Port of Bundaberg Maintenance Dredging Impact Assessment

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Synopsis: **Impact assessment for maintenance dredging works at Port of Bundaberg.**

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Executive Summary

Background

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Bundaberg. The dredged material is disposed of at sea at the designated Dredge Material Placement Area (DMPA) in accordance with Commonwealth Sea Dumping Permits.

GPC is required to undertake environmental assessments to identify potential changes to water quality and the marine environment associated with the annual maintenance dredging activities. This report describes the approach and findings of the environmental assessment of potential maintenance dredging impacts to marine waters. The specific objectives of the report are to:

- Identify relevant matters of national and state environmental significance, and the location of sensitive ecological receptors, within the maintenance dredging footprint and adjacent areas
- Assess potential changes to water quality and the marine environment associated with the proposed dredging
- Assess potential impacts to matters of national and state environmental significance resulting from dredging and disposal activities.

The environmental assessment was based on desktop assessments involving:

- a review and analysis of existing information
- 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 Port of Bundaberg and surrounds supports a mosaic of wetland types vary between marine and estuarine compartments:

- Coastal and offshore waters at and adjacent to the DMPA and sea channel – deep water seagrass meadows; fringing coastal reefs (located to the south of Burnett Heads); sandy beaches; subtidal soft sediment habitat
- The Lower Burnett River estuary - intertidal wetlands (mangroves, saltmarsh and shoals), artificial rock walls, soft sediment habitat (subtidal channel and shoals).

Ecological receptors that are most sensitive to dredging-related changes to water quality (and sedimentation), are seagrass meadows and reef habitats and their communities. These wetland types support diverse flora and fauna communities and habitat for threatened and listed migratory marine species (e.g. turtle nesting habitat, feeding habitat for turtles, dolphins and dugongs), and species of fisheries significance.

The estuary and nearshore environments are affected by multiple water quality stressors. 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. Several metals/metalloids and organic pollutants (organotins) have been detected in dredged sediments, but all had average concentrations well below National Assessment Guidelines for Dredging screening levels and were considered suitable for ocean disposal.

Executive Summary

Potential Impacts

Maintenance dredging and disposal is expected to result in direct and indirect effects.

Maintenance dredging will result in direct disturbance of benthic communities in the dredge area, and dredged material disposal will result in disturbance to benthic macroinvertebrate and seagrass communities at the DMPA. Historical studies indicate that benthic communities in the dredge channel were similar to those outside the channel. Furthermore, historical and recent monitoring indicates that the DMPA supported similar benthic fauna and seagrass communities to areas outside the DMPA. It is therefore anticipated that any direct impacts to benthic fauna and seagrass communities will be highly localised and low intensity.

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 disposal areas (i.e. highly localised effects), however modelled dredging-related deposition rates are predicted 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, reefs, turtle nesting beaches) are expected given the short duration and low intensity of dredge-related turbidity, and the limited spatial extent of significant sediment deposition (restricted to areas within the DMPA).

Other potential impacting processes include:

- Other water quality impacts – dredged sediments do not contain high pollutant loads, and the dredge area and DMPA are well flushed. Any water quality changes associated with the mobilisation and releases of nutrients (and other substances) are likely to be short term and low intensity, and unlikely to result in major impacts to biodiversity values. Monitoring would be required to validate the impact prediction.
- Introduced marine pests - The *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.
- 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 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 management framework.

It is anticipated that future maintenance dredging is expected to have similar range of impacts as previous campaigns given similar dredge volumes and the predicted low intensity/short term nature of impacts. Significant impacts to protected matters (MNES, MSES) are therefore not expected as a result of maintenance dredging and disposal activities.

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1 Introduction

1.1 Background

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Bundaberg (PoB). The dredged material is disposed of at sea at the designated Dredge Material Placement Area (DMPA) in accordance with Sea Dumping Permits issued by the Commonwealth Department of the Agriculture, Water and the Environment (DAWE).

GPC is required to undertake environmental assessments to identify potential changes to water quality and the marine environment associated with the annual maintenance dredging activities. This report describes the approach and findings of the environmental assessment of potential maintenance dredging impacts to marine waters. The environmental assessment was based on desktop assessments involving the review and analysis of existing information, as well as hydrodynamic and sediment transport modelling of the generation, advection and dispersion of dredging-related plumes.

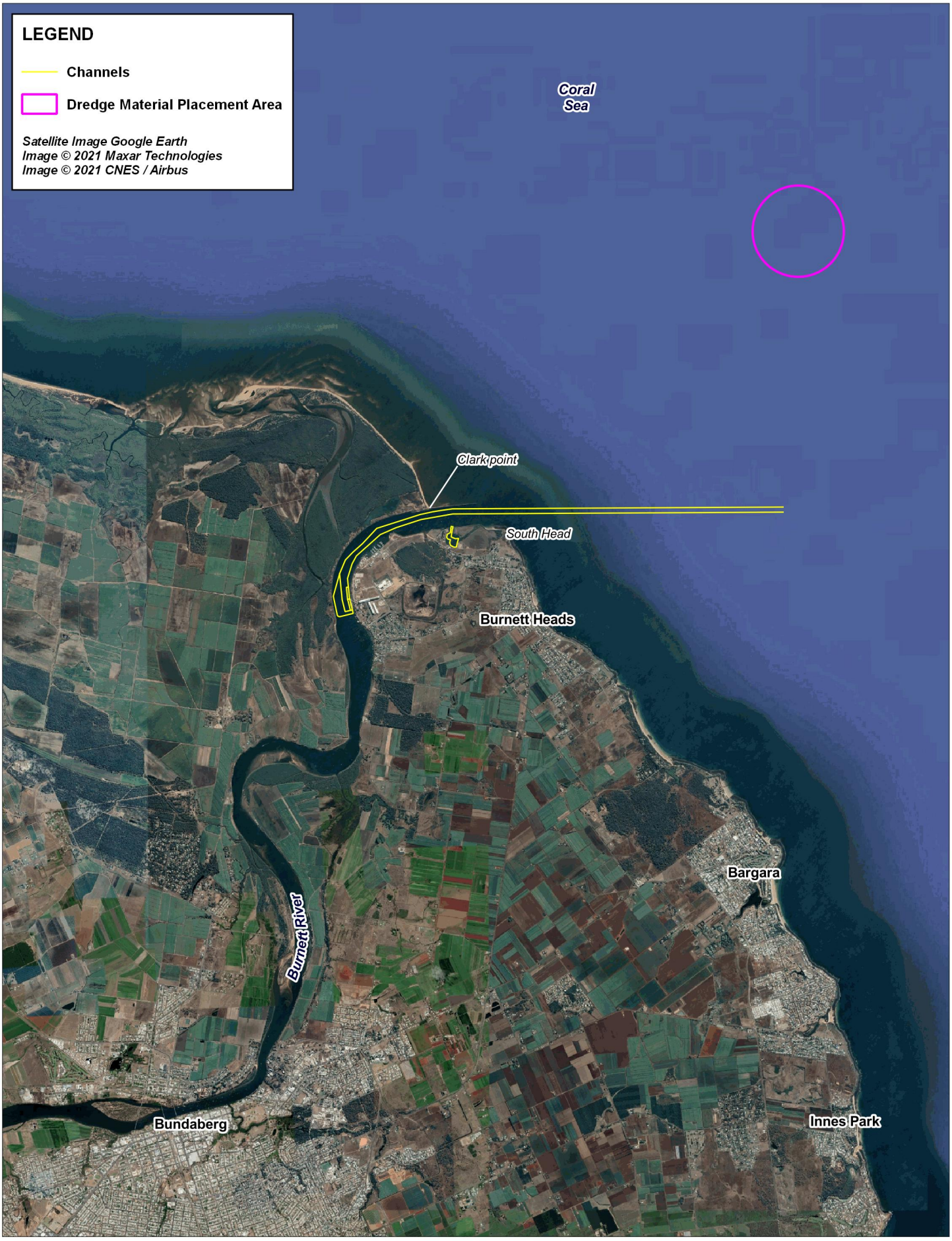
1.2 Study Objectives

The specific objectives of the report is to:

- Identify relevant matters of national and state environmental significance, and the location of sensitive ecological receptors, within the maintenance dredging footprint and adjacent areas shown in refer Figure 1-1;
- Assess potential changes to water quality and the marine environment associated with the proposed dredging; and
- Assess potential impacts to matters of national and state environmental significance 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 tidal portion of the Burnett River and all offshore areas that may be affected by dispersal of dredged sediment. The study area includes all Port areas subject to maintenance dredging, the designated DMPA and their immediate surrounds (refer Figure 1-1).



Title:

Locality Plan

Figure: 1-1

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

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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 matters of national and state environmental significance (MNES and MSES, respectively). MNES and MSES that were known or likely to occur within the study area were defined based on searches using the Environment Protection and Biodiversity Conservation (EPBC) Protected Matters search tool (PMST), and the State Planning Policy (SPP) Interactive Mapping System. The searches identified: (i) legally defined areas listed under Commonwealth and State Government instruments (i.e. mapped conservation areas and other discrete environmental features); and (ii) in the case of PMST, species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that are known or likely to occur within the study area.

Both the PMST and SPP Interactive Mapping System typically have limited locational precision regarding defining habitats for listed species. Other information sources were therefore reviewed to determine the known or likely occurrence of species in the study area, including academic publications, consultancy reports, and wildlife on-line flora and fauna records. The determination of known or likely occurrences was based on: (i) confirmed records of the species; (ii) an assessment of habitat suitability, based primarily on the online Species Profile and Threats Database (DAWE, 2021).

2.2 Impact Assessment

2.2.1 Numerical Model

The numerical modelling software TUFLOW FV was used to simulate the three-dimensional hydrodynamics of the Port 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 the Port 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.

2.2.2 Model Domain and Mesh

The TUFLOW FV model mesh is composed of a regional component (Figure 2-1) and a nested component (Figure 2-2). The boundary of the nested model is provided with water levels, temperature, salinity and suspended sediment outputs from the regional model.

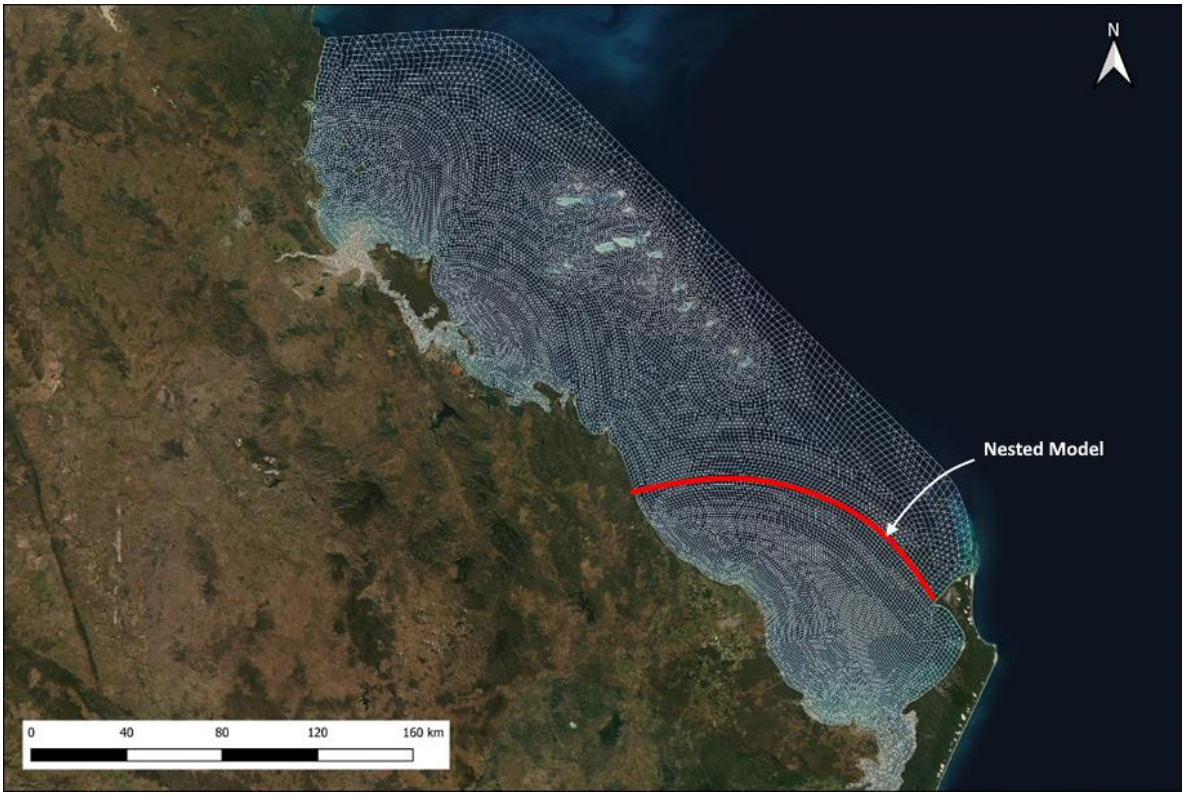

Figure 2-1 TUFLOW FV Model Mesh – Regional Model Domain

Figure 2-2 TUFLOW FV Model Mesh – Local Model Mesh

2.2.3 Bathymetric Data

Bathymetric data in the vicinity of the PoB was sourced from survey data and other publicly available datasets. Bathymetric data for the majority of the model domain was sourced from Project 3DGBR: a high-resolution depth model for the Great Barrier Reef and Coral Sea (Beaman, 2018, 30m horizontal resolution). A number of hydrographic survey data sets collected by Maritime Safety Queensland (MSQ) and BMT for the channel areas were compiled, and a unified Digital Elevation Model (DEM) was developed which incorporated the best available data in each part of the model. The model bathymetry is therefore an accurate representation of the actual bathymetry of the PoB during the model hindcast periods. The adopted model bathymetry is illustrated in Figure 2-3 and Figure 2-4.

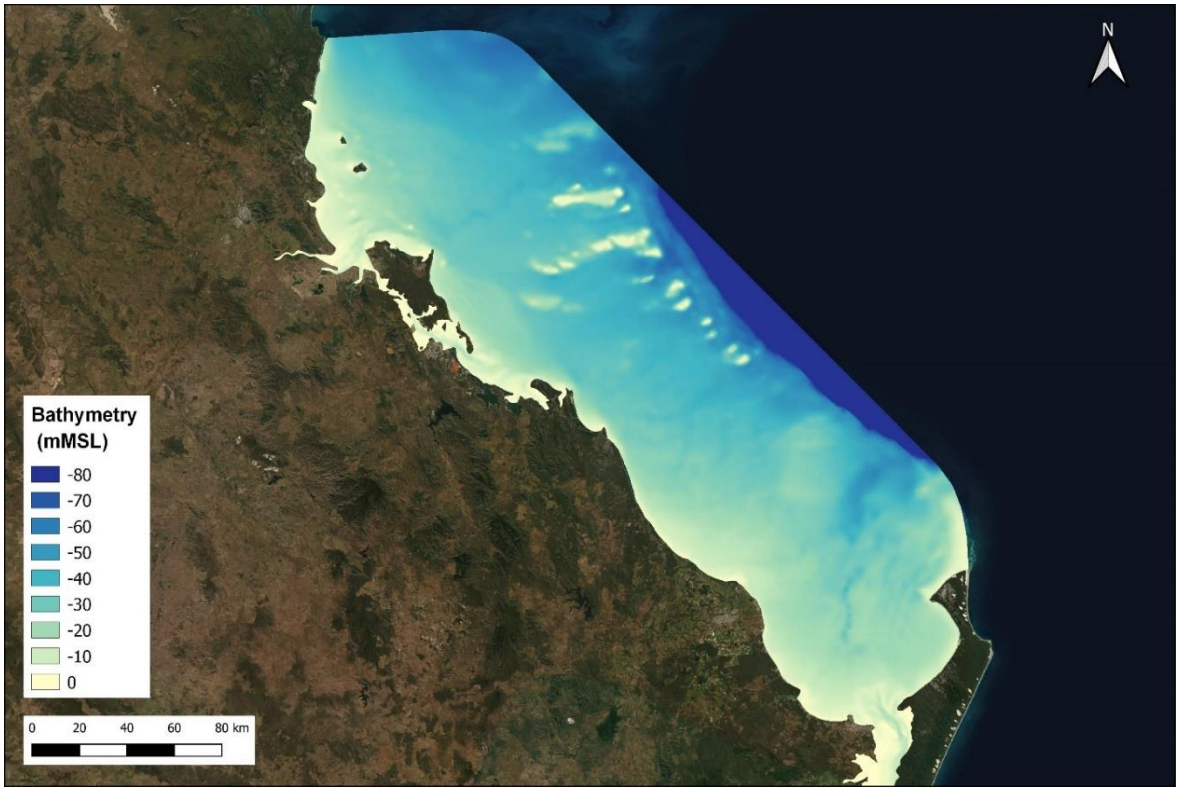

Figure 2-3 Model Bathymetry – Regional Model Domain

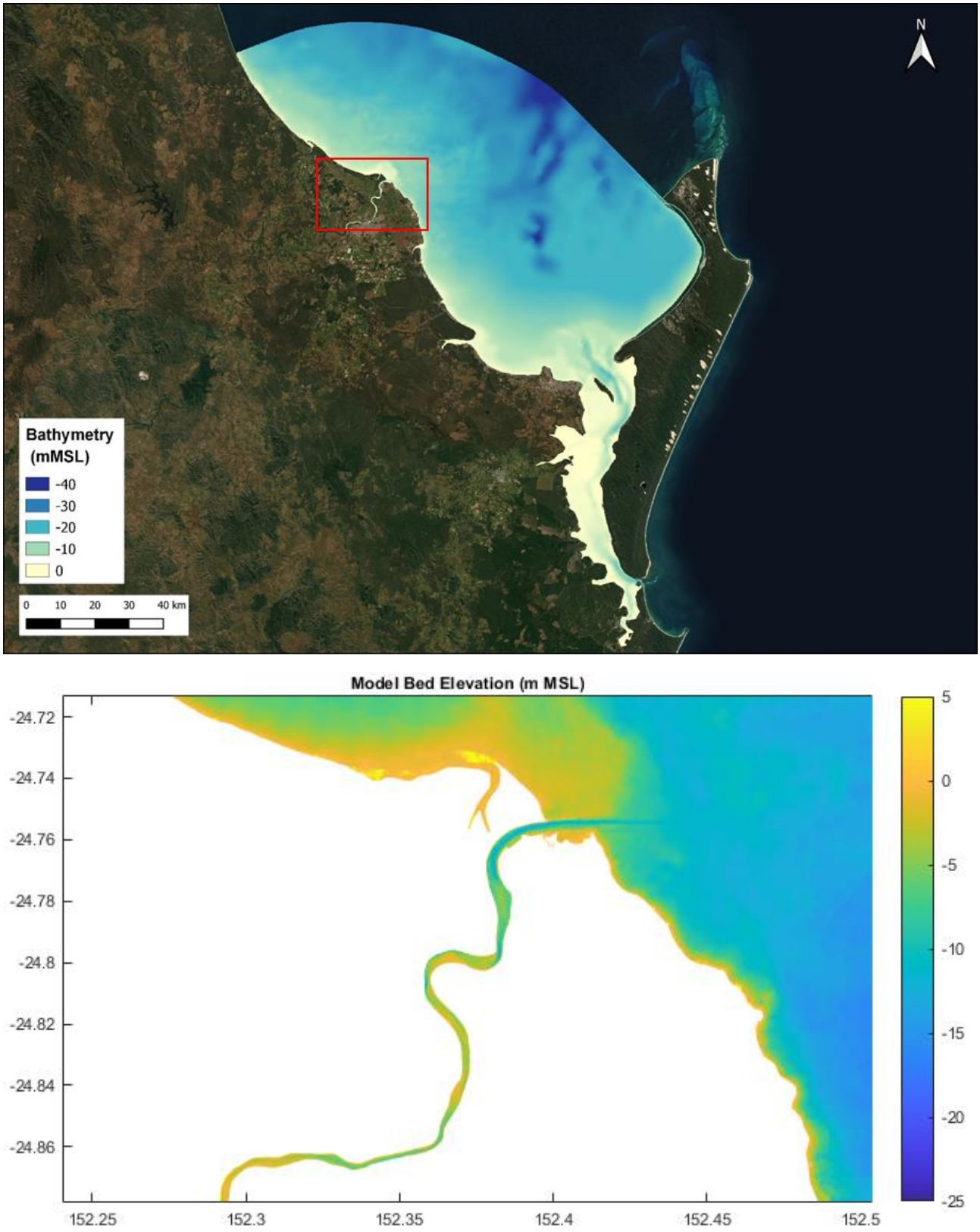

Figure 2-4 Model Bathymetry – Local Model Domain (Bottom Panel Domain is Red Box in Top Panel)

2.2.4 Boundary Conditions

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

A SWAN spectral wave model was developed in order 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 Prediction (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.

2.2.5 Model Validation

The TUFLOW FV numerical model used for the purposes of this study was calibrated and validated as part of the recent Sustainable Sediment Management Project, and the results are presented in the report “Port of Bundaberg Sediment Budget: Model Development and Validation” (BMT, 2021).

2.2.6 Impact Assessment Methodology

The effects of maintenance dredging were assessed based on the modelled increase in turbidity and deposition rate due to dredging (above natural or ambient levels). 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 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 influence of dredging on the modelled turbidity and deposition rate were then compared to biologically-relevant thresholds to determine potential impacts on relevant sensitive receptors.

Further methodological details and results are provided in Section 5.

3 Dredging Project Description

3.1 Maintenance Dredging Volumes and Locations

The description of historical maintenance dredging in the Sampling and Analysis Plan (Worley Parsons, 2010) indicates that there is significant variability in the year-to-year maintenance dredging requirements at the Port. For the purposes of this assessment, a 90,000 m^3 dredging campaign was simulated, which is the largest campaign currently permitted (except in emergency circumstances) and is larger than the typical annual volume removed by maintenance dredging.

3.1.1 Dredging Inputs

The dredging inputs for the model were based on a historical dredge log (2015) representing a volume of 64,000 m^3 of sediment removed from the shipping channels and placed at the DMPA. The campaign was extended (proportionally in each part of the dredging footprint) so that the simulation represented removal of a full 90,000 m^3 of sediment from the Port channels, and was simulated to take place over 9.5 days from 28th May to 6th June. The simulation was run for a total of two months to allow for the effects of sediment resuspension following completion of the dredging campaign.

The campaign involves the *Trailing Suction Hopper Dredge (TSHD) Brisbane* and included the following assumptions based on expert advice and the results of previous dredge monitoring:

- Dry mass in each load defined by the dredge log;
- Dredge cycle time defined by the dredge log;
- Total dredging campaign duration of 10 days (estimate);
- Dredging locations based on the dredging log:
    - 28% of dredging in the berths and swing basin;
    - 44% in the Sea Reach of the channel; and
    - 28% in the Inner and Middle Reaches.
- Placement - 10 minutes per load at defined locations within the boundaries of the DMPA;
- Plume generation rates estimated based on available data and previous modelling work undertaken for the *TSHD Brisbane*. The basic assumptions are:
    - Assumed composition of material: 68% sand, 21% silt, 11% clay based on available Sampling and Analysis Plan data (FPE, 2020)
    - Proportion of fines being dredged forming a passive plume at the draghead: 2%
    - Proportion of fines being dredged lost during overflow dredging operations: 80%
        - 15% of which forms a passive plume of fine sediment in the model
    - Proportion of sand being dredged lost during overflow dredging operations: 25%
        - 15% of which forms a passive plume of fine sediment in the model
    - Proportion of fines that form a passive plume during placement: 10%
    - Proportion of sand that form a passive plume during placement: 2%

4 Existing Conditions

4.1 Sedimentary and Hydrodynamic Environment

The PoB is situated near the mouth of the Burnett River, and the water levels and currents are dominated by tidal influences except during significant flood events. The mean spring tide range is 2.3 metres, so the tidal currents during spring tide periods are relatively strong (up to 0.6 m/s near the Port berths). During flood events the flow velocity can be significantly higher (estimated at up to 3 m/s during the January 2013 flood event).

Due to these strong currents, the seabed sediments are dominated by coarse sediment fractions (sands and gravel) in the river and entrance channel (FPE, 2020). There are some pockets with a higher proportion of silts and clays in some parts of the entrance channel on the inside of the channel bend (sites 10 and 11 in FPE, 2020). Overall, the percentage of silt/clay in sampled sediments was around 30% and sand/gravel approximately 70% within the approach channel and Port.

Offshore, the exposed coastline and moderately energetic wave climate leads to a sedimentary environment dominated by coarser fractions (sands/gravel). The benthic survey of the DMPA (AMA, 2015) indicated that the particle size distribution at sites inside the DMPA and also in areas nearby have a very low fines content. All benthic samples were composed of less than 8% fines (<75 micron diameter), and most sites were composed of less than 4% fines. This is consistent with qualitative sediment descriptions of Smith *et al.* (2020). The significant wave height offshore ranges between zero (0) and two (2) metres for most of the year, with occasional storm events generating larger waves (for example, around four (4) metres significant wave height during the passage of ex-Tropical Cyclone Oswald in January 2013). The hydrodynamics and the ambient sediment dynamics were analysed in more detail as part of the SSM Project (BMT, 2021).

4.2 Water and Sediment Quality

4.2.1 Water Quality

The study area extends across two planning areas for the purposes of *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water and Wetland Biodiversity):

- Burnett Basin and adjacent coastal waters – this incorporates maintenance dredged areas in the Burnett River estuary and coastal waters within and adjacent to the existing offshore DMPA
- Burrum, Gregory, Isis, Cherwell and Elliott Rivers – which incorporates coastal waters adjacent to the existing offshore DMPA.

No Environmental Values (EVs) or Water Quality Objectives (WQOs) have been scheduled under EPP (Water and Wetland Biodiversity) for the Burnett Basin and adjacent coastal waters. The Burnett - Mary Water Quality Improvement Plan (WQIP) (BMRG, 2015) provides draft EVs[1] and WQOs for the Burnett River estuary and adjacent coastal waters. BMRG (2015) classifies both waters as Slightly Moderately Disturbed (SMD) ecosystems. Draft EVs are presented in Table 4-1.

[1] referred to as community values in ANZG (2018)

Table 4-1 Environmental values for Burnett River estuary and adjacent coastal waters (Source: EPP Water and Wetland Biodiversity) and offshore coastal waters south of Burnett Heads (WQIP)

EVs	Open coastal waters south of Burnett Heads (EPP (Water and Wetland Biodiversity))	Open coastal waters north of Burnett Heads including offshore DMPA (WQIP)	Burnett River estuary including dredged area (WQIP)
Type	HEV, SMD	SMD	SMD
Aquatic Ecosystems	✓	✓	✓
Seagrass	✓		
Aquaculture	✓	✓	
Human Consumer	✓	✓	✓
Primary Recreation	✓	✓	✓
Secondary Recreation	✓	✓	✓
Visual Recreation	✓	✓	✓
Industrial Use			✓
Cultural & Spiritual Values	✓	✓	✓

EVs and WQOs have been scheduled under EPP (Water and Wetland Biodiversity) for offshore coastal waters south of Burnett Heads, adjacent to the offshore DMPA. Coastal waters adjacent to the DMPA are classified as High Ecological Value waters (HEV), whereas offshore waters more than five (5) kilometres from the coast are classified as SMD ecosystems. Defined EVs are presented in Table 4-1.

Table 4-2 presents water quality monitoring data (annual medians) for a station located in the Burnett River estuary (CSIRO Station CR6, located at the PoB sugar wharf). The draft WQO was met for turbidity in all years, and pH and dissolved oxygen in 2018 and 2019 but not 2017. Chlorophyll *a* was slightly greater than the draft WQO in all years.

Table 4-2 Annual summary statistics* for in situ parameters measured in the Burnett River estuary (CSIRO Station CR6 - PoB sugar wharf) and respective draft WQOs (lower estuary)

Parameter	WQO	2017	2018	2019	Overall
Chlorophyll a (µg/L)	<2	Median = 2.3 Average = 2.8 Standard deviation = 1.6	Median = 2.4 Average = 3.1 Standard deviation = 2.8	Median = 2.8 Average = 3.4 Standard deviation = 3.0	Median = 2.5 Average = 3.2 Standard deviation = 2.9
Turbidity (NTU)	<6	Median = 3.5 Average = 3.8 Standard deviation = 2.4	Median = 3.6 Average = 11.3 Standard deviation = 192.5	Median = 2.9 Average = 5.0 Standard deviation = 42.9	Median = 3.6 Average = 8.2 Standard deviation = 141.0
pH	8.0-8.4	Median = 7.9	Median = 8.1	Median = 8.1	Median = 8.1
Dissolved oxygen (% saturation)	90-105	Median = 87.5 Average = 87.4 Standard deviation = 5.6	Median = 96.7 Average = 95.5 Standard deviation =6.3	Median = 93.6 Average = 93.0 Standard deviation = 6.3	Median = 94.6 Average = 93.8 Standard deviation = 6.5

* basic data filtering applied to data (removal of zero values), no other QA/QC checks

These results suggest that estuarine water quality in the 2017-19 period was slightly degraded (i.e. did not meet WQOs) relative to reference. Water quality in the riverine and coastal systems of the region show great temporal variability in response to variations in tidal influence, rainfall – drought cycles and seasonality in biological processes. Rainfall is a key water quality driver. Average annual rainfall in the 2017-2019 period was well below average (Figure 4-1), resulting in low loads of sediment, nutrients and other pollutants from catchment sources. The 2017-19 results presented above therefore represent a period of relatively good water quality compared to wetter years. Extreme climatic events, such as the 2013 floods, deliver high loads of pollutants and low salinity waters to the estuary and adjacent coastal waters, resulting in water quality degradation and aquatic ecosystem stress. Key catchment pollutants in the Great Barrier Reef (GBR) region (GBRMPA, 2021) and the study area (BMRG, 2015) are sediments (from catchment runoff and bank erosion), nutrients (especially dissolved inorganic nitrogen) and pesticides (especially photosystem II inhibiting herbicides). In terms of organic contaminants, sediment characterisation studies undertaken at the Port of Bundaberg found that polychlorinated biphenyls, organotins, organochlorine and organophosphate pesticides, total petroleum hydrocarbons and polynuclear aromatic hydrocarbons were below laboratory detection limits and therefore pose a low contamination risk (Worley Parsons 2010).

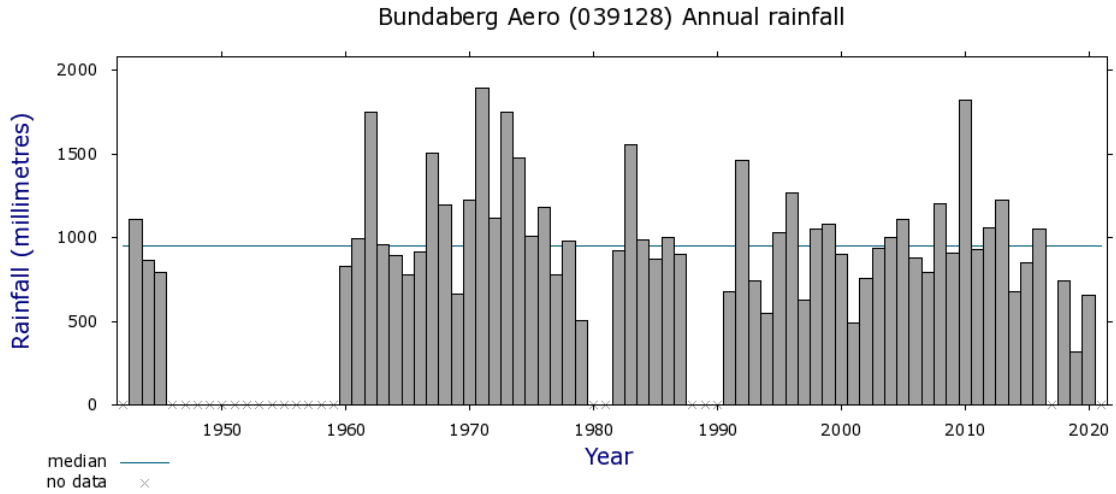

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Figure 4-1 Annual median rainfall at Bundaberg Aero Station

4.2.2 Sediment Quality

The catchments that drain into the port are mostly agricultural lands (grazing, sugar cane) with urban areas at the township of Bundaberg and villages on the coastal fringe and catchment. Dredged sediments are a mix of fine sediment (<75 µm), sand (75 µm - 2 mm) and gravel (2-60 mm), varying greatly among locations and through the sediment profile (GPC unpublished). Particle Size Distribution (PSD) testing of maintenance dredge material (FPE, 2020) indicated that:

- sediments within the Port area (lower estuary to the river mouth) consisted of fine material (i.e. silt and clays) generally overlaying coarser material (i.e. sands) at depth.
- sediments in the River (i.e. areas upstream of the Port area) and Entrance Channel (i.e. coastal waters offshore of Burnett Heads) sediments were generally characterised by a higher portion of coarse material (i.e. sands and gravels) greater than 75 µm in diameter.

Several metals/metalloids and organic pollutants (organotins) have been detected in dredged sediments, but all had average concentrations well below National Assessment Guidelines for Dredging **(**NAGD) screening levels (FPE, 2020). The Port and Entrance Channel sediments are Potential Acid Sulfate Soils (PASS) but do not contain Actual Acid Sulfate Soils (AASS). These sediments were found to have Acid Neutralising Capacity (ANC) in the form of shells, coral fragments etc.

FPE (2020) did not analyse sediment nutrient concentrations.

4.3 Marine Habitats and Communities

The Burnett River estuary and adjacent coastal waters support a range of intertidal and subtidal habitats that are important in maintaining a range of ecological values. Extensive intertidal wetlands (mangroves, saltmarsh, saltpan and mud flats) and subtidal soft sediment substrates occur in the estuary, and coastal waters contain a mosaic of seagrass meadows, nearshore reefs and soft sediment (sand) habitats (Figure 4-2; Figure 4-3).

These habitats support a correspondingly large diversity of tropical, sub-tropical and temperate organisms. The region supports habitats that are important to species of conservation concern, such as sea turtles (particularly at Mon Repos), whales and dugongs. These habitats also support a diverse and abundant invertebrate fauna, including prawns, crabs, molluscs and marine worms. Many species of fish are known from the Bundaberg region, many of which are of commercial and recreational fisheries significance.

The following summarises the marine ecological characteristics of the Port area.

4.3.1 Marine Habitats

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

4.3.1.1 Seagrass Meadows

Smith and Rasheed (2020) provide the most up to date broad scale assessment of seagrass meadows in the Port and surrounds. Three (3) seagrass species were recorded: *Halophila decipiens, H. ovalis* and *H. spinulosa*. These species formed large deep-water meadows in offshore waters but were not recorded in shallower coastal and estuarine areas of the port (Figure 4-3). The Burnett River estuary does not support high quality seagrass habitat (i.e. large tidal range, lack of large shoals, periodically affected by floods etc.).

Smith *et al*. (2020) estimated that deep-water seagrass meadows covered 5,788 ± 975 ha or 35% of the port limits area, and that it was likely that the meadows extended much further outside the port limits. Seagrass was recorded in water depths of 12 to 22 m and had a sparse cover. Smith and Rasheed (2020) found that biomass was similar or greater than other deep water meadows at other ports in the GBR region, which they suggested indicated that meadows were in good condition. The generally dry conditions in recent years (Figure 4-1) are expected to have provided favourable growing conditions.

There are insufficient data to determine long term temporal patterns in seagrass extent over broad scale patterns. Smith *et al.* (2020) suggested that deep-water meadows of the study area would be temporally dynamic, which is supported by the monitoring studies conducted at the offshore DMPA and surrounds (WBM, 1999; Worley Parsons, 2009; AMA, 2015). Based on the general conceptual model of Kilminster *et al.* (2015), deep-water seagrass assemblages of the study area are classified as comprised of 'colonising' species, which have low physiological resistance to disturbance but high capacity for rapid recovery, and a transitory meadow form.

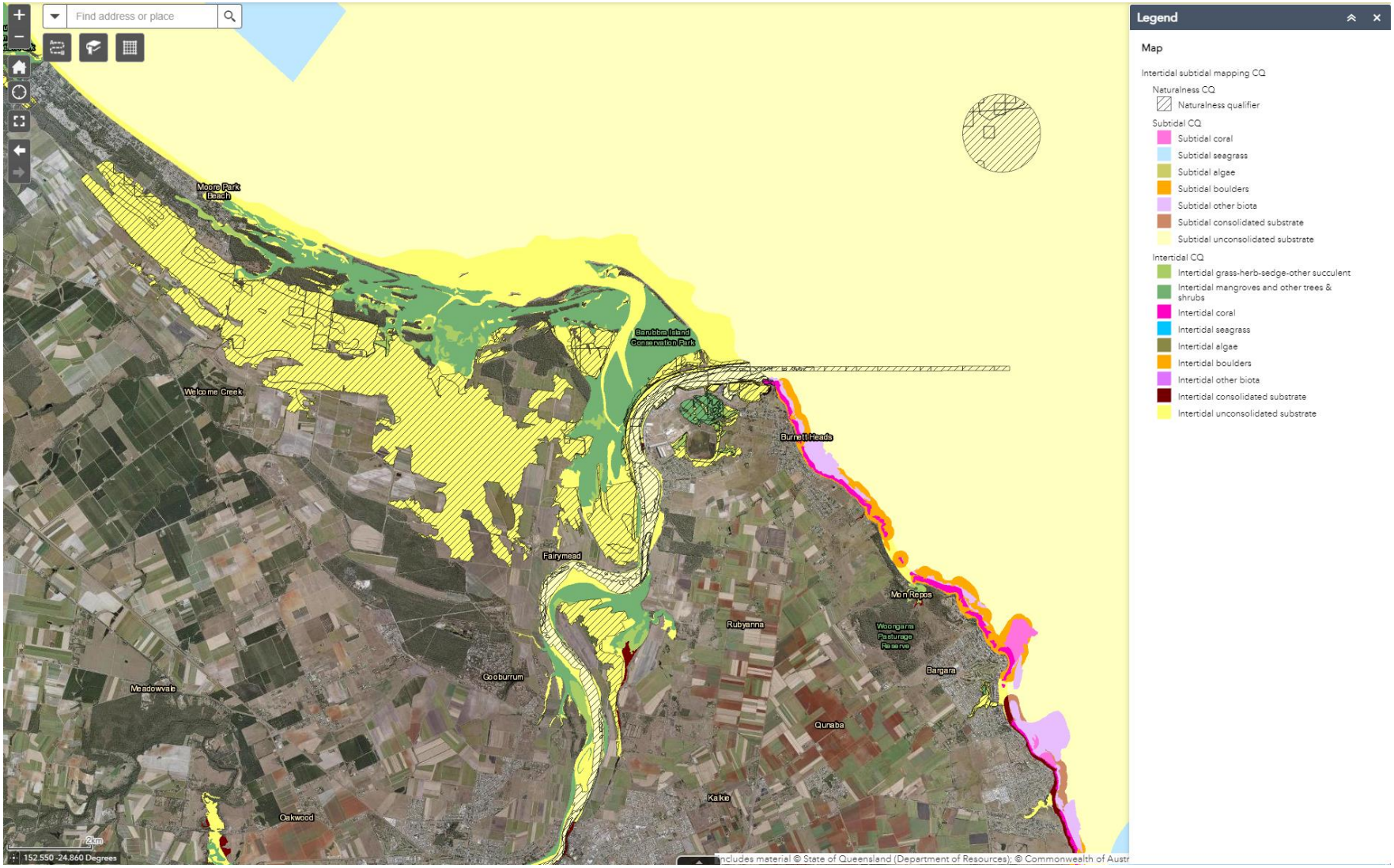


Figure 4-2 Intertidal and subtidal habitats of the Burnett estuary and adjacent coastal waters (Source: Wetlandinfo Wetland Maps)

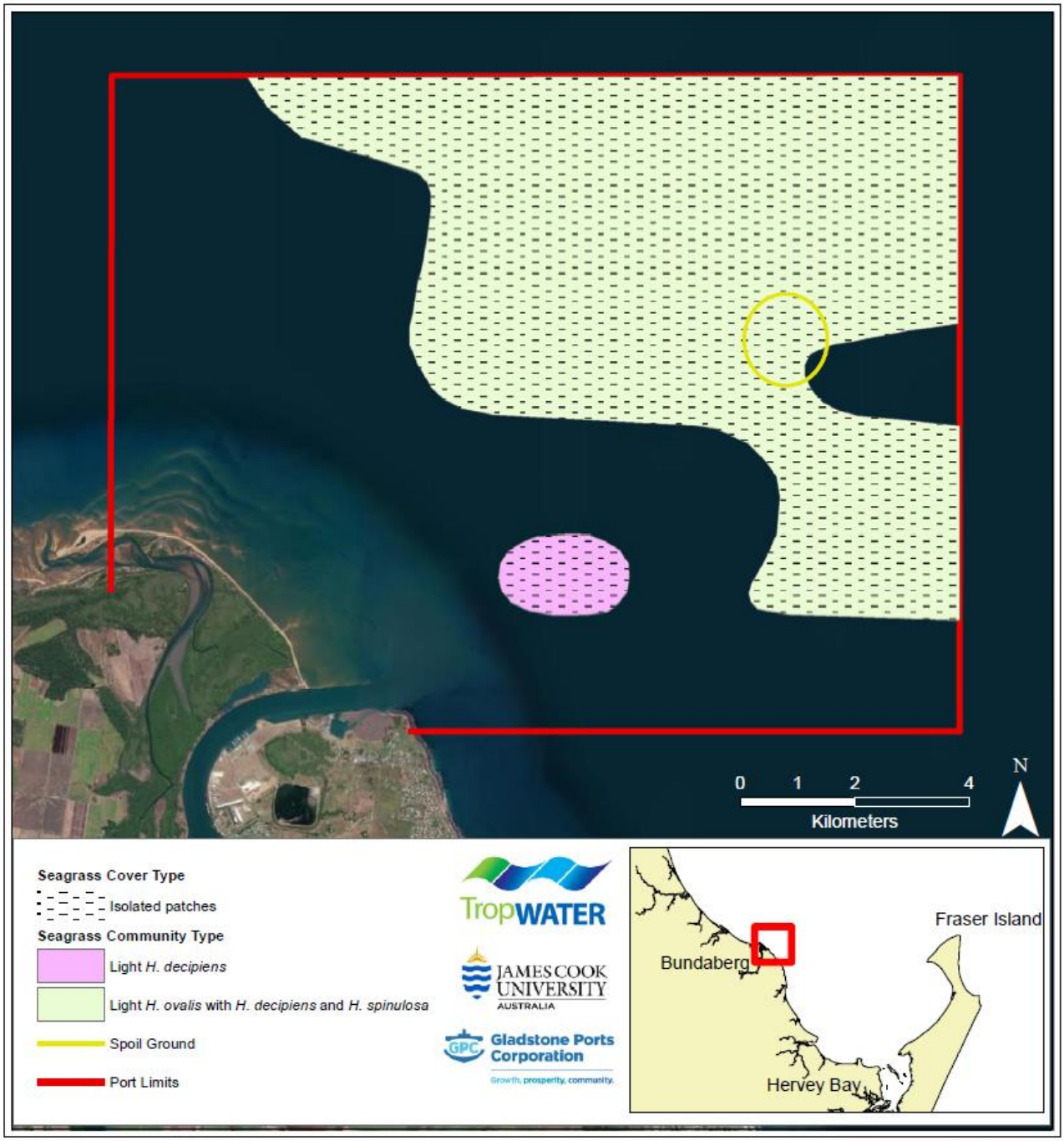


Figure 4-3 Seagrass community types and cover in the Port of Bundaberg 2020 (Source: Smith and Rasheed, 2020)

4.3.1.2 Hard Substrate Habitats and Communities

Reefs and Rocky Shores

Intertidal rocky shores and inshore reefs are present along the Woongarra Coast region (Figure 4-2). These reefs extend from Burnett Heads south to Elliot Heads, covering an area of approximately 2,500 ha.

The rocky shores and reefs on the Woongarra Coast are comprised of basalt outcrops. Reef communities in the area are a mix of tropical, subtropical and temperate species of hard and soft corals, with at least 46 species of hard coral known in the Great Sandy Marine Park (GSMP) (DES, 2021b). The structural characteristics (dominant taxa, richness, abundance) of reef communities near Burnett Heads are undefined.

ESP (2020) describes reef condition as follows: *"inshore reef communities of the Burnett-Mary region are considered to be healthy but are threatened by sediment influx from surrounding catchments. Flooding from the Burnett and Mary rivers in 2011 and 2013 negatively impacted the surrounding coral reefs, reducing coral abundance by up to 60% from Woongarra Coast to the Great Sandy Strait (Butler et al., 2013; Coppo et al., 2014). Additionally, community composition and the location of coral reefs are somewhat driven by the fluctuation of sediment loads associated with different weather events (such as sediment-laden runoff associated with high rainfall or resuspension of sediment associated with high wave action), favouring dominant species and restricting reefs to coastal flats with less turbid waters. Typical coral composition in inshore reefs has seen an increase in the stress tolerant coral Turbinaria, a change from Acropora coral communities (Coppo et al., 2014)."*

Rockwalls and Developed Foreshore Areas

A ~4.4 km long rock wall extends the length of the northern foreshore. This rockwall links the mainland to Barubbra Island, and then to a narrow vegetated islet located downstream of Separation Point. The southern breakwater consists of a series of rock walls, which together form Burnett Heads Boat Harbour. Together, these walls have a length of approximately 3km, and extend from South Head in the east, to the end of the Esplanade in the west.

The main port area has a retaining wall that has an approximate length of 2 km. Associated with this rock wall are three wharves and several jetties. Several jetties also occur downstream of the Port. These constructed structures provide suitable habitat for reef-associated species that are tolerant of estuarine conditions (i.e. widely fluctuating salinity, elevated turbidity etc).

4.3.1.3 Soft Sediment Habitats and Communities

The Burnett River estuary has an unconstricted mouth, with training walls and diverging banks at its entrance. The main drainage line displays complex anabranching on the northern banks of the river mouth, resulting from the dredging of a new river mouth and river training works, both of which were undertaken in the 1950's. Downstream of the PoB, the main channel of the Burnett River is unbranched, and contains several small tributaries (e.g. Ness Creek). O'Neil (2000) found that most of the drainage channels and creeks in the Burnett estuary have been seriously degraded by agricultural and urban development.

The Burnett River estuary channel and offshore coastal waters are comprised of unconsolidated soft substrates. The structural characteristics of benthic communities in dredged channels of the Burnett River estuary were examined by WBM (2003). The river mouth area contained a diverse and abundant benthic macroinvertebrate fauna. There were substantial spatial differences in benthic community structure throughout the area, possibly reflecting differences in sediment types and hydraulic regimes. Tube-building worms (Maldanidae) numerically dominated the swing basin area, a common feature of sheltered subtidal environments containing large quantities of fine material. Benthic community structure gradually changed with distance offshore, with the gradual dominance of mobile crustaceans (amphipods and Tanaidaceans) in offshore areas. The key drivers of community structure gradients are unresolved but may include sediment types (higher proportion of coarse sandy sediments offshore), water quality conditions, bed remobilisation processes and biological interactions. No detectable differences in benthic community structure between the dredged channel and adjacent undredged areas.

Based on case studies in other tropical and sub-tropical estuaries, it is expected that river communities undergo dynamic changes across multiple temporal scales (Stephenson, 1980; Alongi, 1990; Currie and Small, 2005; BMT, 2012a). For example, Currie and Small (2005) found that benthic communities at another subtropical estuary (Port Curtis) did not show predictable seasonal trends, with temporal changes were more closely aligned with flood-drought cycles. 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).

There have been many studies of benthic macroinvertebrate communities at the offshore DMPAs and adjacent areas (WBM, 1998; 2003; Worley Parsons, 2009; AMA, 2015; Smith *et al.*, 2020). Studies of infauna communities demonstrated varying responses to dredged material placement. WBM (2003) found that dredged material disposal from capital dredging resulted in reduced fauna three (3) weeks after disposal, whereas communities at the DMPA were richer and more abundant than adjacent areas 11 months after disposal. AMA (2015) found differences in communities between the DMPA and control sites, which they suggested was a response to changes in sediment type (increased fine sediment).

Smith and Rasheed (2020) mapped 'habitat-forming' epifauna and macroalgae communities in the port area. Habitat forming benthic macroinvertebrates were uncommon, and "*generally consisting of isolated individuals rather than high density continuous habitats. Habitat forming benthic macroinvertebrates included commonly recorded included Porifera (sponges), soft corals, bryozoans and isolated hard corals but were generally restricted to one or two sites in low densities at the north east of the port."*

Macroalgae was described by Smith and Rasheed (2020) as *"common throughout the PoB but had low coverage where it occurred (< 30%) and was dominated by filamentous and erect macroalgae. Filamentous algae was found almost exclusively in the north east of the PoB, offshore of the DMPA. Erect macro-algae, often Caulerpa spp. was widespread within the port with highest cover in the shallower coastal sites north of the Burnett River mouth. Erect calcareous algae included Halimeda sp and Udotea sp. and were restricted to deep habitats while turf algae occurred almost exclusively in the estuary and shipping channel*." A map of macroalgae cover and distribution is presented in Figure 4-4.

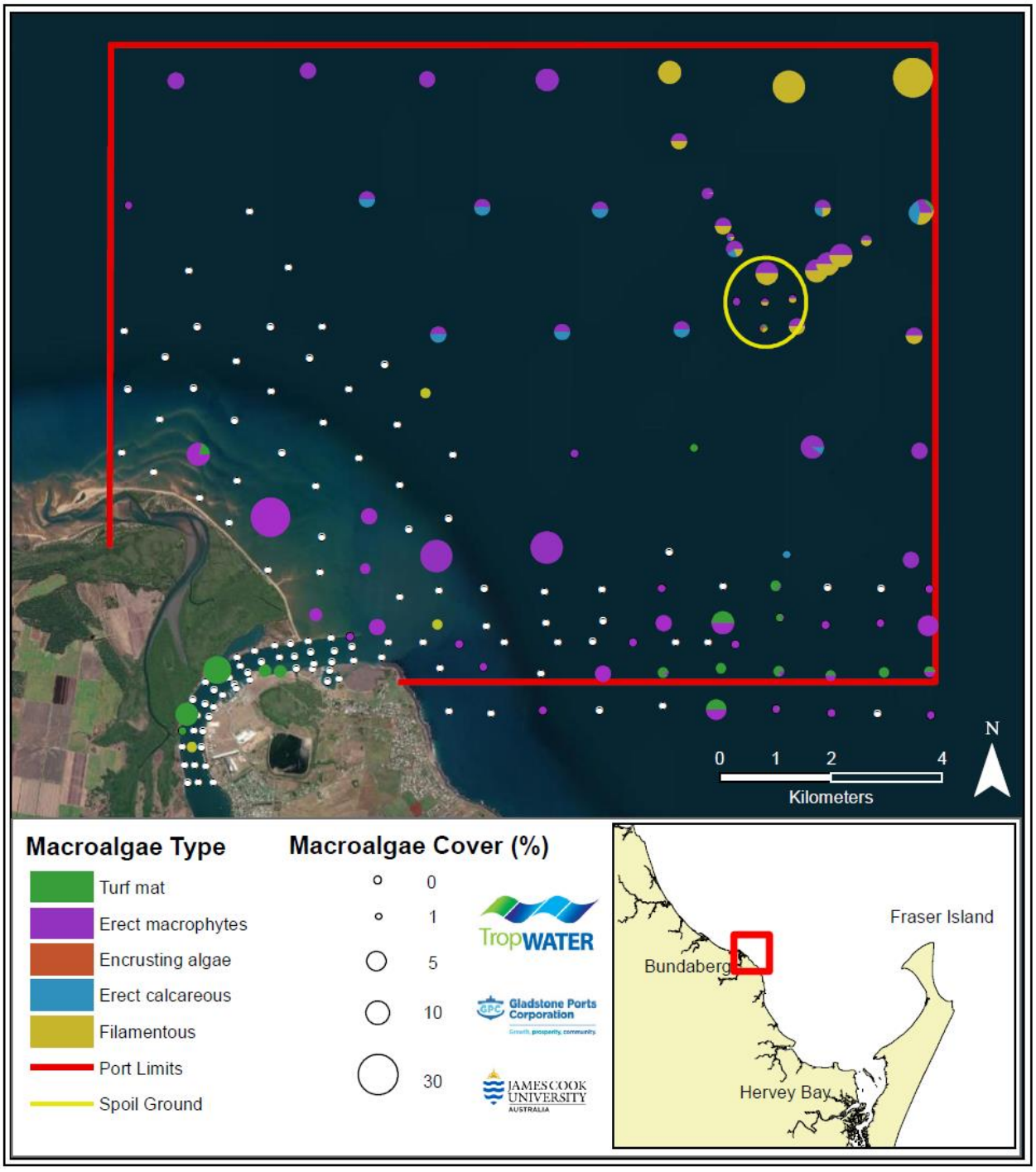


Figure 4-4 Macroalgae distribution, type and percent cover at sites surveyed in the Port of Bundaberg (Source: Smith and Rasheed, 2020)

4.3.1.4 Fish and Economically Important Crustaceans

The PoB contains a broad range of habitats for marine and estuarine fish. The Burnett-Mary supports more than 1500 species (Kirkwood and Hooper, 2004). There are no contemporary fish or macro-crustacean survey data for the Port area, although fisheries catch data are available for the region.

Economically Important Crustaceans

WBM (2002) undertook a review of prawn and crab records for the Burnett River estuary. Many of these species are of direct commercial significance, including:

- penaeid prawn species. Important commercial prawn species in the area include the eastern king prawn, banana prawn, brown tiger prawn, greasyback prawn and bay prawn. The study area would be used by these species for feeding and shelter, however the lack of nearshore seagrass meadows limits its value as a nursery area.
- sand crab (*Portunus pelagicus*) and mud crab (*Scylla serrata*). The lower estuary provides good quality habitat for these species. Shallow areas (both unvegetated and mangrove habitats) would be expected to provide suitable nursery habitats for mud crabs, and would be utilised by adult sand and mud crabs for feeding and shelter.

All species reported in the study area are considered as common and widespread in the region. There are presently no marine or estuarine crustacean species in Australia considered as having rare or threatened populations.

Surveys by Lupton and Heidenreich (1999) at the sampling sites discussed below (see “Fish”) recorded 14 large, mobile crustacean species. The most abundant species was the shrimp *Acetes* species, while the yabby *Trypaea australiensis* was also abundant in shallow waters. Penaeid prawns were also relatively common, and with metapenaeid species increasing in abundance by over 600% during periods of low salinity. Mud crabs (*Scylla serrata*) were present in low numbers during most of the year, although few legal sized crabs were recorded.

Lupton and Heidenreich (1999) suggested that the tidal barrage has significantly reduced fisheries productivity of the river, as large areas of habitat utilised by bay prawn *Metapenaeus bennettae* were lost upstream of the barrier. It was predicted that this may have had significant flow-on effects to available food resources for estuarine and marine fish.

Fish

Queensland Department of Primary Industries (Lupton *et al*., 1995) sampled the fish fauna upstream and downstream of the Ben Anderson Barrage, located 26 km upstream from the river mouth, while O'Neill (2000) undertook population studies of three common estuarine species (yellowfin bream, flathead and whiting) in the estuary. The Australian and Queensland Museums also have records of fish species from the estuary.

Overall, a total of 166 species have been recorded in the estuary, 77 of which are of some economic importance. The fish species previously recorded across the study area are common and widespread species, of both estuarine and marine affinities. There are no records of any protected fish species within the Burnett River mouth area. Lupton *et al*. (1995) recorded an unknown

sygnathid species (recorded as *Syngnathus sp.*) near the Ben Anderson Barrage, which is likely one (1) of the protected sygnathid species listed under EPBC Act.

Lupton and Heidenreich (1999) undertook a fisheries resource assessment survey at eight (8) sites in the Burnett River mouth area. The recorded 101 estuary fish species over a 12 month period. The following trends were observed:

- A total of 246 individuals represented by 38 fish species were recorded by beam trawling in the Burnett Heads Boat Harbour. Overall, the most abundant species were the anchovy *Stolephorus* sp. comprising 33% of the total catch, followed by Hamilton's anchovy *Thryssa hamiltoni* (10% of catch), yellow perchet *Ambassis marianus* (8% of catch), silver jewfish *Nibea soldado* (8% of catch) and sand whiting *Sillago ciliata* (7% of catch).
- At the mouth of Burnett Creek, a total of 2983 individuals from 34 species were recorded by beam trawling. The most abundant species was anchovy (25% of individuals), Hamilton's anchovy (16% of individuals), the goby *Favonigobius* species (15% of individuals) and yellow perchet (14% of individuals).
- At the southern extent of the northern rock wall, a total of 232 individuals from 27 species were recorded by beam trawling. The goby *Favonigobius* sp represented 27% of the catch, followed by cardinalfish *Siphamia roseigaster* (16% of individuals), anchovy (9% of individuals), and silver jewfish (6% of individuals).
- A total of nine (9) individuals from seven (7) species were recorded by gill netting at a site located near the port slipway area. The most common species was the bull shark *Carcharhinus leucas* (three (3) individuals), whereas all other species captured were represented by one (1) individual.

Lupton and Heidenreich (1999) compared species richness, species composition, recruitment levels and average number of economic species (fish and crustaceans) from the Burnett River estuary with two (2) estuaries that are largely unimpacted by human activities (Elliott and Baffle, River estuaries. Similar sampling techniques and fishing effort were used for to sample each estuary. It was concluded that the Burnett River estuary was in poor condition as a fisheries habitat. They concluded that key pressures were mostly related to catchment development, dams and weir constructions, extensive foreshore development and port related activities.

The following sections describe the potential for threatened or otherwise protected fish species to occur in the port and surrounds.

4.4 Matters of National Environmental Significance (MNES)

Table 4-3 summarises EPBC Act PMST results for PoB and immediate surrounds, and an assessment of known/potential occurrence of protected matters in areas directly and indirectly influenced by dredging and disposal. MNES relevant to areas influenced by dredging and disposal are Threatened Ecological Communities, Threatened Species and Listed Migratory Species. The port is outside the or Great Barrier Reef World Heritage Area, Natural Heritage Property and Great Barrier Reef Marine Park (GBRMP). Relevant MNES are described further below. Refer to Appendix A for the PMST report.

Table 4-3 Summary of MNES Protected Matters Search Tool Results

MNES	Search Area (PMST)	Areas Influenced by Dredging and Offshore Disposal
Threatened Ecological Communities	Three TECs	None - does not occur in subtidal waters
Threatened Species	59 species (turtles, cetaceans, sharks, birds, terrestrial fauna)	Likely – multiple marine species
Listed Migratory Species	66 species (turtles, cetaceans, sharks, birds, terrestrial fauna)	Likely – multiple marine species
World Heritage Area	None	None
Natural Heritage Property	None	None
GBRMP	None	None
Wetlands of International Importance	None	None
Commonwealth Marine Area	Present	None

4.4.1 Threatened Ecological Communities (TECs)

The PMST report identifies three (3) TECs as likely occurring in the search area (Table 4-4). All TECs are restricted to lands above high water, outside the area of influence of maintenance dredging or dredged material disposal.

Table 4-4 EPBC Listed Threatened Ecological Communities

TEC	EPBC Status	Occurrence in Search Area (PMST)	Occurrence in Areas Influenced by Dredging and Offshore Disposal
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area	No - does not occur in subtidal waters
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community may occur within area	No - does not occur in subtidal waters
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community may occur within area	No - does not occur in subtidal waters

4.4.2 Threatened and Listed Migratory Species

Table 4-5 lists threatened and listed migratory species known or possibly occurring in the search area, as defined in the PMST report.

Bony Fish

The PMST report identifies the search area as potential habitat for the Endangered White's Seahorse *Hippocampus whitei*. Atlas of Living Australia (ALA) has historical records for White's seahorse in central Queensland, all of which pre-date 1940. This species is highly sensitive to habitat disturbance and has declined in abundance in estuarine areas in NSW. It is unknown whether species is still supported in central Queensland (Short *et al*., 2019), especially given the high degree of habitat modification since the time of last record. Suitable habitat for this species occurs in nearshore reef areas near the river mouth (soft corals/hard substrate).

Sharks and Rays

Several threatened and/or listed migratory pelagic shark and ray species have the potential to occur in the PoB. The dredge and disposal sites are unlikely to represent high quality or otherwise important habitat for these pelagic species.

Green sawfish is a demersal species that utilises habitats similar to those occurring in the dredge area and surrounds. This species is now thought to be restricted to waters north of Cairns. Based on the analysis of Queensland Beach Control Program catch records for the Cairns, Townsville and Rockhampton regions (Stevens *et al*., 2005), 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. Based on the range retraction and its sensitivity to disturbance, it is considered unlikely that the Port area currently represent important habitat for green sawfish.

The other threatened demersal shark species is the grey nurse shark. The closest important congregatory area for this species is Wolf Rock (Department of the Environment, 2014), located more than 150 km south of the port. High-quality habitat (sandy gutters near reefs, rocky caves) is not present in the study area. The National Conservation Values Atlas (NCVA) maps waters between Shoalwater Bay to southern NSW as potential foraging and migratory habitat for this species, hence it is possible this species may occasionally traverse the area.

Marine Mammals

The Australian snubfin dolphin and Australian humpback dolphin are coastal and riverine species. These species form small metapopulations across the north of Australia and undertake regular migrations throughout their geographic range (Cagnazzi *et al*., 2011). While there are no records of these species in the study area, both have been recorded north and south of the Port area and it is likely they would occur here. Cagnazzi (2017) suggests that "Australian snubfin dolphins typically forage in more inshore, benthic habitats than humpback dolphins", and that Australian humpback dolphins may have a broader trophic niche width and may feed in a wider range of habitat types. The NCVA maps Hervey Bay (inclusive of the study area) as a Biologically Important Area (BIA) (foraging habitat) for Australian humpback dolphin.

Dugong has been recorded offshore of Burnett Heads and the Burnett estuary (ESP, 2020). Dugong distribution and abundance is typically associated with seagrass meadow foraging habitats. The Hervey Bay Dugong Protection Area (DPA) represents an important foraging habitat (Coppo *et al*., 2014), but is not designated as a BIA, or critical habitat under the NCVA. It is approximately 1,700 km^2 in size and located approximately 75 km south east of the study area. The dredge/disposal sites are not located at or near dugong protection areas (DPAs) under the *Fisheries Act 1994* nor is it

mapped as part of a BIA for dugong on the NCVA. Dugong may transit through the port area when moving between seagrass meadows. The offshore seagrass meadows in the port area contain the preferred food species for dugong.

Several whale species occur in the Bundaberg region. Humpback whale migrates through the region during the cooler months as part of its annual migration between the Great Barrier Reef and Antarctica. ALA has several records of this species in the study area, and it is likely to traverse through and adjacent to the offshore DMPA. The NCVA maps Hervey Bay (inclusive of the port area) as an important resting area for this species, and coastal waters from Tasmania to near Cooktown (inclusive of offshore waters of the Port area) as species core range (BIAs). The closest core calving habitat Humpback whale is located >200 km north of the study area.

The study area does not include BIAs for other whale species. There is limited information on the occurrence of other whale species in the port area, and it is likely that usage is infrequent.

Marine Reptiles

All six (6) marine turtle species found in Australian waters occur on the east coast of Queensland and are known, or possibly, in Port waters. Based on ALA records, the most frequently recorded species in the study area were loggerhead turtles (84 records), flatback turtle (69 records), olive Ridley turtle (63 records) and green turtle (five (5) records) and hawksbill turtle (three (3) records). Most records are from sandy beaches.

These species use a variety of habitats as part of their life cycle. In conceptual terms (Musick and Limpus, 1997):

- All species nest on beaches (islands and mainland), with mating typically occurring close to nesting beaches.
- Early juvenile nursery habitat is usually pelagic/oceanic, and later juvenile habitat is usually demersal and neritic (shallow waters).
- Adult foraging habitat varies among species and includes both pelagic and demersal habitats, depending on species.

Suitable foraging habitats for older juveniles and adults of most species occurs in the study area, but key foraging habitat (Important Biological Area - IBA; Critical Habitat) critical to supporting species populations is not present. Important nesting habitat is present in the study area as follows:

- Flatback turtle – coastal waters from Hervey Bay to north of Seventeen Seventy is classified as Critical Habitat, and Mon Repos (including coastal sections of the study area) is classified IBA (low density nesting)
- Green turtle - coastal waters of Mon Repos (Burnett Heads to Wreck Rock) is classified as Critical Habitat, Mon Repos (including coastal sections of the study area) is classified IBA (low density nesting and inter-nesting habitat)
- Loggerhead turtle – coastal waters from Elliot Heads to Bustard Head is classified as Critical Habitat, and Mon Repos (including coastal sections of the study area) is classified IBA (high density nesting and inter-nesting habitat).

In addition to marine turtles, the study area (especially Burnett estuary) provides potential foraging and nesting habitat for saltwater crocodile. There are no records of this species in ALA, but it is known to occur as far south as Hervey Bay (ALA, 2021).

Other Marine Species

The EPBC Act PMST search results also identified that numerous species of sea snake, pipefish, and sea horses occur or could occur in the study area. These species are listed marine species and are protected under the EPBC Act, but are not considered to be threatened or listed migratory species under EPBC or state legislation. These species could occur across a wide range of habitats found within the study area.

Table 4-5 Threatened and listed migratory species (marine species) defined in the PMST report, and likelihood of occurrence in dredge/disposal site and surrounds

Common Name	Species Name	EPBC Status	NCA Status	Type of Presence (PMST)	Records (ALA+Wildnet)	Habitat (SPRAT) Potential Occurrence in Dredge/Disposal Sites	Important Areas (BIA, CH, Recovery Plans) in Region
Bony Fish							
White's Seahorse	*Hippocampus whitei*	Endangered	Endangered	Species or species habitat likely to occur within area	ALA sighting 20 km north in 2020 and historic sighting 20 km south in 1982. No Wildnet sightings.	Depth 1-15m; inhabits seagrass, soft coral, macroalgae, sponges and artificial structures, which are represented at and adjacent to dredge/disposal sites. Highly sensitive to habitat disturbance, unknown whether species still supported in central Qld (Short *et al*., 2019).	None
Mammals							
Blue Whale	*Balaenoptera musculus*	Endangered, Mig	-	Species or species habitat may occur within area	Historical ALA and Wildnet sighting near Hervey Bay in 1930.	Pelagic, coastal and offshore waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites. Seasonal migrations (summer)	None
Southern Right Whale	*Eubalaena australis*	Endangered	-	Species or species habitat likely to occur within area	ALA and Wildnet sighting 10 km south in 2018.	Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Humpback Whale	*Megaptera novaeangliae*	Vulnerable, Mig	Vulnerable	Congregation or aggregation known to occur within area	ALA sightings near Bundaberg in 2008 and 1997 with contemporary sightings off Hervey Bay and offshore. Historic Wildnet sighting 50 km away and contemporary sighting at Agnes Waters (90 km north).	Pelagic, coastal and offshore waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	BIA (resting on migration southbound) – includes north of Bundaberg and all of NSW coastline.
Australian Snubfin Dolphin	*Orcaella heinsohni*	Mig	Vulnerable	Species or species habitat known to occur within area	Historic ALA and Wildnet sighting off Bundaberg.	Coastal and estuarine water – close to river mouths and seagrass meadows. This species is abundant in Gladstone Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Australian Humpback Dolphin	*Sousa sahulensis (=chinensis)*	Mig	Vulnerable	Breeding known to occur within area	Contemporary and historic ALA and Wildnet sightings surrounding Hervey Bay and Gladstone.	Inlets, estuaries, major tidal rivers, shallow bays, inshore reefs and coastal archipelagos. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	BIA (foraging) – waters between Bundaberg and Fraser Island.
Dugong	*Dugong dugon*	Mig	Vulnerable	Species or species habitat known to occur within area	Contemporary and historic sightings surrounding Bundaberg and Hervey Bay. Historic Wildnet sightings Bundaberg and Hervey Bay. Hervey Bay is an important feeding area (Meagher *et al.*, 2013)	Seagrass meadows (foraging). Known to occur within the area. May occasionally transit through dredge/disposal sites.	None
Bryde's Whale	*Balaenoptera edeni*	Mig	-	Species or species habitat may occur within area	Historic Wildnet sightings around QLD.	Pelagic, coastal and offshore waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Killer Whale	*Orcinus orca*	Mig	-	Species or species habitat may occur within area	ALA and Wildnet sightings near Fraser Island in 2013.	Pelagic, coastal and offshore waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Reptiles							
Loggerhead Turtle	*Caretta caretta*	Endangered	Endangered	Breeding known to occur within area	Historic Wildnet and ALA sightings near Bundaberg and surrounding areas. Bundaberg offshore ALA sighting in 2020. Turtle Nesting Distribution Abundance and Migration estimates 11-100 nesting females at Woongarra:Burnett Heads.	Nesting sandy beaches (including central Qld), foraging mainly in open waters. Known nesting site at Burnett heads therefore may travel through the dredge and disposal areas.	Habitat critical (nesting) – Elliot Heads to Bustard head BIA (nesting) – Mon Repos.
Green Turtle	*Chelonia mydas*	Vulnerable	Vulnerable	Breeding known to occur within area	Historic ALA and Wildnet sightings surrounding Bundaberg. Most contemporary sighting in 2020 near Fraser Island. Turtle Nesting Distribution	Nesting sandy beaches, foraging in seagrass meadows, macroalgae, mangroves. Known nesting site at Mon Repos therefore may travel through the dredge and disposal areas.	Habitat critical (nesting) – Burnett Heads to Wreck Rock BIA (nesting) – Mon Repos.

Common Name	Species Name	EPBC Status	NCA Status	Type of Presence (PMST)	Records (ALA+Wildnet)	Habitat (SPRAT) Potential Occurrence in Dredge/Disposal Sites	Important Areas (BIA, CH, Recovery Plans) in Region
					Abundance and Migration estimates 1-10 nesting females at Woongarra:Mon Repos.		
Leatherback Turtle	*Dermochelys coriacea*	Endangered	Endangered	Species or species habitat known to occur within area	Historic ALA and Wildnet sightings around Bundaberg. Turtle Nesting Distribution Abundance and Migration estimates 1-10 nesting females at Woongarra:Mon Repos.	Nesting sandy beaches, foraging in open waters. Known nesting site at Mon Repos therefore may travel through the dredge and disposal areas.	BIA (nesting) – Mon Repos.
Hawksbill Turtle	*Eretmochelys imbricata*	Vulnerable	Endangered	Foraging, feeding or related behaviour known to occur within area	Historical ALA sightings around Bundaberg and historic Wildnet sightings off Fraser Island and Gladstone.	Nesting sandy beaches, foraging in open waters, seagrass meadows and reefs. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered	Endangered	Breeding likely to occur within area	Historic ALA and Wildnet sightings around Bundaberg	Nesting occurs on sandy beaches, mostly outside Central Qld (key nesting sites located in Gulf of Carpentaria). Forages in open waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Flatback Turtle	*Natator depressus*	Vulnerable	Vulnerable	Breeding known to occur within area	Numerous historic ALA and Wildnet sightings and one ALA sighting in 2017 at Burnett Heads. DES (2021c) estimates 1-10 nesting females at Woongarra:Mon Repos.	Nesting sandy beaches. Nesting flatback turtles return to nesting beaches approximately every 15 days throughout the season and are dispersed throughout the region during the inter-nesting period (Limpus, 1971). Known nesting site at Mon Repos therefore may travel through the dredge and disposal areas.	Habitat critical (nesting) – Burnett Heads to Wreck Rock BIA (nesting) – Mon Repos.
Salt-water Crocodile	*Crocodylus porosus*	Mig	Vulnerable	Species or species habitat likely to occur within area	No sightings around Bundaberg. ALA and Wildnet sightings near Fraser Island in 2013.	Nesting wetlands; feeding rivers, estuaries, and occasionally coastal waters. Possible transient visitor to Bundaberg, unlikely to regularly use dredge/disposal sites.	None
Sharks and Rays							
Grey nurse shark	*Carcharias taurus*	Critically endangered	-	Species or species habitat may occur within area	No sightings near Bundaberg. ALA and Wildnet sightings offshore and south of Fraser Island.	Pelagic, coastal and offshore waters. Unlikely to visit the area.	BIA (foraging) – Moore Park Beach to Caloundra.
Great White Shark	*Carcharodon carcharias*	Vulnerable	-	Species or species habitat known to occur within area	Historic ALA sighting at Bundaberg in 1993. Other sparse sightings around Fraser Island	Pelagic, coastal and offshore waters. Occasionally reported from Capricorn Bunker region, possible occasional visitor to Bundaberg.	None
Green Sawfish	*Pristis zijsron*	Vulnerable	-	Breeding may occur within area	No Bundaberg ALA or Wildnet sightings. A single ALA sighting near Maryborough.	Demersal, riverine and coastal waters. While suitable habitat is present Bundaberg, the region is outside known geographic range.	None
Whale Shark	*Rhincodon typus*	Vulnerable	-	Species or species habitat may occur within area	Recent Wildnet sighting off Lady Musgrave Island and Historic sighting off Fraser Island.	Pelagic, coastal and offshore waters. Occasionally reported from Capricorn Bunker region, unlikely to occur in Bundaberg.	None
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Mig	-	Species or species habitat may occur within area	Offshore ALA sightings.	Pelagic, coastal and offshore waters. Unlikely to regularly use dredge/disposal sites.	None
Porbeagle Shark	*Lamna nasus*	Mig	-	Species or species habitat may occur within area	Offshore ALA sightings.	Pelagic, coastal and offshore waters. Unlikely to regularly use dredge/disposal sites.	None
Reef Manta Ray	*Mobula alfredi*	Mig	-	Species or species habitat likely to occur within area	ALA sighting near Fraser Island in 2019 and numerous around Magnetic Island.	Pelagic, coastal and offshore waters. Unlikely to regularly use dredge/disposal sites.	None
Giant Manta Ray	*Mobula birostris*	Mig	-	Species or species habitat likely to occur within area	No ALA or Wildnet Queensland sightings.	Pelagic, coastal and offshore waters. Unlikely to regularly use dredge/disposal sites.	None

4.5 Queensland

4.5.1 Matters of State Environmental Significance (MSES)

MSES, referenced under the SPP 2017, are environmental values 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, 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 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 PoB and surrounds are provided in Table 4-6 and Figure 4-6.

Table 4-6 Matters of State Environmental Significance and Relevance to PoB and surrounds

MSES*	Description
Protected areas under the NC Act	There are no marine areas within study area classified as a protected area for the purpose of the NC Act. The Barubbra Island Conservation Park is located at the mouth of the Burnett River on the northern bank, although it is separated from the main channel of the river by a seawall. This conservation park is characterised by estuarine wetlands (mangroves and saltmarsh). The Mon Repos Conservation Park is located on the coast approximately 4 km south of the mouth of the Burnett River. The beach in this conservation park supports the largest concentration of nesting marine turtles on the eastern Australian mainland, and the most significant loggerhead turtle rookery in the South Pacific region.
Marine parks and land within a 'marine national park', 'conservation park', scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* (MP Act) – highly protected features	The GSMP surrounds the PoB and extends seaward to the Commonwealth Marine Waters. However, the Port limits are excluded from the marine park. The waters adjacent to the Portlimits are a General Use Zone of the marine park, with a Habitat Protection Zone along the Woongarra Coast, commencing at the edge of the Port limits at the Burnett River mouth (including the inshore waters at Mon Repos). The dredge footprint and disposal site are located outside the GSMP. There are no 'highly protected' GSMP features listed as a MSES.
Areas within declared fish habitat areas (FHAs)	There are no Fish Habitat Areas (FHAs) within the Port limits. The closest FHA is the Elliot River FHA, approximately 20 km south of the Burnett River mouth
EVNT and special least concern species	Islands and mainland areas surrounding PoB are mapped as habitat for threatened wildlife and/or iconic species listed under NC Act. Refer to Table 4-5 for summary of habitat values for threatened and special least concern species
HES wetlands protected under EP Act	None in marine waters potentially affected by maintenance dredging
Wetlands and watercourses in HEV waters	The coastal waters extending south of the Burnett River mouth to Elliot Heads are identified as HEV waters under the EPP (Water and Wetland Biodiversity) (Area HB1, Hervey Bay). The dredge footprint and disposal sites are located outside of HEV waters.
Regulated vegetation	None in marine waters potentially affected by maintenance dredging
Strategic Environmental Area	None present in PoB
Legally secured offset areas	None present in PoB

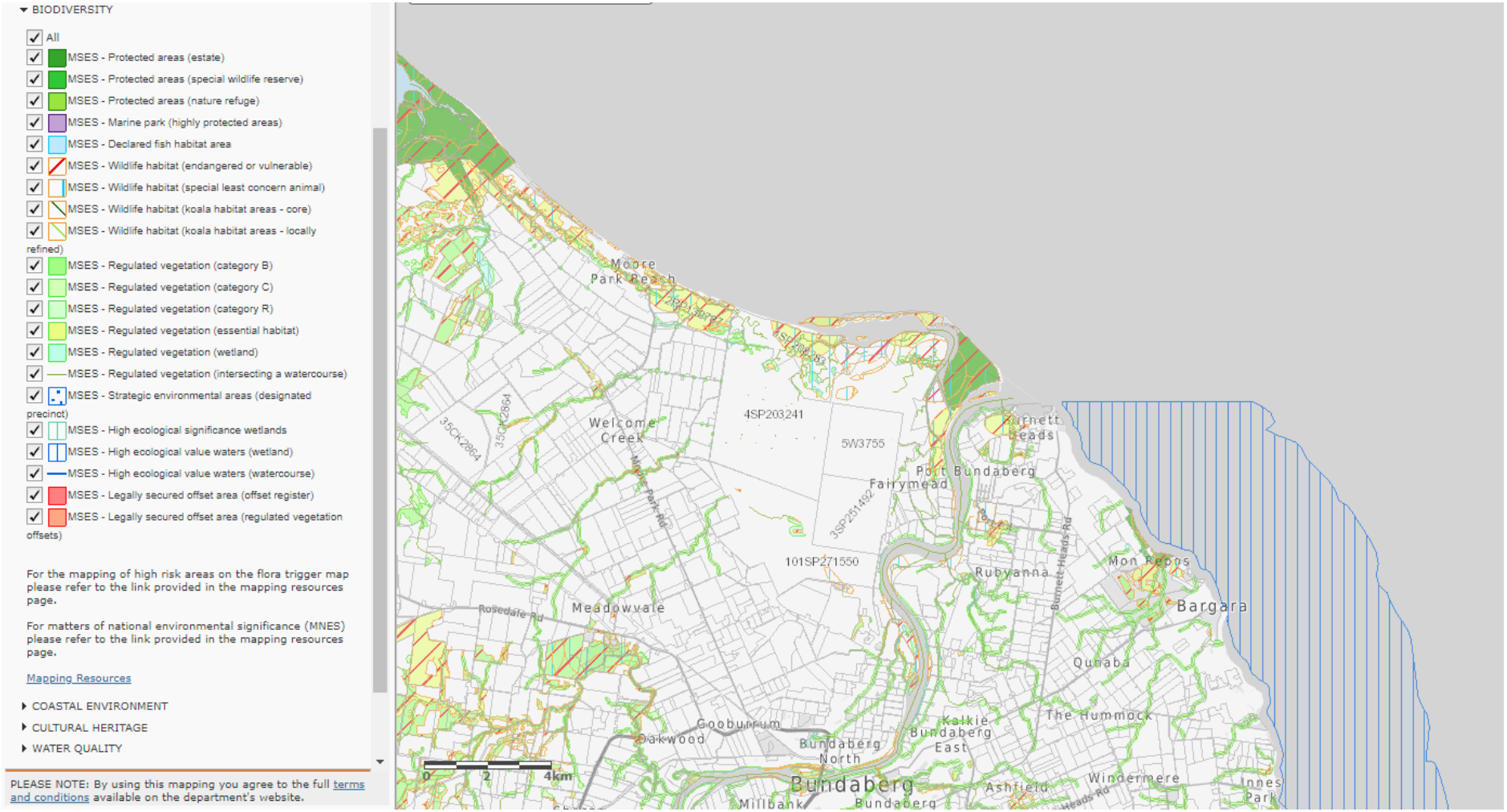


Figure 4-5 MSES in the study area and surrounds

4.5.2 State Code 8 Coastal Development and Tidal Works

State Code 8 Coastal Development and Tidal Works sets out performance outcomes to "…e*nsure 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

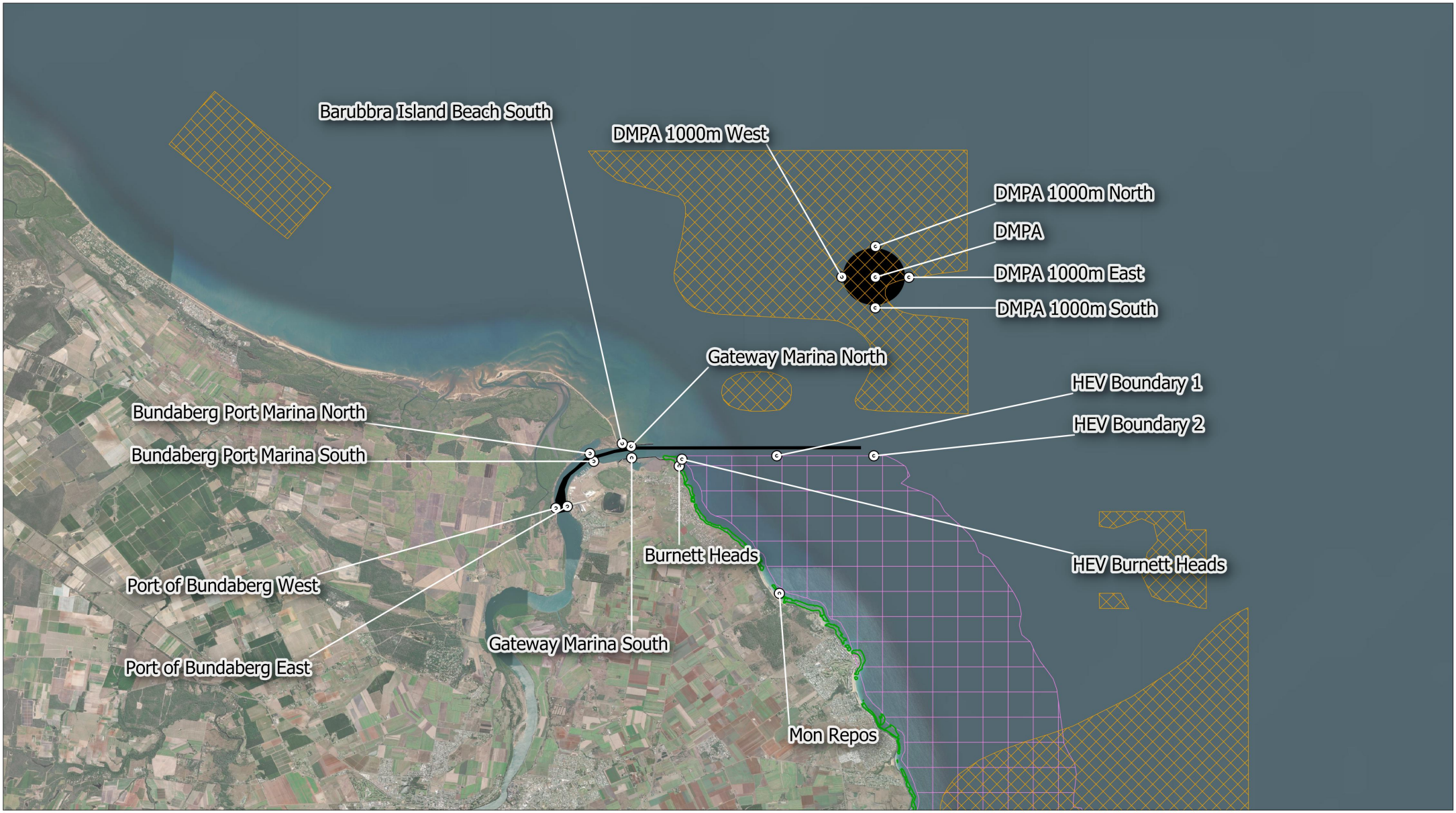
(5) account for the projected impacts of climate change; and

(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 State Development Assessment Provisions (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 State Assessment and Referral Agency (SARA). Dredging and disposal of dredge material in tidal waters triggers assessment against State Code 8.

Assessment of the maintenance dredging activity against relevant sections of State Code 8 are shown in Section 5.6.



LEGEND

- Timeseries Extraction Locations
- Seagrass
- Coral
- HEV (2019)
- Channel and DMPA

Title:

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

Figure: **4-6**

Rev: **A**

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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. subtidal seagrass meadows). The 14-day analysis window was moved forward by five (5) day increments from the start to the end of the 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. Since the duration of the dredging campaign was less than 14 days however, the window that included the whole of the dredging campaign produced the largest change in the percentiles at most locations.

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. The highest percentiles correspond to relatively short-lived increases in turbidity/deposition while the lower percentiles correspond to sustained (but temporary) increases.

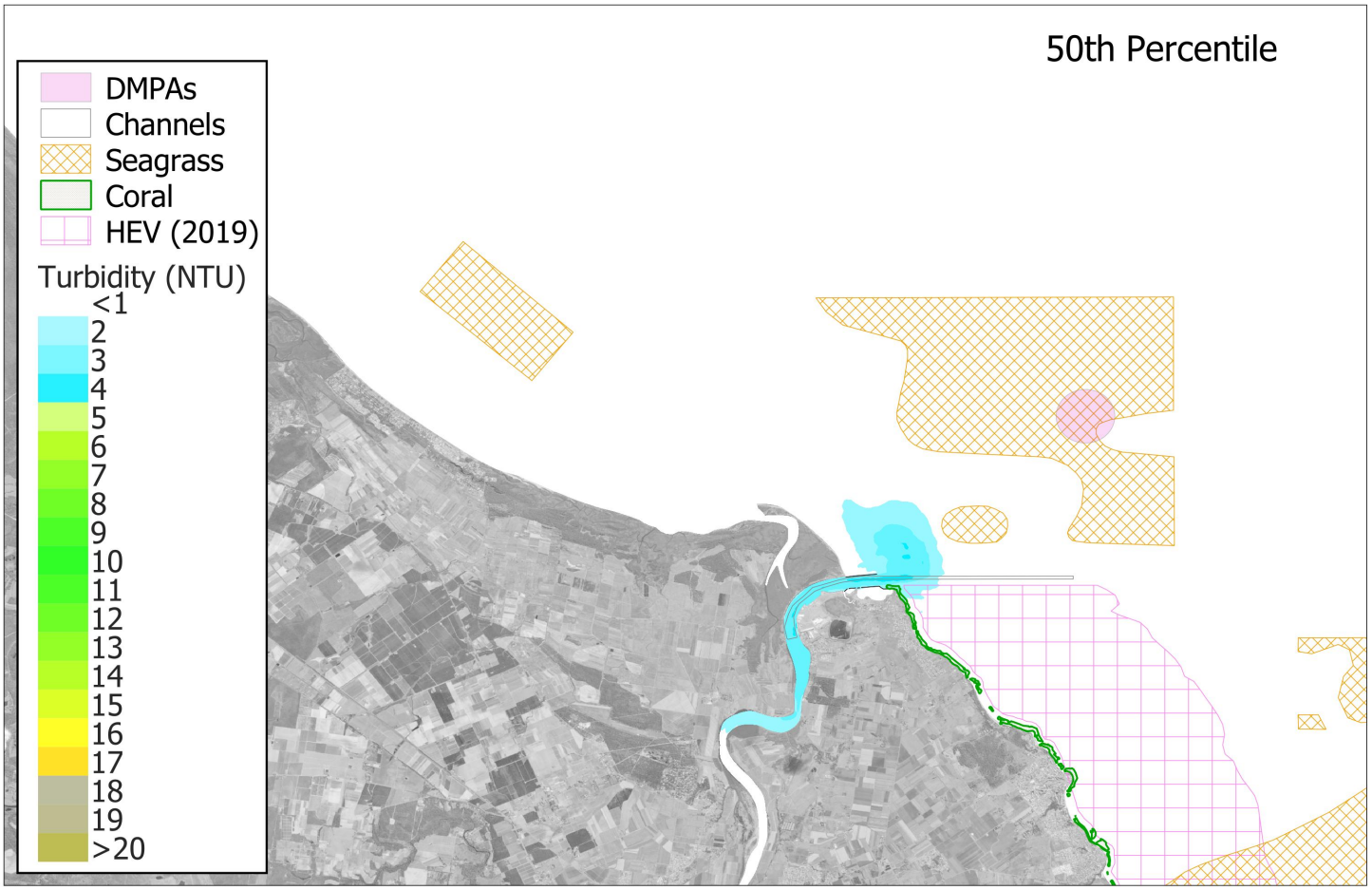
Key features of the moving window percentile analysis include:

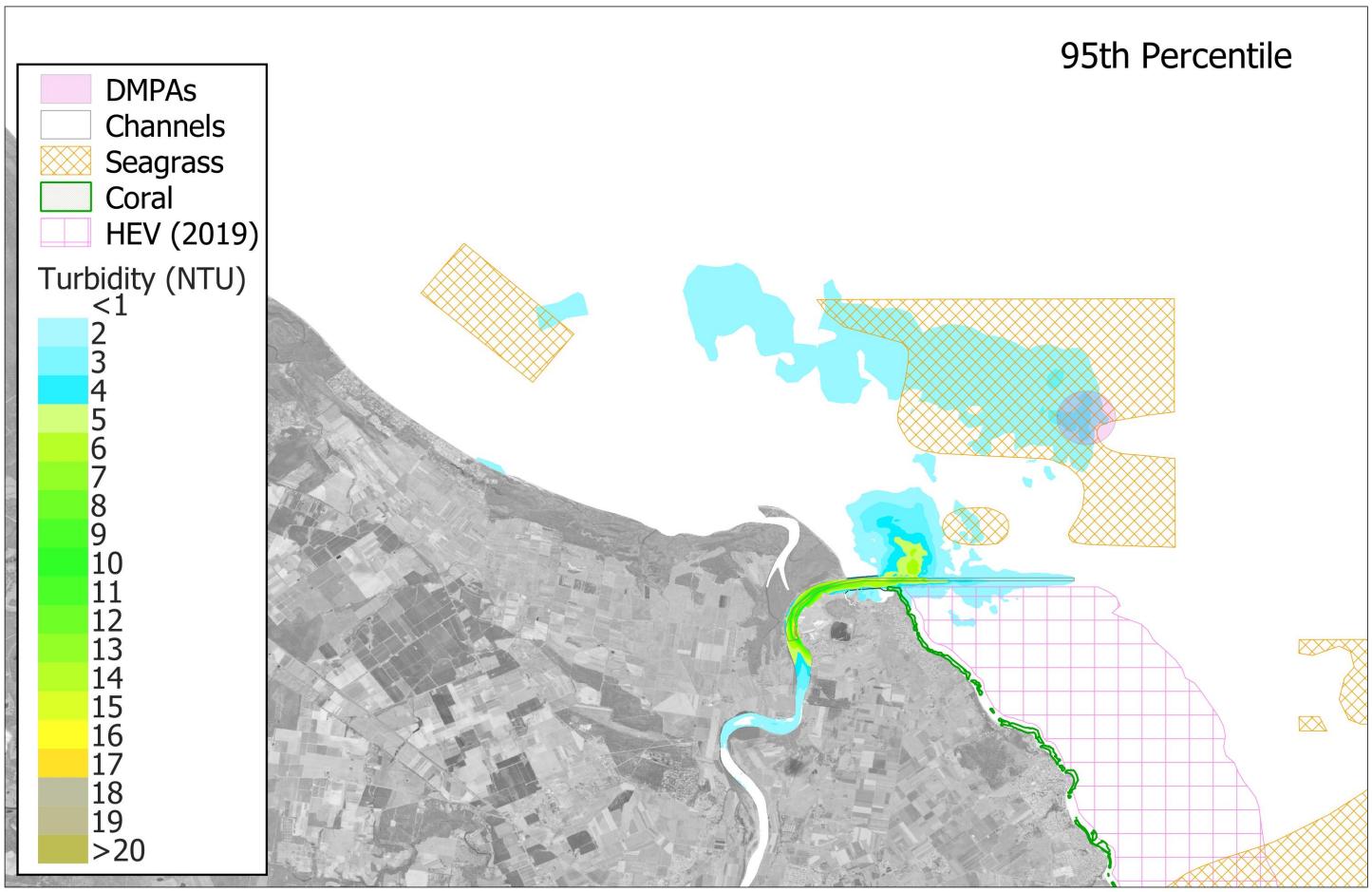
- Consideration of a range of impact durations from short to long term;
- A similar analysis applied to the baseline data can quantify the ambient conditions, including natural variability across different periods.

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.

The modelled impacts to the 50th and 95th percentile of the turbidity for the 90,000 m^3 maintenance dredging campaign are shown in Figure 5-1. Sustained increases to the turbidity (50th percentile increases) are only significant within the river and near the entrance. Short-term increases (95th percentile increases) in the turbidity are noted between the Port and the river entrance and in the vicinity of the DMPA.

The modelled impacts to the deposition rate percentiles for the 90,000 m^3 maintenance dredging campaign are shown in Figure 5-2. The largest increases in deposition rate occur within the shipping channels and at the DMPA.





Title:

90,000m³ Maintenance Dredging Campaign - Change to the 50th & 95th Percentiles of the Modelled Depth Averaged Turbidity due to Dredging

Figure: **5-1**

Rev: **A**

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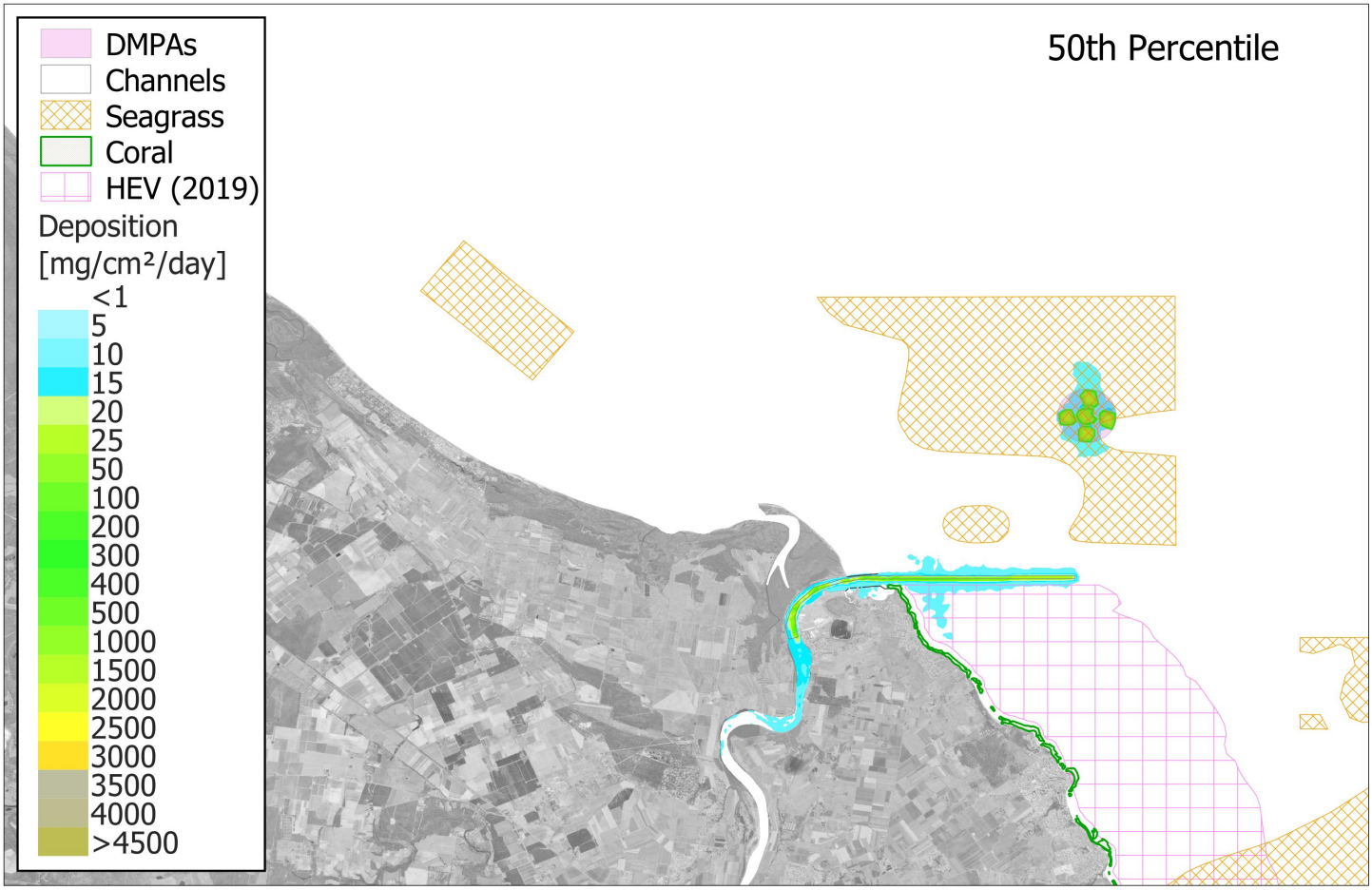

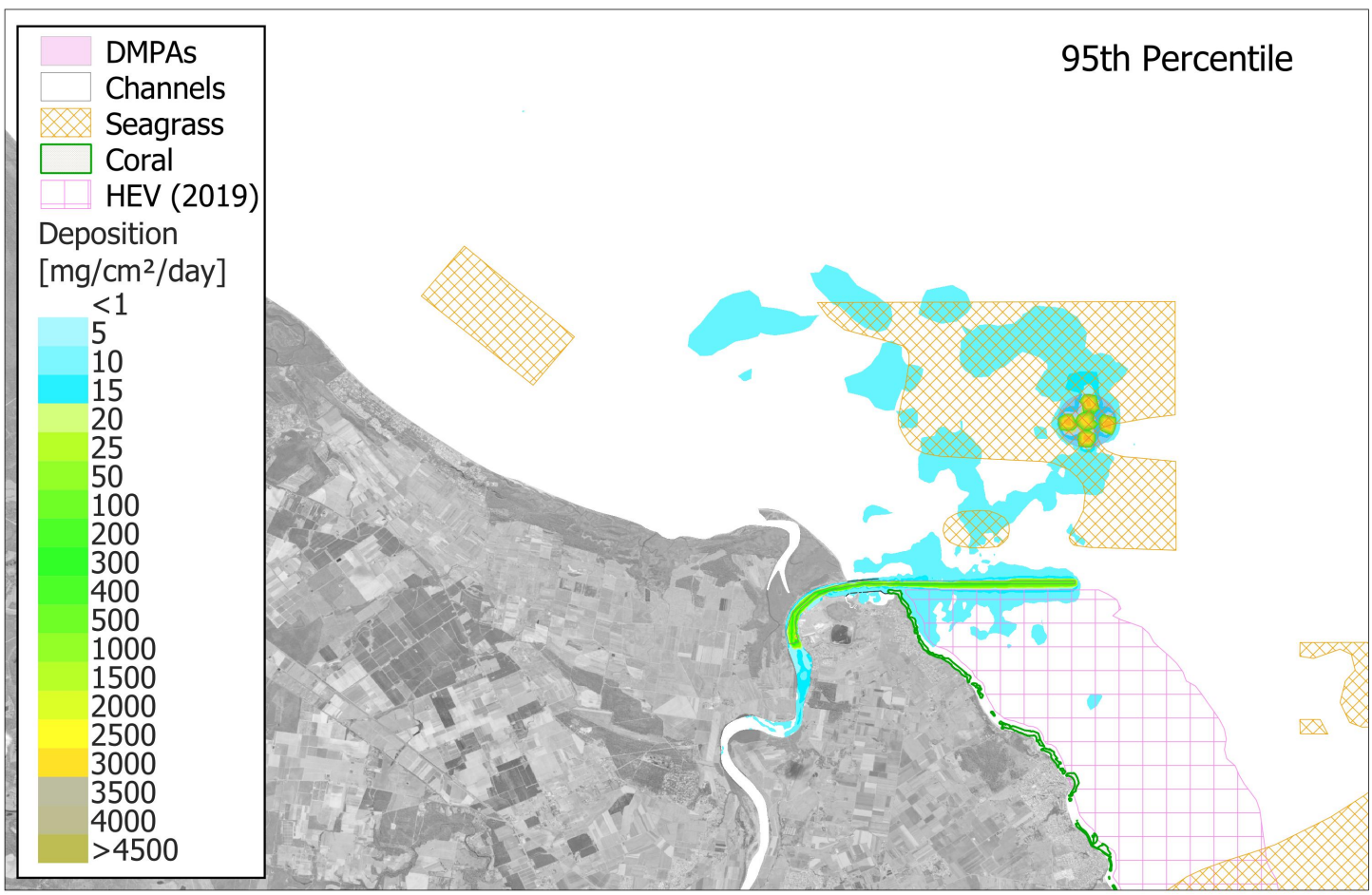

Title:

90,000m³ Maintenance Dredging Campaign - Change to the 50th & 95th Percentiles of the Modelled Deposition Rate due to Dredging

Figure: **5-2**

Rev: **A**

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5.1.2 Impact Thresholds

The following information sources were considered in the context of defining potential water quality impacts:

- WQOs – including scheduled WQOs and draft WQOs presented in other documentation (see Section 4.2.1). Contaminants relevant to dredging at PoB are turbidity and nutrients. WQOs for these contaminants were based on analysis of reference site data. The annual median value for the test site should be compared to the WQO.
- Local (site-specific) background water quality data – which provides contextual information regarding the range of natural variability in water quality. Long-term monitoring of a small set of parameters (temperature, conductivity, pH, turbidity, chlorophyll *a*, dissolved oxygen) is undertaken at a station located in the Burnett River estuary; refer to Section 4.2.1 for annual median values and WQOs. There are no long-term data for the offshore DMPA and surrounds.
- Biological tolerance data – there are no locally-specific biological tolerance data for key sensitive receptors in the region (seagrass, corals). General literature values provide contextual information on likely sensitivities of sensitive receptors and other important fauna (especially threatened/migratory species).

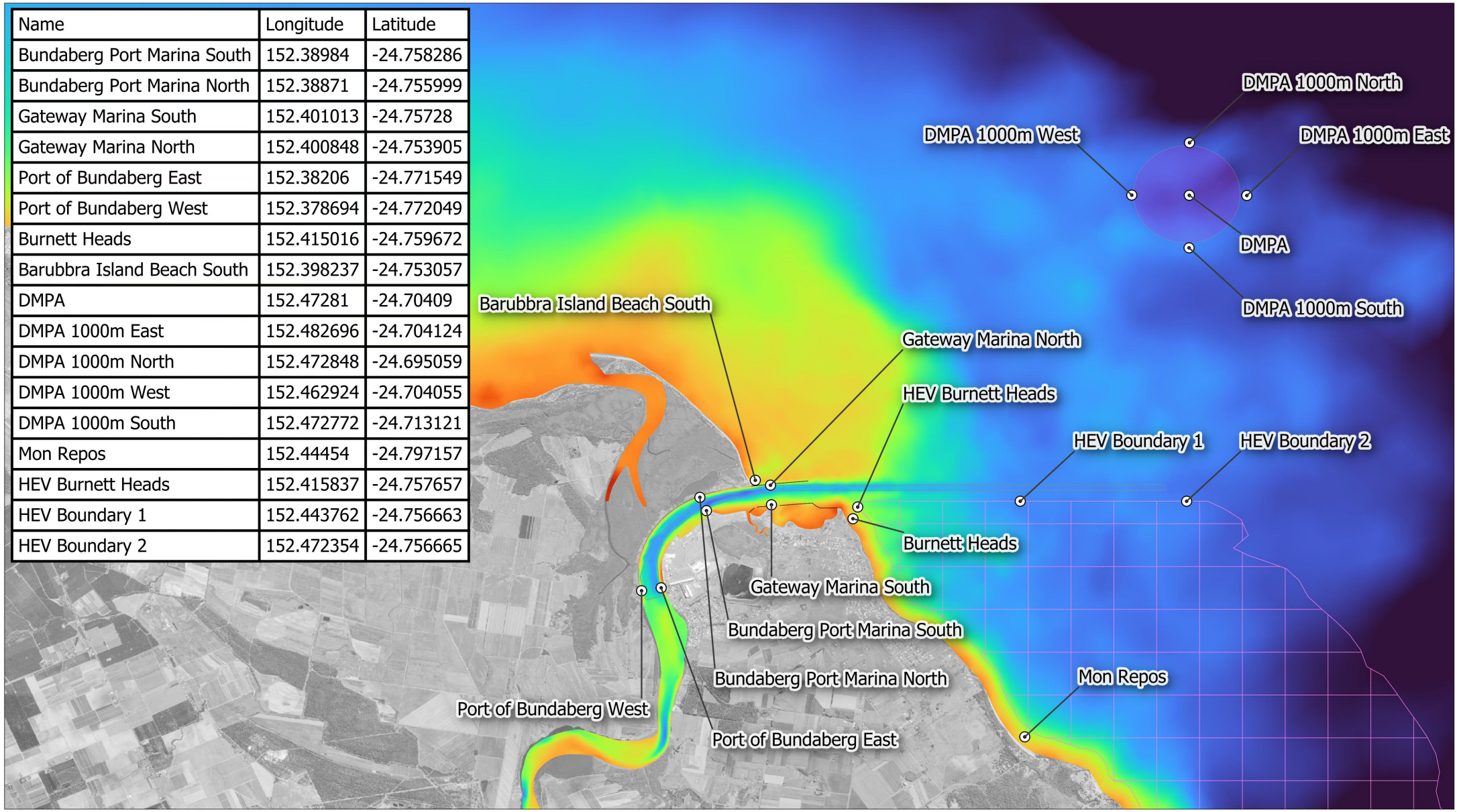
The lack of locally specific biological tolerance data of BPAR data prevents the development of meaningful turbidity (or other water quality) thresholds and impact zones. The approach taken to characterise potential impacts is as follows:

- Coastal waters (i.e. waters seaward of Burnett Heads) – in the absence of long-term monitoring data, modelled turbidity values were compared with relevant WQOs to provide contextual information on the magnitude of change resulting from dredging. In the context of turbidity, the WQO for HEV waters is 1 NTU (median), and the draft WQO for study area waters north of the HEV boundary is <2 NTU.
- Burnett River estuary:
  - consistent with the approach of Orpin *et al.* (2004), it was conservatively assumed that impacts may occur if dredging-generated turbidity is more than one (1) standard deviation of ambient turbidity. Annual standard deviation values for one site in the Burnett River estuary are provided in Table 4-2, and ranged from 2.3 to 192.5 NTU. The lowest annual standard deviation (2.3 NTU) was conservatively adopted.
  - modelled turbidity values were also compared with the draft WQO for lower estuarine waters (<6 NTU), as described for Coastal waters.

5.1.3 Turbidity and Deposition Rate Time Series

Time series of the modelled depth-averaged turbidity and deposition rate were extracted from the model at the points of interest shown in Figure 5-3. 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.

Name	Longitude	Latitude
Bundaberg Port Marina South	152.38984	-24.758286
Bundaberg Port Marina North	152.38871	-24.755999
Gateway Marina South	152.401013	-24.75728
Gateway Marina North	152.400848	-24.753905
Port of Bundaberg East	152.38206	-24.771549
Port of Bundaberg West	152.378694	-24.772049
Burnett Heads	152.415016	-24.759672
Barubbra Island Beach South	152.398237	-24.753057
DMPA	152.47281	-24.70409
DMPA 1000m East	152.482696	-24.704124
DMPA 1000m North	152.472848	-24.695059
DMPA 1000m West	152.462924	-24.704055
DMPA 1000m South	152.472772	-24.713121
Mon Repos	152.44454	-24.797157
HEV Burnett Heads	152.415837	-24.757657
HEV Boundary 1	152.443762	-24.756663
HEV Boundary 2	152.472354	-24.756665



Timeseries Extraction Locations
HEV (2019)
Channels

Bed Elevation (mAHD)
5
-15

Title:
Timeseries Extraction Locations and Model Bathymetry

Figure: **5-3**

Rev: **A**

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Time series of the modelled depth-averaged turbidity at the DMPA reporting site (Figure 5-4) displayed the following trends:

- during the dredging campaign (modelled period 28th May to 6th June) - a series of short-term (measured in 100s of minutes) spikes (>15 NTU) occurred with disposal events, which were interspersed with slightly elevated turbidity (typically <5 NTU)
- a rapid decline in the days immediately after the completion of dredged material disposal (<1 NTU)
- subsequent resuspension events resulted in temporary increases in dredge-related turbidity (less than 5 NTU). During the resuspension event between 11th and 15th June, the contribution of the dredging-related turbidity to the total turbidity was relatively small.

The modelled turbidity therefore temporarily exceeded the draft WQO of <2 NTU at the DMPA.

At the reporting site 1000 m west of the DMPA (Figure 5-4), the modelled dredging-related turbidity was very low during dredging (around 1 NTU) and was also much smaller than the modelled ambient turbidity during resuspension events that occurred after dredging was complete. Both ambient and dredge-related turbidity was predicted to temporarily exceed the WQO of 2 NTU during resuspension events. No major impacts to seagrass meadows are expected given the short duration and low intensity of dredge-related turbidity.

At all other reporting sites in coastal waters and the Burnett River estuary (Figure 5-5 to Figure 5-9) the modelled dredging-related turbidity was a similar magnitude to the ambient turbidity during the dredging operation, and was very low at all locations (less than 1 NTU) following the completion of dredging. This shows that due to rapid dispersion of the dredging-related plumes, the duration of the increase in turbidity due to dredging is limited to the length of the dredging campaign (in this case, 9.5 days).

Time series of the modelled deposition rate at the DMPA (Figure 5-10) show that the modelled dredging-related deposition rate was very high during the dredging activity (to be expected), but was negligible in the period following the completion of dredging. At the site 1000 m west of the DMPA, the modelled dredging-related deposition rate was very low during dredging (up to 5 mg/cm^2/day) and was also much smaller than the modelled ambient deposition rate during resuspension events that occurred after dredging was complete.

At all other locations (Figure 5-11 to Figure 5-15) the modelled dredging-related deposition rate was relatively low during the dredging operation (less than 10 mg/cm^2/day), and was negligible at all locations following the completion of dredging. This shows that due to rapid dispersion of the dredging-related plumes, the deposition rate due to dredging only significantly increased during the dredging campaign itself (in this case, 9.5 days). It is therefore unlikely that there would be any long term impacts to corals or other sensitive receptors due to the relatively low magnitude and short duration of the increase in deposition rate due to dredging.

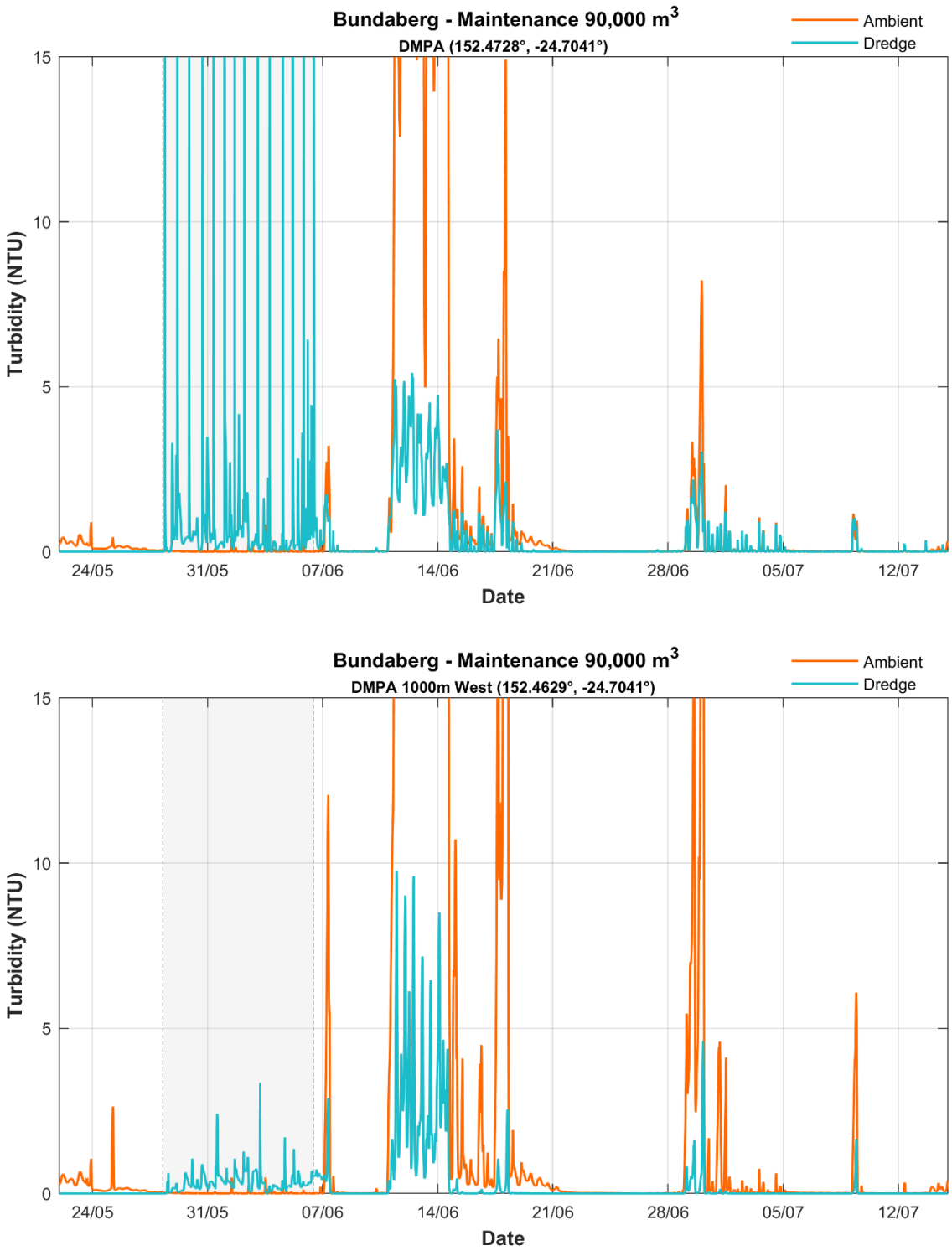

Figure 5-4 Time Series of Modelled Depth-averaged Turbidity at DMPA (Top) and DMPA 1000m West (Bottom)

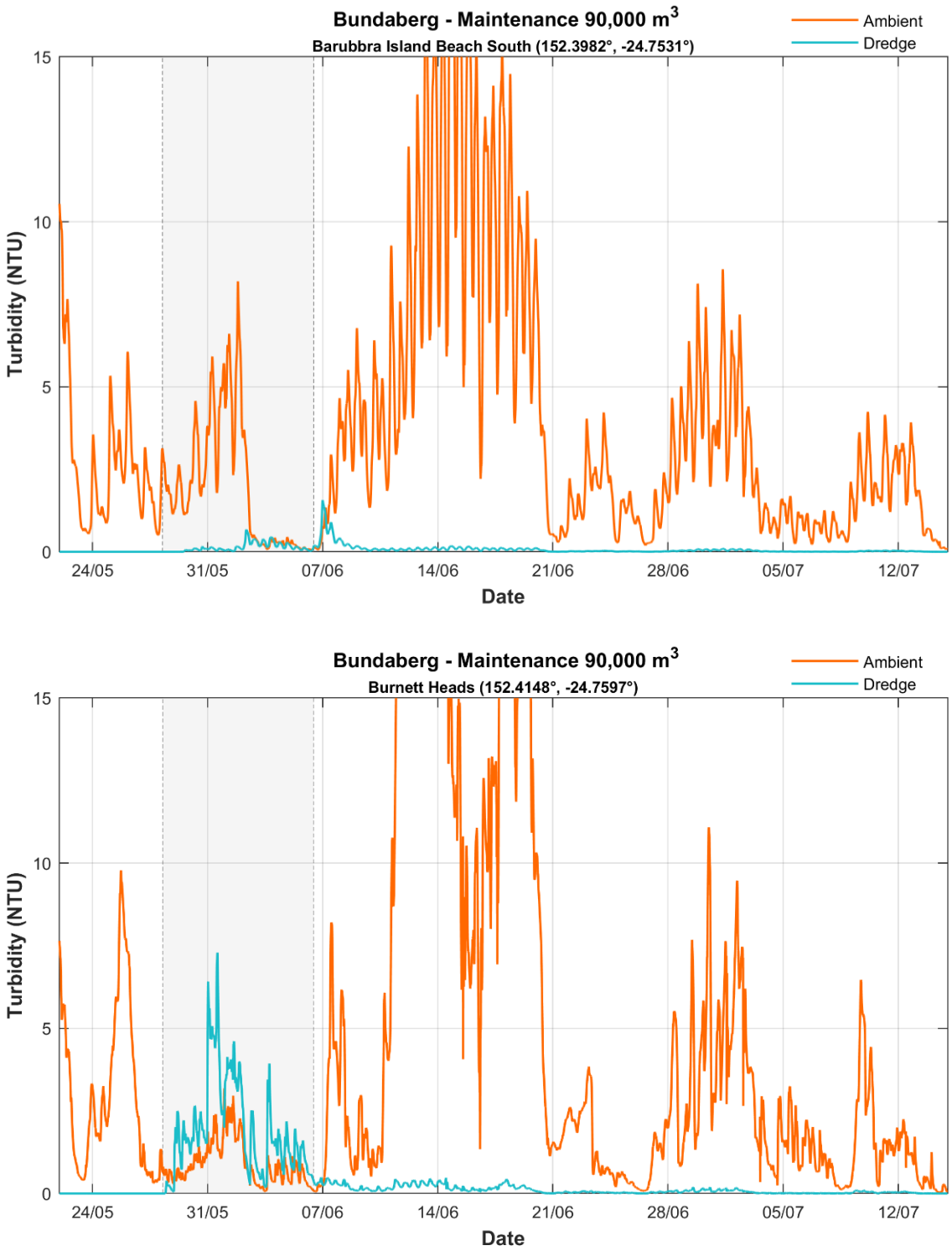

Figure 5-5 Time Series of Modelled Depth-averaged Turbidity at Barubbra Island Beach South (Top) and Burnett Heads (Bottom)

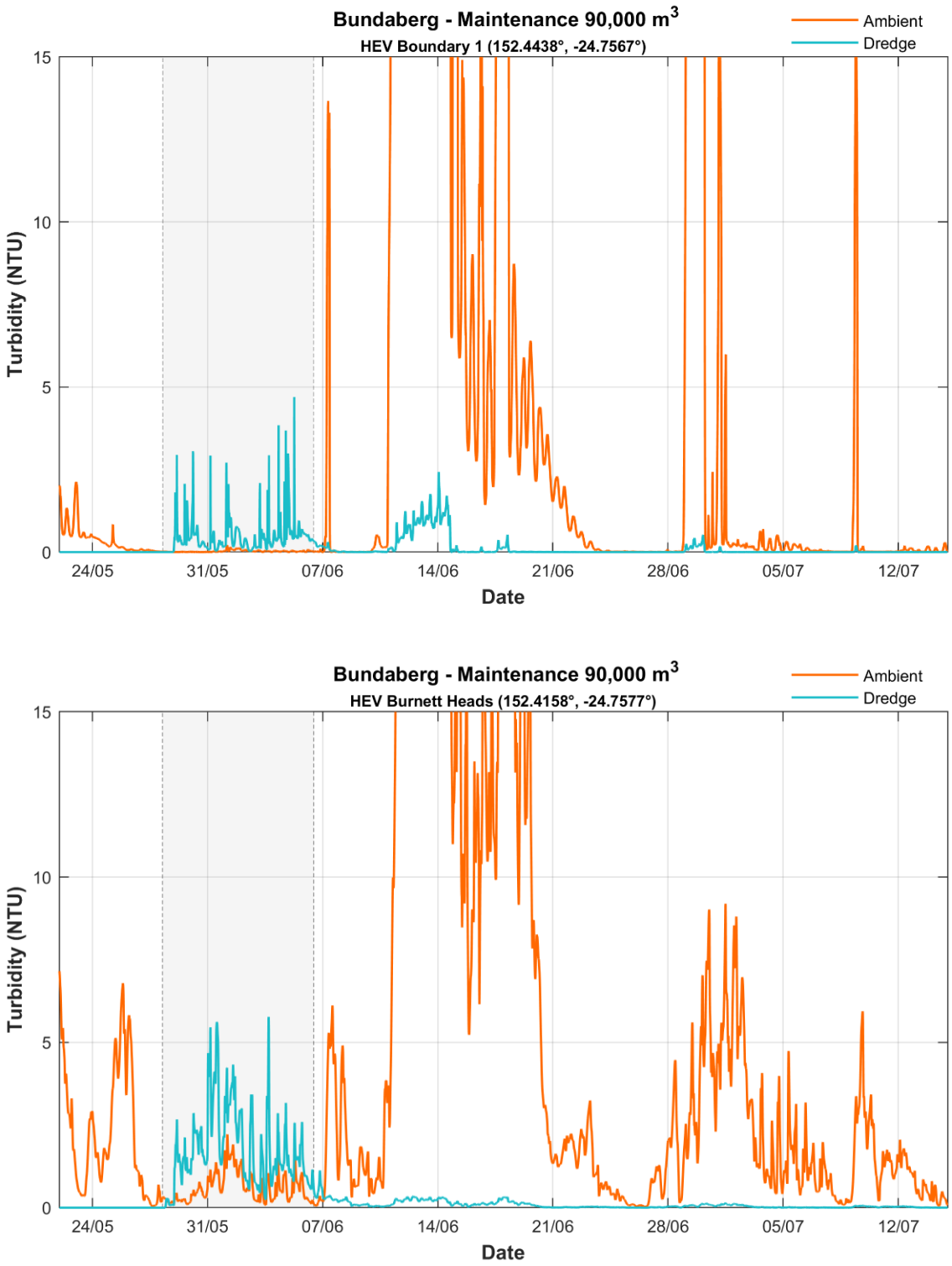

Figure 5-6 Time Series of Modelled Depth-averaged Turbidity at HEV Boundary 1 (Top) and HEV Burnett Heads (Bottom)

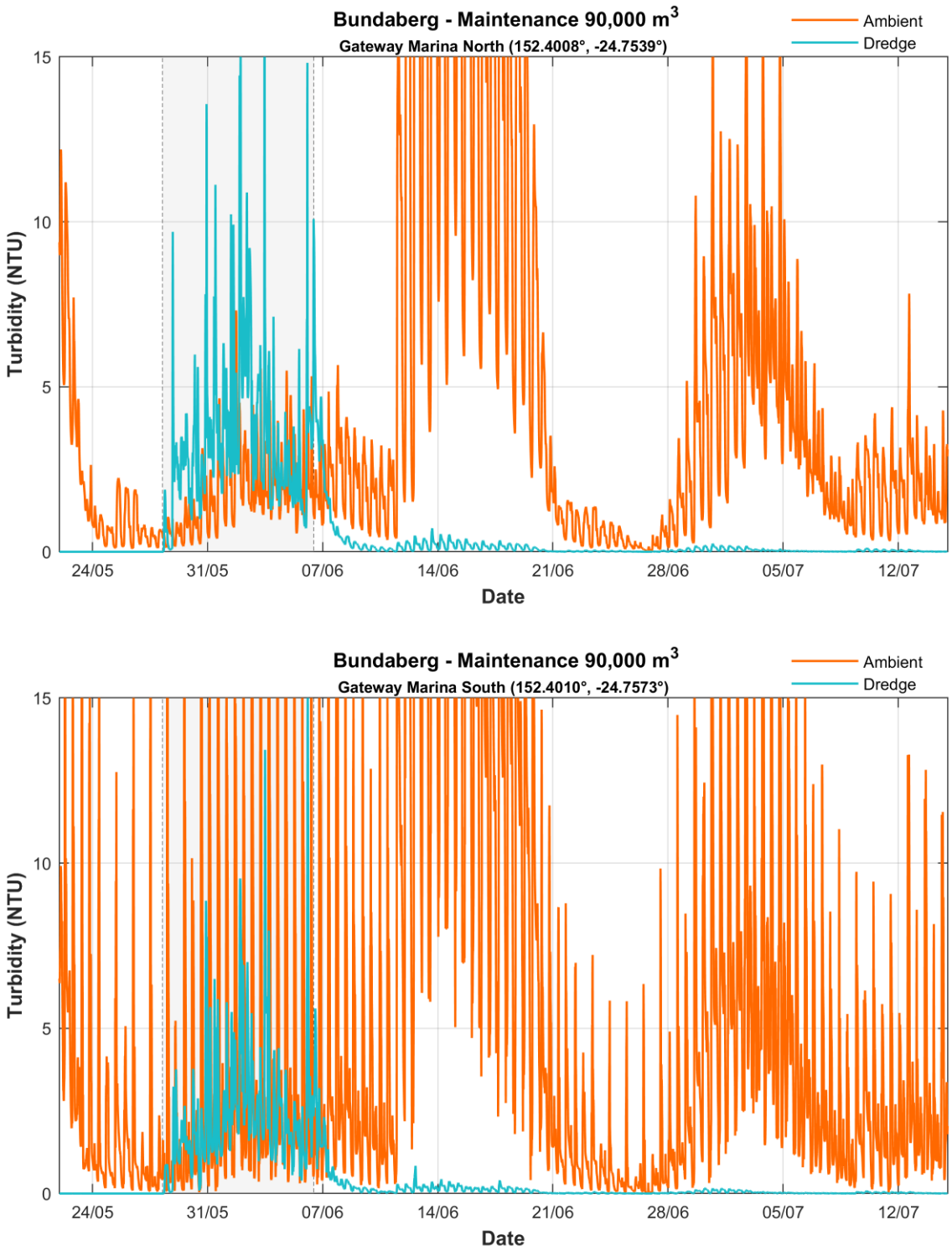

Figure 5-7 Time Series of Modelled Depth-averaged Turbidity at Gateway Marina North (Top) and Gateway Marina South (Bottom)

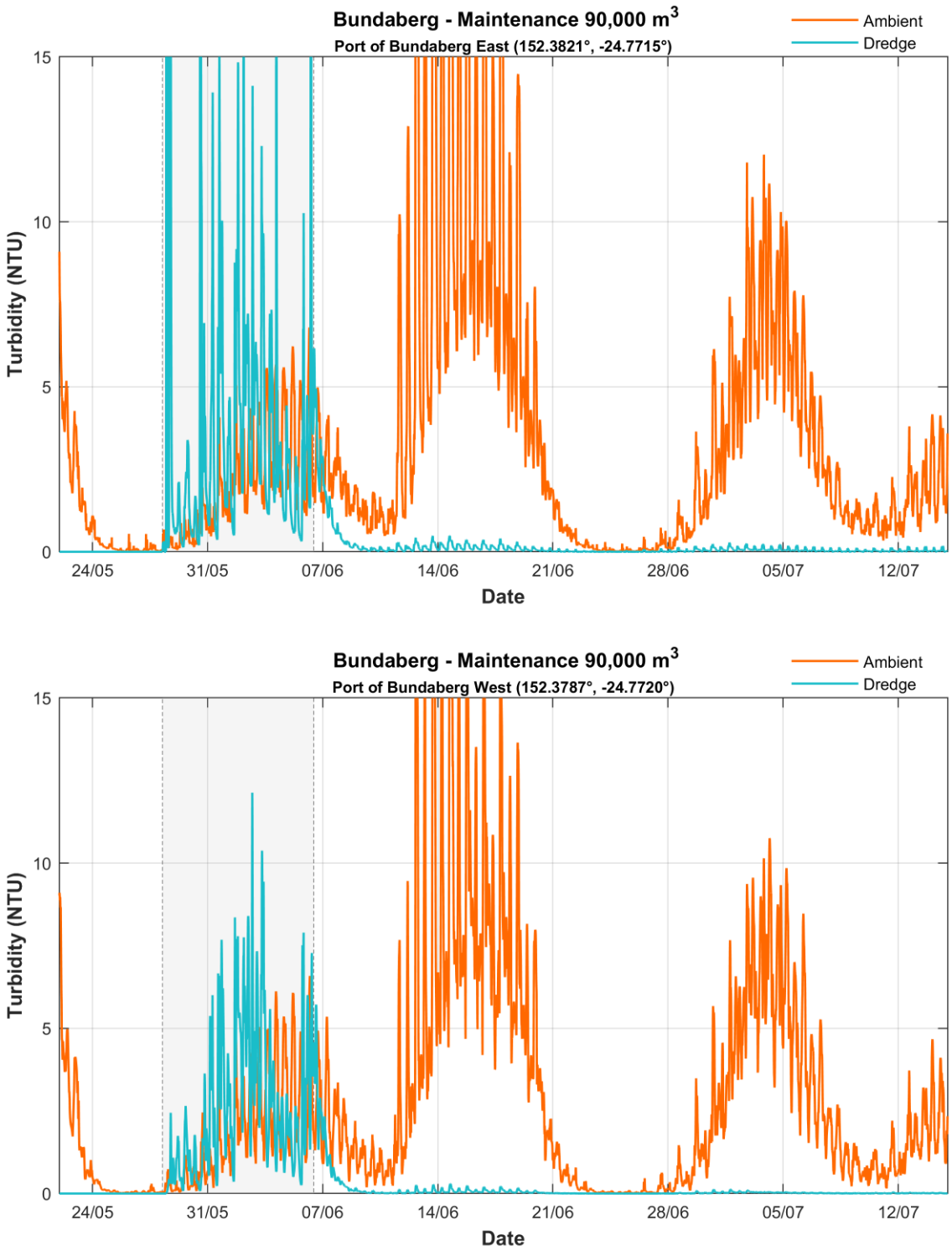

Figure 5-8 Time Series of Modelled Depth-averaged Turbidity at Port of Bundaberg East (Top) and Port of Bundaberg West (Bottom)

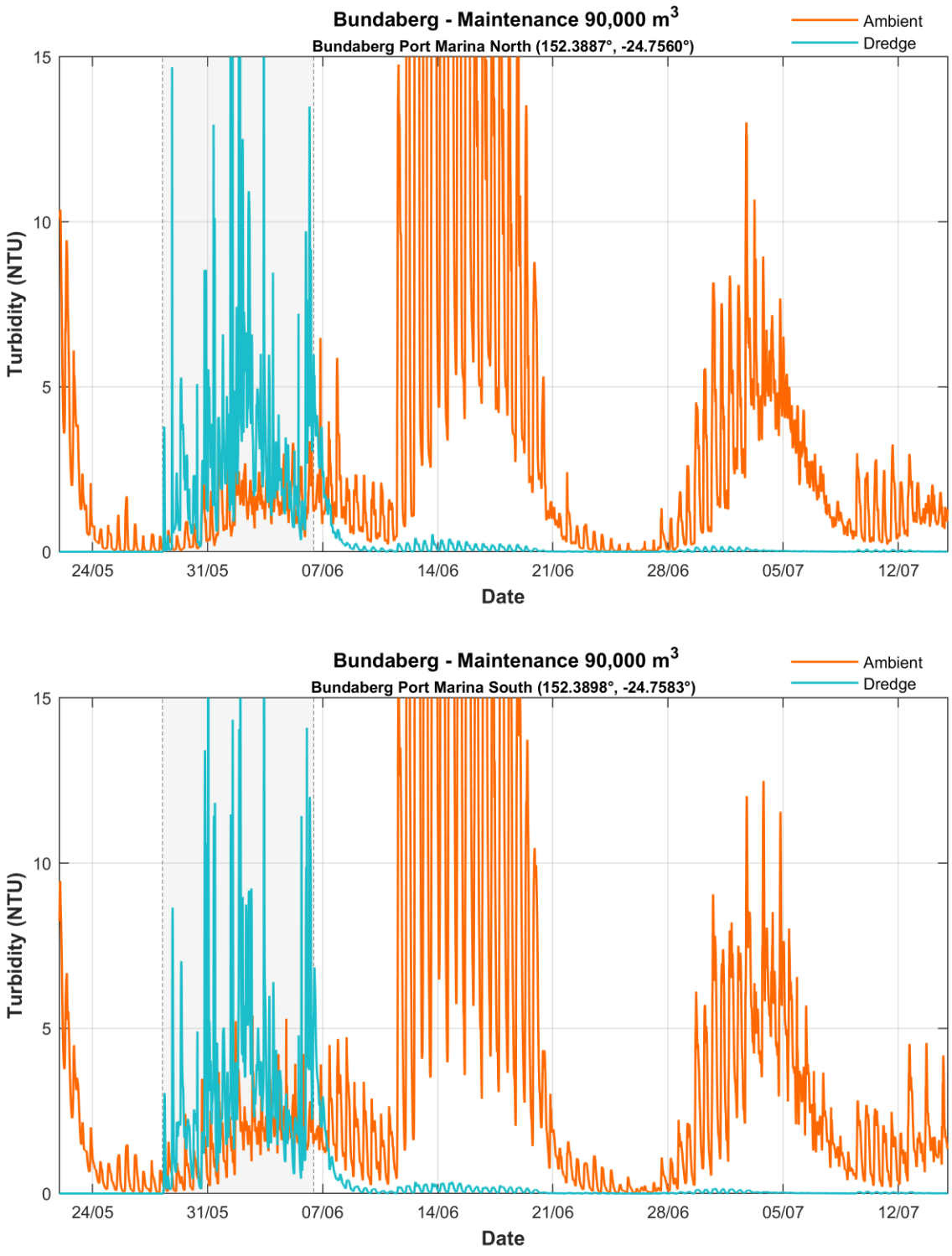

Figure 5-9 Time Series of Modelled Depth-averaged Turbidity at Bundaberg Port Marina North (Top) and Bundaberg Port Marina South (Bottom)

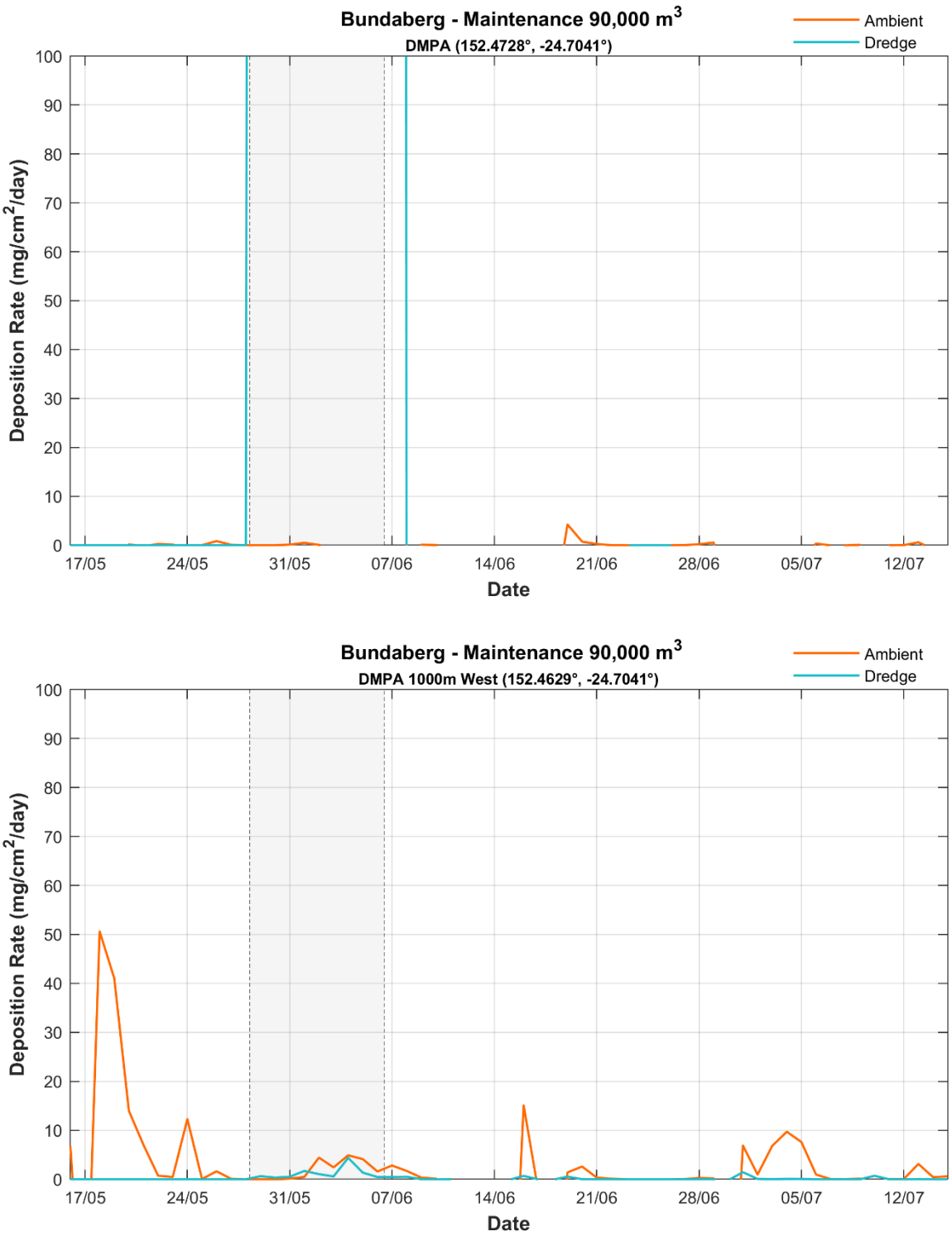

Figure 5-10 Time Series of Modelled Deposition Rate at DMPA (Top) and DMPA 1000m West (Bottom)

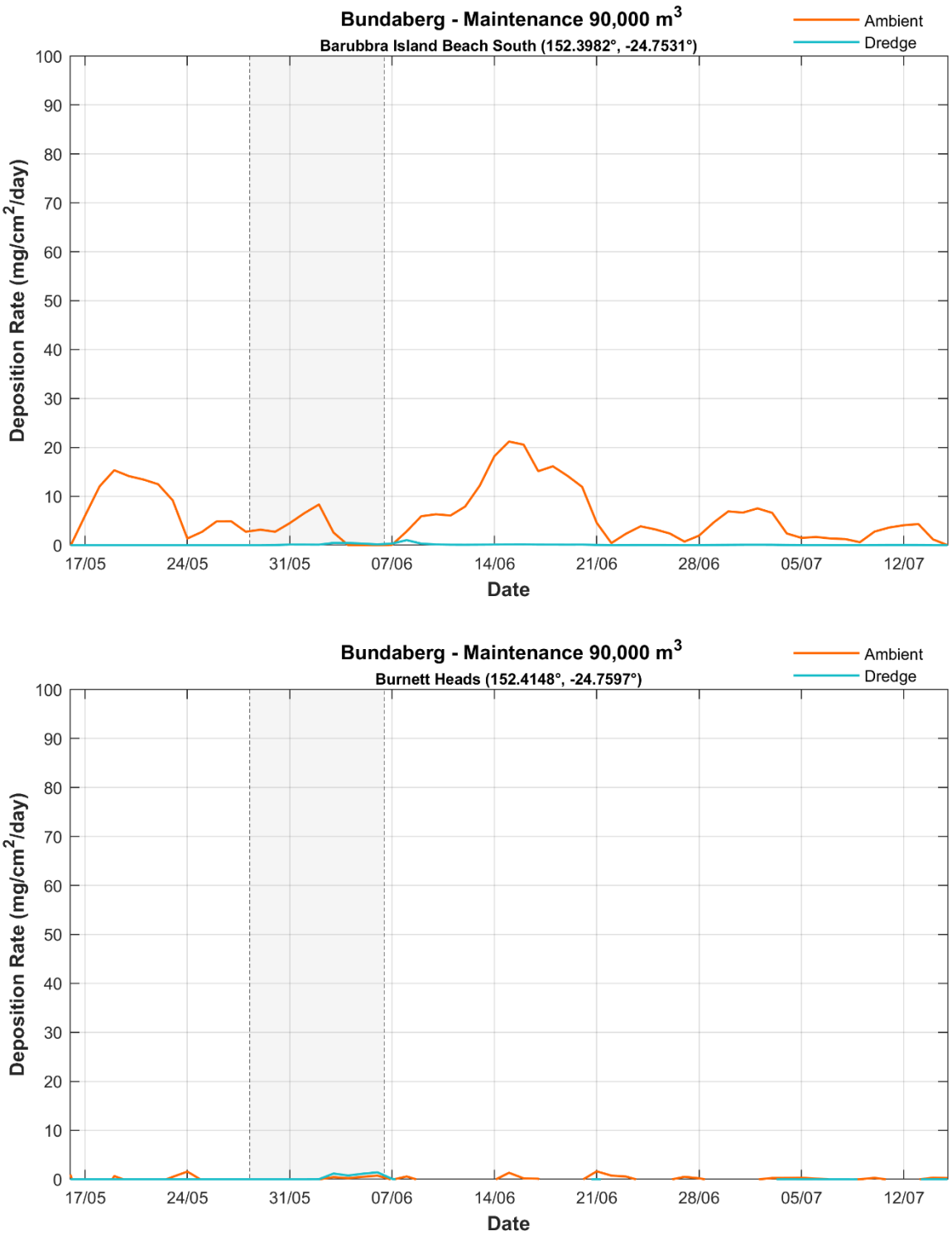

Figure 5-11 Time Series of Modelled Deposition Rate at Barubbra Island Beach South (Top) and Burnett Heads (Bottom)

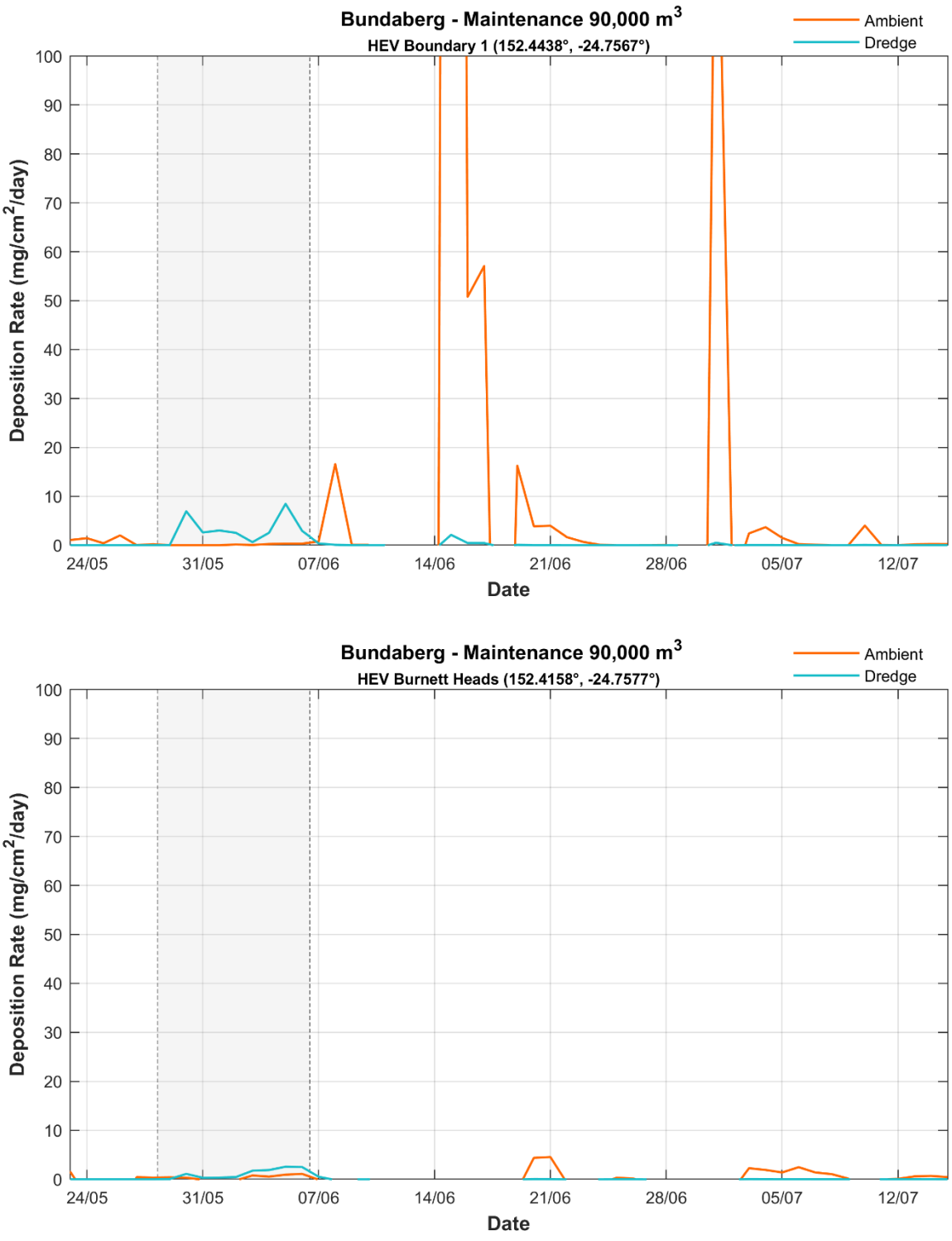

Figure 5-12 Time Series of Modelled Deposition Rate at HEV Boundary 1 (Top) and HEV Burnett Heads (Bottom)

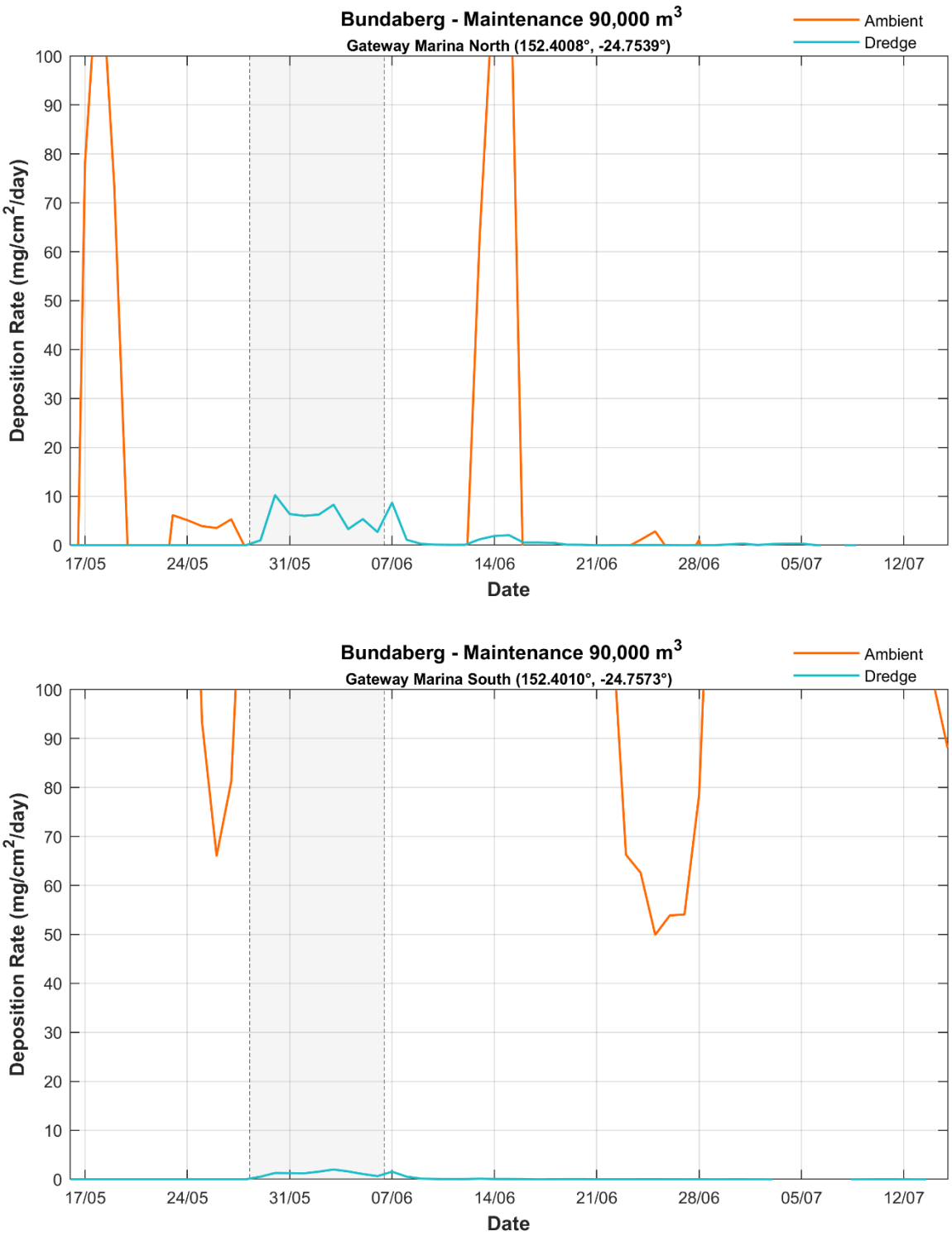

Figure 5-13 Time Series of Modelled Deposition Rate at Gateway Marina North (Top) and Gateway Marina South (Bottom)

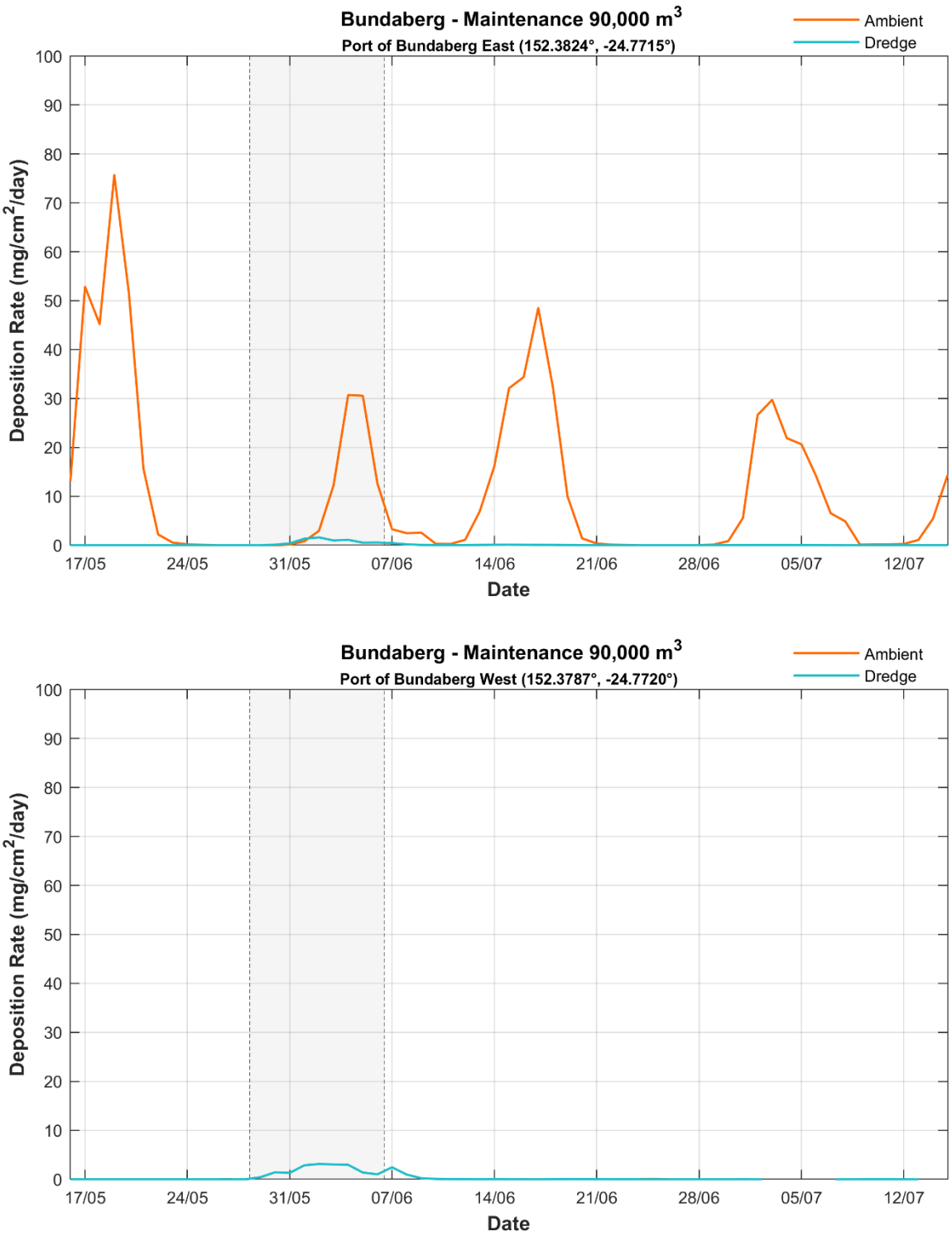

Figure 5-14 Time Series of Modelled Deposition Rate at Port of Bundaberg East (Top) and Port of Bundaberg West (Bottom)

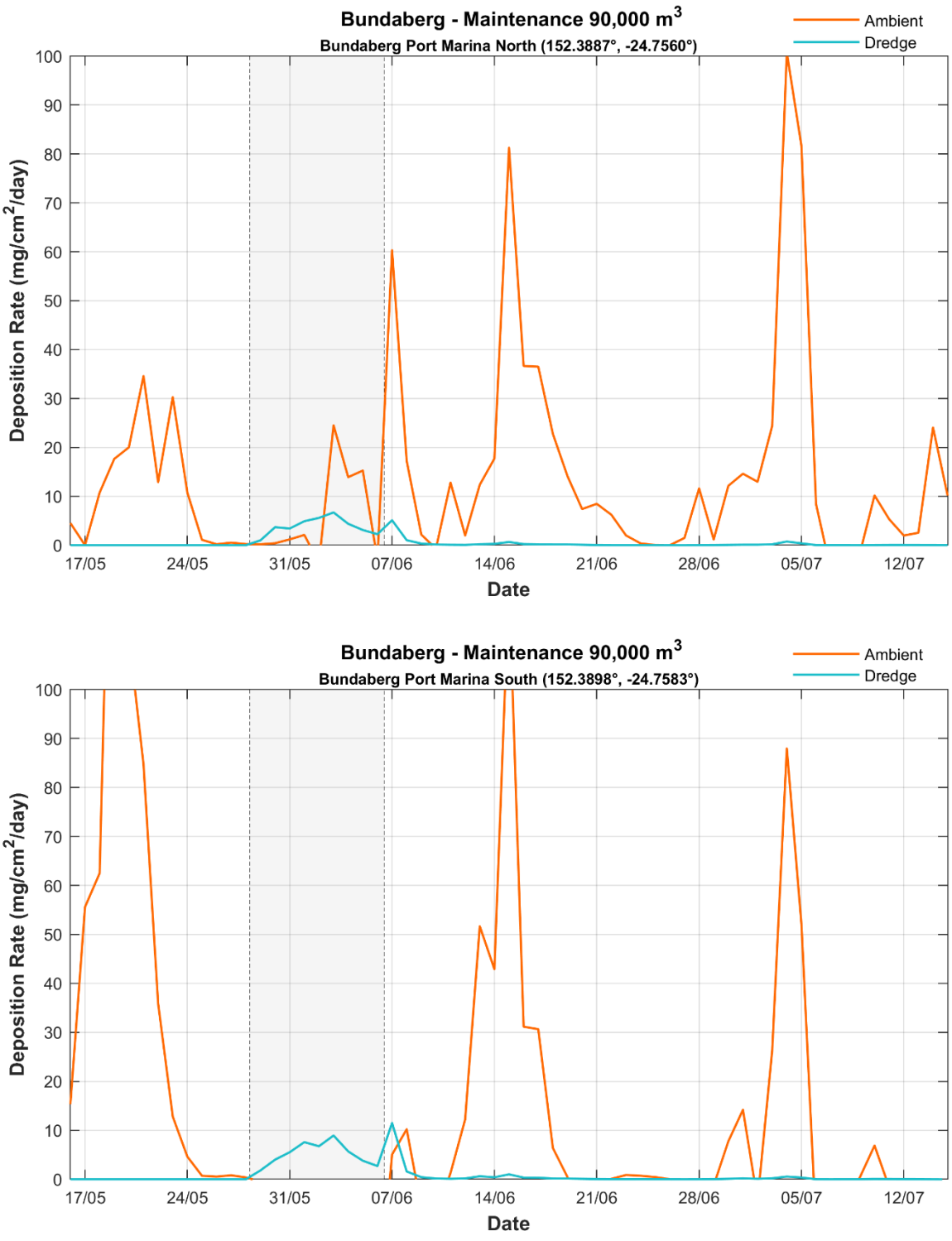

Figure 5-15 Time Series of Modelled Deposition Rate at Bundaberg Port Marina North (Top) and Bundaberg Port Marina South (Bottom)

Within the Burnett estuary, the modelled median dredge-related turbidity value exceeded 2.3 NTU (background turbidity one standard deviation – see above for rationale) within the immediate vicinity of the dredge footprint. The WQO of 6 NTU was also exceeded in the immediate vicinity of the dredge footprint. Rock walls are expected to contain filter-feeding species that may be sensitive to prolonged periods of high turbidity. Time series of modelled turbidity at rock wall locations shows that dredging resulted in short-term, low intensity turbidity spikes (typically <15 NTU) well within the range of ambient turbidity. This is unlikely to result in major changes to rock wall communities.

Coastal waters support several sensitive ecological receptors:

- nearshore reefs – the dredge plume is predicted to propagate through the Burnett River mouth to nearshore reefs immediately south of Burnett Heads. Median turbidity at the most affected reef site is predicted to be 2 NTU, and the 95th percentile is predicted to be 2-3 NTU (Figure 5-1). Both metrics temporarily exceed the WQO of 1 NTU (for HEV coastal). The time-series shows that dredge plumes are short-term (measured in hundreds of minutes), low intensity (maximum dredging turbidity 7 NTU, peaks typically <2-3 NTU) features. On this basis, it is unlikely that dredge plumes would result in detectable changes to reef communities.
- seagrass meadows – the offshore DMPA and immediate surrounds support extensive seagrass meadows. Modelled dredge-related turbidity was >15 NTU within offshore DMPA seagrass meadow reporting location, and the median and 95th percentile values were <1 NTU and 3 NTU respectively. The time series (Figure 5-4) show that dredge plumes were short-term (plumes measured in 10s of minutes to hours), infrequent, low intensity (maximum dredging turbidity ~15 NTU) features. It is possible that a combination of dredging and a sustained period of high turbidity resulting from wind driven events could result in adverse short-term effects to seagrass within the DMPA (e.g. temporary effects on photosynthesis and other signs of stress). Future maintenance campaigns will be a similar magnitude as those that have occurred previously, therefore any impacts to seagrass meadows (and dependent fauna communities) are expected to be within the historical range.
- turtle nesting beaches – dredge plumes are predicted not to extend to turtle nesting beaches.
- HEV boundary – low intensity, short-term dredge plumes are predicted at the HEV boundary. On this basis, and taking into account the short duration of the dredge campaign, impacts to ecological receptors within HEV waters are not expected.

5.2 Other Water Quality Parameters

There are no available plume monitoring data for other water quality parameters at the PoB. Case studies in other Queensland ports (Port of Gladstone, Brisbane etc.) indicate that dredging and disposal plumes can typically have nutrient and other constituents above background levels, in response to the following processes:

- Resuspension of particulate-bound nutrients and other constituents 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.

- Release of particulate-bound and dissolved constituents in dredged sediments and waters from the dredge hopper into the disposal site.

The results from other ports 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 disposal. The degradation rates of organic matter to bioavailable nutrients in pore water depends on the form of the organic matter. Phytoplankton has high reactivity and is therefore broken down at timescales <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. It is expected that the silty and sandy dredged sediments at the PoB will have similar characteristics.

Dredge plume monitoring in similar environments indicate that ammonia and other bioavailable nutrients do not result in persistent water quality impacts. For example, monitoring of dredge plumes at Port Curtis demonstrated that nutrients in plumes generated by dredging and disposal 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 Mud Island DMPA (BMT, 2009). BMT (2009) 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 disposal. These studies 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. Similar processes are expected at the PoB, but monitoring would be required to confirm.

Metals, metalloids and other potential contaminants in dredged sediments do not occur at levels of concern. Monitoring could be undertaken to assess their behaviour and confirm risks.

5.3 Ecological Implications

Table 5-1 summarises marine communities in the dredging and disposal footprint and immediate surrounds (study area), and key impact pathways.

Table 5-1 Marine communities in the dredge and disposal footprint and immediate surrounds (study area) and potential impact pathways

Communities	Direct effects	Indirect effects
Soft-sediment benthic invertebrates	• extraction of benthos living in the channel • smothering of benthos at the disposal site	• physiological impairment by sediment • liberation of nutrients and food resources at the dredge and disposal sites
Plankton and nekton 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	• smothering of seagrass at the disposal site	• 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 and Disposal 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 offshore DMPA.

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 therefore remain in a state of flux, resulting in localised changes to community structure.

Monitoring studies indicates that sediments and benthic communities at the offshore DMPA are different from areas nearby (see Section 4.3.1.3). WBM (2003) detected changes in benthic communities immediately after disposal, but recovery within 12 months. More recent monitoring (AMA, 2015) found differences between DMPA communities (higher richness primarily due to more crustaceans) and those outside the DMPA, which was potentially related to the higher proportion of coarser sediment at the DMPA. It is expected that ongoing disposal will continue to alter communities that are largely confined to within the offshore DMPA.

No seagrass meadows, reef-building coral assemblages, macroalgae beds or mangroves occur in the dredge footprint. As discussed in Section 4.3.1.1, seagrass meadows occur at the offshore DMPA despite a long history of dredged material disposal. Seagrass species in the study area are coloniser species that are capable of rapid recovery (Kilminster *et al.*, 2015; see Section 4.3.1.1).

5.3.1.2 Marine Megafauna Vessel Strike

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).

GHD (2005), citing personal communication from Dr Col Limpus, suggest that the numbers of turtles captured during dredging across all Queensland Ports is decreasing, with an average of 1.7 loggerhead turtles per year being captured across all ports. In the context of PoB, since 2010 there has been 11 dredging campaigns, with an average of 0.4 turtles captured per campaign (GPC unpublished data, 2021). GPC (personal communication August 2021) advised that no turtle strikes occurred in the Inner Reaches of the PoB Channel, Swing Basin or Berths, and that tracking data shows that turtles tend to congregate in the Sea Reach section of the channel.

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

The dredger will represent an intermittent noise source that has the potential to temporarily interfere with marine megafauna communications during the dredge campaign. Further work would be required to assess impacts. Notwithstanding this, any impacts are expected to be within the range of historical campaigns.

5.3.2 Indirect Effects Due to Sediments and Water Quality Changes

5.3.2.1 Nutrients and Algae

There is insufficient data to quantify potential dredge-related changes to nutrients. Given the well flushed nature of dredge and disposal sites, and the highly dispersive nature of dredge plumes, it is expected that any impacts will be short-term and low intensity, and are unlikely to cause algal blooms.

5.3.2.2 Sediment Impacts to Soft Sediment Benthos

Soft sediment benthos occurs within the dredge plume extents, and may be indirectly affected by dredging by:

- 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. Future campaigns are likely to result in similar effects on the DMPA and surrounding soft sediment to what has been observed previously (assuming "clean" material continues to be placed, and that these effects are largely related to physical burial).

5.3.2.3 Sediment Impacts to Seagrass and Reefs

As discussed in Section 5.1, dredge plumes extend to mapped seagrass meadows at the offshore DMPA and surrounds. Plumes are short-lived and low intensity, but there is the potential for localised seagrass impacts within the DMPA if dredging occurs during or following an extended period of poor water quality conditions (see Section 5.1). Any impacts are expected to be within the historical range. Plumes outside the DMPA are low intensity and frequency/duration, and are not expected to result in major impacts to meadows.

Low intensity/duration dredge plumes extend to nearshore reefs at the mouth of the Burnett River. Impacts to these communities due to dredging-related turbidity are not expected. Analysis of the time series of deposition rate presented in Section 5.1 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 have a lateral line system that is used to detect prey, which allow many fish species to feed in highly turbid waters. 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. Fish will also tend to evade unfavourable water quality conditions. Given the low intensity and duration of dredge plumes, impacts to fish are not expected.

Prawns and portunid (mud and sand) crabs represent key species of commercial significance, and utilise both nearshore and offshore waters (including parts of the study area) as part of their life-cycle. These species primarily inhabit turbid water environments, and are tolerant of a wide range of turbidity conditions. These species are also highly mobile and actively burrow into soft sediments, and are therefore tolerant of high rates of sediment burial. 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 2011 and 2012 across the entire Queensland coast, as a result of habitat loss (seagrass) associated with flooding, high turbidity and low visibility (GBRMPA, 2011). These conditions make fauna more susceptible to starvation and boat strike.

Maintenance dredging plumes are not expected to significantly impact on seagrass meadows outside the DMPA or corals (Section 5.3.2.3), nor are major changes to benthic macroinvertebrate communities expected. It is possible that highly localised impacts to seagrass meadows in the DMPA could occur, however any impacts are expected to be short-term. It is therefore 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). 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 and hawksbill turtle, which feed on seagrass and/or in reef environments, may avoid areas affected by turbid plumes. 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 in 2001 and Caribbean tubeworm (*Hydroides sanctaecrucis*) has also been introduced there (Souter, 2009).

No targeted marine pest surveys have been carried out in the port to date. The benthic flora and fauna surveys carried out in the Port (see Section 4.3.1.3) did not note the identify any marine pest infestations. However, these surveys should not be considered exhaustive, given they did not target marine pests, the difficulties associated with surveying large ports and the lack of taxonomic information for many marine species.

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) can subsequently translocate pests within (e.g. the DMPA) and

outside the port area. The environmental and economic impacts due to the introduction of exotic marine pests can be significant. Marine pests, once established, can be difficult to eradicate and can have serious and permanent consequences for the marine environment, marine productivity and public health.

Relative to other vessels using the Port, the dredger is not considered to pose a major risk in terms of introducing marine pests to the Port of Bundaberg. This is based on the following:

- The dredger visits the port on average once a year for maintenance dredging, which is low compared to visitation rates by international and domestic vessels using the Port. The dredge vessel remaining in the study area for the duration of the dredging campaign.
- The *TSHD Brisbane* works primarily within Queensland ports and the Port of Melbourne, and will therefore not introduce marine pests directly from international waters.
- Any TSHD dredger contracted to undertake dredging works will be required to comply with best practices, including the Australian Quarantine and Inspection Service (AQIS) 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.

5.4 Impacts on Other Users

Maintenance dredging operations and associated plumes and sedimentation have the potential to impact other users of the area, including commercial and recreational fishers, recreational boating enthusiasts, and vessel traffic.

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. Maritime Safety Queensland (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 PoB area includes 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.
- 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 5.3.2.3, plumes are not expected to result in major long term impacts to 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 Impact Significance to MNES

The impact of dredging and disposal 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 factors (De Lange *et al.*, 2010; Figure 5-16):

- 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
- Adaptative capacity – the capacity of receptor to adapt or recover from stress.

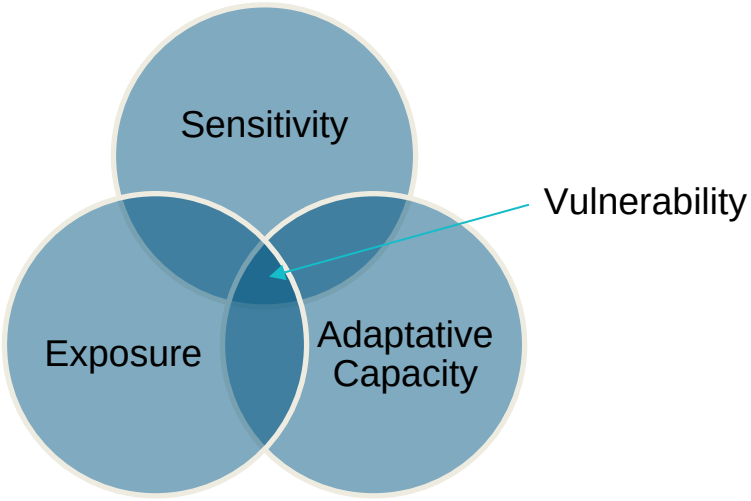

Figure 5-16 Elements defining vulnerability

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 Threatened Ecological Communities (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 maintenance dredging.

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 (2) 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
- interfere with the recovery of the species.

Critically Endangered or Endangered Species that are likely to occur in the study area, and the potential impact of maintenance dredging on this species is provided in Table 5-2. Based on the above criteria, no significant impacts are expected to occur to these species or their habitat.

Table 5-2 Potential Impacts to Critically Endangered or Endangered Species known to, or likely to occur, within the study area as defined in Table 4-5

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
White's Seahorse *Hippocampus whitei*	Very low – potential habitat present, but not known from central Qld	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
Blue Whale *Balaenoptera musculus*	Very low – Possible transient visitor to PoB during summer, highly unlikely to regularly use dredge/disposal 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*	High – The Bundaberg region is an important habitat for this species. Remote from nesting habitat (sandy beaches) and designated important habitats	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 study 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
Leatherback Turtle *Dermochelys coriacea*	Low – Possible transient visitor to the Port, highly unlikely to regularly use dredge/disposal sites. Remote from nesting habitat and designated BIA (inter-nesting habitat outside the Port)	Direct – resilient to periodic high turbidity given background conditions Indirect - Flexible diet, uses food resources	No significant impact – preferred habitat does not overlap with disturbed areas occurs in study area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
		with varying sensitivity to turbidity.	
Olive Ridley Turtle *Lepidochelys olivacea*	Low – Possible transient visitor to the Port, highly unlikely to regularly use dredge/disposal sites. Remote from nesting habitat	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 study 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, or
- 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/or
- populations that are near the limit of the species range.

Vulnerable species that are likely to occur in the study area, and the potential impact of maintenance dredging on this species is provided in Table 5-3. In the context of important populations, PoB provides:

- All Queensland coastal waters represent a BIA for Humpback Whale. It is unlikely to be directly or indirectly affected by transient, localised dredge plumes.

- Listed Critical Habitat (nesting) and BIA (nesting) occur at and adjacent to sandy beaches of the Bundaberg area for vulnerable green and flatback turtle[2]. These areas are remote from dredge plumes. The dredge/disposal 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 5-3 Potential Impacts to Vulnerable species known to, or likely to occur, within the study area as defined in Table 4-5

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
Humpback Whale *Megaptera novaeangliae*	Low – Possible transient visitor during winter, highly unlikely to regularly use dredge/disposal sites BIA present (all Qld 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 in the Burnett River and adjacent coastal waters. Seagrass meadows offshore could provide feeding habitat, and nesting beaches occur along the coast.	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 study 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*	High - Known to occur. Remote from important 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 study 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 reefs) occur near channels. Nesting habitat present on sandy beaches of the region (designated Critical Habitat and BIA)	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 study 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 Port (year-round), highly unlikely to regularly use dredge/disposal sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions Indirect - Flexible diet, uses food resources with varying sensitivity	No significant impact – preferred habitat does not overlap with disturbed areas occurs in study area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

[2] The Turtle Nesting Distribution Abundance and Migration database (DES 2021c) indicates that for the study are, fewer than 10 testing females per year for these species

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
		to turbidity (fish, marine mammals)	
Green Sawfish *Pristis zijsron*	Very low – potential habitat present, but not known from central Qld	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 transient visitor to the Port (year-round), highly unlikely to regularly use dredge/disposal 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 study 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
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

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.

Table 5-4 lists migratory species that occur, or are likely to occur, in the study area. Note that this list excludes critically endangered, endangered or threatened species already considered in previous sections.

In the context of important populations, the study area provides:

- All Queensland coastal waters represent a BIA for Humpback Whale. The dredge site is not known to be regularly frequented by this species, but it may traverse through the DMPA and surrounds. It is unlikely to be directly or indirectly affected by transient, localized dredge plumes.

- Critical Habitat (nesting) and BIA (inter-nesting) occur at and adjacent to sandy beaches of the Bundaberg area for flatback, loggerhead, green, leatherback and flatback turtle. These areas are remote from dredge plumes. The dredge/disposal sites may be frequented by these species, but they are unlikely to be directly or indirectly affected by transient, localized dredge plumes.
- Coastal waters between Bundaberg and Fraser Island within the 20m depth contour represent a BIA for Australian Humpback Dolphin. The dredge/disposal sites are potential 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 5-4 Potential Impacts to migratory species known to, or likely to occur, within the study area (excluding threatened migratory species described elsewhere) as defined in Table 4-5

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
Australian Snubfin Dolphin *Orcaella heinsohni*	High – Potential feeding and breeding in Port area year-round, but unlikely to regularly occur (Table 4-5)	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 study 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 (=chinensis)*	High – Potential feeding and breeding in Port area year-round, possibly occurs at dredge/disposal sites BIA (calving, feeding) present	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 study 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 Port. Offshore seagrass meadows provide potential feeding habitat	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 study area, but the short-term water quality changes are not expected to have direct effects or lead to significant, long term impacts to seagrass habitats or food resources
Bryde's Whale *Balaenoptera edeni*	Very low – Mostly oceanic but possible transient visitor to the Port (year-round), highly unlikely to regularly use dredge/disposal sites	Direct – if present, would require some tolerance to periodic high turbidity given background conditions	No significant impact – preferred habitat does not overlap with study area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources

Species	Exposure (Likelihood of occurrence in study area)	Sensitivity and Adaptive Capacity	Assessment
		Indirect - Flexible diet, uses food resources with varying sensitivity to turbidity (plankton, small fish)	
Killer Whale *Orcinus orca*	Very low – Mostly oceanic but possible transient visitor to the Port (year-round), highly unlikely to regularly use dredge/disposal 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 (fish, marine mammals)	No significant impact – preferred habitat does not overlap with study area. Short-term water quality changes are not expected to have direct effects or lead to significant impacts to habitats or food resources
Salt-water Crocodile *Crocodylus porosus*	Moderate – potential habitat present, but not known from central Qld	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*	Low – Mostly oceanic but possible transient visitor to the Port (year-round), highly unlikely to regularly use dredge/disposal 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 study 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*	Low – Mostly oceanic but possible transient visitor to the Port (year-round), highly unlikely to regularly use dredge/disposal 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 study 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*	Low – Mostly oceanic but possible transient visitor to ther Port (year-round), highly unlikely to regularly use dredge/disposal 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 study 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

Commonwealth Marine Area occurs remote from the influence of dredge and disposal plumes (i.e. no exposure). No impacts to Commonwealth Marine Area will therefore occur as a result of maintenance dredging.

5.6 Matters of State Environmental Significance

Section 4.5 provides an overview on MSES relevant to the proposed 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 at and 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.
- 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.
- The potential for dredging to introduce invasive species into the wetland (seagrass meadows) is low as there are no known high-risk marine pests in the PoB (Section 5.3.3).

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 habitat. 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.
- Not to disrupt ecologically significant locations used for breeding, feeding, nesting, migration or resting.

5.6.3 Highly Protected Zone of State Marine Parks

The dredging activities will take place adjacent to the GSMP. 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.
- Reduce the natural or cultural values of all or part of the GSMP.

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

Categories known or potentially relevant to dredging and disposal are set out in Table 5-5. Compliance with these performance outcomes ensures coastal processes, resources, protection and management is maintained. For dredging and disposal 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 Matters of State Environmental Significance (MSES) are assessed via the avoid, minimise, mitigate and offset hierarchy.

Table 5-5 State Code 8 Coastal Development and Tidal Works Performance Outcomes Relevant to the Project

Category	Performance outcome	Response	Notes
Water Quality	PO11 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 disposal on water quality parameters (based on similar projects) indicates that nutrients, chlorophyll, metals/metalloids and other water quality parameters in dredge plumes represent a low environmental risk. However, monitoring can be undertaken to assess these conclusions and confirm risks. See Section 5.2 for further detail. Dredging and disposal 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	PO16 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: (3) only applies to development on Brisbane core port land within the area identified as E1 Conservation/Buffer, E2 Open Space or Buffer/Investigation in the Brisbane Port Land Use Planning (LUP) precinct plan. Note: Guidance for determining if the development will have a significant residual impact on the matter of state environmental significance is provided in the Significant Residual Impact Guideline, Department of State Development, Infrastructure and Planning, 2014. Where the significant residual impact is considered an acceptable impact on the matter of state environmental significance and an offset is considered appropriate, the offset should be delivered in accordance with the *Environmental Offsets Act 2004*.
Disposal of dredged material other than	PO19 Dredged material is returned to tidal water where this is needed to maintain coastal processes and sediment volume.	Placement of dredged material at the DMPA ensures that the sediment is retained in the dynamic nearshore sedimentary system and helps to maintain natural coastal processes.	None

Category	Performance outcome	Response	Notes
from artificial waterways	PO20 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 disposal 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 Sustainable Sediment Management project (see BMT, 2021)	None
All dredging and any disposal of dredged material in tidal water	PO21 All dredging and any disposal of dredged material in tidal water is: 1. demonstrated to be safe with regard to protection of the marine environment and by meeting the National Assessment Guidelines for Dredging (NAGD) 2009, Department of Environment and Energy, 2009, or later version; and 2. supported by a monitoring and management plan that protects the marine environment and that complies with the National Assessment Guidelines for Dredging 2009, Department of Environment and Energy, 2009, or later version.	Contaminant concentrations in dredged material are typically below screening level or background concentrations. In accordance with NAGD, only material that is deemed clean will be disposed in marine waters. Refer to Section 4.2.2 for further detail. Dredging and disposal will also be supported by a Dredge Management Plan (to be supplied by GPC).	None

6 Conclusion

In summary, the following findings were reported:

- The Port of Bundaberg and surrounds supports a range of marine and estuarine wetland types, including:
  - deep water seagrass meadows in coastal waters at and adjacent to the DMPA and sea channel
  - fringing coastal reefs (located to the south of Burnett Heads)
  - sandy beaches along the coast
  - extensive areas of soft sediment habitat in the Burnett River and offshore environments
  - intertidal wetlands (mangroves, saltmarsh and shoals) within the lower Burnett River (which are outside of the zone of impact from dredging and are not considered further).
- These wetland types provide habitat for flora and fauna communities containing threatened and listed migratory species, and species of fisheries significance.
- Floods and 'freshes' periodically deliver catchment pollutants to estuarine and nearshore coastal waters. Pollutants and freshwater in flood waters exert a strong control on marine and estuarine water quality and ecosystems.
- Long-term water quality monitoring data were collected at a site in the lower estuary during a dry period (2017-19). Water quality in the Burnett River estuary met draft WQOs for turbidity and typically pH and dissolved oxygen. Chlorophyll *a* was slightly greater than the draft WQO in all years. No long-term monitoring data are available for 'wet periods' in the estuary, or for coastal environments.
- Several metals/metalloids and organic pollutants (organotins) have been detected in dredged sediments, but all had average concentrations well below National Assessment Guidelines for Dredging (NAGD) screening levels and were considered suitable for ocean disposal.
- Numerical modelling was carried out to simulate turbidity and sediment deposition rates from dredging and dredged material disposal.
- Modelling results indicate that dredging would result in short-term, low intensity turbidity spikes, typically well within the range of modelled ambient turbidity.
- The modelled dredging-related deposition rate was very high during the dredging activity at the DMPA, but was negligible in the period following the completion of dredging.
- No major impacts to sensitive receptor habitats (seagrass meadows, reefs, turtle nesting beaches) are expected given the short duration and low intensity of dredge-related turbidity, and the limited spatial extent of sediment deposition (restricted to areas within the DMPA).
- Future maintenance dredging is expected to have similar range of impacts as previous campaigns.

- Significant impacts to protected matters (MNES, MSES) are not expected as a result of maintenance dredging and disposal activities.

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Appendix A PMST Report

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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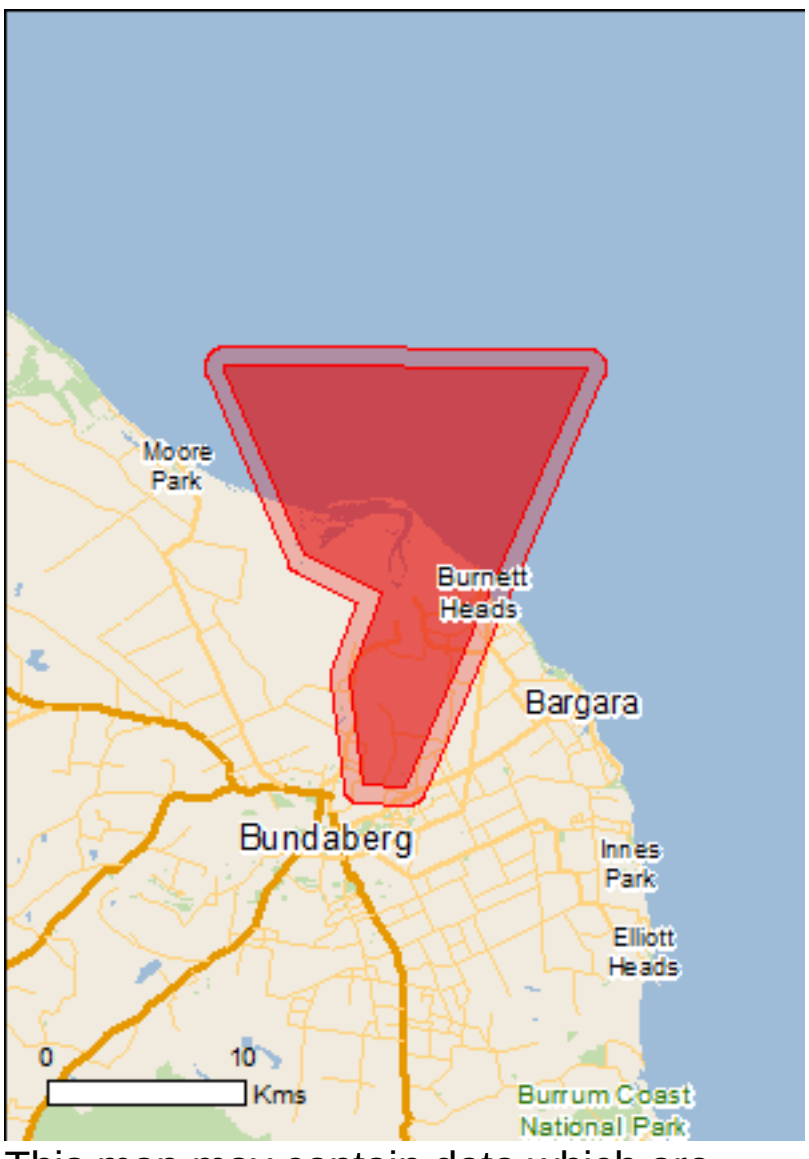

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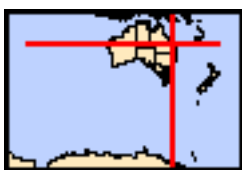

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	59
Listed Migratory Species:	66

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	102
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	27
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

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

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
Temperate East

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.

Name	Status	Type of Presence
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 Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
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

Name	Status	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Cyclopsitta diophthalma_coxeni Coxen's Fig-Parrot [59714]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely 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 may 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
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
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	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 known to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species

Name	Status	Type of Presence
		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 likely to occur within area
Fish		
Hippocampus whitei		
White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	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
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans		
Greater Glider [254]	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]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia attenuata		
[10690]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo [3205]	Vulnerable	Species or species habitat known to occur within area
Dichanthium setosum bluegrass [14159]	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
Macrozamia pauli-guilielmi Pineapple Zamia [5712]	Endangered	Species or species habitat may occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat likely to occur within area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat may occur within area
Reptiles		
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
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 known to occur within area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	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
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		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

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
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]		Foraging, feeding or related behaviour 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
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	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		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species

Name	Threatened	Type of Presence
		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
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	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
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

Name	Threatened	Type of Presence
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Foraging, feeding or related behaviour likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	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
Monarcha trivirgatus Spectacled Monarch [610]		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 likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat 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 known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur

Name	Threatened	Type of Presence
		within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely 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
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour 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]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		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
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea ibis Cattle Egret [59542]		Breeding likely 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 known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known 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
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Foraging, feeding or related behaviour known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat 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 likely to occur within 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
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
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Foraging, feeding or related behaviour known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Thalassarche eremita](#) Chatham Albatross [64457]	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
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
[Tringa stagnatilis](#) Marsh Sandpiper, Little Greenshank [833]		Foraging, feeding or related behaviour known to occur within area
[Xenus cinereus](#) Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
[Acentronura tentaculata](#) Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
[Campichthys tryoni](#) Tryon's Pipefish [66193]		Species or species habitat may occur within area
[Corythoichthys amplexus](#) Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
[Corythoichthys ocellatus](#) Orange-spotted Pipefish, Ocellated Pipefish [66203]		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 grayi](#) Mud Pipefish, Gray's Pipefish [66221]		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

Name	Threatened	Type of Presence
		area
Hippocampus kelloggi Kellogg's Seahorse, Great Seahorse [66723]		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 trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Microphis manadensis Manado Pipefish, Manado River Pipefish [66258]		Species or species habitat may occur within area
Solegnathus dunckeri Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		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
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding 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	Foraging, feeding or related behaviour known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Laticauda colubrina a sea krait [1092]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Laticauda laticaudata a sea krait [1093]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Foraging, feeding or related behaviour likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Barubbra Island	QLD

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Reptiles		
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake,		Species or species

Name	Status	Type of Presence
Cacing Besi [1258]		habitat may occur within area

Caveat

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

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

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

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

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

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

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

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

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

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

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

Coordinates

-24.67566 152.297259,-24.676284 152.461368,-24.848996 152.379657,-24.848373 152.359744,-24.80475 152.354251,-24.778569 152.365237,-24.768593 152.368671,-24.753629 152.333652,-24.676908 152.297259,-24.67566 152.297259

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-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
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-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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