Port of Gladstone Maintenance Dredging Impact Assessment – Alternative Placement

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Client:	GPC
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Synopsis: **Impact assessment for annual maintenance dredging works at Port of Gladstone with alternative placement of dredged material at Tide Island MRA.**

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Executive Summary

Background

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Gladstone (PoG). GPC is assessing the potential for beneficial reuse of maintenance dredging material. One proposed option involves an alternative in-channel Material Relocation Area (MRA) option near Tide Island for placement of predominantly fine dredged sediment from the Liquefied Natural Gas (LNG) terminal swing basins.

This report describes the approach and findings of the environmental assessment of maintenance dredging impacts to marine waters in PoG. The assessment considers all maintenance dredging activities inclusive of bathymetric changes associated with the Clinton Vessel Interaction Project (CVIP) channel footprint, and two levels of placement at the proposed Tide Island MRA.

The specific objectives of the report are to:

- Identify relevant matters of national and state environmental significance (MNES and MSES, respectively), and the location of sensitive ecological receptors, within the footprint and in adjacent areas potentially affected by maintenance dredging;
- Assess potential changes to water quality and the marine environment associated with the proposed dredging; and
- Assess potential impacts to MNES and MSES because of dredging.

The environmental assessment was based on desktop assessments involving:

- Review and analysis of existing information; and
- Hydrodynamic and sediment transport modelling of the generation, advection and dispersion of dredging-related sediment plumes and associated sediment deposition rates.

Findings

Existing Environment

The PoG is a macro-tidal estuary that features significant tidal currents. The energetic tidal hydrodynamic conditions play an important role in the context of natural bed remobilisation processes and ambient turbidity. Floods and ‘freshes’ periodically deliver catchment pollutants to estuarine and nearshore coastal waters, exerting a strong control on marine and estuarine water quality and ecosystems. Metal/metalloid concentrations in waters and sediments typically meet ecosystem protection guideline values and are therefore not key ecosystem stressors.

The PoG supports a range of intertidal and subtidal habitats that are important in maintaining a range of ecological values. Intertidal habitats (rocky shores, mangroves, saltmarsh, saltpan and mud flats) occur throughout the PoG area, and seagrass meadows and reef communities are well developed.

The composition and distribution of biological communities of the PoG are controlled in part by water quality properties, especially high ambient turbidity regime and periodic freshwater inputs. In summary:

- Seagrass meadows found at both shallow and deepwater. Meadows are comprised of coloniser and opportunistic species that are capable recovery following disturbance;
- Reef building corals have low cover and richness within the turbid, fluvial affected sections of the port, but are more abundant in the more marine influenced sections of the port. Hard coral communities in PoG are currently in poor condition, having undergone major declines resulting from flood events in 2011, 2013 and 2015; and
- Soft sediment benthic community richness and abundance is positively correlated with high levels of turbidity and associated freshwater inflow.

These wetland types support diverse flora and fauna communities and habitat for threatened and listed migratory marine species (e.g. feeding habitat for turtles, dolphins and dugongs), and species of fisheries significance.

Potential Impacts

Maintenance dredging and dredged material placement is expected to result in direct and indirect effects. Maintenance dredging will result in direct physical disturbance of benthic communities in the dredge areas, the East Banks Offshore MRA and the proposed Tide Island MRA. The characteristics of benthic communities at the proposed Tide Island MRA have not been specifically surveyed. Direct impacts to benthic fauna in the dredged channel and East Banks Offshore MRA will likely be highly localised and short-term, and this would likely be the same at proposed Tide Island MRA assuming this area has similar benthic community types. Correlation analysis found significant positive correlations between benthos abundance/richness and turbidity, on which Currie and Small (2005) concluded that high turbidity provided favourable conditions for benthic communities.

Modelling results indicate that dredging will result in short-term, low intensity turbidity spikes, typically well within the range of modelled ambient turbidity. Deposition rates will temporarily increase within and immediately adjacent to the dredge and MRAs (i.e. highly localised effects), however modelled dredging-related deposition rates are predicted to be negligible in the period following the completion of dredging (i.e. only short-term effects are expected).

On this basis, no major impacts to sensitive receptor habitats (seagrass meadows, reef communities) are expected given the short duration and low intensity of dredge-related turbidity, and the limited spatial extent of significant sediment deposition (mostly restricted to areas within the MRAs and dredged areas).

Other potential impacting processes include:

- **Water quality** – dredged sediments do not contain high pollutant loads, and the dredge area and proposed MRAs are well flushed. Monitoring of dredge plumes indicates that water quality changes associated with the mobilisation and releases of nutrients (and other substances) are short term and low intensity, and unlikely to result in major impacts to biodiversity values;
- **Marine pests** – The *Trailing Suction Hopper Dredge (TSHD) Brisbane* works primarily within Queensland ports and the Port of Melbourne, and therefore does not routinely travel to overseas countries affected by major pest infestations. Any TSHD dredger contracted to undertake dredging works will be required to comply with best practices; and

- **Vessel strike** – Given the relatively low numbers of turtles captured by dredgers compared to other activities, and the use of effective management and operational practices to reduce the potential for turtle capture, it is not considered that the proposed dredging will have a significant impact on local turtle populations.

Significant impacts to protected matters (MNES, MSES) are therefore not expected because of maintenance dredging and placement activities.

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Acronyms

Acronym	Definition
ALA	Atlas of Living Australia
AMA	Australian Marine Associates
ASS	Acid Sulphate Soils
BIAs	Biologically Important Areas
BPAR	Benthic Photosynthetically Active Radiation
BPM	Blue Planet Marine
CFSR	Climate Forecast System Reanalysis
CH	Critical Habitat
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVIP	Clinton Vessel Interaction Project
DA	Development Application
DAF	Department of Agriculture and Fisheries
DAWE	Department of the Agriculture, Water and the Environment (a predecessor of DCCEEW)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEHP	Department of Environment and Heritage Protection
DEM	Digital Elevation Models
DES	Department of Environment and Science
DEWHA	Department of the Environment, Heritage, Water and the Arts
DILGP	Development, Infrastructure, Local Government and Planning
DMPA	Dredge Material Placement Area
DoE	Department of the Environment (a predecessor of DoEE)

Acronyms

Acronym	Definition
DoEE	Department of Environment and Energy (a predecessor of DAWE)
DIP	Department of Infrastructure and Planning
DPAs	Dugong Protection Areas
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1992*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP	Environmental Protection Policy
EVNT	Endangered, Vulnerable and Near Threatened
EVs	Environmental Values
FHAs	Fish Habitat Areas
GBR	Great Barrier Reef
GBRCMP	GBR Coast Marine Park
GBRMP	GBR Marine Park
GBRMPA	GBRMP Authority
GBRNHP	GBR Natural Heritage Property
GBRWHA	GBR World Heritage Area
GHHP	Gladstone Healthy Harbour Partnership
GPC	Gladstone Ports Corporation Limited
HES	High Ecological Significance
HEV	High Ecological Value
IUCN	International Union for Conservation of Nature

Acronyms

Acronym	Definition
JCU	James Cook Univeristy
LMDMP	Long-term Maintenance Dredging Management Plan
LNG	Liquid Natural Gas
LOR	Limit of Reporting
LUP	Land Use Plan
MNES	Matters of National Environmental Significance
MP Act	*Marine Parks Act 2004*
MRA	Material Relocation Area
MSES	Matters of State Environmental Significance
MSQ	Maritime Safety Queensland
NAGD	National Assessment Guidelines for Dredging
NC Act	*Nature Conservation Act 1992*
NCEP	National Centres for Environmental Predictions
NCVA	National Conservation Values Atlas
NIMPCG	National Introduced Marine Pests Coordination Group
NIMPIS	National Introduced Marine Pest Information System
NOAA	National Oceanic and Atmospheric Administration
NO	Nitrogen Oxide
NSW	New South Wales
NTU	Nephelometric turbidity unit
OUV	Outstanding Universal Value
P&CS	Ports & Coastal Solutions

Acronyms

Acronym	Definition
PAHs	Polycyclic Aromatic Hydrocarbons
PASS	Potential ASS
PCIMP	Port Curtis Integrated Monitoring Program
PMST	Protected Matters Search Tool
PoG	Port of Gladstone
QPWS	Queensland Parks and Wildlife Services
qPCR	Quantitative polymerase chain reaction
REs	Regional Ecosystems
SAP	Sediment Analysis Plan
SARA	State Assessment Referral Agency
SDAP	State Development Assessment Provisions
SE	Standard Error
SOI	Southern Oscillation Index
SPP	State Planning Policy
SPRAT	Species Profile and Threats Database
SSM	Sustainable Sediment Management
TBT	Tributyltin
TECs	Threatened Ecological Communities
TMR	Department of Transport and Main Roads
TN	Total Nitrogen
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons

Acronyms

Acronym	Definition
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Solids
WA	Western Australia
WA EPA	Western Australia Environmental Protection Authority
WICET	Wiggins Island Coal Export Terminal
WQOs	Water Quality Objectives

1 Introduction

1.1 Background

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Gladstone (PoG). Dredge material is placed in the East Banks Offshore Material Relocation Area (MRA) in accordance with Sea Dumping Permits issued by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) (previously the Commonwealth Department of the Agriculture, Water and the Environment (DAWE), and its predecessor Department of Environment and Energy (DoEE)).

GPC is assessing the potential for alternative beneficial reuse of maintenance dredging material, as part of the Sustainable Sediment Management Project (SSM Project). One (1) proposed option involves an alternative in-channel MRA option for placement of predominantly fine dredged sediment from the Liquefied Natural Gas (LNG) terminal swing basins. The alternative MRA is located near Tide Island (refer Figure 1-1) and is referred to in this report as the proposed Tide Island MRA.

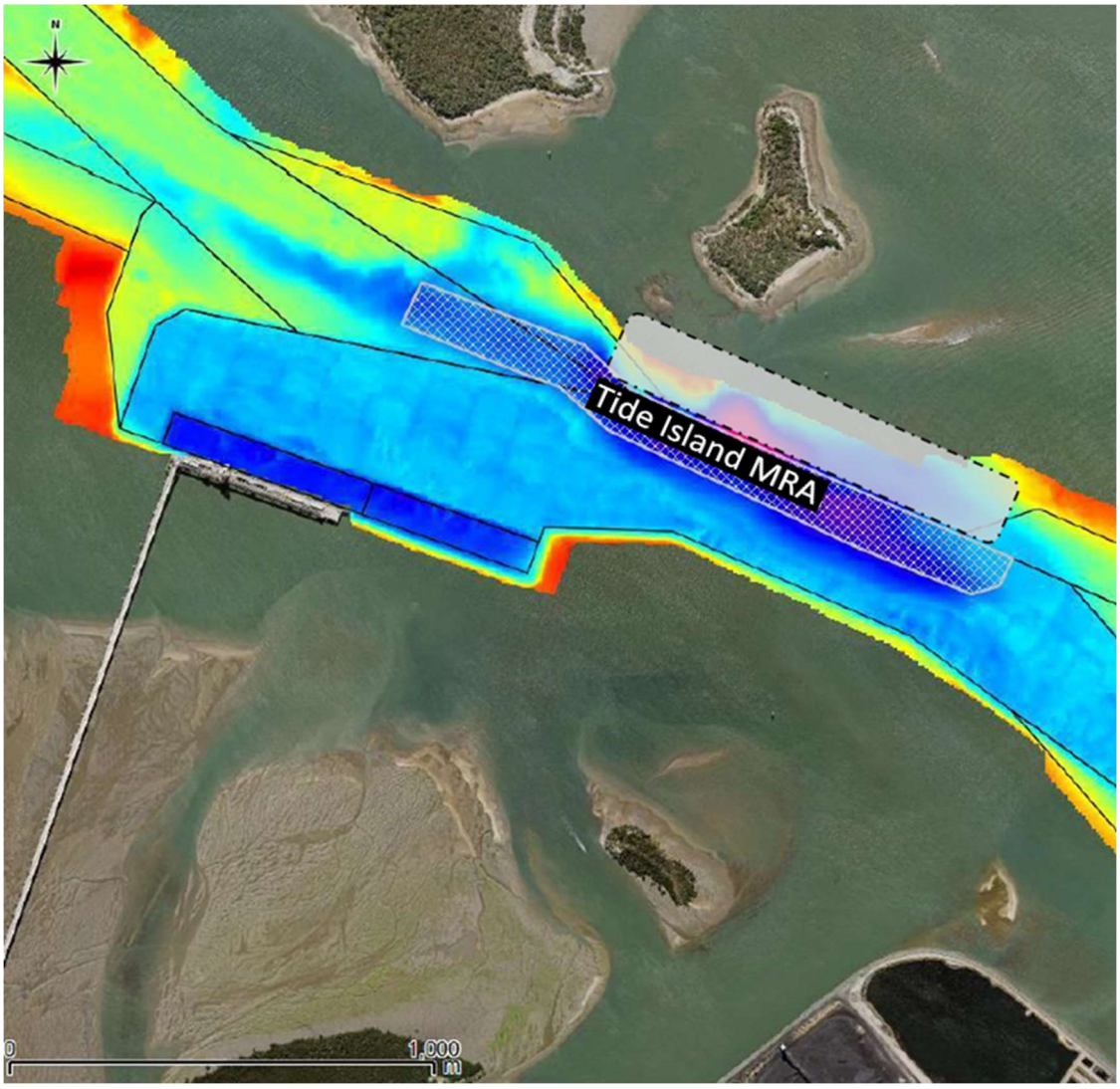


Figure 1-1 Proposed Tide Island MRA, the colour scale represents the channel bathymetry (Source: GPC)

This report describes the approach and findings of the environmental assessment of maintenance dredging impacts to marine waters, including bathymetric changes associated with the Clinton Vessel Interaction Project (CVIP) channel footprint, with two (2) different levels of placement at the Tide Island MRA. The environmental assessment was based on desktop assessments involving the review and analysis of existing information, and hydrodynamic modelling. This study uses the same methodology as the recently completed revised assessment of regular maintenance dredging activities at the PoG (BMT 2021a).

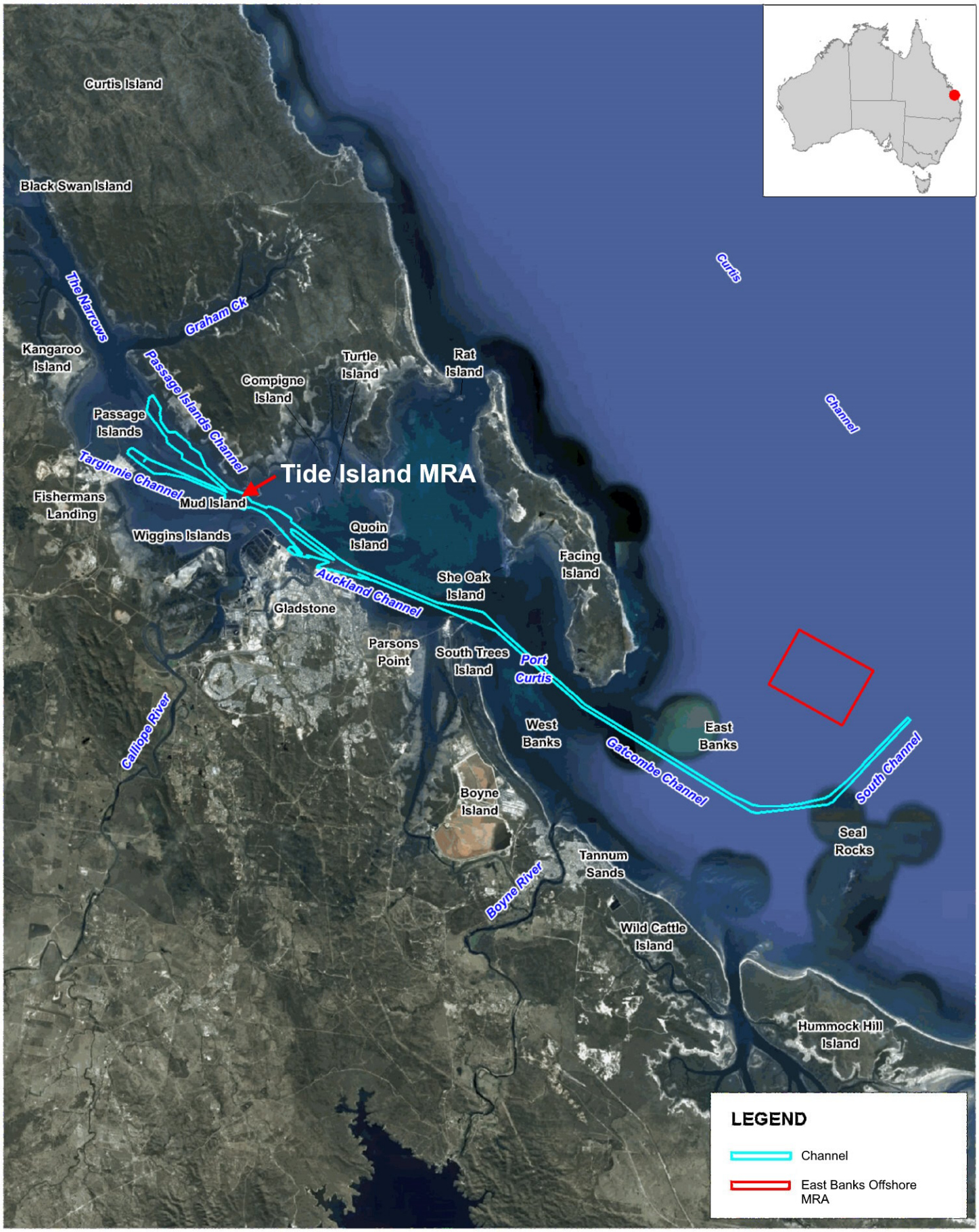
1.2 Study Objectives

The objectives of the report are to:

- Identify relevant matters of national and state environmental significance (MNES and MSES, respectively, and the location of sensitive ecological receptors, within the footprint and in adjacent areas potentially affected by maintenance dredging;
- Assess potential changes to water quality and the marine environment associated with the proposed dredging; and
- Assess potential impacts to MNES and MSES as a result of dredging.

1.3 Study Area

For the purposes of this assessment, the *study area* is defined as all marine waters within the PoG. The location of the channel areas subject to maintenance dredging, the Tide Island MRA and the East Banks Offshore MRA are shown in Figure **1-2**.



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Locality Plan

Figure: 1.2

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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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2 Methodology

2.1 Review of Existing Information

2.1.1 Identifying Features of Biodiversity Significance or Sensitivity

This report considers both MNES and MSES. In March 2021, searches of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) (refer Appendix A), and *the State Planning Policy 2017* (SPP) Interactive Mapping System were undertaken to determine MNES and MSES within the study area. The searches identified:

- Legally defined areas listed under Commonwealth and State Government instruments (i.e. mapped conservation areas and other discrete environmental features; and
- Species listed under the EPBC Act that are known or likely to occur within the study area.

Both the PMST and SPP Interactive Mapping System have limited locational precision for defining habitats of listed species. Additional information sources, including academic publications, consultancy reports, and wildlife on-line flora and fauna records, were subsequently reviewed to determine the known or likely occurrence of species in the study area. The determination of known or likely occurrences was based on:

- Confirmed records of the species; and
- An assessment of habitat suitability, based primarily on the online Species Profile and Threats Database (DAWE 2021).

Moreover, it is important to consider that GPC, as part of its comprehensive maintenance dredging framework, has undertaken extensive monitoring and surveys which validate and extend the information available at the abovementioned platforms. Under the Long-term Maintenance Dredging Management Plan (LMDMP) for the PoG, GPC's long-term monitoring schedule includes sediment sampling, plume monitoring, water quality sampling, seagrass, reef and benthic invertebrate monitoring as well as hydrographic surveys. Other surveys concerning aspects such as megafauna and shorebirds have been conducted as part of and stemming from historical dredging projects and commitments and are available at GPC's corporate website (https://gpcl.com.au/). Finally, GPC participates in the Port Curtis Integrated Monitoring Program (PCIMP) and the Gladstone Healthy Harbour Partnership (GHHP). These programs provide a broad range of ambient data sets for the PoG; data from these programs are reported by GHHP in report cards available on their website (http://ghhp.org.au/). The information obtained from this work is integrated and utilised throughout this report.

2.1.2 Other Data Sources

Other data sources used to characterise environmental features and/or inform modelling assessments include:

- Bathymetry and typography Digital Elevation Models (DEMs) with 10 m resolution for the surrounding area (developed by BMT from available charts and historical survey data progressively over the last 15 years),
- Latest bathymetry and channel extents within PoG supplied by GPC,
- Reef habitat mapping from previous reports (BMT WBM 2015, BMT 2018) and WetlandInfo (https://wetlandinfo.des.qld.gov.au/wetlands/),
- Seagrass mapping data supplied by GPC and contained in seagrass monitoring reports prepared by James Cook University's (JCU's) TropWater (previously part of Department of Agriculture and Fisheries (DAF), formerly the Department of Primary Industries, and its predecessor Department of Employment, Economic Development and Innovation (DEEDI)). ; and Boundary condition data from global tidal, wind and atmospheric model outputs (NOAA 2012).

2.2 Impact Assessment

2.2.1 Numerical Model

The numerical modelling software TUFLOW FV was used to simulate the three-dimensional hydrodynamics of PoG and the advection and dispersion of suspended sediment (both ambient sediment and plumes generated during dredging). The model was used to simulate the dredging campaigns in full so that the potential effect on the turbidity levels and deposition rate within PoG could be estimated. TUFLOW FV carries out calculations on an unstructured mesh, which allows the mesh resolution to be enhanced in the areas of greatest interest.

The coarse regional PoG model mesh and the high-resolution local nested model mesh is presented in Figure 2-1. The model bathymetry was updated to include the most recent survey data collected after completion of the CVIP dredging project.

2.2.2 Model Bathymetry

The model bathymetry is based on a DEM of PoG, which has been derived from the following survey components:

- Detailed hydrographic survey data of the dredged channels, swing basins and berths as provided by Maritime Safety Queensland (MSQ) and GPC, together with the progressive inclusion of ongoing surveys to ensure that the model bed levels match the actual bathymetric configuration at the time of the simulation period, and,
- Hydrographic survey data and outlines of the edges of the shoreline, mangroves and saltpans used in producing Boating Safety Charts of the area, as provided by MSQ.

Typical levels have been adopted for the edges of the mangroves and saltpan areas for interpolation in those upper inter-tidal zones where no specific survey level data is available. The various data components have been combined and prioritised with respect to date and detail where there is overlap in producing a base DEM. For modelling purposes, all data has been adjusted to a consistent mean sea level datum.

2.2.3 Boundary Conditions

The regional scale model is supplied with external water level boundary conditions from a University of Newcastle Great Barrier Reef (UoNGBR) Tide Model (Seifi *et al*. 2019). The nested high-resolution local model is coupled with the regional model to provide detailed results within PoG.

A SWAN spectral wave model was developed to include the influence of waves on the sediment dynamics (Delft University of Technology 2006). Wave model outputs were input as a boundary condition for the TUFLOW FV model to enable the calculation of total bed shear stresses.

Due to the large scale of the model, regional oceanic effects needed to be incorporated in the offshore open ocean boundary conditions. This was done using HYCOM global ocean circulation model hindcast outputs (www.hycom.org). This model provided 3D current, salinity and temperature data which was applied on the ocean boundary in combination with the tidal water level variation.

Further boundary conditions were also applied to the model to represent atmospheric influences. These boundary conditions were derived from the National Centers for Environmental Predictions (NCEP) Climate Forecast System Reanalysis (CFSR) (www.ncep.noaa.gov) and included wind, temperature, humidity, short and long wave radiation, which were applied on a spatially varying grid throughout the model domain with a temporal resolution of one (1) hour.

2.2.4 Model Validation

The TUFLOW FV numerical model used for the purposes of this study has evolved from previous PoG models which have been progressively updated, refined and calibrated over many years using a large number of recorded water level, wave and current velocity measurements.

The most recent set of model calibration and validation results are available in the report titled Post-CVIP Port of Gladstone TUFLOW FV Model Validation (BMT 2021b).

2.2.5 Impact Assessment Methodology

The effects of dredging were assessed based on modelled increases in turbidity and deposition rate above natural or ambient levels, consistent with the methodology used for the PoG Gatcombe and Golding Cutting Channel Duplication Project Environmental Impact Statement EIS (BMT 2019b). Both ambient and dredge related signals were resolved in the numerical model, which allows for an understanding of how significant the dredge contribution is in relation to ambient conditions.

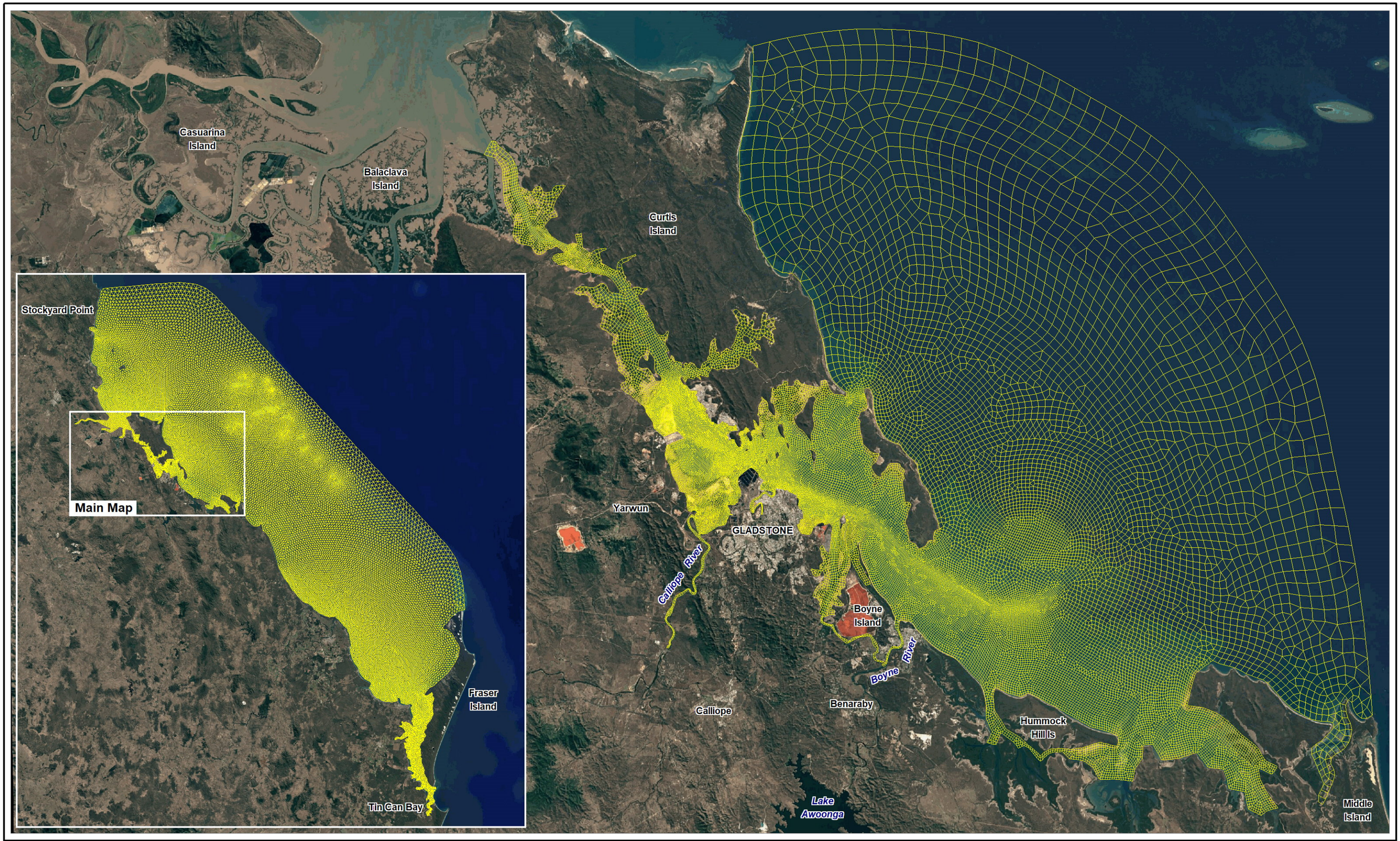
Depth-averaged turbidity values (in nephelometric turbidity unit (NTU)) are presented since they are most relevant to assessing ecological impacts due to the reduction in Benthic Photosynthetically Active Radiation (BPAR). Deposition rate impacts were derived from the daily rate of change in bed sediment mass. The deposition rate was calculated in units of $mg/cm^2/day$.

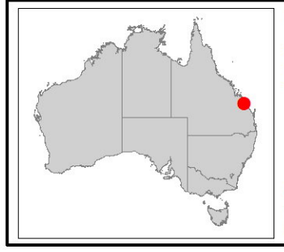
The anticipated effects of dredging were assessed by analysing:

- Time series of turbidity and deposition rate at representative sensitive receptor sites; and
- Spatial plots of the change in the percentiles of the turbidity and deposition rate due to dredging.

The impacts of dredging on the modelled turbidity and deposition rate were then compared to biologically-relevant thresholds to determine potential Zones of Influence (where plumes are detectable but cause no ecological impact) and Zones of Impact (where some temporary ecological effects are anticipated to occur).

Further methodological details and results are provided in Section 5.





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Model mesh

Satellite imagery:
Google Earth December 2016
Image Landsat / Copernicus

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Regional Coarse Model Mesh (Inset) and Local Nested Model Mesh

Figure: **2-1**

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Main Map (km)

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Inset (km)

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3 Dredging Project Description

3.1 Maintenance Dredging Volumes and Locations

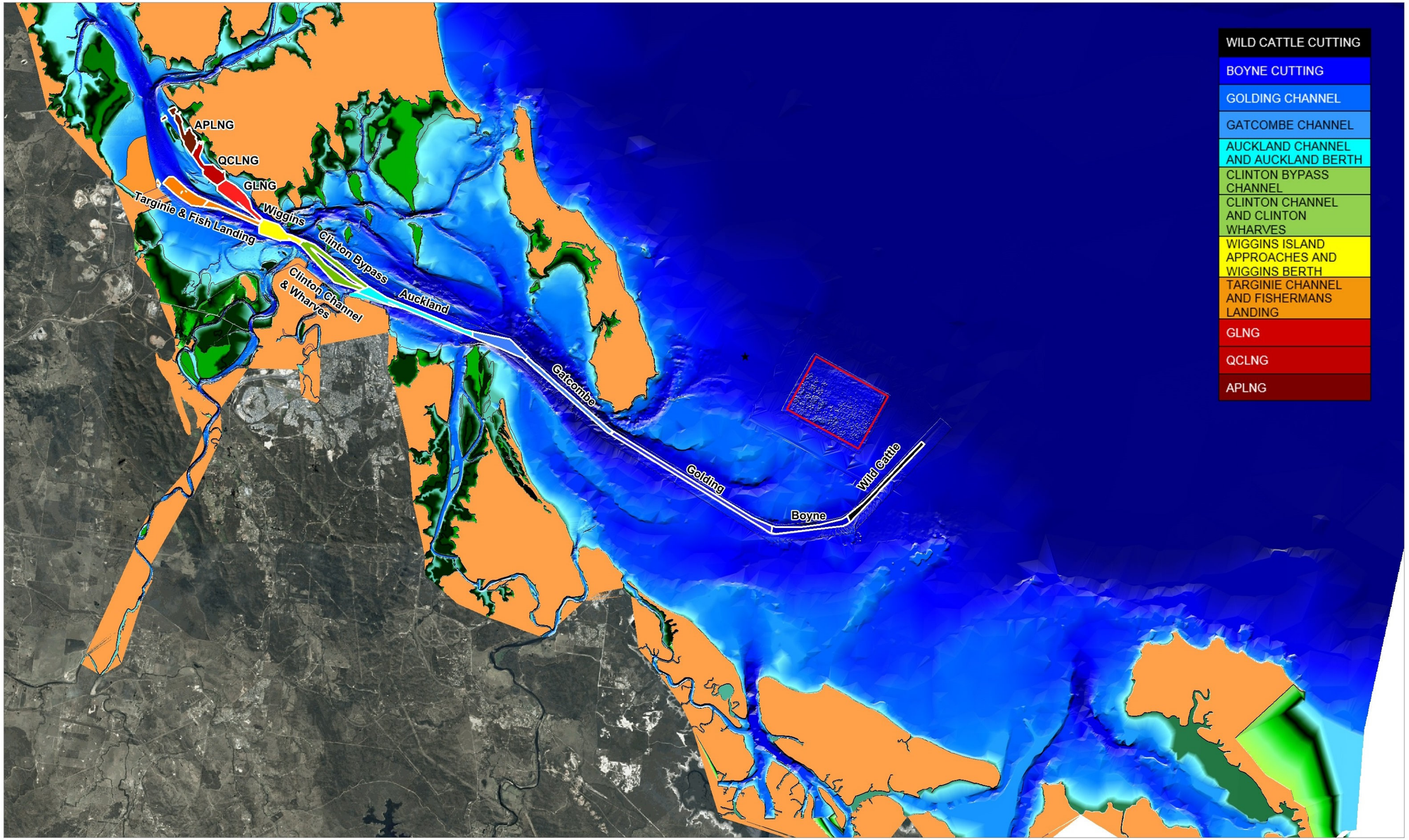
The impact assessment was based on a 'typical' annual PoG maintenance dredging campaign, which involved the removal of approximately 260,000 m^3 of material.

The distribution of the material to be dredged was the same as that adopted in the recent Maintenance Dredging Impact Assessment (BMT 2021a), with percentages allocated to the 12 dredging parcels shown in Table 3.1. The locations of each dredge parcel are listed in Table 3.1 are shown in Figure 3-1. The colours of the various parcels in Table 3.1 match the colours of the polygons in Figure 3-1.

The modelling assumptions regarding the particle size distribution in each parcel, the dredging productivity, plume release rates and dredging cycle times were all the same as those adopted in the recent Maintenance Dredging Impact Assessment (BMT 2021a), except for the modified treatment of the dredging operation in the Gladstone Liquefied Natural Gas (GLNG), Queensland Curtis LNG (QCLNG) and Australia Pacific LNG (APLNG) parcels, which is described in the next section.

Table 3.1 Distribution of Simulated Maintenance Dredging Requirements

Parcel	*Percentage of Maintenance Dredging Campaign Requirement [%]*
WILD CATTLE CUTTING	15
BOYNE CUTTING	3
GOLDING CUTTING	20
GATCOMBE CHANNEL	3
AUCKLAND CHANNEL AND AUCKLAND BERTH	3
CLINTON BYPASS CHANNEL	2
CLINTON CHANNEL AND CLINTON WHARVES	2
WIGGINS ISLAND APPROACHES AND WIGGINS BERTH	13
TARGINNIE CHANNEL AND FISHERMANS LANDING	5
GLNG	7
QCLNG	7
APLNG	20



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East Banks MRA

-20 -15 -10 -5 -2 0 2 4 6 8 10

Elevation (m AHD)

Title:

Locations of Maintenance Dredging Parcels

Figure: **3.1**

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Approx.Scale

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3.1.1 Placement at the East Banks Offshore Material Relocation Area and the Tide Island Material Relocation Area

3.1.1.1 Simulation 1: 45,000 m³ to the Tide Island Material Relocation Area

The proportion of a typical 260,000 m³ campaign that is allocated to each channel segment is shown in Table 3.2. In order to allocate a total of 45,000 m³ to the Tide Island MRA, the 'standard' maintenance dredging pattern was altered so that every second Trailing Suction Hopper Dredge (TSHD) trip from the three (3) LNG swing basins (GLNG, QCLNG and APLNG parcels) was diverted to place it's load at the Tide Island MRA rather than the East Banks Offshore MRA. The steaming time for each of those trips was also shortened in proportion to the reduction in the sailing distance. This resulted in half of the total amount dredged from those areas being placed at the Tide Island MRA (approximately 45,000 m³).

3.1.1.2 Simulation 2: 75,000 m³ to the Tide Island Material Relocation Area

To allocate a total of 75,000 m³ to Tide Island MRA, the 'standard' maintenance dredging pattern was altered so that 85% of the TSHD trips from the three (3) LNG swing basins were diverted to place loads at the Tide Island MRA rather than the East Banks Offshore MRA. The steaming time for each of those trips was also shortened in proportion to the reduction in the sailing distance. This resulted in 85% of the total amount dredged from those areas being placed at the Tide Island MRA (approximately 75,000 m³).

Table 3.2 Allocation of Maintenance Dredging Volumes

Channel Area	Percentage of Total Volume	Volumes for a 260,000 m³ Campaign	45,000 m³ to Tide Island MRA	75,000 m³ to Tide Island MRA
WILD_CATTLE_CUTTING	15	39,000	100% to East Banks Offshore MRA	100% to East Banks Offshore MRA
BOYNE_CUTTING	3	7,800		
GOLDING_CUTTING	20	52,000		
GATCOMBE_CHANNEL	2.5	6,500		
SOUTH_TREES_BERTH	0.5	1,300		
AUCKLAND_CHANNEL	2.25	5,850		
AUCKLAND_POINT_BERTH	0.75	1,950		
CLINTON_CHANNEL	3	7,800		
CLINTON_WHARVES	1	2,600		
TARGINNE_CHANNEL	2.75	7,150		
FISHERMANS_LANDING	2.25	5,850		
WIGGINS_ISLAND	13	33,800		
GLNG	7	18,200	Total 88,000 m³ 50% to Tide Island MRA	Total 88,000 m³ 85% to Tide Island MRA
QGC	7	18,200		
APLNG	20	52,000		

4 Existing Conditions

4.1 Sedimentary and Hydrodynamic Environment

The PoG is within a macro-tidal estuary featuring significant tidal currents. The energetic tidal hydrodynamic conditions play an important role in the context of natural bed remobilisation processes. In the main channels where tidal velocities are high, surface sediments are typically dominated by coarser fractions with finer particles swept away. Shallow areas consist of sands and silts with fine sediment dominating areas of low current/wave energy.

The dredged channels in PoG are effective sediment traps, due to their increased depth relative to the surrounding seabed. Maintenance dredging is carried out on an annual basis. The Maintenance Dredging Strategy for GBR World Heritage Area (GBRWHA) Ports (TMR 2016) estimated that the average annual campaign volume is likely to be 260,000m^3 going forward, based on an analysis of dredging volumes from 2004 to 2014 plus an allowance for the maintenance requirements of the channel servicing the LNG terminals. The average for the last four years of dredging has been 227,000 m^3, so the 260,000 m^3 annual estimate may be somewhat conservative. The composition of the dredged material is variable, with sediments in the main navigation channels dominated by sands and gravels (where tidal currents are strong) and sediments in the berth pockets and closed-ended channels having a higher fines content (BMT WBM 2014a).

GPC is undertaking the SSM Project to help obtain a robust, well considered, long term solution for the management of maintenance dredging sediment. As part of this project, a quantitative sediment budget was developed that estimated the sediment fluxes, sources and sinks in PoG (P&CS 2019).

The East Banks Offshore MRA is located in an exposed coastal environment at the entrance to the PoG. The East Banks Offshore MRA is partially retentive, with sediments consisting of sands with low proportion of silts and gravel, due to winnowing by wave/current resuspension (BMT WBM 2012a). Recent analysis undertaken to develop the quantitative sediment budget for PoG indicates that between 5-40% of sediment placed at the East Banks Offshore MRA could be moved on by natural wind/wave events (P&CS 2019).

The Calliope River discharges sediment directly into PoG, as do smaller catchments on Curtis Island. The Boyne River also discharges into PoG but sediment discharge is relatively minor due to sediment trapping and flow attenuation by the Awoonga Dam (CQUniversity and BMT WBM 2018). Overall, the sediment fluxes contributed by these catchments are very small compared to the channel infilling that is driven by energetic spring tide currents (within PoG) and wave activity (outside PoG) (BMT 2019c). Connectivity between new fluvial inputs and maintenance dredging requirements is weak.

4.2 Water and Sediment Quality

The PCIMP is a long-term water quality and ecosystem health monitoring program encompassing the estuarine and marine waters of PoG. PCIMP undertakes quarterly water quality sampling at 54 sites in 13 zones (refer to Figure 4-1). Surface sediment is sampled annually at each of the 54 water sites.

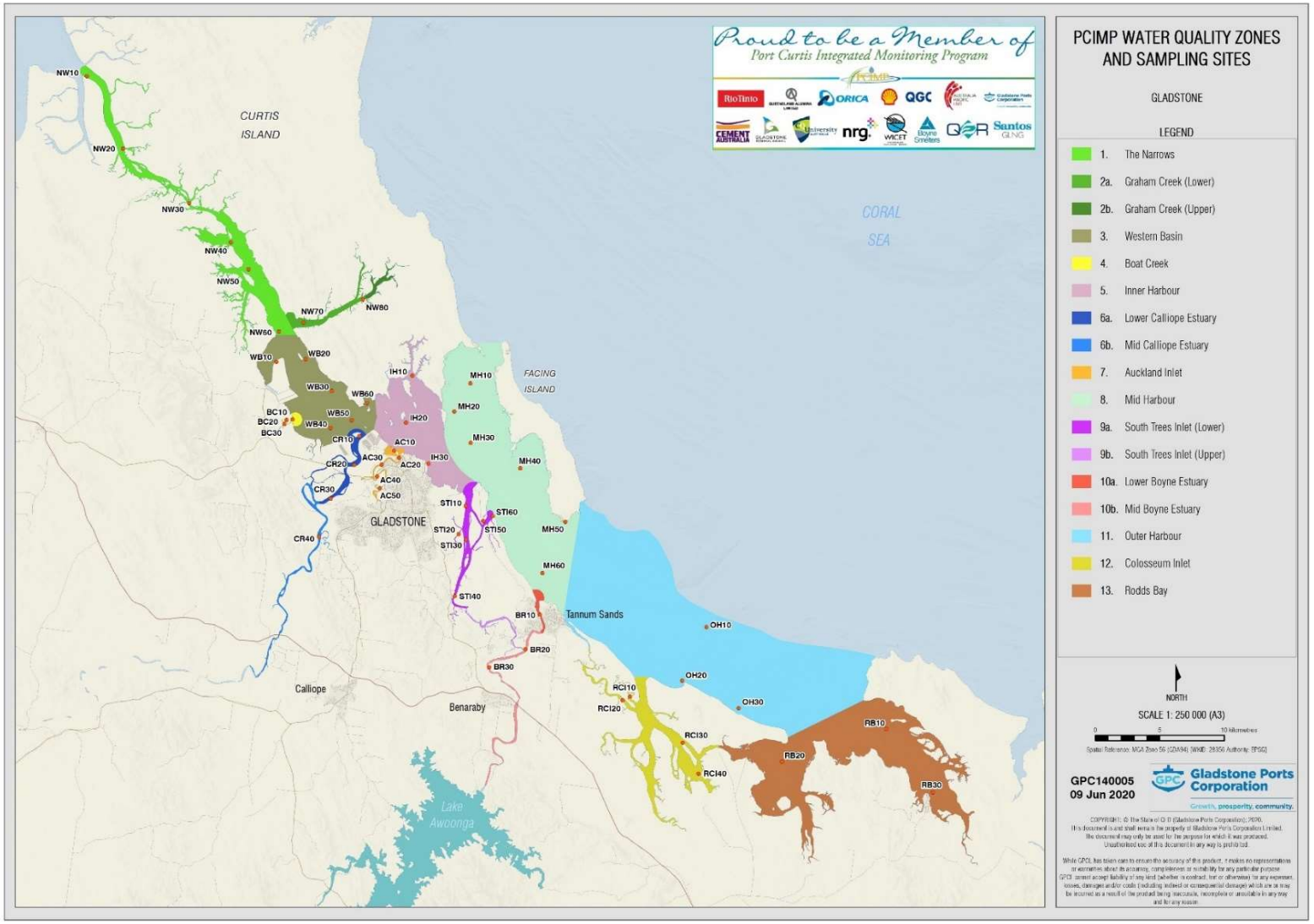


Figure 4-1 Gladstone Harbour Monitoring Regions (Source: AIMS 2015)

4.2.1 Water Quality

The study area extends across several water types within the PoG, all of which are classified as *Moderately Disturbed* waters under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity) (DES 2019). Water Quality Objectives (WQOs) have been defined for the protection of scheduled aquatic ecosystem and human use environmental values (EVs[1]) shown in Table 4.1. GPC monitoring data (mean and standard error[2]) reported by PCIMP for key water quality variables and scheduled WQOs are presented in Figure 4-2 and Figure 4-3 for sites from the Inner Harbour zone[4]. The GHHP report card ratings developed from PCIMP data are summarised in Table 4.2 for all zones.

Table 4.1 Scheduled EVs for the PoG and adjacent coastal waters, mainland estuaries (Source: EPP Water and Wetland Biodiversity)

GLADSTONE HARBOUR, ADJACENT COASTAL WATERS, MAINLAND ESTUARIES THE NARROWS FITZROY DELTA	Environmental values[1–7]											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation[5]	Secondary recreation[5]	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
GLADSTONE HARBOUR (listed west to east)[7] AND ADJACENT COASTAL WATERS												
Western Basin	✓					✓		✓[5]	✓		✓	✓
Inner Harbour (including waters adjacent to Spinnaker Park beach, Barney Point)	✓					✓	✓[5]	✓[5]	✓	✓[6]	✓	✓
Mid Harbour	✓					✓	✓[5]	✓[5]	✓	✓[6]	✓	✓
Outer Harbour	✓					✓	✓[5]	✓[5]	✓	✓[6]	✓	✓
Coastal waters outside Gladstone Harbour east and south of Facing Island (to southern limits of Port)	✓					✓	✓[5]	✓[5]	✓	✓[6]	✓	✓

[1] referred to as community values in ANZG (2018)
[2] note that comparisons of WQOs to measured data should be based on median values rather than means. The comparisons shown herein should be considered indicative
[4] Inner Harbour waters are representative of water quality characteristics of dredged areas within Gladstone Harbour PoG? (see Table 4.2)

Table 4.2 Water quality sub-indicator, zone and harbour scores from the 2023 GHHP technical report. Overall water quality scores 2022 and 2021 are also shown (Source: GHHP 2023)

Water quality	Physico-chemical	Nutrients	Dissolved metals	2023	2022	2021
1. The Narrows	0.80	0.55	1.00	0.79	0.77	0.84
2. Graham Creek	0.91	0.64	1.00	0.85	0.85	0.92
3. Western Basin	0.79	0.55	1.00	0.78	0.77	0.95
4. Boat Creek	0.68	0.38	1.00	0.69	0.78	0.84
5. Inner Harbour	0.73	0.62	1.00	0.78	0.84	0.94
6. Calliope Estuary	0.78	0.65	1.00	0.81	0.81	0.94
7. Auckland Inlet	0.76	0.60	0.94	0.77	0.78	0.85
8. Mid Harbour	0.79	0.66	1.00	0.82	0.84	0.91
9. South Trees Inlet	0.87	0.68	1.00	0.85	0.79	0.91
10. Boyne Estuary	0.59	0.52	1.00	0.70	0.86	0.87
11. Outer Harbour	0.99	0.84	1.00	0.94	0.88	0.97
12. Colosseum Inlet	0.97	0.66	1.00	0.88	0.81	0.93
13. Rodds Bay	0.84	0.76	1.00	0.86	0.76	0.96
Harbour score	0.81	0.62	1.00	0.81	0.81	0.91

Score card ratings: A = Dark green; B = light green; C = yellow; D = red

In summary GHHP 2023 technical report trend show:

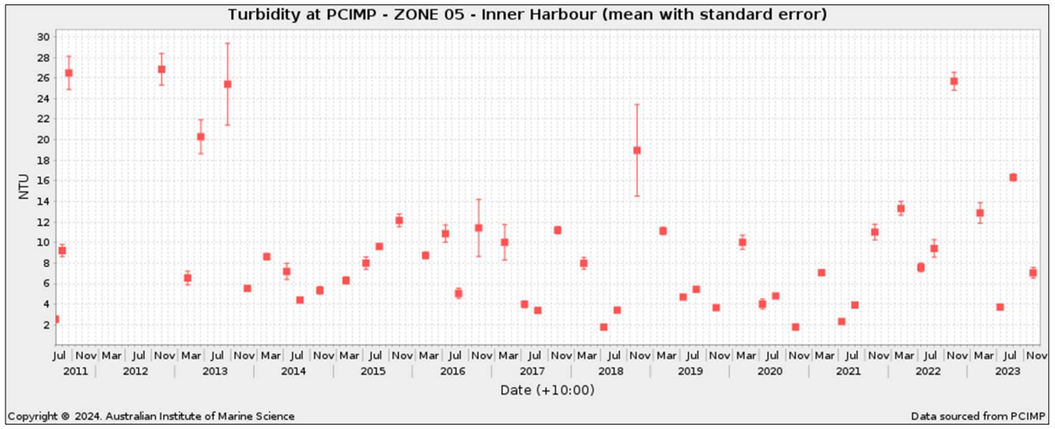
- In the majority of zones, water quality grade degraded slightly between 2021 and 2021, and was rated as ‘B’ (Good) in most zones . Water quality improved again in some zones which received an ‘’A’’ score (Very Good) in 2023 (Table 4.2)..
- In 2023, Inner Harbour and Western Basin zones were rated as ‘B’ for physio-chemical stressors (turbidity, pH),‘A’ for dissolved metals/metalloids and ‘C’ for nutrients (Table 4.2).

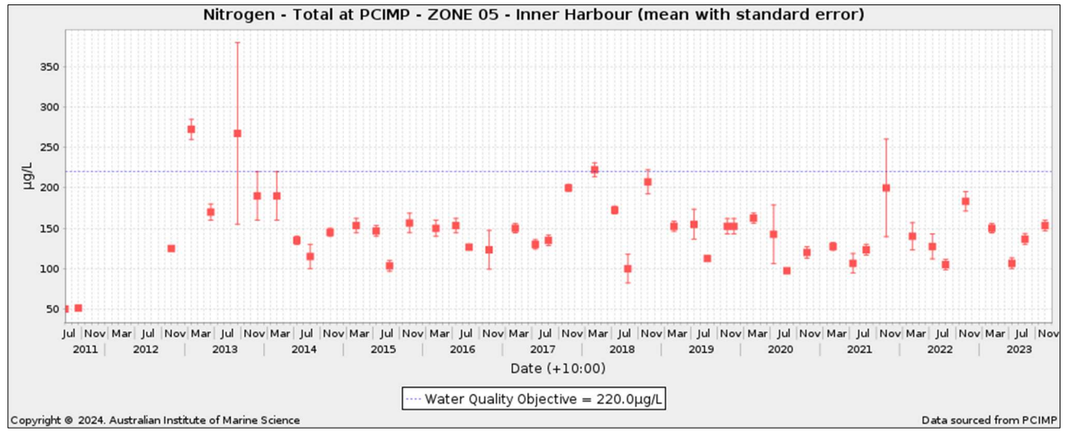
PCIMP water quality data trends show:

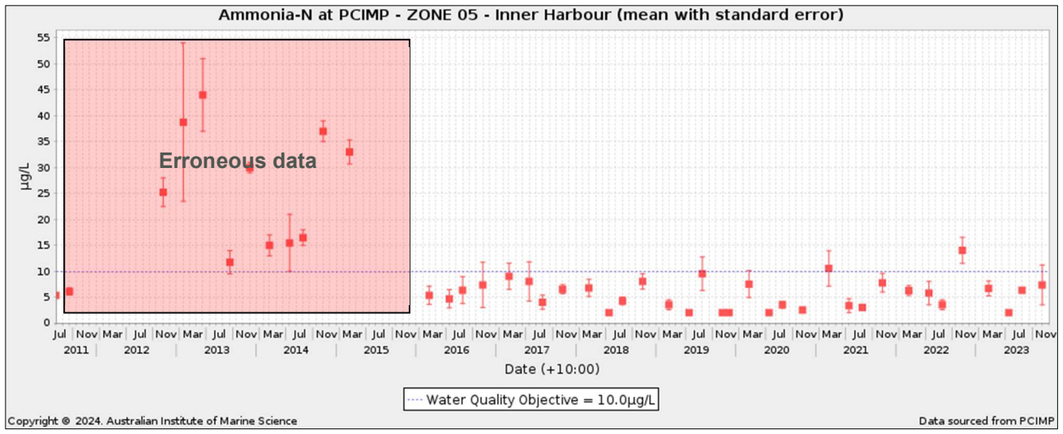
- Turbidity displayed great variability over time, mostly in response to variations in tidal and rainfall conditions. Quarterly grab-based turbidity measurements exceeded the Queensland WQO median range (Figure 4-2) and logging instruments have recorded turbidity peaks >50 NTU in the Inner Harbour.
- Mean total nitrogen (TN) has remained below the WQO since the 2018-2019 wet season (Figure 4-2). Mean ammonia concentrations were generally less than or at the WQO in the period 2016-2023. (Note that ammonia data collected prior to July 2015 are erroneous and have been disregarded.) NOx displayed great variability over time and among sites, with the mean concentration exceeding the WQO on four (4) of 28 sampling occasions.

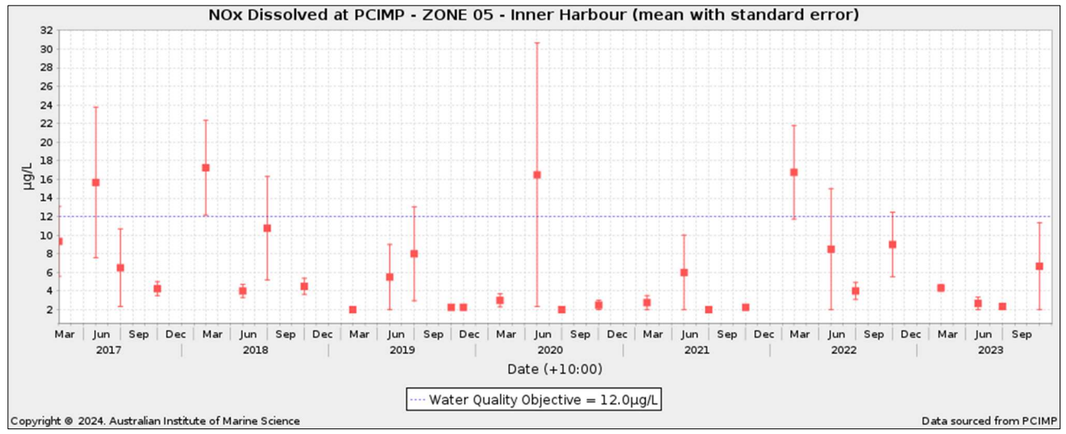
- Mean TP concentrations were below the WQO, except wet season 2012-2013 when the harbour experienced major flooding.
- Chlorophyll *a* (a surrogate for phytoplankton biomass) was generally less than the WQO in the period 2016-2023 except the wet season 2017-2018. The period prior and thus 2014-2015 had chlorophyll *a* concentrations near the WQO.
- Mean concentrations of dissolved metals/metalloids were generally less than WQOs. The exception was aluminium (exceeded in February 2020) and zinc (exceeded in May and August 2014).

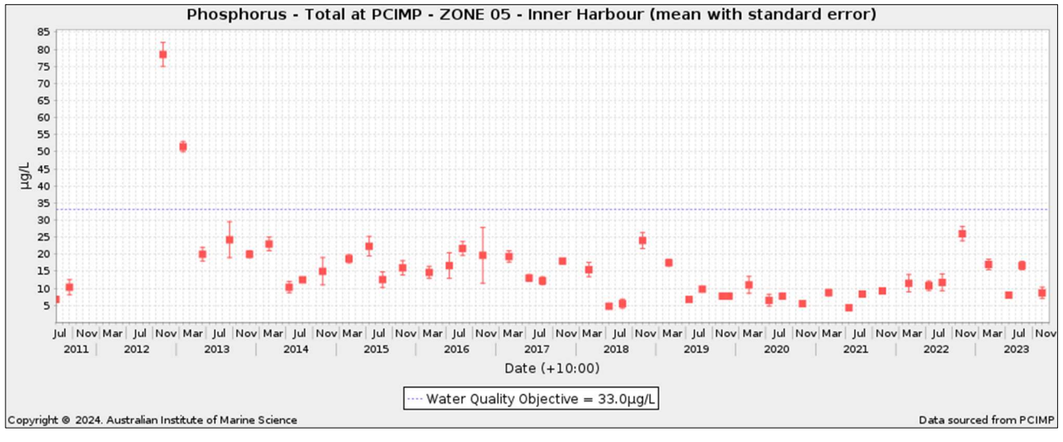
GHHP (2023) suggested that the key processes affecting water quality in the PoG are: (i) nutrient (and other contaminant) inputs from point and diffuse (pulsed, rainfall driven events) sources, and (ii) sediment (and associated nutrients and other compounds) resuspension by tides and (iii) oceanic inputs of low nutrient and turbidity waters. The relative influence of these drivers, and the spatial and temporal scales at which they operate, has not been examined in detail in PoG. PoG is a highly dynamic system that is generally well mixed, with areas of greatest turbidity occurring between Wiggins Island and Grahams Creek, in the upper reaches of The Narrows, and within South Trees Inlet (areas where fine sediment has accumulated). These processes have implications for the distribution of seagrasses and reef-associated benthos within the broader PoG area; both communities typically occur in shallow waters and/or are remote from areas that experience the greatest tidally-driven sediment resuspension.











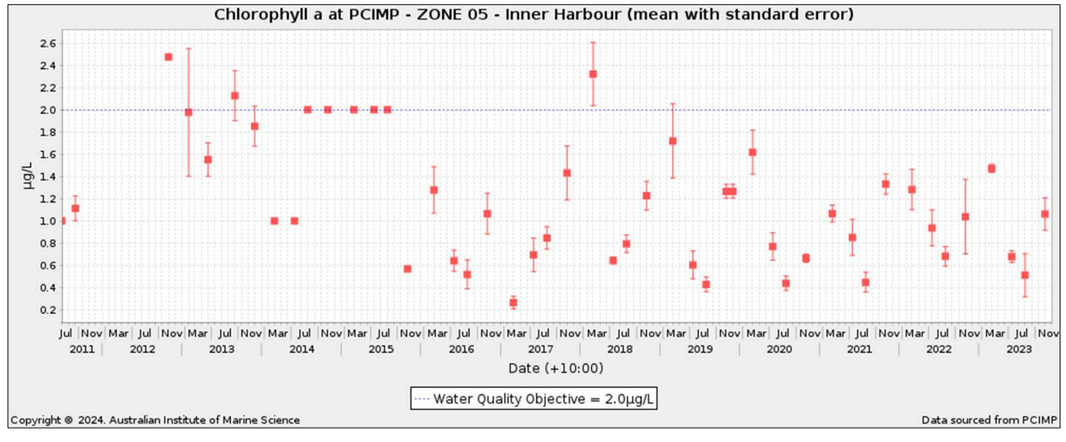
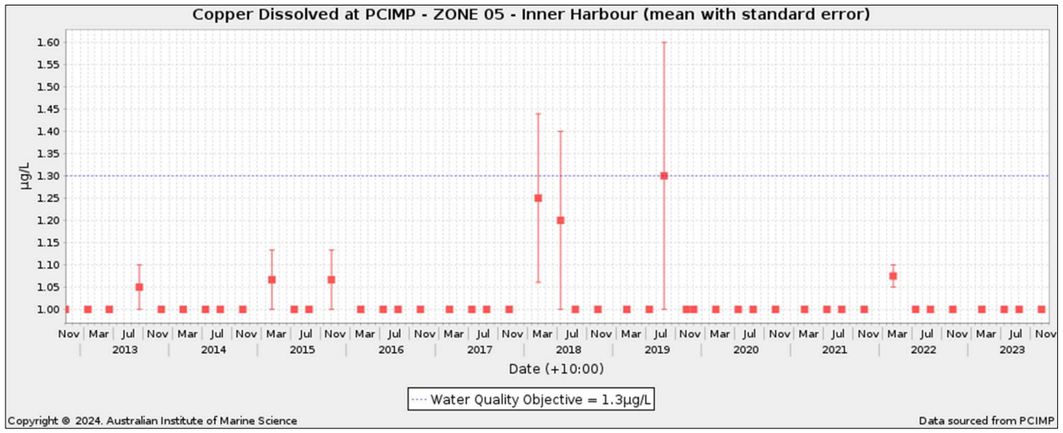
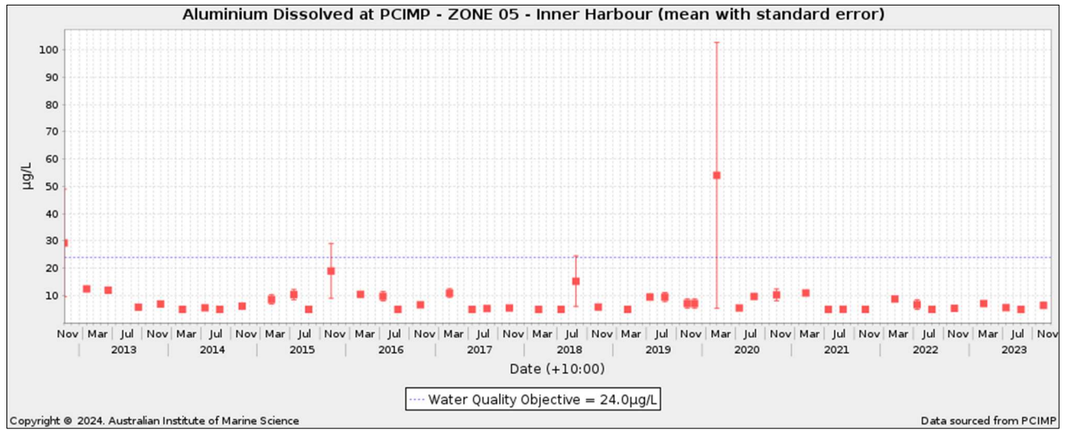
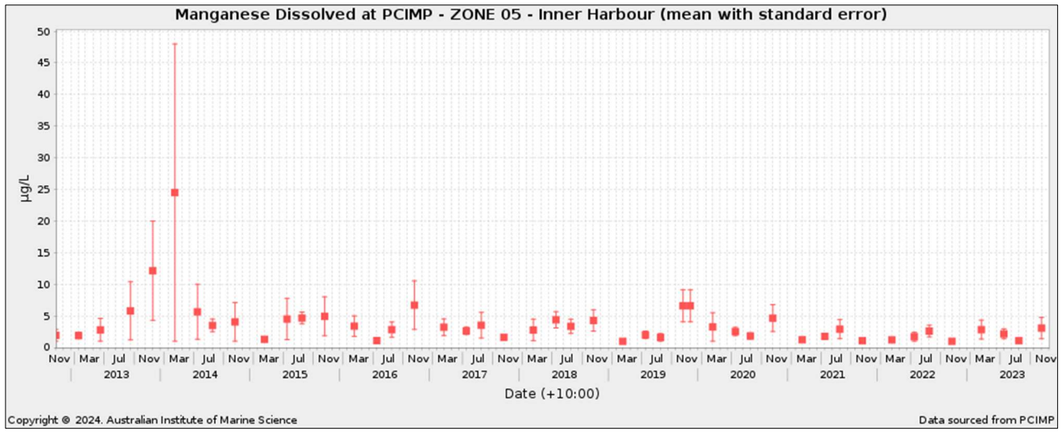
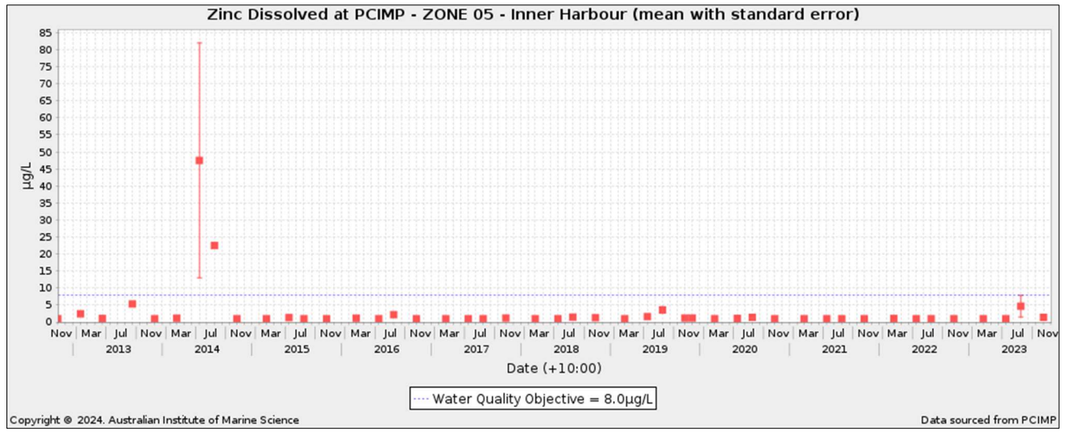


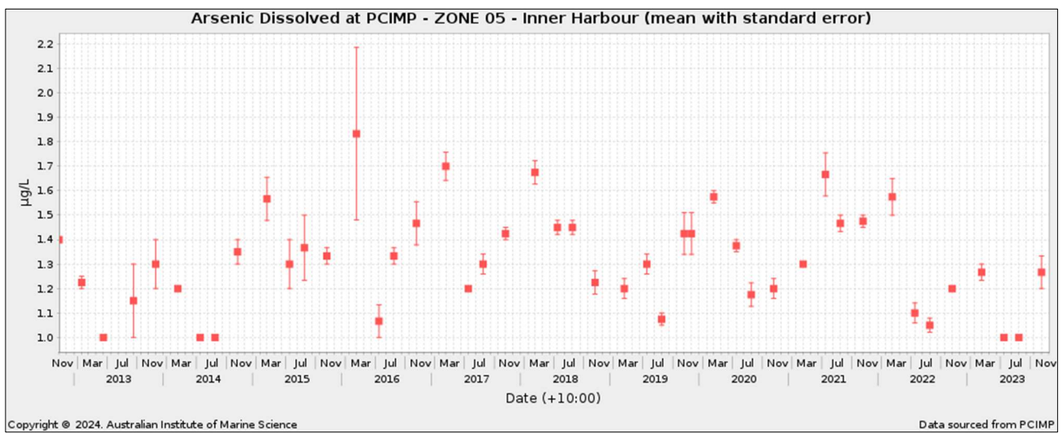
Figure 4-2 Mean (error bars ± SE) turbidity (NTU), TN, ammonia, NOx, TP, chlorophyll *a* (µg/L) – Inner Harbour water quality monitoring sites 2011-2021 (Source: PCIMP 2024)











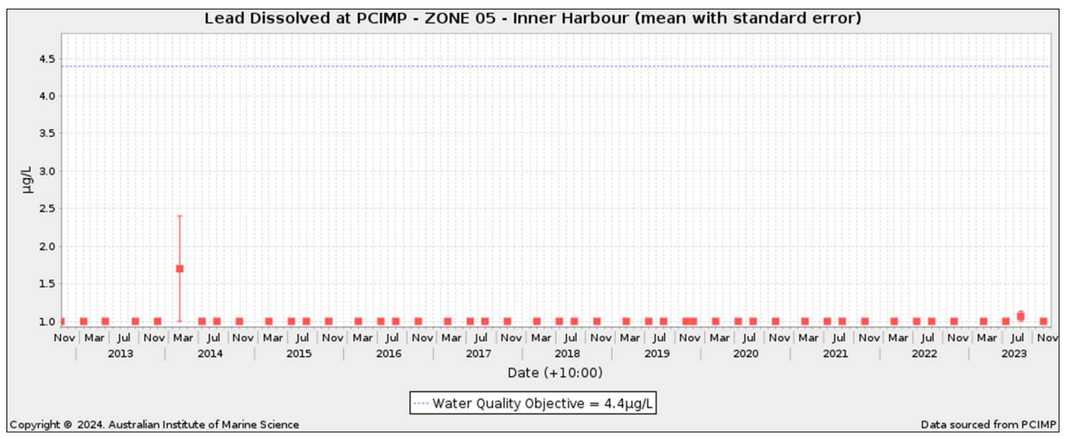


Figure 4-3 Mean (error bars ± SE) dissolved copper, aluminium, manganese, zinc – Inner Harbour water quality monitoring sites 2011-2021 (Source: PCIMP 2021)

4.2.2 Sediment Quality

The catchments that drain into PoG are mostly agricultural lands, with urban and industrial areas on the coastal fringe. Dredged sediments consist of sand/gravel in the channel, and mostly silts and clays in berths.

BMT WBM (2017a) reviewed Sediment Analysis Plan (SAP) reports for dredged areas in PoG. The review found that several metals/metalloids and organic pollutants (Polycyclic Aromatic Hydrocarbons (PAHs), and occasionally Total Petroleum Hydrocarbon (TPH)) were detected in dredged sediments, but all had average concentrations below the screening level or background (BMT WBM 2017a). On occasions, arsenic was elevated in places, however the average was well below screening level. Other contaminants, including Tributyltin (TBT) and pesticides were not detected or well below screening levels.

The sediment analysis plan (SAP) for the Western Basin Dredging and Disposal Project (BMT WBM 2014a) detected potential acid sulphate soil (PASS) in surficial layers, but at concentrations where minor or no treatment would be required if placed on land. In the 2017 maintenance dredging SAP, sediment samples from Upper Auckland Inlet, Gladstone Marina, and Gatcombe Head Harbour were the subject of ASS analytical testing. All Gladstone Marina and Gatcombe Head samples returned net acidity <0.02% S, which indicates that no further consideration of PASS) is required at these locations (AMA 2018).

GHHP scores derived from PCIMP data indicated that overall sediment quality scores were Very Good ('A') across all zones of the PoG in the period 2020-2023 (Table 4.3). Scores for individual parameters were typically also rated as 'A', except arsenic and nickel were occasionally good ('B') or satisfactory ('C'). The source of arsenic and nickel was likely natural (geological formation on the area) and not associated with anthropogenic inputs (Angel *et al.* 2012; GHHP 2023).

Table 4.3 Scores for sediment quality measures for each zone – 2023 (Source: GHHP 2023)

Zone	2023	2022	2021	2020
1. The Narrows	0.95	0.94	0.92	0.91
2. Graham Creek	1.00	0.97	0.95	0.90
3. Western Basin	0.99	0.98	0.99	0.98
4. Boat Creek	0.94	0.89	0.92	0.89
5. Inner Harbour	0.93	0.94	0.94	0.93
6. Calliope Estuary	0.97	0.97	0.95	0.95
7. Auckland Inlet	0.97	0.95	0.93	0.95
8. Mid Harbour	0.97	0.98	0.96	0.97
9. South Trees Inlet	0.96	0.97	0.97	0.96
10. Boyne Estuary	0.99	0.99	0.99	1.00
11. Outer Harbour	0.99	1.00	0.98	0.99
12. Colosseum Inlet	1.00	0.96	1.00	0.97
13. Rodds Bay	1.00	1.00	0.98	0.96
Harbour score	0.97	0.96	0.96	0.95

4.3 Marine Habitats and Communities

4.3.1 Marine Habitats

The PoG supports a range of intertidal and subtidal habitats that are important in maintaining a range of ecological values. Intertidal habitats (rocky shores, mangroves, saltmarsh, saltpan and mud flats) occur throughout the PoG area, and seagrass meadows and reefs are well developed.

The following provides a summary of the marine habitats located within or adjacent to dredge areas, namely seagrass meadows, reef communities and soft sediment habitats. Although extensive areas of intertidal habitat (mangroves, saltmarsh, saltpan and mud flats) occur throughout the PoG, these are outside of the zone of impact from dredging (see Section 5) and are not considered further.

4.3.1.1 Seagrass Meadows

Seagrass Species and Meadow Types

Six (6) species of seagrass have been identified in the PoG by JCU[5] namely: *Zostera muelleri*[6], *Halodule uninervis*, *Cymodocea serrulata, Halophila spinulosa*, *H. ovalis* and *H. decipiens*. *Cymodocea serrulata* is uncommon and has not been recorded in the study area in the last three (3) years (Smith *et al*. 2020).

Figure 4-4 shows two (2) broad types of seagrass meadow:

- Permanent/semi-permanent coastal meadows. This meadow type occurs on the tidal flats of PoG, and was numerically dominated by *Zostera* and a mix of *Halophila* species; and
- Deep water meadows (>5 m deep), which are typically sparser than coastal meadows and are typically dominated by *Halophila* species. This meadow type occurs in offshore coastal waters, which have higher water clarity than the enclosed waters of PoG. These are ephemeral meadows, varying in response to temporal changes in water clarity and disturbance.

Temporal Trends

The results of annual monitoring studies conducted by JCU on behalf of GPC indicate that the distribution, extent and density of seagrass meadows within the PoG and surrounds can show great variation over a range of temporal scales. At inter-annual timescales, there was a major reduction in seagrass meadow extent in the period 2009-2013, and a period of recovery in subsequent years (Figure 4-5). Between 2009 and 2011, seagrass cover and biomass at Fishermans Landing, Wiggins Island, and Rodds Bay had almost disappeared with average percent cover less than 1% (Sankey *et al*. 2011) and *H. ovalis* was no longer observed in the study area. The disappearance of seagrass from these areas was thought to be related to heavy rainfall associated with strong Southern Oscillation Index values for 2010 and 2011 (Sankey *et al*. 2011). Heavy rainfall associated with Cyclone Oswald resulted in further reductions in seagrass meadow extent between 2012 and March 2013 at Fishermans Landing, Wiggins Island and Rodds Bay (Amies *et al.* 2013). Overall, seagrass in the PoG and Rodds Bay was in poor condition from 2010 to 2017 following the abovementioned seagrass losses in 2009-2012 as a result of high rainfall and flooding events associated with extended La Niña weather conditions. From 2017, seagrass meadows have recovered, likely due to low catchment flows resulting in favourable conditions allowing seagrass to expand and maintain good overall condition (Smith *et al* 2022a).

[5] Refer to Section 2.1.2 regarding the previous names of organisations conducting seagrass monitoring
[6] *Zostera muelleri* subspecies *capricorni* (Ascherson) 1876 afterwards referred to as *Zostera muelleri*

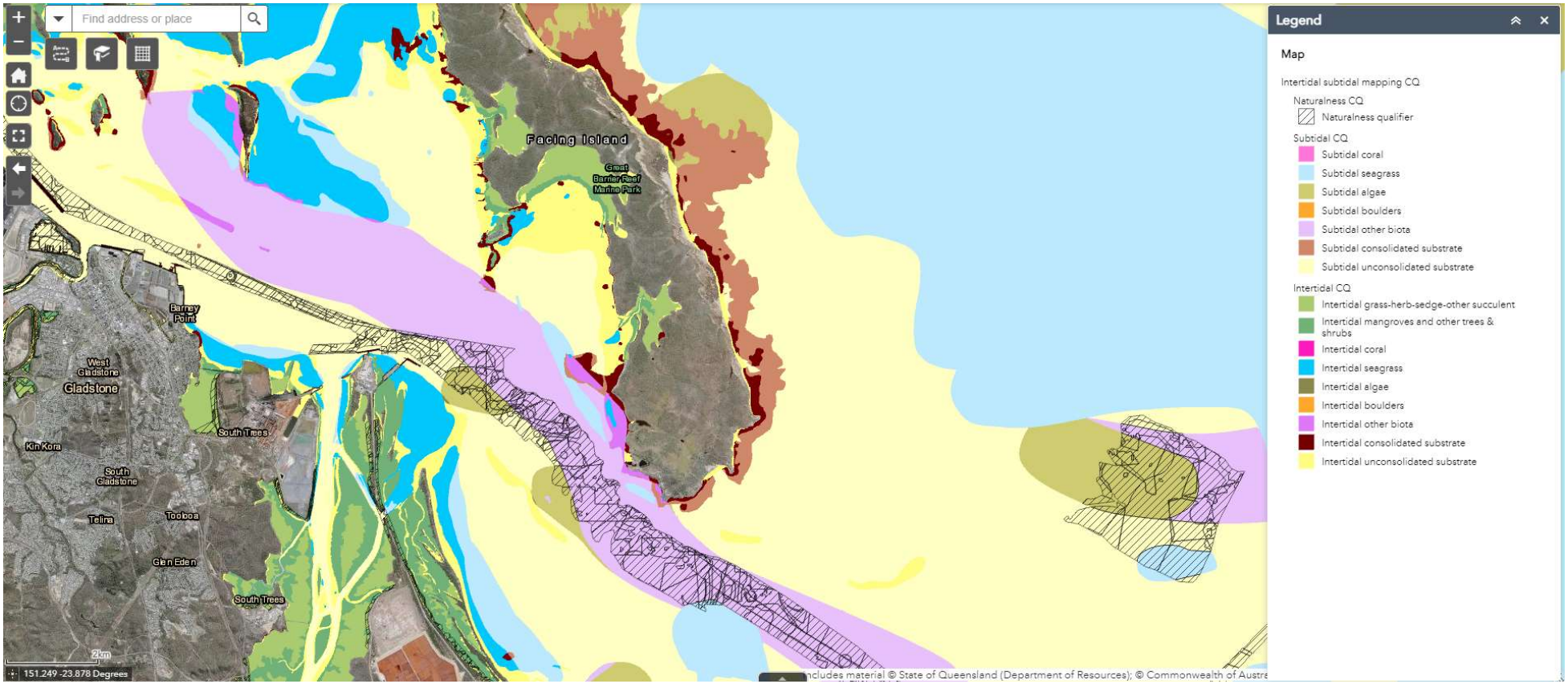


Figure 4-4 Intertidal and subtidal habitats of PoG, including modified habitats (naturalness qualifier) (Source: DES 2019)

As per water quality and sediments, the GPC seagrass monitoring program results are also utilised and reported by the GHHP who provided a composite seagrass condition grading for the period 2015-2023 (Figure 4-5). Key indicators within each of the monitoring meadows include:

- Biomass: changes in average above-ground biomass.
- Percent cover.
- Species composition: relative abundance of species.

Seagrass meadow condition remained in poor condition between 2015 and 2018. There was an improvement to seagrass meadow condition from score 'D' to 'B' between 2018 and 2020 respectively (Figure 4-5). From 2020 to 2022 seagrass condition remained relatively consistent when then it decreased to score 'C' in 2023 indicating an overall satisfactory condition. One of the main drivers for this decrease in overall score was the conditon of one of the key meadow, Pelican Banks (Meadow 43) which in 2023 was graded 'D' and thus in poor condition. Recent research conducted by Scott *et al*. (2021) suggests that the Pelican Banks meadow might be subject to high levels of herbivory from dugongs and turtles that may be altering the species composition and restricting recovery of this meadow and therefore resulting in lower grades (GHHP 2023). 2020).

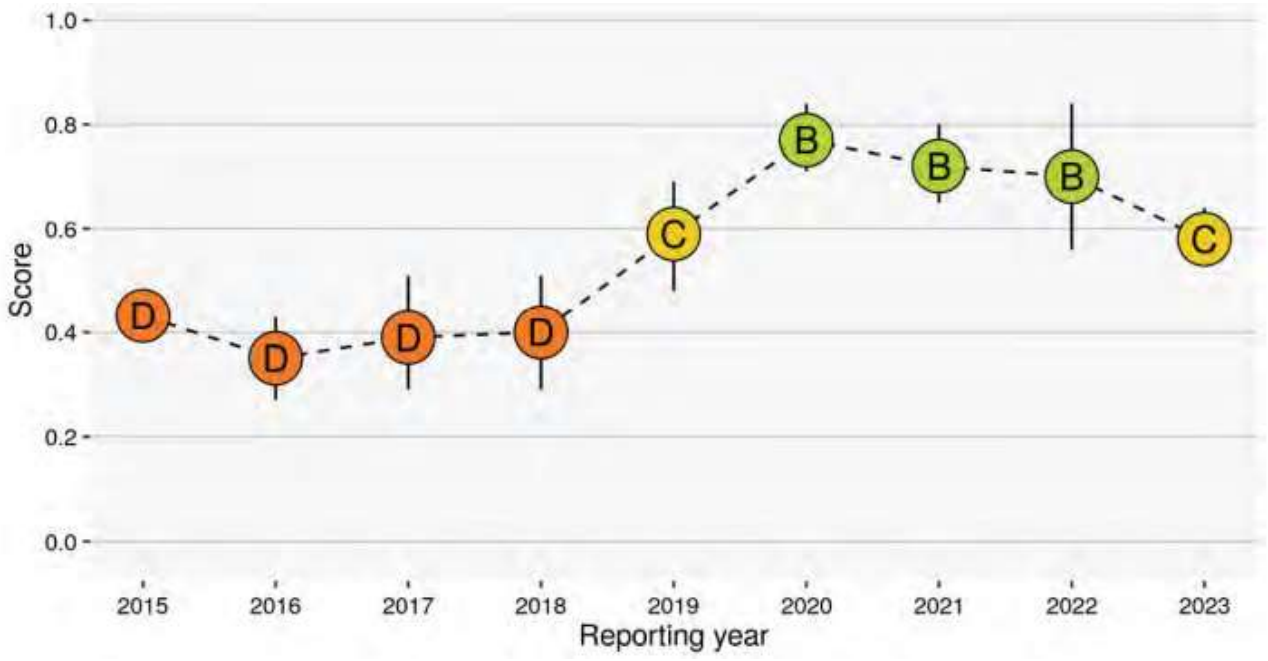


Figure 4-5 GHHP seagrass condition scores for the PoG (GHHP 2023)

4.3.1.2 Hard Substrate Habitats

Hard substrate habitats in the PoG are comprised of intertidal rocky shores, shallow water reefs, deep water cobble/bedrock reefs and artificial hard structures (rock walls, pylons etc.). Several studies have mapped the extent of hard substrate habitats within PoG (Rasheed *et al*. 2003; Connolly *et al*. 2005; BMT WBM 2009a and 2015; DES 2023a).

Inter-tidal Rocky Shores

The natural rocky shores along the south-west coast of Curtis Island consist of terrigenous fringing reefs (see Figure 4-4). The supra-littoral and upper intertidal zone of these rocky shores was typically comprised of unconsolidated soft sediment (mud, sand and gravel), and the mid to lower intertidal zone was comprised of either massive/bedrock platform reef, boulder fields or rubble fields (BMT WBM 2009a). All rocky shores in this area were dominated by oysters in the intertidal zone, and sponges, soft coral, hydroids, gorgonians and algae in the subtidal zone (BMT WBM 2009a).

Shallow-water Reefs

BMT WBM (2009a) recorded high hard coral cover at several shallow (<2 m deep) subtidal reefs in the study area including Bushy Island, Manning Reef and surrounding Facing Island. Follow-up surveys in 2014 indicate that reef communities within the study area experienced a major change in structure since the 2009 baseline surveys (BMT WBM 2015). In contrast to 2009 surveys, reefs in PoG in 2014 had minimal living hard coral cover, and were dominated by bare substrate, turfing algae and macroalgae. Reef communities between the PoG and Rodds Bay also had low hard coral cover, however, limited baseline data make changes through time difficult to determine. Nearshore reefs along the eastern coastline of Facing Island, which are less affected by floods, had diverse and abundant hard coral cover in 2014, similar to 2010 survey results (BMT WBM 2015). Water quality modelling and measurements indicate that reefs within the PoG were strongly affected by flood events in 2010 and 2013, with reduced salinities and high turbidity likely to be a major driver of change in coral cover (BMT WBM 2015).

Coral monitoring undertaken in 2015 revisited a small selection of the previously surveyed sites within the PoG (Thompson *et al.* 2015), all of which were noted by BMT WBM (2015) as having experienced coral loss. Thompson *et al.* (2015) found that the surveyed reef communities had not recovered to pre-2010 levels of coral cover.

GHHP (2020) undertakes annual monitoring of coral condition. Four (4) sub-indicators of coral health were measured to calculate the Gladstone Harbour Report Card coral score:

(1) Coral cover (%): the combined cover of hard and soft corals observed at the monitored reefs

(2) Macroalgal cover (%): the cover of macroalgae observed at the monitored reefs

(3) Juvenile coral density (m^2): the density of juvenile corals observed at the monitored reefs

(4) Change in hard coral cover (%): averaged over a three (3)-year period to give the rate at which hard coral cover increases or decreases.

Coral condition grades for the 2015-2023 period are shown in Figure 4-6. Coral condition grade has remained in very poor condition (score ‘E’) in most years except 2017 when consition was poor (score ‘D’). This indicates that reefs had low living coral cover, low numbers of juveniles, and that macroalgae numerically dominated reefs. This suggests that corals display little evidence of recovery, and a phase shift

from coral to macroalgae dominance. A combination of factors appears to be restricting coral recovery, including interactions with macroalgae (shading, competition), interactions with bio-eroding sponge *Cliona orientalis*, and high water temperatures resulting in coral bleaching in some areas.

Given the poor condition of coral assemblages, it is expected that:

- Recovery will be dependent on inputs from areas outside PoG;
- Recovery timeframes, if it occurs, are expected to be measured in years to decades; and
- Coral assemblages will continue to have low resilience and capacity to cope with additional stressors (e.g. increased sediment concentrations, low salinity due to rainfall) during this recovery period.

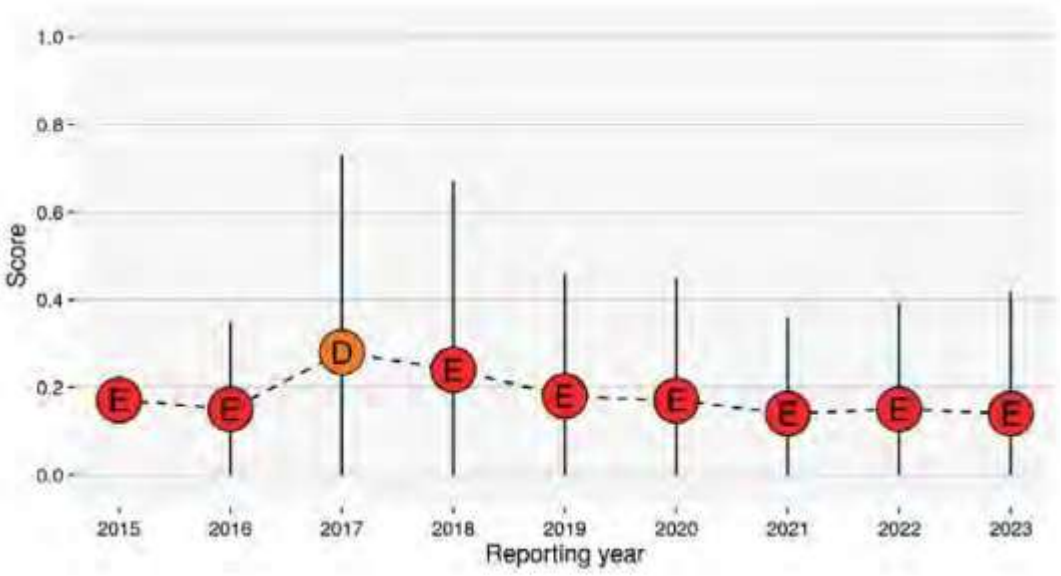


Figure 4-6 GHHP coral condition scores for the PoG (GHHP 2023)

Deep Water Communities

Rasheed *et al.* 2003 mapped deep water benthic communities in 2002 where many remote camera deployments were used to map benthic community types throughout PoG and Rodds Bay. The spacing of points within each habitat class polygon is relatively sparse, varying between 1.2 and 4 km. Rasheed *et al*. 2003 used four (4)-minute camera tows at drift speeds less than one (1) knot to classify communities into density categories consisting of:

- Open substrate – dominant feature was bare substrate with occasional isolated benthic macro-invertebrate individuals,
- Low density – benthic macro-invertebrates present on the screen for <10% of the site video record,
- Medium density – benthic macro-invertebrates present in 10-80% of the site video record, and,

- High density – benthic macro-invertebrates present on the screen for >80% of the site video record.

The distribution of benthic communities and the intensity of sampling used to make these classifications are shown in Figure 4-7. This work demonstrated that the deep inner harbour section of PoG (Benthic community region 9 in Figure 4-7) was composed of moderate density rubble reef communities dominated by bivalves, ascidians, bryozoans and hard corals. From Fishermans Landing to South Trees, the deep water benthos consisted of scallop and rubble reef along the most of the natural channel (Figure 4-7 region 18), while the channel arm near Curtis Island (Figure 4-7 region 8) was mostly open substrate. Downstream from South Trees to East Banks Offshore MRA epibenthic communities (Figure 4-7 regions 16, 22, 23) were also classified as high density rubble reefs, with dominant taxa including scallops, bryozoans, sponges, ascidians, bivalves, soft and hard corals. The relatively high densities of epibiota were a significant finding and believed to be the result of strong tidal currents acting as a food supply for filter feeders. Another significant finding from this study was the presence of hard corals at several community regions. Moderately dense hard coral colonies were observed at benthic community regions 16, 17, and 23; south and west of Facing Island and surrounding Seal Rocks.

These deep-water rubble/soft sediment substrates do not represent habitats for reef building (hermatypic) corals. There are knowledge gaps regarding the distribution, extent and ecology of these deep-water systems (see BMT WBM 2014b), but it can be reasonably inferred that species in these environments have adaptations that allow them to cope with a range of stressors including high turbidity, high sediment deposition, no to low light, and periodic low salinity conditions.

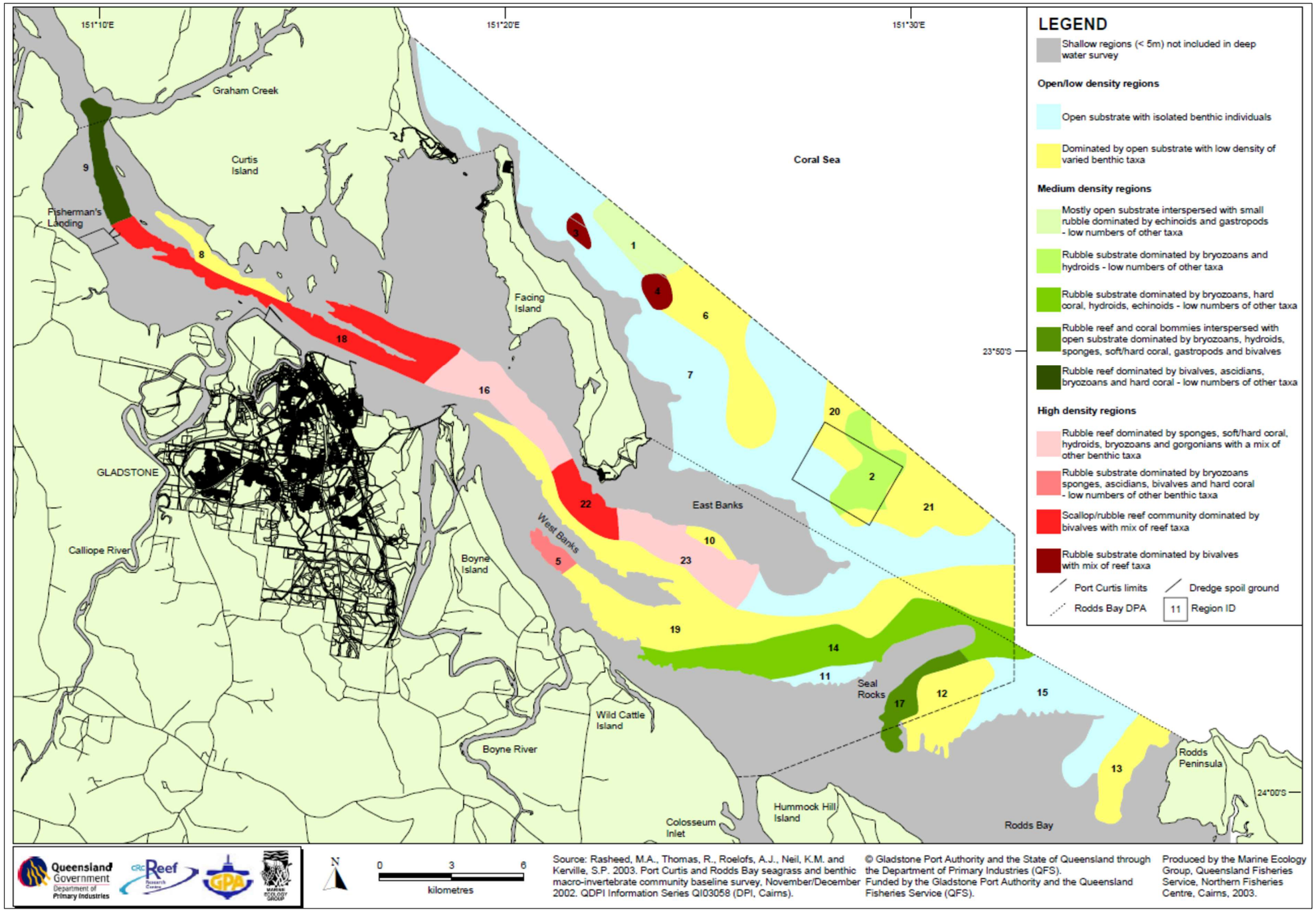


Figure 4-7 Deep Water Benthic Macro-Invertebrate Regions in PoG, November/December 2002 (Source: Rasheed *et al.* 2003)

4.3.1.3 Soft Sediment Habitats and Communities

Soft sediment invertebrate communities within PoG were comprehensively described by Currie and Small (2005) and have been described in lesser detail by LNG project proponents. Moreover, as part of the PoG LMDMP and associated long-term monitoring schedule, regular studies on soft sediment communities within and adjacent to the East Banks Offshore MRA have been conducted. Most recent studies were conducted by BMT WBM (2012a), Vision Environment (2017) and Smith *et al*. (2022).

Currie and Small (2005) investigated changes in macroinvertebrates at 30 sites in PoG, twice yearly, over six (6) years between 1995 and 2001. Currie and Small (2005) found that the bivalve *Carditella torresi* and to a lesser extent, the sea-squirt *Ascidia sydneiensis*, were the most abundant taxa, particularly in subtidal waters. Great variability in community structure was observed. Gradients in abundance and species richness were principally driven by depth and sediment grain size, with extremely fine, or extremely coarse sediments having the lowest richness and abundance. Species richness and abundance were lowest on intertidal muddy substrates, and greatest in coarse, sandy sediments predominantly occurring in the deeper channels of the estuary. Bivalve molluscs, ascidians, polychaetes and pistol shrimp (*Alpheus* sp.) were among the most important taxa defining the difference between intertidal and subtidal sediments.

Nearshore tropical and sub-tropical benthic fauna communities are dynamic, varying across multiple temporal scales (Stephenson 1980; Currie and Small 2005; BMT WBM 2012a). Currie and Small (2005) found that benthic communities in PoG did not show predictable seasonal trends, unlike in higher latitudes where seasonal changes in water temperature and other processes can lead to changes in community structure. Instead, Currie and Small (2005) found that temporal changes in communities were more closely aligned with the Southern Oscillation Index (SOI), with the most significant El Niño (drought) episode during the measurement period coincident with a halving of taxa richness and abundance. Correlation analysis found significant positive correlations between benthos abundance/richness and turbidity, on which Currie and Small (2005) concluded that high turbidity provided favourable conditions for benthic communities.

It is possible that Tropical Cyclone Yasi and associated flooding in 2011 had resulted in changes to benthic communities since the Currie and Small (2005) study. For example, BMT WBM (2012a) examined temporal patterns in benthic communities at and near the East Banks Offshore MRA. No strong seasonality was observed, however benthic abundance and to a lesser extent richness was observed to significantly decline at most locations immediately before and one month after Tropical Cyclone Yasi. Other case studies demonstrate that river flows and associated nutrient inputs can promote benthic abundance in the longer term (e.g. review by Gillanders and Kingsford 2002). No significant changes in communities were observed over the East Bank Offshore MRA and surrounding environments between the 2016 and 2017 wet season and the 2017 dry season (Vision Environment 2017).

Table 4.4 Abundance (per 0.1 m^2) and richness measured by Currie and Small (2005)

Parameter	Currie and Small (2005)
Dominant taxa	*Carditella torresi* (14% of individuals), *Ascidia sydneiensis* (4% of individuals)
Proportion of uncommon taxa (accounting for <2% of individuals)	98% of species
Mean (± s.e.) no. individuals per 0.1 m^2	5.9 ± 0.40 to 24.4 ± 1.25
Mean (± s.e.) no. taxa	3.6 ± 0.20 to 11.6 ± 0.48 per 0.1 m^2
Mean (± s.e.) no. polychaetes per 0.1 m^2	1.0 ± 0.09 to 8.0 ± 0.59
Mean (± s.e.) no. molluscs per 0.1 m^2	4.0 ± 0.32 to 10.3 ± 0.71
Mean (± s.e.) no. crustaceans per 0.1 m^2	0.6 ± 0.09 to 2.7 ± 0.28

Vision Environment (2017) undertook an assessment of benthic macroinvertebrate abundance and richness assemblages within the maintenance dredge footprint and adjacent non-dredged areas. The results of this study are difficult to compare with those recorded in Currie and Small (2005) or BMT WBM (2012a) due to the different authors reporting grab volume versus grab area. Notwithstanding this, Vision Environment (2017) found no significant difference in macroinvertebrate communities in areas that had been dredged and undredged areas (Vision Environment 2016). This suggests that benthic assemblages may have a high capacity to recover from disturbance due to maintenance dredging. The most recent study conducted by Smith *et al*. (2022) corroborates previous investigations findings reporting no evidence of maintenance dredging sediment deposition in the East Bank Offshore MRA having measurable effects on benthic habitats sourrounding the area. Infauna communities were found to be more diverse and abundant within and to the east of the the East Bank Offshore MRA than to the west of the area and at control locations. Moreover due to differences in methodologies between studies, infauna assemblages could not be statistically compared, however overall composition and distribution were similar to what highlighted in previous investigations (Smith *et al*. 2022).

4.3.1.4 Fish Communities from Soft Sediments

PoG contains a broad range of habitats for marine and estuarine fish. Connolly *et al.* (2006) undertook the most detailed fish surveys in PoG, where 105 intertidal and shallow subtidal sites were surveyed using a 5 m wide beam trawl.

The survey recorded 88 fish species and 2294 individuals from 315 replicate trawl shots. Small schooling fish dominated the samples as is typical of similar environments elsewhere in Queensland (Blaber *et al.* 1989). Approximately 30 of the fish species recorded were of direct or indirect economic importance.

Sites located on mud flats and seagrass meadows in the study area had the richest (i.e. highest number of species) and most abundant fish assemblages on a PoG wide scale (Figure 4-8). Connolly *et al.* (2006) also found that seagrass meadows had a distinctive fish fauna that differed from assemblages on 'unvegetated' habitats, emphasizing the importance of seagrass in maintaining marine fish communities.

Connolly *et al.* (2006) also undertook studies using stable isotope analysis to trace energy pathways and nutrient cycling in PoG. They found that seagrass was an important component at the base of food webs,

including in areas beyond the seagrass meadows themselves. The analysis suggested that the food webs that sustain many economically important fisheries species caught over mudflats (e.g. whiting) and in mangrove-lined creeks (e.g. mud crabs) rely largely on organic matter produced in seagrass meadows.

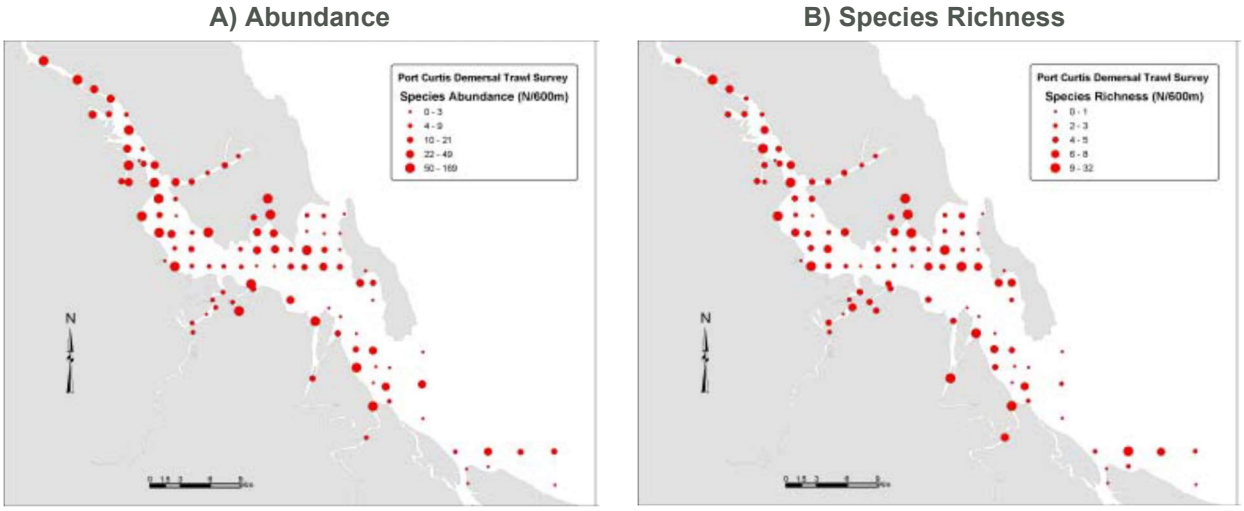


Figure 4-8 Map of PoG showing a) Total Species Abundance and b) Total Species Richness of Demersal Fish Collected from three (3) Replicate Beam Trawl Samples (200 m Length) at 105 Sampling Stations (Source: Connolly *et al.* 2006)

4.4 Matters of National Environmental Significance (MNES)

According to the PMST report, relevant MNES are; Threatened Species, Listed Migratory Species, World Heritage Area, Natural Heritage Property and GBR Marine Park (GBRMP), as summarised in Table 4.5 and detailed in the following sections (refer Appendix A).

Table 4.5 Summary of MNES Protected Matters Search Tool Results

MNES	Search Area (PMST)	Areas Influenced by Dredging and Offshore Placement
Threatened Ecological Communities (TECs)	Seven TECs	None – does not occur in subtidal waters
Threatened Species	67 species (turtles, cetaceans, sharks, birds, terrestrial fauna)	Likely – multiple marine species
Listed Migratory Species	68 species (turtles, cetaceans, sharks, birds, terrestrial fauna)	Likely – multiple marine species
World Heritage Area	Present – GBR World Heritage Area (GRBWHA)	Present – GBRWHA
Natural Heritage Property	Present – GBR Natural Heritage Property (GBRNHP)	Present – GBRNHP
GBRMP	Present	Outside dredging and placement sites. GBRMP (General Use zone) adjacent to East Banks Offshore MRA

MNES	Search Area (PMST)	Areas Influenced by Dredging and Offshore Placement
Wetlands of International Importance	None	None
Commonwealth Marine Area	None	None

4.4.1 Threatened Ecological Communities (TECs)

TECs occurring in the Gladstone region are restricted to lands above high water, outside the area of influence of maintenance dredging or dredge material placement and have therefore not been summarised in this report (AECOM 2016 and Appendix A).

4.4.2 Threatened and Listed Migratory Species

Threatened and Listed Migratory species, known to be occurring or possibly occurring in the search area are detailed in the following sections and summarised in Table 4.7.

Bony Fish

The Atlas of Living Australia (ALA) has records of the endangered White's seahorse in the PoG prior to 1940 (ALA 2023). This species is highly sensitive to habitat disturbance and has declined in abundance in estuarine areas in NSW. Suitable habitat for this species occurs near the study area (i.e. soft corals/hard substrate) however, it is unknown whether this species is currently supported in central Queensland (Short *et al*. 2019).

Sharks and Rays

Several threatened and/or listed migratory pelagic shark and ray species have the potential to occur in thePoG. The dredge and placement sites are impacted sites undergoing regular modification unlikely to represent high quality or otherwise important habitat for these species.

Green sawfish is a demersal species that utilises habitats like those within the study area. Based on the analysis of Queensland Beach Control Program catch records for the Cairns, Townsville and Rockhampton regions, a major decline in sawfish catches was observed in the 1970's and 1980's, and no sawfish have been recorded by the netting program in the Rockhampton region since the early 1990's (Stevens *et al.* 2005). This species is now thought to be restricted to waters north of Cairns. With the range retraction and its sensitivity to disturbance, it is considered unlikely that the nearshore waters of PoG currently represent important habitat for green sawfish (Stevens *et al.* 2005). .

Marine Mammals

Dolphins

Australian humpback (*Sousa sahulensis*) and snubfin dolphins (*Orcaella heinsohni*) (humpback and snubfin dolphins hereafter) are medium sized delphinids, both less than 270 cm in length (Cagnazzi 2017). In Queensland, both species are listed as 'vulnerable' under the *EPBC Act* (Woinarksi *et al.* 2014). Humpback and snubfin dolphins are considered opportunistic generalised feeders, feeding on a wide variety of prey species that are readily available (Cagnazzi 2017).

Snubfin dolphins live in small populations of approximately 500 to 100 individuals, inhabit shallow inshore and estuarine waters, exhibit fine-scale population structure and have relatively small home ranges (DoE 2013). Snubfin dolphins have been confirmed to only occur in Port Alma and Keppel Sands, and therefore not within the study area (Cagnazzi 2017).

Recent genetic studies indicate Australian humpback dolphins live in small and relatively isolated populations with limited gene flow among them (Parra and Cagnazzi 2016). As reported by Parra and Cagnazzi (2016), the available abundance estimates range from 14 to 207 individuals and no population studied to date, is estimated to contain more than 104 mature individuals. Studies have sighted Australian humpback dolphins over an area extending from Keppel Sands down to Rodds Bay and thus could occur at dredge and placement sites

Whales

Humpback whales (*Megaptera novaengliae*) are a migratory marine species listed as vulnerable under the *EPBC Act.* Humpback whales generally occur in offshore areas and are observed off Curtis Island (DIP 2010). Whales considered to be the melon-headed whale (*Peponocephala* electra) have been recorded in shallow waters north of Curtis Island (DIP 2010).

Based on records in ALA (2023), the dredge site and Tide Island MRA are not known to represent high quality whale habitat. It is possible that whales may occasionally traverse these areas.

Dugongs

Dugongs (*Dugong dugon)* are a migratory marine species, with dugongs or dugong habitat known to occur within the study area (PMST). Under the *EPBC Act,* dugong in Queensland are listed as a 'vulnerable' species.

The PoG and Rodds Bay area is a potentially important connecting habitat for dugong populations in southern Queensland (Sobtzick *et al.* 2013, 2017, Cleguer *et al*. 2015). Dugong are common in PoG, utilising a large area where extensive seagrass meadows support feeding (Rasheed *et al*. 2017). However, there are no seagrass meadows at and immediately adjacent to dredge and placement sites.

Dugong may transit through the study area when moving between seagrass meadows. Moreover, the placement site is located within the PoG and Rodds Bay dugong protection area (DPA) (listed under the *Fisheries Act 1994),* and is mapped as part of a BIA for dugong in the National Conservation Values Atlas (NCVA).

Turtles

Queensland's coastlines support significant populations of threatened species of marine turtles as summarised in Table 4.6 Species of marine turtle found in Queensland and their conservation status (QPWS 2021 and DES 2021). The green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), loggerhead turtle (*Caretta caretta*) and hawksbill turtle (*Eretmochelys imbricate*) are the relatively the most common found within the PoG. Nesting in this area has only been recorded for green, flatback and loggerhead turtles with the most prevalent and thus well studied species within the PoG being the green turtle. Species such as olive ridley have instead been seldom recorded throughout the harbour or broader area with no record of this species breeding in eastern Australia (Limpus *et al*. 2013 and 2013a).

Table 4.6 Species of marine turtle found in Queensland and their conservation status (QPWS 2021 and DES 2021)

Common name	Scientific name	Conservation status		
		Queensland (NC Act)	Commonwealth (EPBC Act)	IUCN Red List
Flatback turtle	*Natator depressus*	Vulnerable	Vulnerable	Data deficient
Green turtle	*Chelonia mydas*	Vulnerable	Vulnerable	Endangered – global
Loggerhead turtle	*Caretta caretta*	Endangered	Endangered	Vulnerable – global; critically endangered in South Pacific
Hawksbill turtle	*Eretmochelys imbricata*	Endangered	Vulnerable	Critically endangered – global
Olive ridley turtle	*Lepidochelys olivacea*	Endangered	Endangered	Vulnerable – global

The **flatback turtle** (*Natator depressus*) is the most common species to nest in the Gladstone region . Flatback turtle nesting areas recorded near the study area are Tannum Sands, Hummock Hill Island and the eastern side of Facing Island, all of which represent low density nesting areas (Hamann *et al.* 2017). One (1) to 10 female flatback turtles have been estimated to nest within the PoG (from Boyne Island to Hummock Hill) each year (DES 2022, FBA 2023). Hamann *et al.* (2017) concluded that the waters immediately offshore of Curtis and Facing Islands, the waters along the southern coast of Facing Island and the waters between Facing Island and the mainland are important habitat for inter-nesting flatback turtles, and that adult female flatback turtles will be present in these areas from October to January each year. The entire study area is defined as a Biologically Important Area (BIA) for Flatback turtle nesting (Appendix E), but is not a Critical Habitat (CH) (DCCEEW 2022). Flatback turtles are expected to traverse and feed in and around Gladstone Harbour, including the project area (Limpus *et al*. 2013).

Green turtles (*Chelonia* mydas) are the most common within the PoG and utilise this area to feed on seagrass, algae and mangrove fruits (Limpus *et al.* 2017). Studies have shown that the PoG is not a significant area for aggregation of breeding green turtles for courtship or mating. Whilst this species has been recorded nesting within the PoG such as on Curtis and Facing Island beaches, offshore islands of the GBR are the preferred locations for this purpose (Limpus *et al* 2013; Limpus and FitzSimmons 2020). More recent surveys conducted in the 2021-2022 and 2022-2023 report green turtle nesting on Wild Cattle Island, Canoe Point and Tannum Sands (FBA 2022; FBA 2023). Tagging studies conducted on green turtles indicate that individuals display a high degree of fidelity to foraging areas within Pelican Banks (Hamann *et al.* 2015) which also corroborates what reported in Section 4.3.1.1. Other tagging studies reported that green turtles were most abundant at Pelican Banks and Wiggins Island with particularly juvenile individuals found in shallow intertidal areas (Limpus *et al.* 2017).

From the studies reported above and related information, green turtles feed on seagrass meadows within the PoG, including meadows located in shallow areas of the inner PoG and thus they may traverse through the Tide Island MRA and dredge site as they move between seagrass meadows.

Loggerhead turtle (*Caretta caretta*) CH (nesting) occurs: (i) from Rodds Peninsula/Eurimbula National Park south to Hervey Bay, and (ii) approximately 15 km from the east side of Facing Island (DCCEEW 2022).Nesting of this species has also been reported on Facing Island (FBA 2022) The BIA (inter-nesting and foraging habitat) occurs: (i) waters in the eastern portion of Hummock Hill Island to Hervey Bay; and (ii) approximately 15 km from the east side of Facing Island (DCCEEW 2022). Refer to Appendix E for mapping. DES (2022) estimated one (1) to 10 female loggerhead turtles nest on the northern beaches of Eurimbula (Rodds Peninsula) and Middle Head (Bustard Head Conservation Park). These nesting sites are located east and south of the dredge and placement areas, respectively. Based on the above information, loggerhead turtles are unlikely to traverse the dredge and placement areas.

Other Marine Species

The PMST search identified several species of sea snake, pipefish and sea horses occur or could occur in the PoG (Appendix A). These species could occur across a wide range of habitats found within the PoG, and are all considered listed protected marine species, with both sea snakes, pipefish and many seahorses species not considered threatened. However White's Seahorse, Crowned Seahorse, and Sydney Seahorse are considered ‘Endangered’ under state legislation or the EPBC Act.

PoG provides potential foraging habitat for migratory saltwater crocodile. The ALA (2023) and the Queensland Government Crocodile Sightings Dashboard (DES 2023b) have one record of saltwater crocodile in the lower Calliope River.

Table 4.7 Threatened and listed migratory species (marine species) defined in the PMST report, and likelihood of occurrence in dredging/placement site and surrounds

Common Name	Species Name	EPBC Act Status	NC Act Status	Type of Presence (PMST)	Records (ALA+Wildnet)	Habitat (SPRAT[7]) Potential Occurrence in Dredging/Placement Sites	Important Areas (BIA, CH, Recovery Plans) in Region
Bony Fish							
White's Seahorse	*Hippocampus whitei*	Endangered	Endangered	Species or species habitat may occur within area	Historical ALA record in the PoG and other locations in central Queensland (all pre-date 1940). No nearby Wildnet sightings.	Depth 1-15 m; inhabits seagrass, soft coral, macroalgae, sponges and artificial structures, which are represented at and adjacent to dredge /placement sites. Highly sensitive to habitat disturbance, unknown whether species still supported in central Queensland (Short *et al*. 2019).	None
Mammals							
Blue Whale	*Balaenoptera musculus*	Endangered, Mig	-	Species or species habitat may occur within area	No ALA records in the PoG, historical and contemporary records from Port Alma area. Historical Wildnet sighting off Saint Lawrence.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to the PoG, and highly unlikely to regularly use dredge/placement sites. Seasonal migrations (summer) (ALA 2023)	None
Humpback Whale	*Megaptera novaeangliae*	Vulnerable, Mig	Vulnerable	Species or species habitat known to occur within area	Historical ALA and Wildnet records in the PoG, multiple contemporary records in offshore waters	Pelagic, coastal and offshore waters. Transient visitor to the PoG, unlikely to regularly use dredge/placement sites (ALA 2023).	All Queensland coastal waters represent BIA (breeding/calving)
Australian Snubfin Dolphin	*Orcaella heinsohni*	Mig	Vulnerable	Species or species habitat known to occur within area	No ALA records in the PoG, historical and contemporary ALA records in the wider region. Historical Wildnet sighting in the PoG and contemporary sightings off Yeppoon.	Coastal and estuarine water – close to river mouths and seagrass meadows. This species has a geographic range that extends south to Gladstone (AMCS 2023). It has been recorded in Port Alma (Cagnazzi 2017), located north of PoG. Snubfin dolphins have been confirmed to only occur in Port Alma and Keppel Sands, and therefore not within the study area (Cagnazzi 2017).	None
Australian Humpback Dolphin	*Sousa sahulensis (=chinensis)*	Mig	Vulnerable	Breeding known to occur within area	Numerous contemporary ALA and Wildnet records in PoG. This species is abundant in Gladstone Harbor (Cagnazzi 2017).	Inlets, estuaries, major tidal rivers, shallow bays, inshore reefs and coastal archipelagos. This species is abundant in Gladstone Harbor (Cagnazzi 2017) and likely feeds in dredge/placement sites.	BIA (feeding, calving) – coastal waters south of Shoalwater Bay to Rodds Bay (particularly Port Alma and the PoG), within the 20 m depth contour
Dugong	*Dugong dugon*	Mig	Vulnerable	Species or species habitat known to occur within area	Two ALA records from the PoG. Historic Wildnet sightings in the PoG.	Seagrass meadows (foraging). Known to be common, especially in seagrass meadows throughout the PoG (Rasheed *et al*. 2017). May occasionally transit through dredging/placement sites (Cleguer *et al*. 2015).	Rodds Bay Dugong Protection area
Bryde's Whale	*Balaenoptera edeni*	Mig	-	Species or species habitat may occur within area	No ALA or Wildnet records for the PoG, but recorded elsewhere in the central Queensland coastal region	Pelagic, coastal, and offshore waters. Possible (but highly unlikely) transient visitor to the PoG, and highly unlikely to regularly use dredge/placement sites (ALA 2023).	None
Killer Whale	*Orcinus orca*	Mig	-	Species or species habitat may occur within area	No ALA records for the PoG, but recorded elsewhere in the central Queensland coastal region. No nearby Wildnet records.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to the PoG, and not known to regularly use the the PoG or dredge/placement sites (ALA 2021).	None
Reptiles							
Loggerhead Turtle	*Caretta caretta*	Endangered	Endangered	Breeding known to occur within area	Two ALA and Wildnet records in the PoG (1989, 1997) – Boyne Island and Calliope River.	Nesting sandy beaches (including central Queensland), foraging mainly in open waters (FBA 2022). Nesting occurs within, the PoG including Curtis (South End Beach) and Facing Island and Woongarra coast (Limpus *et al.* 2016)	Critical Habitat (nesting) – beaches south of Elliot Heads and offshore islands of Capricorn Bunker group, remote from dredging/placement BIA (inter-nesting) – waters extending from Turkey Beach around past Agnes Water, remote from dredging/placement
Green Turtle	*Chelonia mydas*	Vulnerable	Vulnerable	Breeding known to occur within area	Numerous records throughout harbor, especially Pelican Banks and Western Basin. Historic Wildnet records in Calliope River.	Based on Limpus and FitzSimmons (2020): (i) the most abundant sea turtle in the PoG; (ii) key feeding aggregations at Pelican Banks and tidal flats adjacent to estuaries; (iii) no feeding aggregations in turbid waters of the Western	None

[7] Habitat descriptions extracted from Species Profile and Threats Database (SPRAT).

Common Name	Species Name	EPBC Act Status	NC Act Status	Type of Presence (PMST)	Records (ALA+Wildnet)	Habitat (SPRAT[7]) Potential Occurrence in Dredging/Placement Sites	Important Areas (BIA, CH, Recovery Plans) in Region
						Basin; (iv) most juveniles occur around rocky reefs and mangroves; (v) foraging turtles have high site fidelity, except when undertaking breeding migrations; (vi) the PoG is not a significant courtship, mating or nesting area, however low density nesting does occur on sandy beaches (FBA 2022; FBA 2023).. The Project area has soft substrates which do not represent foraging habitat for this species. Likely to transit through the Project area.	
Leatherback Turtle	*Dermochelys coriacea*	Endangered	Endangered	Species or species habitat known to occur within area	No records in ALA, but likely to occur. Historical Wildnet records off Agnes Waters and Heron Island.	Nesting sandy beaches (PoG is not a key area), foraging in open waters. Possible transient visitor to the PoG, unlikely to regularly use dredging/placement sites (ALA 2023).	BIA (inter-nesting) – Mon Repos to Agnes Water, remote from dredging/placement
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable	Endangered	Species or species habitat known to occur within area	Most records in ALA from sandy beaches on Facing Island, but also Boyne Island and mouth of Calliope River. Historic Wildnet record off Tannum Sands.	Nesting sandy beaches (PoG is not a key area), foraging in open waters, seagrass meadows and reefs (Limpus *et al.* 2013b). GHD (2009) reported this species in low abundance around North Passage. Incidental sightings of hawksbill turtles in Port Alma and the PoG are predominantly associated with foraging habitats, including seagrass meadows, reefs and soft-bottomed subtidal areas (Limpus et al 2013b)	None
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered	Endangered	Breeding likely to occur within area	Several ALA records on the beaches particularly at South Trees Island, Facing Island and Curtis Island. No nearby Wildnet records.	Nesting occurs on sandy beaches, mostly outside Central Queensland (key nesting sites located in Gulf of Carpentaria). Forages in open waters. Possible transient visitor to the PoG, unlikely to regularly use dredging/placement sites (ALA 2023).	None
Flatback Turtle	*Natator depressus*	Vulnerable	Vulnerable	Breeding known to occur within area	Numerous ALA sightings on the beaches particularly at South Trees Island, Facing Island, Wild Cattle Island and Curtis Island. Historic Wildnet records in the PoG and surrounding islands.	Nesting sandy beaches (Curtis and Facing Island). Curtis Island considered to be a moderate size, high quality rookery (Limpus *et al.* 2021a). There has been a substantial decline in nesting turtles at Curtis Island (and Peak Island), which does not appear to be due to a decrease in population size (Limpus *et al.* 2021b). Flatback turtles utilise the waters from Rodd Bay to Curtis Island as core habitat. They migrate north up the Queensland coast to foraging areas (Hamann *et al*. 2017). Possible transient visitor to the PoG, unlikely to regularly use dredging/placement sites.	Critical Habitat (nesting) – Curtis Island, includes seaward beaches. Internesting buffer of 60 km around Curtis Island (Limpus *et al.* 2016)
Salt-water Crocodile	*Crocodylus porosus*	Mig	Vulnerable	Species or species habitat likely to occur within area	Historic Wildnet and ALA record in Calliope River DES (2023b), and while no records in the POG, they potentially occur.	Nesting wetlands; feeding rivers, estuaries, and occasionally coastal waters. Transient visitor to the PoG, unlikely to regularly use dredge/placement sites.	None
Sharks and Rays							
Great White Shark	*Carcharodon carcharias*	Vulnerable	-	Species or species habitat known to occur within area	No PoG records in ALA or Wildnet, but could occur.	Pelagic, coastal and offshore waters. Occasionally reported from Capricorn Bunker region, possible occasional visitor to PoG.	None
Green Sawfish	*Pristis zijsron*	Vulnerable	-	Breeding may occur within area	No PoG records in ALA or Wildnet. Contemporary records for this species north of Cairns only.	Demersal, riverine and coastal waters. While suitable habitat is present in PoG, the region is outside known geographic range.	None
Whale Shark	*Rhincodon typus*	Vulnerable	-	Species or species habitat may occur within area	No PoG records in ALA. Nearest sighting Fraser Island therefore, unlikely to occur. No nearby Wildnet records, closest record off Lady Musgrave Island.	Pelagic, coastal and offshore waters. Occasionally reported from Capricorn Bunker region. Possible (but highly unlikely) transient visitor to PoG, and highly unlikely to regularly use dredge/placement sites.	None
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Mig	-	Species or species habitat may occur within area	No PoG records in ALA or Wildnet. Nearest sighting offshore of Fraser Island therefore, unlikely to occur.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to PoG, and highly unlikely to regularly use dredge/placement sites.	None
Porbeagle Shark	*Lamna nasus*	Mig	-	Species or species habitat may occur within area	No PoG records in ALA or Wildnet. Nearest sighting offshore of Fraser Island therefore, unlikely to occur.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to PoG, and highly unlikely to regularly use dredge/placement sites.	None

Common Name	Species Name	EPBC Act Status	NC Act Status	Type of Presence (PMST)	Records (ALA+Wildnet)	Habitat (SPRAT[7]) Potential Occurrence in Dredging/Placement Sites	Important Areas (BIA, CH, Recovery Plans) in Region
Reef Manta Ray	*Mobula alfredi*	Mig	-	Species or species habitat likely to occur within area	No PoG records in ALA or Wildnet. Nearest sighting near Heron Island, but may occur.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to PoG, and highly unlikely to regularly use dredge/placement sites.	None
Giant Manta Ray	*Mobula birostris*	Mig	-	Species or species habitat likely to occur within area	No PoG records in ALA or Wildnet. Nearest sighting offshore of Rainbow Beach therefore, unlikely to occur.	Pelagic, coastal and offshore waters. Possible (but highly unlikely) transient visitor to PoG, and highly unlikely to regularly use dredge/placement sites.	None

4.4.3 World Heritage Area and Natural Heritage Property

The dredging and placement sites occur in the GBRWHA and GBR Natural Heritage Property (GBRNHP). Both MNES share the same boundaries, which in the context of the PoG encompass all waters seaward of low water mark, and all islands within the boundaries shown in Figure 4-9.

World Heritage properties are recognised for their Outstanding Universal Value (OUV). A Statement of OUV provides a summary of the rationale for including a property on the World Heritage List. The GBRWHA was listed as meeting four World Heritage criteria for OUV, which are summarised in Table 4.8. The Statement of OUV is, by necessity, a high-level summary, and does not characterise the OUV attributes represented at individual locations within the property.

The *EPBC Act referral guidelines for the Outstanding Universal Value of the Great Barrier Reef World Heritage Area* (DoE 2014) set out examples of the attributes of the GBR that contribute to its listing under the criteria of the World Heritage Convention. The GBR Marine Park Authority (GBRMPA) also identified the series of values, attributes and processes of the GBR that contribute to world heritage and natural heritage property values as part of the GBR Strategic Assessment (GBRMPA 2014).

Building on this, AECOM (2016) describes the OUV attributes of the GBRWHA represented within the PoG master planned area, which includes all waters in PoG including dredging and placement sites. Table 4.8 summarises OUV attributes expressed in the Gladstone region as determined by AECOM (2016), and OUV attributes potentially relevant to marine areas at and adjacent to dredging and placement sites (blue shaded). Within and adjacent to dredge and placement sites, relevant OUV attributes include: contributing to habitat connectivity; corals and reef environments (see Section 4.3.1.2); fauna species and species diversity; seagrass meadows (see Section 4.3.1.1), marine megafauna species (see Section 4.4.1 and 4.4.2); and traditional owner interaction with the environment (e.g. fishing, recreation, scenic, spiritual).

Table 4.8 OUV attributes expressed in the proposed Gladstone region from AECOM (2016) (✓) and attributes relevant to waters at and directly adjacent to dredging and placement sites (blue shaded)

Overview of attributes	Criterion vii – aesthetic values and superlative natural phenomena	Criterion vii – ongoing geological processes	Criterion ix – ecological and biological processes	Criterion x – biodiversity conservation
Connectivity: cross-shelf, longshore & vertical		✓	✓	✓
Continental islands	✓	✓	✓	✓
Beaches	✓			
Dune systems	✓	✓		
Fringing reefs	✓	✓	✓	✓
Inshore turbid reefs		✓	✓	✓
River deltas	✓	✓	✓	✓
Marine faunal groups diversity	✓		✓	✓
Coral species – diversity & extent	✓	✓	✓	✓

Overview of attributes	Criterion vii – aesthetic values and superlative natural phenomena	Criterion vii – ongoing geological processes	Criterion ix – ecological and biological processes	Criterion x – biodiversity conservation
Total species diversity	✓		✓	✓
Island plant species diversity	✓		✓	✓
Seagrass	✓	✓	✓	✓
Mangroves	✓	✓	✓	✓
Marine turtles	✓			✓
Whales	✓			✓
Threatened & endangered species				✓
Dolphins	✓			✓
Seabirds	✓		✓	✓
Traditional Owner interaction with the natural environment			✓	

4.4.4 Great Barrier Reef Marine Park

The GBRMP is managed under the *Great Barrier Reef Marine Park Act 1975*. Under the existing zoning plan, waters along the east coast of Facing Island adjacent to the East Banks Offhsore MRA are zoned Habitat Protection, whereas waters further offshore are zoned General Use (Figure 4-9). The GBRMP sits outside the PoG and does not include the dredged channels and East Banks Offshore MRA.

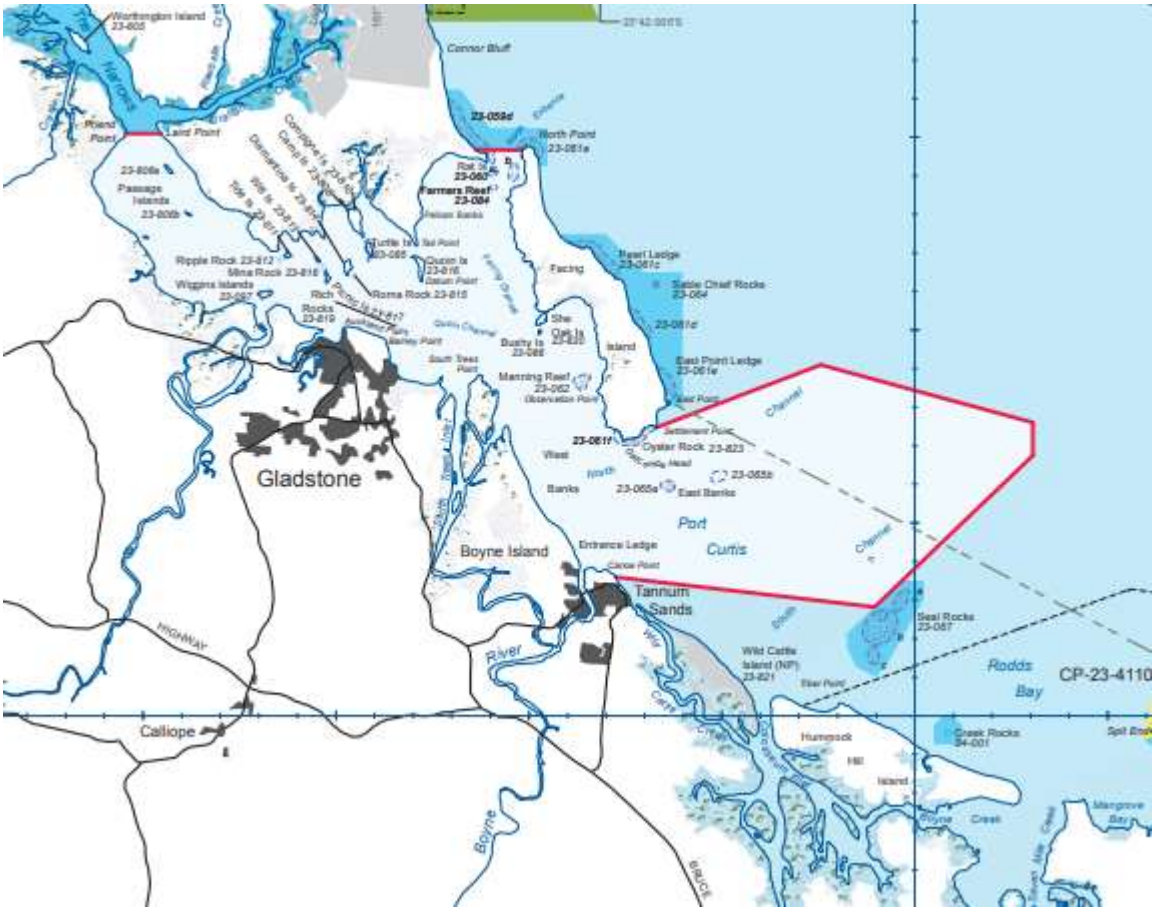


Figure 4-9 Great Barrier Reef Marine Park Zones, WHA and NHP Boundaries (GBRMPA 2017)

4.5 Matters of State Environmental Significance (MSES)

MSES referenced under the (SPP), are EVs that are protected under Queensland legislation including the *Nature Conservation Act* 1992 (NC Act), *Marine Parks Act* 2004 (MP Act), the *Fisheries Act* 1994, *Environmental Protection Act* 1992 (EP Act), the *Regional Planning Interests Act* 2014, and the *Vegetation Management Act 1999*. MSES have been defined by the Queensland Government as the following natural values and areas:

- Protected areas under the NC Act.
- Marine parks and land within a 'marine national park', 'conservation park', scientific research', 'preservation' or 'buffer' zone under the MP Act.
- Areas within declared fish habitat areas (FHAs).
- Endangered, vulnerable and near threatened (EVNT) and special least concern species.
- Regulated vegetation, including:
  - Category B, C and R areas.
  - Areas of essential habitat for wildlife prescribed as endangered or vulnerable under the NC Act.

- Regional ecosystems (REs) that intersect with watercourses/wetlands.

- Wetland/watercourse features that are:
  - Wetlands in a wetland protection area.
  - Wetlands of High Ecological Significance (HES).
  - Wetlands/watercourses in High Ecological Value (HEV) waters.
- Designate precincts in a Strategic Environmental Area.
- Legally secured offset areas.

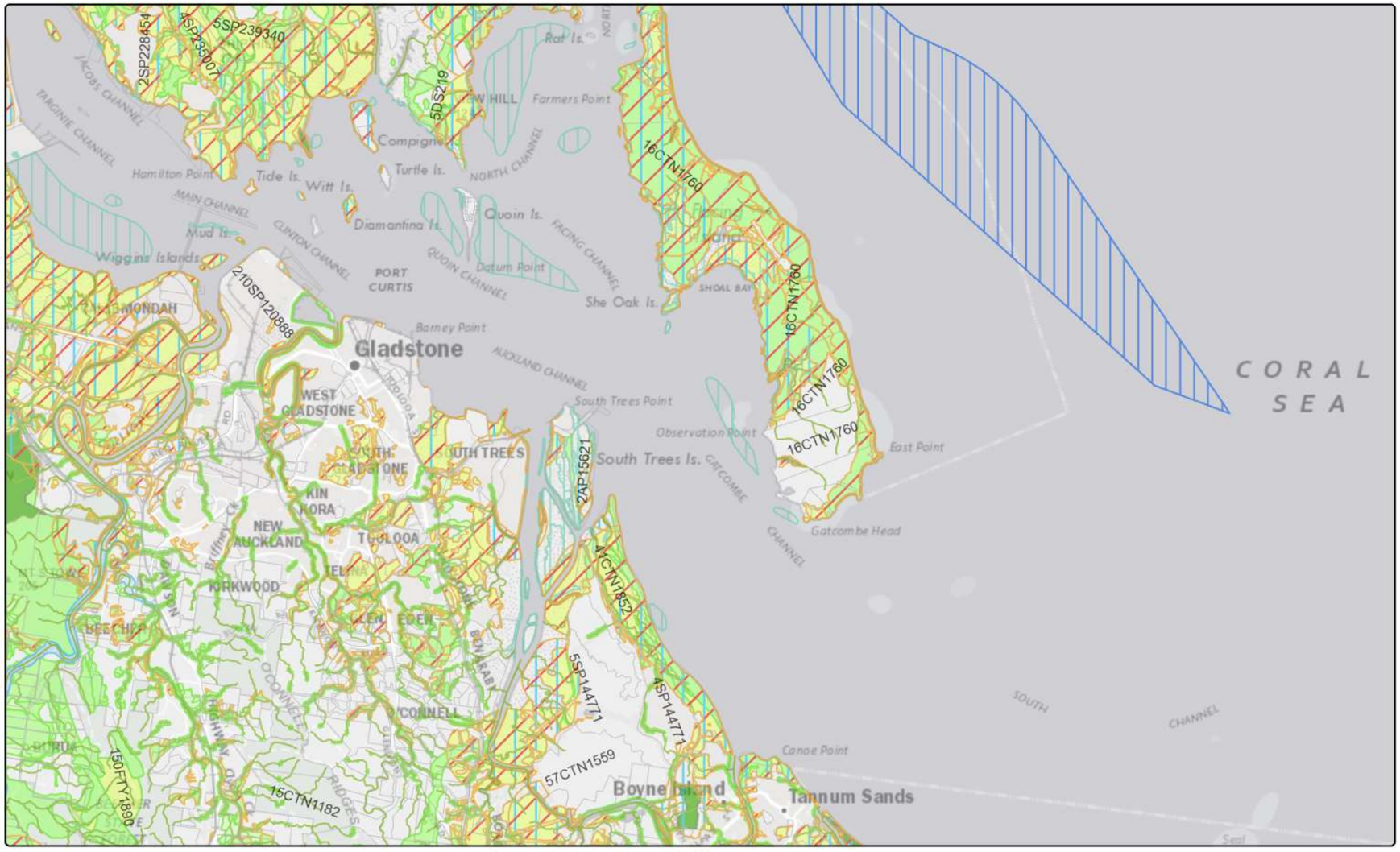
With the exception of ENVT and special least concern species, all of these features are spatially defined based on mapping and regulations. For species, the Queensland Government *Method for mapping: Matters of State environmental significance for use in land use planning and development assessment* (v1.4, DEHP 2014) uses several mapping layers as a 'surrogate' for species occurrence. This includes essential habitat mapping, peer-reviewed modelled habitat distributions, mapped distributions based on known habitat factors, and point records within remnant or regrowth REs. In addition, this mapping methodology adopts dugong protection areas (relevant to Project), southeast Queensland koala habitat value areas (not relevant), and Ramsar sites (not relevant) as specific surrogates for the occurrence of dugongs, koalas and migratory shorebirds (respectively).

MSES relevant to the PoG are provided in Table 4.9 and Figure 4-10.

Table 4.9 MSES and Relevance to PoG

MSES*	Description
Protected areas under the NC Act	There are no marine areas within PoG classified as a protected area for the purpose of the NC Act. Garden Island Regional Park is located in the PoG outside the dredge footprint and placement sites.
Marine parks and land within a 'marine national park', 'conservation park', scientific research', 'preservation' or 'buffer' zone under the (MP Act – highly protected features	The GBR Coast Marine Park (GBRCMP) is located offshore of PoG and extends into the southern part of Rodds Bay, and the Narrows. The dredge footprint and placement sites are located outside the GBRCMP. The closest 'highly protected' GBRCMP feature listed as a MSES is the marine national park zone located on the eastern coast of Curtis Island, outside PoG.
Areas within declared FHAs	The Colosseum Inlet FHA is located approximately 30 km from dredge and placement sites. The Dē-răl-lĭ (Calliope River) FHA is located in the Calliope River, >5 km from dredging and placement sites.
EVNT and special least concern species	Islands and mainland areas surrounding PoG are mapped as habitat for threatened wildlife and/or iconic species listed under NC Act. Dredge and placement sites are within the PoG-Rodds Bay DPA, which is a surrogate for known/potential dugong habitat. Refer to Table 4.7 for summary of habitat values for threatened and special least concern species

MSES*	Description
HES wetlands protected under EP Act	Many of the seagrass meadows present in PoG are considered HES wetlands
Wetlands and watercourses in HEV waters	No HEV areas present
Regulated vegetation	None in marine waters potentially affected by maintenance dredging
Strategic Environmental Area	None present in PoG
Legally secured offset areas	None present in PoG



Legend

Cadastre (150k)
Cadastre (150k)

MSES - Wildlife habitat (sea turtle nesting areas)
MSES - Wildlife habitat (sea turtle nesting areas)

MSES - Regulated vegetation (intersecting a watercourse)
MSES - Regulated vegetation (intersecting a watercourse)

MSES - High ecological value waters (watercourse)
MSES - High ecological value waters (watercourse)

MSES - Wildlife habitat (endangered or vulnerable)
MSES - Wildlife habitat (endangered or vulnerable)

MSES - Wildlife habitat (special least concern animal)
MSES - Wildlife habitat (special least concern animal)

MSES - Wildlife habitat (koala habitat areas - core)
MSES - Wildlife habitat (koala habitat areas - core)

MSES - Wildlife habitat (koala habitat areas - locally refined)
MSES - Wildlife habitat (koala habitat areas - locally refined)

MSES - Strategic environmental areas (designated precinct)
MSES - Strategic environmental areas (designated precinct)

MSES - High ecological significance wetlands
MSES - High ecological significance wetlands

MSES - High ecological value waters (wetland)
MSES - High ecological value waters (wetland)

MSES - Legally secured offset area (offset register)
MSES - Legally secured offset area (offset register)

MSES - Legally secured offset area (regulated vegetation offsets)
MSES - Legally secured offset area (regulated vegetation offsets)

MSES - Protected areas (estate)
MSES - Protected areas (estate)

MSES - Protected areas (special wildlife reserve)
MSES - Protected areas (special wildlife reserve)

MSES - Protected areas (nature refuge)
MSES - Protected areas (nature refuge)

MSES - Marine park (highly protected areas)
MSES - Marine park (highly protected areas)

MSES - Declared fish habitat area
MSES - Declared fish habitat area

MSES - Regulated vegetation (category B)
MSES - Regulated vegetation (category B)

MSES - Regulated vegetation (category C)
MSES - Regulated vegetation (category C)

MSES - Regulated vegetation (category R)
MSES - Regulated vegetation (category R)

MSES - Regulated vegetation (essential habitat)
MSES - Regulated vegetation (essential habitat)

MSES - Regulated vegetation (wetland)
MSES - Regulated vegetation (wetland)

Queensland Government

State Planning Policy
Making or amending a local planning instrument and designating land for community infrastructure

0 2,300 4,600 6,900 9,200
Metres

Date: 21/07/2023

Disclaimer:
This map has been prepared with due care based on the best available information at the time of publication. However, the State of Queensland (acting through the department) makes no representations, either express or implied, that the map is free from errors, inconsistencies or omissions. Reliance on information contained in this map is the sole responsibility of the user. The State disclaims responsibility for any loss, damage or inconvenience caused as a result of reliance on information or data contained in this map.

Figure 4-10 MSES in the Gladstone Region (Queensland Government 2023)

4.5.1 State Code 8 Coastal Development and Tidal Works

The State Assessment Referral Agency (SARA) assesses development applications against the State Development Assessment Provisions (SDAP). SDAP defines the state's interest in development assessment and includes the assessment benchmarks or matters SARA will assess an application against. State Code 8 Coastal Development and Tidal Works sets out performance outcomes to "…*ensure that developments are designed and located to:*

(1) protect life, buildings and infrastructure from the impacts of coastal erosion

(2) maintain coastal processes

(3) conserve coastal resources

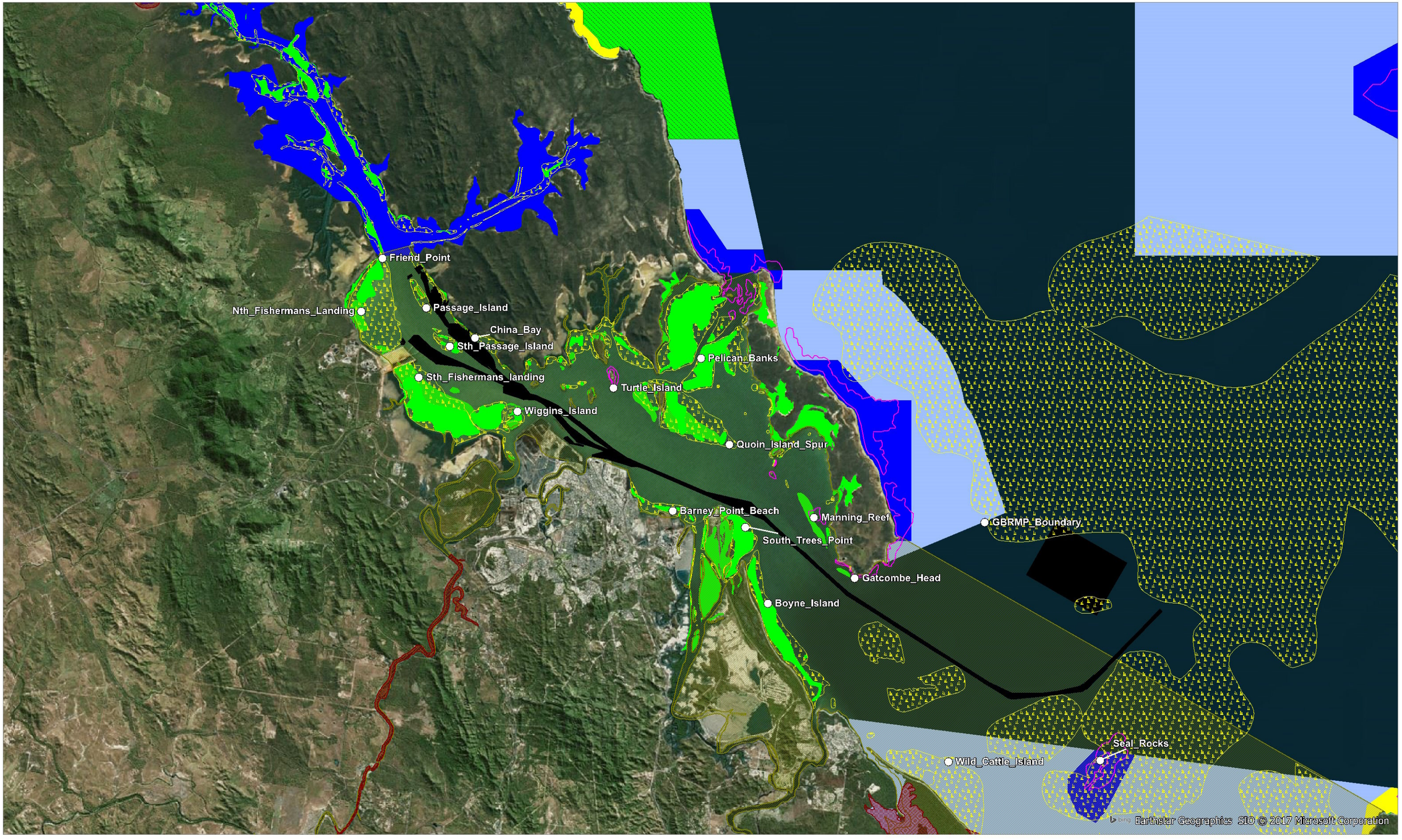
(4) maintain appropriate public use of, and access to and along, state coastal land

(5) account for the projected impacts of climate change; and

(6) avoid impacts on matters of state environmental significance and, where avoidance is not reasonably possible, minimise and mitigate impacts, and provide an offset for significant residual impacts where appropriate.

In addition to the above, the purpose of this code is to ensure that development involving operational works which is not assessed by local government is designed and located to protect life and property from the impacts of storm tide inundation."

State Code 8 applies in circumstances where coastal development and tidal works are assessable under the Planning Regulation 2017. The Department of Development, Infrastructure, Local Government and Planning (DILGP) as the assessment manager (or concurrence agency) uses the SDAP) to inform their assessment of a Development Application (DA). The SDAP incorporates state codes in a module for each of the matters of interest to SARA. Dredging and placement of dredge material in tidal waters triggers assessment against State Code 8. Assessment of the project against relevant sections of State Code 8 is provided in Section 5



LEGEND

- Dredge Footprint and East Banks Offshore MRA
- Seagrass composite distribution (2002-2014)
- Coral Reefs (BMT WBM 2014)
- Rodds Bay Dugong Protection Area
- High Ecological Significance Wetlands
- Calliope River and Colosseum Inlet Fish Habitat Areas

Great Barrier Reef Coastal Marine Park Zoning

- General Use Zone
- Habitat Protection Zone
- Marine National Park Zone
- Conservation Park Zone

** Great Barrier Reef Marine Park Authority 2006*

Title:

Features Listed as Matters of State Environmental Significance and Model Output Points

Figure: 4.11

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5 Impact Assessment

5.1 Modelling Results

5.1.1 Modelled Changes to the Turbidity and Deposition Rate Percentiles

Spatial representations of the dredging impacts were based on percentile analysis of the model results and were derived by applying a moving 14-day analysis window over each simulation period. The 14-day window in a physical hydrodynamic context represents the approximate duration of one (1) spring-neap tidal cycle, while in an ecological context it provides meaningful timescales (i.e. exposure measured in hours and days) for assessing impacts to key sensitive receptors in the area (e.g. intertidal seagrass meadows). The 14-day analysis window was moved forward by five (5)-day increments from the start to the finish of each simulation period, to ensure full coverage of the simulation.

The percentile impact plots correspond to the modelled increase in turbidity and deposition rate above ambient conditions that are attributable to the dredging. Impacts at each percentile level were calculated for every 14-day window during the simulation, and the maximum increase for any window at each location in the model domain is presented. Different locations within the model will have experienced their highest turbidity at different times during the simulation.

The 95th percentile of the turbidity or deposition rate is the level that is exceeded for approximately 17 hours over the 14-day window. The 50th percentile of the turbidity or deposition rate is the level that is exceeded for approximately seven (7) days in total over the 14-day window. An increase in the highest percentiles correspond to relatively short-lived increases in turbidity/deposition while an increase in the lower percentiles correspond to sustained (but temporary) increases.

Key features of the moving window percentile analysis include:

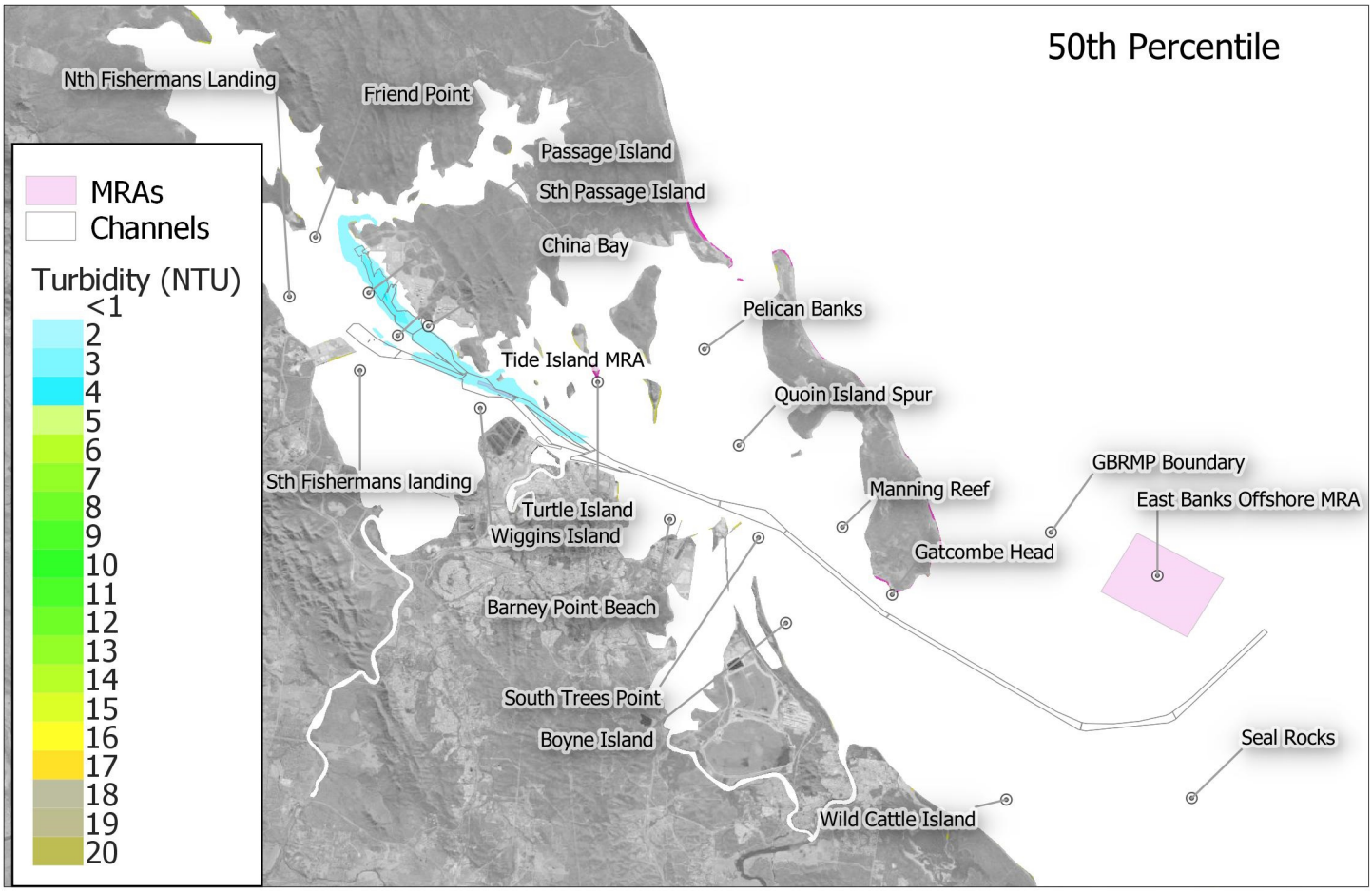
- Consideration of a range of impact durations from short to long term; and
- Can be applied to a long term program and capture periods of high intensity versus low intensity impacts.

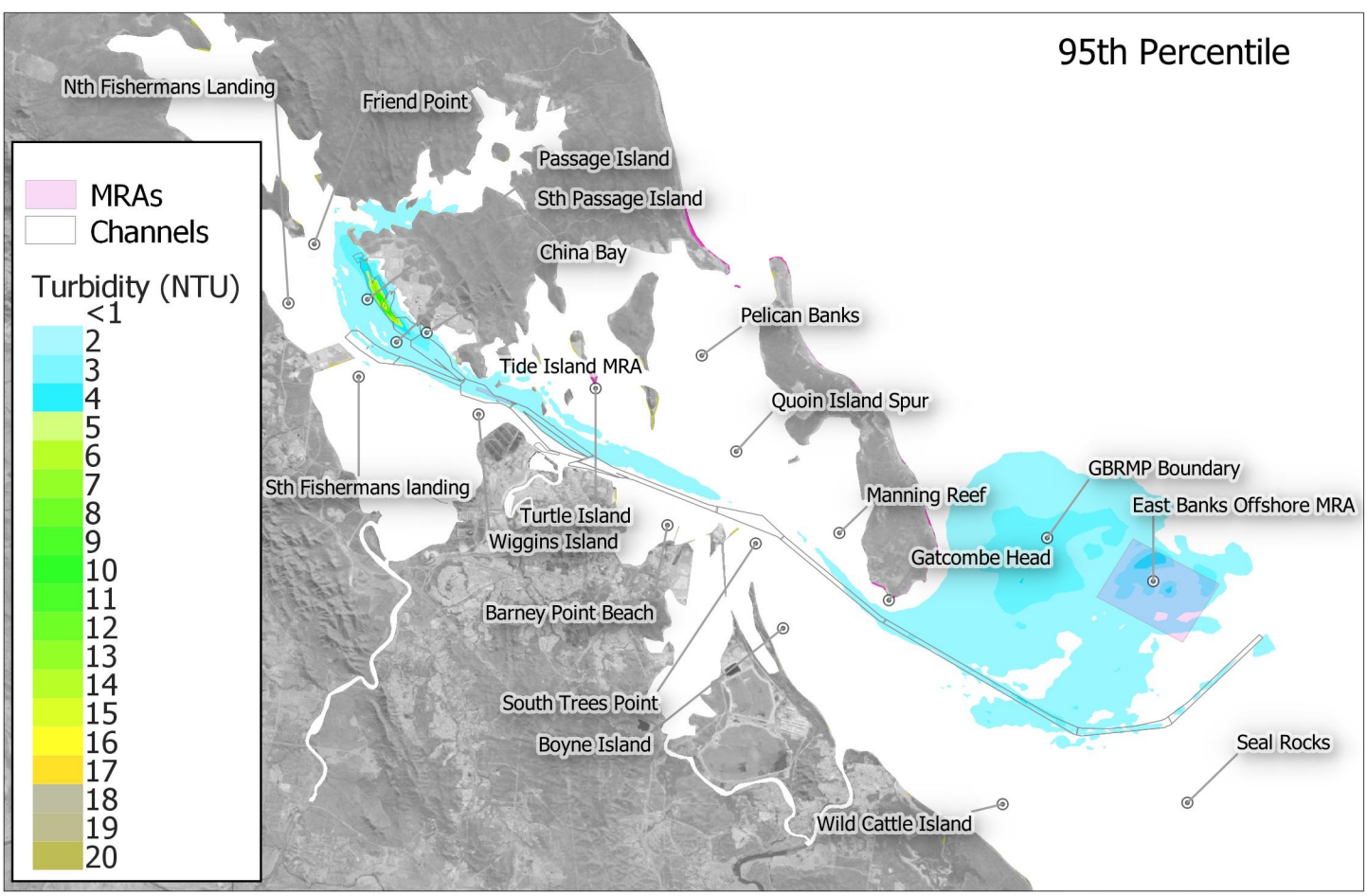
It is important to note that the percentile plots presented in this report are not ‘snapshots’ of the levels of turbidity or deposition rate, and the impact plots do not represent what the visible plume might look like at any one time. They are representations of turbidity and deposition rate statistics over long periods of time, and the impact plots show the potential changes to those statistics.

5.1.1.1 260,000m^3 of Maintenance Dredging with 45,000m^3 Placement at Tide Island

The modelled impacts to the 50th and 95th percentile of the turbidity for the ‘typical’ maintenance dredging campaign including 45,000m^3 placed at the Tide Island MRA are shown in Figure 5-1. Small sustained increases to the turbidity (the change in the 50th percentile) are only significant in the vicinity of the LNG terminals and near the Tide Island MRA. Short-term increases in the turbidity (the change in the 95th percentile) are noted near the LNG terminals, near the Tide Island MRA, in the vicinity of the East Banks Offshore MRA, and the outer parts of the shipping channel.

The modelled impacts to the deposition rate percentiles are shown in Figure **5-2**. The largest increases in deposition rate occur within the shipping channels and at the two (2) offshore MRAs.





Title:

260,000m³ Campaign with 45,000m³ Disposal at Tide Island MRA - Change to the 50th & 95th Percentiles of the Modelled Depth Averaged Turbidity due to Dredging

Figure: **5.1**

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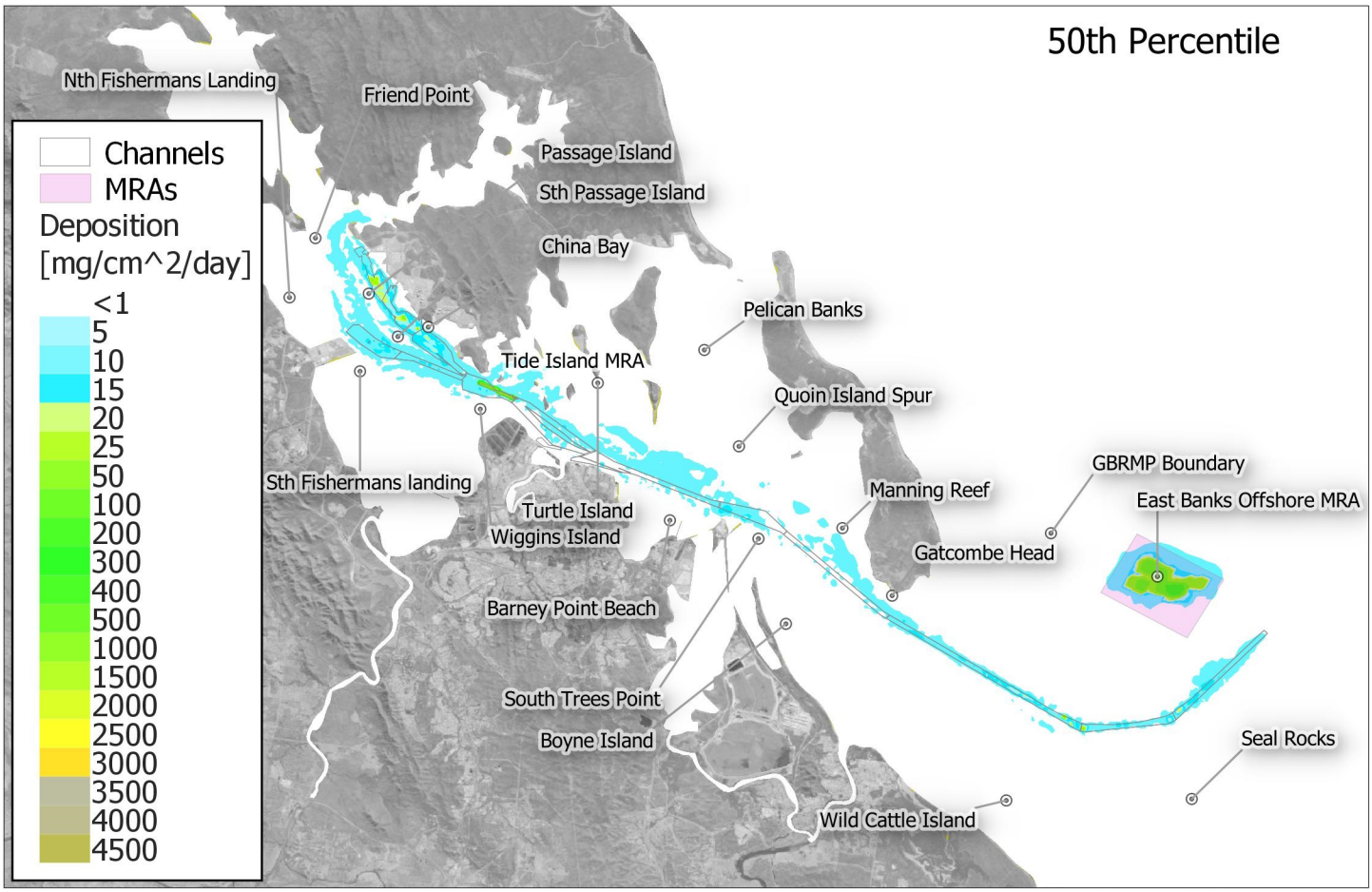

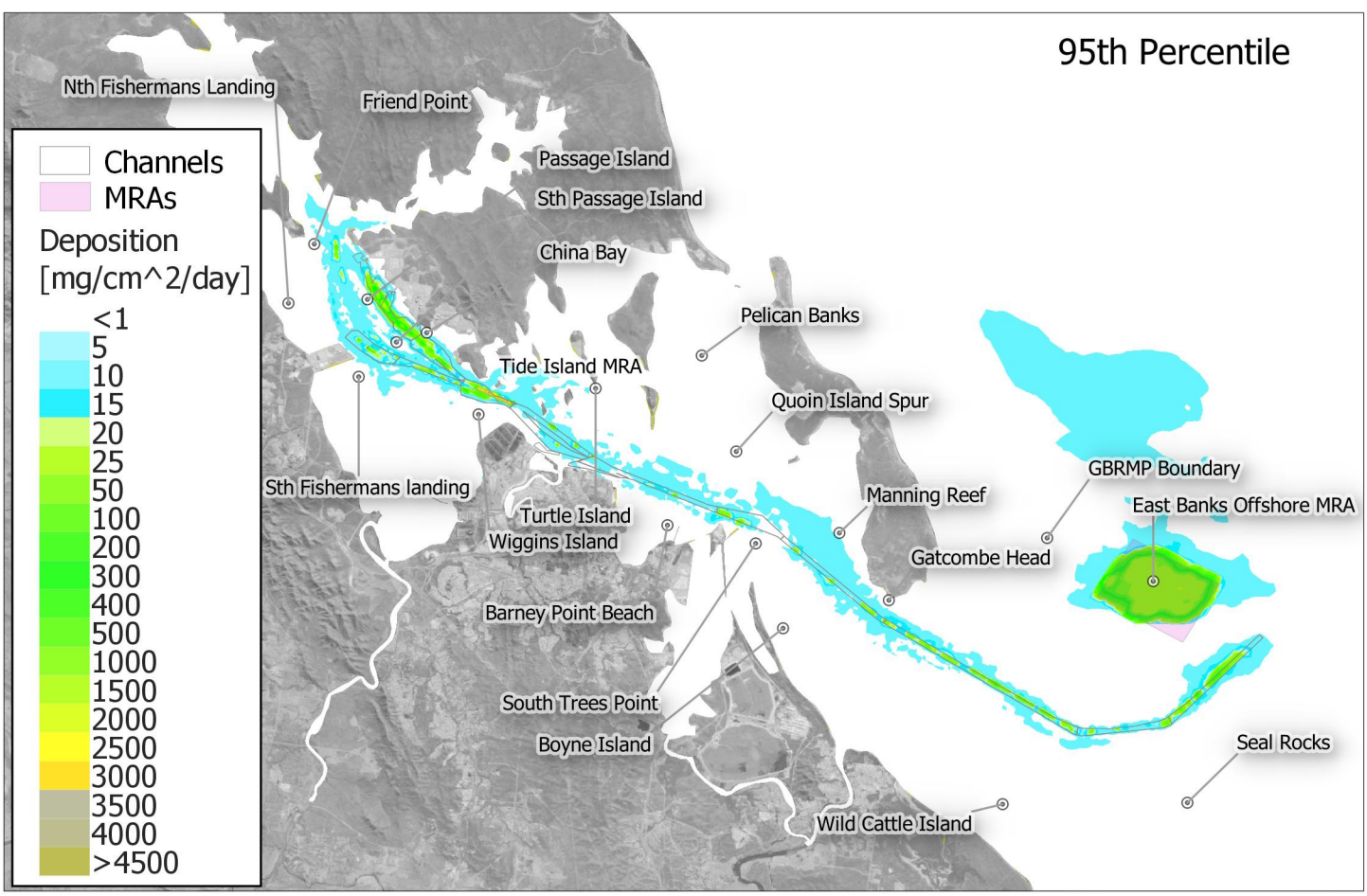

Title:

260,000m³ Campaign with 45,000m³ placement at the Tide Island MRA - Change in the 50th & 95th Percentile of the Modelled Deposition Rate due to Dredging

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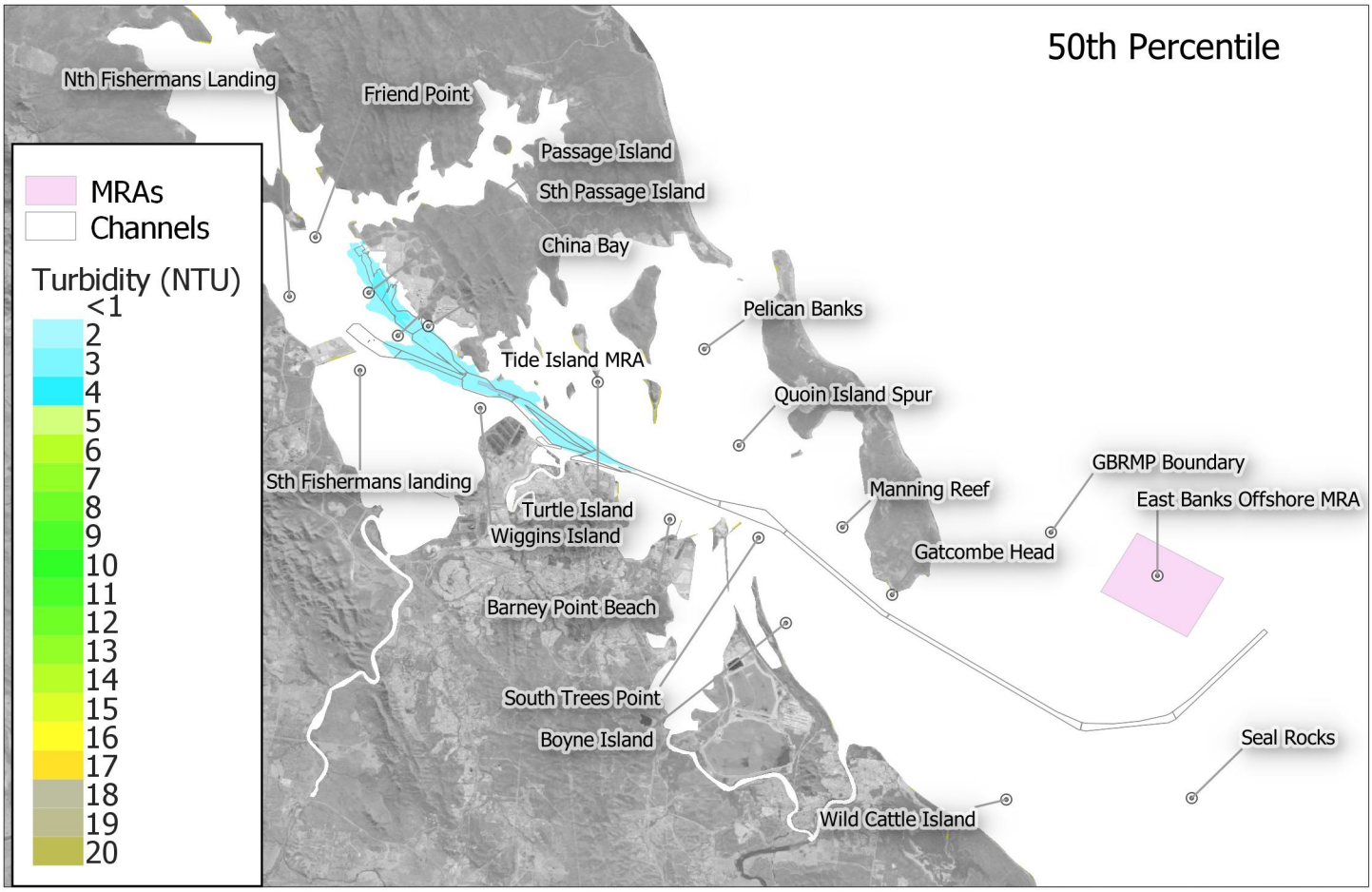
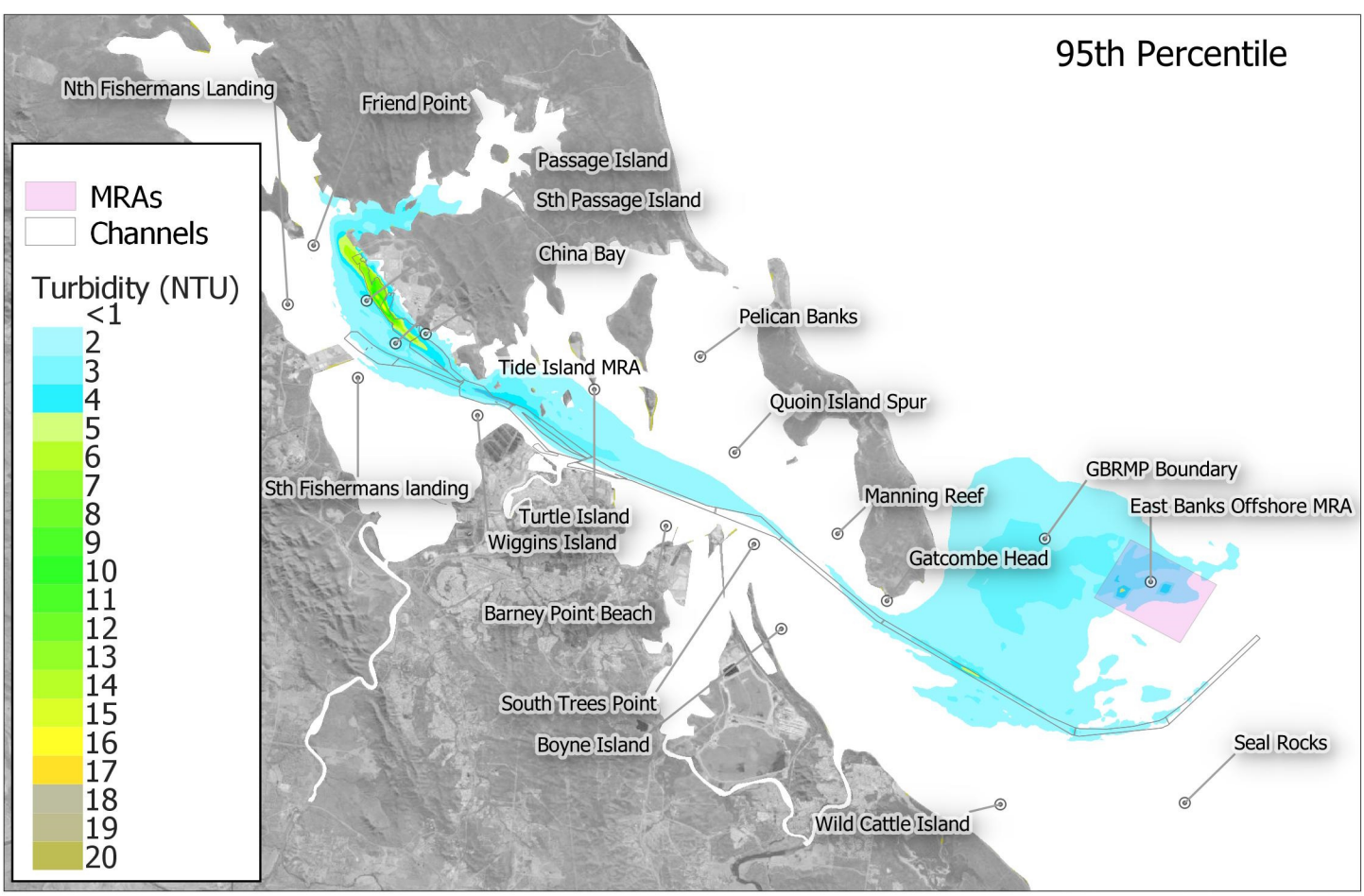
5.1.1.2 260,000m³ of Maintenance Dredging with 75,000m³ Placement at Tide Island

The modelled impacts to the 50th and 95th percentile of the turbidity for a maintenance dredging campaign including 75,000 m³ placed at the Tide Island MRA are shown in Figure 5-3. The increases in the 50th and 95th percentiles of the turbidity are similar to the 45,000 m³ placement scenario, though somewhat larger in magnitude and extent in the vicinity of the Tide Island MRA.

The modelled impacts to the deposition rate percentiles are shown in Figure 5-4. The modelled increases are similar to the 45,000 m³ placement scenario, with higher deposition rate increases at the Tide Island MRA due to the increased volume of placement at that location.





Title:

260,000m³ Campaign with 75,000m³ Disposal at Tide Island MRA - Change to the 50th & 95th Percentiles of the Modelled Depth Averaged Turbidity due to Dredging

Figure: **5.3**

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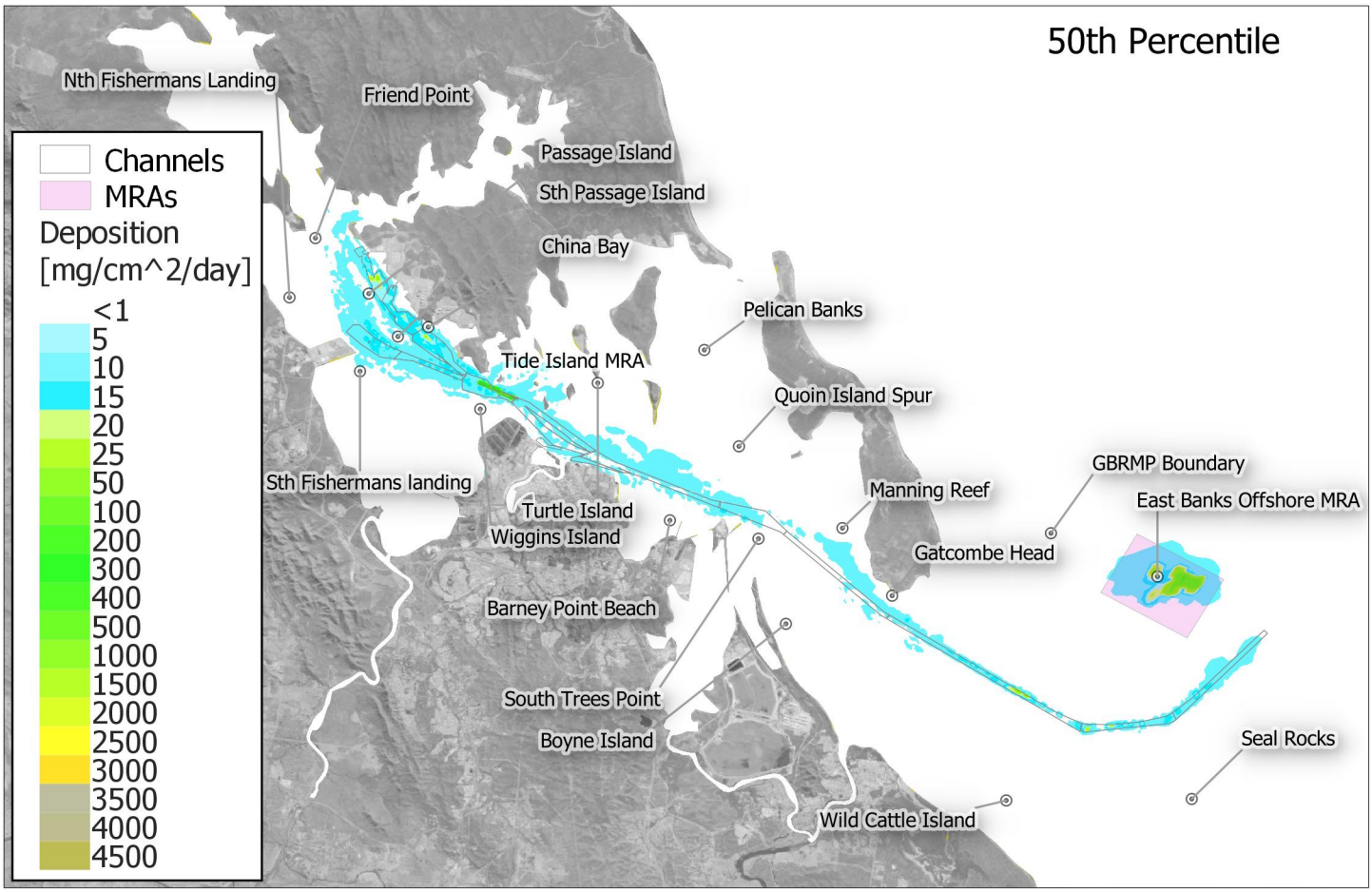

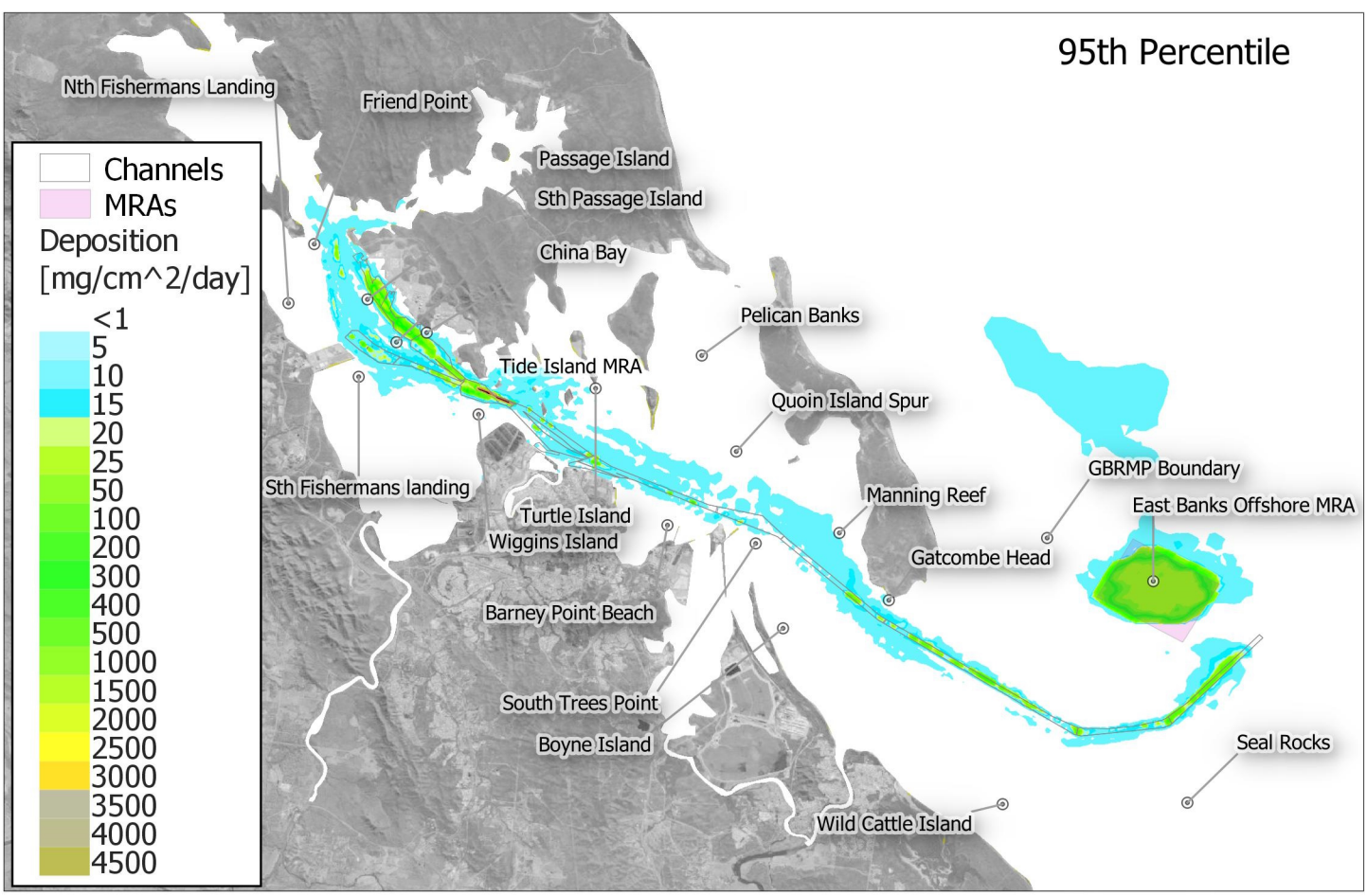

Title:

260,000m³ Campaign with 75,000m3 placement at the Tide Island MRA - Change in the 50th & 95th Percentile of the Modelled Deposition Rate due to Dredging

Figure: **5.4**

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5.1.2 Zones of Influence and Impact

The modelled impacts to the turbidity were compared to threshold values derived from measured data to assess the potential impacts to marine water quality and ecologically sensitive areas. These are presented as 'Zones of Impact', in accordance with standard industry practice such as the Western Australia Environmental Protection Authority (WA EPA) (2016) dredging environmental assessment guidelines. Four (4) zones were defined in accordance with WA EPA (2016):

- Zone of High Impact = Excess turbidity from dredging most likely to cause water quality to deteriorate beyond natural variation;
- Zone of Moderate Impact = Excess turbidity from dredging likely to cause water quality to deteriorate beyond natural variation;
- Zone of Low Impact = Excess turbidity from dredging may cause water quality to deteriorate beyond natural variation; and
- Zone of Influence = Extent of detectable plume (as measured by instrumentation) but no predicted ecological impacts.

To determine the threshold values to delineate the Zones of Impact, a combination of referential and biological tolerances methods was used. This entailed using baseline water quality monitoring data to set initial threshold values (referential method). These values were then compared to biological tolerances from literature values as a 'reality check' to see if the threshold values are biologically meaningful.

5.1.2.1 13-Month Baseline Water Quality Data

As part of the Gatcombe and Golding Cutting Channel Duplication Project EIS (BMT 2019b), continuous turbidity data (and other parameters) were collected over a 13-month period (May 2014 to June 2015) at eight (8) sites within the PoG area. The monitoring data set underwent a quality control process to remove invalid data (outliers resulting from fouling or malfunction).

5.1.2.2 Threshold Values

As the long term data shows variability in turbidity among sites during the same time period, site-specific thresholds were derived which reflect the natural variability of the turbidity in that location. To determine initial impact threshold values, the 13-month baseline water quality monitoring dataset was analysed and percentile curves were produced. These percentile curves provide an indication of magnitude of turbidity and combined duration/frequency metrics for a range of conditions.

The 13-month baseline data were analysed over a moving 14-day window period to give a range of percentile values over different periods. The 14-day moving window analysis was undertaken by moving the 14-day window by five (5)-day increments over the entire monitoring period (approximately 77 different 14-day periods). This method provides an indication of natural variability around each percentile value and provides context for excess turbidity from dredging.

As an example, Figure 5-5 shows the percentile curves for data collected at Site WB50. This shows the natural variability measured around the median (50th percentile) and other percentile values. The x-axis in Figure 5-5 represents the different percentile values extracted from the moving 14-day window analysis from frequently exceeded on the left to rarely exceeded on the right. The different curves are statistics representing the variability of the turbidity percentiles across the different 14-day periods (making up the

13-month baseline monitoring period). The lower curve represents the least turbid conditions during any window within the 13-month period, while the upper limit is the result for the windows with the most turbid conditions. The solid red line is the mean of the different 14-day window conditions.

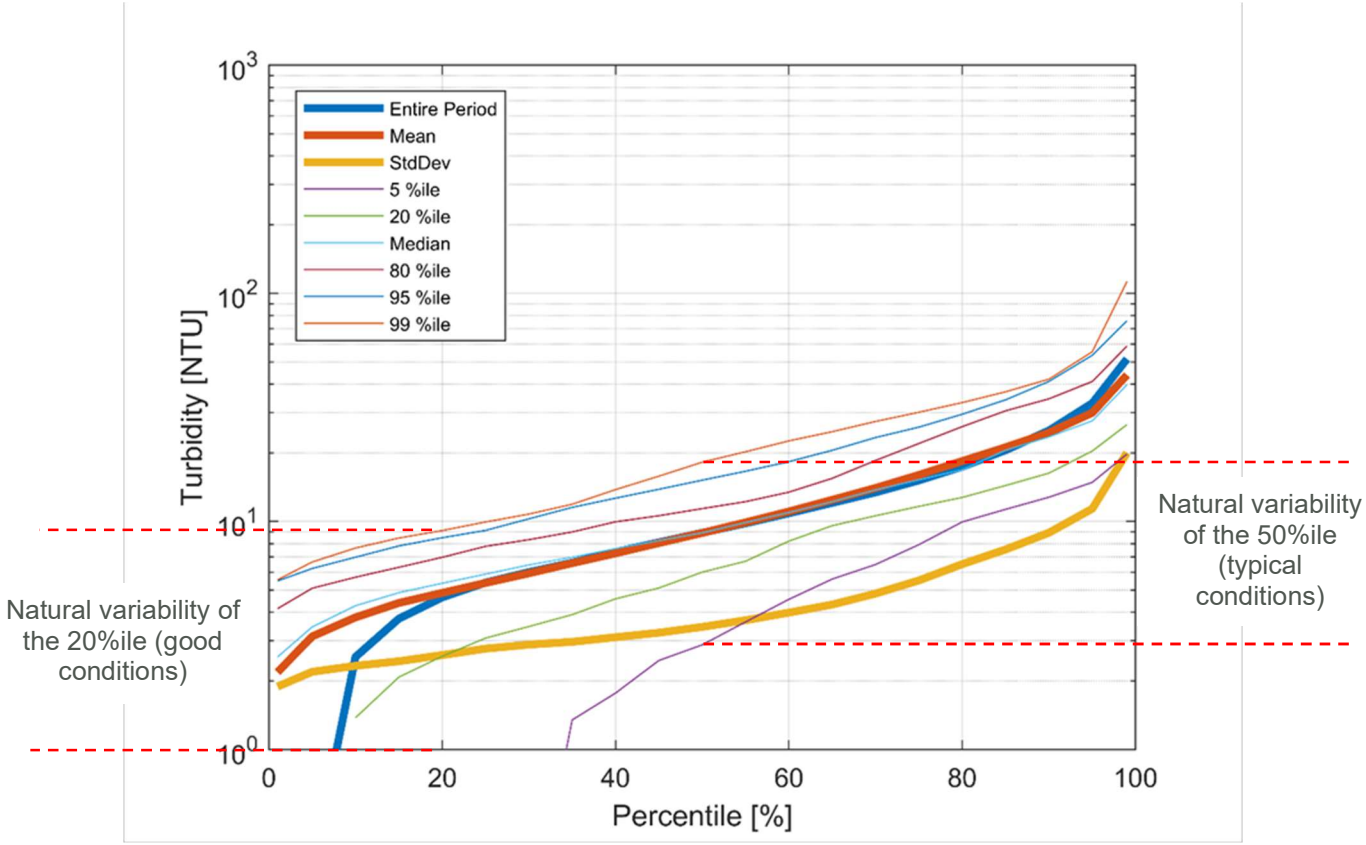


Figure 5-5 Example Summary Analysis of Baseline Data for Site WB50 (BMT 2019b)

Threshold values were derived from these percentile curves based on the natural variability around the 50th percentile (average conditions), 20th percentile (good conditions – neap tides or low winds and waves) and the 80th percentile (poor conditions – spring tides or moderate to high wind and waves). Therefore, this method considers both short term and sustained impacts.

A description of the threshold values for the three (3) zones of impact and how they relate to the natural variability is provided in Table 5.1. The approach used to determine the threshold levels involved using the standard deviation from the natural background mean of each percentile over all of the 14-day windows (i.e. 20th, 50th and 80th percentiles). This is a similar approach to the one (1) developed by Orpin *et al.* (2004) to assess impacts from construction-related turbidity increases in Townsville. Orpin *et al.* (2004) suggested that one (1) standard deviation from ambient conditions could be used as a possible conservative upper limit of an acceptable increase in turbidity. Orpin *et al.* (2004) noted that the standard deviation of natural turbidity levels was considered to be a reasonable and convenient envelope within which an allowable construction-related increase could occur. If construction-related turbidity remained within one (1) standard deviation of natural variation, Orpin *et al.* (2004) suggested it would not be detectable over and above the natural variability. Extending this method out, threshold levels for the Zone of Moderate Impact and the

Zone of High Impact were determined using two (2) and three (3) standard deviations from the mean, respectively. These levels were also tested against biological tolerance literature values (refer BMT 2019b).

The Zone of Influence was defined as the probable maximum extent of detectable plumes due to the proposed dredging. Turbid plumes were assumed to become detectable by instrumentation once they were approximately 20-30% above background conditions. To determine the extent of this zone, the following criteria were used (with any one (1) criterion to be satisfied):

- 0.5 NTU above 50th percentile conditions;
- 2 NTU above 80th percentile conditions;
- 5 NTU above 95th percentile conditions; and
- 10 NTU above 99th percentile conditions.

Included in Table 5.1 are biological tolerance literature values for seagrass in other regions. Only biological tolerances for seagrass are included as corals are too variable among species and sites to define at this stage. As the seagrass tolerances are expressed as light requirements, a relationship between BPAR and turbidity was used to convert light requirements to turbidity.

Further to the conservative nature of the literature values, it is acknowledged (including by regulators and scientists) that there are uncertainties regarding the responses of seagrass to high turbidity values, which is used here as a proxy for light. Therefore, the biological tolerance literature values are only used as a means for cross-checking potential ecological relevance of changes to turbidity values.

For full details of the derivation and testing of the impact zone threshold values, refer to the PoG Gatcombe and Golding Cutting Channel Duplication Project EIS, Appendix D (BMT 2019b). The threshold values for each zone at each monitoring site are provided in Table 5.2.

The threshold values at each site in Table 5.2 for each percentile were used to derive an interpolated grid of threshold values for the entire Port. The modelled increases in the 20th, 50th and 80th percentiles of the turbidity in each cell of the model were then compared to the local threshold values, and the cell was included in an impact zone if any of the threshold values for that zone at that location were exceeded.

Table 5.1 Description of Threshold Values (BMT 2019b)

Impact Zone	Referential (Water Quality)	Biological Tolerances (Seagrass)*
Zone of High Impact	Excess turbidity *most likely* to cause total turbidity to go beyond natural variation Threshold value = excess turbidity greater than three (3) standard deviations from the natural background mean	*Z. muelleri* – 14 day rolling average of <6 mol photons m^{-2} day^{-1} over 28 days *Halodule uninervis* – 14 day rolling average of <5 mol photons m^{-2} day^{-1} over 40 days **Halophila* spp. – seven (7) day rolling average of <2 mol photons m^{-2} day^{-1} over 14 days
Zone of Moderate Impact	Excess turbidity *likely* to push total turbidity beyond natural variation Threshold value = excess turbidity greater than two (2) standard deviations from the natural background mean	*Z. muelleri* – 14 day rolling average of <6 mol photons m^{-2} day^{-1} over 21 days *H. uninervis* – 14 day rolling average of <5 mol photons m^{-2} day^{-1} over 21 days **Halophila* spp. – seven (7) day rolling average of <2 mol photons m^{-2} day^{-1} over 10 days
Zone of Low Impact	Excess turbidity *may* push total turbidity beyond natural variation Threshold value = excess turbidity greater than one (1) standard deviation from the natural background mean	*Z. muelleri* – 14 day rolling average of <6 mol photons m^{-2} day^{-1} *H. uninervis* – 14 day rolling average of <5 mol photons m^{-2} day^{-1} **Halophila* spp. – seven (7) day rolling average of <2 mol photons m^{-2} day^{-1}
Zone of Influence	Extent of detectable plume (as measured by instrumentation) but no predicted ecological impacts Turbidity related to dredging activities exceeds: - 0.5 NTU above 50th percentile conditions - 2 NTU above 80th percentile conditions - 5 NTU above 95th percentile conditions - 10 NTU above 99th percentile conditions	*Z. muelleri* – 14 day rolling average of >6 mol photons m^{-2} day^{-1}, however less than ambient *H.e uninervis* – 14 day rolling average of >5 mol photons m^{-2} day^{-1}, however less than ambient **Halophila* spp. – 7 day rolling average of >2 mol photons m^{-2} day^{-1}, however less than ambient

*As per Collier *et al.* (2016), *Halophila ovalis* has different light thresholds for intertidal and deepwater environments. The above thresholds apply to *H. ovalis* in deepwater environments, whereas intertidal *H. ovalis* has broadly similar light requirements to *Z. muelleri*

Table 5.2 Impact Threshold Values (Above Background) for each Monitoring Site (BMT 2019b)

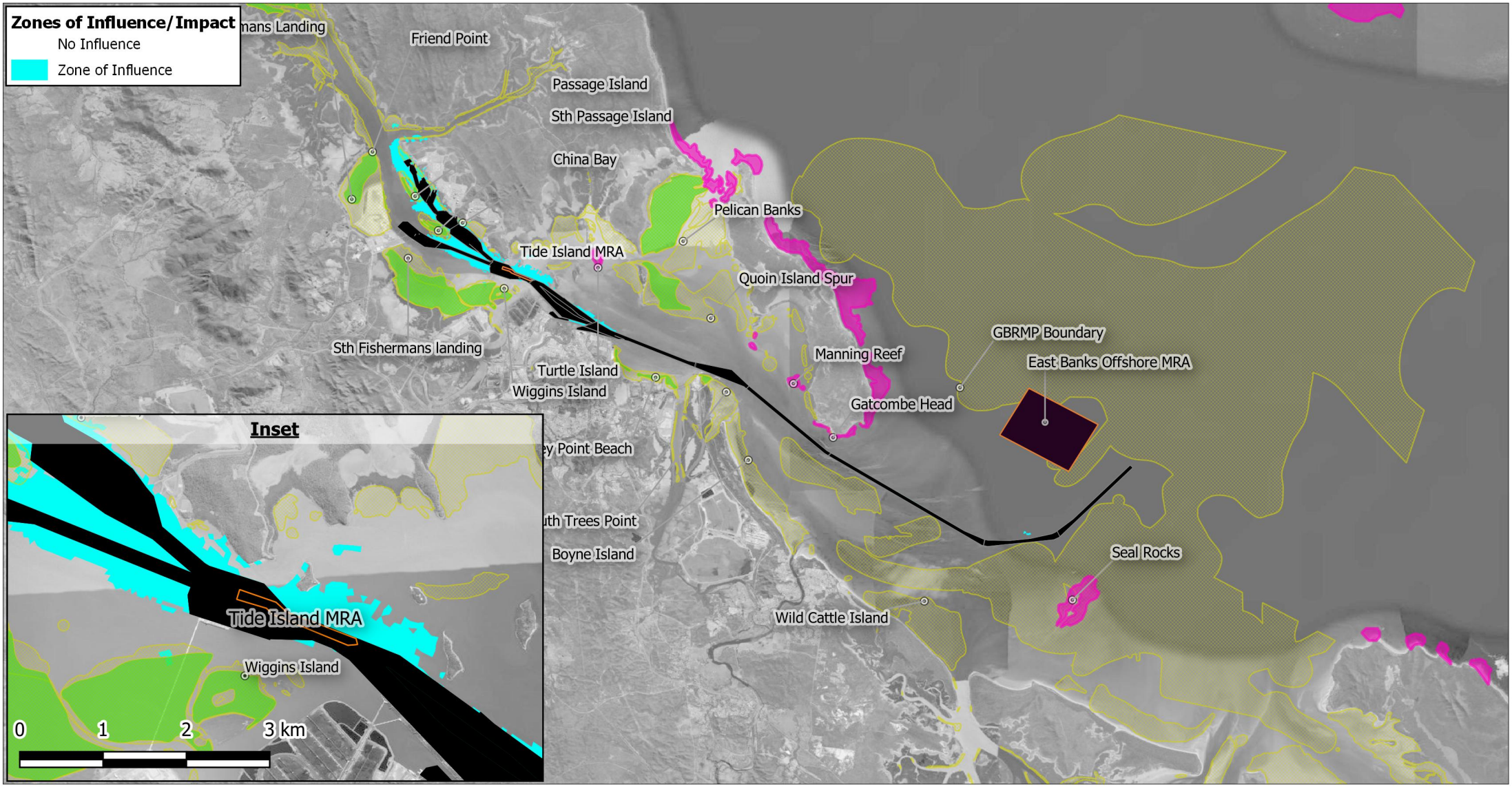
Impact Zone	Description	Method	Percentile	Descriptor	CD1	CD2	CD3	CD4	CD5	WB50	MH30	QE3
					Turbidity Threshold Values (NTU) *above background*							
Zone of High Impact	Excess turbidity *most likely* pushes total turbidity beyond natural variation	3 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time	4	5	6	4	2	8	3	12
		3 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time	7	7	9	5	4	10	5	13
		3 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time	12	12	16	8	8	20	13	20
Zone of Moderate Impact	Excess turbidity *likely* pushes total turbidity beyond natural variation	2 x standard deviations from 20%ile mean	20%ile	Exceeded 80% of the time	3	3	4	3	2	5	2	8
		2 x standard deviations from 50%ile mean	50%ile	Exceeded 50% of the time	5	5	6	4	3	7	4	9
		2 x standard deviations from 80%ile mean	80%ile	Exceeded 20% of the time	8	8	10	5	6	13	8	13
Zone of Low Impact	Excess turbidity *may* push total turbidity beyond natural variation	1 x standard deviation from 20%ile mean	20%ile	Exceeded 80% of the time	1	2	2	1	1	3	1	4
		1 x standard deviation from 50%ile mean	50%ile	Exceeded 50% of the time	2	2	3	2	1	3	2	4
		1 x standard deviation from 80%ile mean	80%ile	Exceeded 20% of the time	4	4	5	3	3	7	4	7
Zone of Influence	Full extent of detectable plumes (including resuspension)	Dredging-related turbidity exceeds 0.5 NTU	50%ile	Exceeded 50% of the time	0.5							
		Dredging-related turbidity exceeds 2 NTU	80%ile	Exceeded 20% of the time	2							
		Dredging-related turbidity exceeds 5 NTU	95%ile	Exceeded 5% of the time	5							
		Dredging-related turbidity exceeds 10 NTU	99%ile	Exceeded 1% of the time	10							

5.1.2.3 Results

The Zone of Influence and Impact for each campaign was calculated according to the methodology outlined in the previous sections.

Apart from the area of direct impact (within the channels where dredging occurs), there was no Zone of Impact for either the 45,000 m^3 placement at the Tide Island MRA or the 75,000m^3 placement at the Tide Island MRA.

The Zone of Influence was similar in extent for both campaigns (though slightly larger in extent for the 75,000m^3 placement scenario) and therefore a single Zone of Influence for both campaigns is provided in Figure 5-6. The Zone of Influence (the area where plumes are expected to have a measurable effect on the turbidity statistics, but cause no ecological impact) is limited to areas near the LNG facilities on Curtis Island (Jacobs Channel), the Tide Island MRA, a small area near the Clinton Channel and Clinton Bypass, and a small area adjacent to the outer channel. This is slightly larger in extent than the Zone of Influence determined for the typical PoG maintenance dredging campaign (BMT 2021a), but importantly the ecological effects due to elevated turbidity are not expected to be more significant since the Zone of Impact is the same.



Legend

- Time Series Output Locations
- Direct Impact - Channels
- Direct Impact - MRAs
- Seagrass (2020)
- Coral Reefs (BMT WBM 2015)
- Seagrass Compositie Distribution (2002-2020)

Title:

Direct Impacts and Zone of Influence with Mapped Sensitive Receptors - 260,000m³ Campaign with 75,000m³ Placement at Tide Island MRA

Figure: **5.6**

Rev: **B**

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5.1.3 Turbidity and Deposition Rate Time Series

Time series of dredging-related changes to turbidity and deposition rate were extracted from the model at predetermined points of interest. Having simulated both dredging and ambient sediment, the time series show both these contributions to the total signal and in doing so provide important information on the relative magnitude of the dredging related signal.

Time series of depth averaged ambient and dredging-related turbidity are provided in Appendix C of this report for the output locations shown in Figure 5-6. The modelled total turbidity at each location is the sum of the dredging-related and ambient turbidity.

Time series of the deposition rate for dredged and ambient sediment at the same locations are provided in Appendix D. The dredging-related contribution to the total deposition rate is very small at all of the output locations.

5.2 Other Water Quality Parameters

The effect of maintenance dredging and placement on other water quality parameters was considered based on a review of previous water quality monitoring programs (BMT WBM 2017;BMT 2021b). These results are considered representative of future campaigns given:

- Sediment types in the new dredged areas (CVIP footprint) are similar to those previously assessed by BMT WBM (2017c) and BMT (2019c));
- The BMT (2021b) study examined the new dredged areas in the widened Clinton Channel;
- The increase in dredge volume due to inclusion of newly dredged areas in the widened Clinton Channel is negligible (approximately an extra 1,000 m^3 per annum); and
- The load for each dredge and placement run is the same. Monitoring indicates that nutrient and metal/metalloid concentrations rapidly degrade in dredge and placement plumes (measured in hours), hence there is low likelihood of cumulative impacts from multiple dredge runs.

BMT (2019a) involved monitoring at representative dredge sites throughout the PoG and the East Banks Offshore MRA, and reviewed previous monitoring undertaken in 2014. BMT (2021b) monitored CVIP sites before and after dredging. These results are summarised in Table 5.3.

Most parameters had higher concentrations in 2014 than 2017 and 2019. This is consistent with PCIMP monitoring results which indicate a general improvement in water quality conditions since major flooding in 2013 (see Section 4.2.1).

Increases (above background) in nutrient species and some metals were recorded in plumes generated by dredging and placement. Increases in nutrient and metal/metalloid concentrations in dredge plumes occur as a result of the following processes:

- Resuspension of particulate-bound nutrients and metals by the dredge head at the dredge site;
- Release of dissolved constituents contained in pore waters resulting from disturbance of the seafloor by the dredge head; and
- Release of particulate-bound and dissolved constituents in dredged sediments and waters from the dredge hopper into the placement site.

The results indicate that most nitrogen and phosphorus in dredge plumes was particulate-bound forms contained in organic matter. Particulate forms are the least bioavailable, but eventually break down over time to more readily bioavailable forms (e.g. ammonia). Organic matter degradation processes are not fundamentally altered by dredging and placement. The degradation rates of organic matter to bioavailable nutrients in pore water depends on the form and reactivity of the organic matter. For example, phytoplankton has high reactivity and is therefore broken down at timescales less than one (1) year. Most organic matter in nearshore sediments (including dredged sediments) is terrestrial matter with low reactivity, with degradation half-life measured in years to millennia (Batley *et al.* 2015).

In a review of monitoring studies in Queensland and worldwide, Batley *et al.* (2015) suggested that increased concentrations of soluble ammonia associated with pore water release and desorption from particles was typically of most concern, whereas release of dissolved nitrite, nitrate and phosphate were generally minor and of least concern. The results of the present study confirm that ammonia was the dominant form of bioavailable nitrogen in dredge and placement plumes.

Ammonia (and other nutrient) concentrations exceeded the local WQO but did not approach the toxicity guideline value for ammonia. Furthermore, ammonia and other bioavailable forms are highly unlikely to result in persistent water quality impacts. While the present study represents a snap-shot and was replicated in time and space, the data shows that nutrients in plumes generated by dredging and placement did not persist for more than one (1) hour. This is consistent with monitoring results for highly nutrient enriched dredged sediments (from Toondah Harbour) disposed at the Mud Island placement area (BMT WBM 2009b). BMT WBM (2009b) found that ammonia concentrations in the water column were close or slightly above background concentrations within 10 minutes of dredged material placement, and had returned to background concentrations (often below laboratory detection limit of ~0.002 mg/L) within one (1) hour of placement. These results indicate that through dilution and biological uptake of nutrients in dredged sediments in the water column, nutrient concentrations were well below levels of potential concern. Monitoring results (Table 5.3) do not suggest an increase in chlorophyll *a* concentrations in dredge plumes.

In terms of metals and metalloids, concentrations in maintenance dredge plumes at Jacobs Channel in July 2014 were below WQOs. Similarly, sampling conducted for the CVIP project (BMT 2021b)[8] found that all dissolved metals and metalloids in the dredge plumes were either below the limit of reporting (LOR) or below their respective WQOs[9]. Total concentrations of most metals/metalloids were low in the dredge plumes and were within the typical range of baseline conditions. The exceptions were slightly elevated concentrations of total copper and total zinc at some sample sites, consistent with ambient monitoring by PCIMP (2021). Total copper and zinc concentrations in dredge plumes were similar to baseline and control site measurements, indicating that a natural occurrence of these metals (see for example Angel *et al*. 2012 and Section 4.2).

[8] note that this sampling considered capital dredged material, but provides general contextual information regarding potential water quality changes in this new section of the maintenance dredge footprint
[9] note – one anomalous background sample had high dissolved copper, but was considered erroneous as it was higher than the total copper fraction

Table 5.3 Summary of dredge plume monitoring data for East Banks Offshore MRA and dredging sites (BMT WBM 2012b, 2019a; BMT 2021b)

Parameter	East Banks Offshore MRA		Dredge Sites		
	2014	2017	2014	2017	2021 (CVIP)
Ammonia	• <0.003 mg/L (background) • 0.017-0.02 mg/L in dredge plume >WQO of 0.003 mg/L	• <0.005-0.018 mg/L in dredge plume • Two (2) dredge plume samples >WQO of 0.003 mg/L • Not detected one (1) hour after dredging	• Background ranged from <0.003-0.004 mg/L • Dredge samples ranged from 0.003-0.062 mg/L, frequently exceeding WQO of 0.003 mg/L	• Dredge plume samples were ≤0.033 mg/L; one sample > WQO • Higher concentration in near-bed background sample indicates natural sediment nutrient flux	• Dredge plume samples <0.005-0.011 mg/L, with three (3) of 39 dredge plume samples >WQO • Background samples were <0.005 mg/L
NOx	• Dredge plume and baseline samples were ≤0.003 mg/L • One plume and background sample at WQO, indicating slightly elevated background	• Not detected (<0.002 mg/L) in any samples	• Background ranged from <0.002-0.013 mg/L • Dredge samples ranged from 0.002-0.038 mg/L, frequently exceeding WQO of 0.003-0.005 mg/L	• Nitrite was not detected (<0.002 mg/L) in any samples. • Nitrate was 0.003-0.004 mg/L in background samples, and 0.003-0.005 mg/L in plume samples (average = 0.003 mg/L). • Near bed concentrations were typically greater than surface in both background and plume samples, indicating some sediment nutrient flux	• Not detected (<0.002 mg/L) in any samples
TN	• WQO (0.1 mg/L) exceeded in background and dredge plume samples (0.1-0.18 mg/L)	• WQO (0.1 mg/L) met in all samples	• Background ranged from 0.013-0.018 mg/L • Dredge samples ranged from 0.013-0.4 mg/L, frequently exceeding WQO of 0.13-0.17 mg/L	• WQO (0.17 mg/L) met in all samples (0.01-0.15 mg/L)	• WQO for total nitrogen (0.17 mg/L) was met in all but one sample (0.08-0.33 mg/L)
TP	• 0.01-0.015 mg/L (background) and 0.018-0.021 mg/L (dredge plumes) • WQO (0.008 mg/L) exceeded in all samples	• Concentrations <0.005 mg/L detection limit in all but one (1) sample (surface plume = 0.006 mg/L) • WQO (0.008 mg/L) met in all samples	• Background ranged from 0.012-0.031 mg/L • Dredge samples ranged from 0.018-0.140 mg/L, frequently exceeding WQO of 0.014-0.018 mg/L	• <detection limit of 0.005 mg/L in background samples • dredge plume samples ranged from <0.005-0.046 mg/L (average 0.018 mg/L) when overflow commenced. However, TP was below detection limits (i.e. background) in plume samples ≥1 hour after dredging. The WQO for TP(0.018 mg/L) was exceeded in three (3) plume samples.	• Total phosphorus concentrations were <laboratory LOR and guideline value of 0.005 mg/L in all background and dredge plume samples
Filterable reactive phosphorus	• <0.002 mg/L (background) and 0.002-0.003 mg/L (dredge plumes) • WQO (0.001 mg/L) exceeded in all dredge samples	• Filterable reactive phosphorus was not detected in any samples (<0.001 mg/L), and therefore met the WQO of 0.001 mg/L.	• Background ranged from <0.002-0.003 mg/L • Dredge samples ranged from <0.002-0.023 mg/L, occasionally exceeding WQO of 0.002-0.003 mg/L	• Filterable reactive phosphorus was typically either not detected (<0.001 mg/L) or 0.001 mg/L in most samples. All but one (1) sample met the WQO of 0.003 mg/L; the near-bed plume sample at Wiggins Island Coal Export Terminal (WICET) during overflow (0.004 mg/L).	• Filterable reactive phosphorus concentrations were < laboratory LOR of 0.001 mg/L and guideline value (0.007 mg/L) in all background and dredge plume samples
Chlorophyll *a*	• All samples < detection limit of <1 µg/L, meeting WQO of 2 µg/L	• Not assessed	• Background ranged from <1-2 µg/L, with one sample at the WQO. Dredge sites ranged from <1-1 µg/L, which was at or below the WQO	• Not assessed	• Most samples <1 µg/L except one (1) background sample (41 µg/L) and one (1) dredge plume sample (41 µg/L); both samples exceeded WQO of 2 µg/L
Metals/Metalloids	• Not assessed	• Not assessed	• Metals/metalloids in the dredge plumes typically within range or slightly greater than baseline • Dissolved fractions of most parameters < laboratory LOR • Dissolved fractions <WQO, whereas total copper exceeded WQO	• Not assessed	• Metals/metalloids in the dredge plumes typically within range of baseline conditions • Most parameters < laboratory LOR and guideline values • Slight exceedances of WQO were recorded for copper, zinc and nickel in <50% of samples

Overall, these monitoring results suggest that nutrients, chlorophyll *a*, metals/metalloids and other physio-chemical parameters (including pH, dissolved oxygen) in dredge plumes represent a low environmental risk.

5.3 Ecological Implications

Table 5.4 summarises marine communities in the dredging and placement footprint and immediate surrounds (project area), and key impact pathways.

Table 5.4 Marine communities in the dredge and placement footprint and immediate surrounds (project area) and potential impact pathways

Communities	Direct effects	Indirect effects
Soft-sediment benthic invertebrate communities	• extraction of benthos living in the channel • smothering of benthos at the placement site	• physiological impairment by sediment • liberation of nutrients and food resources at the dredge and placement sites
Plankton and nekton communities in the water column	• potential fauna injury by the dredge head • entrainment of plankton and small fish in the dredge	• physiological impairment by sediment • liberation of nutrients resulting in increased algal production
Seagrass meadows	• not applicable (outside impact footprint)	• reduced light resulting in impaired energy production and growth
Reef communities	• not applicable (outside impact footprint)	• physiological impairment by sediment • reduced light resulting in impaired energy production and growth

5.3.1 Direct Effects

5.3.1.1 Benthic Flora and Fauna in the Dredge Footprint

The dredger will extract benthic fauna from the dredge areas. The fate of fauna extracted by the dredger is unknown, although it is possible that some surviving fauna may colonise the East Banks Offshore MRA and/or the proposed Tide Island MRA.

Benthic fauna will begin to recolonise the dredge areas shortly after dredging is completed. The dredge areas are regularly disturbed by maintenance dredging and in some areas propellor wash. Benthic communities in affected areas would therefore remain in a state of flux, resulting in localised changes to community structure.

Benthos at the East Banks Offshore MRA and the proposed Tide Island MRA could be smothered by dredged material placement. Monitoring of benthic communities within and adjacent to the East Banks Offshore MRA by BMT (2012b) indicate benthic macroinvertebrate communities are resilient to changes associated with maintenance material placement, and the long history of dredged material placement activities has created a change in community structure within and adjacent to the East Banks Offshore MRA. Within the East Banks Offshore MRA sediments are coarser and support more attached sessile forms, while adjacent communities are dominated by deposit feeders over softer sediments. It is expected that this will continue to be the case longer term. The characteristics of benthic communities at the proposed Tide Island MRA have not been

surveyed. Assuming that the proposed Tide Island MRA are comprised of soft sediment communities similar to those elsewhere in the PoG, it is expected that any dredging impacts will be short-term.

No seagrass meadows, reef-building coral communities, macroalgae beds or mangroves occur in the dredge or East Banks Offshore MRA footprint.

5.3.1.2 Marine Megafauna Vessel Interactions

Marine animals that swim near the water surface, such as whales, dolphins, dugongs and turtles, could interact with the dredger. A dredger is slow-moving, which would provide marine fauna time to evade the approaching vessel. Turtles are also highly mobile and will tend to avoid the dredger. When active, sea turtles must swim to the ocean surface to breathe every few minutes, however, they can remain underwater for as long as two hours without breathing when they are resting. There are recorded incidences of turtles being killed or injured by TSHDs. Cutter-suction and back-hoe dredgers pose a low risk to turtles as they do not have trailing suction dragheads (Dickerson *et al*. 2004).

The *TSHD Brisbane* undertaking maintenance dredging in Gladstone has reported capturing five (5) turtles in the 10-year period between 2005 and 2015 (TMR 2016). Given the relatively low numbers of turtles captured by dredgers compared to other activities, and the use of effective management and operational practices to reduce the potential for turtle capture, it is not considered that the proposed dredging will have a significant impact on turtle populations in the study area. Direct effects of loading (dredger interaction) will be mitigated using existing practices aboard the *TSHD Brisbane* as a part of their environmental management plan and in accordance with GPC's permit conditions and adaptive monitoring and management framework.

5.3.1.3 Underwater Noise

Underwater noise assessments carried out in association with the Western Basin dredging suggest suggested that cetaceans and dugongs may start to show a behavioural response within two (2) km from the dredger or associated booster pumps, while turtles would be affected within fifty (50) metres (BPM 2013). This assumes no attenuation or amplification in sound due to the physical environment. Dolphins, dugong or turtles remaining within one (1) metre of a dredge or booster pump for more than 10 minutes would suffer immediate physical impact (BPM 2013). However, even at relatively close distances it would take time for injuries to occur. At 100 m away, impacts would not occur for any animal until at least one (1) hour of exposure to dredge noise or three (3) hours of exposure to booster pump noise. Given the close distances and durations required, it was considered that marine megafauna in the PoG were unlikely to suffer physical impacts from dredging noise. The dredger will represent an intermittent noise source that has the potential to temporarily interfere with marine megafauna communications during the dredge campaign.

5.3.2 Indirect Effects Due to Sediments and Water Quality Changes

5.3.2.1 Nutrients and Algae

BMT WBM (2017b) and BMT (2019a) described the effects of maintenance dredging and placement on nutrient concentrations and algae biomass (chlorophyll *a*) in the water column. Both studies found short-term (less than one (1) hour) low intensity increases in TP and filterable reactive phosphorous, nitrate and ammonia concentrations in plume samples. Algae biomass (chlorophyll *a*) was low in both the dredge plume and background, which suggest that dredging and placement did not result in algae blooms (see Section 5.2). The dredge and placement scenarios considered in the present study are expected to result in similar effects.

5.3.2.2 Sediment Impacts to Soft Sediment Benthos

Soft sediment benthos occurs within the Zone of Impact, and may be indirectly affected by dredging as a result of:

- Increasing food resources availability in the form of suspended sediments and benthic fauna;
- Increasing sediment deposition levels, resulting in burial of sessile fauna; and
- Increasing suspended sediment concentrations causing the interference or blocking of respiratory and feeding structures.

There is a lack of information on critical levels of sedimentation or suspended sediment concentrations that would result in smothering, clogging of the filtering apparatus or other deleterious effects to benthic macroinvertebrates. The benthic macroinvertebrate communities regularly experience total suspended solid (TSS) concentrations greater than 70 mg/L, and it is therefore unlikely that species that are highly sensitive to sediment loading would occur here.

Previous investigations demonstrate that dredged material placed at the existing offshore East Banks Offshore MRA rapidly settles and tends to have little short-term effect on areas outside the East Banks Offshore MRA, and that there was no evidence that sediment deposition in the EBSDS was having any measurable effect on benthic habitats surrounding the EBSDS (Smith 2022). The effect of placement within the East Banks Offshore MRA is heavily dependent on the volume of material relocated.

The 2021 Benthic Habitat Monitoring 2021 found that sediment was predominantly sand (75µm – 2 mm) across the survey area. In the East Banks Offshore MRA fine sediment composition (< 75 µm) was higher and sand sediment lower than in the other locations. These results contrast previous surveys in 2005, 2010/11 and 2016/17 when fine sediment was lower in the East Banks Offshore MRA. However, small areas of seagrass extended into the East Banks Offshore MRA which is consistent with previous surveys and infauna assemblages composition and distribution were relatively similar.

Previous monitoring programs demonstrated that while placement effects were benign after placement of 126,000 m^3 of maintenance material, the placement of 600,000 m^3 of capital material resulted in markedly decreased abundance and richness (BMT WBM 2011a).

Therefore, future campaigns are likely to result in similar effects on the East Banks Offshore MRA and surrounding soft sediment to what has been observed previously (assuming “clean” i.e. below National Assessment Guidelines for Dredging 2009 (NADG 2009) screening thresholds, material continues to be placed, and that these effects are largely related to physical burial).

5.3.2.3 Sediment Impacts to Seagrass and Reef Communities

The Zones of Impact thresholds were derived in part on information on seagrass tolerances (Section 5.1.2.2). As discussed in Section 5.1.2, no seagrass meadows or reefs occur in the Zone of Impact. The Zone of Influence extends to mapped seagrass meadows near Passage Island and South Passage Island in the Western Basin (Figure 5-6). By definition, impacts to seagrass and other sensitive receptors are not expected to occur in the Zone of Influence, although a visible plume may be present. While impacts to these (and other) seagrass meadows are not expected, an adaptative monitoring framework will be followed to manage unanticipated dredge plume risks.

The Zone of Impact and Zone of Influence for turbidity do not extend to fringing/coral reefs. Impacts to these communities due to dredging-related turbidity are therefore not expected. Analysis of the time series of deposition rate presented in Appendix D indicates that the dredging-related contribution to the total deposition rate at reef sites is very low, and therefore there are not expected to be any impacts to these communities due to dredging-related increases to sediment deposition.

5.3.2.4 Sediment Impacts to Fish and Shellfish

Fish and invertebrates that inhabit the PoG regularly experience periods of tidally-driven turbidity. Fish have a lateral line system that is used to detect prey, which allow many fish species to feed in highly turbid waters (Higham *et al.* 2015). However, physiological effects to fish can occur at very high suspended sediment concentrations. For example, Jenkins and McKinnon (2006) suggested that TSS concentrations of 4000 mg/L could block gills, eventuating in fish mortality. There are very few documented cases of fish kills resulting solely from turbid plumes, and predicted TSS levels are not predicted to approach these levels.

Penaeidae prawns and Portunidae (mud and sand) crabs are the most economically important shellfish species in the study area (BMT WBM 2017c). These species inhabit estuarine, nearshore and offshore environments (Kailola *et al.* 1993), which requires tolerance to a wide range of turbidity conditions. These species are also highly mobile and are able to actively burrow through soft sediments. Therefore, indirect impacts to prawns and crabs as a result of high suspended sediment concentrations and sedimentation from maintenance dredging are not expected.

5.3.2.5 Sediment Impacts to Marine Megafauna

The highest recorded stranding rates for turtles and dugongs were documented in 2011 and 2012 across the entire Queensland coast, as a result of habitat loss (seagrass) associated with flooding, high turbidity and low visibility (Meager and Limpus 2012). These conditions make marine megafauna more susceptible to starvation and boat strike.

Maintenance dredging plumes are not expected to significantly impact seagrass meadows or reef communities (Section 5.3.2.3), nor are major changes to benthic macroinvertebrate communities expected. It is therefore highly unlikely that dredging would result in a loss of food resource availability to the extent where flow-on effects to turtles and dugong would occur.

The sediment plumes created by dredging will temporarily reduce visibility. The dolphin species found in the study area are capable of successfully foraging in turbid waters. Dolphins often stir up bed sediments when foraging for benthic prey, resulting in limited to no visibility for prey detection. It is thought that dolphins detect prey using echolocation rather than visual cues (Mustoe 2006, 2008, Branstetter *et al.* 2012). Dugongs have poorly developed eyesight and rely on bristles on their upper lip, rather than visual cues, to detect seagrass food resources. Therefore, high suspended solid concentrations generated by dredging and dredged material placement are not expected to adversely affect foraging success for cetaceans or dugongs. Sea turtles generally have good eyesight and rely on visual and olfactory cues to detect prey and other food resources (e.g. Swimmer *et al*. 2005). Flatback turtles are known to feed in turbid shallow waters (Robins 1995) and may not be directly affected by turbid plumes generated by dredging. Other species such as green turtles (which are common in the PoG) and hawksbill turtles (which are occasionally found in the PoG), which feed in seagrass and/or in reef environments, may avoid areas affected by turbid plumes (Limpus *et al* 2013). It is noted however that the key feeding areas for these species are not predicted to be exposed to highly turbid dredge plumes.

5.3.3 Introduced Marine Pests

5.3.3.1 Existing Status

More than 250 non-indigenous marine species have been recorded in Australian waters to date (NIMPCG 2013). There are several potential vectors by which non-indigenous species may enter domestic waters; however, it is thought that most species are unintentionally introduced through shipping and vessel movements, either in ballast waters or from biofouling on the hull of vessels (Hewitt and Campbell 2010). Other vectors include intentional transfer of aquaculture and mariculture organisms, transfer of food products for the aquarium trade and use of biological material for packing (Hewitt and Campbell 2010). Asian green mussels (*Perna viridis*), considered to be a potential threat in tropical waters, were found on a vessel's hull in Cairns harbour 2001 and Caribbean tubeworm (*Hydroides sanctaecrucis*) has also been introduced there (Souter 2009).

A baseline marine pest survey was carried in the PoG in 2000 (Lewis *et al.* 2001). The aim of this baseline survey was to describe existing non-indigenous species, including target pest species listed by the Australian Ballast Water Management Committee (Hewitt and Martin 1996; Furlani 1996). Although no pest species were detected, 10 introduced species were found, including the ascidians *Styela plicata* and *Botrylloides leachi*; the bryozoans, *Amathia distans*, *Bugula neritina*, *Cryptosula pallasiana*, *Watersipora subtorquata*, and *Zoobotryon verticillatum*; the hydrozoan *Obelia dichotoma*; the isopod, *Paracerceis sculpta*, and the dinoflagellate *Alexandrium sp*. Each of these species are found in ports across Australia and internationally and were not thought to represent a threat to native species in the PoG, apart from some spatial competition from some of the bryozoans species (Lewis *et al.* 2001).

Vision Environment (2015) undertook a marine pest survey in the PoG in 2015. The survey discovered four species registered on National Introduced Marine Pest Information System (NIMPIS), including the Caribbean tubeworm (*Hydroides sanctaecrucis*), sea lettuce (*Ulva fasciata*), sponge isopod (*Paracerceis sculpta*), and

the encrusting bryozoan (*Cryptosula pallasiana*) (Vision Environment 2015). These species appear to be relatively widespread throughout the PoG and are not considered high-risk species, although the Caribbean tubeworm is considered a medium impact pest by CSIRO. Based on their ubiquity in other Australian ports, throughout the PoG, and their present pest status, their presence did not warrant a pest emergency response (Vision Environment 2015).

Wiltshire *et al*. (2019) undertook marine pest surveys in the PoG utilising novel methodologies combining plankton collection and molecular technologies in particular quantitative polymerase chain reaction (qPCR) assays. Sample analysis showed several detections of the genus *Arcuatula* whose status in Gladstone was deemed unclear due to the lack of availability of biological specimens and sequences of related taxa that results can be screened against. No further detections and evidence of other PoG target pests species was found (Wiltshire *et al*. 2019).

DAF (2021), in partnership with GPC, undertook a pilot marine pest survey in the PoG using e-DNA methodology. No invasive marine pests were detected. The methodology successfully resolved the detection of taxa from marine pest 'families', but in most cases invasive marine pest targets were ruled out. The exception was the detection of *Sargassum* seaweed, however the analysis could not resolve whether this was detection was the invasive *Sargassum muticum*. The introduced feather-duster worm *Branchiomma bairdi* was also detected. This worm is not a declared invasive marine pest in Australia, however DAF and GPC (2021) recommended that future surveillance could target this species.

It should be noted that field studies of introduced marine species should not be considered exhaustive, given the difficulties associated with surveying large ports and the fundamental lack of taxonomic information for many marine species (Sliwa *et al.* 2009). Given that many marine taxa are difficult to identify to species, these could represent native species or non-native introductions. Lewis *et al.* (2001) specifically targeted known or potential pest species so it is likely that marine pest prevalence estimates are more reliable than those of total introduced species estimates.

5.3.3.2 Potential Impacts

There are two (2) key vectors for introduced marine pests entering a port: biofouling of the vessel hull, or the release of pests into the marine environment via ballast waters (Hewitt and Campbell 2010). Vessels (including dredgers, cargo vessels, high speed craft etc.) can subsequently translocate pests within and outside the port area. In areas containing marine pests, there is a risk that pests could be transferred by the dredger from the dredge site to the East Banks Offshore MRA. As discussed above, despite the presence of introduced species in the PoG, none of these are considered marine pest species. Based on this, it is considered that the risk of translocating pest species within the PoG (i.e. from the loading site to the East Banks Offshore MRA) is considered to be low.

Any TSHD contracted to undertake dredging works will be required to comply with best practices, including Australian Quarantine and Inspection Service and Biosecurity Queensland requirements in relation to ballast water and marine pest management, including the National System for the Prevention and Management of Marine Pest Incursions, in particular the National Biofouling Management Guidance for Non-Trading Vessels (Marine Pest Sectoral Committee, 2018).

The *TSHD Brisbane* represents a low risk of species translocation because it works primarily within Queensland ports and the Port of Melbourne.

5.4 Impacts on Other Users

Maintenance dredging operations and associated plumes and sedimentation are not expected to impact other users of the area, including commercial and recreational fishers, recreational boating enthusiasts, and vessel traffic to the LNG projects on Curtis Island.

Potential impacting processes include:

- Interference with other vessels. Maintenance dredging operations are unlikely to significantly interfere with small craft movements. Dredger movements comprise a small proportion of total ship movements in the port. MSQ also advises small craft to keep clear of ship navigation areas, including shipping channels, berths, swing basins etc. subject to maintenance dredging. Dredging operations are co-ordinated around the movements and berthing schedules of larger ships;
- Direct effects to fishing operations. Commercial fishing activities in the PoG include setting of crab pots, nets and trawling. Netting and trawling are not permitted in navigational areas subject to maintenance dredging, therefore direct effects to commercial fishing operators are not expected; and
- Indirect effects due to dredge plume. Modelling predicts that sediment plumes and sedimentation rates created by dredging will be within the range of natural tidally generated turbidity during spring tides. As described in Section 5.1.2, plumes are not expected to significantly impact on high value fisheries habitats such as seagrass, high-density epibenthos or mangroves, and on this basis significant impacts to fisheries resource values are not expected.

5.5 Matters of National Environmental Significance

The impact of dredging and placement plumes to MNES was assessed using criteria set out in the MNES Significant impact guidelines 1.1 (Commonwealth of Australia 2013). The vulnerability of MNES to water quality changes resulting from dredge plumes was considered in the assessment of the impact significance criteria. Vulnerability is a product of three (3) factors (De Lange *et al.* 2010; Figure 5-7):

- Exposure – the intensity, duration of dredge plumes at the receptor site, as determined from dredge modelling results;
- Sensitivity – the sensitivity of the receptor to water quality changes, including direct sensitivity (e.g. interference to feeding or physiological impact) or indirect sensitivity (sensitivity of food and habitat resources, and the capacity of species to switch to other resources); and
- Adaptative capacity – the capacity of receptor to adapt or recover from stress.

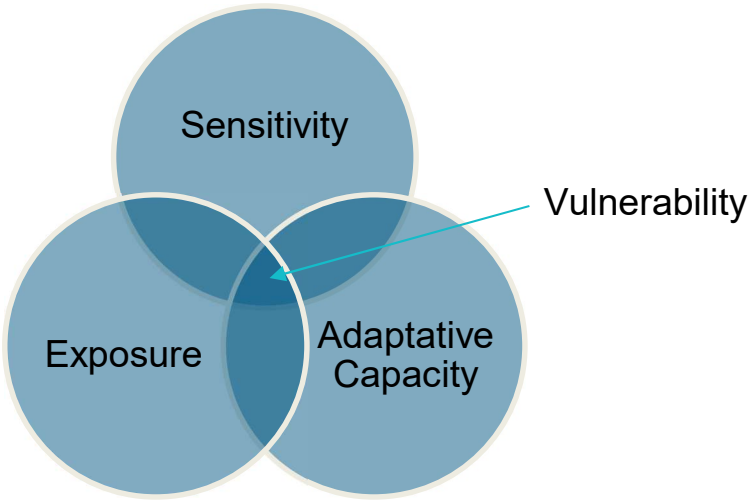

Figure 5-7 Elements defining vulnerability

The impact significance assessment for each MNES is structured around these three (3) elements of vulnerability, as described below.

5.5.1 Threatened Ecological Communities

No TECs occur in marine waters of the study area (i.e. no exposure). No impacts to these communities will occur as a result of the project.

5.5.2 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; and
- Interfere with the recovery of the species (Commonwealth of Australia 2013).

Critically Endangered or Endangered Species that are likely to occur in the study area, and the potential impact of the project on this species is provided in Table 5.5. Based on the above criteria, no significant impacts are expected to occur to these species or their habitat.

Table 5.5 Potential Impacts to Critically Endangered or Endangered Species known to, or likely to occur, within the study area

Species	Exposure (Likelihood of occurrence in project area)	Sensitivity and Adaptive Capacity	Assessment
White's Seahorse *Hippocampus whitei*	Very low – potential habitat present, but not known from central Queensland	Direct – would require resilience to periodic high turbidity given background conditions. Indirect – uses food resources with varying sensitivity to turbidity (mostly micro-crustaceans). Uses biogenic and abiogenic habitat – the most sensitive being macroalgae (as occurs around shallow reefs)	No significant impact – current species distribution does not overlap with disturbed areas, unlikely to be highly sensitive to the predicted short-term water quality changes (Short *et al.* 2019)
Blue Whale *Balaenoptera musculus*	Very low – Possible (but highly unlikely) transient visitor to the PoG during summer (ALA 2023), highly unlikely to regularly use dredge/placement sites	If present, would require resilience to periodic high turbidity given background conditions	No significant impact – preferred habitat does not overlap with disturbed areas and unlikely to be highly sensitive to short-term water quality changes
Loggerhead Turtle *Caretta caretta*	Possible – Nesting occurs at several places surrounding, the PoG (Limpus *et al.*, .2016).Recent surveys also report nesting of this species on Facing Island (FBA 2022).	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity.	No significant impact – occurs outside project area. There may be short-term water quality changes but these are not expected to have direct effects or lead to significant impacts to habitats or food resources
Leatherback Turtle *Dermochelys coriacea*	Very low – Possible transient visitor to the PoG, highly unlikely to regularly use dredge/placement sites. Remote from nesting habitat and designated BIA (inter-nesting habitat outside the PoG) (ALA 2023).	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity.	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Olive Ridley Turtle *Lepidochelys olivacea*	Very low – Possible transient visitor to the PoG, highly unlikely to regularly use dredge/placement sites. Remote from nesting habitat (ALA 2023).	Direct – if present, would require resilience to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity.	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

5.5.3 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; and
- Interfere substantially with the recovery of the species.

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; and
- Populations that are near the limit of the species range (Commonwealth of Australia 2013).

Vulnerable species that are likely to occur in the study area and the potential impact of the project on these species is provided in Table 5.6. In the context of important populations:

- All Queensland coastal waters represent a BIA for Humpback Whale. The PoG and dredge/placement sites are not known to be regularly frequented by this species, and it is unlikely to be directly or indirectly affected by transient, localised dredge plumes; and.
- Critical Habitat (nesting) and BIA (inter-nesting) occur at and adjacent to sandy beaches of the PoG for loggerhead turtle and flatback turtle. Loggerhead turtle has been recently found to nest within the PoG, in particular on Facing Island (FBA 2022). These areas are remote from dredge plumes. The PoG and dredge/placement sites may be frequented by both species, but they are unlikely to be directly or indirectly affected by transient, localised dredge plumes

Based on the criteria, no significant impacts are expected to occur to Vulnerable species or their habitat.

Table 5.6 Potential Impacts to Vulnerable species known to, or likely to occur, within the study area

Species	Exposure (Likelihood of occurrence in project area)	Sensitivity and Adaptive Capacity	Assessment
Humpback Whale *Megaptera novaeangliae*	Low – Possible transient visitor to the PoG during winter, highly unlikely to regularly use dredge/placement sites (ALA 2023). BIA present (all Queensland coastal waters)	Direct – would require resilience to periodic high turbidity given background conditions. Indirect – does not feed in tropical waters and uses pelagic habitat.	No significant impact – preferred habitat does not overlap with disturbed areas, not sensitive to be short-term water quality changes
Green Turtle *Chelonia mydas*	High – Known to occur around channels in the PoG, but more abundant around seagrass feeding habitat (Limpus *et al.* 2017; Limpus and FitzSimmons 2020). Remote from nesting habitats within the PoG.	Direct – resilient to periodic high turbidity given background conditions Indirect – Seagrass specialist, and therefore potentially sensitive to indirect turbidity impacts	No significant impact – occurs in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Hawksbill Turtle *Eretmochelys imbricata*	Moderate – While not a core habitat, there are multiple records of this species in the PoG (ALA 2023). Remote from nesting habitat	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet – uses food resources with varying sensitivity to turbidity	No significant impact – occurs in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Flatback Turtle *Natator depressus*	High – Potential foraging habitat (especially reef communities) occur in the PoG (Hamann *et al.* 2015). Known foraging habitat occurs north and south of the PoG (Limpus *et al*. 2013a). Remote from nesting habitat and designated CH (nesting and inter-nesting buffer)	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity	No significant impact – occurs in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Great White Shark *Carcharodon carcharias*	Low – Possible transient visitor to the PoG (year-round), highly unlikely to regularly use dredge/placement sites (Hamann *et al*. 2017)	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (fish, marine mammals)	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Green Sawfish *Pristis zijsron*	Very low – potential habitat present, but not known from central Queensland	Direct – highly tolerant of high turbidity. Indirect – uses food resources with varying sensitivity to turbidity (shellfish, fish).	No significant impact – current species distribution does not overlap with disturbed areas, unlikely to be highly sensitive to the predicted short-term water quality changes
Whale Shark *Rhincodon typus*	Very low – Possible (but highly unlikely) transient visitor to the	Direct – if present, would require some	No significant impact – preferred habitat does not overlap with

Species	Exposure (Likelihood of occurrence in project area)	Sensitivity and Adaptive Capacity	Assessment
	PoG (year-round), highly unlikely to regularly use dredge/placement sites	tolerance to periodic high turbidity given background conditions Indirect – Uses food resources with varying sensitivity to turbidity (zooplankton, small fish)	disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

5.5.4 Listed 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; and/or
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; and/or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

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

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- Habitat that is of critical importance to the species at particular life-cycle stages; and/or
- Habitat utilised by a migratory species which is at the limit of the species range; and/or
- Habitat within an area where the species is declining (Commonwealth of Australia 2013).

Table 5.7 lists migratory species that occur, or are likely to occur, in the study area (PMST Report, Appendix A. Note that this list excludes critically endangered, endangered or threatened species already considered in previous sections.

In the context of important migratory populations:

- All Queensland coastal waters represent a BIA for Humpback Whale. The PoG and dredging/placement sites are not known to be regularly frequented by this species, and it is unlikely to be directly or indirectly affected by transient, localised dredge plumes;.
- Critical Habitat (nesting) and BIA (inter-nesting) occur at and adjacent to sandy beaches of the PoG for loggerhead turtle and flatback turtle. These areas are remote from dredge plumes. The PoG and dredge/placement sites may be frequented by both species, but they are unlikely to be directly or indirectly affected by transient, localised dredge plumes; and
- Coastal waters south of Shoalwater Bay to Rodds Bay (particularly Port Alma and the PoG), within the 20 m depth contour represent a BIA for Australian Humpback Dolphin. The PoG and

dredge/placement sites are regularly frequented by this species. This species can feed in highly turbid waters, and because it has a relatively broad diet, it is able to switch to alternate prey. The transient, localised dredge plumes are unlikely to lead to significant direct and indirect impacts to this species or its habitats.

Based on the impact significance criteria, no significant impacts are expected to occur to listed migratory species or their habitat.

Table 5.7 Potential Impacts to migratory species known to, or likely to occur, within the study area (excluding threatened migratory species described elsewhere)

Species	Exposure (Likelihood of occurrence in project area)	Sensitivity and Adaptive Capacity	Assessment
Australian Snubfin Dolphin *Orcaella heinsohni*	Possible – Has been recorded in nearby areas, including Port Alma (Cagnazzi 2017) could occur at dredge/placement sites.	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (multiple shellfish and fish species)	No significant impact – could in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Australian Humpback Dolphin *Sousa sahulensis*	High – Feeding and breeding extending from Keppel Sands down to Rodds Bay year-round, highly likely to occur at dredge/placement sites (Parra and Cagnazzi 2016). BIA (calving, feeding) present for the species geographic range (inc. the PoG)	Direct – resilient to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (multiple shellfish and fish species)	No significant impact – occurs in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Dugong *Dugong dugon*	High – Known to traverse throughout the PoG, but more abundant around seagrass feeding habitat (Davies *et al.* 2015)	Direct – resilient to periodic high turbidity given background conditions Indirect – Seagrass specialist, and therefore potentially sensitive to indirect turbidity impacts	No significant impact – occurs in project area, but the short-term water quality changes are not expected to have direct effects or lead to significant impacts to seagrass habitats or food resources
Bryde's Whale *Balaenoptera edeni*	Very low – Mostly oceanic but possible transient visitor to the PoG (year-round), highly unlikely to regularly use dredge/placement sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (plankton, small fish)	No significant impact – preferred habitat does not overlap with project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Killer Whale *Orcinus orca*	Very low – Mostly oceanic but possible transient visitor to the PoG (year-round), highly	Direct – if present, would require some tolerance to periodic	No significant impact – preferred habitat does not overlap with project area. Short-term water quality changes are not expected to have

Species	Exposure (Likelihood of occurrence in project area)	Sensitivity and Adaptive Capacity	Assessment
	unlikely to regularly use dredge/placement sites	high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (fish, marine mammals)	direct effects or lead to significant impacts to habitats or food resources
Salt-water Crocodile *Crocodylus porosus*	Moderate – potential habitat present, transient visitor to the PoG with recent observations (DES 2023b), unlikely to regularly use dredgeor disposal area	Direct – highly tolerant of high turbidity. Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (mostly fish and some shellfish, birds, terrestrial animals)	No significant impact – current species distribution does not overlap with disturbed areas, unlikely to be highly sensitive to the predicted short-term water quality changes
Oceanic Whitetip Shark *Carcharhinus longimanus*	Very low – Mostly oceanic but possible transient visitor to the PoG (year-round), highly unlikely to regularly use dredge/placement sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (mostly fish and some shellfish, birds)	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Porbeagle Shark *Lamna nasus*	Very low – Mostly oceanic but possible transient visitor to the PoG (year-round), highly unlikely to regularly use dredge/placement sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect – Flexible diet, uses food resources with varying sensitivity to turbidity (mostly fish and some shellfish)	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Reef Manta Ray *Mobula alfredi* Giant Manta Ray *Mobula birostris*	Very low – Mostly oceanic but possible transient visitor to the PoG (year-round), highly unlikely to regularly use dredge/placement sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect – Uses food resources with varying sensitivity to turbidity (zooplankton, small fish)	No significant impact – preferred habitat does not overlap with disturbed areas occurs in project area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

5.5.5 Commonwealth Marine Area

A Commonwealth Marine Area occurs >5 km east of Facing Island, remote from the influence of dredge and placement plumes (i.e. no exposure). No impacts to Commonwealth Marine Area will therefore occur as a result of the project.

5.5.6 Great Barrier Reef World Heritage Area and Natural Heritage Place

According to the MNES Significant impact guidelines (Commonwealth of Australia 2013) an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- One or more of the World Heritage values to be lost;
- One or more of the World Heritage values to be degraded or damaged; and
- One or more of the World Heritage values to be notably altered, modified, obscured or diminished.

Examples of significant impact thresholds in the impact significance guidelines that are relevant to the project are as follows.

Geological

(1) Damage, modify, alter or obscure important geological formations in a World Heritage property;

(2) Damage, modify, alter or obscure landforms or landscape features, for example, by excavation or infilling of the land surface in a World Heritage property;

(3) Modify, alter or inhibit landscape processes, for example, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes, in a World Heritage property; and

(4) Substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants or substances in a river, wetland or water body in a World Heritage property.

Dredging and placement will not result in significant impacts to geological formations or geological processes (criteria 1-3 above). Dredge and placement plumes will result in increased pollutant concentrations (criteria 4). However, the increased pollutant concentrations are not considered substantial given plumes will be highly localised, short-term (measured at timescales of 10s of minutes to hours), not cumulative, and levels are within the upper range of natural variability (e.g. during storms).

Biological

(5) Reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property;

(6) Fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property;

(7) Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property; and

(8) Cragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property.

Dredging activities will be carried out in the GBRWHA, which will result in temporary impacts to water quality near the dredge loading site during dredging, and effects to benthic communities within the dredge loading site

(which based on Section 5.1, suggest impacts are of a temporary nature). Significant impacts to biodiversity values are not expected as:

- Dredging will be carried out within existing channels, which represents a previously disturbed environment rather than a green-field site;
- Dredging areas are not known or likely to support habitats of critical importance to threatened or otherwise conservation dependent species or communities;
- Habitat within the disturbance footprint is not known or likely to provide unique or critical functions to the maintenance of aquatic ecosystems within the PoG; and
- Indirect impacts to habitats and communities of high biodiversity value (seagrass, and surrounding reefs) are not expected.
- Direct or flow-on impacts to threatened or migratory species are not expected.

On the basis of the above, in the context of EPBC Act Significant Impact Guidelines 1.1 (Commonwealth of Australia 2013; see Table 5.8), it is expected that the proposed dredging will:

- Not result in loss of one or more World Heritage values;
- Not result in one (1) or more World Heritage values to be degraded or damaged; and
- Not result in one (1) or more World Heritage values to be notably altered, modified, obscured or diminished.

Table 5.8 Criteria listed by the EPBC Act for a 'significant impact' and the 'likelihood' of impact to World Heritage Values, Commonwealth Marine Waters or GBR

Significance criteria	Assessment
Reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property.	Maintenance dredging will lead to short-term modifications to benthic fauna assemblage structure as a result of dredging in the channel and placement at the East Banks Offshore MRA. These impacts are expected to be highly localised (i.e. within the lawful dredging and placement footprint), and are not expected to result in broader scale impacts to the biodiversity values of the PoG.
Fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property.	Maintenance dredging will remove sediments from less than 1 $km^2$of existing channel extent. Such habitats are well represented elsewhere within other parts of the non-dredged channel. None of the area to be disturbed is habitat that is known to be unique to the PoG. Maintenance dredging will not isolate marine habitats. Maintenance dredging and placement at the East Banks Offshore MRA will not form a barrier to fauna movements within, or in and out of, the PoG.
Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property. Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in the World Heritage property.	In the absence of mitigation, modelling suggests that maintenance dredging could lead to short-term water quality impacts at some meadows at Passage Islands. Any detectable secondary effects to seagrass meadows are expected to be minor in magnitude (possible stress but unlikely to cause major loss of biomass), highly localised and of a temporary nature. Long term declines in the population status of any species are not expected to occur as a result of maintenance dredging. Endemic coral species are known from northern the PoG, but these are thought to be remote from the potential impacts of dredging.

5.5.6.1 Impacts to Outstanding Universal Value

The OUV of the GBR is composed of cultural and natural heritage elements. The four (4) natural heritage criteria that the GBRWHA satisfy are its geological phenomena, ecological and biological processes, its aesthetics and natural beauty, and its biological diversity including the threatened species it supports. The integrity of the GBRWHA and the value of these attributes are supported by the sheer size of the property and its potential for effective conservation management.

As described above, proposed maintenance dredging is not expected to impact flora, fauna, or have flow-on effects to threatened species (Section 5.5.2 – 5.5.4). The proposed dredging is also not expected to affect the property's geological phenomena, or significantly impact the ecological or biological processes. The dredging will not permanently alter the natural beauty of the property beyond the dredge campaign; they will not result in greater vessel occupancy or additional permanent infrastructure. Therefore, impacts to the OUV are not expected from the maintenance dredging activity.

5.6 Matters of State Environmental Significance

Section 4.5 provides an overview on MSES relevant to the proposed maintenance dredging, and potential impacts were considered based on the study findings in Section 5.

5.6.1 Wetlands and Watercourses

Dredging activities will be carried out with the potential for turbid plume impacts to result in temporary reductions in water quality affecting seagrass meadows near the dredge loading site. Seagrass meadows are listed as wetlands of high ecological significance and offsets may be required if dredging is deemed to have significant residual impact. Significant residual impacts to seagrass meadows are not expected because:

- Major direct or indirect impacts to seagrass meadows are not expected (refer to Section 5.3 for further information on ecological implications);
- Seagrass meadows with potential to be affected by dredge plumes could be protected by mitigation measures that may include the relocation of the dredger or the establishment of an adaptive monitoring program; and
- The potential for dredging to introduce invasive species into the wetland (seagrass meadows) is very low considering there are no high-risk marine pests in the PoG.(refer to Section 5.3.3 for further information).

5.6.2 Protected Wildlife Habitat

Section 5.5.2, 5.5.3 and 5.5.4 considers potential impacts to marine fauna. The proposed dredging activities are not expected to lead to significant direct or indirect effects to protected wildlife. In accordance with the significant residual impact criteria, the proposed dredging is predicted:

- Not to lead to a long-term decrease in the size of a local population;
- Not to reduce the extent of occurrence of the species or fragment and existing population;
- Not to result in genetically distinct populations resulting from habitat isolation;

- Not to result in invasive species establishing that are detrimental to endangered or vulnerable species;
- Not to introduce diseases that may cause the population to decline;
- Not to interfere with the recovery of a species; and
- Not to disrupt ecologically significant locations used for breeding, feeding, nesting, migration or resting.

5.6.3 Fish Habitat Areas and Highly Protected Zone of State Marine Parks

The dredging activities will take place adjacent to the GBRCMP which covers similar areas to the GBRMP. Based on significant residual impact criteria for protected areas, the proposed dredging will **not:**

- Result in exclusion or reduction in the public use or enjoyment of the part or all of the nearby protected areas;
- Result in disturbance to any FHAs which are located more than 5 km from the project; and
- Reduce the natural or cultural values of all or part of the GBRCMP.

State significant residual impact criteria for highly protected zones of State Marine Parks refer specifically to works to be conducted within these zones. As the proposed dredging falls outside of these area boundaries, these criteria are not relevant.

5.7 Assessment of Performance Outcomes – State Code 8 Coastal Development and Tidal Works

The State Assessment Referral Agency (SARA) assesses development applications against the State Development Assessment Provisions (SDAP). SDAP defines the state's interest in development assessment and includes the assessment benchmarks or matters SARA will assess an application against. State Code 8 Coastal Development and Tidal works (SDAP v3.0 2022) sets out the performance outcomes related to developments within a coastal and tidal region. Categories known or potentially relevant to dredging and placement works are set out in Table 5.9. Compliance with these performance outcomes ensures coastal processes, resources, protection and management is maintained. For dredging and placement operations key performance outcomes include maintaining water quality of the dredged area and receiving environment of placement activities, ensuring coastal processes such as the natural sediment balance are adequately maintained, ensuring dredged material is not harmful upon disturbance and handling and ensuring impacts to MSES are assessed via the avoid, minimise, mitigate and offset hierarchy.

Table 5.9 State Code 8 Coastal Development and Tidal Works Performance Outcomes Relevant to the Project (SDAP v3.0 2022)

Category	Performance outcome (PO)	Response	Notes
Water Quality	PO13 Development: 1. maintains or enhances environmental values of receiving waters 2. achieves the water quality objectives of Queensland waters 3. avoids the release of prescribed water contaminants to tidal waters.	As per Section 5.2, assessment of the effect of maintenance dredging and placement on water quality parameters indicates that there are minor exceedances of nutrients during dredging which typically persist over short time frames (less than one hour). The assessment also indicted that metals and metalloids in the dredge plumes are either below the LOR or below their respective WQOs. Overall, monitoring results suggest that nutrients, chlorophyll *a*, metals/metalloids and other water quality parameters in dredge plumes represent a low environmental risk. See Section 5.2 for further detail. Dredging and placement will also be supported by a Dredge Management Plan (to be supplied by GPC).	See Environmental Protection (Water and Wetland Biodiversity) Policy 2019 for the relevant water quality objectives.
Matters of state environmental significance	PO17 Development: 1. avoids impacts on matters of state environmental significance; or 2. minimises and mitigates impacts on matters of state environmental significance after demonstrating avoidance is not reasonably possible; and 3. provides an offset if, after demonstrating all reasonable avoidance, minimisation and mitigation measures are undertaken, the development results in an acceptable significant residual impact on a matter of state environmental significance.	No significant residual impact assessment for MSES. Refer to Section 5.6 for further detail.	Statutory note: For Brisbane core port land, an offset may only be applied to development on land identified as E1 Conservation/Buffer, E2 Open Space or Buffer/Investigation in the Brisbane Port Land Use Plan (LUP) precinct plan.
Placement of dredged material other than from artificial waterways	PO20 Dredged material is returned to tidal water where this is needed to maintain coastal processes and sediment volume.	Placement of dredged material at the East Banks Offshore MRA ensures that the sediment is retained in the dynamic nearshore sedimentary system and helps to maintain natural coastal processes.	None

Category	Performance outcome (PO)	Response	Notes
	PO21 Where it is not needed to maintain coastal processes and sediment volume, the quantity of dredged material disposed to tidal water is minimised through beneficial reuse or placement on land.	Alternative placement locations that are still within the coastal sedimentary system but that also involve some beneficial reuse (e.g. beach nourishment) are being actively investigated as part of GPC's SSM Project (see https://gpcl.com.au/ports-and-trade/dredging/dredging-sustainable-sediment-management/)	None
All dredging and any placement of dredged material in tidal water	PO22 Dredging or placement of dredged material in tidal waters does not adversely impact on coastal processes and coastal resources.	Placement of dredged material will occur within the approved East Banks Offshore MRA. This placement area was selected due to its proximity to the dredge footprint and sediment will be retained within the nearshore sedimentary system. No changes to existing coastal process and coastal resources is anticipated as a result of the dredging and placement works. Dredging and placement will also be supported by a Dredge Management Plan (to be supplied by GPC).	None

6 Conclusion

The environmental impacts associated with two (2) alternative maintenance dredging campaigns involving the placement of different quantities of fine dredged sediment at the Tide Island MRA were assessed. One of the scenarios involved a 'typical' annual dredging campaign but with 40,000 m^3 of fine sediment from the LNG terminal basins placed at the Tide Island MRA, with the remainder placed at the East Banks Offshore MRA. The other scenario also involved a 'typical' annual dredging campaign but with placement of 75,000 m^3 of fine sediment from the LNG terminal basins at the Tide Island MRA, with the remainder placed at the East Banks Offshore MRA.

The potential effects of dredging were assessed using a numerical model to estimate increases in turbidity and deposition rate above natural or ambient levels, consistent with the methodology used for the Port of Gladstone Gatcombe and Golding Cutting Channel Duplication Project EIS (BMT 2019b). Both ambient and dredge related signals were resolved in the numerical model, which allows for an understanding of how significant the dredge contribution is in relation to ambient conditions.

The study found:

- Consistent with dredge plume monitoring studies, modelling predicts that turbid plumes will be short-term features (measured in tens to hundreds of minutes duration) of limited spatial extent (largely within and directly adjacent to dredged areas);
- Seagrass and reef habitats occur in the vicinity of the dredged area. Turbid plumes from maintenance dredging are expected to cause measurable increases in turbidity in some seagrass areas, but not at reef areas;
- Modelling indicates that turbid plumes at seagrass sites will mostly be short-lived features and result in small increases in turbidity above the natural background levels.
- Seagrass and reef habitats are considered unlikely to be impacted given the predicted low intensity and short duration of dredge plumes at these sites. Validation monitoring is recommended;
- Direct impacts to benthic fauna in the dredged channel and East Banks Offshore MRA will likely be highly localised and short-term, and this would likely be the same at proposed Tide Island MRA assuming this area has similar benthic community types; and
- Significant impacts to threatened species, migratory species, and properties/ features listed as MNES or MSES are not expected.

Compared to the results of the impact assessment of a typical maintenance dredging campaign at the PoG (BMT 2021a), the results indicate only a slightly larger Zone of Influence of dredging-related plumes in the vicinity of the Tide Island MRA, and no increase in ecological impact is expected as a result of these plumes.

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Appendix A EPBC PMST Report

Australian Government

Department of Climate Change, Energy, the Environment and Water

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. Please see the caveat for interpretation of information provided here.

Report created: 25-Jul-2023

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	6
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	65
Listed Migratory Species:	70

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	112
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	1

Extra Information

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

State and Territory Reserves:	13
Regional Forest Agreements:	None
Nationally Important Wetlands:	4
EPBC Act Referrals:	40
Key Ecological Features (Marine):	None
Biologically Important Areas:	9
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Legal Status
Great Barrier Reef	QLD	Declared property

National Heritage Places [Resource Information]

Name	State	Legal Status
Natural		
Great Barrier Reef	QLD	Listed place

Great Barrier Reef Marine Park [Resource Information]

Zone Type	Zone ID	IUCN
Conservation Park	CP-23-4110	IV
General Use	GU-21-6016	VI
Habitat Protection	HP-23-5367	VI
Habitat Protection	HP-23-5369	VI
Habitat Protection	HP-23-5370	VI
Habitat Protection	HP-23-5374	VI

Listed Threatened Ecological Communities [Resource Information]

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.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community likely to occur within area
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community may occur within area

Community Name	Threatened Category	Presence Text
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and South East Queensland bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Cyclopsitta diophthalma coxeni Coxen's Fig-Parrot [59714]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Epthianura crocea macgregori Capricorn Yellow Chat, Yellow Chat (Dawson) [67090]	Critically Endangered	Species or species habitat likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat known to occur within area
FISH		

Scientific Name	Threatened Category	Presence Text
Hippocampus whitei		
White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Petauroides volans		
Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area
Petaurus australis australis		
Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Bosistoa transversa		
Three-leaved Bosistoa, Yellow Satinheart [16091]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Bulbophyllum globuliforme Miniature Moss-orchid, Hoop Pine Orchid [6649]	Vulnerable	Species or species habitat may occur within area
Cossinia australiana Cossinia [3066]	Endangered	Species or species habitat may occur within area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo [3205]	Vulnerable	Species or species habitat known to occur within area
Cycas megacarpa [55794]	Endangered	Species or species habitat known to occur within area
Cycas ophiolitica [55797]	Endangered	Species or species habitat may occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Fontainea venosa [24040]	Vulnerable	Species or species habitat may occur within area
Leichhardtia brevifolia listed as Marsdenia brevifolia [91893]	Vulnerable	Species or species habitat may occur within area
Macadamia integrifolia Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat known to occur within area
Hemiaspis damelii Grey Snake [1179]	Endangered	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Breeding known to occur within area
[Crocodylus porosus](#) Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
[Dugong dugon](#) Dugong [28]		Species or species habitat known to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
[Lamna nasus](#) Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
[Lepidochelys olivacea](#) Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
[Megaptera novaeangliae](#) Humpback Whale [38]		Species or species habitat known to occur within area
[Mobula alfredi as Manta alfredi](#) Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
[Mobula birostris as Manta birostris](#) Giant Manta Ray [90034]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Breeding known to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat likely to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat may occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
[Numenius minutus](#) Little Curlew, Little Whimbrel [848]		Roosting known to occur within area overfly marine area
[Numenius phaeopus](#) Whimbrel [849]		Roosting known to occur within area
[Pachyptila turtur](#) Fairy Prion [1066]		Species or species habitat likely to occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat known to occur within area
[Phaethon lepturus](#) White-tailed Tropicbird [1014]		Species or species habitat may occur within area
[Phoebetria fusca](#) Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
[Pluvialis fulva](#) Pacific Golden Plover [25545]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area overfly marine area
Pterodroma cervicalis White-necked Petrel [59642]		Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat known to occur within area overfly marine area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area overfly marine 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
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys haematopterus Reef-top Pipefish [66201]		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
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
Filicampus tigris Tiger Pipefish [66217]		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

Scientific Name	Threatened Category	Presence Text
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
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat may occur within area
Hippocampus zebra Zebra Seahorse [66241]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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 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
Mammal		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptile		
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

Scientific Name	Threatened Category	Presence Text
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known 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
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Lapemis curtus as Lapemis hardwickii Spine-bellied Seasnake [83554]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, 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]		Species or species habitat known to occur within area

Current Scientific Name	Status	Type of Presence
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa sahulensis Australian Humpback Dolphin [87942]		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

Habitat Critical to the Survival of Marine Turtles		
Scientific Name	Behaviour	Presence
Aug - Sep		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur

Extra Information

State and Territory Reserves		[Resource Information]
Protected Area Name	Reserve Type	State
Colosseum Inlet	Fish Habitat Area (B)	QLD
Colosseum Inlet	Fish Habitat Area (A)	QLD
Curtis Island	National Park	QLD
Curtis Island	Conservation Park	QLD
Eurimbula	National Park	QLD
Fitzroy River (Rev.1)	Fish Habitat Area (A)	QLD

Protected Area Name	Reserve Type	State
Garden Island	Conservation Park	QLD
Great Barrier Reef Coast	Marine Park	QLD
Port of Gladstone - Rodds Bay	Dugong Protection Area (B)	QLD
Rodds Harbour	Fish Habitat Area (A)	QLD
Rodds Harbour	Fish Habitat Area (B)	QLD
Southend	Conservation Park	QLD
Wild Cattle Island	National Park	QLD

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Colosseum Inlet - Rodds Bay	QLD
Great Barrier Reef Marine Park	QLD
Port Curtis	QLD
The Narrows	QLD

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Boyne Tannum Aquatic Recreation Centre	2022/09442		Completed
Controlled action			
Aluminium Smelter Expansion.	2001/477	Controlled Action	Post-Approval
Bridge Construction Connecting Mainland & Curtis Island	2008/4400	Controlled Action	Completed
Clinton Vessel Interaction Project - Clinton Widening, Qld	2017/7976	Controlled Action	Post-Approval
Construct and operate 447km high pressure gas transmission pipeline	2009/4976	Controlled Action	Post-Approval
Construction of a Chlor-Alkali-Ethylene Di-Chloride (CA/EDC) Plant at the Gladst	2002/764	Controlled Action	Completed
Construction of Bridge and Road to Access Proposed Natural Gas Liquification Park	2008/4060	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Development, Construction and Decommissioning of LNG Plant and Onshore Faciliti	2008/4402	Controlled Action	Post-Approval
Development of a Natural Gas Liquefaction Park	2008/4057	Controlled Action	Post-Approval
Development of marine facilities to service natural gas liquefaction park	2008/4058	Controlled Action	Post-Approval
Development of the Yarwun Coal Terminal	2012/6348	Controlled Action	Completed
Gas Pipeline with Alternative Pipleine to Supply Natural Gas Liquefaction Park	2008/4096	Controlled Action	Post-Approval
Hummock Hill Island Development	2005/2502	Controlled Action	Completed
install & operate gas pipeline	2005/2059	Controlled Action	Post-Approval
LNG Plant and Ancillary onshore and marine facilities	2009/4977	Controlled Action	Post-Approval
Lower Fitzroy River Infrastructure Project	2009/5173	Controlled Action	Post-Approval
Pacificus Tourism Project	2012/6643	Controlled Action	Post-Approval
Port of Gladstone Gatcombe & Golding Cutting Channel Duplication Project	2012/6558	Controlled Action	Post-Approval
Port of Gladstone Western Basin Strategic Dredging and Disposal Project	2009/4904	Controlled Action	Post-Approval
Queensland Curtis LNG Project - Curtis Island Road	2008/4404	Controlled Action	Completed
Queensland Curtis LNG Project - LNG Marine Facilities	2008/4401	Controlled Action	Post-Approval
Queensland Curtis LNG Project - Mainland Road and Bridge Approach	2008/4403	Controlled Action	Completed
Queensland Curtis LNG Project - Pipeline Network	2008/4399	Controlled Action	Post-Approval
Queensland Curtis LNG Project - Swing Basin and Channel Dredging	2008/4406	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Shipping Activities Associated with the QLD Curtis LNG Project	2008/4405	Controlled Action	Post-Approval
Talisman Saber 2005 Military Exercise	2004/1819	Controlled Action	Post-Approval
The Arrow Gas Transmission Pipeline, Gladstone to Curtis Island	2009/5008	Controlled Action	Post-Approval
The Arrow LNG Facility, Curtis Island, Gladstone	2009/5007	Controlled Action	Post-Approval
Turtle Street Beach Resort, Curtis Island, Qld	2015/7585	Controlled Action	Post-Approval
Wiggins Island Coal Terminal	2005/2374	Controlled Action	Post-Approval
Not controlled action			
Construction of a portable water pipeline and a sewer pressure main	2010/5646	Not Controlled Action	Completed
Expansion and dredging at existing RG Tanna Coal Terminal	2004/1619	Not Controlled Action	Completed
Expansion of Red Mud storage facility	2006/2928	Not Controlled Action	Completed
Extension of R G Tanna Coal Wharf	2000/54	Not Controlled Action	Completed
Fisherman's Landing Port Facility	2000/124	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
RG Tanna Coal Terminal Expansion	2004/1906	Not Controlled Action	Completed
Not controlled action (particular manner)			
Curtis Island Water & Sewerage Facilities Project Seismic Survey	2010/5735	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Gas Transmission Pipeline to supply Natural Gas Liquefaction Park	2008/4061	Referral Decision	Completed
Port of Gladstone Western Basin Strategic Dredging and Disposal Project	2009/4826	Referral Decision	Completed

Biologically Important Areas		
Scientific Name	Behaviour	Presence
Dolphins		
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Likely to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Internesting	Likely to occur
Seabirds		
Anous minutus Black Noddy [824]	Foraging	Likely to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging	Likely to occur
Sterna sumatrana Black-naped Tern [800]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Foraging	Likely to occur
Sharks		
Carcharias taurus Grey Nurse Shark [64469]	Foraging	Known to occur
Whales		
Megaptera novaeangliae Humpback Whale [38]	Breeding and calving	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

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

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

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

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

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

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-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.

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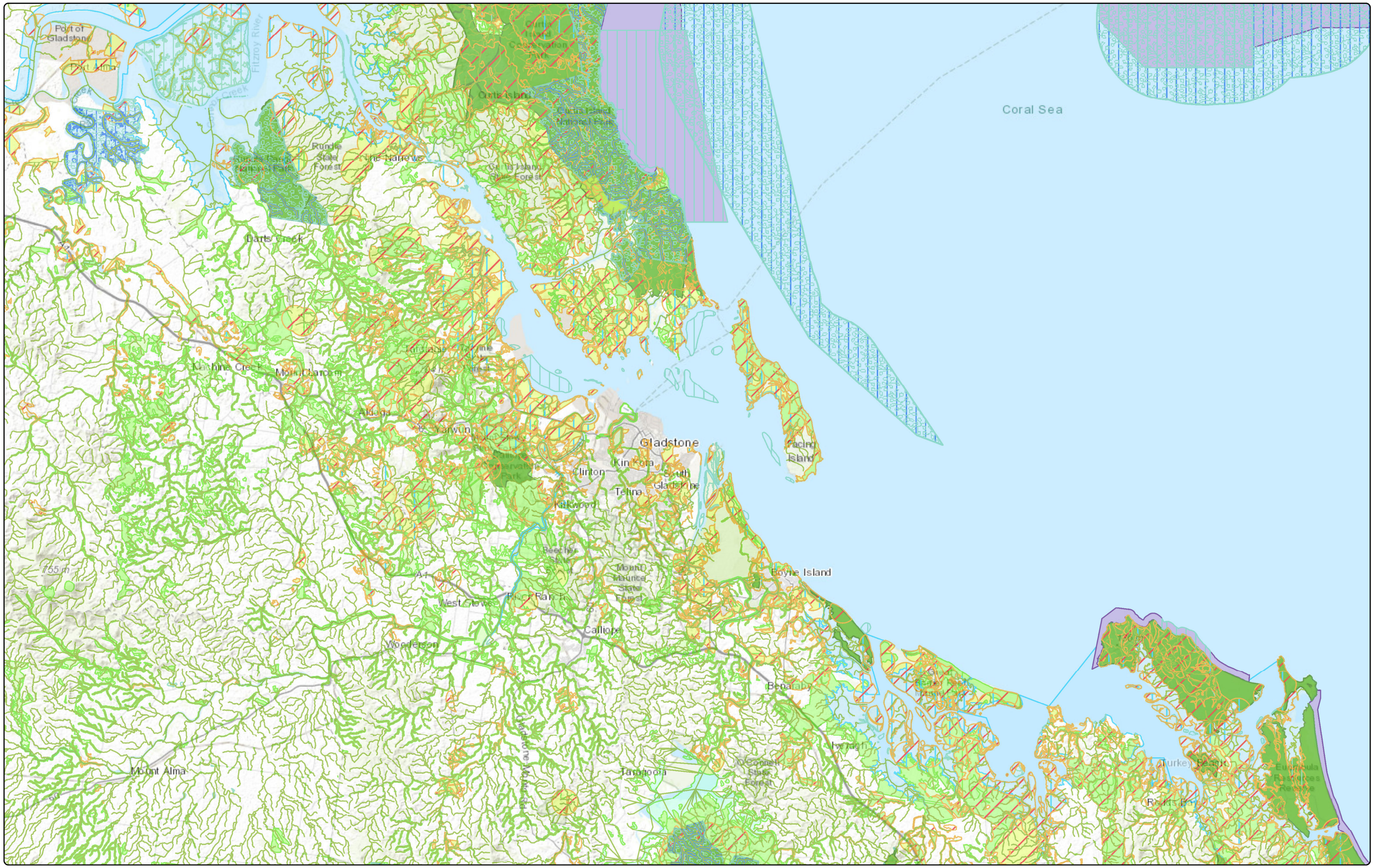
Appendix B SPP Mapping Tool Results



Queensland Government

N

State Planning Policy

Making or amending a local planning instrument and designating land for community infrastructure

0 4,750 9,500 14,250 19,000

Metres

Date: 29/03/2021

Legend

MSES - Regulated vegetation (intersecting a watercourse)

MSES - Regulated vegetation (intersecting a watercourse)

MSES - High ecological value waters (watercourse)

MSES - High ecological value waters (watercourse)

High ecological value water areas

High ecological value water areas

Water resource catchments

Water resource catchments

MSES - Wildlife habitat (endangered or vulnerable)

MSES - Wildlife habitat (endangered or vulnerable)

MSES - Wildlife habitat (special least concern animal)

MSES - Wildlife habitat (special least concern animal)

MSES - Wildlife habitat (koala habitat areas - core)

MSES - Wildlife habitat (koala habitat areas - core)

MSES - Wildlife habitat (koala habitat areas - locally refined)

MSES - Wildlife habitat (koala habitat areas - locally refined)

MSES - Strategic environmental areas (designated precinct)

MSES - Strategic environmental areas (designated precinct)

MSES - High ecological significance wetlands

MSES - High ecological significance wetlands

MSES - High ecological value waters (wetland)

MSES - High ecological value waters (wetland)

MSES - Legally secured offset area (offset register)

MSES - Legally secured offset area (offset register)

MSES - Legally secured offset area (regulated vegetation offsets)

MSES - Legally secured offset area (regulated vegetation offsets)

MSES - Protected areas (estate)

MSES - Protected areas (estate)

MSES - Protected areas (special wildlife reserve)

MSES - Protected areas (special wildlife reserve)

MSES - Protected areas (nature refuge)

MSES - Protected areas (nature refuge)

MSES - Marine park (highly protected areas)

MSES - Marine park (highly protected areas)

MSES - Declared fish habitat area

MSES - Declared fish habitat area

MSES - Regulated vegetation (category B)

MSES - Regulated vegetation (category B)

MSES - Regulated vegetation (category C)

MSES - Regulated vegetation (category C)

MSES - Regulated vegetation (category R)

MSES - Regulated vegetation (category R)

MSES - Regulated vegetation (essential habitat)

MSES - Regulated vegetation (essential habitat)

MSES - Regulated vegetation (wetland)

MSES - Regulated vegetation (wetland)

Water supply buffer area

Water supply buffer area

Queensland Government

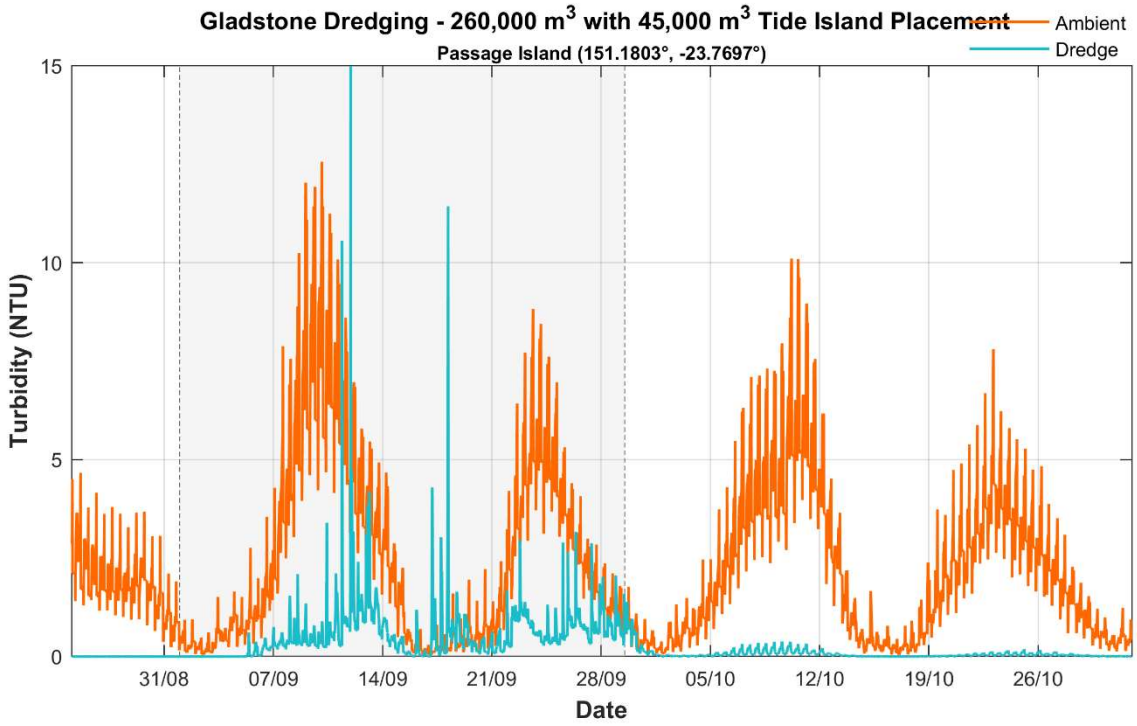
State Planning Policy

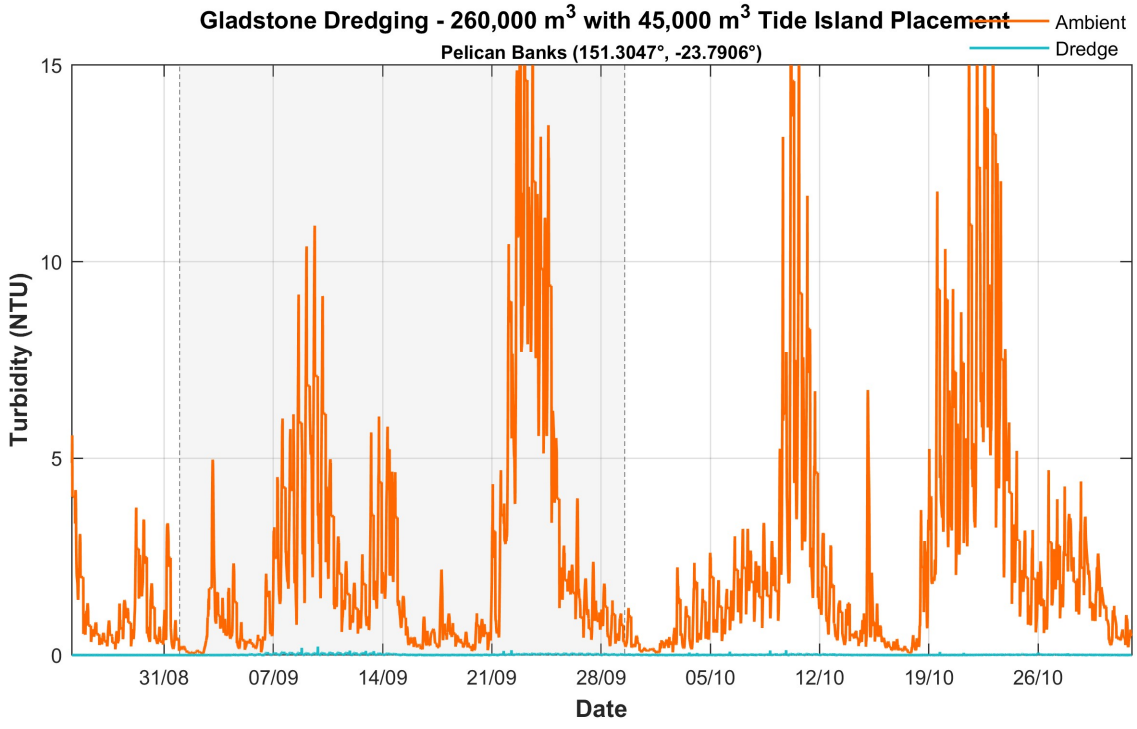
Making or amending a local planning instrument and designating land for community infrastructure

Date: 29/03/2021

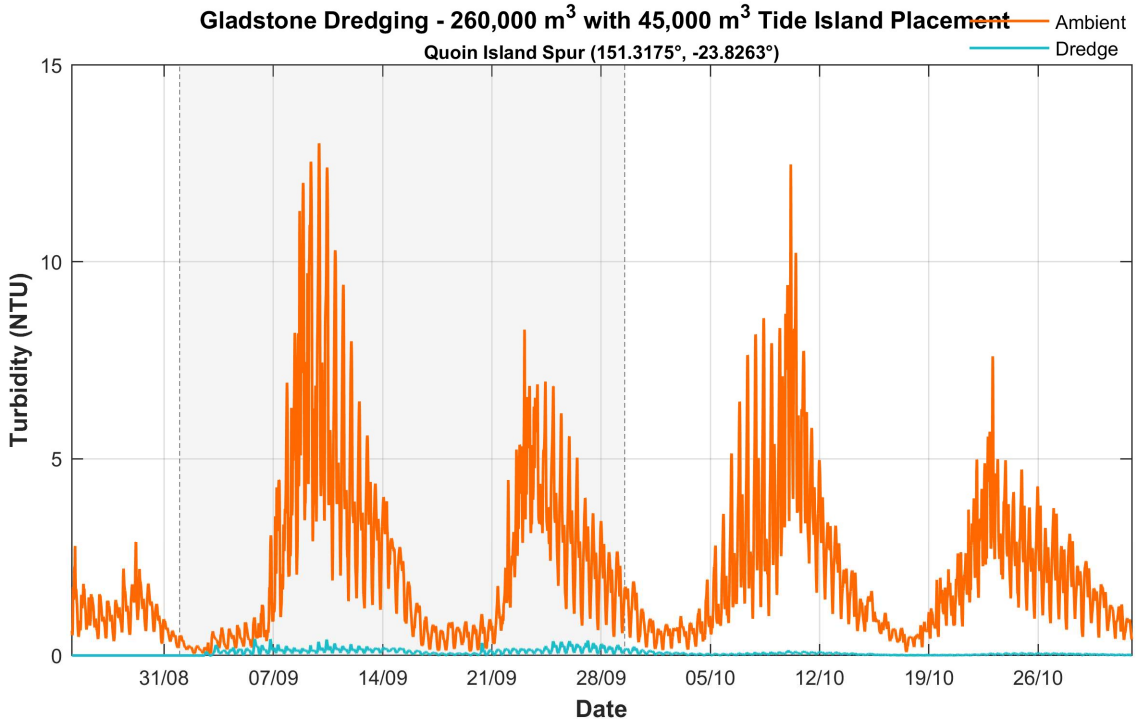
Appendix C Time Series of Modelled Turbidity

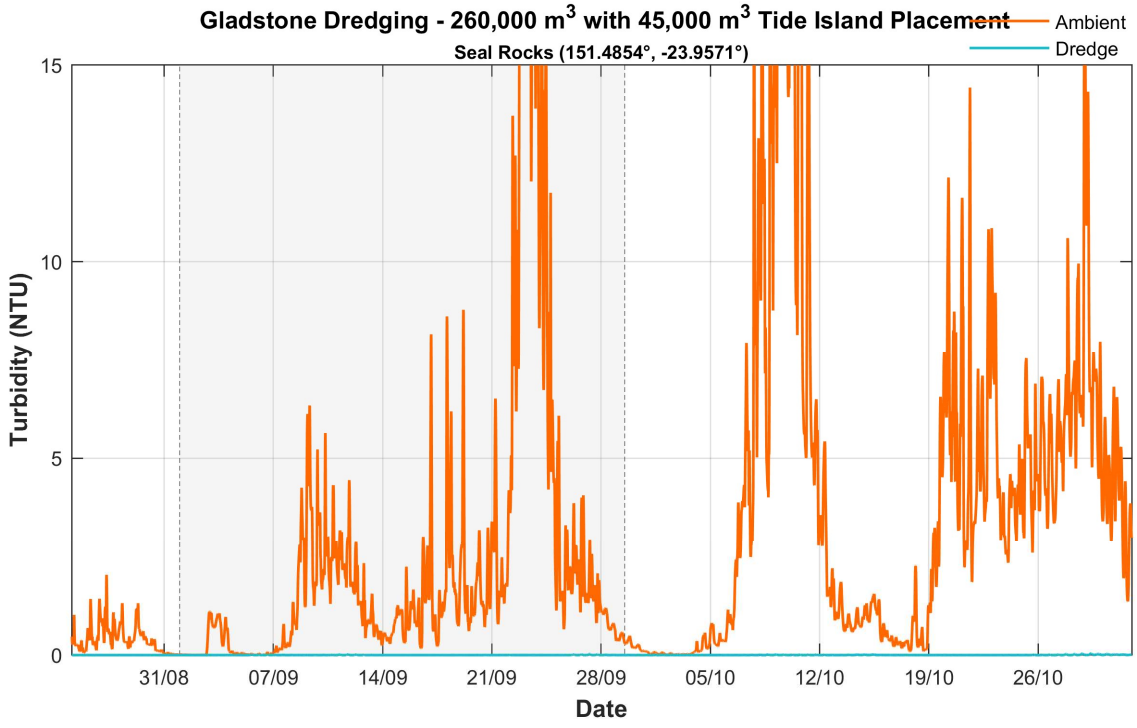
C.1 45,000m^3 Placement at Tide Island Results



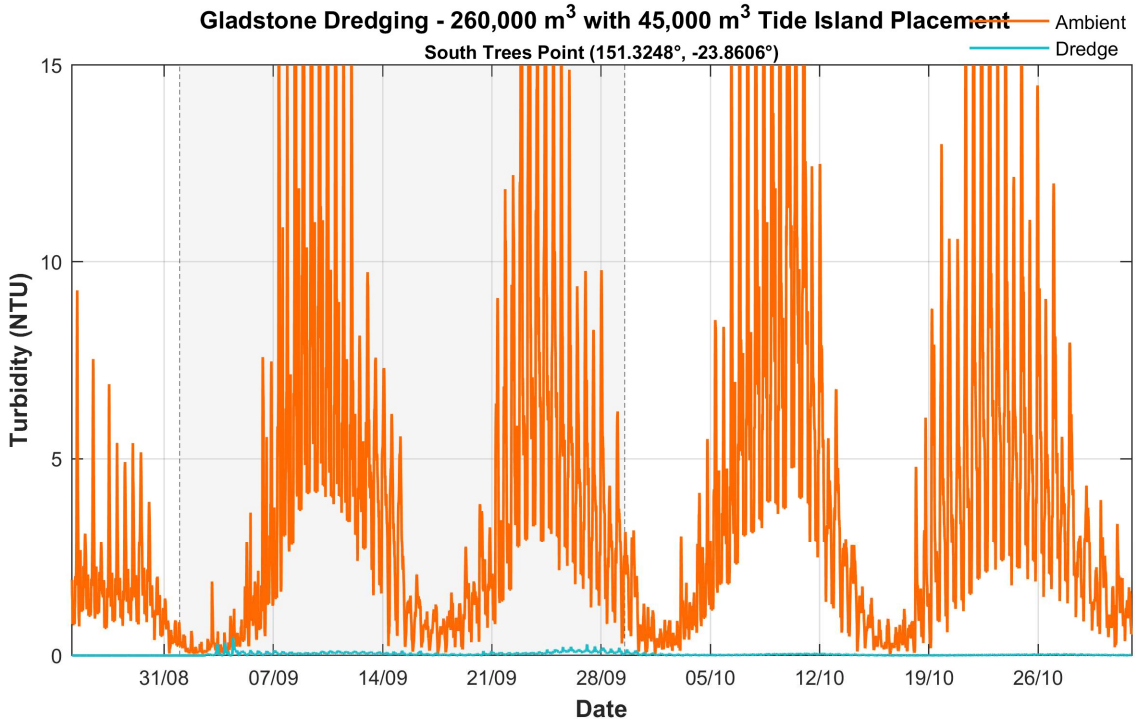


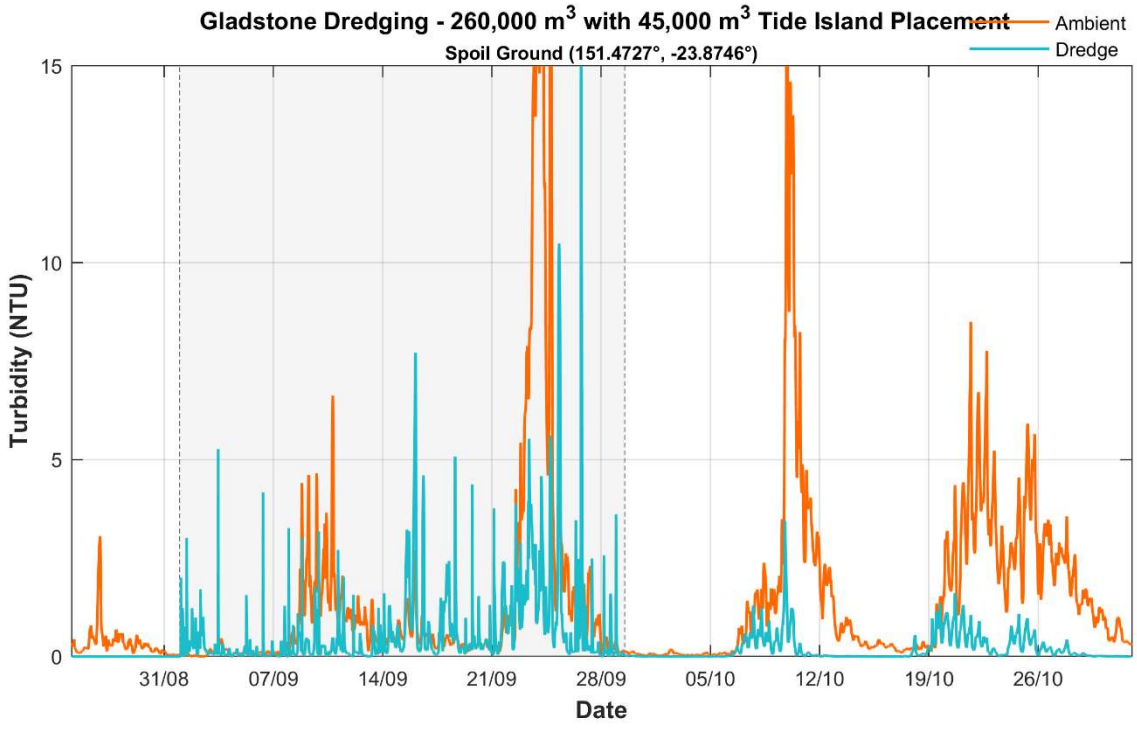
Time Series of Modelled Turbidity



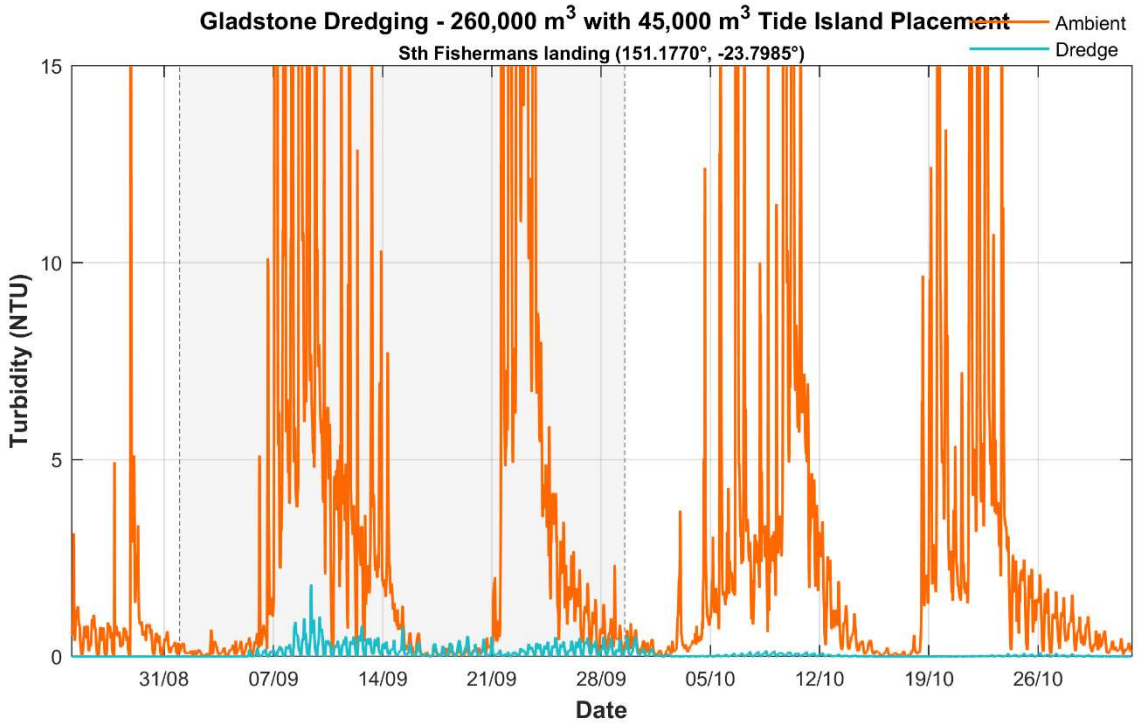


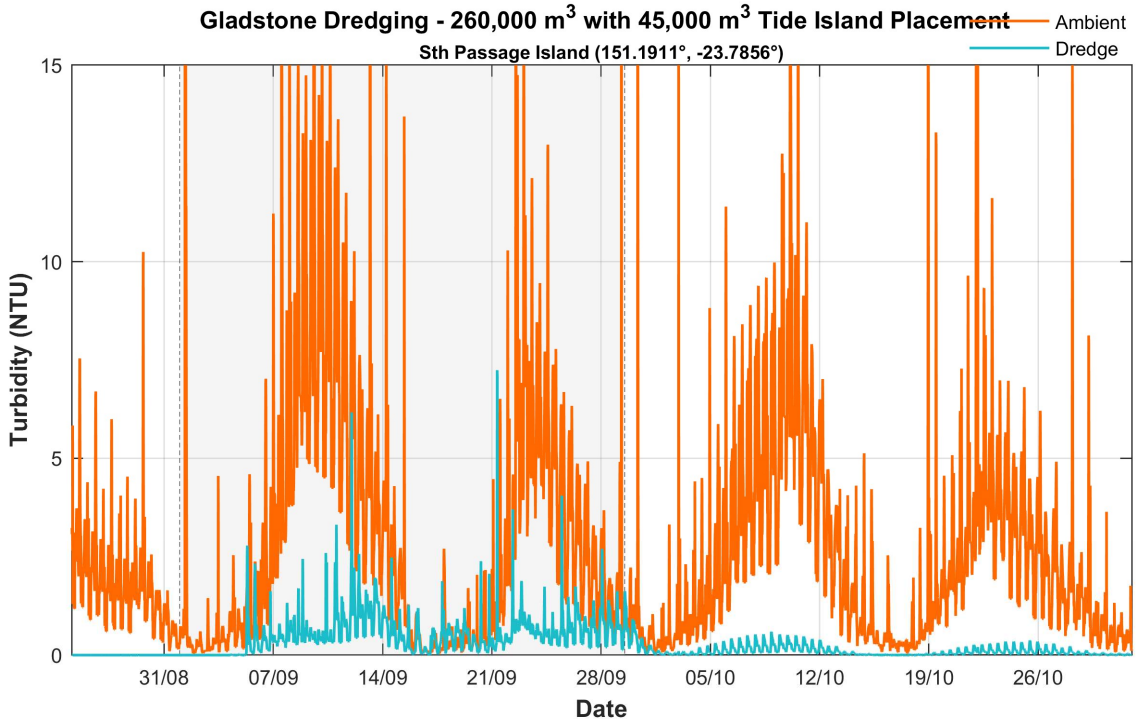
Time Series of Modelled Turbidity



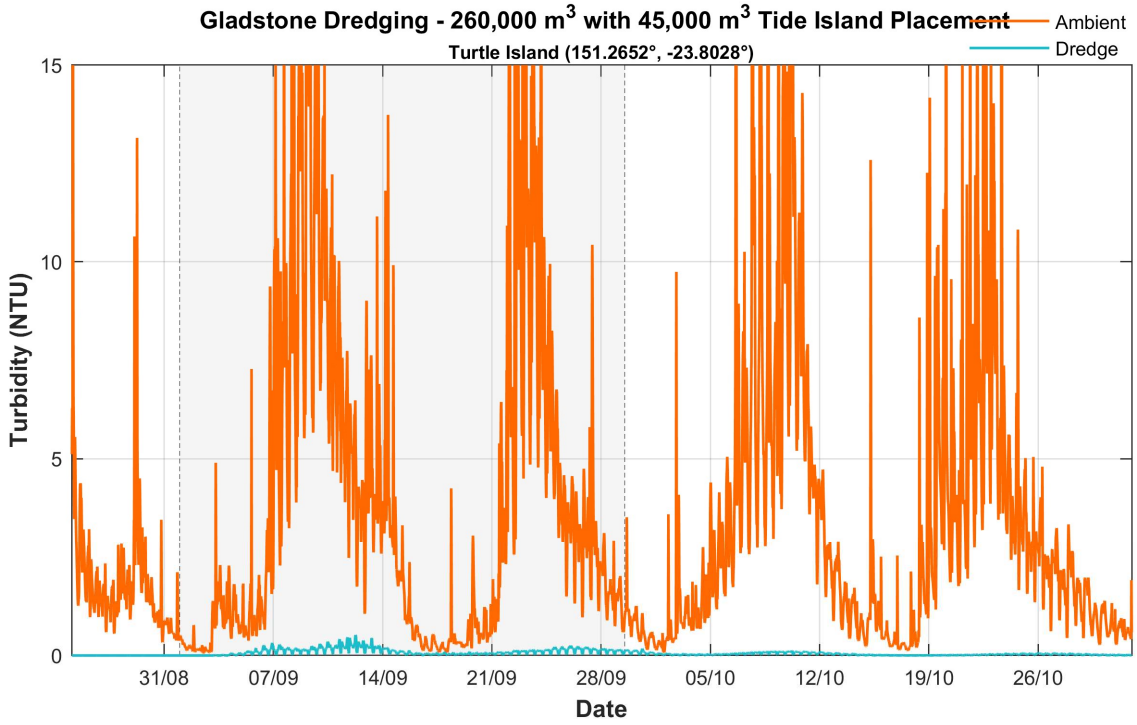


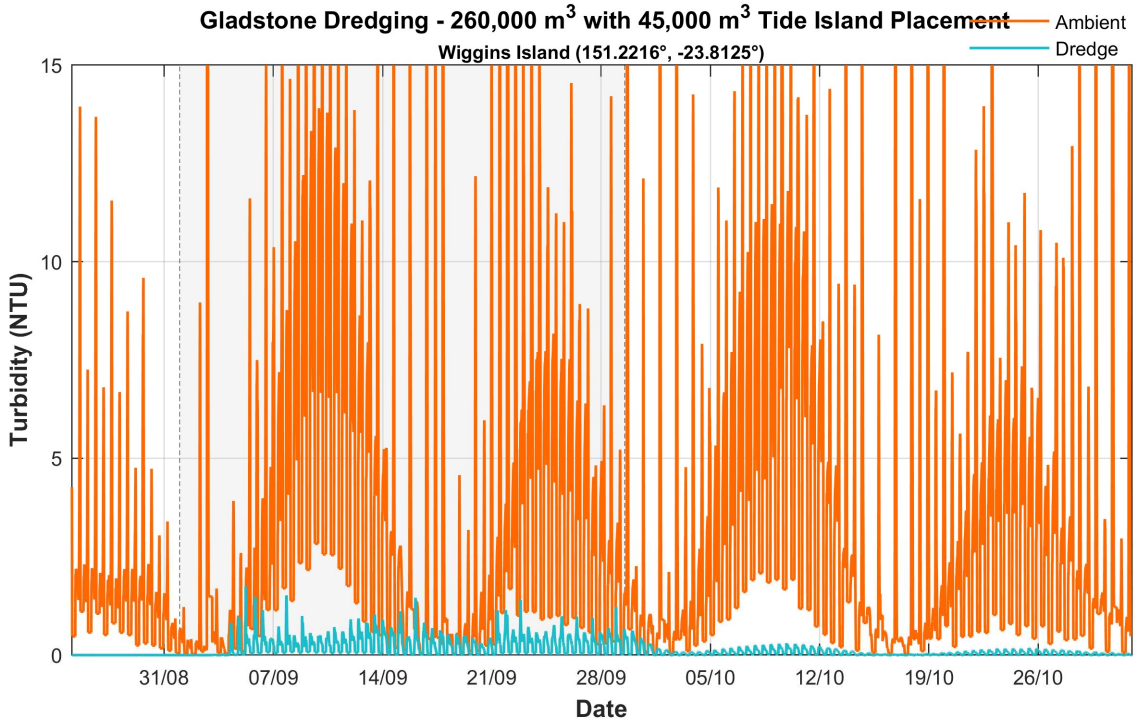
Time Series of Modelled Turbidity



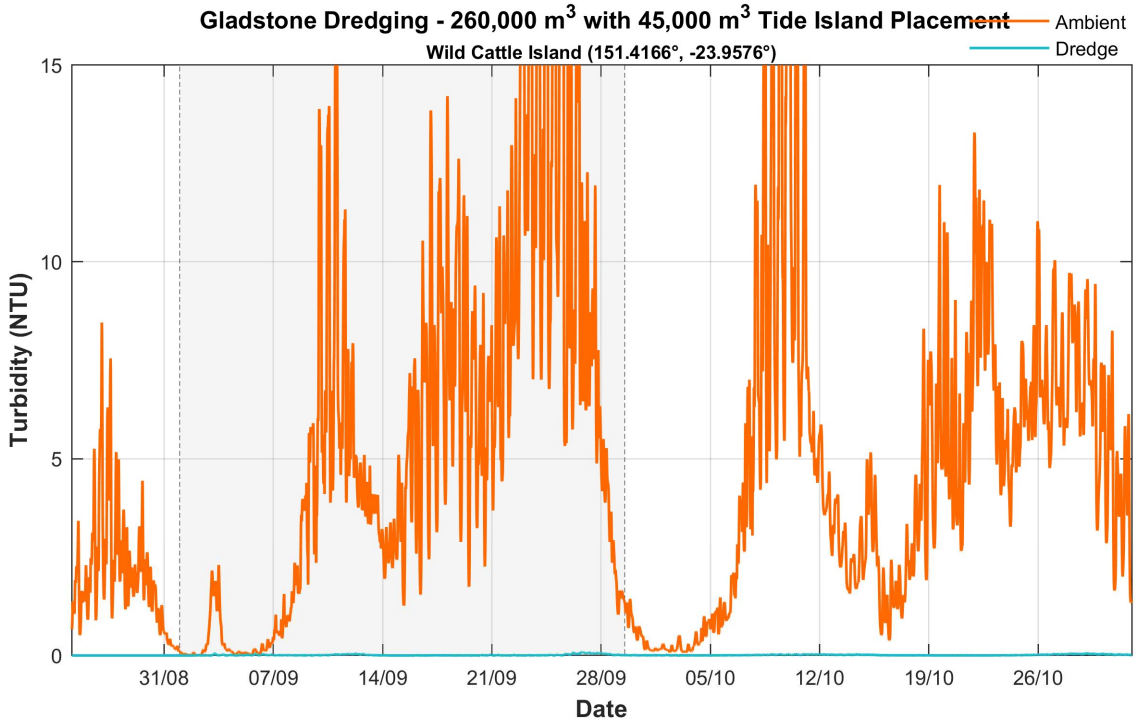


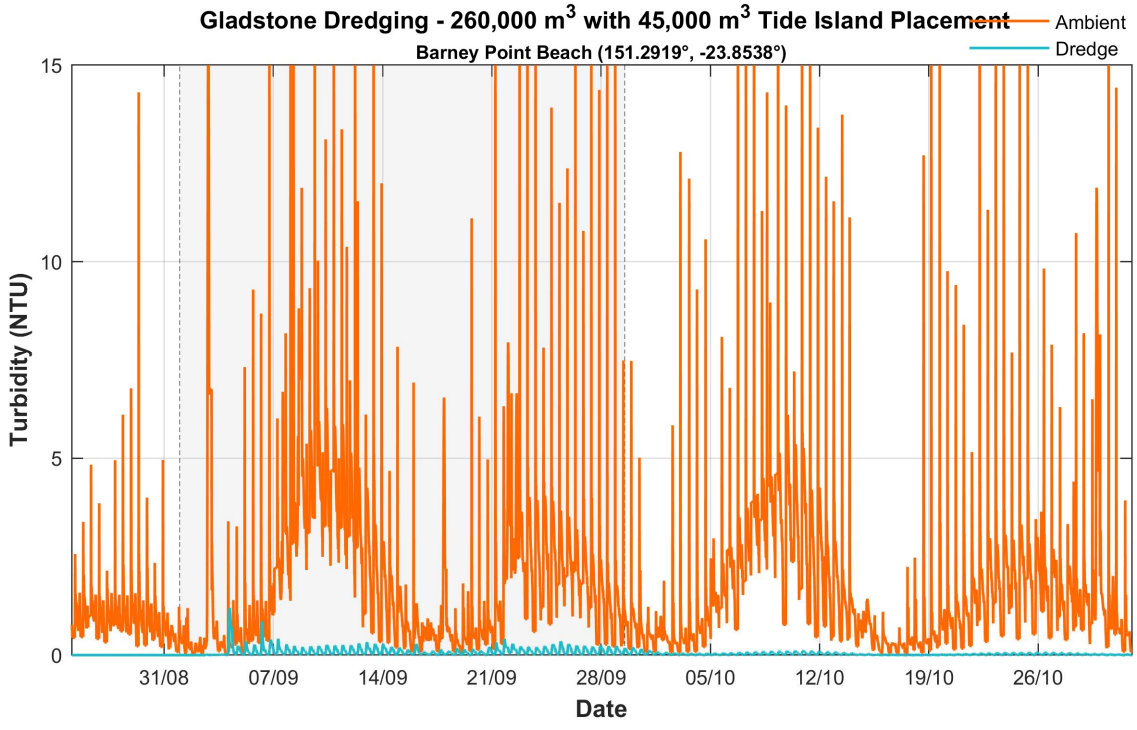
Time Series of Modelled Turbidity



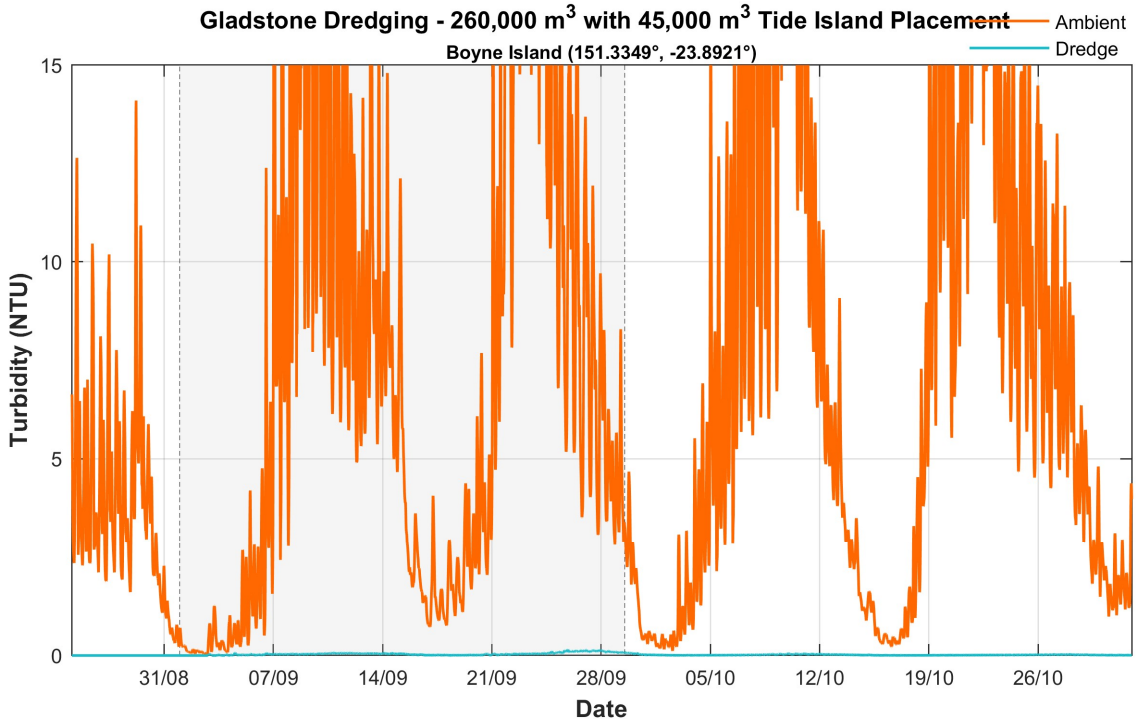


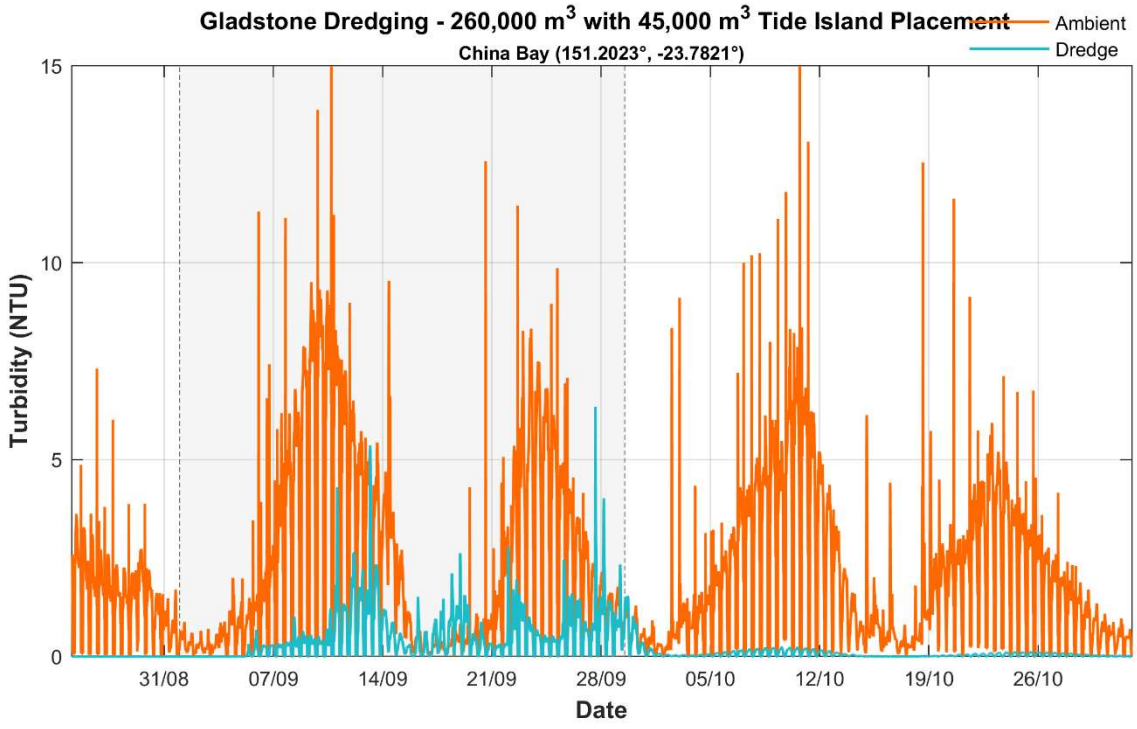
Time Series of Modelled Turbidity



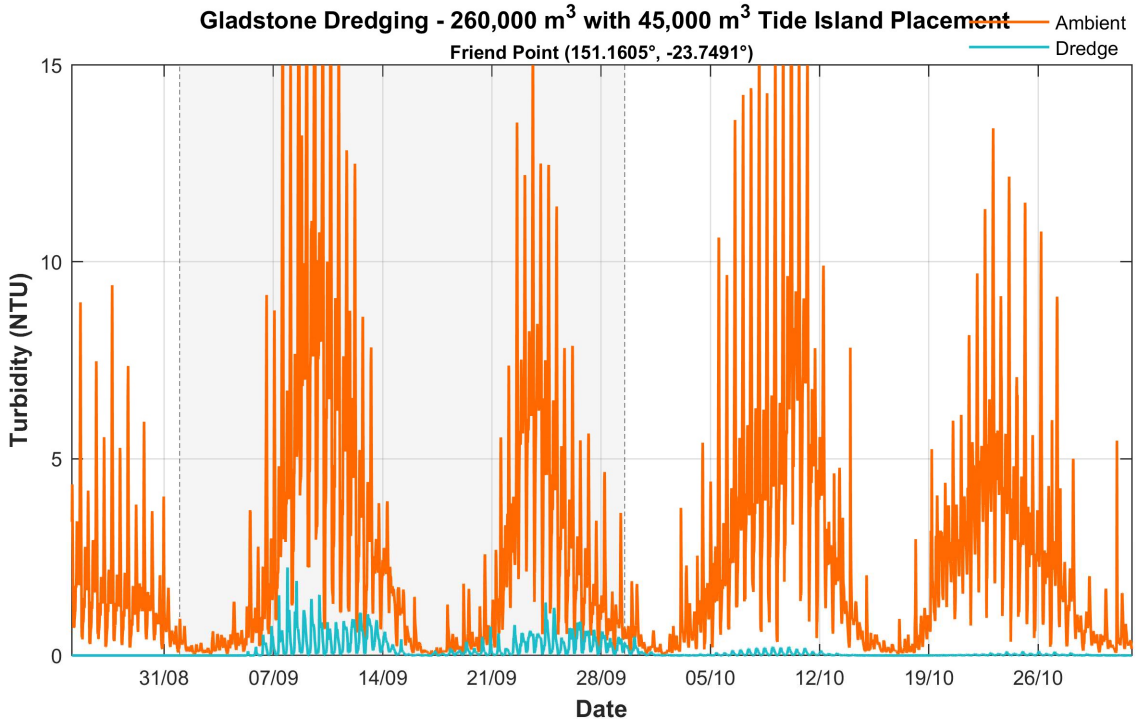


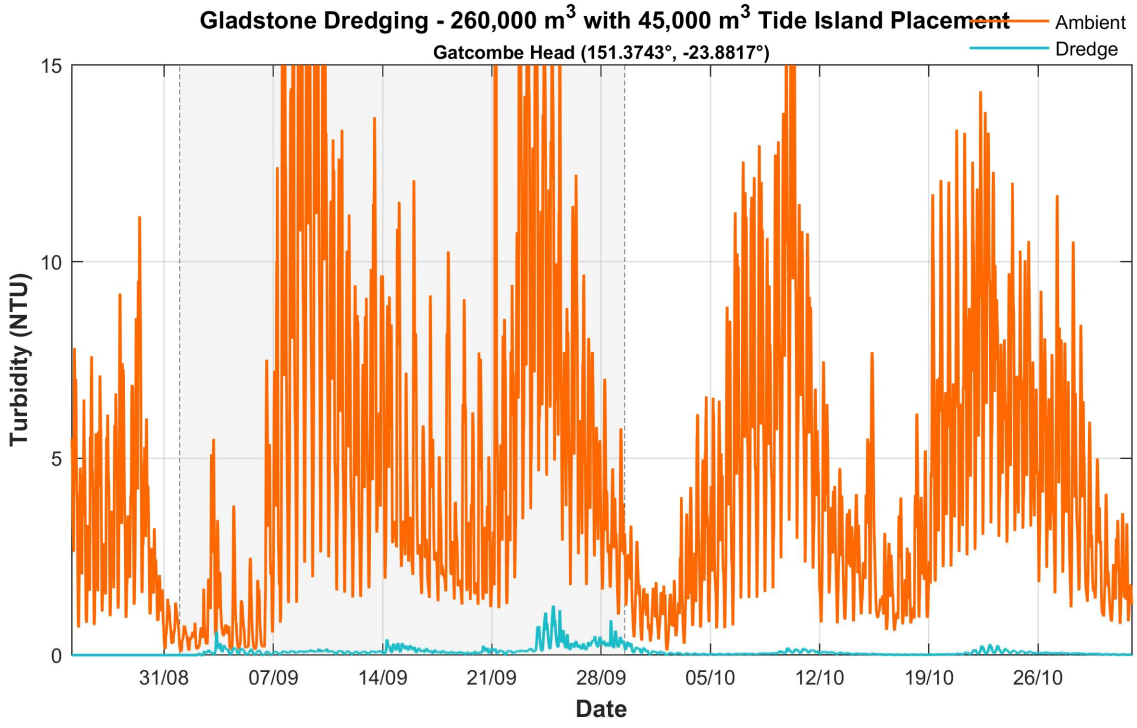
Time Series of Modelled Turbidity



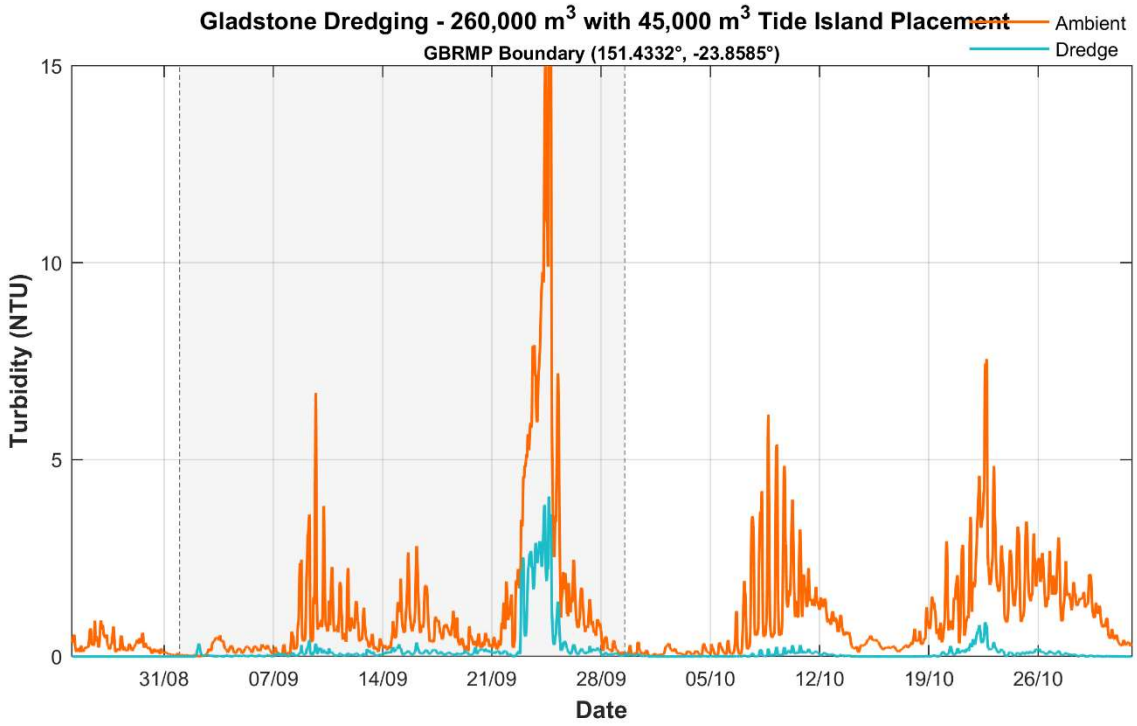


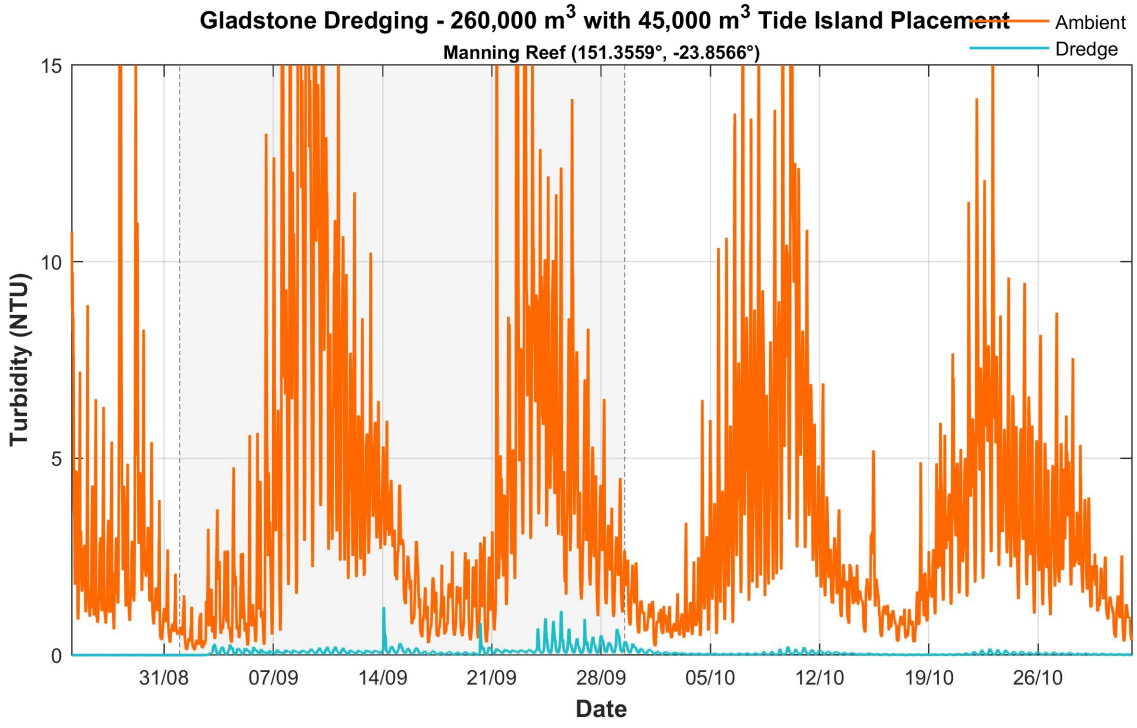
Time Series of Modelled Turbidity



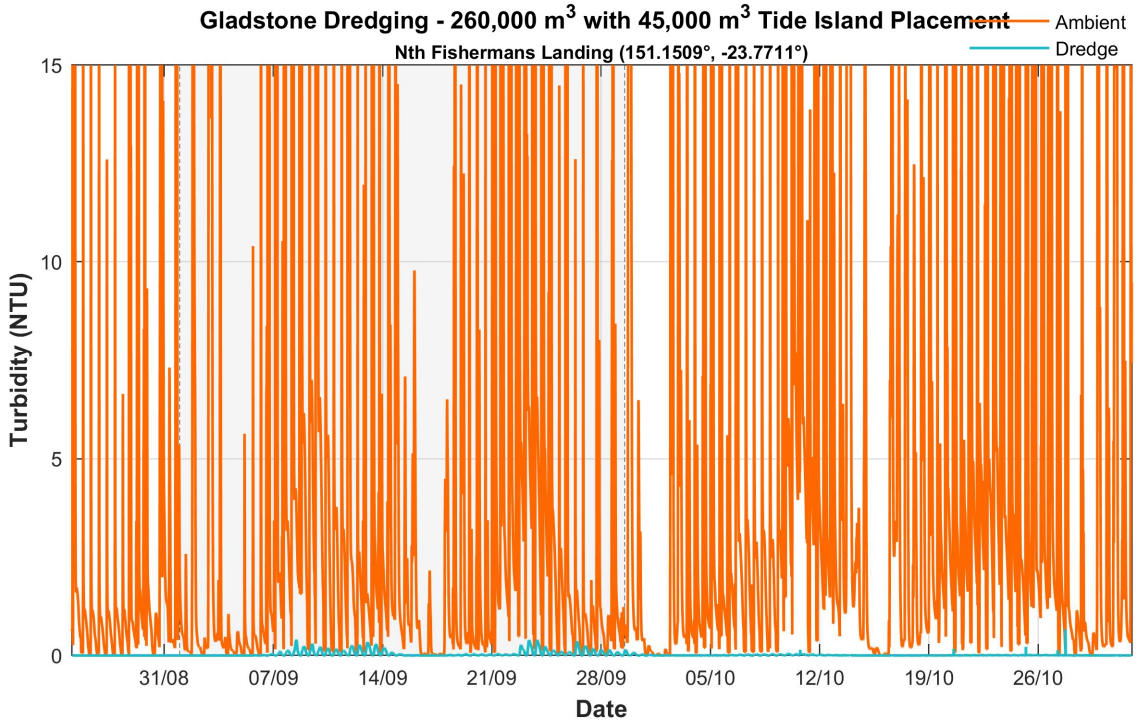


Time Series of Modelled Turbidity

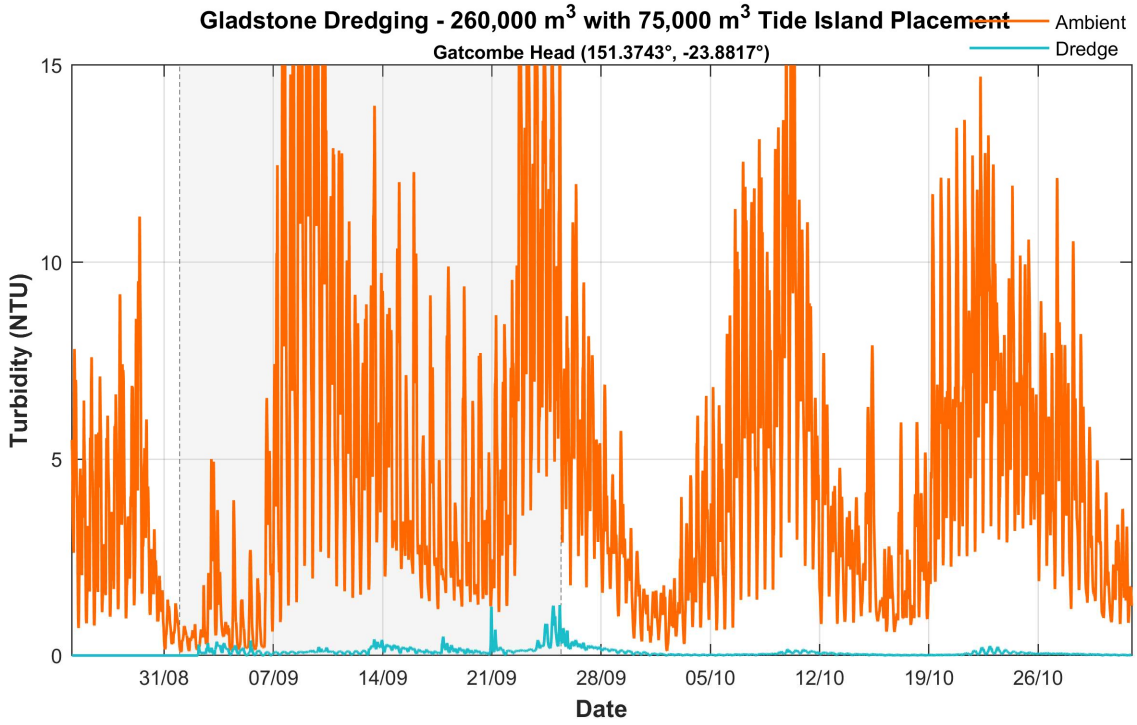


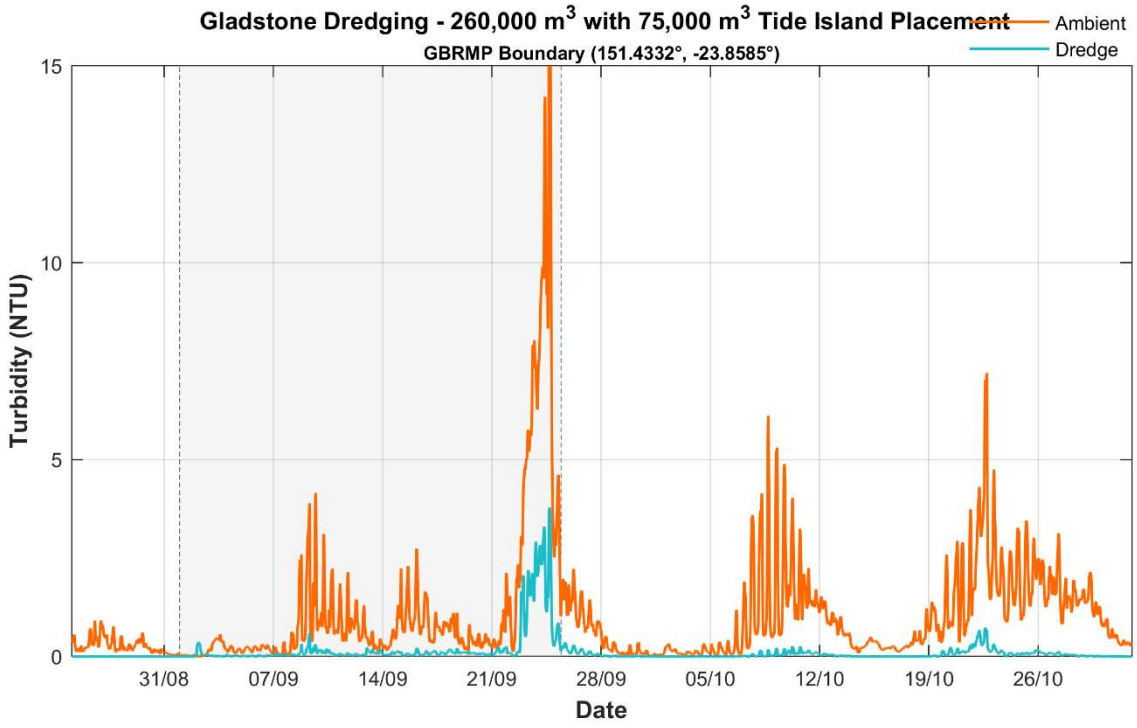


Time Series of Modelled Turbidity



C.2 75,000m^3 Placement at Tide Island Results





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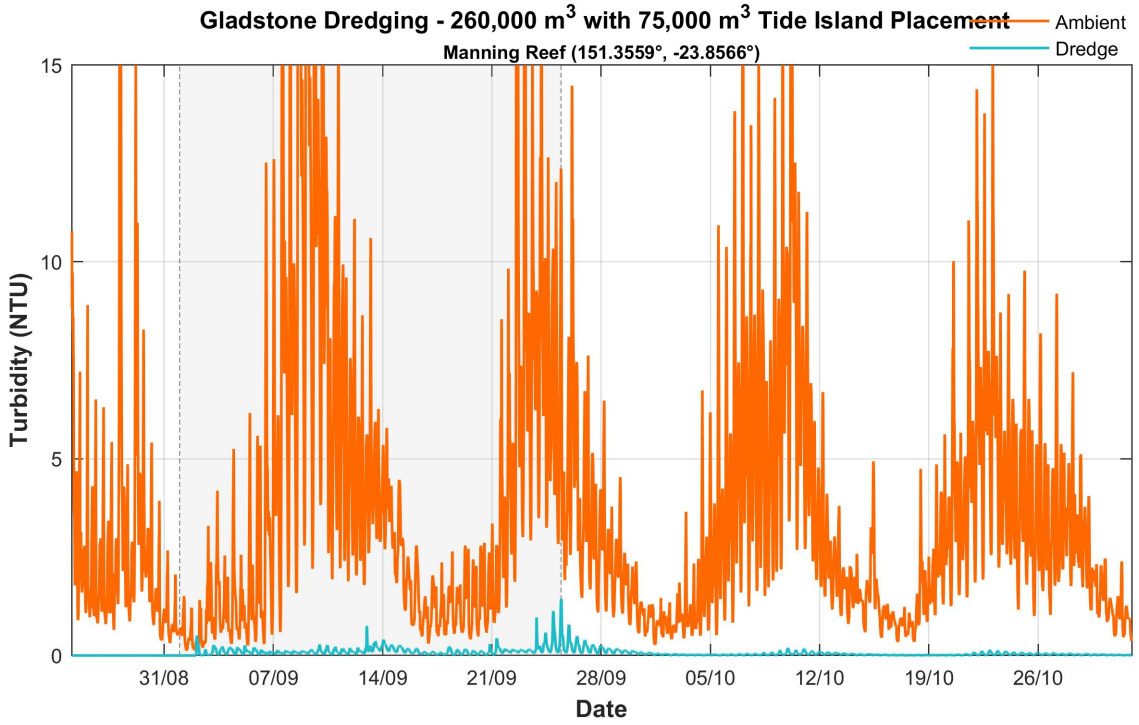

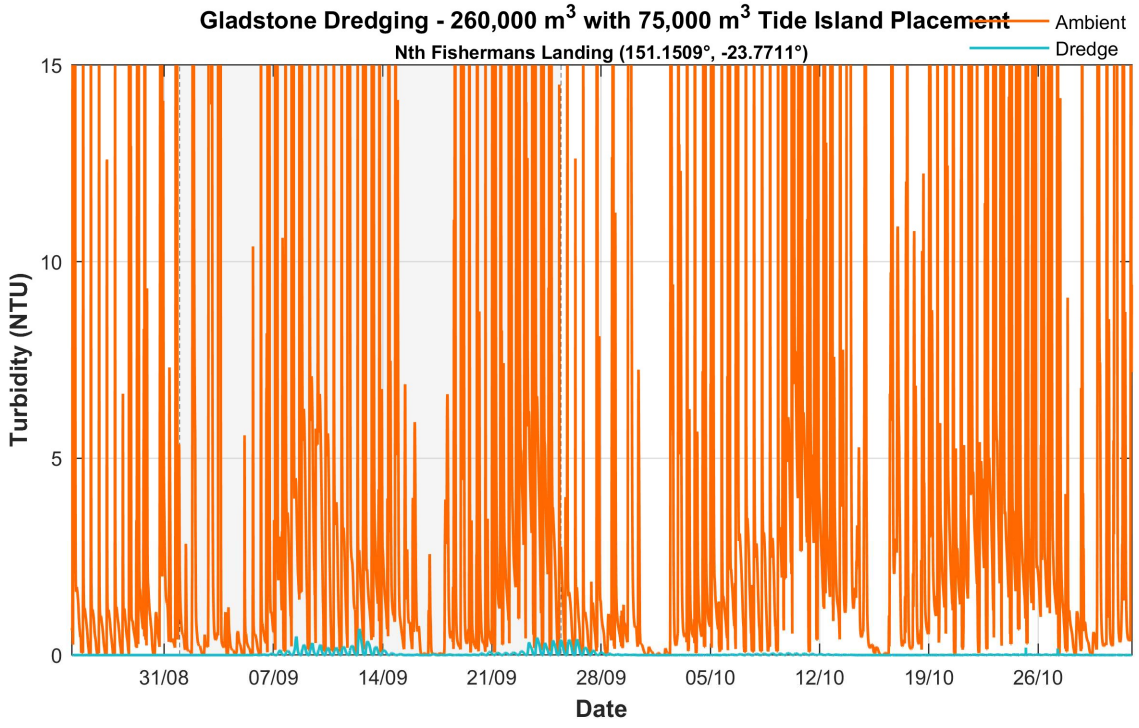

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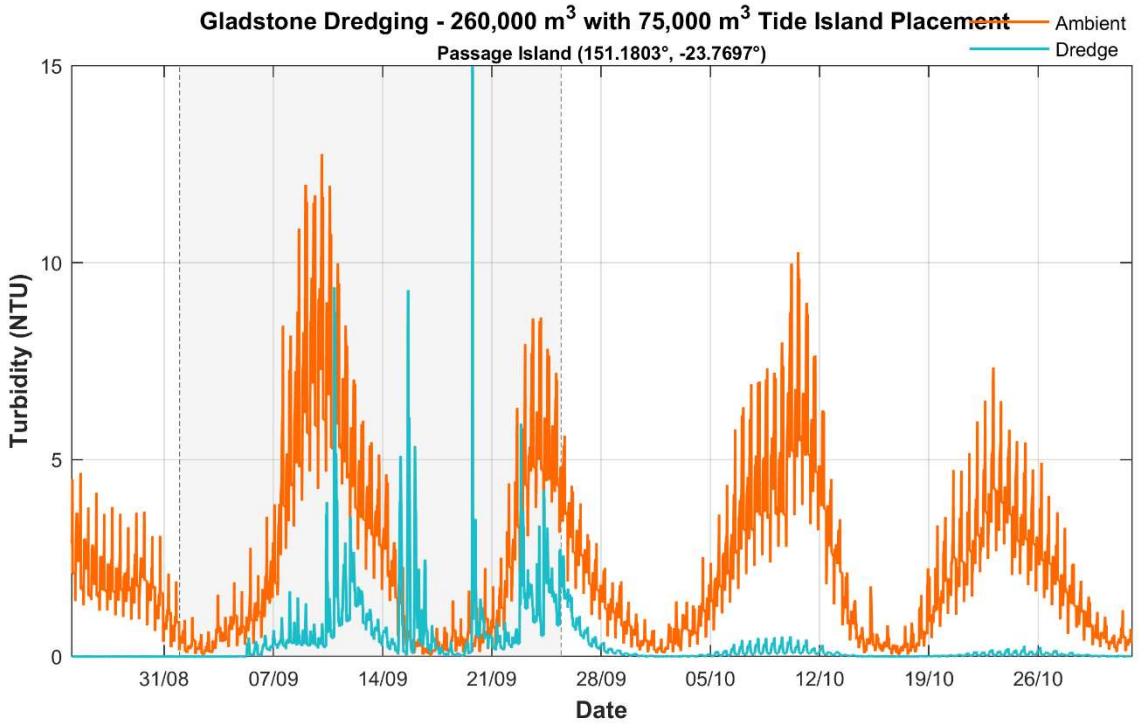

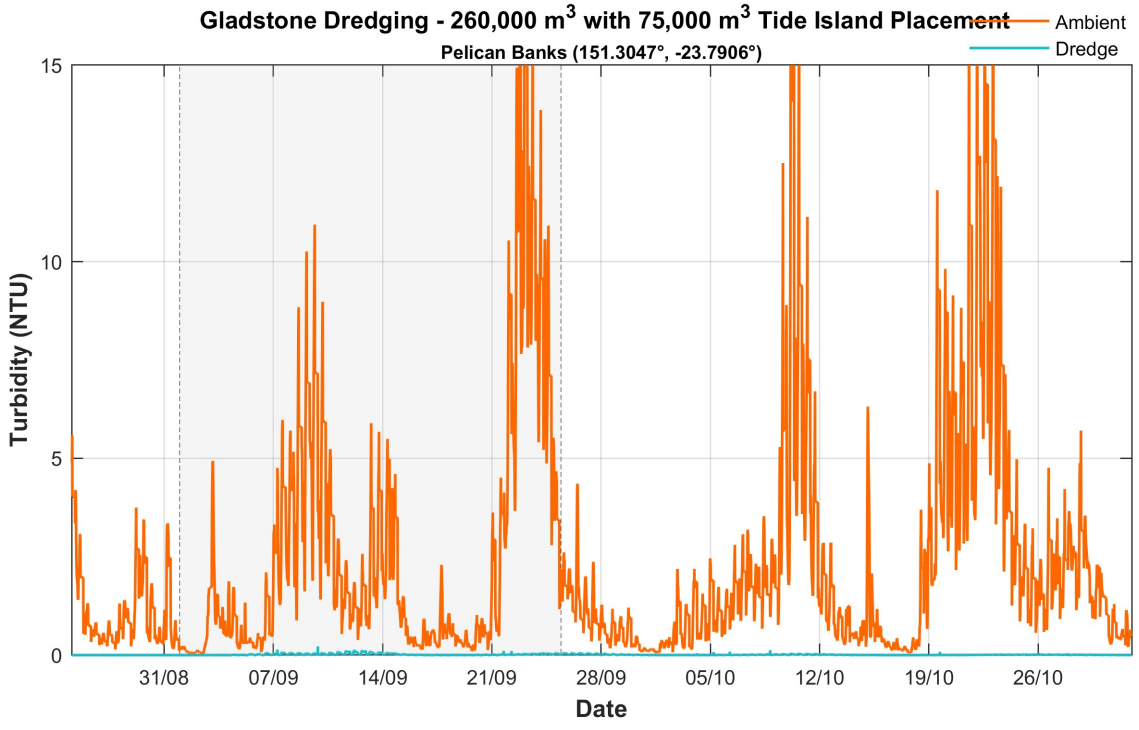

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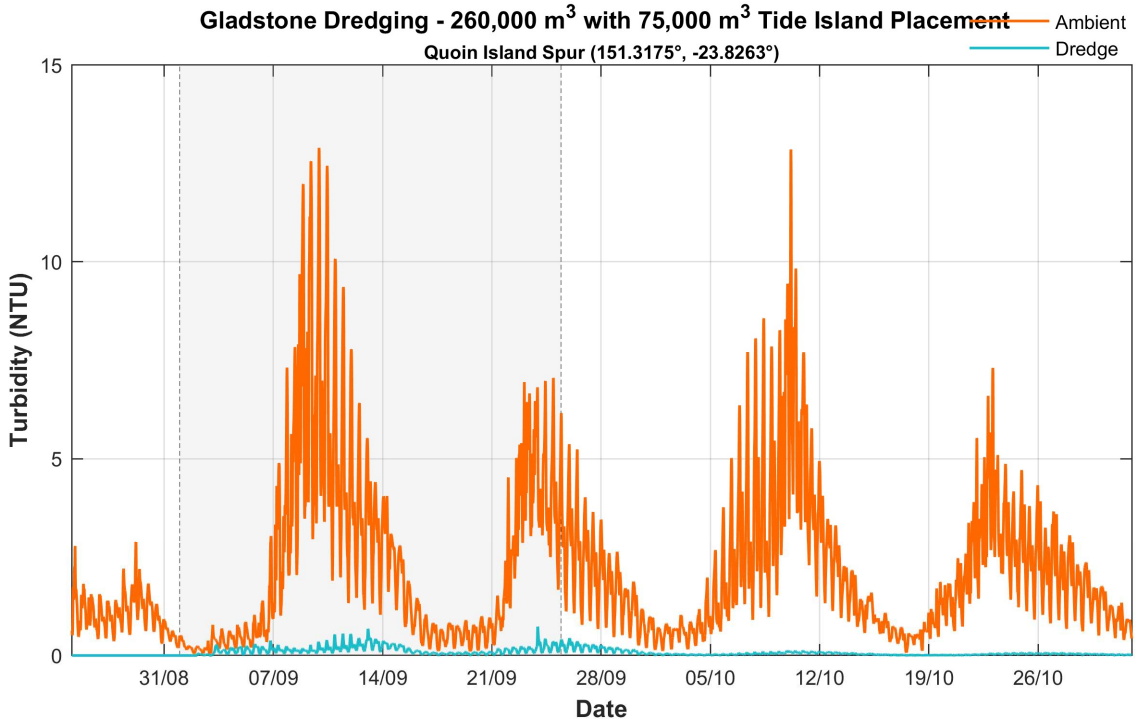

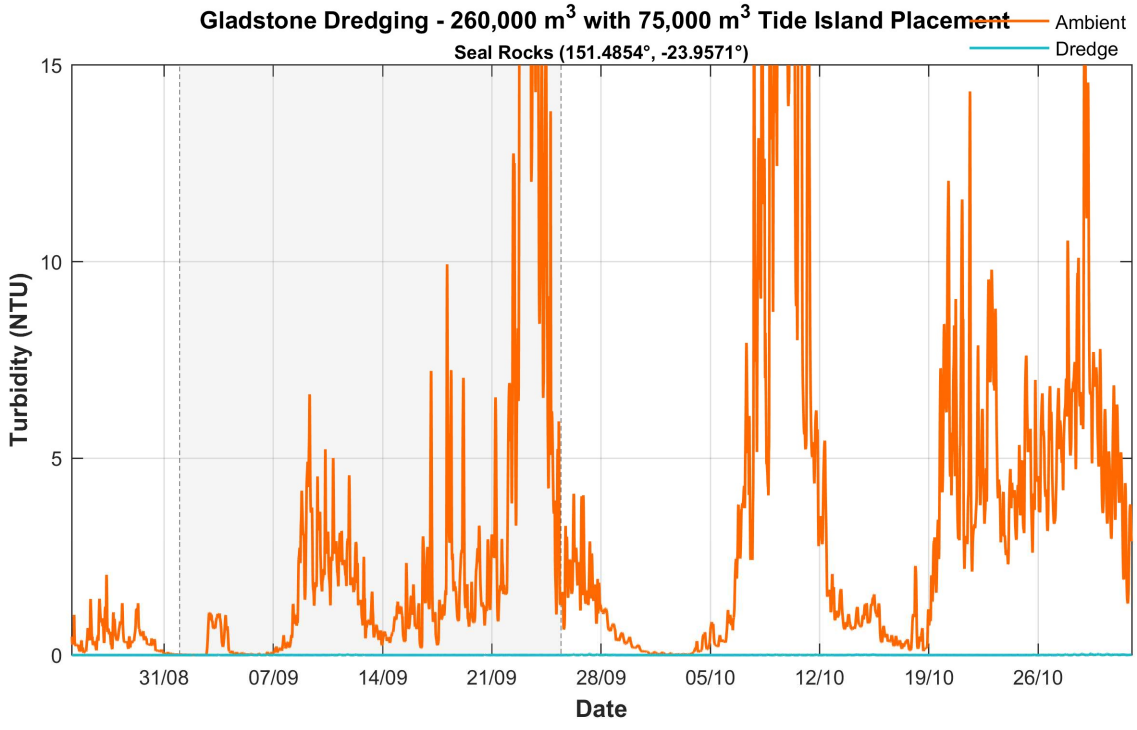

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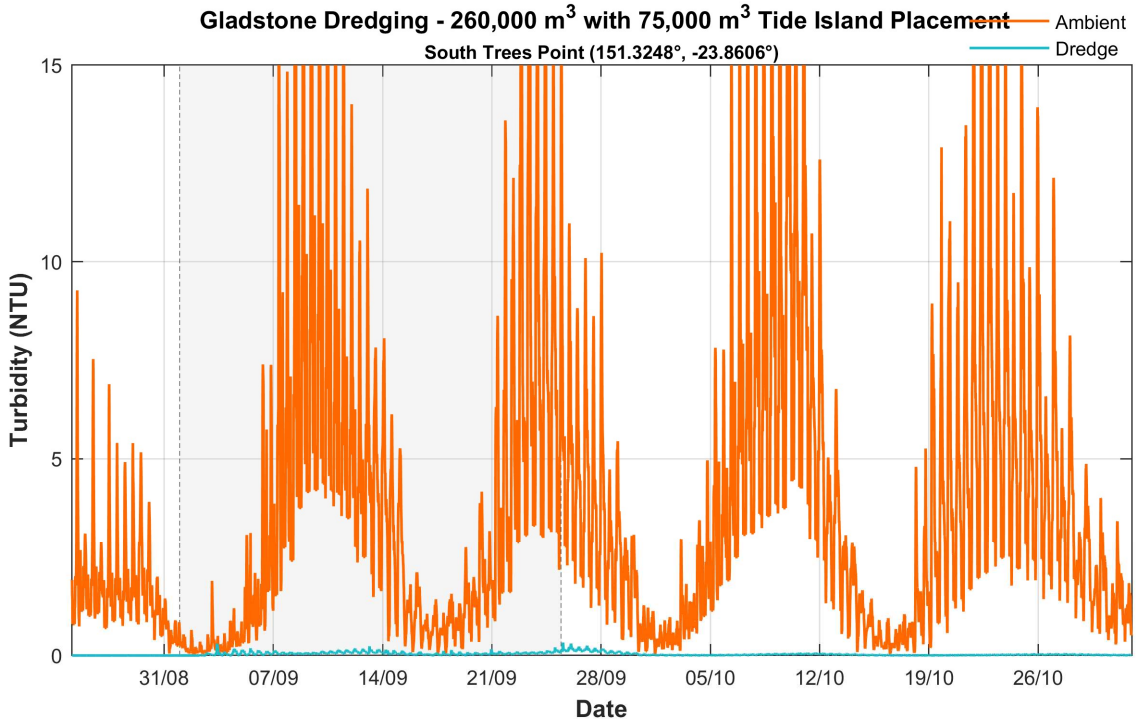

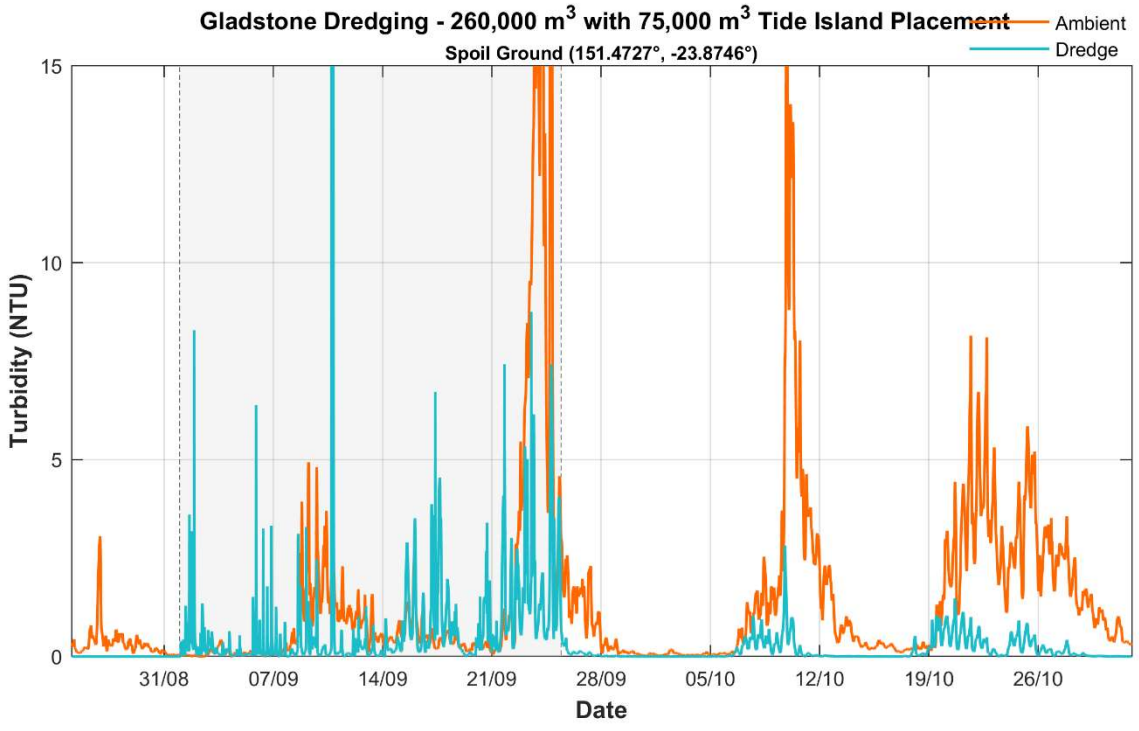

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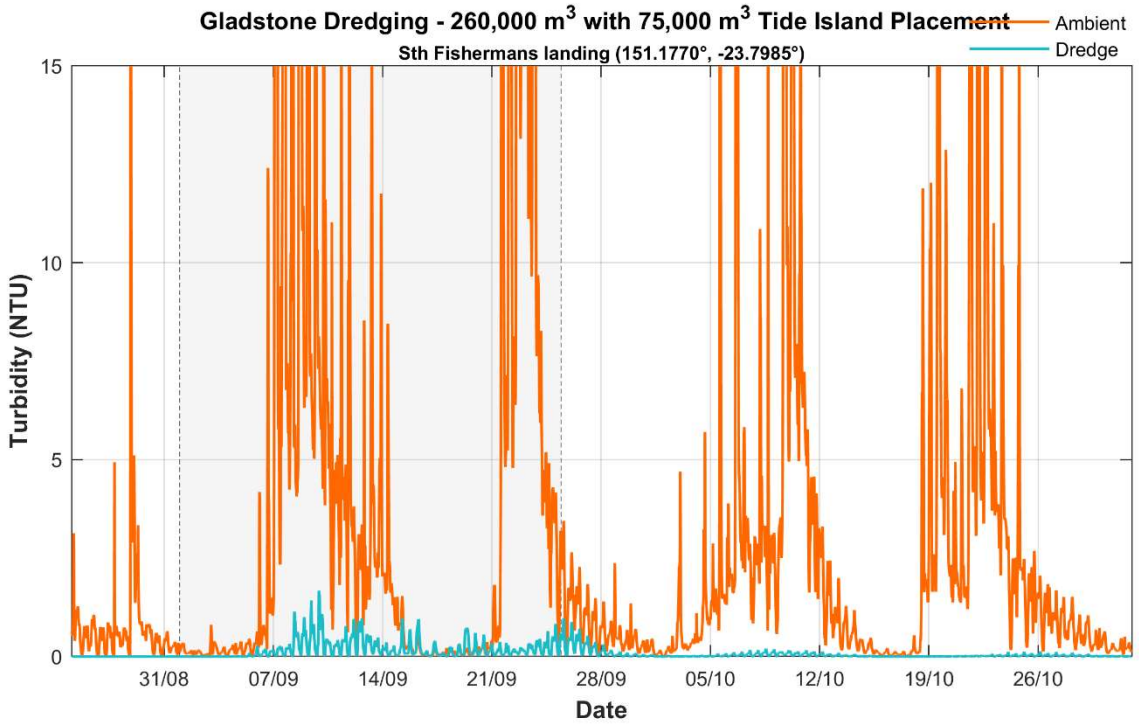

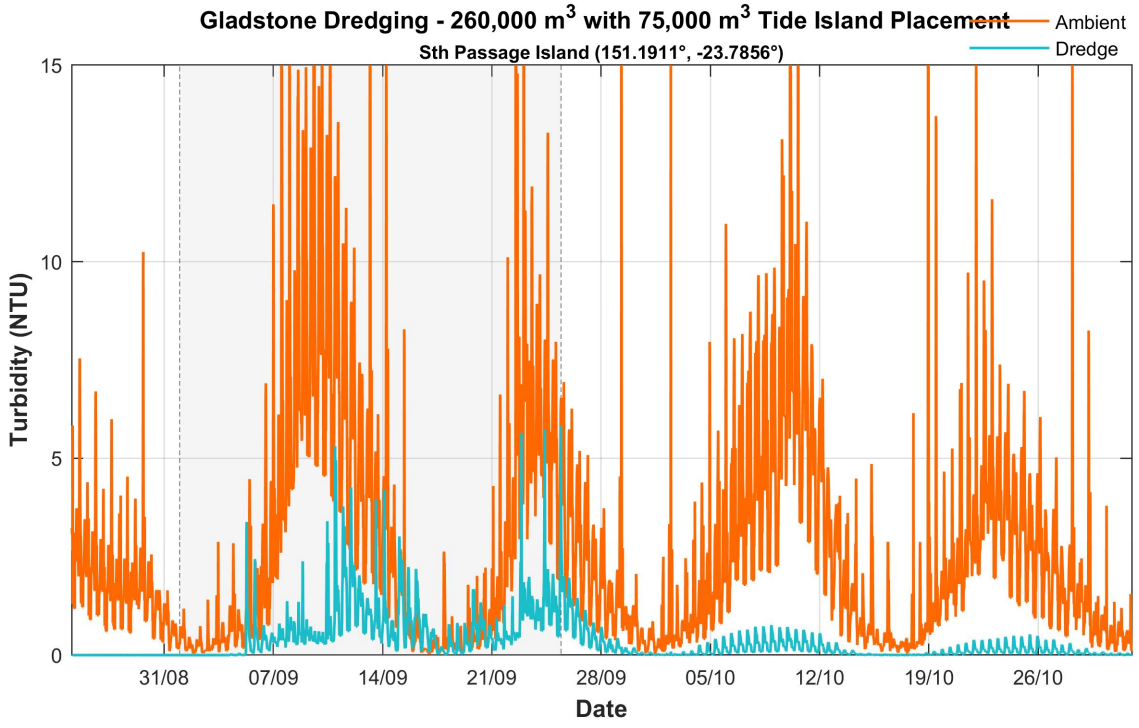

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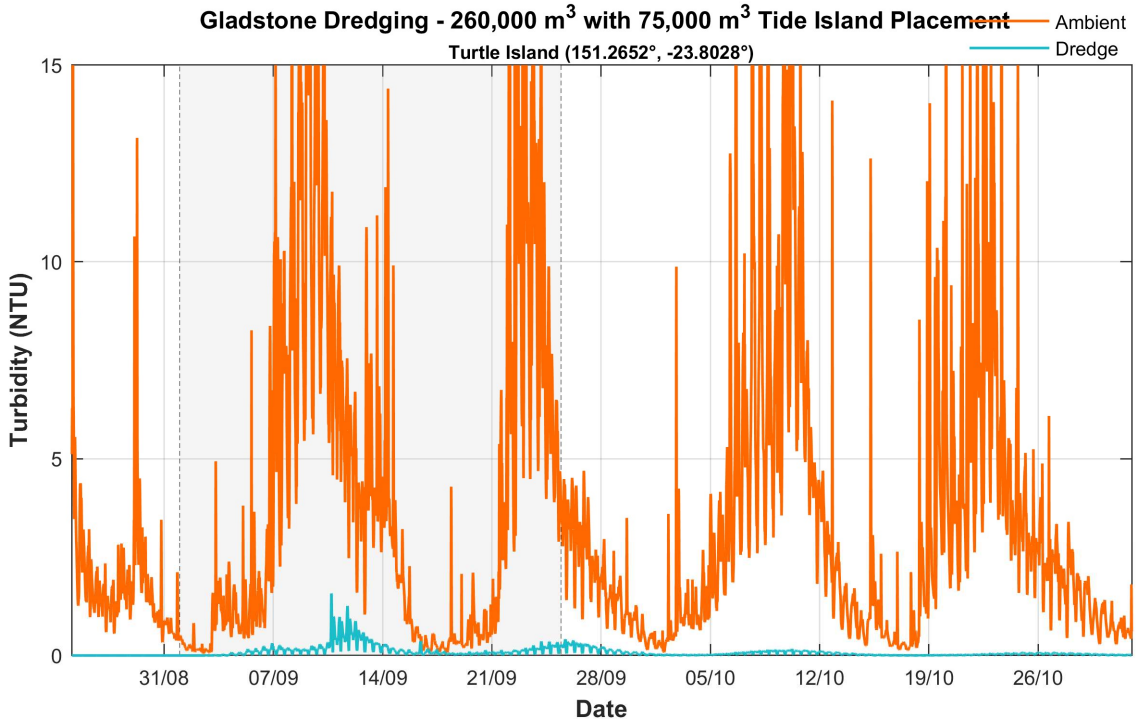

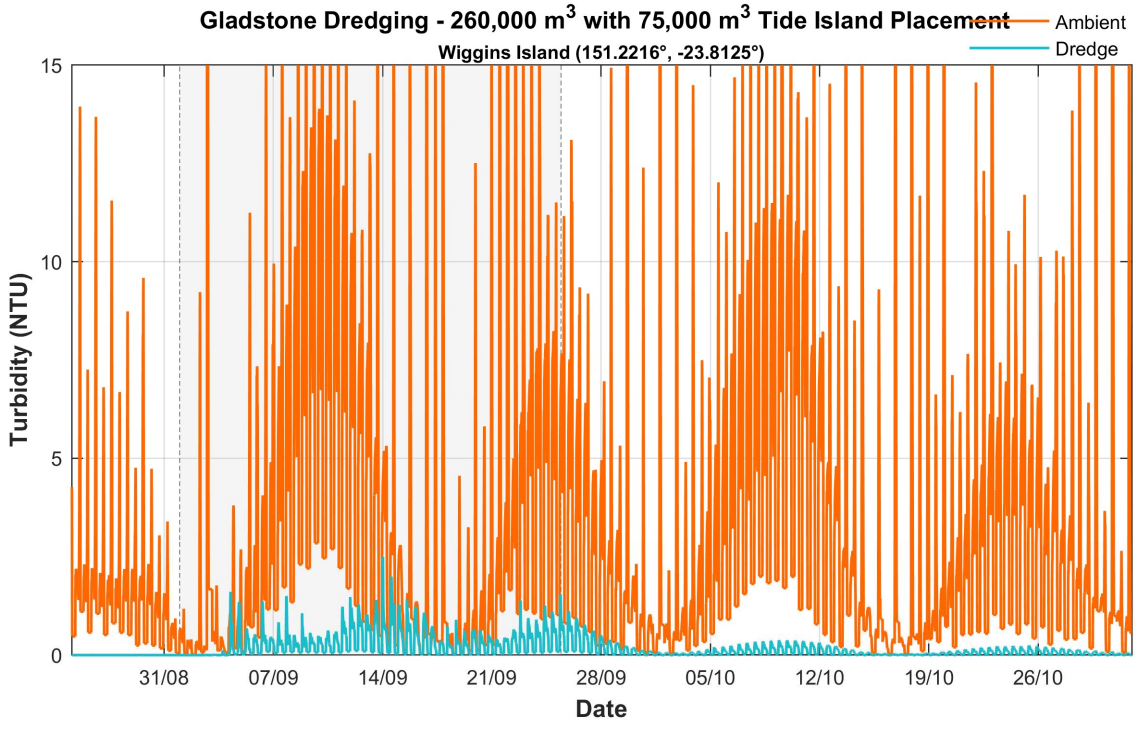

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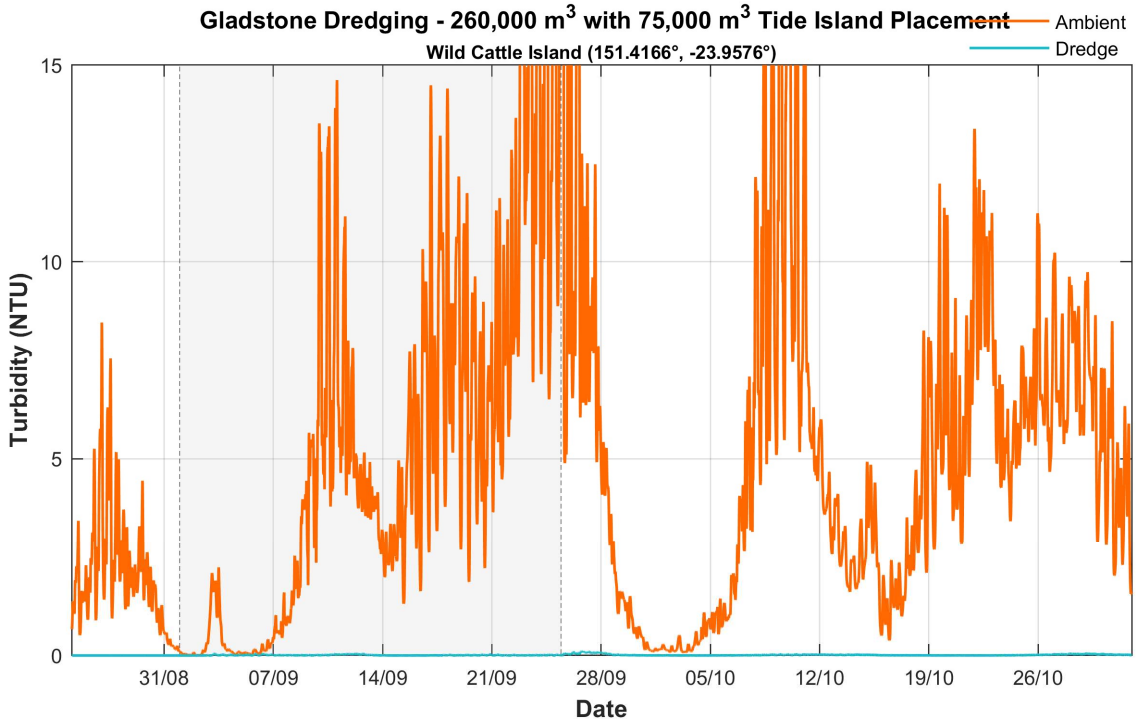

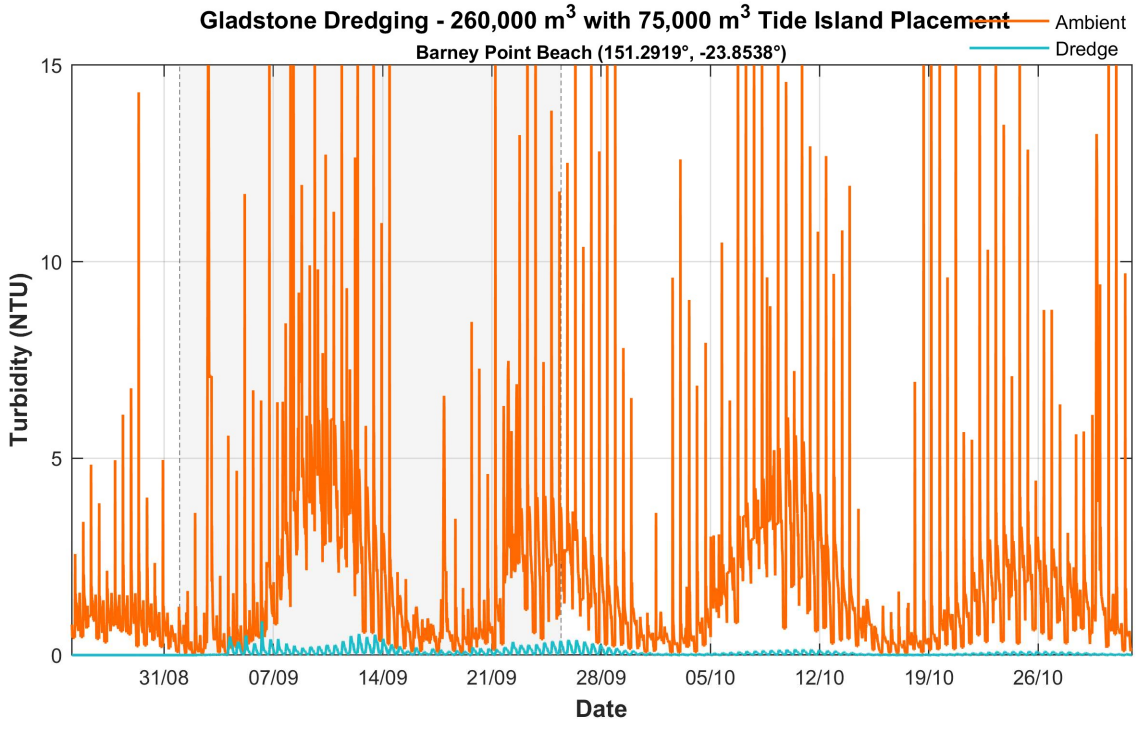

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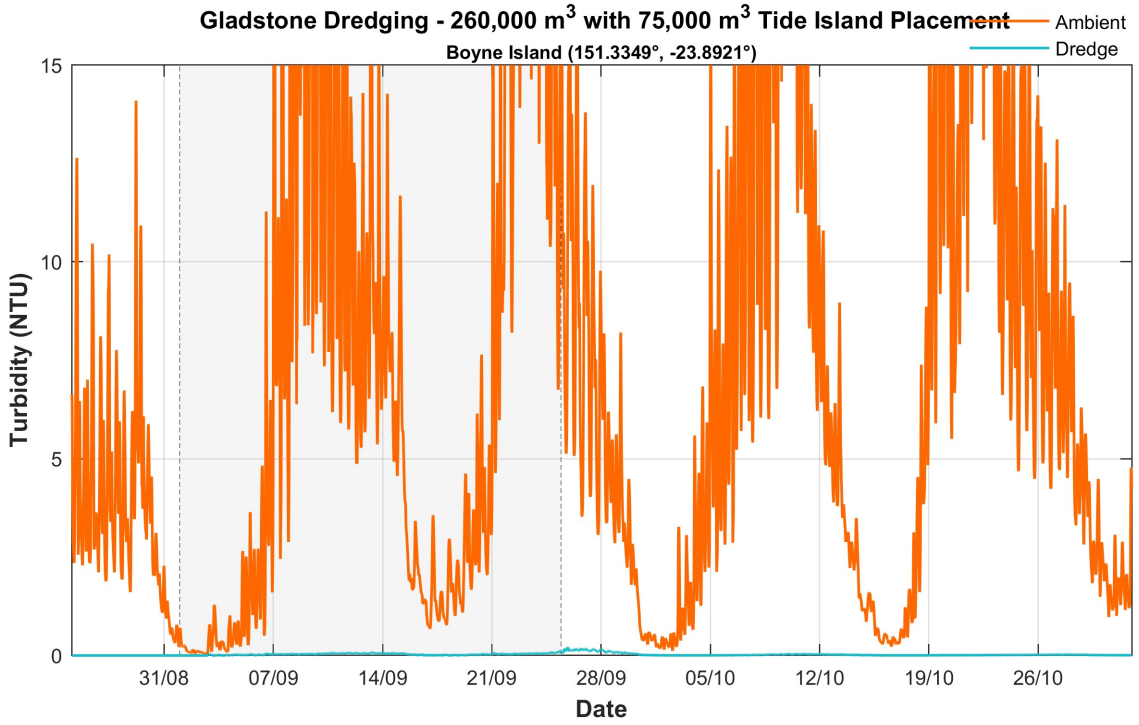
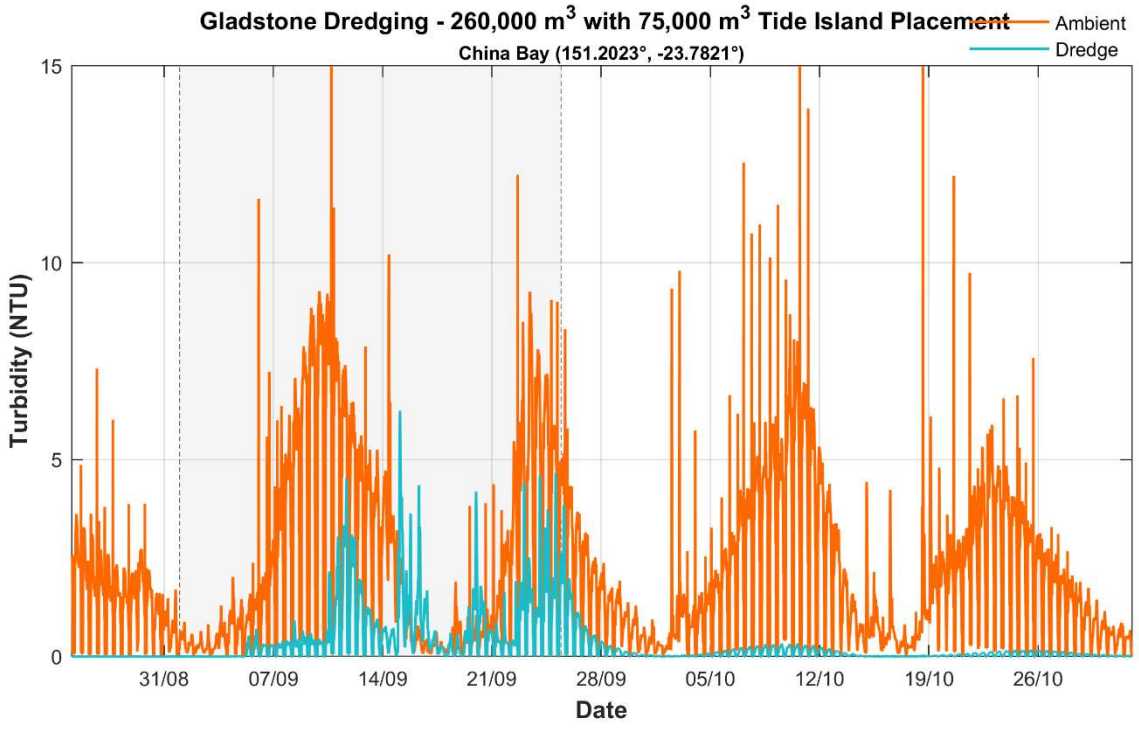
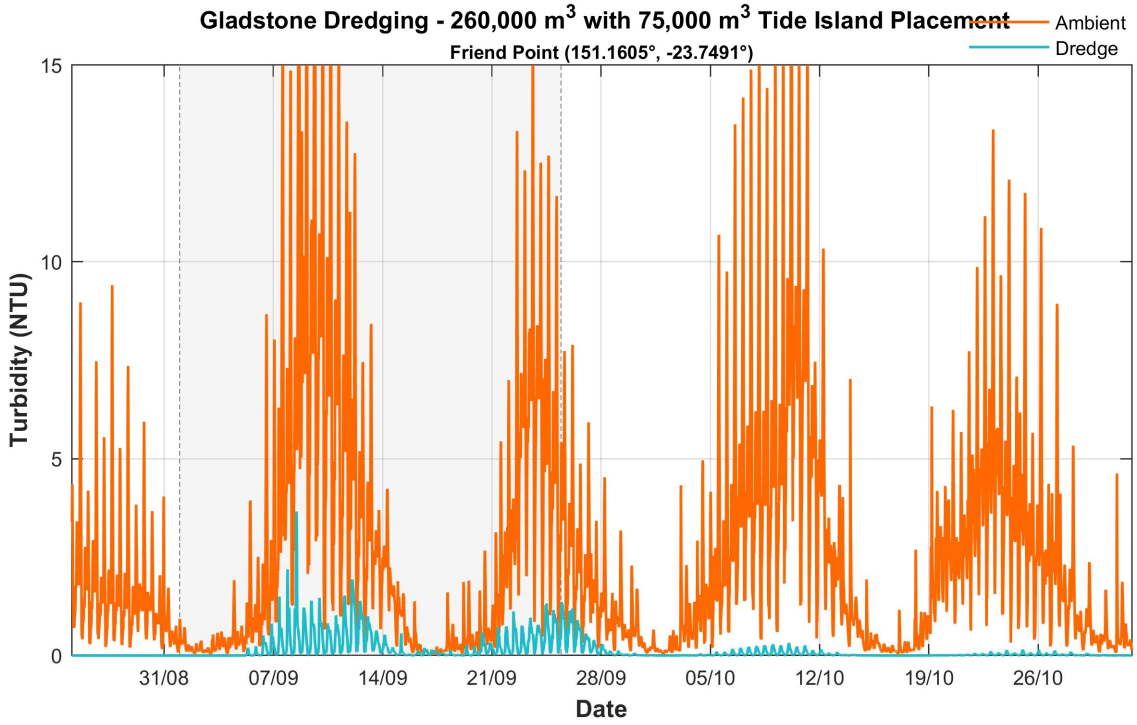


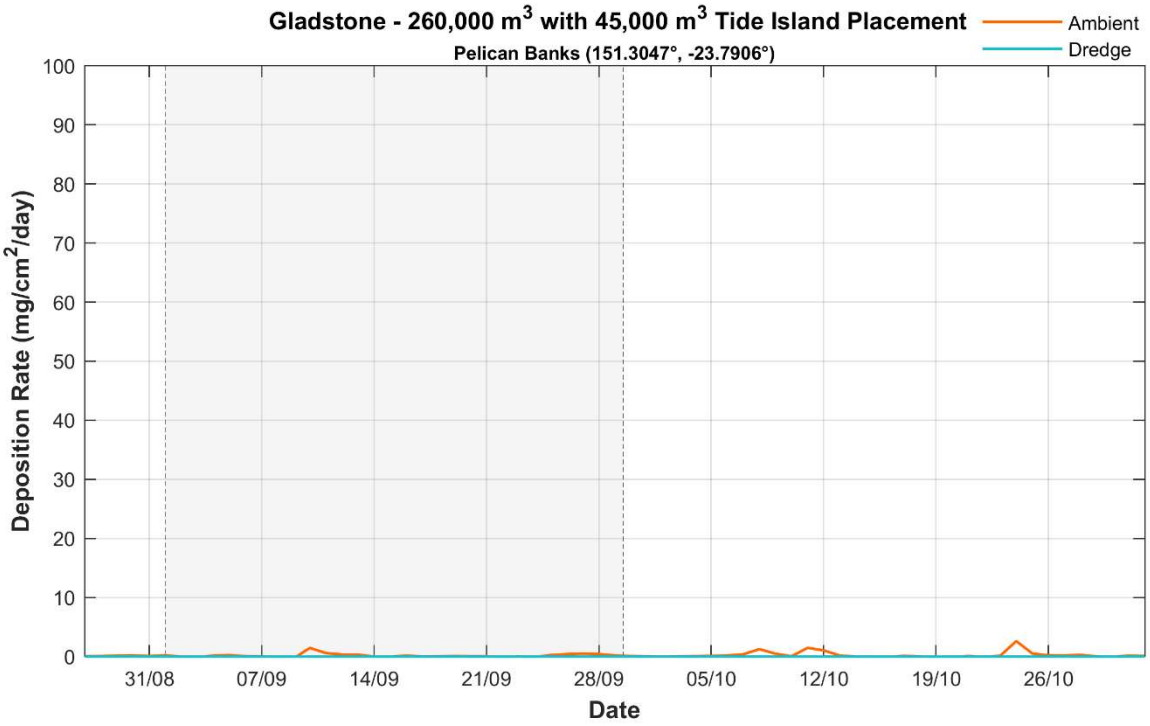


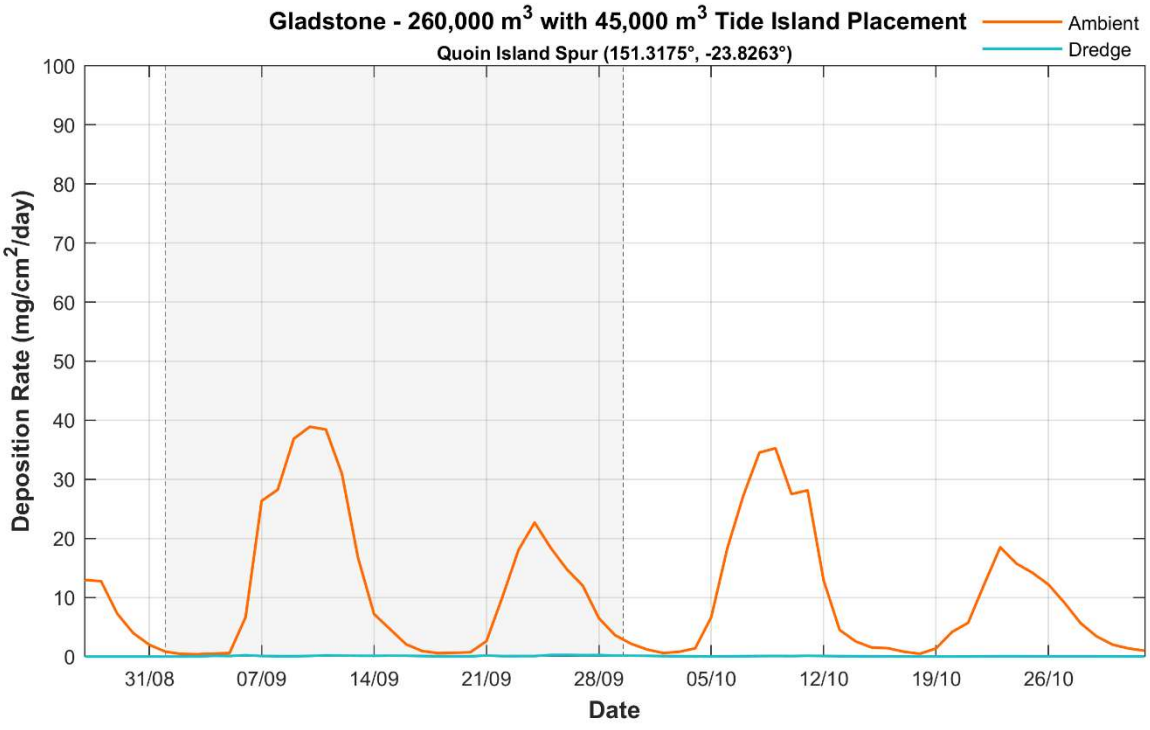
Time Series of Modelled Turbidity



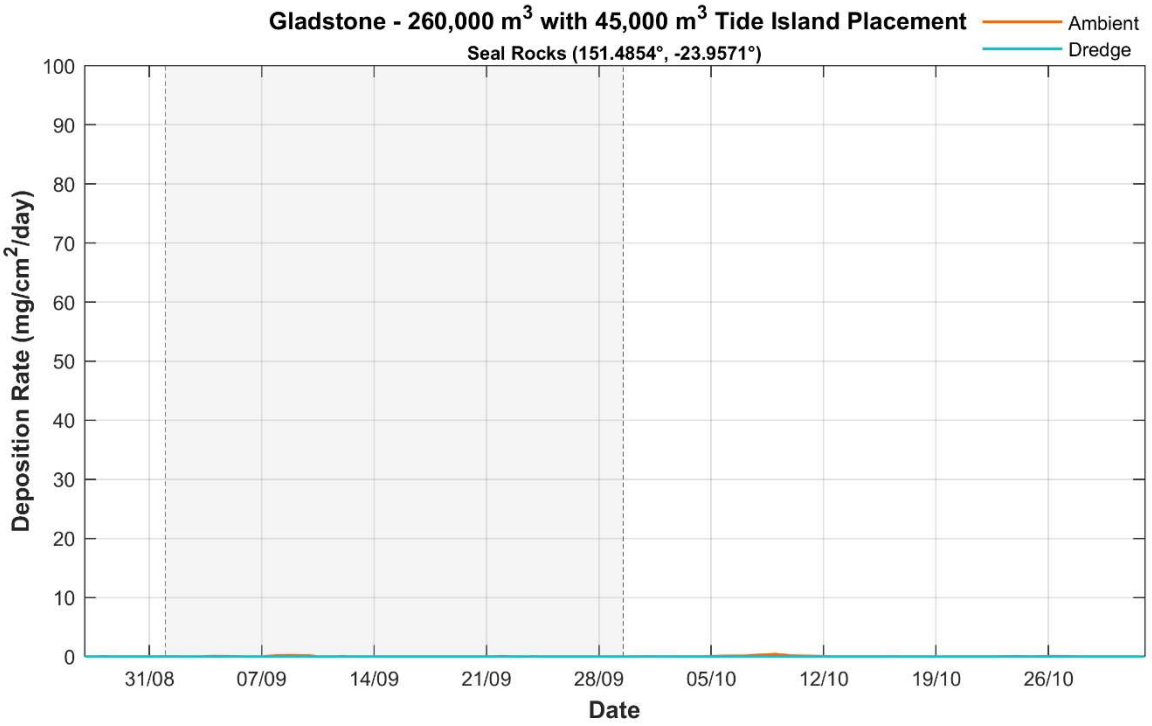
Appendix D Time Series of Modelled Deposition Rate

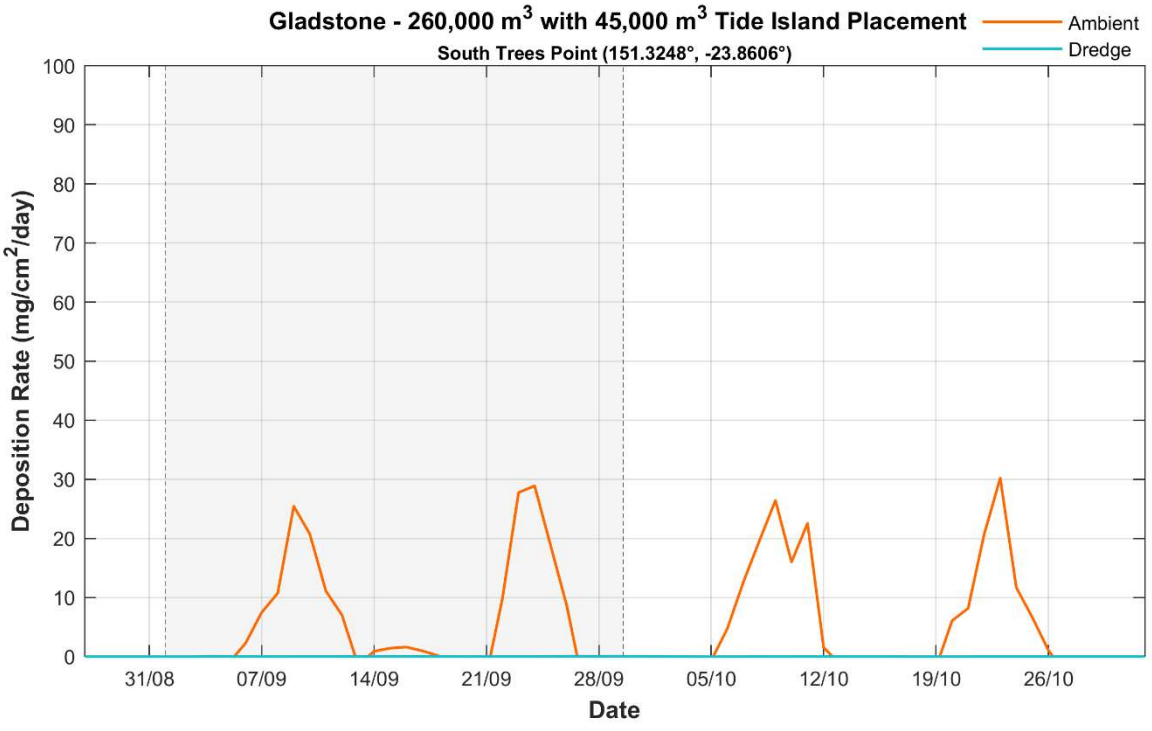
D.1 45,000m^3 Placement at Tide Island Results



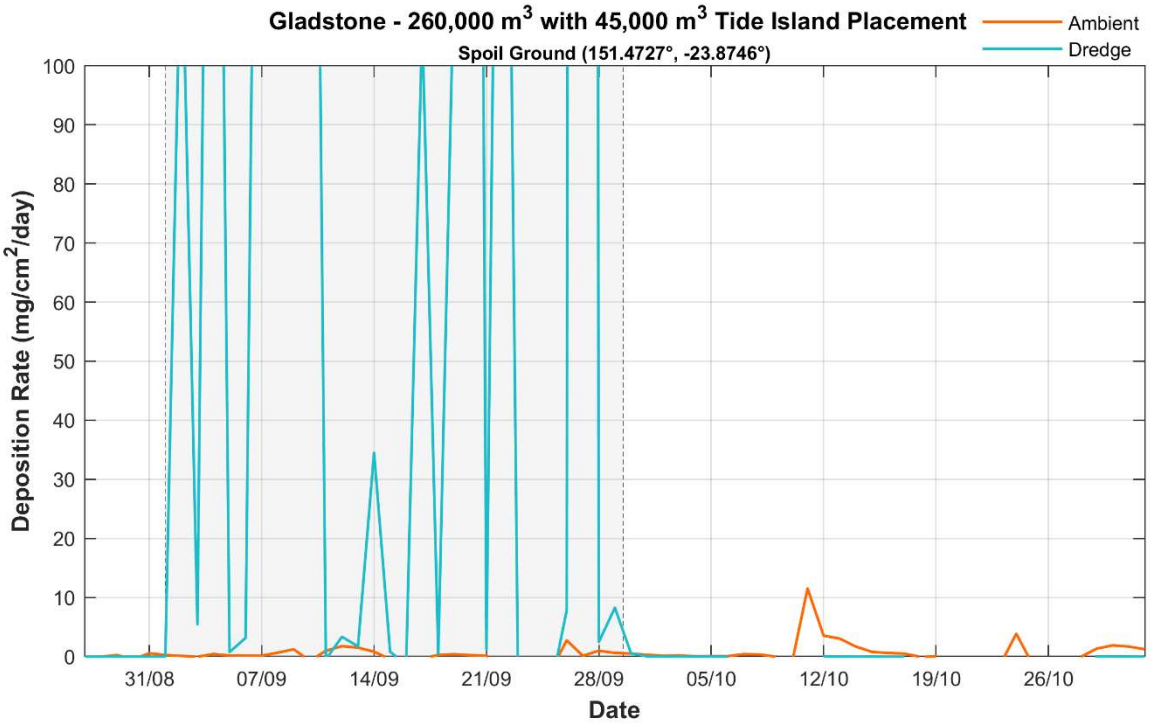


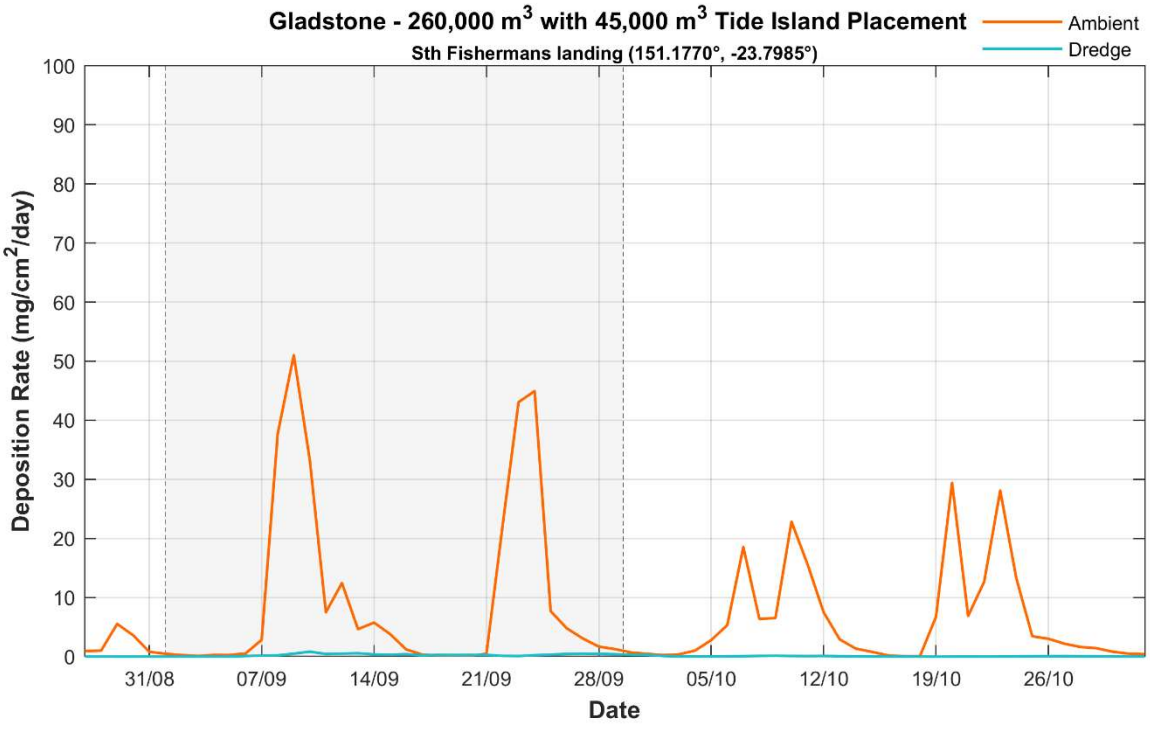
Time Series of Modelled Deposition Rate



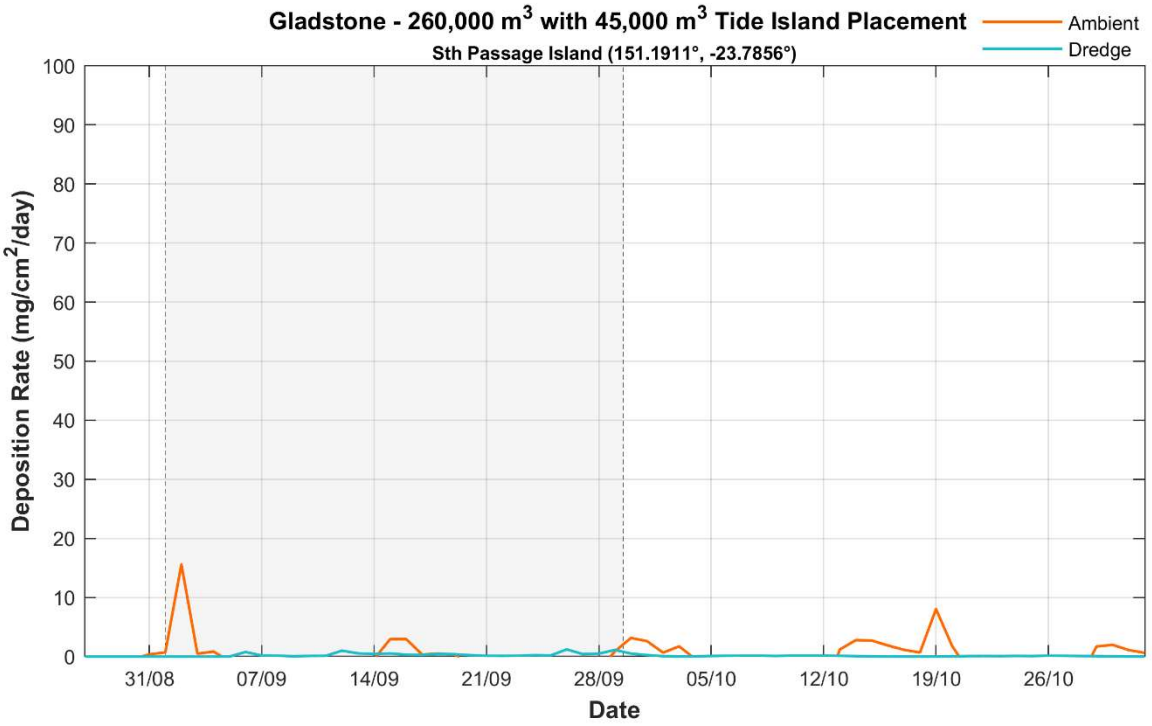


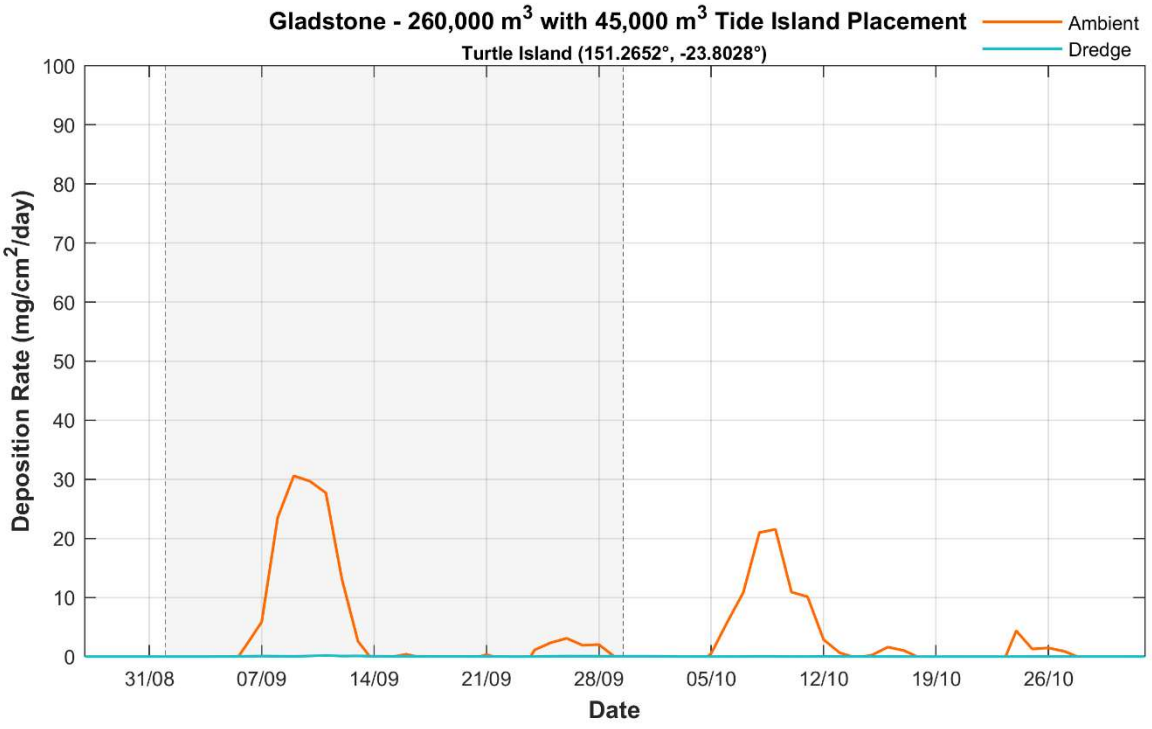
Time Series of Modelled Deposition Rate



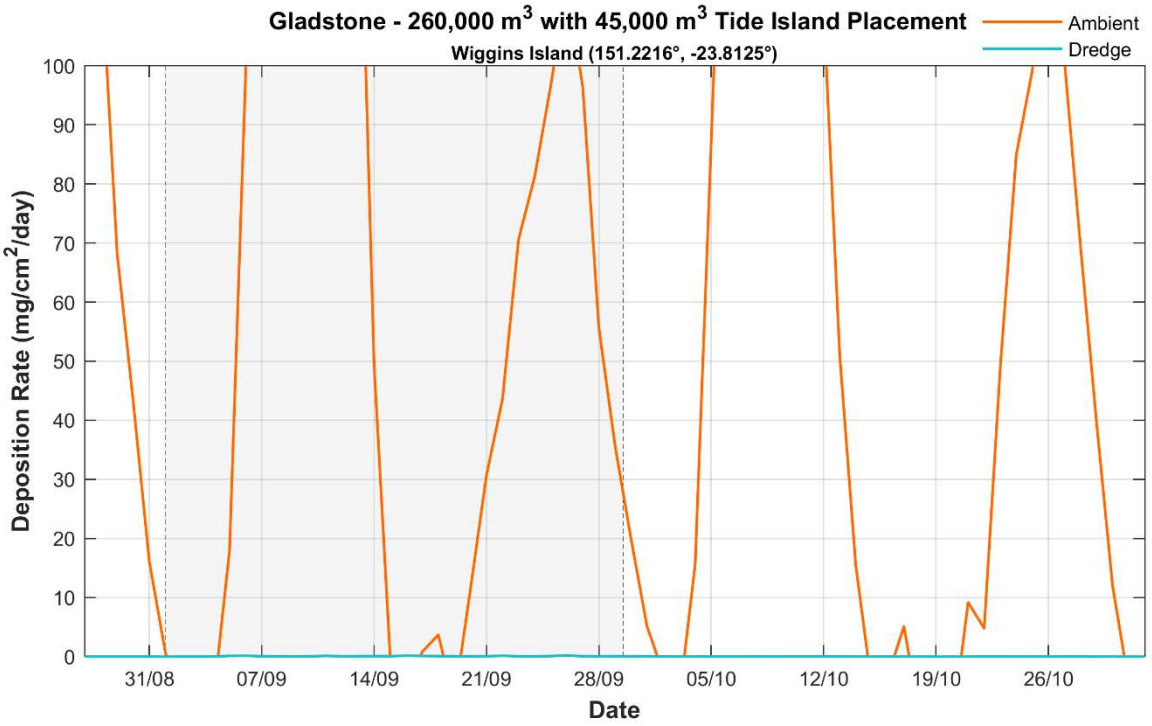


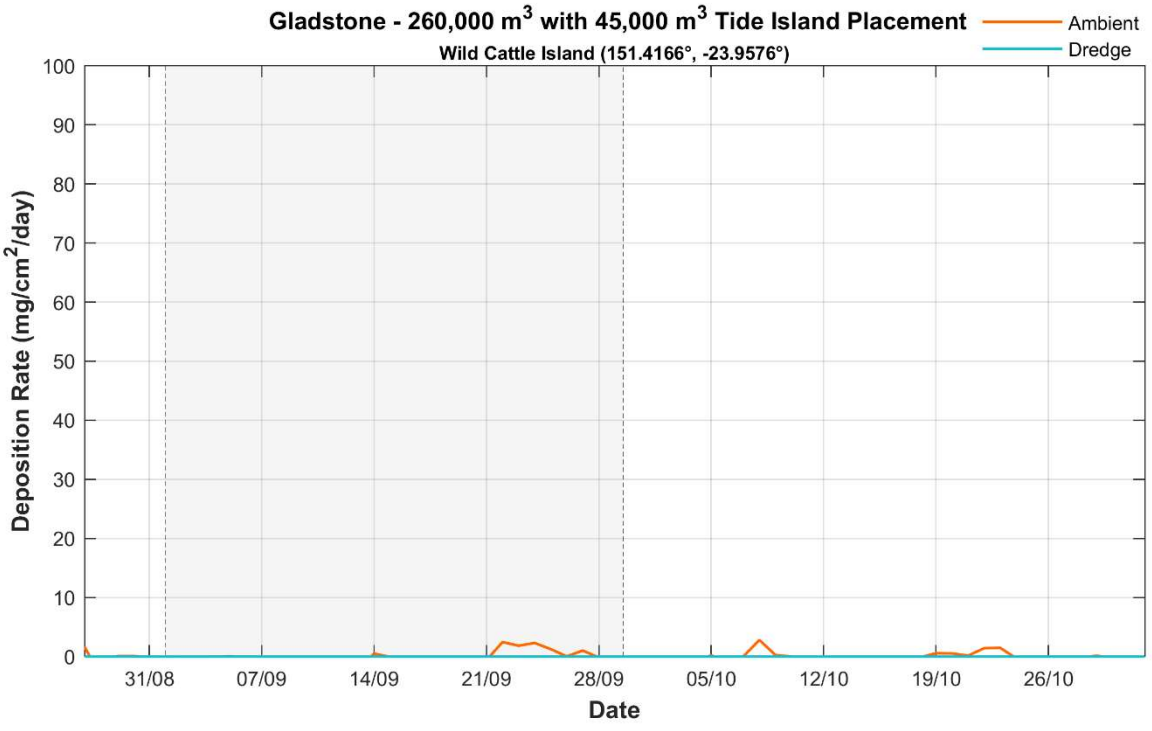
Time Series of Modelled Deposition Rate



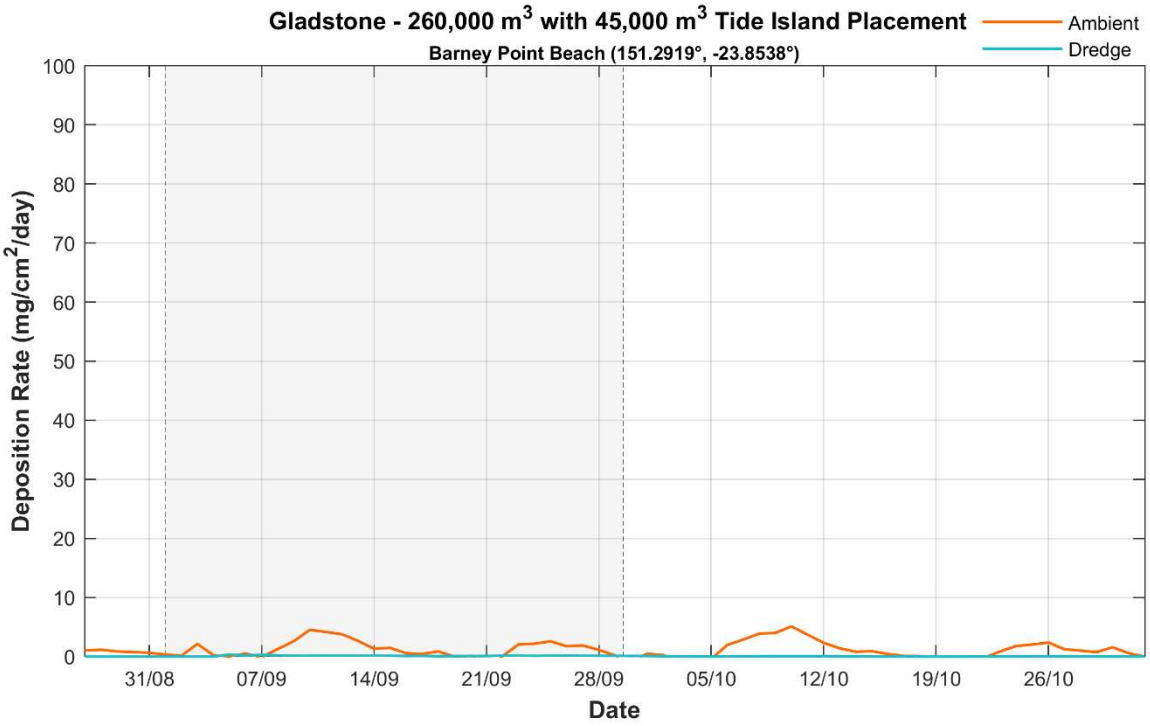


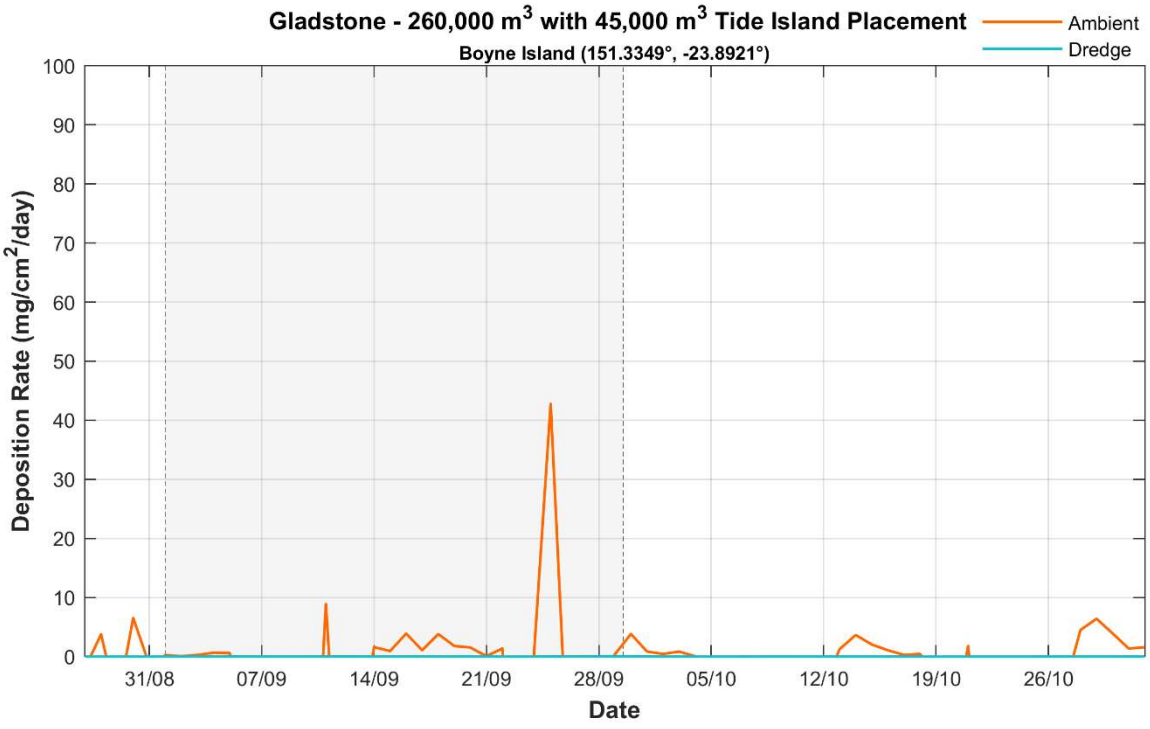
Time Series of Modelled Deposition Rate



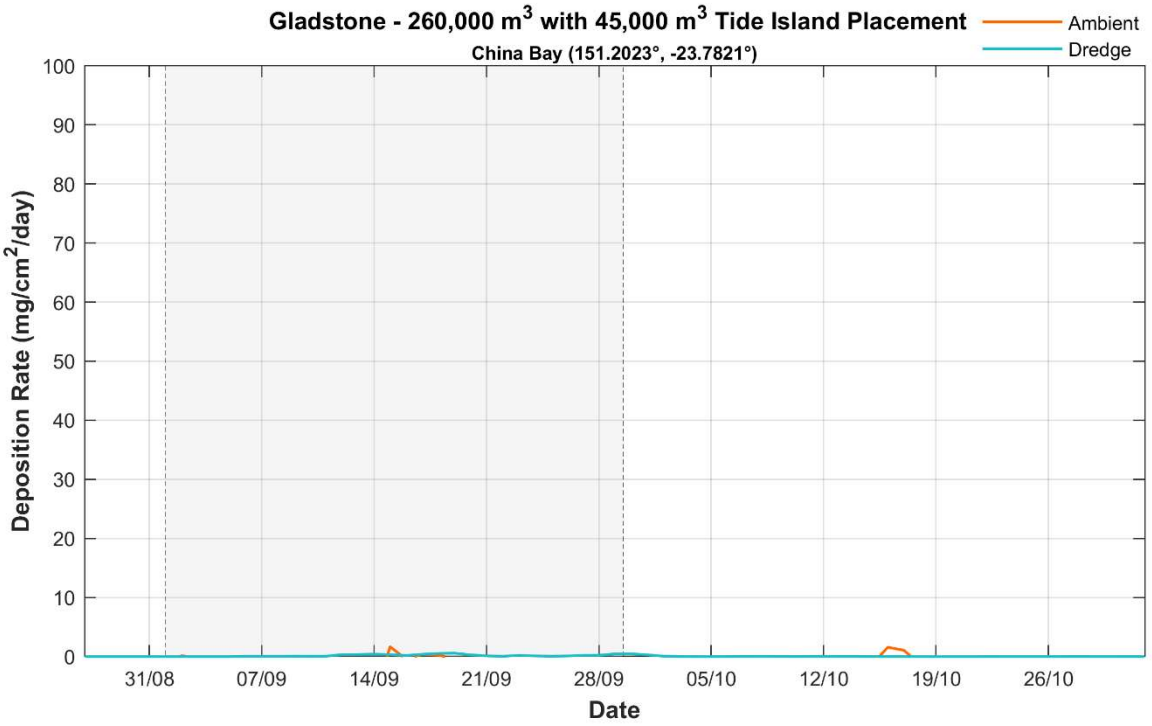


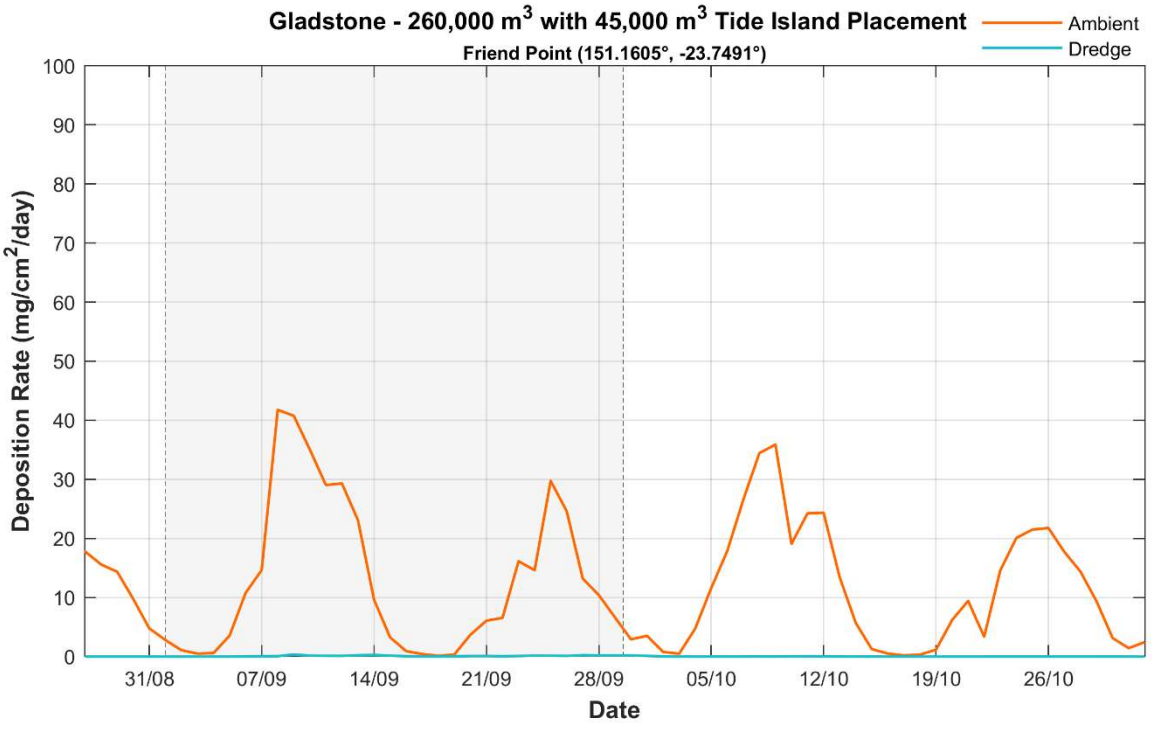
Time Series of Modelled Deposition Rate



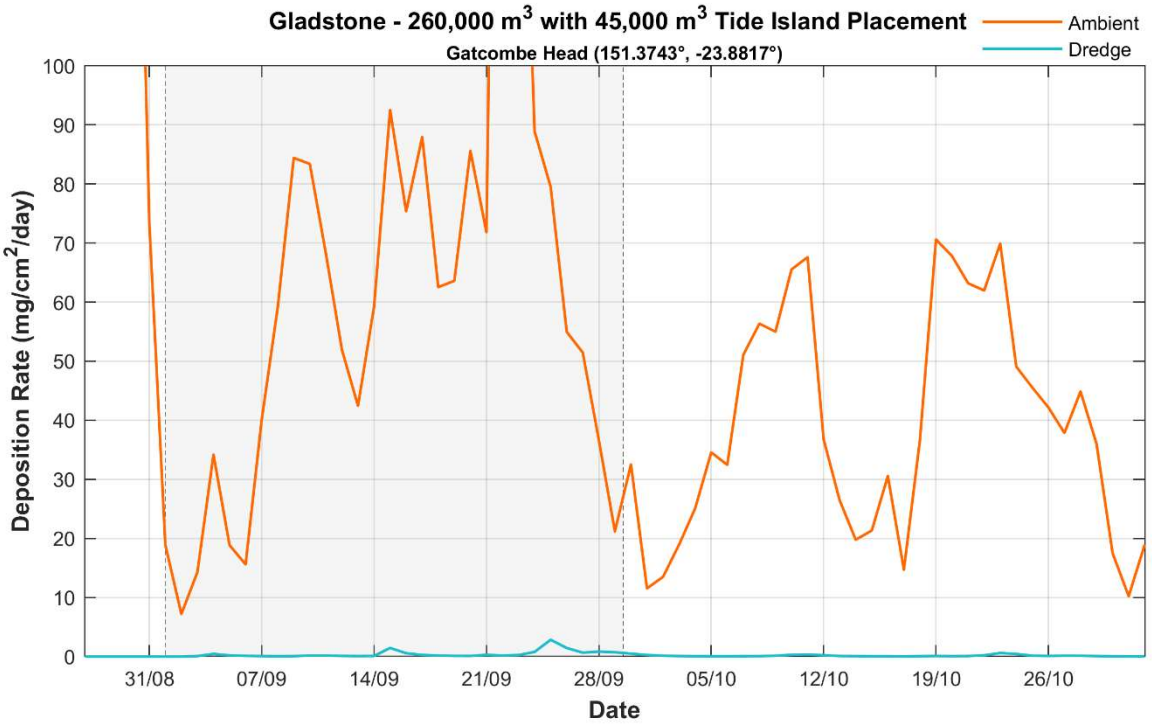


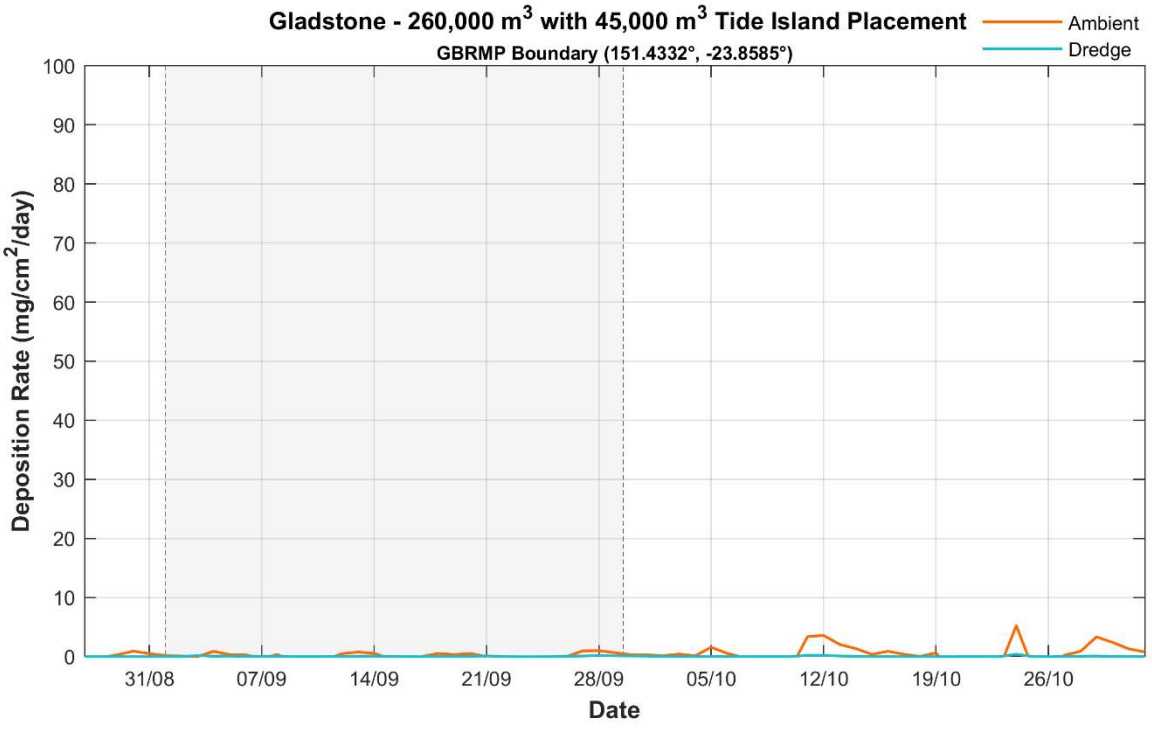
Time Series of Modelled Deposition Rate



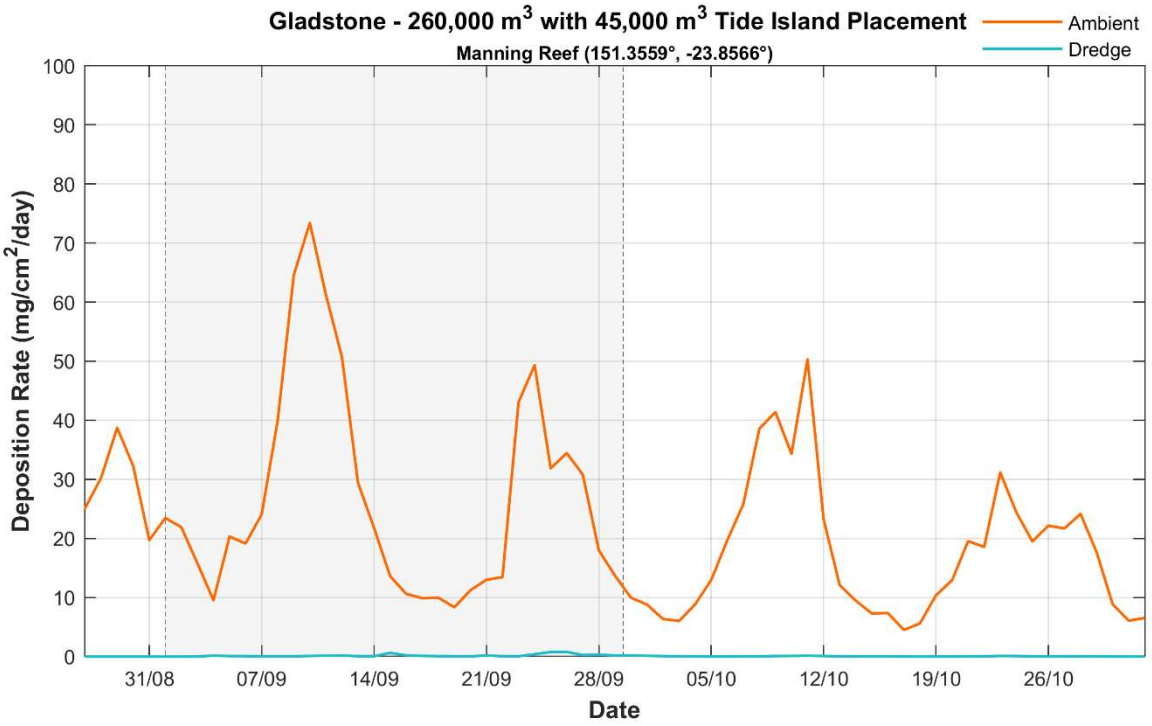


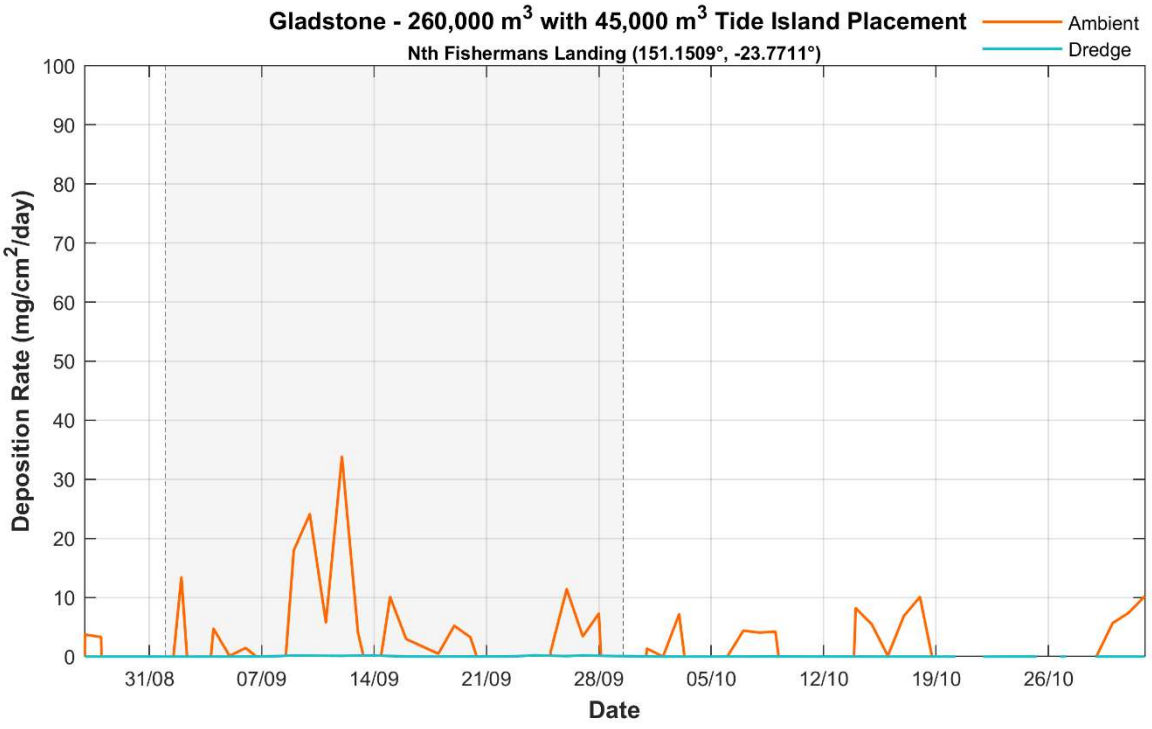
Time Series of Modelled Deposition Rate



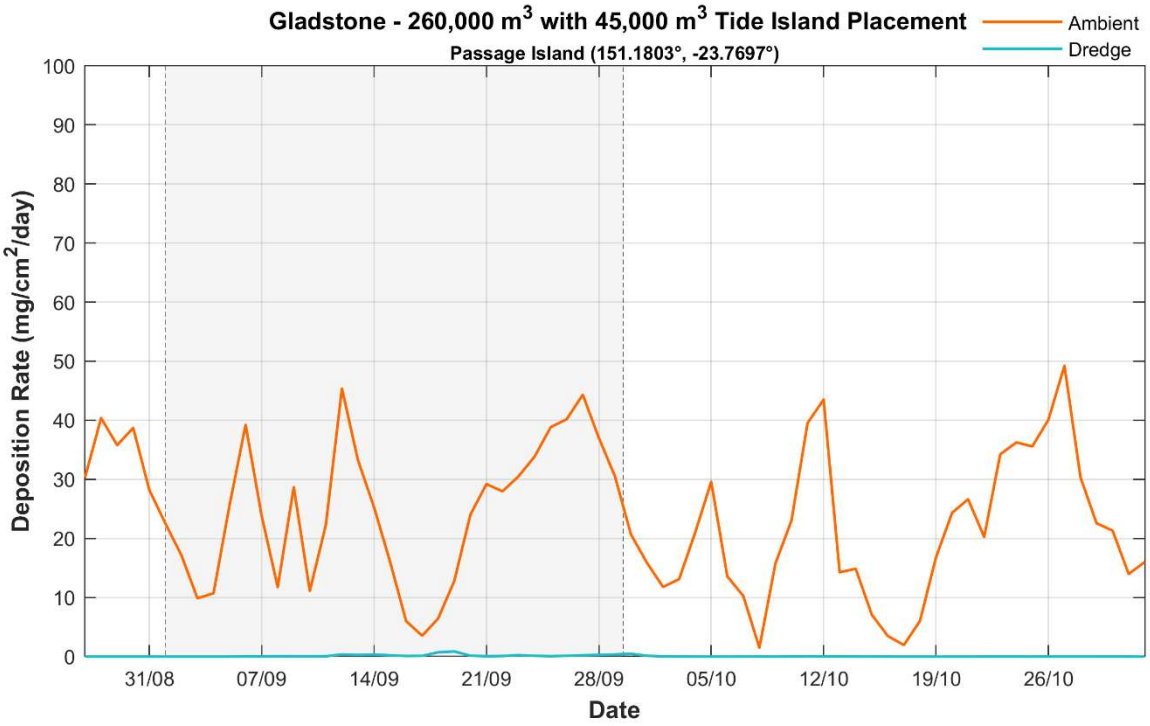


Time Series of Modelled Deposition Rate

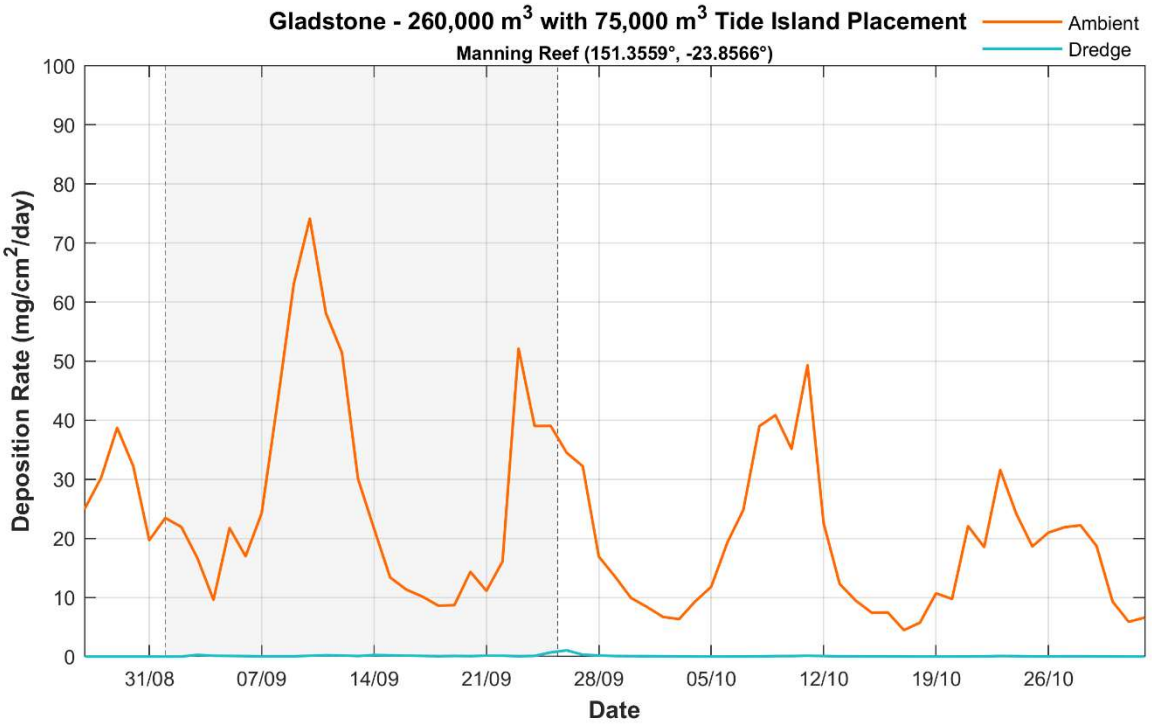


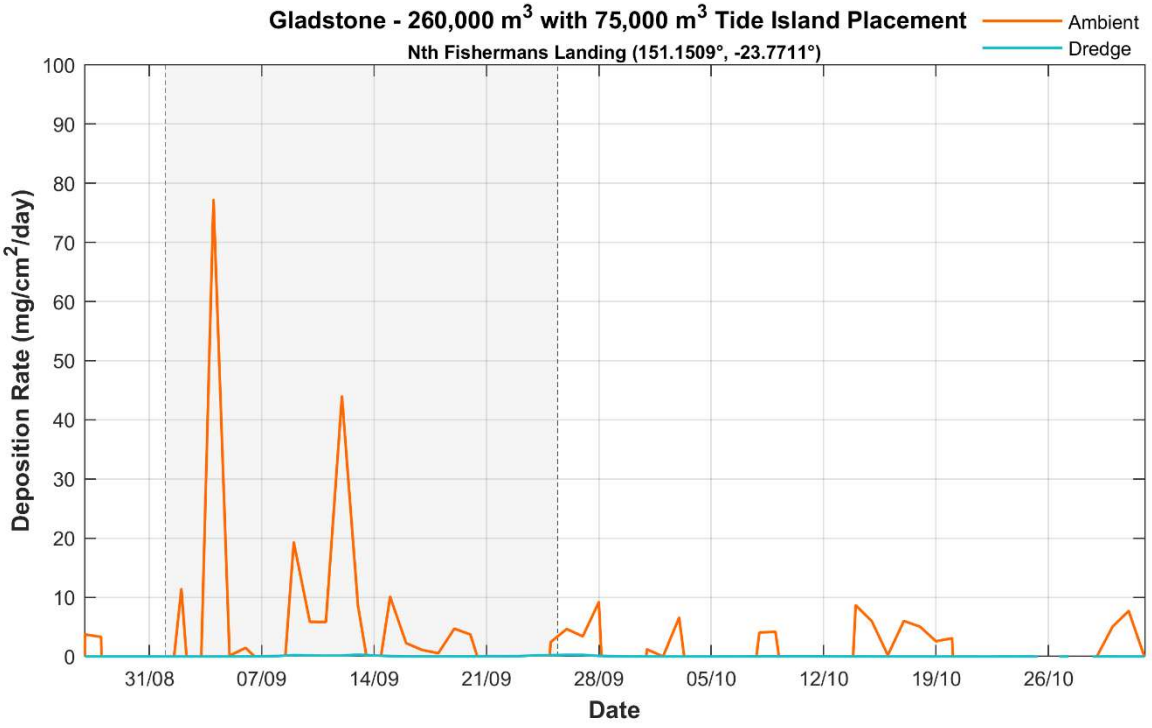


Time Series of Modelled Deposition Rate

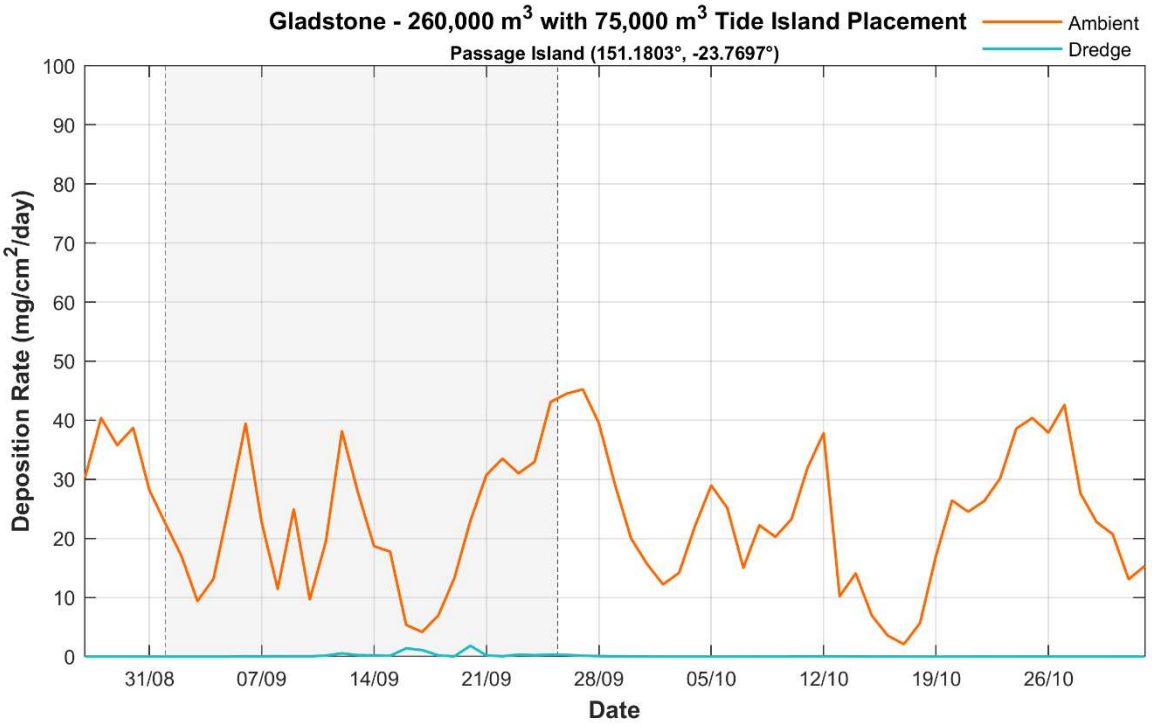


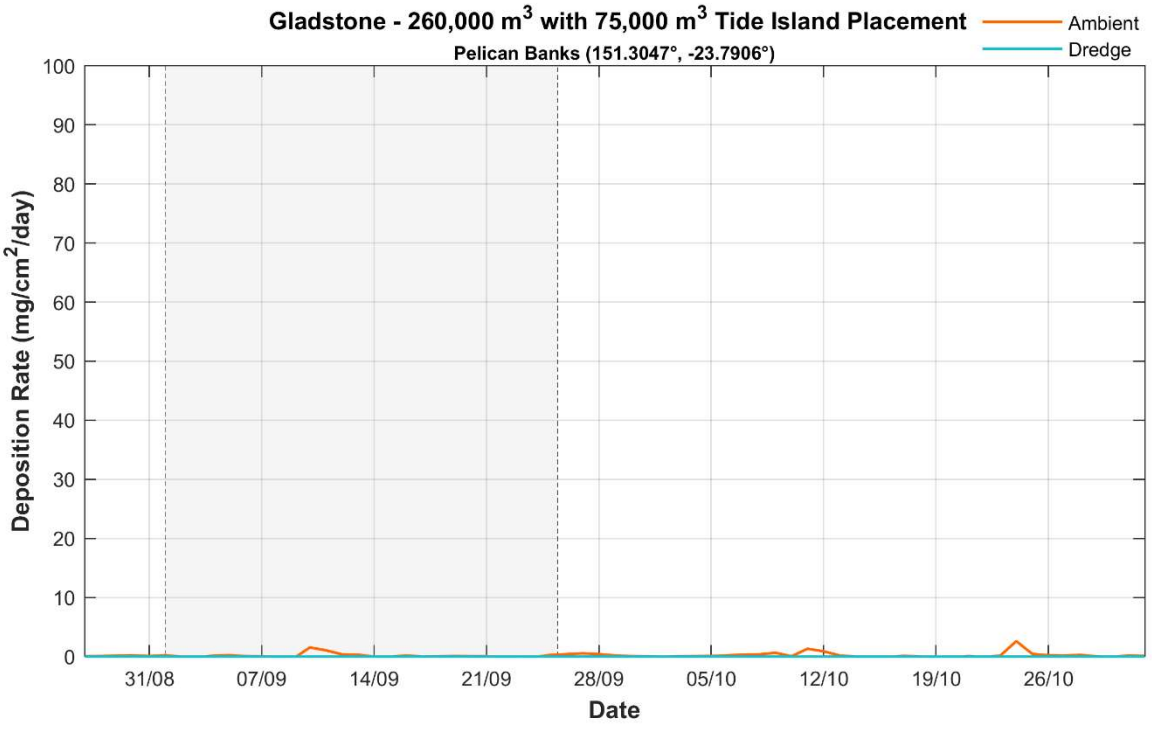
D.2 75,000m^3 Placement at Tide Island Results



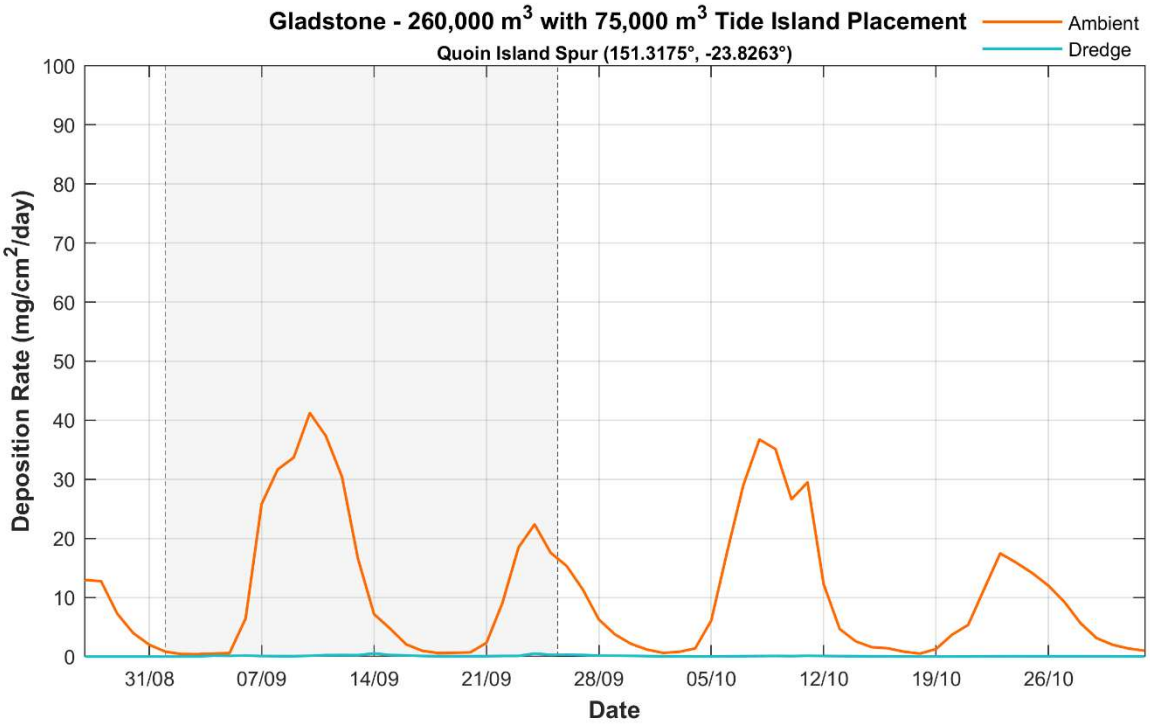


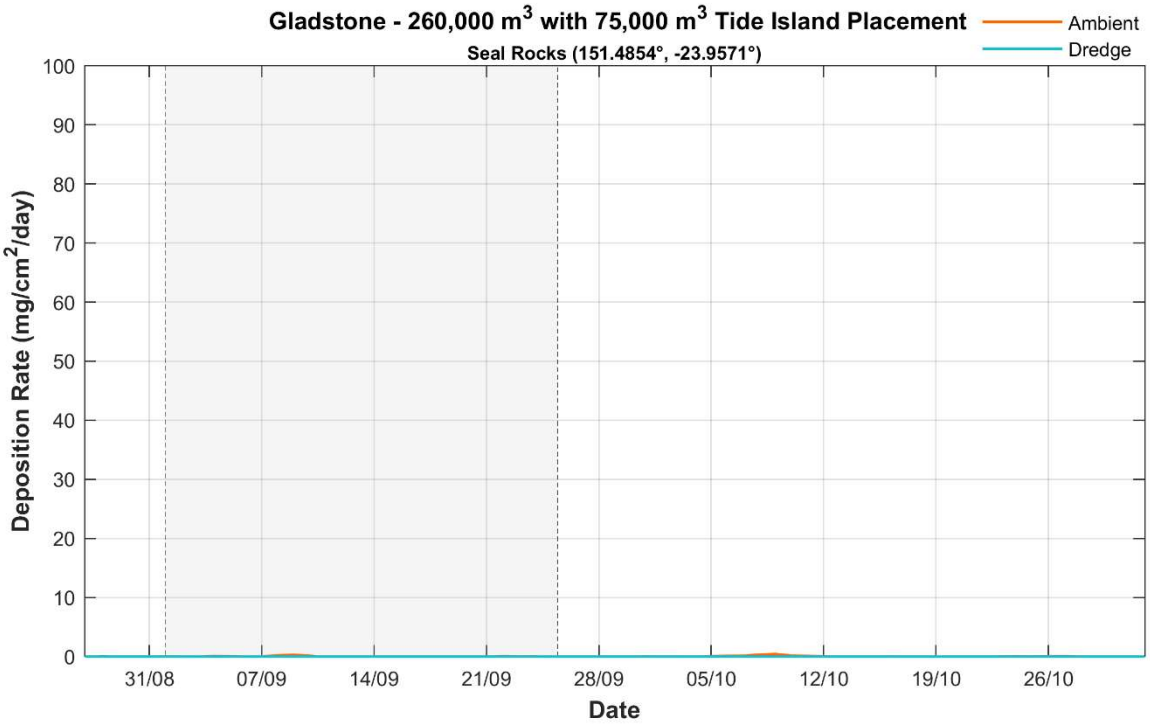
Time Series of Modelled Deposition Rate



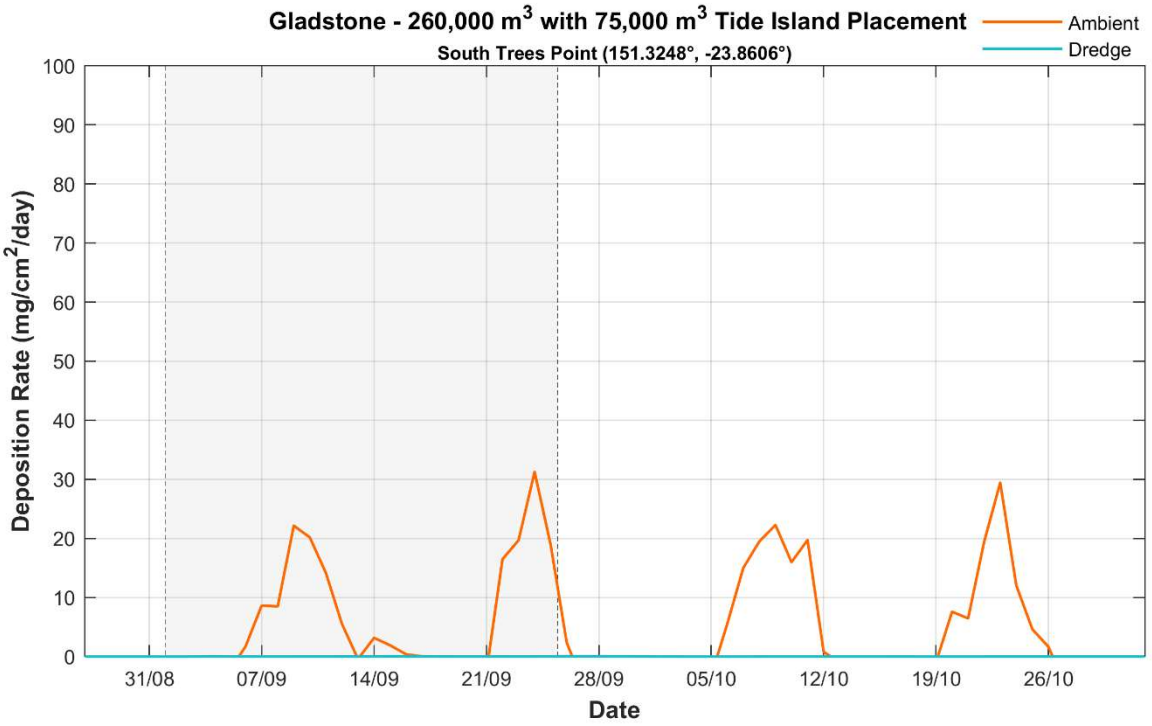


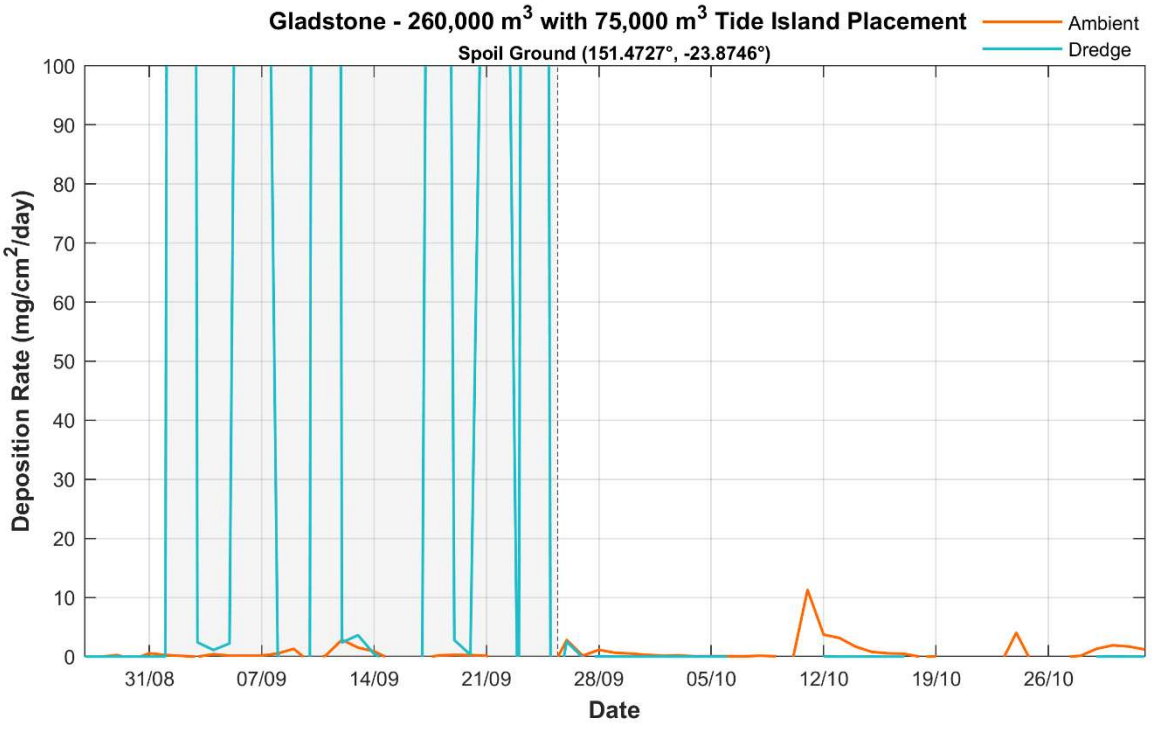
Time Series of Modelled Deposition Rate



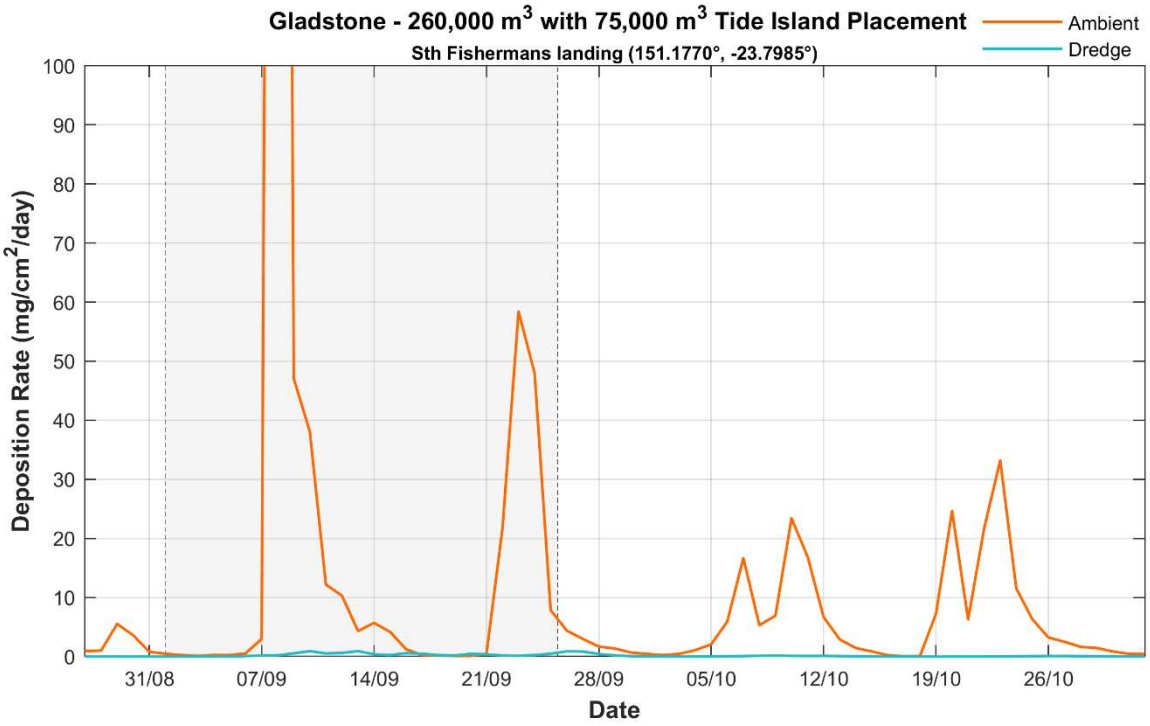


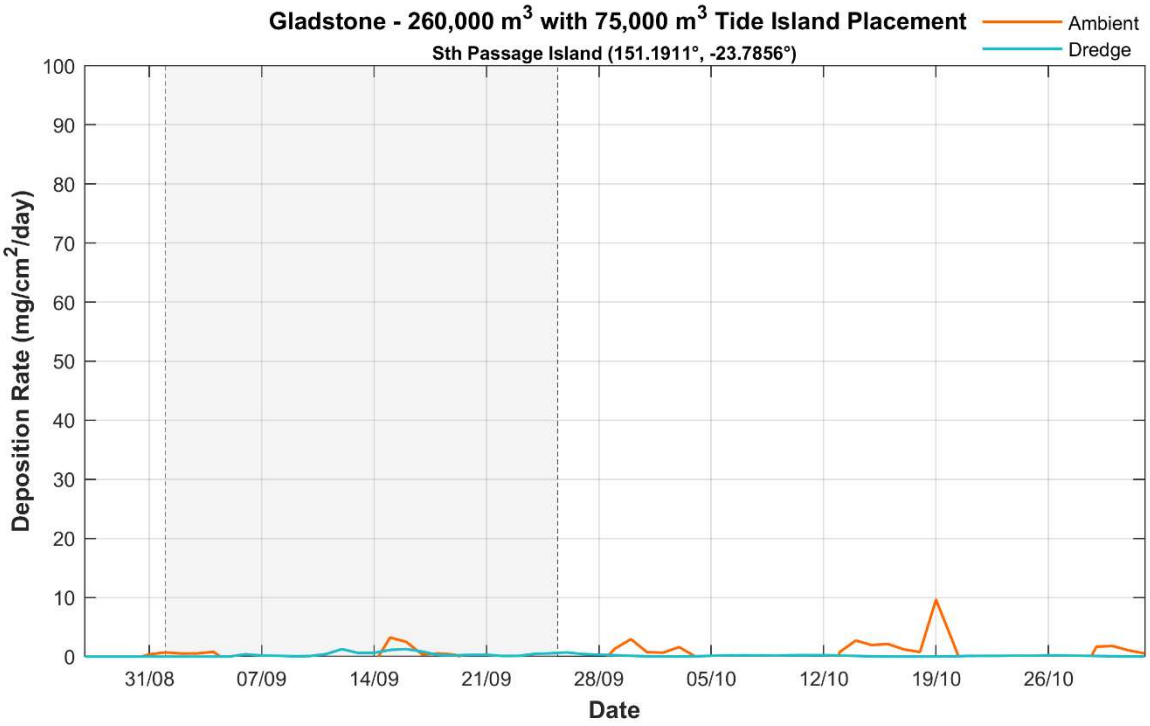
Time Series of Modelled Deposition Rate





Time Series of Modelled Deposition Rate





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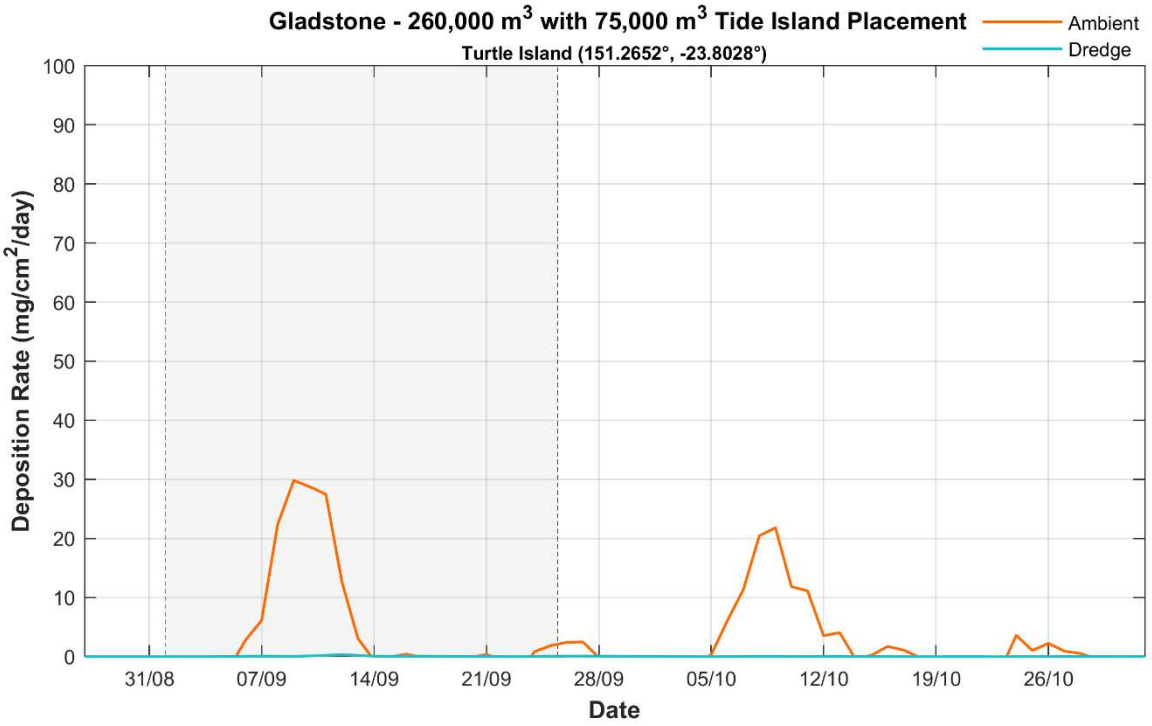

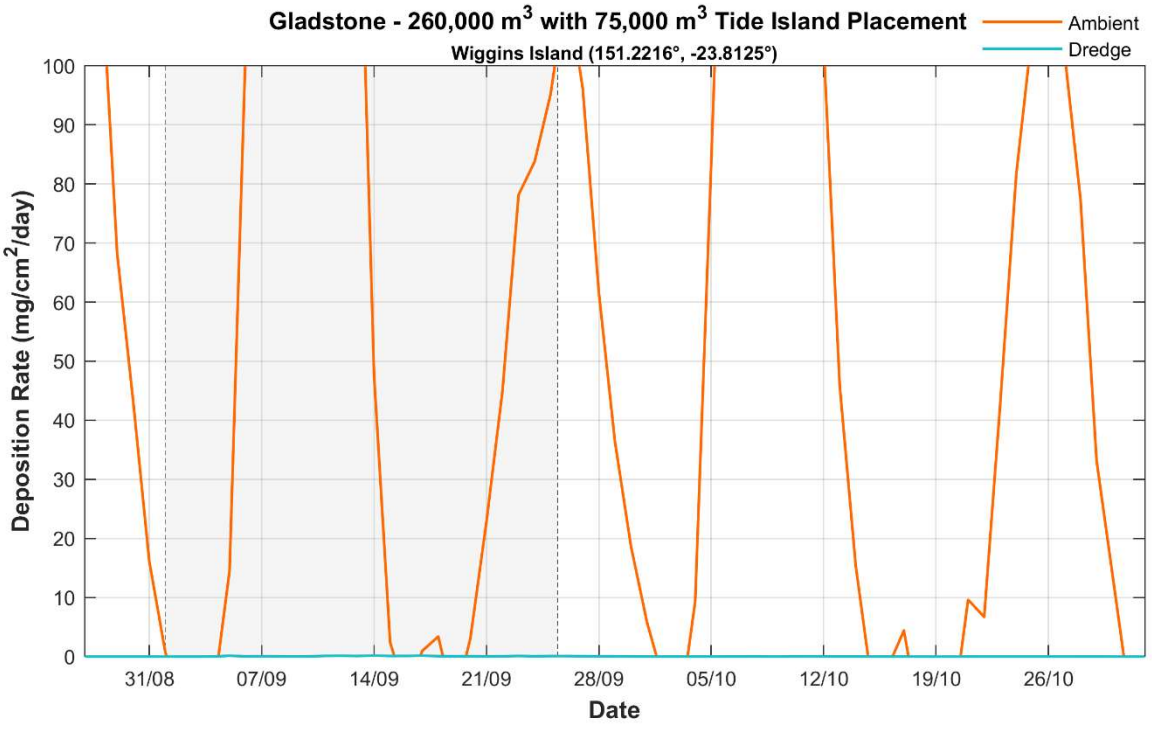

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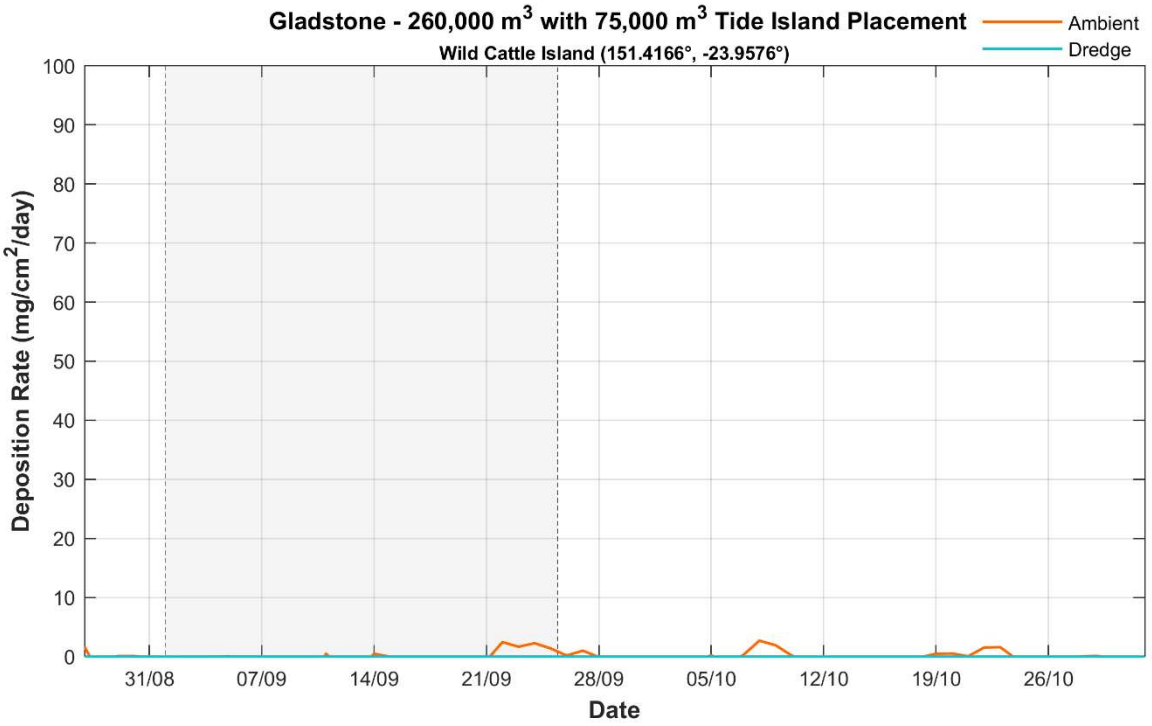

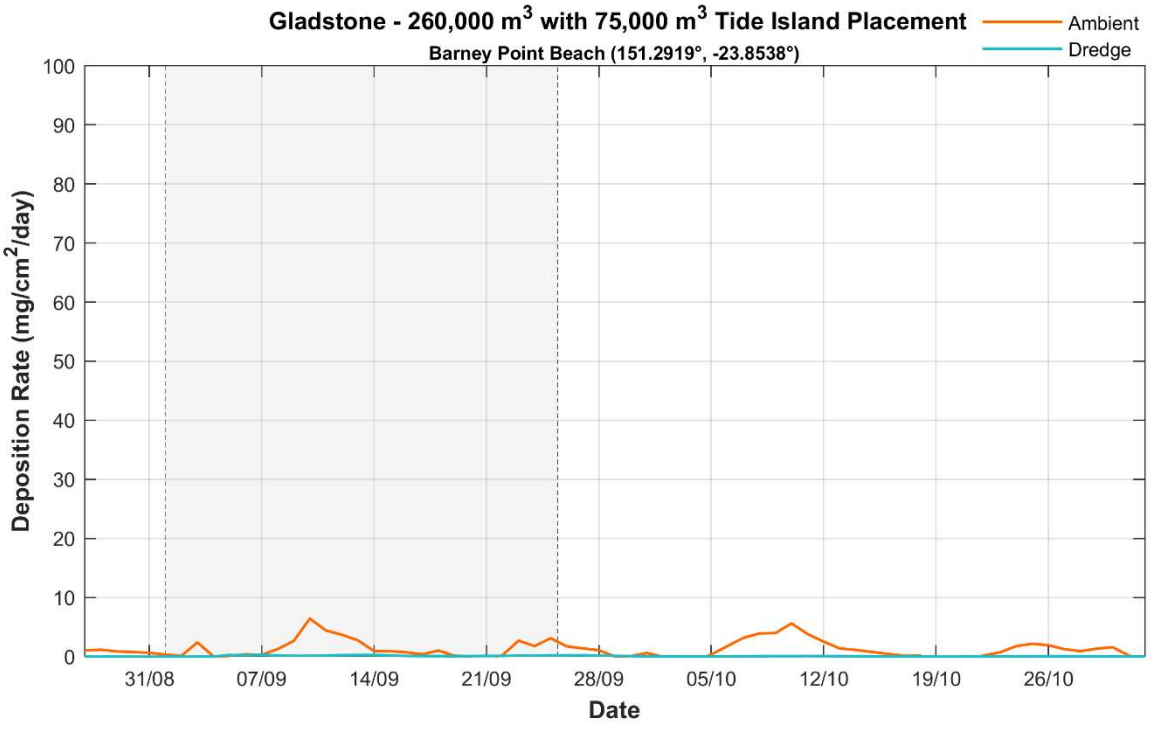

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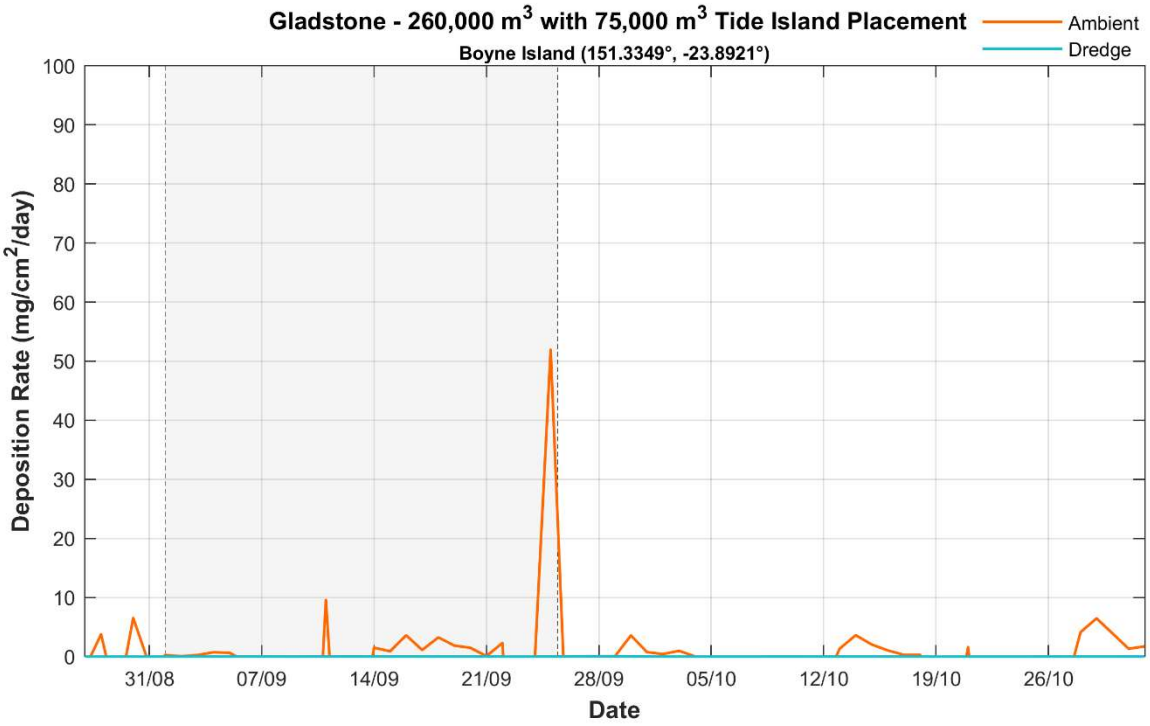

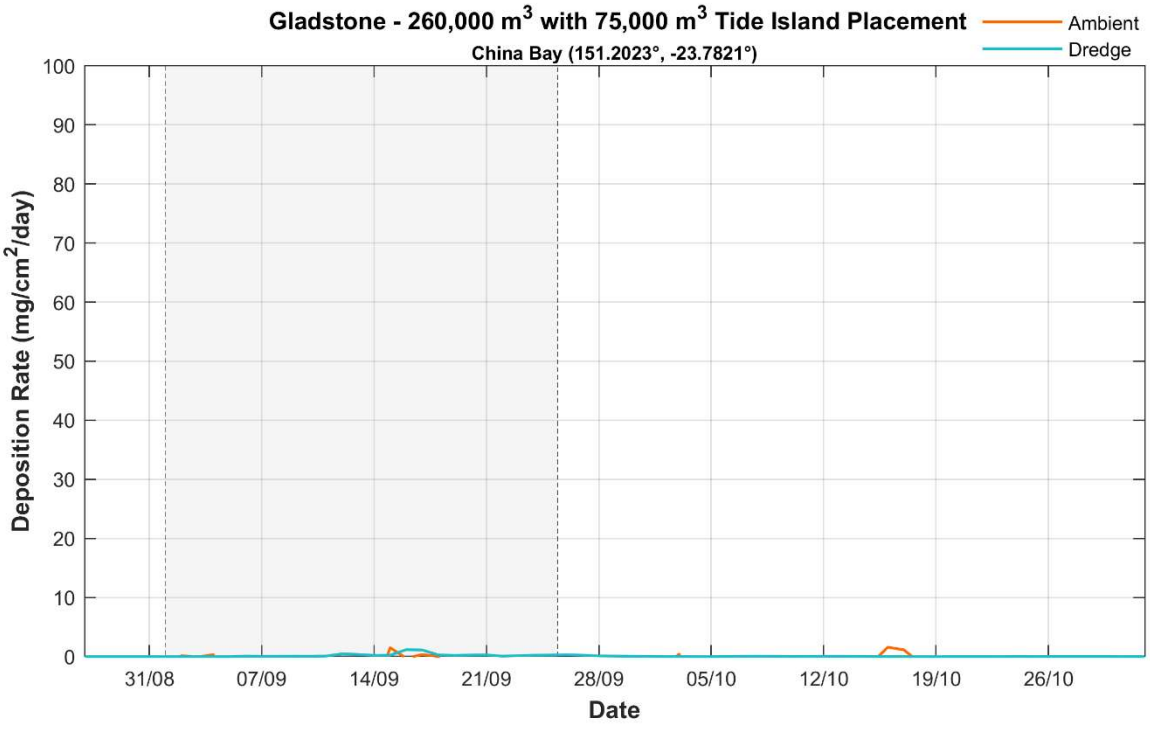

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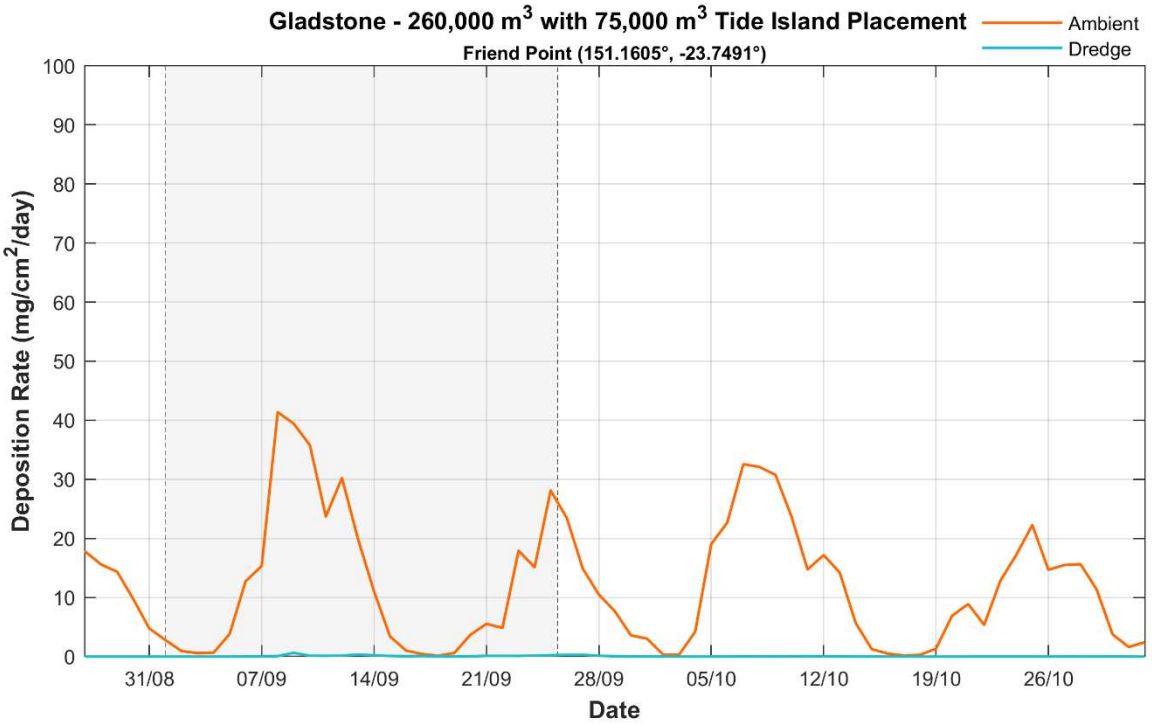
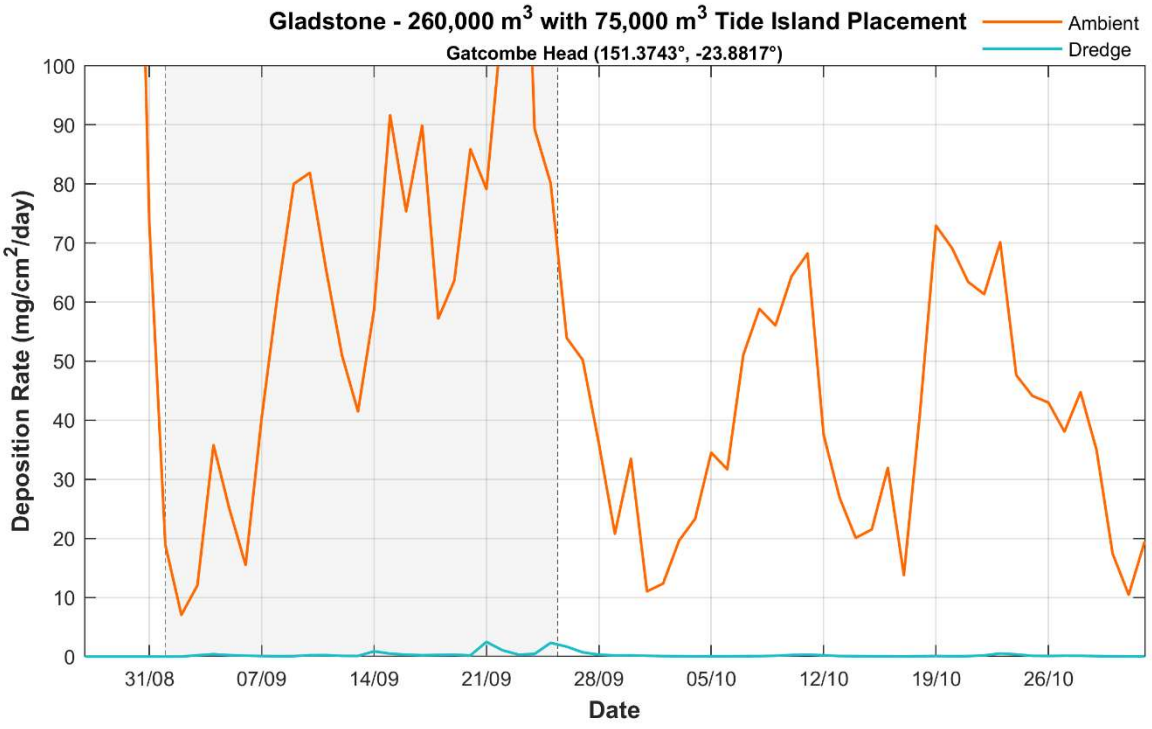
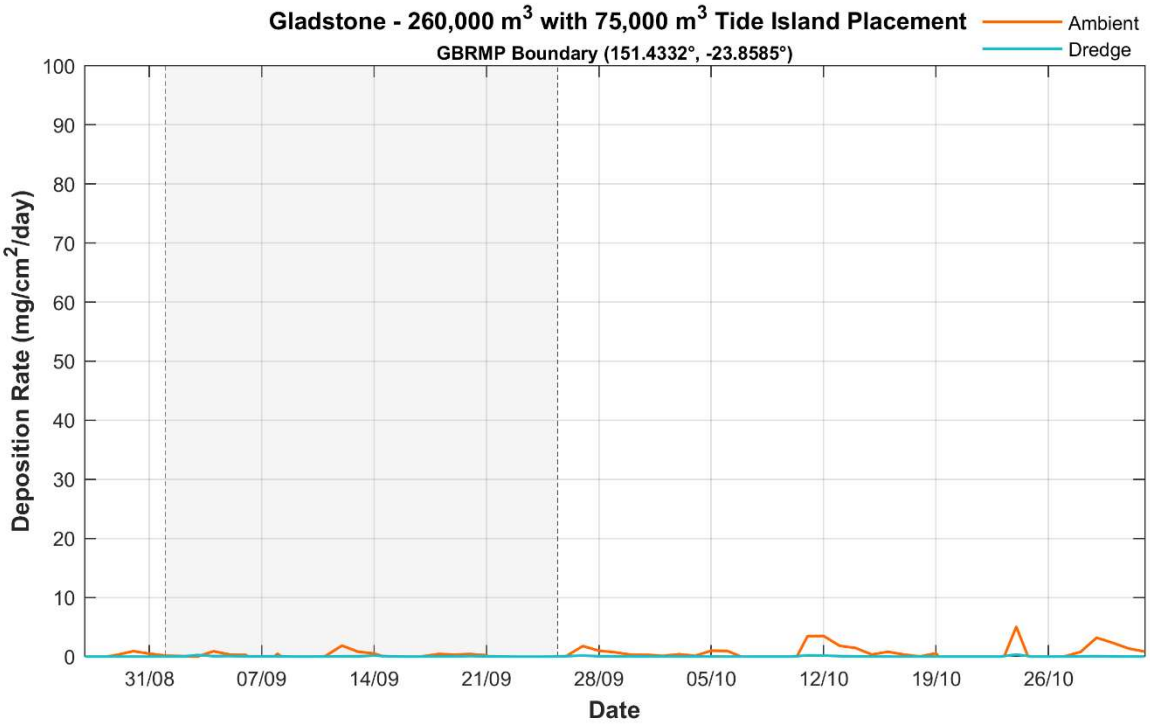




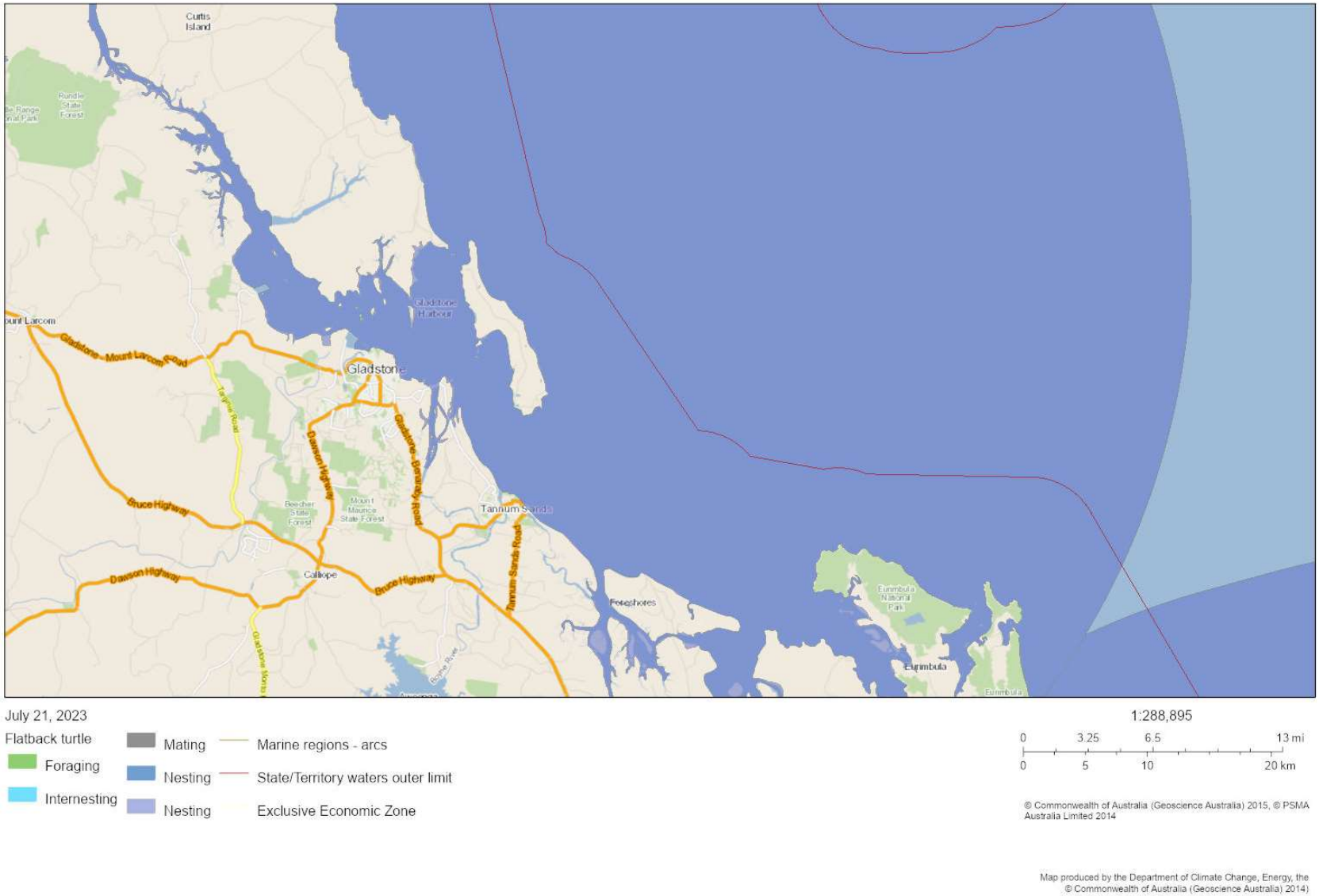
Time Series of Modelled Deposition Rate



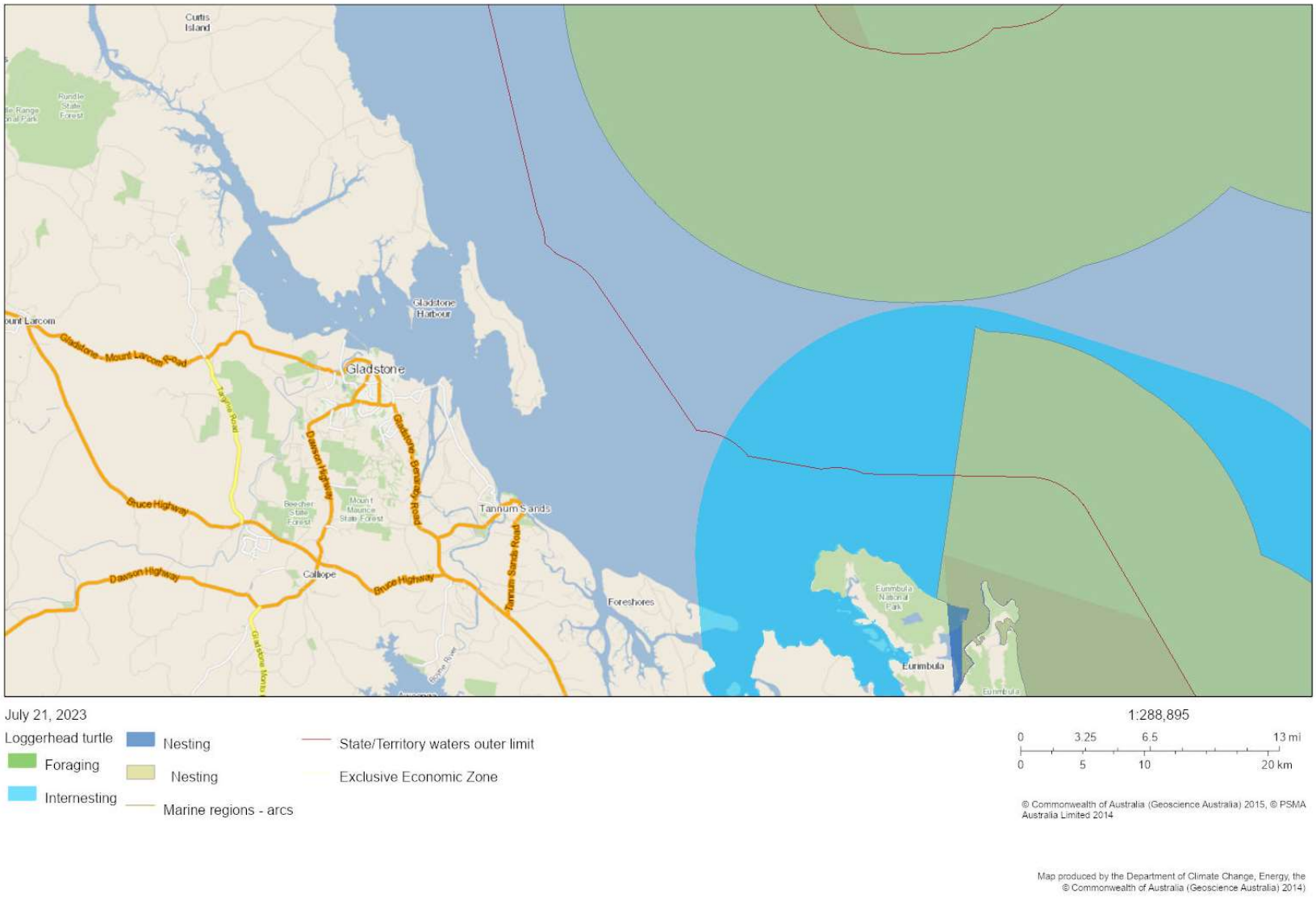
Appendix E Critical Habitat and BIA for Flatback and Loggerhead Turtle (Source: NCVA 2023)

Critical Habitat and BIA for Flatback and Loggerhead Turtle (Source: NCVA 2023)

Flatback turtle CH and BIA



Critical Habitat and BIA for Flatback and Loggerhead Turtle (Source: NCVA 2023)



BMT has a proven record in addressing today's engineering and environmental issues.

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