port of Abbot Point Emergency Continuity Plan. Onshore refuelling will be conducted by licensed fuel suppliers in accordance with their Standard Operating Procedures. Implementation of the contractors Occupational Health and Safety strategy. Emergency Response Procedures will be implemented by the contractor with training provided in the procedure provided to all crew and personnel. An Emergency Contact List will be maintained with an up to date copy retained. Storage of fuel, lubricants and oil in discrete containers on board vessels will

	be minimised. When required they will be stored in a secure area and any spills will be cleaned immediately. Any visible or reasonably suspected fuel, lubricant or hydraulic fluid loss will be treated as an 'incident' and reported appropriately.
	
	A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board will be maintained.
	
	Supply and maintain a spill control kit containing at a minimum – floating booms to a minimum length of 12ms and absorbent pads and materials to handle a spill of up to 80L in the marine environment.
	
	Note the location of additional oil spill kits at the Abbot Point Coal Terminal in case of larger spills.
	
	A significant spill is defined as:
	
	A spill to land greater than:
	• 200 L for hydrocarbons
	• 100 L for chemicals
	• 10,000 L for untreated sewage
	
	A spill to receiving waters greater than:
	• 20 L for hydrocarbons
	• 20 L for chemicals
	• 500 L for untreated sewage
	
	Spill Response
	
	In the event of a significant spill to the marine environment, the dredging contractor is to undertake the following:
	• Stop the source of the spill
	• Prevent the oil/chemical from entering the water and mop up with spill with appropriate absorbent material from an on-board spill kit. The absorbent material is to be stored on-board until it can be appropriately disposed of to a licensed facility
	• Notify the following personnel immediately:
	    o Dredging Contractor to notify the Site Supervisor
	    o In the event of a fire or other emergency, the Dredging Contractor is to immediately call 000 and inform the relevant marine authority (MSQ) then advise as soon as possible, the Site Supervisor.

	Dispose of any material that has been used from the kit off-site and replace the contents before recommencing works. Supply and maintain personal protection equipment and appropriate training in relation to the use of spill kits. Isolate any booster pumps with bunds. No unregulated dumping of waste oil burying in landfill, by pouring on the ground or any drainage channels.
Monitoring	Vessel crew to regularly check equipment for evidence of leaks and fitness of hydraulic hoses and seals. Daily visual inspections of the works and storage areas. Daily visual inspection of pipeline and pumps for leakages and/or spills.
Performance Indicators	No unapproved release of substances. Rapid response clean-up for any spill.
Response	Contain any significant spills, isolate the area and clean up immediately. Cease operation of any equipment leaking fuel or oil to the environment until leaks are repaired. Record any spillage, maintenance requirements or incorrect usage. Report any significant spill immediately to the Site Supervisor. In the event of a fire or other emergency, the Dredging Contractor is to immediately call 000 and inform the relevant marine authority (MSQ) then advise the Site Supervisor as soon as possible. Where necessary the Site Supervisor will coordinate the on-site response to environmental incidents.

8.1.8 Proposed seagrass and returning water monitoring plan.

The nearshore seagrass communities at Abbot Point are likely to be minimally impacted by the discharge waters from the return water outlet while the offshore seagrasses are likely to be minimally impacted by the dredging plume associated with dredging of T0.

The proposed adaptive management will be based on a two-tiered adaptive strategy of an initial alert and response period, and if criteria continue to be exceeded then a notification to regulators requirement is triggered. Criteria have been developed for turbidity and benthic light requirements. Specific details of the monitoring program and adaptive management approach are described in the Outline Dredging Management Plan.

8.2 Summary

The project area is located adjacent to the GBRMP and Commonwealth marine areas. However, analysis of the values present indicates that the project area does not constitute a unique or important contribution to these sites beyond being part of the overall range of habitats and ecological zones represented.

The Port of Abbot Point port limits are known to provide habitat for a number of threatened and migratory species. The species likely or potentially occurring are:

- One threatened marine mammal species (Humpback Whale)
- Three migratory marine mammal species (Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin and Dugong)
- Five threatened marine turtle species (Green, Hawksbill, Olive Ridley, Loggerhead and Flatback Turtles).

The project area does not support important populations of any of these species and does not contain habitat critical to the survival of these species. The Project is not likely to result in a significant impact on a listed threatened or marine migratory species. The Project is expected to have temporary and permanent impacts to the marine environment at Abbot Point. Where low or moderate impacts have been identified, mitigation measures are provided to minimise effects to the project area and adjacent waters.

With the implementation of the outline Dredging Management Plan no residual significant impact to MNES is expected.

9. REFERENCES

Ahern, C.R., Ahern, M.R. and Powell, B. (1998). *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998*. QASSIT, Department of Natural Resources, Resource Sciences Centre, Indooroopilly

ANZECC/ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra

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.* 2012 **65**(4-9). p.236

BOM (2014). Cyclone summary information for cyclone Dylan and cyclone Ita, accessed June 2014:http://www.bom.gov.au/announcements/sevwx/qld/qldtc20140130.shtml http://www.bom.gov.au/announcements/sevwx/qld/qldtc20140405.shtml

Bell, I. (2003). *Turtles population dynamics in the Hay Point, Abbot Point and Lucinda Port areas*. Prepared for Ports Corporation of Queensland Ltd

BMA (2011). *Environmental Management Plan (Marine Ecology) for Dredging and Dredged Material Relocation, Hay Point Coal Terminal Expansion Phase 3 (HPX3).*

BMT WBM (2012). *Port of Abbot Point Offshore Dredged Material Relocation Area Site Selection Report*. Prepared for North Queensland Bulk Ports Corporation, July 2012

Bowen, B.W., A.B.Meylan, J.P.Ross, C.J.Limpus, G.H.Balazs and J.C.Avise (1992). *Global population structure and natural history of the Green Turtles (Chelonia mydas) in terms of matriarchal phylogeny*. Evolution 46(4):865-881

Brown, B.E., Le Tissier, M.D.A., ScEnvironment Ausoffin, T.P. and Tudhope, A.W. (1990). *Evaluation of the environmental impact of dredging on intertidal corals at Ko Phuket, Thailand, using ecological and physiological parameters.* Marine Ecology Progress Series 65: 273–281

Brown, B.E., Clarke, K.R. and Warwick, R.M. (2002). *Serial patterns of biodiversity change in corals across shallow reef flats in Ko Phuket, Thailand, due to the effects of local (sedimentation) and regional (climatic) perturbations*. Marine Biology 141: 21–29

CDM Smith (2013a). *Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging Public Environment Report Supplementary Report (EPBC 2011/6213/GBRMPA G34897.1).* Prepared for North Queensland Bulk Ports Corporation, May 2013

CDM Smith (2013b). *Marine Turtle Nesting Surveys, Abbot Beach.*. Prepared for Adani Mining Pty Ltd.

Chartrand, K.M., Ralph, P.J., Petrou, K. and Rasheed, M.A. (2012*). Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program*., DEEDI Publication, Fisheries Queensland, Cairns, 91 pp

Chartrand, K., McCormack, C. and Rasheed, M.A. (2014). *Interim Report: Deepwater Seagrass Dynamics – Update on field-based studies of light requirements, seasonal change and mechanisms of recruitment for deepwater seagrasses*. Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication, James Cook University, Cairns

Coles, R.G., Lee Long, W.J., McKenzie, L.J. and Roder, C.A. (2002). *Seagrasses and Marine Resources in the Dugong Protection Areas of Upstart Bay, Newry Region, Sand Bay, Llewellyn Bay, Ince Bay and the Clairview Region April/May 1999 and October 1999.* Series: Research publication Great Barrier Reef Marine Park Authority no. 72

Collier, C.J., Lavery, P.S., Ralph, P.J. and Masini, R.J. (2009). '*Shade-induced response and recovery of the seagrass Posidonia sinuosa*', Journal of Experimental Marine Biology and Ecology, vol. 370, pp. 89-103

Commonwealth of Australia (2003). *Recovery Plan for Marine Turtles in Australia*. Available online at http://www.environment.gov.au/system/files/resources/6d26f4aa-751e-4b72-9ab0-984a1d6e0fea/files/marine-turtles.pdf.

Commonwealth of Australia (2005). *Humpback Whale Recovery Plan 2005 – 2010*. Available online at: http://www.environment.gov.au/system/files/resources/32f6b764-2af1-4251-b79d-c8bf67d8303a/files/m-novaeangliae.pdf.

Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging*, Commonwealth of Australia, Canberra

Corkeron, P.J., Morisette, N.M., Porter, L. and Marsh, H. (1997). *'Distribution and status of Humpback Dolphins, Sousa chinensis, in Australian waters'*. Asian Marine Biology, volume 14, pp. 49–59

Dobbs, K., Fernandes, L., Slegers, S., Jago, B., Thompson, L., Hall, J., Day, J., Cameron, D., Tanzer, J. Macdonald F., Marsh, H. and Coles, R. (2007). *Incorporating dugong habitats into the marine protected area design for the Great Barrier Reef Marine Park, Queensland, Australia.* Ocean & Coastal Management 51:368-375

DERM (2009). *Queensland Water Quality Guidelines*. Version 3. Department of Environment and Resource Management. Queensland Government. Queensland

DoE (2008). *Guidelines for the Assessment and Management of Contaminated Land in Queensland Environmental or Health Investigation Levels*.

DoE (2013). *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*.

DoE (2014a). Abbot Point Dredging and Onshore Placement of Dredged Material. Referral (EPBC 2014/7356). http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=current_referral_detail&proposal_id=7356.

DoE (2014b). *Megaptera novaeangliae in Species Profile and Threats Database*. Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014c). *Orcinus orca)* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014d). *Balaenoptera musculus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014e).*Balaenoptera edeni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014f). *Sousa chinensis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014g). *Orcaella heinsohni)* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014h). *Chelonia mydas* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014i). *Natator depressus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014j). *Eretmochelys imbricata)* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014k). *Caretta caretta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014l). *Lepidochelys olivacea* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014m). *Dermochelys coriacea* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014n). *Carcharodon carcharias* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014o). *Lamna nasus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014p). *Rhincodon typus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014q). *Manta birostris* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014r). *Pristis zijsron* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2014s). *Dugong dugon* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2015). *Guidelines for an Environmental Impact Statement to undertake capital dredging, onshore placement and reuse of dredged material at Abbot Point, 25km north of Bowen, North Queensland (EPBC 2015/7467) issued June 2015*. Available from http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=referral_detail&proposal_id=7467

Dutton, P., Broderick, D. and Fitzsimmons, N. (2002). *Defining management units: molecular genetics, in I Kinan (ed.)*, Proceedings of the western Pacific sea turtle co-operative research and management workshop, Western Pacific Regional Fishery Management Council, Honolulu, pp. 93–101

Ecological (2014). *Terrestrial Ecology Assessment report for Abbot Point Dredging and Onshore Placement of Dredged Material*.

Ecowise Environmental (2004). *Assessment of the status of marine sediments at Abbot Point*. Prepared for NCA Project, Xstrata Limited

EPA (2011). *Environmental Assessment Guideline for Marine Dredging Proposals (EAG 7).* Western Australia.

Duarte, C.M. (1991). *Seagrass depth limits*. Aquatic Botany 40, 363–377.

Erftemeijer, P.L.A. and Lewis, R.R.R (2006). *Environmental Impacts of dredging on seagrasses: a review*. Marine Pollution Bulletin 52:1553-1572.

Environment Australia (2003). Recovery Plan for Marine Turtles in Australia – July 2003. [Online]. Canberra: Environment Australia. Available from: http://www.environment.gov.au/coasts/publications/turtle-recovery/index.html

Environmetrics Australia (2007). *Statistical Aspects of Turbidity Monitoring*. Prepared for Port of Melbourne Corporation

Fabricius, K.E. and Wolanski, E.J. (2000). *Rapid smothering of coral organisms by muddy marine snow*. Estuarine Coastal and Shelf Science 50: 115-120

GHD (2008). *Benthic Baseline Assessment Report: Baseline Environmental Monitoring for Port of Abbot Point*. Prepared for the Abbot Point Multi Cargo Facility Environmental Impact Statement, June 2008

GHD (2009a). *Report for Proposed Multi Cargo Facility, Abbot Point: Preliminary Sediment Quality Assessment*. Prepared for Ports Corporation of QLD

GHD (2009b). Port *of Abbot Point X110 Apron and Berth Capital Dredging: Sediment Sampling and Analysis Program*. Prepared for Ports Corporation of QLD

GHD (2009c). *Abbot Point Coal Terminal X110 Expansion Draft Voluntary Environmental Assessment*. October 2009

GHD (2009d). *Marine Ecology Benthic Survey Report: Proposed Abbot Point Multi Cargo Facility EIS*. September 2009

GHD (2009e). *Baseline Marine Fauna Report, Port of Abbot Point Baseline Monitoring*. Prepared for North Queensland Bulk Ports Corporation, September 2009

GHD (2009f). *Megafauna Assessment Report: Proposed Abbot Point Multi Cargo Facility EIS*. December 2009

GHD (2010). *Proposed Abbot Point Multi Cargo Facility Environmental Impact Statement*. Prepared for North Queensland Bulk Ports Corporation, May 2010

GHD (2012a). *Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report*. Prepared for North Queensland Bulk Ports Corporation, July 2012

GHD (2012b). *Abbot Point, Terminals 0, 2 and 3 Capital Dredging Project Hydrodynamic and Sediment Transport Analysis*. Prepared for North Queensland Bulk Ports Corporation, July 2012

GHD (2012c). *Abbot Point Cumulative Impact Assessment, Technical Report Marine Water Quality*. Prepared for the Abbot Point Working Group, August 2012

GHD (2012d). *Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging, Public Environment Report, (EPBC 2011/6213/GBRMPA G34897.1)*. Prepared for North Queensland Bulk Ports Corporation, December 2012

GHD (2012e). *Abbot Point Cumulative Impact Assessment* Prepared for the Abbot Point Working Group, August 2012

Golder (2014) Abbot Point Port and Wetland Project: Acid Sulphate Soil Investigation – Interpretative Report. Report prepared for Worley Parsons.

Golder (2015a). *Preliminary Acid Sulfate Soil Investigation - Report for the Containment Pond Area - Abbot Point Growth Gateway, Dredge Material Containment Ponds*. Prepared by Golder and Associates for DSD, 14 July 2015

Golder (2015b). *Preliminary Acid Sulfate Soil Management Plan - Abbot Point Growth Gateway, Dredge Material Containment Ponds*. Prepared by Golder and Associates for DSD, 22 July 2015

Great Barrier Reef Marine Park Authority (GBRMPA) (2007). *Climate change and the Great Barrier Reef: a Vulnerability Assessment* 2007. Available from: http://www.gbrmpa.gov.au/outlook-for-the-reef/climate-change/how-climate-change-can-affect-the-reef/great-barrier-reef-vulnerability-assessment.

Great Barrier Reef Marine Park Authority (GBRMPA) (2009). *Great Barrier Reef Outlook Report 2009*. Great Barrier Reef Marine Mark Authority

Great Barrier Reef Marine Park Authority (GBRMPA) (2010). *Great Barrier Reef Water Quality Guidelines.* Great Barrier Reef Marine Park Authority

Great Barrier Reef Marine Park Authority (GBRMPA) (2012). *Great Barrier Reef Biodiversity Conservation Strategy 2012 (draft)*, GBRMPA, Townsville

Great Barrier Reef Marine Park Authority (2014). *Great Barrier Reef Outlook Report 2014*, GBRMPA, Townsville. Available at http://www.gbrmpa.gov.au/managing-the-reef/great-barrier-reef-outlook-report

Great Barrier Reef Marine Park Authority (2015). *Synthesis of current knowledge of the biophysical impacts of dredging and disposal on the Great Barrier Reef*. GBRMPA, Townsville. Available at http://elibrary.gbrmpa.gov.au/jspui/handle/11017/2935

Grech, A. and Marsh, H. (2007). *Prioritising areas for dugong conservation in a marine protected area using a spatially explicit population model*. Applied GIS 3(2):1–14.

Hammerstrom, KK, Kenworthy, WJ, Fonseca, MS and Whitfield, PE. (2006). *Seed bank, biomass and productivity of Halophila decipiens a deep water seagrass on the west Florida continental shelf*, *Aquatic Botany*, vol. 84, pp. 110-120.

Hardy, S. and Stoinescu, M. (2012). *Draft Whitsunday Region Marine Turtle Management Plan*. Whitsunday Regional Council, Mackay

Hayashi, M. (2004). *Temperature-electrical conductivity relation of water for environmental monitoring and geophysical data inversion*. Environmental Monitoring and Assessment 96: 121-130

Hodgson, A.J. and Marsh, H. (2007). *Response of dugongs to boat traffic: the risk of disturbance and displacement.* Journal of Experimental Marine Biology and Ecology 340:50-61.

Hof, C. and Bell, I. (2014). *Determining the spatial distribution and densities of marine turtle nesting and predator activity in the northern Great Barrier Reef, Queensland*. Final Report to WWF-Australia and Threatened Species Unit, Department of Environment and Heritage Protection

Jefferson, T.A. (2000). *Population biology of the Indo-Pacific humpback dolphin in Hong Kong waters.* Wildlife Monographs 144:65

Kirk, J.T.O. (1994). *Light and photosynthesis in Aquatic Ecosystems*. (Cambridge University Press: Cambridge)

Kirkman, H. (1997). *Seagrasses of Australia, Australia: State of the Environment Technical paper Series (Estuaries and the Sea)*. Department of the Environment, Canberra

Limpus, C.J. (2007). *A biological review of Australian marine turtle species. 5. Flatback turtle, Natator depressus (Garman)*. Queensland Environmental Protection Agency

Limpus, C.J. (2008a). *A biological review of Australian marine turtle species. 2. Green turtle, Chelonia mydas (Linnaeus).* Queensland Environmental Protection Agency

Limpus, C.J. (2008b). *A biological review of Australian marine turtle species, 1 Loggerhead turtle, Caretta caretta (Linnaeus*), Environmental Protection Agency, Brisbane

Limpus, C.J. (2008c) *A biological review of Australian marine turtle species. 4. Olive Ridley Lepidochelys olivacea (Linnaeus).* Queensland Environmental Protection Agency

Limpus, C.J. (2009a). *A biological review of Australian marine turtle species, 3 Hawksbill turtle, Eretmochelys imbricata*, Environmental Protection Agency, Brisbane

Limpus, C.J. (2009b). *A biological review of Australian marine turtle species, 6 Leatherback turtle, Dermochelys coriacea.* Environmental Protection Agency, Brisbane.

Longstaff, BJ & Dennison*, WC. (1999). Seagrass survival during pulsed turbidity events: the effects of light deprivation on the seagrasses Halodule pinifolia and Halophila ovalis, Aquatic Botany vol. 65, pp. 105-121.*

Marsalek, D.S. (1981). *Impact of dredging on a sub-tropical reef community, southeast Florida, U.S.A*. Proceedings of the 4th International; Coral Reef Symposium Manila 1: 147-154

Marsh, H., Corkeron, P., Lawler, I.R., Lanyon, J.M. and Preen, A.R. (1996). *The status of the dugong in the southern Great Barrier Reef Marine Park.* Great Barrier Reef Marine Park Authority Research Publication No. 41

Marsh, H. and Lawler, I (2001). *Dugong distribution and abundance in the Southern Great Barrier Reef Marine Park and Hervey Bay: results of an aerial survey in October to December 1999.* Great Barrier Reef Marine Park Authority: Townsville, Australia

McArthur P.E., Ferry R. and Proni J. (2002). *Development of Guidelines for Dredged Material Disposal based on Abiotic Determinants of the Coral Reef Community Structure*. Proceedings of the Third Speciality Conference on Dredging and Dredged Material Disposal. Coasts, Oceans, ports and Rivers Institute (COPRI) of ASCE. May 5 2020, Orlando, Florida, USA

McCauley, R., Maggi, A., Duncan, A., Salgado-Kent, C., Parnum, I. and Erbe, C. (2012). *Underwater Noise Prediction from Port Development at Abbot Point, QLD*. Prepared for Abbot Point Working Group (APWG) by Centre for Marine Science & Technology R201218, Curtin University Perth, Western Australia

McKenna, S.A., Rasheed, M.A., Unsworth, R.K.F. and Chartrand, K.M. (2008). *Port of Abbot Point seagrass baseline surveys - wet & dry season 2008*. DPI&F Publication PR08-4140', pp. 51

McKenna, S.A., and Rasheed, M.A. (2011). *Port of Abbot Point Long-Term Seagrass Monitoring: Interim Report 2008-2011*. DEEDI Publication, Fisheries Queensland, Cairns, 52 pp

McKenna, S.A. and Rasheed, M.A. (2013). *Port of Abbot Point Long-Term Seagrass Monitoring: Annual Report 2011-2012*. JCU Publication, Centre for Tropical Water & Aquatic Ecosystem Research, Cairns, 42 pp

McKenna, S.A. and Rasheed, M.A. (2014). *Port of Abbot Point Long-Term Seagrass monitoring: Annual Report 2012-2013*. JCU Publication, Centre for Tropical Water and Aquatic Ecosystem Research, Cairn, 45pp

McKenna, S.A., Chartrand, K.M., Jarvis, J.C., Carter, A.B. and Rasheed, M.A. (2015). *Port of Abbot Point - Initial light thresholds for modelling impacts to seagrass from the Abbot Point Growth Gateway Project*. JCU Publication, Centre for Tropical Water & Aquatic Ecosystem Research, Cairns, 18 pp

McMillan, C. (1988). The seed reserve of *Halophila decipiens* Ostenfeld (Hydrocharitaceae) in Panama, *Aquatic Botany*, vol. 31, pp 177-182.

McMillan, C. (1991). The longevity of seagrass seeds, *Aquatic Botany*, vol. 40, pp. 195-198.

MScience (2012). *Browse LNG Development: Sediment Impact Thresholds Developed for James Price Point Nearshore Benthic Communities*. Prepared for Woodside Energy Limited, March 2012.

National Environmental Protection Council (NEPC) (1999). *National Environmental Protection (Assessment of Site Contamination Measure (amended 2013).*

Noad, M.J., Dunlop, R.A., Paton, D. and Kniest, H. (2011). *Abundance estimates of the east Australian humpback whale population: 2010 survey and update*. Paper SC/63/SH22 submitted to the International Whaling Commission Scientific Committee, Tromsø, Norway (unpublished)

North Queensland Bulk Ports Corporation Limited (NQBP) (2010). *Port of Abbot Point Land Use Plan*.

Ottaway, J.R., Andrews, J.S., Burdon-Jones, C., Hammond, L.S., Roberts, C.R. and Saalfeld, W.K. (1989). *Marine environmental impacts of construction of an off-shore coal-loading facility at Abbot Point*. Queensland, Department of Marine biology, School of Biological Sciences, James Cook University, Townsville

Parra, G.J., Corkeron, P.J. and Marsh, H. (2004). *The Indo-Pacific humpback dolphin, Sousa chinensis (Osbeck, 1765) in Australian waters: a summary of current knowledge*. Aquatic Mammals 30(1): 197-206

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

Parra, G.J., Corkeron, P.J. and Marsh, H. (2006). *Population sizes, site fidelity and residence patters of Australian Snubfin and Indo-Pacific humpback dolphins: implications for conservation*. Biological Conservation 129 (2): 167-180

Preen, A.R. (1999). *Dugongs in the Shoalwater Bay area (draft)*. Prepared for the Great Barrier Reef Marine Park Authority, Townsville, Australia

Pollock, F.J., Lamb, J.B., Field, S.N., Heron, S.F., Schaffelke, B., Shedrawi, G., *et al.* (2014). *Sediment and Turbidity Associated with Offshore Dredging Increase Coral Disease Prevalence on Nearby Reefs*. PLoS ONE 9(7): e102498. doi:10.1371/journal.pone.0102498

Ralph, PJ, Durako, MJ, Enriquez, S, Collier, CJ & Doblin, MA. (2007). Impact of light limitation on seagrasses, *Journal of Experimental Marine Biology Ecology*, vol. 350, pp. 176-193.

Rasheed, M.A., Thomas, R. and McKenna, S.A. (2005). *Port of Abbot Point seagrass, algae and benthic macroinvertebrate community survey - March 2005*. DPI&F Information Series QI05044 (DPI&F, Cairns), 27 pp

Royal Haskoning DHV (2015). *Abbot Point Growth Gateway Project Dredging and Onshore Placement of Material Numerical Modelling Report*. Prepared for the Queensland Department of State Development, June 2015

Schaffelke, B., Thompson, A., Carleton, J., Cripps, E., Davidson, J., Doyle, J., Furnas, M., Gunn, K., Neale, S., Skuza, M., Uthicke, S., Wright, M., and Zagorskis, I. (2008). *Water Quality and Ecosystem Monitoring Programme – Reef Water Quality Protection Plan*. Final Report August 2008. Report to the Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science, Townsville. 153pp

Sheppard, J.K., Marsh, H., Jones, R.E. and Lawler, I.R. (2010). *Dugong habitat use in relation to seagrass nutrients, tides, and diel cycles.* Marine Mammal Science 26, 855-879

SLR (2015a) *Abbot Point Growth Gateway Project, Underwater Noise Impact Assessment.* Report prepared for Advisian on behalf of DSD.

SLR (2015b) *Abbot Point Growth Gateway Project, Terrestrial Noise Impact Assessment.* Report prepared for Advisian on behalf of DSD.

Smith, J.N., Grantham, H.S., Gales, N., Double, M.C., Noad, M.J. and Paton, D. (2012). *Identification of humpback whale breeding and calving habitat in Great Barrier Reef*. Marine Ecology Progress Series 447:259-272

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R.J., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations*. Aquatic Mammals 33(4):411-521

Trimarchi S. and Keane J. (2007). *Port of Hay Point Apron Areas and Departure Path Capital Dredging Project Environmental Review*. EcoPorts Monograph Series No.24. prepared by Ports Corporation of Queensland. 63pp

Tyack, P.T. (2008). *Implications for marine mammals of large-scale changes in the marine acoustic environment.* Journal of Mammalogy 89: 549-558

Unsworth, R.K.F., McKenna, S.A. and Rasheed, M.A. (2010*). Seasonal dynamics, productivity and resilience of seagrass at the Port of Abbot Point: 2008-2010*. DEEDI Publication, Fisheries Queensland, Cairns, pp. 68

Weishampel, J.F., Bagley, D.A. and Ehrhart, L.M. (2004). *Earlier nesting by loggerhead sea turtles following sea surface warming.* Global Change Biology 10: 1424-1427.

Williams, S.L., and Dennison, W.C. (1990). *Light availability and diurnal growth of a green macroalga (Caulerpa cupressoides) and a seagrass (Halophila decipiens*). Marine Biology 106, 437–443

Witherington, B.E. 1997. The Problem of photopollution for sea turtles and other nocturnal animals. Chapter 13 **In**: Clemmons, J.R. and Buchholz, R. (Eds). *Behavioural Approaches to Conservation in the Wild*. Page(s):303-328. Cambridge University Press, Cambridge.

Worley Parsons (2007). *Port of Abbot Point: Sediment Quality Assessment Report (305/15503/02)*. December 2007.

WorleyParsons (2014). *Abbot Point Baseline Water Quality Monitoring Report*. Prepared for North Queensland Bulk Ports, 132pp.

Appendix 1 EPBC Act Protected Matters Report

Australian Government
Department of the Environment

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.

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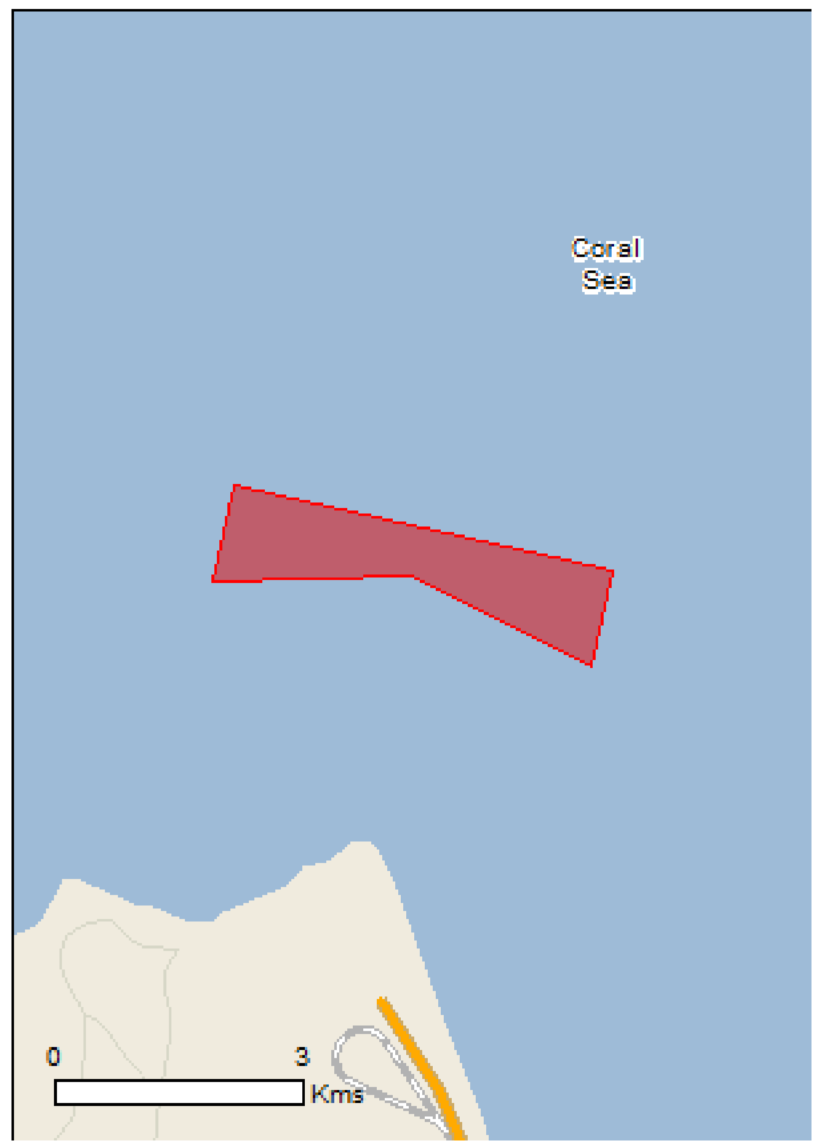

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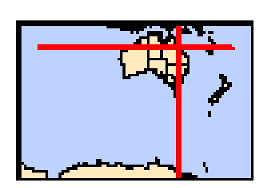


Summary

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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	11
Listed Migratory Species:	20

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

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.

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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	60
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.

Place on the RNE:	1
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
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

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
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
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	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
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	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation 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	Species or species habitat likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely 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	Species or species habitat likely to 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

Name	Threatened	Type of Presence
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcaella brevirostris		
Irrawaddy Dolphin [45]		Species or species habitat may occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may 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 Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may 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

Name	Threatened	Type of Presence
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
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris 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

Name	Threatened	Type of Presence
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 brevirostris 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
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 likely 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	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation 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	Species or species habitat 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	Species or species habitat likely to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli 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 habitat may occur within area
Laticauda colubrina a sea krait [1092]		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	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation 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

Name	Status	Type of Presence
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	Congregation or aggregation known to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat may 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

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Great Barrier Reef Region	QLD	Registered

Coordinates

-19.8554 148.0631,-19.8456 148.0655,-19.8545 148.1066,-19.8643 148.1042,-19.8549 148.0848,-19.8554 148.0631

Caveat

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

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

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

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

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the 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.

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:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA 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
-State Forests of 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.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Technical Memorandum

To:	Department of State Development	**Date:**	16 July 2015
CC:		**From:**	Advisian
Doc No:	301001-01956-00-EN-MEM-0001	**File Loc:**	
Subject:	Abbot Point Growth Gateway Project - Alternative Shoreline Pipeline Corridor Impact Assessment	**Project:**	301001-01956

Alternative Shoreline Pipeline Corridor Impact Assessment

As part of the Abbot Point Growth Gateway Project (the Project) Marine Technical Report, return water and dredged material pipeline alignments were assessed for potential impacts to the marine environment.

Marine Ecological Assessment (WorleyParsons, 2015) has previously been undertaken for a proposed pipeline route which traverses north of the marine offloading facilities (MOF) (Figure 1). This Technical Memorandum assesses an alternative route. The alternative route for the return water and dredged material pipeline are located at the northern end of Abbot Beach, immediately to the south and adjacent to the existing MOF. The alternative return water discharge point is to be located in -4m LAT, approximately 200m to the south east of the current pipeline alignment return water discharge point.

This memorandum provides supplementary information on the existing marine environment along the new route, and assesses the potential impacts on the marine habitat and marine fauna that utilise this habitat. The memorandum also briefly compares the spatial distribution of the return water suspended sediments from the current return water discharge location to the spatial distribution of the return water suspended sediment from the alternative return water discharge location.

Existing Environment

Figure 1 highlights the range of marine constraints found in close proximity to the alternative pipeline route. The figure is a composite of:

- Known seagrass habitat from surveys 1987 - July 2014 (McKenna et al 2014)
- Macro algae habitat surveys (Rasheed et al 2005, GHD 2009a)
- Marine megafauna surveys (GHD 2009b)
- Macroinvertebrate surveys (sponges, corals, other benthos) (GHD 2009a)

The existing habitat along the submerged alternative pipeline route (shoreline to 300m offshore) is devoid of seagrass, algae, sponges, corals and other benthos habitat and consists of an open sandy seafloor. The alternative pipeline intersects with mapped seagrass approximately 300m offshore, within 250m of the existing route. The alternative pipeline is likely to temporarily impact upon a similar area of seagrass habitat as the existing pipeline route (~0.43 ha, refer WorleyParsons 2015).

The beaches to the south of the MOF are known turtle nesting sites. Both Green and Flatback Turtles nest on Abbot beach between November and February; associated turtle hatchling occurs between January and March.

Recent targeted turtle nesting and hatching surveys 2013 and 2014 found:

- CDM Smith (2013a, 2013b) undertook surveys of turtle nesting sites in December 2012 and January 2013 over a walking transect extending for 6km south from the existing MOF located south of Abbot Point (Figure 2). Evidence of limited marine turtle nesting was recorded in December 2012, with 11 sets of tracks recorded over the transect length. Six tracks could be attributed to a specific species, with five of these being Flatback Turtles. Both the December and January surveys indicated a concentration of marine turtles (including Green Turtles, Loggerhead Turtles and Flatback Turtles) associated with the rocky reef that extends ~2.5km south of the MOF.
- Hof and Bell (2014) undertook aerial surveys in December 2014 and reported that Flatback Turtle nesting occurs along the majority of the Whitsunday-Burdekin–Townsville coastline with higher density nesting on mainland coastal beaches including Rita Island (51 tracks), Paradise Bay (22 tracks) and Abbot Point (21 tracks) respectively (Figure 3).

The CDM assessment (2013b) assessment also examined the suitability of Abbot Beach for marine turtle nesting based on the following categories:

A. Nesting habitat suitable with appropriate beach access and access to the supra-littoral (shoreline) zone for marine turtles. A known turtle rookery where nesting density is high (e.g. Mon Repos, Heron and North-West Island).
B. Nesting habitat suitable with appropriate beach access and access to the supra-littoral zone for marine turtles. Not a known turtle rookery but low density nesting previously recorded or highly likely.
C. Nesting habitat less than optimal. Narrow supra-littoral zone and/or physical barriers to effective nesting (e.g. large scarps).
D. Nesting habitat extremely limited or absent. Shoreline fringed by mangroves or saltmarsh with beach habitat limited in extent or absent by natural or man-made features.

The results of the surveys found the 100m beach area directly to the south of the MOF where the alternative pipeline route is proposed, is best described a category 'C' nesting habitat. This is primarily due to the presence of a large scarp approximately 3 meters high which would limit any nesting activity. The remaining section of Abbot Point beach to the south of this area was classified as category 'B'

Alternative return water discharge location

The following is advice supplied by from Andy Symonds at Royal Haskoning DHV regarding the new return water discharge point in relation to hydrodynamic modelling. This information refers specifically to results from the Report - *Abbot Point Growth Gateway Project Dredging and Onshore Placement of Material Numerical Modelling Report*. Prepared for the Queensland Department of State Development, June 2015 (Royal Haskoning DHV, 2015).

The currents during peak flood and ebb (Royal Haskoning DHV 2015 - Figures 26 and 27) shows that the flow vectors approximately follow the orientation of the shoreline. The material released from the two discharge locations would still be transported to approximately the same places. The current speeds are bit lower at the new proposed site so the original site might have more initial advection but any differences would be small.

The sensitivity testing related to the return water pipe depth location also helps explain any differences between the two pipeline discharge points and the effect on the modelling results (see Section 4 of Royal Haskoning DHV 2015) . A comparison between the results of the sensitivity testing from Points 4 (-4m LAT) and Points 7 (-7m LAT) give an indication the potential differences in the sediment distribution between the existing and new discharge point despite the difference depths of discharge.

The plots below show a smaller plume at Point 7 compared to Point 4 which is partially a result of returning water being released into deeper water. The extent of the plume from the alternative discharge location is also expected to be reduced toward the west and somewhat increased to the southeast. The difference though is likely to be negligible due to the rapid dilution of suspended sediments which occur with 10-60m of the return water discharge point.

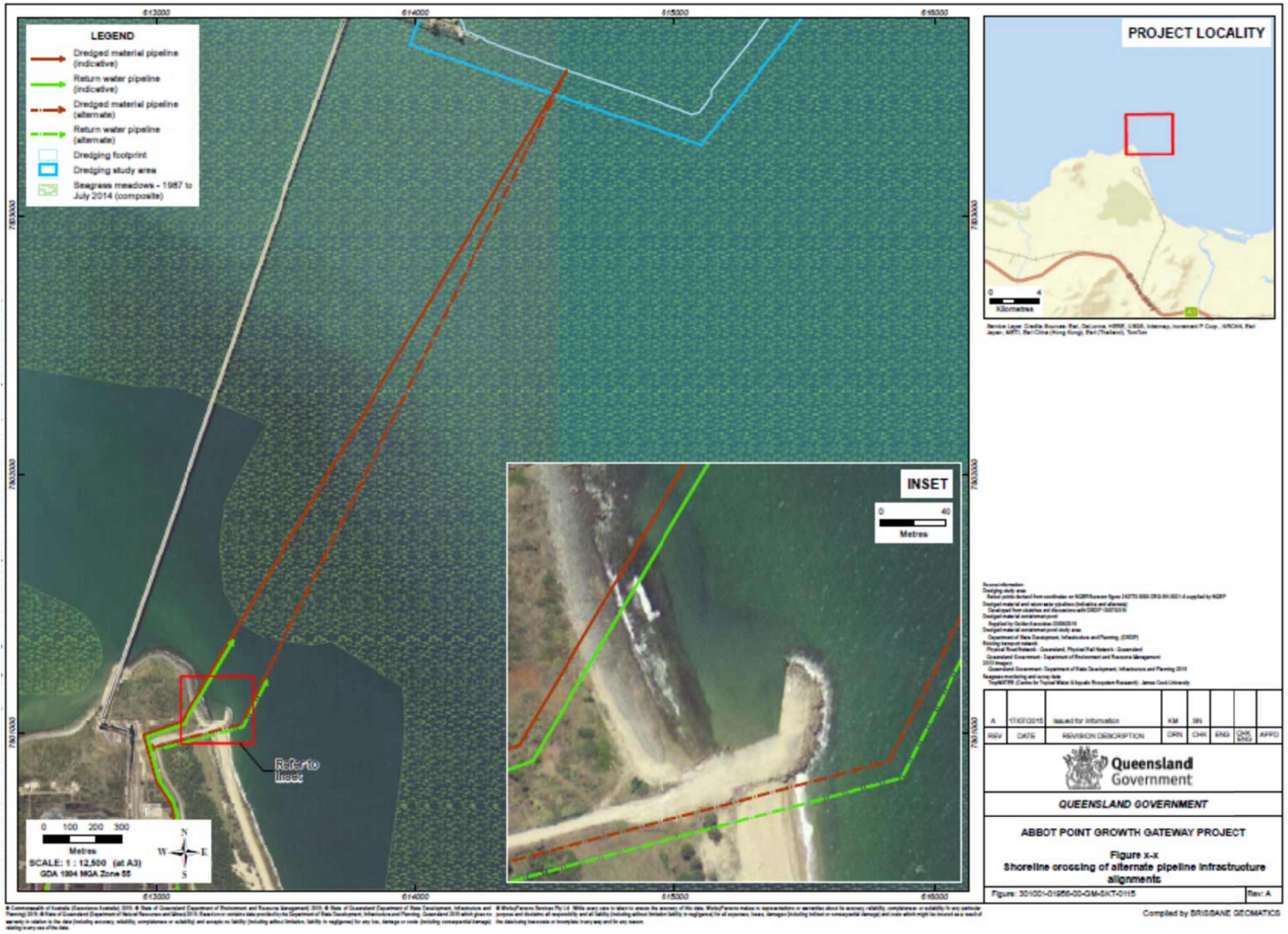
Impact Assessment

Based on the above results:

- The alternative pipeline route does not traverse across habitat that contains seagrass, corals, macroalgae or any other habitat until 300m offshore in greater than 5m of water.
- The impacts on seagrass communities from the alternative pipeline route are similar in magnitude to the existing route (~0.43ha).
- The alternative pipeline traverses the beach adjacent to a rock wall which forms the outer barrier of the MOF. The beach where the pipeline traverses in considered less than optimal habitat for turtle nesting
- More suitable habitat for turtle nesting (and therfore hatching) occurs 100m to the south of the MOF and extends for several kilometres along Abbot Beach
- The hydrodynamic conditions at the alternative discharge point are similar to the current location
- The lack of any sensitive habitat near the alternative return water discharge point means that no additional impacts to marine habitat are predicted due to the change in return water discharge location.

In summary, no impacts to the marine habitat or marine fauna that may utilise this area are predicted due to the alternative pipeline route. The construction, operation and decommissioning of the alternative pipeline will be managed as per the outline Dredge Management Plan which is designed to minimise other impacts to the habitat and marine fauna due to these activities.

Figure 1 Marine constraint – alternate pipeline route (to be rev zeroed)



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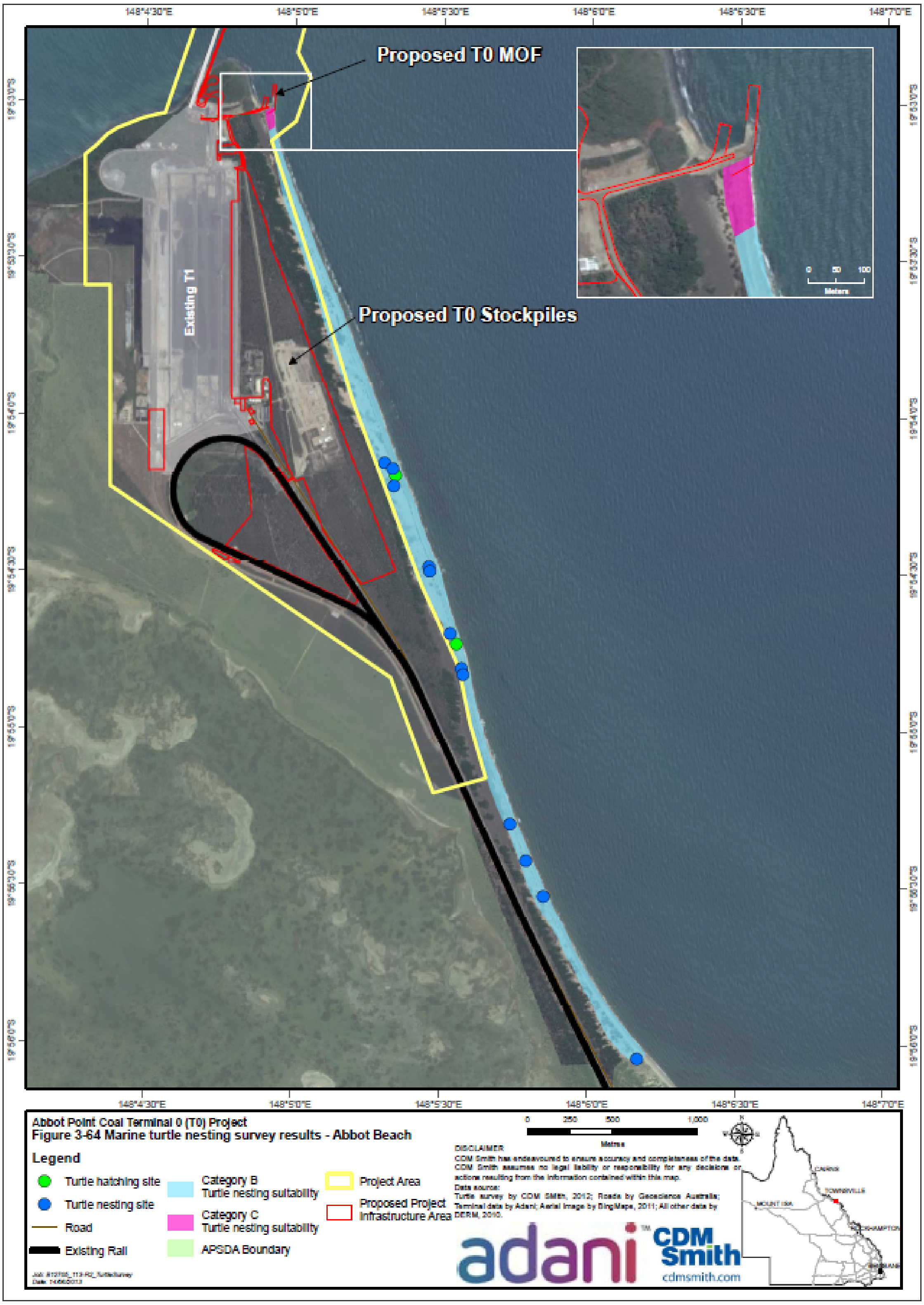

Figure 2. Marine Turtle nesting survey results – Abbot Beach (source CDM Smith (2013a)

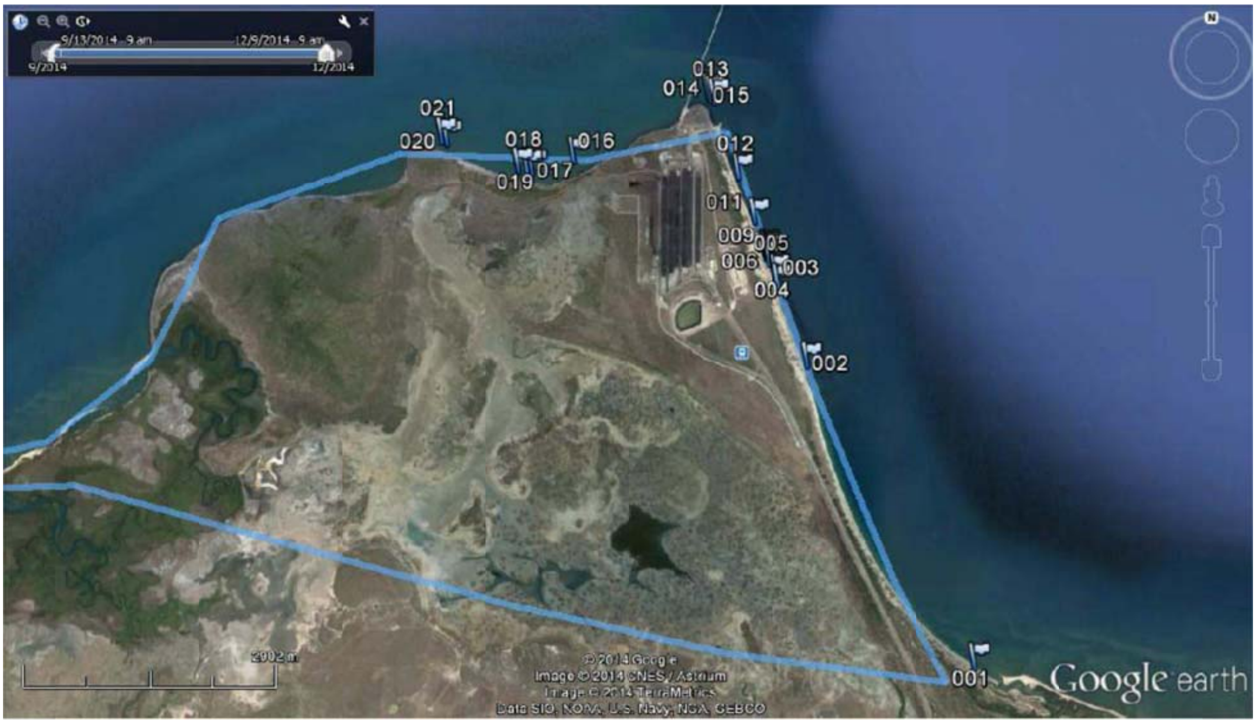

Figure 3. Abbot Point aerial survey results - the numbered marks represent aerial observations of individual turtle tracks (source Hof and Bell 2014)

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References

CDM Smith (2013a). *Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging Public Environment Report Supplementary Report (EPBC 2011/6213/GBRMPA G34897.1)*. Prepared for North Queensland Bulk Ports Corporation, May 2013

CDM Smith (2013b). *Abbot Point, Terminal 0, Terminal 2 and Terminal 3 Capital Dredging Public Environment Report Supplementary Report (EPBC 2011/6213/GBRMPA G34897.1)*.Appendix B11 – marine Turtle Nesting Surveys, Abbot Beach. Prepared for Adani Mining Pty Ltd.

GHD (2009a). *Marine Ecology Benthic Survey Report: Proposed Abbot Point Multi Cargo Facility EIS*. September 2009

GHD (2009b). *Baseline Marine Fauna Report, Port of Abbot Point Baseline Monitoring*. Prepared for North Queensland Bulk Ports Corporation, September 2009

Hof, C. and Bell, I. (2014). *Determining the spatial distribution and densities of marine turtle nesting and predator activity in the northern Great Barrier Reef, Queensland*. Final Report to WWF-Australia and Threatened Species Unit, Department of Environment and Heritage Protection

Rasheed, M.A., Thomas, R. and McKenna, S.A. (2005). *Port of Abbot Point seagrass, algae and benthic macroinvertebrate community survey - March 2005*. DPI&F Information Series QI05044 (DPI&F, Cairns), 27 pp

Royal Haskoning DHV (2015). *Abbot Point Growth Gateway Project Dredging and Onshore Placement of Material Numerical Modelling Report*. Prepared for the Queensland Department of State Development, June 2015

McKenna, S.A. and Rasheed, M.A. (2014). *Port of Abbot Point Long-Term Seagrass monitoring: Annual Report 2012-2013*. JCU Publication, Centre for Tropical Water and Aquatic Ecosystem Research, Cairn, 45pp

WorleyParsons (2015). *Abbot Point Growth Gateway Project: Marine Ecology Technical Report*. Prepared for DSD