# Northern Land Expansion Project - Southern Reclamation Area Bund Wall Construction Receiving Environment Monitoring Program

## Brief description

This document describes the receiving environment attributes, environmental monitoring and related adaptive management actions to be implemented for the Northern Land Expansion Project Southern Reclamation Area bund wall construction (the Project), which will take place in the Western Basin area, Port of Gladstone. The document includes all sensitive receptors, habitats and biota, as well as stressors that can affect them, and aims to ensure that every environmental risk from construction activities is considered and measured appropriately to identify, avoid or mitigate potential impacts. The document details the environmental monitoring designed and put in place for this purpose and all the elements, analysis and information considered. The monitoring program is based on government guidelines, best practise, and years of monitoring and research, and is considered robust, science-based and fit for purpose.

This document has been prepared to address the Project *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) controlled action (**EPBC 2012/6558**), **DA2022/10/01** and **PA-EA-100261837** approval conditions.

| EPBC Act controlled action approval information | |
|---|---|
| EPBC number | 2012/6558 |
| Project name | Port of Gladstone Gatcombe and Golding Cutting Channel Duplication Project, Gladstone, Queensland |
| Proponent/approval holder and ABN | Gladstone Ports Corporation Limited (ABN 96 263 788 242) |
| Proposed/approved action | To duplicate the existing Gatcombe and Golding Cutting shipping channel, disposal of capital dredge spoil to land reclamation, and upgrade associated infrastructure in the Port of Gladstone, Queensland (refer EPBC Act referral 2012/6558 received on 26 September 2012 and subject to the variations to the action accepted by the Minister under section 156B on 25 March 2019 and 26 August 2020). |
| Location of the action | Port of Gladstone |

| Document information | |
|---|---|
| Current version | #1646415 v5H |
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|---|---|
| Audience | All GPC representatives, Government and other stakeholders |

| Document accountability | |
|---|---|
| **Role** | **Position** |
| Owner | Executive GM Safety & Environmental Social & Governance |
| Custodian | Project Manager |

## Declaration of accuracy

In making this declaration, I am aware that Section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

**Signed** Glenn Sheahan (17/06/2026 16:44:38 GMT+10)

**Full name (please print)**-GLENN SHEAHAN

**Position**- Executive GM Safety & Environmental Social & Governance

**Organisation (please print)** Gladstone Ports Corporation Limited

**Date** 17/06/2026

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# 1 Terms and definitions

**“ADCP”** means Acoustic Doppler Current Profiler;

**‘’ANZECC‘’** means Australian and New Zealand Environment and Conservation Council’’;

**‘’ARMCANZ‘’** means Agriculture and Resource Management Council of Australia and New Zealand;

**‘’AWQG’’** means Australian Water Quality Guidelines;

**“BACI”** means before-after, control-impact;

**‘’BPAR’’** means Benthic photosynthetically active radiation;

**‘’BUF’’** means Barge Unloading Facility;

**‘’CEMP’’** means Construction Environmental Management Plan;

**“CMERC”** means Coastal Marine Ecosystems Research Centre;

**‘’CVIP’’** means Clinton Vessel Interaction Project;

**“DESI”** means Department of Environment, Science and Innovation

**“DCCEEW”** means Department of Climate Change, Energy, the Environment and Water;

**‘’DFT’’** means dugong feeding trail;

**‘’DGV’’** means default guideline value;

**‘’DO’’** means dissolved oxygen;

**“EA”** means Environmental Authority

**‘’EAAF’’** means East Asian-Australasian Flyway;

**‘’EC’’** means electrical conductivity;

**‘’ECS’’** means Environmental Compliance Specialist;

**‘’EIS’’** means Environmental Impact Statement;

**‘’EPA’’** means Environmental Protection Authority;

**‘’EPBC Act’’** means *Environment Protection and Biodiversity Conservation Act 1999*;

**‘’EPP’’** means Environmental Protection Policy;

**‘’ERA’’** means Environmentally Relevant Activity;

**‘’ESM’’** means Environmental Specialist for Monitoring;

**‘’EVs’’** means Environmental Values;

**‘’EWMA’’** means Exponentially Weighted Moving Average;

**‘’FGS’’** means fine-grained sediment;

**‘’GBR’’** means Great Barrier Reef;

**‘’GHHP’’** means Gladstone Healthy Harbour Partnership;

**‘’GPC’’** means Gladstone Ports Corporation Limited;

**‘’HEV’’** means high ecological value;

**‘’JCU’’** means James Cook University;

**“LISST”** means Laser In Situ Scattering and Transmissometry

**‘’LMDMP’’** means Long-term Maintenance Dredging Management Plan;

**‘’MD’’** means Moderately Disturbed;

**‘’MNES’’** means matter of national environmental significance;

**‘’NAGD’’** means National Assessment Guidelines for Dredging;

**‘’NATA’’** means National Association of Testing Authorities;

**‘’NLEP’’** means Northern Land Expansion Project;

**‘’NTU’’** means Nephelometric Turbidity Units;

**‘’PAR’’** means Photosynthetically Active Radiation;

**“PCCC”** means Port Curtis Coral Coast;

**‘’PCIMP’’** means Port Curtis Integrated Monitoring Program;

**‘’PFAS’’** means per-and poly-fluoroalkyl substances;

**‘’PoG’’** means Port of Gladstone;

**“Project”** means Northern Land Expansion Project;

**“PSD”** means Particle Size Distribution

**‘’RA’’** means rolling average;

**“REMP”** means Receiving Environment Monitoring Program;

**‘’SAP’’** means sediment analysis plan;

**‘’SD’’** means slightly disturbed;

**‘’SRA’’** means Southern Reclamation Area;

**‘’SSC’’** means suspended sediment concentration;

**‘’SSM’’** means Sustainable Sediment Management;

**‘’TBT’’** means Tributyltin;

**‘’TDP’’** means Total Daily PAR;

**‘’TPH’’** means Total Petroleum Hydrocarbons;

**‘’TSS’’** means total suspended solids;

**‘’WB’’** means Western Basin;

**‘’WBDDP’’** means Western Basin Dredging and Disposal Project;

**‘’WQOs’’** means Water Quality Objectives;

**‘’ZOI’’** means Zone of Impact.

# 2 Introduction

## 2.1 Purpose

The present Receiving Environment Monitoring Program (REMP) has been developed and tailored to the Northern Land Expansion Project Southern Reclamation Area (NLEP SRA or the Project), whose proponent is the Gladstone Ports Corporation Limited (GPC).

The Project will consist of the construction of a rock bund wall within the Western Basin (WB) area, Port of Gladstone (PoG) (refer Figure 1). In this document, the REMP area is defined as the area surrounding the NLEP SRA bund construction footprint to where the largest combined Zones of Impact (ZOIs) (low, medium and high) – as defined and identified by modelling scenarios and impact assessment – extends and thus a portion of the WB area (refer Section 6 and Figure 1). In this document, the REMP monitoring program area is defined as the combined areas covered by the monitoring programs included in this REMP (refer Figure 1).

This REMP addresses the following aspects:

- Assessment of the current baseline conditions of receiving waters and environmental values (EVs) such as aquatic habitats and fauna within the PoG and particularly the REMP area. As part of this assessment, related stressors are also identified and discussed. An overall conceptual model illustrating these dynamics is presented in Section 5;

- Identification of potential impacts of NLEP SRA bund wall construction activities to the receiving environment through modelling and impact assessment (refer Section 6 and Appendix B). The EVs to be protected within and adjoining the REMP area are clearly presented in Section 7;

- Description of the monitoring programs/plans design, monitoring locations, indicators and methods utilised to monitor, assess, prevent or minimise any harm to the receiving environment and EVs resulting from construction activities (refer Section 8); and

- Address commitments and compliance requirements related to environmental approvals as per Construction Environmental Management Plan (CEMP) (refer CEMP Section 6).

Full background information and details on the Project can be found in the Project CEMP (GPC, 2024).

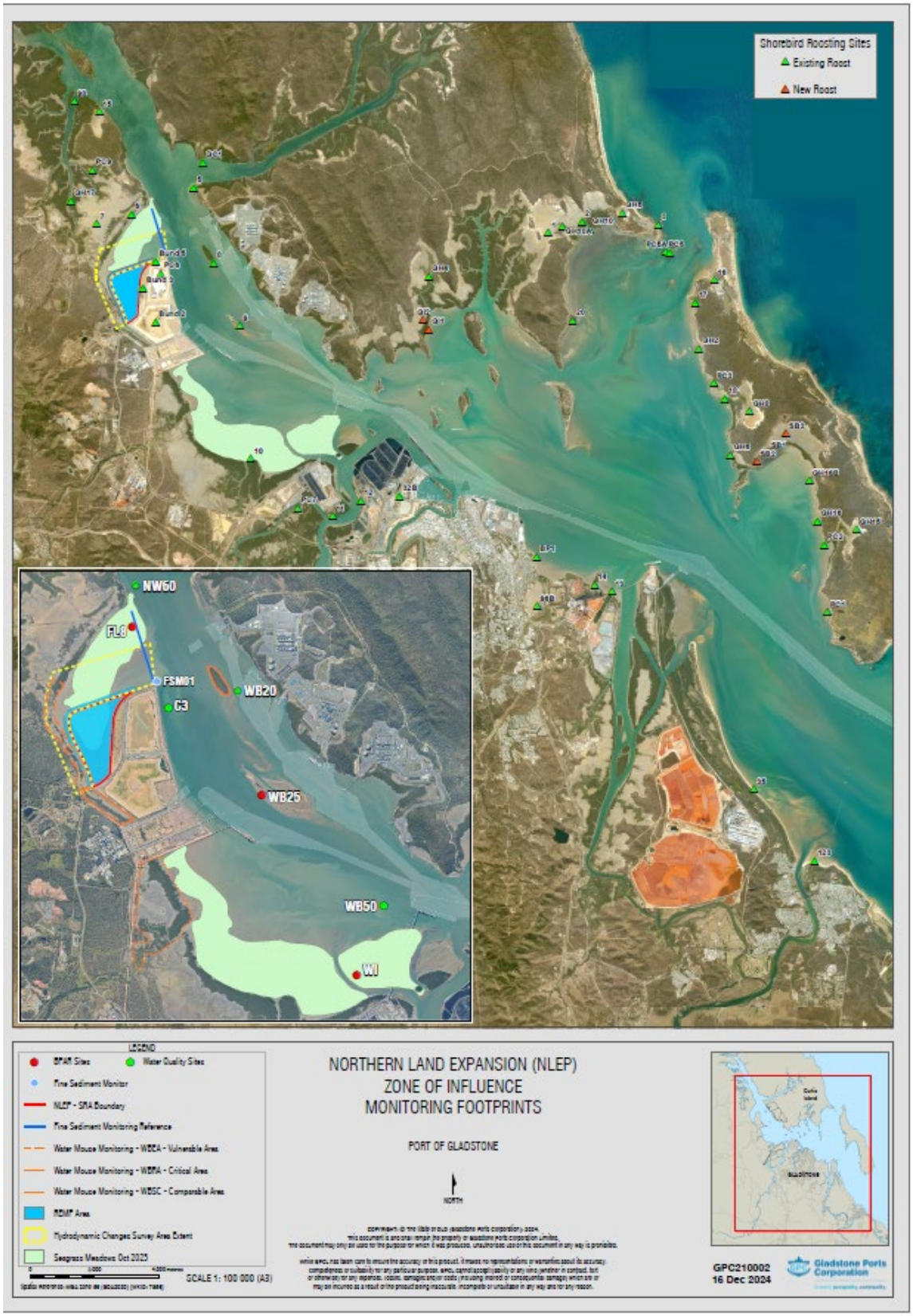


*Figure 1: NLEP SRA bund wall construction footprint, REMP area (combined ZOIs) and REMP monitoring program area*

**Figure note**: A buffer zone of approximately 100m has also been applied to the REMP area.

## 2.2 Scope

The document covers all aspect of the environmental monitoring undertaken prior, during and post NLEP SRA construction activities within the REMP area and general PoG area by GPC and engaged contractors.

The environmental monitoring includes different aspects such as water quality and habitat condition which will be monitored with appropriate methodologies and timeframes. These have been developed in collaboration with third party experts over years of research and monitoring. Most of the environmental monitoring detailed herein commenced in November 2020, it will continue throughout NLEP SRA construction activities and it will conclude post activities completion. Note that to comply with different approval conditions, different monitoring will be conducted at specific intervals and conclude at different timelines post construction activities completion (refer Section 8.13). This document supports and is to be read in conjunction with the following:

- Project CEMP (eDOC # 1683932);
- Water quality monitoring program (refer Section 8.1);
- Benthic photosynthetically active radiation (BPAR) monitoring program (refer Section 8.2);
- Seagrass and macroalgae monitoring program (refer Section 8.3);
- Water mouse monitoring program (refer Section 8.4.2);
- Acid Sulfate Soil Management Plan (eDOC # 1741219)
- Eastern curlew and other shorebird monitoring program (refer Section 8.7);
- Hydrodynamic changes monitoring plan (refer Section 8.9);
- Fine-grained sediment validation monitoring plan (refer Section 8.10); and
- NLEP SRA bund wall integrity monitoring program (refer Section 8.12).

## 2.3 Objectives

This REMP aims to provide all relevant information, systems and procedures that will allow GPC to meet commitments and maintain compliance with Project related permits and environmental approvals detailed in Section 3. In fact, this document will provide a description and demonstrate understanding of the receiving environment and EVs which will in turn allow to identify all relevant habitats and indicators to be monitored as part of the Project and the factors that might affect them. This together with the impact assessment output (refer Section 6) and adaptive management framework (refer Section 9) will ensure that the spatial and temporal extent as well as frequency of the monitoring is appropriate to monitor, assess, prevent or minimise any harm to the receiving environment and EVs.

By providing all relevant information on existing aquatic receiving environment and EVs as well as related monitoring methodology implemented before, during and after the Project construction activities, GPC aims to provide confidence to external stakeholders and regulators that a robust, science-based and fit for purpose approach and monitoring program has been adopted. The latter will also provide a better understanding of bund wall construction activities impacts in the REMP area and adjacent areas assisting in identifying and quantifying environmental risks as well as designing pragmatic and efficient monitoring programs in any future project. The performance of this REMP will be measured through assurance activities such as internal and external audits as part of GPC's Environmental Management System.

## 2.4 Management of potential Project impacts on protected matters

The management of potential Project impacts on the Project EPBC Act controlled action approval protected matters are addressed by the combined implementation of the Project CEMP and this REMP.

Table 1 summarises the potential Project impacts on the Project EPBC Act controlled action approval protected matters and the CEMP section location where the relevant management measures are provided and REMP section location where the monitoring requirements are provided within this REMP.

*Table 1: Potential Project impacts on protected matters and CEMP sections that contain management measures and the REMP sections that contain monitoring procedures to avoid and minimise impacts on protected matters*

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Coral reefs | • Increase in turbidity at coral reef locations within the Port of Gladstone results in decrease in coral reef health<br>• Decrease in water quality at coral reefs within the Port of Gladstone results in decrease in coral reef health from low pH from disturbance of acid sulfate soils, Project equipment leaks or spills into marine waters, and/or Project release of hazardous substances and/or waste | While no Project impacts on coral reefs within the Port of Gladstone are likely (i.e. outside the zone of influence of the Project), the management measures contained within the following sections will minimise impacts to this protected matter:<br>• Section 19.2 (acid sulfate soils)<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.7 (pests)<br>• Section 19.8 (hazardous substance and waste)<br>• Section 19.9 (erosion and sediment control and stormwater)<br>• Section 19.10 (traffic considerations) | • Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning turbidity trigger level to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity will not impact on coral reefs within the Port of Gladstone<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning pH trigger levels to allow the management measures included in the Project CEMP (refer CEMP Section 19.2) and the Project ASSMP to be implemented to avoid and minimise water quality impacts on coral reefs within the Port of Gladstone<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to avoid and minimise water quality impacts on coral reefs within the Port of Gladstone |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Marine water quality | • Increase in turbidity for marine waters within the Port of Gladstone<br>• Decrease in marine water quality within the Port of Gladstone from low pH from disturbance of acid sulfate soils, Project equipment leaks or spills into marine waters, and/or Project release of hazardous substances and/or waste | The management measures contained within the following sections will minimise impacts to this protected matter:<br>• Section 19.2 (acid sulfate soils)<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.8 (hazardous substance and waste)<br>• Section 19.9 (erosion and sediment control and stormwater)<br>• Section 19.10 (traffic considerations) | • Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning turbidity trigger level to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity will be minimised within the marine waters of the Port of Gladstone<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning pH trigger levels to allow the management measures included in the Project CEMP (refer CEMP Section 19.2) and the Project ASSMP to be implemented to minimise the water quality impacts within the marine waters of the Port of Gladstone<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to minimise the water quality impacts within the marine waters of the Port of Gladstone |
| | • Increase in fine-grained sediment within marine waters of the GBRWHA | This potential impact is a Project indirect impact with the significant residual impact to be determined post construction of the NLEP SRA in accordance with the Project EPBC Act controlled action condition 19(d) (refer Section 5 of the NLEP SRA Project Stage 1 Offset Strategy) | |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Marine megafauna (dugongs, species of whale, species of dolphins, migratory whales) | • Loss of seagrass and macroalgae and associated dugong and dolphin habitat from direct impact from the construction of the NLEP SRA outer bund wall | The significant residual impact from the Project direct impact will be addressed by implementing the NLEP SRA Project Stage 1 Offset Strategy (refer Section 4.3 of the Offset Strategy) | |
| Listed migratory species – Australian humpback dolphin and dugong | • Loss or decrease in seagrass and macroalage health and associated dugong and dolphin habitat from increase in turbidity and/or sedimentation at seagrass and macroalgae areas outside of the Project direct impact area<br>• Loss or decrease in seagrass and macroalgae health and associated dugong and/or dolphin habitat from Project release of hazardous substances, waste and/or Project vehicle leaks or spills at seagrass and macroalgae areas outside of the Project direct impact area<br>• Injury or mortality of dugongs and/or dolphins due to Project release of hazardous substances and/or waste | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.7 (pests)<br>• Section 19.8 (hazardous substance and waste)<br>• Section 19.9 (erosion and sediment control and stormwater) | • Water quality and BPAR monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) and BPAR monitoring program (refer Section 8.2) will provide an early-warning turbidity trigger level and BPAR levels to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity and/or sedimentation at seagrass and macroalgae areas, and associated dugong and dolphin habitat outside of the Project direct impact areas will be avoided and minimised<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to avoid and minimise the water quality impacts at seagrass and macroalgae areas, and associated dugong and dolphin habitat outside of the Project direct impact areas |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| | • Loss of dugong and dolphin habitat (i.e. seagrass and macoalgae) from indirect hydrodynamic impacts caused by the establishment of the NLEP SRA | This potential impact is a Project indirect impact with the significant residual impact to be determined post construction of the NLEP SRA in accordance with the Project EPBC Act controlled action condition 19(c) (refer NLEP SRA Project Stage 1 Offset Strategy) | |
| | • Temporary displacement of marine megafauna during the placement of rock within intertidal and marine waters<br>• Injury, mortality, entrapment or standing of dugongs and/or dolphins during construction of the bund wall or during bund closure | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.5 (flora, fauna and water quality) | • Marine megafauna monitoring will occur daily during the bund wall rock placement activities to ensure construction activities do not impact on marine megafauna (refer Section 8.5)<br>• During bund wall closure the Project Aquatic Salvage Plan will be implemented (refer Section 8.6) |
| Marine turtles<br>Listed threatened species – Loggerhead turtle, Olive ridley turtle, Flatback turtle, Green turtle and Hawksbill turtle | • Loss of seagrass and macroalgae and associated marine turtle habitat from direct impact from the construction of the NLEP SRA outer bund wall | The significant residual impact from the Project direct impact will be addressed by implementing the NLEP SRA Project Stage 1 Offset Strategy (refer Section 4.3 of the Offset Strategy) | |
| | • Loss of marine turtle habitat (i.e. seagrass and macoalgae) from increase in turbidity and/or sedimentation at seagrass and macroalgae areas outside of the Project direct impact area<br>• Loss or decrease in seagrass and macroalgae health and associated marine turtle habitat from Project release of hazardous substances, waste | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.7 (pests)<br>• Section 19.8 (hazardous substance and waste) | • Water quality and BPAR monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) and BPAR monitoring program (refer Section 8.2) will provide an early-warning turbidity trigger level and BPAR levels to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity and/or sedimentation at seagrass and macroalgae areas, and associated marine turtle habitat outside of the |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| | and/or Project vehicle leaks or spills at seagrass and macroalgae areas outside of the Project direct impact area<br>• Injury or mortality of marine turtles due to Project release of hazardous substances and/or waste | • Section 19.9 (erosion and sediment control and stormwater) | Project direct impact areas will be avoided and minimised<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to avoid and minimise the water quality impacts at seagrass and macroalgae areas, and associated marine turtle habitat outside of the Project direct impact areas |
| | • Loss of marine turtle habitat (i.e. seagrass and macoalgae) from indirect hydrodynamic impacts caused by the establishment of the NLEP SRA | This potential impact is a Project indirect impact with the significant residual impact to be determined post construction of the NLEP SRA in accordance with the Project EPBC Act controlled action condition 19(c) (refer NLEP SRA Project Stage 1 Offset Strategy) | |
| | • Temporary displacement of marine turtles during the placement of rock within intertidal and marine waters<br>• Injury, entrapment or standing of marine turtles during construction of the bund wall or during bund closure | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.5 (flora, fauna and water quality) | • Marine turtle monitoring will occur daily during the bund wall rock placement activities to ensure construction activities do not impact on marine turtles (refer Section 8.5)<br>• During bund wall closure the Project Aquatic Salvage Plan will be implemented (refer Section 8.6) |
| Seagrass and macroalgae | • Loss of seagrass and macroalgae from direct impact from the construction of the NLEP SRA outer bund wall | The significant residual impact from this Project direct impact will be addressed by implementing the NLEP SRA Project Stage 1 Offset Strategy (refer Section 4.3 of the Offset Strategy) | |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| | • Loss of seagrass and macoalgae from increase in turbidity and/or sedimentation at seagrass and macroalgae areas outside of the Project direct impact area | The management measures contained within the following sections will minimise impacts to this protected matter:<br>• Section 19.2 (acid sulfate soils)<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.8 (hazardous substance and waste)<br>• Section 19.9 (erosion and sediment control and stormwater) | • Water quality and BPAR monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) and BPAR monitoring program (refer Section 8.2) will provide an early-warning turbidity trigger level and BPAR levels to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity and/or sedimentation at seagrass and macroalgae areas outside of the Project direct impact areas will be avoided and minimised<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning pH trigger levels to allow the management measures included in the Project CEMP (refer CEMP Section 19.2) and the Project ASSMP to be implemented to minimise the water quality impacts at seagrass and macroalgae areas outside of the Project direct impact areas |
| | • Loss of seagrass and macoalgae from indirect hydrodynamic impacts caused by the establishment of the NLEP SRA | The significant residual impact from the Project indirect impacts on seagrass and macoalgae from indirect hydrodynamic impacts caused by the establishment of the NLEP SRA will be addressed by implementing the NLEP SRA Project Stage 1 Offset Strategy (refer Section 4.5 of the Offset Strategy) | |
| Shorebirds and migratory seabirds | • Loss of Eastern curlew intertidal mudflat foraging habitat from indirect impacts from the construction of the NLEP SRA outer bund wall | The significant residual impact from the Project indirect impacts on Eastern curlew intertidal mudflat foraging habitat from indirect impacts from the construction of the NLEP SRA outer bund wall will be addressed by implementing the NLEP SRA Project Stage 1 Offset Strategy (refer Section 3.7 of the Offset Strategy) | |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Listed migratory species – Eastern curlew | • Temporary increase noise, vibration and/or light levels results in temporary displacement of foraging shorebirds, migratory seabirds and/or Eastern curlews<br>• Injury or death of shorebirds, migratory seabirds and/or Eastern curlews from construction equipment and/or placement of rock | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.3 (air quality, noise, vibration and lighting)<br>• Section 19.5 (flora, fauna and water quality) | • If Project construction activities are observed to be resulting in the displacement of Eastern curlews or other shorebirds within the adjacent foreshore areas during the Eastern curlew and other shorebird monitoring program field surveys, the NLEP SRA Project Manager will be advised and the CEMP corrective actions will be implemented (refer REMP Section 8.7.1 and CEMP Sections 19.3 and 19.5). |
| | • Loss of potential shorebird, including Eastern curlew foraging habitat (intertidal areas adjacent to the NLEP SRA) from hydrodynamic impacts caused by the closure of the bund wall and establishment of the NLEP SRA | This potential impact is a Project indirect impact with the significant residual impact to be determined post construction of the NLEP SRA in accordance with the Project EPBC Act controlled action condition 19(a) (refer Section 3.7 of the NLEP SRA Project Stage 1 Offset Strategy) | |
| Flora, fauna and ecological communities<br>Note: coral reefs, seagrass, macroalgae, shorebirds, migratory seabirds and Eastern curlew protected matters are provided above | • Temporary increase noise, vibration and/or light levels results in temporary displacement of native fauna<br>• Dust from construction activities covers foreshore vegetation resulting in a loss or reduction in vegetation condition | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.3 (air quality, noise, vibration and lighting) | • If Project construction activities are observed to be resulting in the displacement of Eastern curlews or other shorebirds within the adjacent foreshore areas during the Eastern curlew and other shorebird monitoring program field surveys, the NLEP SRA Project Manager will be advised and the CEMP corrective actions will be implemented (refer REMP Section 8.7.1 and CEMP Sections 19.3 and 19.5) |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| | | | • If Project construction activities are observed to be resulting in Project-related dust covering adjacent foreshore vegetation during the mangrove and saltmarsh monitoring program field surveys, the NLEP SRA Project Manager will be advised and the CEMP and Project Air Quality Management Plan corrective actions will be implemented (refer REMP Section 8.4.1.1 and CEMP Section 19.3) |
| Diversity supporting marine fauna species | Potential Project impacts on the diversity supporting marine fauna species are provided in marine megafauna and marine turtles protected matters above | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.7 (pests)<br>• Section 19.9 (erosion and sediment control and stormwater) | • Water quality and BPAR monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) and BPAR monitoring program (refer Section 8.2) will provide an early-warning turbidity trigger level and BPAR levels to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity and/or sedimentation within the Port of Gladstone marine waters outside of the Project direct impact areas will be avoided and minimised<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to avoid and minimise the water quality impacts within the Port of Gladstone outside of the Project direct impact areas<br>• During bund wall closure the Project Aquatic Salvage Plan will be implemented (refer Section 8.6) |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Total species diversity | Potential Project impacts on the total species diversity are provided in coral reefs, seagrass, macroalgae, marine megafauna, marine turtles, flora, fauna and ecological communities protected matters above | The management measures contained within the following sections will minimise impacts to these protected matters:<br>• Section 19.2 (acid sulfate soils)<br>• Section 19.3 (air quality, noise, vibration and lighting)<br>• Section 19.5 (flora, fauna and water quality)<br>• Section 19.7 (pests)<br>• Section 19.8 (hazardous substance and waste)<br>• Section 19.9 (erosion and sediment control and stormwater) | • Water quality and BPAR monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) and BPAR monitoring program (refer Section 8.2) will provide an early-warning turbidity trigger level and BPAR levels to allow the EWMA adaptive management measures (refer Section 9.2.2) to be implemented which will ensure Project-related increases in turbidity and/or sedimentation within the Port of Gladstone marine waters outside of the Project direct impact areas will be avoided and minimised<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning total petroleum hydrocarbons trigger levels to allow the management measures included in the Project CEMP (refer CEMP Sections 19.5, 19.8 and 19.10) to be implemented to avoid and minimise the water quality impacts within the Port of Gladstone outside of the Project direct impact areas<br>• Water quality monitoring sites (refer Figure 17) included in the water quality monitoring program (refer Section 8.1) will provide an early-warning pH trigger levels to allow the management measures included in the Project CEMP (refer CEMP Section 19.2) and the Project ASSMP to be implemented to minimise the water quality impacts within the Port of Gladstone outside of the Project direct impact areas<br>• During bund wall closure the Project Aquatic Salvage Plan will be implemented (refer Section 8.6) |

| Protected matter | Potential Project impact | CEMP section that contains management measures | REMP section that contains the monitoring requirement |
|---|---|---|---|
| Listed threatened species – Water mouse | Loss of potential Water mouse habitat (foreshore area adjacent to the NLEP SRA) from hydrodynamic impacts caused by the establishment of the NLEP SRA | This potential impact is a Project indirect impact with the significant residual impact to be determined post construction of the NLEP SRA in accordance with the Project EPBC Act controlled action condition 19(b) (refer Section 6 of the NLEP SRA Project Stage 1 Offset Strategy) | |

# 3 Legislative obligations

## 3.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999 controlled action conditions

Table 2 provides the REMP section or CEMP section that addresses the Project *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) controlled action approval condition 1 compliance.

The Project Coordinated-General's evaluation report on the environmental impact statement (CG Report) stated conditions relevant to the Project EPBC Act controlled action condition 1, have been incorporated into the Project Environmentally Relevant Activity (ERA) 16 (dredging) Environmental Authority (EA) conditions, including the same condition number. As a result, Table 2 also demonstrates compliance with the Project ERA 16 EA conditions included in the Project EPBC Act controlled action condition 1.

*Table 2: REMP section or CEMP section that addresses the Project EPBC Act controlled action approval condition 1 compliance and relevant ERA 16 EA condition compliance*

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 1. | 1b. | To minimise impacts to protected matters, the approval holder must comply with the following conditions of Queensland Coordinator-General's stated conditions as they relate to protected matters:[1]<br>**G16 (CG Report and ERA 16 EA)**<br>Sediment plume associated monitoring (SPAM) must be undertaken. This must include continuous logging at concern sites and control sites, with a baseline collection phase (baseline-based assessment with control site-based checking). | REMP Section 7.1.2 (baseline collection)<br>REMP Section 8.1 (water quality prior, during and post construction phase)<br>REMP Section 8.2 (BPAR prior, during and post construction phase) | The following summarises how the condition 1b. (ERA 16 EA condition G16) SPAM requirements have been addressed:<br>• Monitoring sites (concern and control) were selected based on hydrodynamic modelling (refer Section 6 and Appendix B)<br>• The Project baseline water quality monitoring program was implemented from November 2020 to February 2024<br>• Water quality monitoring will be undertaken prior, during and post NLEP SRA bund construction<br>• BPAR monitoring will be undertaken prior, during and post NLEP SRA bund construction. |
| 2. | 1f. | **WT1 (CG Report and ERA 16 EA)**<br>A REMP must be developed and implemented to monitor, identify, describe and respond to any adverse impacts to:<br>(a) marine water quality<br>(b) water flows<br>(c) aquatic flora and fauna<br>(d) corals and<br>(e) any receiving waters. | REMP Section 8.1 (water quality), Section 8.2 (BPAR), Section 8.3 (seagrass and macroalgae), Section 8.4 (mangrove, saltmarsh and Water mouse), Section 8.9 (hydrodynamic changes), Section 8.10 (fine-grained sediment (FGS)), Section 9 (adaptive management responses), and Section 10 (reporting) | The following summarises how the condition 1f. (ERA 16 EA condition WT1) REMP requirements have been addressed:<br>• Water quality, BPAR, seagrass condition, mangroves, saltmarsh and Water mouse, and FGS monitoring will be undertaken prior, during and post NLEP SRA bund construction<br>• Hydrodynamic changes surveys post NLEP SRA bund construction<br>• Implementation of adaptive management framework responses based on turbidity EWMA and BPAR alert levels, adaptive management levels, and external alert levels<br>• Internal and external reporting. |
| 3. | 1g. | **WT2 (CG Report and ERA 16 EA)**<br>The REMP must include periodic monitoring for the effects of any release on the receiving environment as a result of contaminant releases to waters from the construction or dredging activity. | REMP Section 8.1.2 | The following summarises how the condition 1g. (ERA 16 EA condition WT2) REMP requirements have been addressed:<br>• Monthly grab samples for metal(loid)s, nutrients, chlorophyll *a* and Total Petroleum Hydrocarbons (TPH) will also be undertaken at the water quality monitoring sites pre, during and post bund construction operations. |

[1] Note: In the case of any inconsistency between the EPBC Act condition 1 and Queensland Coordinator-General's stated conditions as they relate to protected matters, the conditions in the EPBC Act approval Annexure apply.

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 4. | 1h. (a) | **WT3 (a) (CG Report and ERA 16 EA)**<br>The REMP must:<br>Assess the condition or state of receiving waters spatially within the Port of Gladstone (the REMP area) using accurate and reliable monitoring approaches sufficient to describe temporal variation (e.g. seasonality). | REMP Section 7.1 | The following summarises how the condition 1h. (a) (ERA 16 EA condition WT3) REMP requirements have been addressed:<br>• The Project baseline water quality monitoring program was implemented from November 2020 to February 2024 to address seasonality and meeting the Australian and New Zealand Environment and Conservation Council (ANZECC), which recommends a minimum of two full dry and wet seasons of monitoring to establish an appropriate baseline water quality dataset<br>• Monitoring sites (concern and control) were selected based on hydrodynamic modelling which predicted the Project ZoIs and Zone of Influence (refer Section 6 and Appendix B)<br>• Water quality equipment included two (dual) multi-parameter sondes (YSI EXO3), each encased in a copper plated cage, were placed into secured antifouled PVC tubes attached to the base of a modified special marker buoy<br>• The sondes recorded turbidity (NTU), temperature (°C), conductivity (mS/cm), pH and dissolved oxygen (% saturation) every 15 minutes at approximately 0.75m below the water surface, with a central wiper cleaning the sonde probes prior to each data log. The sondes were attached to solar powered telemetry units installed within the buoy, with data transferred via telemetry to a database every 15 minutes.<br>• All sondes were maintained at a minimum of monthly, or as required based on examination of real time data. Each sonde was calibrated, and log-tested prior to deployment as per Vision Environment Health Safety Environment and Quality Management System protocols. |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 5. | 1h. (b) | **WT3 (b) (CG Report and ERA 16 EA)**<br>Describe a conceptual model that defines stressors and potential impacts in the receiving environment and identifies the linkages between expected response and the monitoring indicators to be monitored including but not limited to turbidity and Total Suspended Solids (TSS), nutrients, metals and metalloids and justify:<br>(i) the indicators and sampling frequency and timing, and<br>(ii) assumptions and choices made in preparation of the REMP. | REMP Section 5 (conceptual model), Section 6 and Appendix B (impact assessment modelling), Sections 4 and 7 (receiving environmental values), and Section 8 (monitoring programs/plans) | The following summarises how the condition 1h. (b) (ERA 16 EA condition WT3 (b)) REMP requirements have been addressed:<br>• The Project baseline and construction monitoring programs/plans have been designed based on a comprehensive knowledge of the PoG marine environment and sensitive receptors and dynamics that drive changes in the main parameters able to subject these habitats under stress<br>• The main stressors relevant to the Project will be environmental factors such as tides, rainfall and associated runoff and severe and extreme weather events (refer Figure 4 and Figure 5). The only anthropogenic stressor which has the potential to impact sensitive receptors through turbid plumes is bund wall construction. Stressors will be appropriately monitored through a range of programs/plans (refer Section 8).<br>• Hydrodynamic modelling of Project activities (placement of rock material within the marine and intertidal area, and bund construction and closure scenarios) predicted the Project ZOIs (low, medium and high) and Zone of Influence<br>• The modelling results indicate that the increases in turbidity and deposition rate associated with NLEP SRA construction activities are likely to be minor and unlikely to cause ecological impacts on seagrass or other sensitive receptors as the ZOIs (low, medium and high), including the Zone of Influence, are limited to the immediate vicinity of the anticipated plume release locations (BMT, 2021)<br>• Water quality, BPAR, bed level, seagrass condition, mangroves, saltmarsh and Water mouse monitoring, shorebirds surveys, and FGS monitoring will be undertaken prior, during and post NLEP SRA bund construction<br>• Pre-construction intertidal and foreshore conditions adjacent to the proposed NELP SRA included in the Project EIS<br>• Hydrodynamic changes surveys post NLEP SRA bund construction. |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 6. | 1h. (c) | **WT3 (c) (CG Report and ERA 16 EA)**<br>The monitoring design (i.e. monitoring locations, indicators, sampling frequency and data analysis techniques) must facilitate assessment against water quality objectives for the relevant environmental values that need to be protected. | REMP Section 6 and Appendix B (monitoring design), Figure 13 (location of monitoring sites), Section 8.1.3 (EWMA turbidity data analysis), Section 8.2.2 (seagrass BPAR measurement), Section 8.1.2 (other water quality parameters data analysis), and Section 9 (adaptive management framework) | The following summarises how the condition 1h. (c) (ERA 16 EA condition WT3 (c)) REMP requirements have been addressed:<br>• Monitoring sites (concern and control) were selected based on hydrodynamic modelling (refer Section 6 and Appendix B)<br>• Continuous real-time water quality data monitoring, 15 minute logging interval (turbidity, temperature, EC, pH and DO) will be undertaken prior, during and post NLEP SRA bund construction<br>• Continuous real-time BPAR monitoring (with 15 minute logging intervals) will be undertaken prior, during and post NLEP SRA bund construction<br>• Water quality grab samples to be analysed by NATA accredited laboratory for TSS, nutrients, chlorophyll, metals and TPH<br>• Data analysis and the implementation of adaptive management framework responses based on turbidity EWMA and BPAR alert levels, adaptive management levels, and external alert levels. |
| 7. | 1h. (d)(i) | **WT3 (d) (CG Report and ERA 16 EA)**<br>Detail monitoring locations and water quality indicators pertinent to the sensitive receptor types and locations that have been designed to:<br>(i) determine the baseline condition of water quality and sensitive receptors (i.e. corals and seagrass meadows) within the zone of influence to a sufficient resolution to be capable of reliably detecting lethal and sublethal (stress) impacts | REMP Section 7.1.2 (baseline water quality), Figure 13 (location of the water quality and BPAR monitoring sites), and Section 7.3 (baseline seagrass and macroalgae) | The following summarises how the condition 1h. (d)(i) (ERA 16 EA condition WT3 (d)(i)) REMP requirements have been addressed:<br>• The Project baseline water quality monitoring program was implemented from November 2020 to February 2024 within and outside of the Zone of Influence<br>• The Project baseline seagrass and macroalgae monitoring program was implemented in 2023, however monitoring has occurred annually since 2004 (refer Section 4.6.1)<br>• In the WB area and thus the REMP area reefs are not present; the WB area is a naturally highly turbid area with sediments mostly characterised by silt and clay and thus not the right substrata for coral settlement. Moreover, the REMP area is characterised by a shallow bathymetry with the vast majority of the area becoming exposed at spring low tide (refer Section 4.7). |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 8. | 1h. (d)(ii) | (ii) based on the draft trigger values contained in Table WT3 and Table WT4 confirm the locally-relevant trigger values for key water quality indicators including turbidity, and | REMP Section 8.1.3 (EWMA turbidity trigger values), Section 8.1.2 (other water quality objectives (WQOs)) and Section 8.2 (seagrass BPAR triggers) | The following summarises how the condition 1h. (d)(ii) (ERA 16 EA condition WT3 (d)(ii)) REMP requirements have been addressed:<br>• EWMA turbidity internal alert level, adaptive management levels, and external alert level have been determined for the Wet Season and Dry Season for the concern water quality monitoring site (i.e. NW60 (QE4))<br>• Other WQOs have adopted the Port Curtis WQOs where specified in *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (DEHP, 2014) or ANZG (2018)<br>• Site-specific seagrass BPAR internal alert levels, adaptive management levels and external alert level have been determined for a seagrass monitoring site (i.e. FL8). |
| 9. | 1h. (d)(iii) | (iii) provide on-line near real-time monitoring capability for key sediment plume related indicators (including but not limited to turbidity, pH, electrical conductivity). | REMP Section 8.1.1 (real-time water quality monitoring) and Section 8.2.2 (real-time seagrass BPAR monitoring) | The following summarises how the condition 1h. (d)(iii) (ERA 16 EA condition WT3 (d)(iii)) REMP requirements have been addressed:<br>• Continuous real-time water quality data monitoring (turbidity, temperature, EC, pH and DO), with a 15 minute logging interval, will be undertaken prior, during and post NLEP SRA bund construction<br>• Continuous real-time BPAR monitoring, with a 15 minute logging interval, will be undertaken prior, during and post NLEP SRA bund construction. |
| 10. | 1h. (e) | **WT3 (e) (CG Report and ERA 16 EA)**<br>Specify the frequency and timing of sampling required in order to reliably assess ambient conditions and to provide sufficient data to derive site specific background reference values in accordance with the *Environmental Protection (Water) Policy 2009 (Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives)* (DEHP 2014) | REMP Section 7.1 (baseline water quality monitoring), Section 8.1.3 (turbidity EWMA trigger values), Section 8.2.2 (BPAR monitoring sites) and Section 8.2.3 (seagrass and BPAR trigger values) | The following summarises how the condition 1h. (e) (ERA 16 EA condition WT3 (e)) REMP requirements have been addressed:<br>• The Project baseline water quality monitoring program was implemented from November 2020 to February 2024<br>• EWMA turbidity internal alert level, adaptive management levels, and external alert level have been determined for the Wet Season and Dry Season for the concern water quality monitoring site (i.e. NW60 (QE4))<br>• Site-specific seagrass BPAR internal alert levels, adaptive management levels and external alert level have been determined for a seagrass monitoring site (i.e. FL8). |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 11. | 1h. (f) | **WT3 (f) (CG Report and ERA 16 EA)**<br>Provide an assessment of seagrass meadow health and extent in the receiving waters | REMP Section 4.6.1 (previous seagrass monitoring) and Section 7.3 (Project baseline seagrass monitoring) | The following summarises how the condition 1h. (f) (ERA 16 EA condition WT3 (f)) REMP requirements have been addressed:<br>• Seagrass monitoring has occurred annually within the Port of Gladstone since 2004<br>• The Project baseline seagrass and macroalgae monitoring program was implemented in 2023. |
| 12. | 1h. (g) | **WT3 (g) (CG Report and ERA 16 EA)**<br>Include, where appropriate, monitoring of metals/metalloids in sediments (for example, in accordance with ANZECC & ARMCANZ 2000 and/or the most recent version of Australian Standard 5667.1) | Not applicable | The NLEP SRA geochemical investigation of sediments under the proposed bund wall alignment has shown that no analytes in any samples returned results exceeding the National Assessment Guidelines for Dredging (NAGD) Sediment Quality High Values (SQG-High). Also all samples analysed for per-and poly-fluoroalkyl substances (PFAS) compounds reported concentrations below the laboratory limits of reporting.<br>As a result of the findings of the NLEP SRA geochemical investigation, no monitoring of metals/metalloids in sediments during construction is considered necessary to manage sediment and water quality impacts. |
| 13. | 1h. (h) | **WT3 (h) (CG Report and ERA 16 EA)**<br>Apply procedures and/or guidelines from ANZECC and ARMCANZ 2000 and other relevant guideline documents | REMP Section 4.2 (Port Curtis WQOs), Section 4.3 (previous water quality sampling in Port Curtis), and Section 8.1.2 (Project WQOs for metal(loid)s) | The following summarises how the condition 1h. (h) (ERA 16 EA condition WT3 (h)) REMP requirements have been addressed:<br>• The development of the Port Curtis WQOs have been based on the ANZECC and ARMCANZ (2000), and where relevant have been included in *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (DEHP, 2014)<br>• The Project WQOs for relevant metal(loid)s have been adopted from the *Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives* (DEHP, 2014) or ANZG (2018). |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 14. | 1h. (i) | **WT3 (i) (CG Report and ERA 16 EA)**<br>Describe sampling and analysis methods and quality assurance and control. | REMP Section 8.1.1 (real-time turbidity, temperature, conductivity, pH and DO), Section 8.1.2 (metal(loid)s, nutrients, chlorophyll *a* and TPH), Section 8.1.3 (turbidity EWMA triggers), Section 8.2 (BPAR sampling and triggers) | The following summarises how the condition 1h. (i) (ERA 16 EA condition WT3 (i)) REMP requirements have been addressed:<br>• The real-time water quality sites will utilise two (dual) multi-parameter sondes, each encased in a copper plated cage, which will be placed into secured antifouled PVC tubes attached to the base of a modified special marker buoy<br>• All sondes will be maintained at a minimum of monthly, or as required based on examination of real time data. Each sonde will be calibrated, and log-tested prior to deployment as per Health Safety Environment and Quality, and Management System protocols<br>• Monthly water quality grab samples will be analysed by a National Association of Testing Authorities (NATA) accredited laboratory holding the accreditation for the analyses required<br>• A replicate water sample for all parameters will be collected at one site per survey as per established protocols, with a field blank and laboratory blank also collected per survey<br>• Analytical laboratory quality control measures will include laboratory duplicates, method blanks, analysis of certified reference material and matrix spikes.<br>• PAR monitoring Li-Cor light sensors will be mounted on benthic frames and integrated into a real-time monitoring and reporting system<br>• Water quality and BPAR data analysis and quality control procedures will be established. |
| 15. | 1i. | **WT6 (CG Report and ERA 16 EA)**<br>The proponent must not discharge, irrigate or otherwise release potable water, wastewater, stormwater, harvested water, bilge water or sewage effluent unless the discharge complies with discharge criteria defined for this activity and approved by the administering authority. | REMP Section 8.1.2 (metal(loid)s, nutrients, chlorophyll *a* and TPH)<br><br>CEMP Section 19.10 | The following summarises how the condition 1i. (ERA 16 EA condition WT6) requirements have been addressed:<br>• Monthly water quality grab samples at water quality monitoring sites<br>• Implementation of the Project CEMP<br>• Construction of the NLEP SRA bund wall does not involve the ERA 16 EA dredging dewatering discharges from the reclamation area, therefore the EA discharge criteria are not applicable for the NLEP SRA. |

| Ref | Cond. no. | EPBC Act controlled action condition requirement relevant to REMP or CEMP | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 16. | 1j. | **WT9 (CG Report and ERA 16 EA)**<br>The only contaminants to be released to surface waters are:<br>(a) bed sediments necessarily disturbed during dredging and construction at locations specified in condition G1<br>*Note: condition G1 includes NLEP SRA outer bund wall.* | REMP Section 2.1 and Figure 1 (bund wall construction location) | The following summarises how the condition 1j. (ERA 16 EA condition WT9 requirement) have been addressed:<br>• The disturbance of the bed sediment for the construction of the NLEP SRA bund wall will be restricted to the approved footprint and a 100m buffer to account for bed sediment disturbances from work vessels and construction equipment (e.g. vessel anchoring, prop wash, etc.) during the construction of the NLEP SRA bund wall. |
| 17. | 1k. | **WT14 (CG Report and ERA 16 EA)**<br>Monitoring of turbidity and benthic PAR must be undertaken at the locations and timing specified in Table WT2 – Water quality monitoring names and locations and must not exceed the limits specified in Table WT3 – Water quality management limits and light associated monitoring requirements in Table WT4 – Management light limits and associated monitoring requirements.<br>*Note: ERA 16 EA conditions Table WT2, Table WT3 and Table WT4 are included in Appendix A.* | REMP Section 6 and Appendix B (modelling for selecting monitoring locations), Section 8.1.1 (turbidity monitoring locations and timing), Section 8.2.2 (BPAR monitoring locations and timing), Figure 17 (monitoring locations), Section 8.1.3 (turbidity trigger limits) and Section 8.2.3 (BPAR trigger limits) | The following summarises how the condition 1k. (ERA 16 EA condition WT14 requirements have been addressed:<br>• Location of turbidity and BPAR monitoring sites were selected based on hydrodynamic modelling for the NLEP SRA bund wall construction (refer Section 6 and Appendix B)<br>• Previous and Project baseline monitoring of turbidity and BPAR data have been utilised to define the water quality (turbidity) management limits and management light (BPAR) limits for the NLEP SRA bund wall construction. It is worth noting that these are more conservative than the Environmental Protection (water) Policy 2009, water for Port Curtis; see: *Curtis Island, Calliope River and Boyne River Basin Environmental Values and Water Quality Objectives (des.qld.gov.au)* |

**Table note:** The EPBC Act controlled action conditions 1a (CG Report stated condition G13), 1c (CG Report stated condition G17), 1d (CG Report stated condition G18), 1e (CG Report stated condition G25), 1j (CG Report stated condition WT9(b), 1l to 1n (CG Report stated conditions L1 to L3), 1o (CG Report stated condition L7) and 1p 1l (CG Report stated condition 8 of Schedules 9 and 10) have not been included in the table above as the CG Report stated that these conditions are not relevant to the construction of the NLEP SRA outer bund wall (e.g. relevant only to dredging activity).

Table 3 provides REMP sections or CEMP sections that address the relevant Project EPBC Act controlled action approval conditions compliance and the relevant ERA 16 EA condition compliance.

*Table 3: REMP section or CEMP section that addresses the relevant Project EPBC Act controlled action approval conditions compliance and the relevant ERA 16 EA condition compliance*

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 1. | 7. | The approval holder must not cause any impact to the Friend Point Eastern Curlew roost site, except for indirect impacts during construction, for the duration of the effect of the approval. | REMP Section 8.7 | The following summarises how the condition 7 requirements have been addressed:<br>• A dedicated monitoring program for Eastern curlew and other shorebirds has been prepared, incorporating acute phase, long-term and Eastern curlew behavioural monitoring components for the Friend Point roost site<br>• An approach to analysing the monitoring data has been developed to test the Project impact on the Eastern curlew population and behaviour at Friend Point roost site, including monitoring indicators, triggers for investigation and frequency<br>• Annual monitoring reports will be prepared on the results of the monitoring, comparison with previous results, review of the effectiveness and appropriateness of the monitoring program in meeting the monitoring program objectives, recommendations to inform relevant management program to adaptively manage and mitigate impacts to Eastern curlew. |
| 2. | 11. (a) | The approval holder must undertake baseline surveys within the 12 months prior to each of the commencement of Project Stage 1 (in respect of the areas specified in relation to Project Stage 1) and the commencement of Project Stage 3 (in respect of the areas specified in relation to Project Stage 3) to determine:<br>(a) the location, condition and density of all seagrass and macroalgae that could be directly impacted by Project Stage 1 and Project Stage 3 | REMP Section 7.3.2 (seagrass and macroalgae location, condition and density) and Section 6 and Appendix B (impact assessment modelling) | The following summarises how the condition 11 (a) requirements have been addressed:<br>• A Project baseline seagrass and macroalgae monitoring program was implemented in 2023 and further monitoring has occurred annually since 2004 (refer Section 4.6.1)<br>• Impact assessment studies and modelling of the Project activities (placement of rock material within the marine and intertidal area, and bund construction and closure scenarios) predicted the Project ZOIs (low, medium and high). |

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 3. | 11. (b) | (b) the location, condition and density of all seagrass and macroalgae that could be indirectly impacted by Project Stage 1 and Project Stage 3 | REMP Section 7.3.2 (seagrass and macroalgae location, condition and density) and Section 6 and Appendix B (impact assessment modelling) | The following summarises how the condition 11 (b) requirements have been addressed:<br>• A Project baseline seagrass and macroalgae monitoring program was implemented in 2023 and further monitoring has occurred annually since 2004 (refer Section 4.6.1)<br>• Impact assessment studies and modelling of the Project activities (placement of rock material within the marine and intertidal area, and bund construction and closure scenarios) predicted the Project Zone of Influence. |
| 4. | 11. (c) | (c) in accordance with the Referral Guidelines for the vulnerable water mouse, the extent and location of Water Mouse habitat, including foraging habitat and breeding places and an estimate of the current population present, within the area that could be indirectly impacted by Project Stage 1 and Project Stage 3 as determined by a suitably qualified ecologist. | REMP Section 7.6.2 | The following summarises how the condition 11 (c) requirements have been addressed:<br>• Three Project baseline surveys for Water mouse were undertaken in 2020, 2021 and 2023 utilising a combination of radiometric thermal mapping and ground truthing<br>• The surveys found an abundance of potential Water mouse prey, however did not find any evidence of characteristic Water mouse nest structures, shelter sites or breeding places and did not confirm the presence of Water mouse in the Project study area. |
| 5. | 13. (a) | All baseline surveys and survey results required under Conditions 11 and 12 must:<br>(a) be designed and undertaken in accordance with recognised guidelines | REMP Section 7.3.1 (seagrass and macroalgae surveys) and Section 7.6.1 (Water mouse surveys) | The following summarises how the condition 13 (a) requirements have been addressed:<br>• The Project baseline and other previous seagrass and macroalgae surveys have been designed and undertaken by the Seagrass Ecology Group at James Cook University's (JCU) Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER) and are in accordance with international best practices<br>• The Project baseline Water mouse surveys were undertaken in accordance with the Referral Guidelines for the Vulnerable Water mouse (Department of Environment, 2015) |

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
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| 6. | 13. (b) | (b) be undertaken by a person suitably qualified to design and/or implement the specific plan or program and who is a suitably qualified person, such as a suitably qualified field ecologist, or a marine sediment expert | REMP Section 7.3.1 (seagrass and macroalgae) and Section 7.6.1 (Water mouse) | The following summarises how the condition 13 (b) requirements have been addressed:<br>• Project baseline seagrass and macroalgae surveys have been designed and led by Professor Michael Rasheed (JCU), with over 29 years' experience leading successful research programs on topical marine habitats with a focus on seagrass ecology<br>• Project baseline Water mouse surveys were coordinated and led by Dr Amie Anastasi, a CQUniversity researcher with over 16 years' experience in environmental studies, and, Professor Emma Jackson, Coastal Marine Ecosystems Research Centre (CMERC) Director and marine ecologist with over 21 years' experience in ecological studies. |
| 7. | 13. (c) | (c) inform relevant monitoring programs/plans required by this approval in Conditions 14 and 15 | REMP Section 7.3.2 (seagrass and macroalgae surveys results), Section 7.6.1 (Water mouse surveys results), Section 8.3 (seagrass and macroalgae monitoring program) and Section 8.4.2 (Water mouse monitoring program) | The following summarises how the condition 13 (c) requirements have been addressed:<br>• Seagrass monitoring locations for the Project occur in areas where there is a long (>20 year) history of monitoring data to more effectively ascertain the condition of seagrasses relative to historical variability and between impact and reference meadows<br>• The long-term seagrass monitoring within the PoG adds greater certainty around the expected condition of seagrasses, placing any changes occurring into a historical perspective and providing strong statistical support for determining if Project impacts have occurred<br>• The Project Water mouse baseline surveys undertaken in 2020, 2021 and 2023 have informed the Water mouse monitoring program which includes monitoring the extent, location and condition of the Water mouse foraging habitat on an annual basis during construction and for two years following the completion of construction<br>• The Water mouse foraging habitat remote sensing data will be classified and evaluated according to three criteria, including a species-specific risk matrix, appropriate trigger criteria, and linked to an agreed Alert-to-Action protocol to be implemented for the condition assessment of the shoreline mangroves |

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| 8. | 13. (d) | (d) be reported on within 10 business days of completion of the survey and the report submitted to the Department within 10 business days of the completion of the final report of the survey. | REMP Section 10 | The following summarises how the condition 13 (d) requirements have been addressed:<br>• The REMP contains a commitment for GPC to provide comply with this condition. |
| 9. | 14. (a) | The approval holder must implement, commencing prior to the commencement of each relevant Project Stage, the following monitoring programs in respect of Project Stage 1 and Project Stage 3:<br>(a) a program capable of accurately monitoring any effects of Project Stage 1 and Project Stage 3 on the population and behaviour of the Eastern Curlew within Eastern Curlew habitat utilised by the species within the shorebird area including at Friend Point, the WB reclamation area and South Passage Island until 2 years following completion of construction of Project Stage 1 and Project Stage 3 | REMP Section 8.7 (Project Eastern curlew and other shorebird monitoring program) | The following summarises how the condition 14 (a) requirements have been addressed:<br>• A dedicated monitoring program for Eastern curlew and other shorebirds has been prepared which incorporates acute phase, long-term and Eastern curlew behavioural monitoring components for the Friend Point roost site<br>• An approach to analysing the monitoring data has been developed to test the Project impact on the Eastern curlew population and behaviour at Friend Point roost site, including monitoring indicators, triggers for investigation and frequency<br>• Annual monitoring reports will be prepared on the results of the monitoring, comparison with previous results, review of the effectiveness and appropriateness of the monitoring program in meeting the monitoring program objectives, recommendations to inform relevant management plans to adaptively manage and mitigate impacts to Eastern curlew. |
| 10. | | (b) a program capable of accurately monitoring the integrity of all the WBE reclamation area bund walls and promptly detecting any failure, including appropriate monitoring locations, methods and frequency, for the period of effect of the approval | REMP Section 8.12 (NLEP SRA bund wall integrity monitoring program) | The following summarises how the condition 14 (b) requirements have been addressed:<br>• A risk assessment has been completed to identify the hazards that could affect the short and long-term integrity of the rock wall bund during its construction, post construction (prior to reclamation works) and reclamation works, future development and end use stages of the bund wall lifecycle<br>• During construction of the bund wall and geofabric installation quality monitoring and remediation will be undertaken in accordance with the civil and earthworks specification and the Project quality plan, which includes inspection and test pits, hold points and witness points inspected by a registered professional engineer of Queensland, and audits |

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| | | | | • Post construction bund wall integrity monitoring will be conducted at 15 monitoring points regularly spaced along the rock wall bund structure, and will include surveys and visual inspections of the:<br>- Settlement of the bund wall (surveys at 6 months and 2.5 years after the completion of the bund wall, and a survey every 5 years thereafter)<br>- Stability of the bund wall and rip rap and rock berm undertaken at low tide (surveys at 3 months, 9 months and 2 years and 9 months after the completion of the bund wall, and a survey every 5 years thereafter)<br>- Excessive release of sediment/turbidity through the bund wall (weekly visual inspections during the first month post construction and if no issues monthly inspections for next 11 months thereafter, and water quality monitoring buoys for 2 months post construction in accordance with the Project water quality monitoring program).<br>• If the results of monitoring surveys show non-compliances in the detailed design specifications (i.e. detailed design drawings, civil and earthworks specification and geofabric installation works specification), corrective actions will be undertaken (e.g. maintenance of wearing course and subgrade, geotextile filtration system and revetment remedial works, other remedial actions developed in consultation with a registered professional engineer of Queensland)<br>• Additional post construction bund wall integrity monitoring surveys will be undertaken following severe and extreme weather events, such as a cyclone, dangerous thunderstorms, strong winds, heavy rain, lighting and/or hail, that are triggered under the GPC Emergency Response Plan. |
| 11. | | (c) a program capable of accurately monitoring and quantifying the impact of hydrodynamic changes including erosion, sedimentation, and channelisation which occur as a result of either Project Stage 1, Project Stage 3, or the combined effects of both, and any resulting impacts on protected matters | REMP Section 8.9 (Hydrodynamic changes monitoring plan) | The following summarises how the condition 14 (c) requirements have been addressed:<br>• Bathymetric surveys of the channel to the west of the NLEP SRA will be undertaken immediately post completion of the construction. A follow up survey will be undertaken after three months post completion and then twice yearly for two years. |

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| | | | | • LiDAR or drone surveys of the shoreline to the west of the NLEP SRA immediately post construction and at six-monthly intervals for a period of two years. |
| 12. | | (d) if Water Mouse habitat is identified during baseline surveys required under condition 11(c), a program capable of accurately monitoring and quantifying any changes to the extent, and location of Water Mouse habitat, including foraging habitat and breeding places, until 2 years following completion of construction of Project Stage 1 and Project Stage 3 | REMP Section 8.4.2 (Water mouse monitoring program) | The following summarises how the condition 14 (d) requirements have been addressed:<br>• Water mouse monitoring program includes monitoring the extent, location and condition of the Water mouse foraging habitat on an annual basis during construction and for two years following the completion of construction<br>• The Water mouse foraging habitat remote sensing data will be classified and evaluated according to three criteria, including a species-specific risk matrix, appropriate trigger criteria, and linked to an agreed Alert-to-Action protocol for assessment of the mangroves' condition along the shoreline. |
| 13. | | (e) a program capable of accurately monitoring and quantifying any sub-lethal or lethal impacts to seagrass and macroalgae identified in the surveys required under Condition 11(b) during Project Stage 1 and Project Stage 3 and for a period of 2 years following completion of the construction of the southern reclamation area and northern reclamation area | REMP Section 8.3 (Seagrass and macroalgae monitoring program) | The following summarises how the condition 14 (e) requirements have been addressed:<br>• Quarterly assessments will be undertaken of the seagrass meadow that lies within the Zone of Influence of construction and two nearby reference meadows with similar characteristics and historical trends from 3 months prior to start of works to 6 months post completion.<br>• Continued seagrass meadow condition assessment of the Project Zone of Influence and reference monitoring meadows as part of the annual seagrass monitoring program each November for two years post completion of the works.<br>• Light conditions within the Zone of Influence and at reference meadows will be compared to observed seagrass condition to identify potential light-related stress and changes in seagrass condition. |

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| 14. | | (f) a Fine-grained Sediment Validation Monitoring Plan (FSVMP):<br>(i) capable of accurately quantifying the amount of fine-grained sediment released or returned to the marine environment including from tailwater discharge and erosion as a result of each of Project Stage 1 and Project Stage 3 that was not available for resuspension before the commencement of each of Project Stage 1 and Project Stage 3;<br>(ii) capable of accurately quantifying the amount of fine-grained sediment released or returned to the marine environment that was available for resuspension before the commencement of each of Project Stage 1 and Project Stage 3;<br>(iii) which includes an assessment of the effectiveness of the methods specified in the FSVMP for monitoring and measuring fine-grained sediment releases and for validating the fine-grained sediment release and return modelling; and<br>(iv) which includes the findings of a review undertaken by the Dredge Technical Reference Panel (DTRP) or other suitably qualified person prior to the FSVMP's submission to the Department, accompanied by details of how any recommendations from this review have been addressed in the FSVMP. | REMP Section 8.10.2 (FGS monitoring plan) | The following summarises how the condition 14 (f) requirements have been addressed:<br>• The validation of the overall sediment release estimate will involve analysing the data that is collected as part of this REMP to confirm that the measured turbidity during bund construction was in line with expectations given the estimated quantity of fine sediment release<br>• Measurements of turbidity and particle size distribution will also be undertaken at an additional site close to the edge of the mudflat to provide additional data for the analysis<br>• Baseline measurements of the flux of sediment entering the estuary from the mudflats to the north of the NLEP SRA will be undertaken using a boat-mounted Acoustic Doppler Current Profiler (ADCP), and additional measurements will be undertaken during similar tidal and weather conditions during construction to allow a comparison of the sediment fluxes<br>• Optical sensor profile measurements are used to calibrate the conversion of ADCP backscatter into equivalent TSS. Laser In Situ Scattering and Transmissometry (LISST) Particle Size Distribution (PSD) measurements will be used to characterise suspended sediment particle sizing.<br>• A number of water samples will be collected during ADCP transecting, and will be analysed for TSS and PSD. The TSS measurements will be used to calibrate the optical sensor measurements (NTU to TSS) and ADCP backscatter.<br>• Drone photography will be undertaken at a known state of tide, elevation and orientation both before and during construction to assist in identifying the extent of any construction-related plumes<br>• Satellite photography will be obtained for snapshots at times available both before and during construction to assist in identify the extent of any construction-related plumes<br>• Numerical hindcast modelling will be used to assess the likely construction plume source rates by comparing modelled and measured TSS. |

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| 15. | 17. (a) | All monitoring plans and programs required under conditions 14, 15 and 16 must:<br>(a) be designed and undertaken by a person suitably qualified to design and/or implement the specific plan or program and who is a suitably qualified person, such as a suitably qualified field ecologist, or a marine sediment expert | Condition 14 compliance refer REMP Section 8.7.1 (Eastern curlew), Section 8.12 (bund wall integrity), Section 8.9 (hydrodynamic changes), Section 8.4.2 (Water mouse), Section 8.3 (seagrass and macroalgae), and Section 8.10 (FGS)<br>Conditions 15 and 16 compliance is not relevant for this REMP as this condition is for dredging (Project Stages 2 and 4) | The following summarises how the condition 17 (a) requirements have been addressed:<br>• The dedicated monitoring program for Eastern curlew and other shorebirds has been designed by Professor Richard Fuller of the University of Queensland. The monitoring program has been prepared Dr Penn Lloyd (Principal Ecologist) and Dr Colin Trainor (Senior Ecologist), who are both experienced in shorebird surveys<br>• The bund wall integrity monitoring program has been prepared by Chris Bridges and Corne Marinus, both of whom are included as registered professional engineer of Queensland. A registered professional engineer of Queensland will implement the monitoring program during and post bund wall construction.<br>• The hydrodynamic changes monitoring plan has been designed and prepared by Dr Paul Guard (BMT), who has over 20 years of experience in the numerical modelling of coastal processes and holds a PhD in coastal engineering and an honours undergraduate degree in civil engineering, both through the University of Queensland<br>• The Water mouse monitoring program has been designed and prepared Dr Penn Lloyd (Principal Ecologist, BAAM Ecological Consultants), who has extensive experience in the development and implementation of Water mouse surveys.<br>• The seagrass and macroalgae monitoring program has been designed and prepared by Professor Michael Rasheed (JCU), who has over 29 years' experience in developing and leading successful research programs on tropical marine habitats with a focus on seagrass ecology |

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| | | | | • The FGS validation monitoring plan has been designed and prepared by Dr Paul Guard (BMT), who has over 20 years of experience in the numerical modelling of coastal processes and holds a PhD in coastal engineering and an honours undergraduate degree in civil engineering, both through the University of Queensland. The monitoring plan has been reviewed by Dr Andy Symonds (Director, Port and Coastal Solutions), who has over 20 years of experience in port and coastal projects, specialising in numerical modelling and marine data analysis, and extensive experience in sediment transport, FGS validation monitoring plans and dredging projects. |
| 16. | 17. (b) | (b) be submitted for the Minister's approval prior to the commencement of the relevant Project Stage | Not applicable | The following summarises how the condition 17 (b) requirements have been addressed:<br>• GPC has submitted the Project monitoring programs/plans to Department of Climate Change, Energy, the Environment and Water (DCCEEW) within the timeframe required by this condition. |
| 17. | 17. (c) | (c) include commitments for reporting to the Department the relevant findings and outcomes of monitoring, including performance against specified monitoring objectives, and procedures for undertaking periodic reviews of the effectiveness and appropriateness of the monitoring plan/program | REMP Section 10 (reporting to DCCEEW), Section 8 (annual review of monitoring programs/plans) and Section 10 (review requirements) | The following summarises how the condition 17 (c) requirements have been addressed:<br>• Reporting to DCCEEW within two business days of becoming aware of the EWMA turbidity adaptive management level 2 occurring at water quality monitoring site NW60 (QE4)<br>• Reporting to DCCEEW within two business days of becoming aware of the BPAR adaptive management level 2 light threshold occurring at BPAR monitoring site FL4<br>• This REMP and in particular the operation and implementation of Sections 8 and 9, will be reviewed following the findings of internal and external audits (refer CEMP Section 11), as part of the annual findings and review of the effectiveness of the monitoring programs/plans and/or in the event that a performance indicator is not met. Reviews of this REMP will be undertaken at least annually.<br>• The Project monitoring programs/plans will be reviewed and revised (if needed) annually to assess the effectiveness and appropriateness of the monitoring programs/plans. |

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| 18. | 17. (d) | (d) commit to submit completion reports to the Department within 6 months following the completion of each monitoring program (i.e. the completion of the monitoring in respect of the particular Project Stage which is the subject of the monitoring plan or program) | REMP Section 10 | The following summarises how the condition 17 (d) requirements have been addressed:<br>• Commitment to submit the completed Project monitoring programs/plans reports for Eastern curlew, bund wall integrity, hydrodynamic changes, and FGS within 6 months following the completion of each monitoring program<br>• Commitment to submit the completed Project seagrass and macoalgae, and Water mouse monitoring completion reports within six months following the completion of the second year of post construction monitoring. |
| 19. | 17. (e) | (e) inform relevant management plans required by this approval to adaptively manage and mitigate impacts to protected matters | REMP Section 7 (baseline studies), Section 8 (monitoring programs/plans) and Section 9 (adaptive management framework) | The following summarises how the condition 17 (e) requirements have been addressed:<br>• The Project baseline surveys for Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae, and FGS have informed the monitoring programs/plans and adaptive management framework included in this REMP and CEMP. |
| 20. | 17. (f) | (f) be used to inform the development and delivery of environmental offsets for protected matters | REMP Section 8.9 (hydrodynamic changes), Section 8.4.2 (Water mouse), Section 8.3.8 (seagrass and macroalgae) and Section 8.10.2.3 (FGS) | The following summarises how the condition 17 (f) requirements have been addressed:<br>• The findings of the Project monitoring programs/plans will be incorporated into the assessment and reporting to determine if the Project has resulted in a significant residual impact to protected matters.<br>• The updated significant residual matter assessment may trigger an amendment of the Project Stage 1 offset Strategy which will be resubmitted to the Minister for approval. |
| 21. | 18. | The approval holder must not commence any Project Stage unless the Minister has approved all monitoring programs and plans relevant to that Project Stage required under conditions 14, 15 and the approval holder must implement each approved monitoring program and plan as relevant to that Project Stage | REMP Section 8.7 (Eastern curlew), Section 8.12 (bund wall integrity),Section 8.9 (hydrodynamic changes), Section 8.4.2 (Water mouse), Section 8.3 (seagrass and macroalgae) and Section 8.10.2 (FGS) | The following summarises how the condition 18 requirements have been addressed:<br>• GPC will not commence Project works until the Minister for the Environment and Water has approved the Project Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae, and FGS monitoring programs/plans |

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| | | | | • GPC will implement the Project Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae, and FGS monitoring programs/plans as approved by the Minister for the Environment and Water. |
| 22. | 24. (a) | In addition to implementing the Queensland Coordinator General's stated conditions WT1, WT2 and WT3, the approval holder must include in each Receiving Environment Management Plan (REMP):<br>(a) clearly defined objectives, outcomes and performance criteria for protected matters in relation to the undertaking of the action in the marine environment | REMP Section 8.9 (hydrodynamic changes), Section 8.4.2 (Water mouse), Section 8.3.8 (seagrass and macroalgae) and Section 8.10.2.3 (FGS) | The following summarises how the condition 24 (a) requirements have been addressed:<br>• The Project CEMP contains the defined objectives, outcomes and performance criteria for protected matters (refer CEMP Sections 19.1 to 19.2)<br>• The primary objective of the REMP is to provide all relevant information, systems and procedures that will allow GPC to meet commitments and maintain compliance with Project related permits and environmental approval conditions<br>• Water quality objectives for metal(loid)s and EWMA turbidity trigger levels and adaptive management measures for the concern water quality monitoring site (i.e. NW60 (QE4))<br>• BPAR management light trigger levels and adaptive management measures for the concern BPAR monitoring site (i.e. FL8)<br>• Quarterly and annual assessment of the seagrass meadow that lies within the Zone of Influence of construction and two nearby reference meadows with similar characteristics and historical trends from 3 months prior to start of works to 6 months post completion<br>• Light conditions within the Zone of Influence and at reference meadows will be compared to observed seagrass condition to identify potential light related stress and changes in seagrass condition<br>• The extent, location and condition of the Water mouse foraging habitat will be monitored on an annual basis during construction and for two years following the completion of construction<br>• An approach to analysing the Eastern curlew monitoring data has been developed to test the Project impact on the Eastern curlew population and behaviour at Friend Point roost site, including monitoring indicators, triggers for investigation and frequency |

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| | | | | • Hydrodynamic changes monitoring performance objectives include demonstrating that the measured changes in bathymetry and/or shoreline changes (if any) have not caused significant impacts to protected matters<br>• A Project FGS validation monitoring plan has been developed to provide an estimate of the total amount of FGS that will be released to the marine environment due to the NLEP SRA bund wall construction, that was not previously available for resuspension. |
| 23. | 24. (b) | (b) details of how the DTRP and/or other scientific and technical experts have contributed, or will contribute, to the development, implementation and review of the REMP, and the development of specific management measures | REMP Section 8.7.1 (Eastern curlew), Section 8.12 (bund wall integrity), Section 8.9 (hydrodynamic changes), Section 8.4.2 (Water mouse), Section 8.3 (seagrass and macroalgae), and Section 8.10 (FGS)<br>The DTRP is not applicable for the Project Stage 1 (construction of the southern reclamation area) | The following summarises how the condition 24 (b) requirements have been addressed in relation to scientific and technical experts that have contributed and will be involved in the implementation and review of the relevant monitoring program:<br>• Eastern curlew and other shorebird monitoring program – Professor Richard Fuller of the University of Queensland; Dr Penn Lloyd (Principal Ecologist) and Dr Colin Trainor (Senior Ecologist)<br>• Bund wall integrity monitoring program – Chris Bridges and Corne Marinus, both are included as registered professional engineers of Queensland. A registered professional engineer of Queensland will implement the monitoring program during and post bund wall construction<br>• Hydrodynamic changes monitoring plan – Dr Paul Guard (BMT)<br>• Water mouse monitoring program – Dr Penn Lloyd (Principal Ecologist, BAAM Ecological Consultants)<br>• Seagrass and macroalgae monitoring program – Professor Michael Rasheed (JCU)<br>• FGS validation monitoring plan – Dr Paul Guard (BMT) and Dr Andy Symonds (Director, Port and Coastal Solutions).<br>Section 17 of the CEMP states that as part of the CEMP preparation and review process, including the further development of management actions and procedures, GPC will utilise a combination of in-house, universities and consultants scientific and technical experts which are provided in Appendix 1 of the CEMP. |

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| 24. | 24. (c) | (c) specific and auditable mitigation and management measures to avoid and minimise impacts to protected matters from noise, artificial light, vessel strike, invasive marine species, storm-water run-off, chemical and fuel management, acid sulfate soils and accidental release of waste and/or other contaminant spills into the marine environment, including: objectives, controls, performance indicators, early-warning trigger levels, risk management, adaptive management strategies, corrective actions, and emergency response measures | CEMP Section 19.3 (noise, air quality and light), Section 19.13 (vessel strike), Section 19.8 (pests), Section 19.9 (chemical and fuel management), Section 19.2 (acid sulfate soil) and Section 9.11 (erosion and sediment control)<br>REMP Section 8.1 (stormwater runoff) | The following summarises how the condition 24 (c) requirements have been addressed:<br>• Potential Project impacts to protected matters from noise, air quality, light, vessel strike, invasive marine species, storm-water run-off, chemical and fuel management, acid sulfate soils and accidental release of waste and/or other contaminant spills into the marine environment, have been addressed in the Project CEMP with specific objectives, actions, performance indicators, reporting and corrective actions for each potential impact<br>• Implementation of an Acid Sulfate Management Plan<br>• Implementation of an Erosion and Sediment Control Plan developed in accordance with International Erosion Control Association. |
| 25. | 24. (d) | (d) contingency plans, should undesirable or unforeseen impacts occur, including as a result of extreme weather events or any additional pressures that may impact protected matters | REMP Section 9.2 (EWMA turbidity triggers and adaptive management measures) and Section 9.3 (BPAR seagrass light triggers and adaptive management measures)<br>CEMP Section 15 (emergency preparedness) | The following summarises how the condition 24 (d) requirements have been addressed in relation to management measures that will be implemented if the relevant management trigger levels are exceeded:<br>• The Project CEMP contains the contingency plans, including as a result of extreme weather events or any additional pressures that may impact protected matters (refer CEMP Section 15)<br>• Reduction in rock placement rates at any of the two placement locations with efforts being redirected as appropriate<br>• Other appropriate adaptive management actions (refer Section 9.2.2) in order to reduce turbidity levels and in turn assist in BPAR values returning to above the threshold.<br>GPC has documented policies, Cyclone Preparedness and Response; Biosecurity Prevention Preparedness Response and Recovery; Spill Prevention Preparedness Response and Recovery; Crisis Management which provide a framework for ensuring GPC develops and maintains capacity to efficiently prepare for, respond to, and recover from, an emergency, major business disruption and/or crisis event. |

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| 26. | 24. (e) | (e) mechanisms for reviewing and modifying mitigation and management measures to avoid or minimise impacts to protected matters | REMP Section 9.2 (EWMA turbidity triggers and adaptive management measures) and Section 9.3 (BPAR seagrass light triggers and adaptive management measures) | The following summarises how the condition 24 (e) requirements have been addressed:<br>• If turbidity EWMA adaptive management trigger values are exceeded and/or BPAR light adaptive management trigger values are below the thresholds, consultation with GPC Environmental Compliance Specialist (ECS) and other GPC stakeholders will occur to deliberate any management measure to be implemented to rectify construction related impacts on turbidity and/or BPAR levels. The investigation and management measures will remain in place until construction activities related turbidity and/or BPAR levels no longer activates the Internal Alert Level 1 trigger and/or BPAR Adaptive Management 1, respectively. |
| 27. | 24. (f) | (f) measures recommended by the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 or any subsequent official version | Not applicable | All activities will be conducted during daylight hours, therefore no artificial light from the Project will disrupt wildlife within, or displace wildlife from, important habitat areas. As a result, the Project will not trigger the need to implement measures recommended in the National Light Pollution Guidelines for Wildlife (May 2023). |
| 28. | 24. (g) | (g) mechanisms for the regular review of the performance of the REMP in achieving its objectives and to support continuous improvement | REMP Section 8 (review of monitoring programs/plans) and Section 10 (review requirements) | The following summarises how the condition 24 (g) requirements have been addressed:<br>• The Project monitoring programs/plans will be reviewed and revised (if needed) annually to assess the effectiveness and performance of the REMP in the objectives and to support continuous improvement<br>• This REMP and in particular the operation and implementation of Sections 8 and 9, will be reviewed following the findings of internal and external audits (refer CEMP Section 11), as part of the annual findings and review of the effectiveness of the monitoring programs/plans and/or in the event that a performance indicator is not met. Reviews of this REMP will be undertaken at least annually. |

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| 29. | 24. (h) | (h) procedures for reporting to the Department on outcomes of monitoring, performance monitoring, and periodic reviews of the REMP | REMP Section 9.2 (EWMA turbidity exceedance reporting), Section 9.3 (BPAR below levels reporting) and Section 10 (reporting and review requirements) | The following summarises how the condition 24 (h) requirements have been addressed:<br>• Reporting to the DCCEEW will comply the Project EPBC Act controlled action conditions 13 d. and 17 b. (refer above for details)<br>• Reporting to the DCCEEW within two business days of becoming aware of the EWMA turbidity adaptive management level 2 occurring at water quality monitoring site NW60 (QE4)<br>• Reporting to DCCEEW within two business days of becoming aware of the BPAR adaptive management level 2 light threshold occurring at BPAR monitoring site FL4<br>• Submission to DCCEEW of annual Project monitoring programs/plans reports for Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae and FGS. |
| 30. | 24. (i) | (i) mechanisms for Indigenous stakeholder consultation on and input into the implementation of the REMP | REMP Section 7.6.1 (Water mouse surveys) | The following summarises how the condition 24 (i) requirements have been addressed:<br>• Gidarjil Development Corporation staff were involved in the Project baseline Water mouse surveys<br>• Ongoing consultation occurs with Indigenous stakeholders as part of the Project communications and stakeholder engagement plan, and implementation of the Indigenous Land Use Agreement that applies to the area impacted by the Project<br>• First Nations people via Port Curtis Coral Coast representatives will be invited to be involved in the implementation of the REMP (refer Section 8). |
| 31. | 24. (j) | (j) an outline of the governance structure, including roles and responsibilities, for implementing the REMP. | CEMP Section 8 | The following summarises how the condition 24 (j) requirements have been addressed:<br>• GPC staff and contractors are responsible for the environmental performance of their activities and for implementing and complying with the Project CEMP, REMP and associated management plans |

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| | | | | • The Project owner will be GPC's Port Infrastructure Asset Manager, assisted by a GPC Project Manager (coordinate and oversee Project activities and implementation of the REMP), and GPC staff will undertake the environmental management, monitoring program/plan compliance, adaptive management compliance and internal and external reporting. |
| 32. | 25. | The approval holder must submit each REMP to the Minister for approval prior to the commencement of the relevant Project Stage. Each REMP must be prepared in accordance with the Department's Environmental Management Plan Guidelines. The approval holder must not commence any Project Stage unless the REMP relevant to that Project Stage has been approved by the Minister in writing. The approval holder must implement the REMP approved by the Minister. | Not applicable | The following summarises how the condition 25 requirements have been addressed:<br>• GPC has submitted the Project monitoring programs/plans to DCCEEW within the timeframe required by this condition.<br>• The Project CEMP has been prepared in accordance with the relevant requirements of the DCCEEW's Environmental Management Plan Guidelines. The combination of the REMP and CEMP content is considered appropriate for compliance with this condition.<br>• GPC will not commence Project works until the Minister for the Environment and Water has approved the REMP in writing. |
| 33. | 56. | Unless otherwise stated or agreed in writing by the Minister, each plan which requires the approval of the Minister must be peer reviewed by an independent suitably qualified person before submission to the Minister for approval. | Not applicable | The following summarises how the condition 56 requirements have been addressed:<br>• Dr Paul Erftemeijer has peered reviewed the draft REMP, and suggested amendments and comments have been addressed in this REMP. |
| 34. | 57. | The reviews required under conditions 20, 22 and 24 must include an analysis of the effectiveness of the avoidance and mitigation measures in meeting the outcomes, targets or management measures proposed in the plan being reviewed. | REMP Section 10 (review requirements)<br><br>Project EPBC Act controlled action condition 22 is not relevant to the Project (i.e. relates to the Dredge Management Plan for Project Stages 2 and 4 | The following summarises how the condition 57 requirements have been addressed:<br>• This REMP, in particular the operation and implementation of Section 8 (NLEP SRA environmental monitoring program) and Section 9 (adaptive management framework), will be reviewed, amended and continually improved based on the findings of internal and external audits (refer CEMP Section 11), the annual review of the effectiveness and appropriateness of the monitoring programs/plans, and a review of the effectiveness of the avoidance and mitigation measures in meeting the outcomes, targets or management measures proposed in the REMP in the event that an outcome and/or performance indicator/target are not achieved, and at least annually. |

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 35. | 58. | Unless otherwise specified in these conditions or notified in writing by the Minister, the approval holder must provide to the Minister a copy of all advice and recommendations made by the independent peer reviewer(s) with the plan, and an explanation of how the advice and recommendations will be implemented, or an explanation of why the approval holder proposes not to implement certain recommendations of the independent peer reviewer(s). | Not applicable | The following summarises how the condition 58 requirements have been addressed:<br>• Dr Paul Erftemeijer has peer reviewed the draft REMP, and the advice and recommendations have been addressed in this REMP (refer separate REMP independent peer reviewer comments and GPC responses table). |
| 36. | 59. | The approval holder must notify the Department in writing of the date of commencement of the action within 10 business days after the date of the commencement of the action. | Not applicable | GPC will comply with this condition. |
| 37. | 61. | The approval holder must notify the Department in writing of the date of the commencement of each Project Stage within 10 business days after the date of the commencement of that Project Stage. | Not applicable | GPC will comply with this condition. |
| 38. | 62. | The approval holder must maintain accurate and complete compliance records. | REMP Section 10 (reporting requirements) | The following summarises how the condition 62 requirements have been addressed:<br>• GPC will comply with this condition as specified in Section 10. |
| 39. | 64. | The approval holder must:<br>(a) submit plans electronically to the Department;<br>(b) unless otherwise agreed to in writing by the Minister, publish each plan on its website within 20 business days of the date of:<br>i. this approval, if the approved version of the plan is specified in these conditions; or<br>ii. the date a plan is submitted to the Department, if the plan does not require the approval of the Minister and is not finalised before the date of this approval; or | Not applicable | GPC will comply with this condition. |

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| | | iii. the date a plan has been approved by the Minister in writing, if the plan requires the approval of the Minister;<br>(c) exclude or redact sensitive ecological data from plans published on the website or provided to a member of the public; and<br>(d) keep plans published on the website for the duration of this approval. | | |
| 40. | 65. | The approval holder must prepare a compliance report for each 12-month period following the date of commencement of the action, or otherwise as agreed to in writing by the Minister. The approval holder must:<br>(a) publish each compliance report on the website within 60 business days following the relevant 12-month period;<br>(b) notify the Department by email that a compliance report has been published on the website and provide the weblink for the compliance report within five business days of the date of publication;<br>(c) keep all compliance reports publicly available on the website until this approval expires;<br>(d) exclude or redact sensitive ecological data from compliance reports published on the website; and<br>(e) where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication. | REMP Section 10 (reporting requirements) | The following summarises how the condition 65 requirements have been addressed:<br>• GPC will comply with this condition as specified in Section 10. |

| Ref | Cond. no. | EPBC Act controlled action condition relevant to this document | REMP or CEMP reference | How the REMP addresses condition requirements and commitments made in the plan to address condition requirements |
|---|---|---|---|---|
| 41. | 66. | The approval holder must notify the Department in writing of any: incident; non-compliance with the conditions; or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify:<br>(a) any condition which is or may be in breach<br>(b) a short description of the incident and/or non-compliance; and<br>(c) the location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available. | REMP Section 10 (reporting requirements)<br>CEMP Section 13 (environmental non-compliances and incidents) | The following summarises how the condition 66 requirements have been addressed:<br>• Notifying in writing to the DCCEEW within two business days of becoming aware of the EWMA turbidity adaptive management level 2 occurring at water quality monitoring site NW60 (QE4)<br>• Notifying in writing to the DCCEEW within two business days of becoming aware of the BPAR adaptive management level 2 light threshold occurring at BPAR monitoring site FL4<br>• Notifying in writing to the DCCEEW within two business days of a Project incident which causes or has the potential to cause environmental harm, is unlawful, involves the release of a contaminant, involves marine megafauna injury or death, identifies a new environmental risk, or is not in accordance with the REMP, CEMP and/or environmental approval conditions. |
| 42. | 67. | The approval holder must provide to the Department the details of any incident or non-compliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying:<br>(a) any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future;<br>(b) the potential impacts of the incident or non-compliance; and<br>(c) the method and timing of any remedial action that will be undertaken by the approval holder. | CEMP Section 13 (reporting of environmental non-compliances and incidents) | The following summarises how the condition 67 requirements have been addressed:<br>• A full investigation report provided to the DCCEEW within 10 business days after becoming aware of the non-compliance or incident, specifying any corrective action or investigation which GPC has already taken or intends to take in the immediate future, the potential impacts of the non-compliance or incident, and the method and timing of any remedial action that will be undertaken by GPC. |

## 3.2 Development Permit and ERA 16 EA approval conditions

Table 4 provides the REMP section or Project CEMP section that addresses the relevant Project Development Permit (DA2022/10/01) and ERA 16 EA approval conditions (PA-EA-100261837).

*Table 4: Summary of relevant Queensland Government environmental approval conditions for the Project and location within this document that addresses the compliance with the approval condition*

| Relevant Development Permit and ERA 16 EA approval conditions | REMP section or CEMP section where condition compliance is addressed |
|---|---|
| **Development Permit conditions (DA2022/10/01)**<br>**Part 1: Assessment Manager Conditions** | |
| 28. Prior to works commencing, a Receiving Environment Monitoring Program (REMP) specific to this application and its associated works, is to be submitted to the Assessment Manager (GPC) for approval. The REMP must identify the environmental values of the receiving environment, and monitoring programs to be established which ensure that the identified values are protected or enhanced for the duration of the associated works. Any changes to the REMP must be submitted to the Assessment Manager for approval. | GPC has submitted this REMP to the Assessment Manager for approval<br>REMP Sections 4 and 7 (receiving environment values), Section 8 (monitoring programs/plans) and Section 10 (approval of changes to REMP) |
| 30. Environmental incident notification must be included in any Environmental Management Plans for the premises/development. | CEMP Section 13 |
| **ERA 16 EA conditions (PA-EA-100261837)**<br>**G1 (i)**<br>Activities conducted under the environmental authority must be conducted in general accordance with the following limitations:<br>Construction or dredging must not result in an impact to seagrass meadow condition and extent in the receiving environment unless approved under the *Fisheries Act 1994*. | REMP Section 8.1 (water quality monitoring program and EWMA turbidity trigger levels) and Section 8.2 (BPAR trigger levels) |
| **G2**<br>All reasonable and practicable measures must be taken to prevent or minimise the likelihood of environmental harm being caused by the activities. | REMP Section 8 (environmental monitoring programs/plans) and Section 9 (adaptive management framework) |
| **G3**<br>Any breach of a condition to this environmental authority must be reported to the administering authority as soon as practicable within 24 hours of you becoming aware of the breach. Records must be kept including full details of the breach and any subsequent actions undertaken. | CEMP Section 13 (environmental non-compliance and incidents) |
| **G4**<br>Other than as permitted by this environmental authority, the release of a contaminant into the environment must not occur. | CEMP Section 19.9 (chemical and fuel management) |

<table>
<tr><th>Relevant Development Permit and ERA 16 EA approval conditions</th><th>REMP section or CEMP section where condition compliance is addressed</th></tr>
<tr><td>G5<br>Unless otherwise specified by a condition of this environmental authority, records must be:<br>a. kept for the period outlined in Table G5 – Record keeping requirements; and<br>b. provided to the administering authority upon request.<br>Table G5 – Record keeping requirements
<table>
<tr><th>Description of records</th><th>Retention requirement</th></tr>
<tr><td>Monitoring results.</td><td>Retain for 15 years.</td></tr>
<tr><td>All other records.</td><td>Retain for 5 years.</td></tr>
</table>
</td><td>CEMP Section 14 (records)</td></tr>
<tr><td>G6<br>An appropriately qualified and experienced person(s) must monitor, record and interpret all indicators that are required to be monitored by this environmental authority and in the manner specified by this environmental authority and the Dredge Management Plan (DMP).</td><td>REMP Section 8</td></tr>
<tr><td>G7<br>All analyses required under this environmental authority must be carried out by a laboratory that has National Association of Testing Authorities (NATA) certification, or an equivalent certification, for such analyses. The only exceptions to this condition are for in situ monitoring of:<br>• turbidity;<br>• temperature;<br>• pH;<br>• conductivity;<br>• dissolved oxygen (DO); and<br>• BPAR.</td><td>REMP Section 8.1.2</td></tr>
<tr><td>All monitoring equipment must be calibrated for each monitoring round and monitoring must be conducted in accordance with the latest version of the administrative authority's Monitoring and Sampling Manual.</td><td>REMP Section 8.1.2</td></tr>
<tr><td>G8<br>When required by the administering authority, monitoring must be undertaken in the manner prescribed by the administering authority, to investigate a complaint of environmental nuisance arising from the activity. The monitoring results must be provided to the administering authority, or nominated delegate, within the specified time period and in the specified format upon request.</td><td>CEMP Section 12</td></tr>
<tr><td>G9<br>Written notification of the commencement date must be provided to the administering authority at least five (5) business days prior to establishing the construction or dredging activity.</td><td>GPC will comply with this condition requirement</td></tr>
</table>

| Relevant Development Permit and ERA 16 EA approval conditions | REMP section or CEMP section where condition compliance is addressed |
|---|---|
| **G10**<br>The activity must be undertaken in accordance with written procedures that: | |
| a. identify potential risks to the environment from the activity during routine operations, closure and an emergency; | REMP Sections 5 and 6 |
| b. establish and maintain control measures that minimise the potential for environmental harm; | REMP Sections 8 and 9, and CEMP Section 19 |
| c. ensure plant, equipment and measures are maintained in a proper and effective condition; | CEMP Section 9.1 |
| d. ensure plant, equipment and measures are operated in a proper and effective manner; | CEMP Section 9.1 |
| e. ensure that staff are trained in and aware of their obligations under the *Environmental Protection Act 1994*; | CEMP Section 10 |
| f. ensure that reviews of environmental performance are undertaken at least annually. | REMP Section 10 and CEMP Section 17 |
| **G13**<br>Any containment structures at the Northern Land Expansion Project southern reclamation area in condition G12 must be certified by an appropriately qualified and experienced person(s) (e.g. registered professional engineer of Queensland) and maintained to the certified design.<br><br>*Note: G12 relates to dredged material placement within the NLEP SRA.* | REMP Section 8.12 |
| **A2**<br>An Air Quality Management Plan must be developed and implemented by an appropriately qualified and experienced person(s) prior to the commencement of activities. The Air Quality Management Plan must be submitted to the administering authority at least sixty (60) business days prior to commencement of construction or dredging activities. The proponent will amend the Air Quality Management Plan in accordance with any comments made by the administering authority prior to the commencement of construction or dredging activities. | CEMP Section 19.3 |
| **WT4**<br>The REMP must be implemented prior to commencement of construction and/or dredging activities and not cease until after construction and/or dredging activities are completed. | REMP Section 8.13 |
| **WT5**<br>A report outlining the findings of the REMP, including all monitoring results and interpretations must be prepared and made publicly available on the proponent's website annually, within one month of its completion and remain accessible for the duration of the action. The first report must be published prior to the commencement of construction or dredging activities. This report must describe the results from the program described above. Reports completed after commencement must include a comparison between conditions before and after commencement of the activity for all indicators. | REMP Section 10 |

| Relevant Development Permit and ERA 16 EA approval conditions | REMP section or CEMP section where condition compliance is addressed |
|---|---|
| **WT10**<br>**Exponentially weighted moving average (EWMA) methodology**<br>The turbidity EWMA approach is to be implemented in accordance with the Gatcombe and Golding Cutting Channel Duplication Project, Application of the EWMA approach document dated 24 January 2020, reference: 237374, revision 1. | REMP Section 8.2 |
| **WT11**<br>The release of contaminants to waters permitted in condition WT9 must not cause environmental harm. | REMP Section 2.1 and Figure 1 |
| **N1**<br>Noise generated by the activity must not cause environmental nuisance to any sensitive place or commercial place. | CEMP Section 19.3 |
| **N2**<br>When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practical timeframe nominated by the administering authority at any sensitive place or commercial place, and results of the monitoring results must be submitted to the administering authority within fourteen (14) days following completion of monitoring. | CEMP Section 12 |
| **N3**<br>Noise monitoring and recording as required under condition N2 must include the following descriptor characteristics and matters:<br>a. LAN,T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins);<br>b. background noise LA90;<br>c. the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels;<br>d. atmospheric conditions, including temperature, relative humidity and wind speed and directions;<br>e. effects due to any extraneous factors such as traffic noise;<br>f. location, date and time of monitoring;<br>g. if low frequency noise is present, MaxLpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 to 200 hertz range. | CEMP Section 12 |
| **N4**<br>The method of measurement and reporting as required under condition N2 of noise levels must comply with the latest edition of the administering authority's Noise Measurement Manual. | CEMP Section 12 |

# 4 Receiving environment attributes

## 4.1 Overview

The construction of the NLEP SRA will take place in the WB area, within the PoG. The majority of the latter is located within the Port Curtis region, on the East coast of Australia approximately 525km north of Brisbane. This region is identified as between Port Alma and the Rodds Peninsula. Port Curtis is a macro-tidal estuarine system encompassing a complex network of rivers, creeks, inlets, shoal, mud banks, channels and islands. Strong tidal flows, wind and swell as well as riverine input from the Calliope and Boyne catchments contribute to biogeochemical processes that profoundly influence the region. In fact, these processes shape the prevailing patterns in water quality, physical-chemistry and biology as well as the habitats such as seagrass meadows, mangroves, mudflats and reefs including their distribution and gradients.

In addition to the summary of receiving environmental attributes/values contained in this section, Project environmental baseline monitoring and reports have been undertaken to support the preparation of this REMP (refer Section 7).

## 4.2 Port Curtis WQOs

WQOs are numerical measures put in place around a range of parameters to protect EVs. These measures are based on national and state water quality guidelines and objectives such as the Australian Water Quality Guidelines (AWQG). These were initially developed by the ANZECC and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) in 2000. The WQOs are also formulated in accordance with the principles of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (Environmental Protection Policy (EPP) (Water)).

WQOs have been established for Port Curtis which has also been divided into water types and zones (DEHP, 2014). Port Curtis includes a range of water types such as freshwater, estuarine and coastal waters with most of the zones classified as moderately disturbed (MD) and only the Narrows, Colosseum Inlet and Rodds Bay classed as slightly disturbed (SD) or high ecological value (HEV) zones. The Project and related proposed NLEP SRA (refer Section 2.1) is located within the WB area which is classified as MD and a lower estuary, enclosed-coastal water zone extending from the southern boundary of The Narrows to and including the mouth of the Calliope River. Of particular relevance to the Project and the protection of EVs is turbidity. Turbidity WQOs established for the WB and The Narrows, the two areas relevant to the Project, to protect EVs are reported in Table 5.

*Table 5: WB and The Narrows turbidity WQOs*

| EPP (Water) area/type | Parameter | Wet season (1 October to 31 March) | | | Dry season (1 April to 31 September) | | |
|---|---|---|---|---|---|---|---|
| | | 20th %ile | 50th %ile | 80th %ile | 20th %ile | 50th %ile | 80th %ile |
| MD2421 Western Basin | Turbidity (NTU) | 7 | 13 | 29 | 4 | 8 | 17 |
| SD2441 The Narrows | | 8 | 15 | 30 | 4 | 7 | 12 |

For the purpose of this REMP, specific water quality (turbidity) triggers were developed for 80$^{th}$ and 95$^{th}$%iles (refer Section 8.1.3) based on exponentially mean weighted averages of long term continuous data (refer Section 7.1.2.1). Note that in some instances the triggers developed and adopted for this Project are more stringent than the WQOs reported in this section.

## 4.3 Water quality

This section provides a summary of the findings of previous water quality monitoring programs in the PoG.

Water quality in the PoG is and has been extensively monitored throughout the years either as part of far-field long-term programs such as the Port Curtis Integrated Monitoring Program (PCIMP) or around specific activities and projects collecting baseline and impact assessment data such as the Project EIS water quality monitoring baseline data collection, PoG Maintenance Dredging, the Western Basin Dredging and Disposal Project (WBDDP) and the Clinton Vessel Interaction Project (CVIP). These programs have collected data from a wide range of monitoring locations spanning from The Narrows to Rodds Bay as well as at inshore and offshore sites. As the Project and REMP area are located and concerned with the WB area only, mainly inshore sites will be considered in the below sections.

Generally, the PoG is a well-mixed estuary due to its macro-tidal regime and resulting tidal ranges in excess of 4m. The latter generate strong tidal currents able to effectively mix and flush the estuary. Other factors that are found to profoundly affect water quality within the port and the REMP area are rain and catchments discharge, wind, waves and their seasonal as well as inter-annual patterns. The extensive above-mentioned datasets show clear general patterns in all standard water quality physical-chemical parameters:

- **Water temperature:** Water temperature is similar across monitoring sites and thus the PoG ranging from ~18°C in the dry season to ~30°C in the wet season. Daily patterns and diurnal/nocturnal fluctuations are also typically recorded. Small rapid decreases in water temperature have also been recorded in response to rain events (Vision Environment, 2020; 2015c).

- **Electrical conductivity (EC):** EC is affected by the presence of inorganic dissolved solids such as salts and it provides an indication of the degree of rainfall entering a system. Generally, EC in the Gladstone Harbour and thus the REMP area is fairly stable and averages ~56mS/cm, however this parameter can quickly respond to rainfall events and catchment inputs. This can be particularly apparent at sites located at the mouth of rivers and creeks such as NW60 (QE4) adjacent to the REMP area and WB50 (P2B). This was apparent at NW55 (QE3), a site located within the Narrows and in relative proximity to NW60 (QE4) which was utilised during CVIP (Vision Environment, 2020). Moreover, during mid-January to mid-February 2015, rain events of more than 100mm resulted in EC below 20mS/cm at NW55 (QE3) and EC below 40mS/cm at WB50 (P2B) (Vision Environment, 2020; 2015c).

- **pH:** pH is a measure of the acidity or alkalinity of water. This parameter is affected by a range of variables such as precipitation, coagulation and disturbance of benthic sediments (APHA, 2005). In the PoG, pH is overall similar across monitoring sites. However, a typical pattern of slightly lower pH (~7.9) at inner sites such as NW60 (QE4) and WB50 (P2B) and thus adjacent and in proximity to the REMP area increasing towards the outer harbour (~8.1) has also been historically observed (Vision Environment, 2020; 2020a; 2015c). The pattern is due to the inner estuarine areas of Port Curtis being lined with mangrove habitats. Here the higher organic content and resulting breakdown processes generally lead to lower water pH.

- **Turbidity:** Measured in Nephelometric Turbidity Units (NTU), turbidity is a measurement of water clarity. Changes in turbidity are caused by suspended colloidal matter such as sediments and other organic and inorganic matter. Turbidity is an expression of the optical property of light to be scattered and absorbed rather than transmitted through water (APHA, 2005). A greater amount of matter within the water column causes a higher amount of light scattering and thus higher turbidity. Turbidity is intimately linked to hydrodynamics and sediment dynamics (refer Section 4.4). This parameter will be particularly important during the Project SRA construction activities, which can impact the receiving environment and sensitive receptors through increasing turbidity.

Gladstone Harbour is generally a high energy and turbid environment, with turbidity significantly higher at inshore monitoring sites than at offshore sites during both wet and dry season. This historical pattern of higher turbidity inshore compared to offshore has been reported for Port Curtis on numerous previous occasions (Vision Environment, 2020; 2020a; 2015c) and it is due to a combination of river inputs, other land-derived inputs and sediment resuspension from wind-wave action in shallower areas for inshore areas, and the mixing of clearer oceanic waters for the outer harbour sites. Particularly inner estuary sites, such as the ones within the WB and Narrows areas, display significantly higher turbidity values during the wet season than dry season (Vision Environment, 2015c). This pattern is consistent with other studies undertaken within the Great Barrier Reef (GBR) (Fabricius *et al.* 2014; Weeks *et al.* 2012). Mechanisms responsible for this important dynamic include less rainfall and thus less sediment transport downriver to coastal environments during the dry season. This prevents the injection of new sediments to coastal areas that can directly increase turbidity in the dry season. Moreover, less river transport can also prevent new nutrients and trace elements reaching coastal waters which can thus become scarce or depleted causing a decline in plankton. During the dry season (which are also the cooler months), plankton display reduced growth rates. A reduced presence of plankton in the water column can also result in increased water clarity. Moreover, sediment transported into coastal waters during the wet season can undergo breakdown and compaction during the dry season, therefore requiring more energy by wave action or tidal currents to be resuspended and in turn causing higher turbidity. Finally, prevailing winds and currents during the dry season can also push clear and nutrient poor oceanic waters towards the coast further improving water clarity (Fabricius *et al.* 2014; Weeks *et al.* 2012).

At inshore areas such as the WB, particularly evident during the wet season, but also true for the dry season, is an increase in turbidity during spring tides associated with the full and new moon periods. Here stronger tidal currents associated to spring tides and in turn larger tidal ranges, cause a higher level of mixing and resuspension of particles within the water column (PCS, 2019). Instead, during neap tides associated with quarter moon phases, tidal ranges and associated currents are lower with turbidity levels decreasing accordingly (Vision Environment, 2020; 2020a; 2020b; 2015c).

Considering the patterns described above, during the 2020 PoG Maintenance Dredging monitoring program pre and post phases, turbidity at WB50 (P2B), which will be utilised in the Project monitoring program (refer Section 8.1), ranged from 4 to 11 NTU during the pre-dredge phase (baseline) and from 4 to 29 NTU during the post-dredge phase. Highest turbidity levels were associated with spring tides as well as periods of strong winds. Moreover, it is important to consider that rainfall in Gladstone (Central-East Queensland) in 2020 has been below to well below average (BOM, 2020). Despite the overall lack of rain, the above-mentioned turbidity levels at the WB site reached the WQOs wet season 80th %tile (29 NTU) during the post-dredge phase in October 2020 (Vision Environment, 2020b). In the 2018, a slightly wetter year than 2020, PoG Maintenance Dredging monitoring program, turbidity at WB50 (P2B) ranged instead from 3 to 56 NTU during the post dredge phase reaching well above the WB area WQOs wet season 80th %tile (29 NTU) (Vision Environment, 2019b).

- **Dissolved oxygen (DO):** DO (expressed in mg/L or as % saturation), is a measurement of the gaseous oxygen dissolved in the water column. In the PoG, this parameter generally ranges between ~93% and ~100% saturation and it exhibits a similar trend to pH (Vision Environment, 2020; 2020a; 2015c). In fact, an increasing gradient from inner to outer harbour is observed. Diurnal fluctuations, especially in the wet season and thus warmer months, are also observed. Here higher concentrations of DO are observed during daytime due to photosynthesis of plants and algae present in the water column whilst lower concentrations are observed at night during plant respiration (Vision Environment, 2020). A further important dynamic in DO is the immediate decrease in this parameter associated to rain events. Here the injection of detritus and organic matter through freshwater runoff and related breakdown in organic matter causes the decrease of available oxygen in the water column due to increased bacterial activity.

As part of the abovementioned programs and projects, water quality in the PoG has also been extensively sampled and analysed for metal(loid)s, nutrients, organics, Tributyltin (TBT) and chlorophyll a with analyses conducted by NATA accredited laboratories. Results are generally screened against WQOs for Port Curtis (DEHP, 2014) and the related zone classification which is MD for most areas (95% marine species protection) including the WB and thus REMP area. Furthermore, it is important to notice that for metals the WQOs refer to the ANZECC/ARMCANZ guidelines. Whilst both total and dissolved concentrations can be compared to guidelines values, the dissolved fraction is of most relevance as considered to be the potential bioavailable fraction (ANZG, 2018). Moreover, similarly to what was discussed in Section 4.2 for the WQOs, also the ANZECC/ARMCANZ guidelines and related default guideline values (DGVs) are generic and hence not tailored specifically for the WB or Port Curtis (ANZG, 2018).

Studies have shown that contaminant pathways to the PoG can be via flows from the Fitzroy River and through The Narrows as well as the Calliope and Boyne rivers. The presence of certain elements in high concentrations, particularly in the total fraction, such as aluminium and iron is in fact associated to fluvial input and biogeochemical processes typical of high energy environments such as the PoG. Another element whose presence has been associated to the geological formation in the Port Curtis area is arsenic (Angel *et al.* 2012). Moreover, various industrial and anthropogenic discharges together with mobilisation from mangrove dominated regions can contribute to water contaminant concentrations found within the PoG (Aurecon, 2019). Despite these potential sources, water quality is generally good across the harbour with nutrients and dissolved metal(loid)s receiving good scores in the Gladstone Harbour Report Card since 2015 and a very good score grade in 2020 which is the best overall score of the past 6 years (Gladstone Healthy Harbour Partnership (GHHP), 2020; 2019). Moreover, for nutrients and metal(loid)s, total concentrations (the fraction of less concern) are generally considerably higher than the dissolved concentrations.

- **Nutrients and chlorophyll *a*:** Nutrients and chlorophyll *a* within the PoG water display seasonal variations with concentrations overall lower during the dry season than in the wet season (Vision Environment, 2020a; 2015c). An evident spatial variation with a general pattern of elevated nutrients inshore decreasing towards the outer Port Curtis areas is also present. Inner areas such as The Narrows and WB exhibit higher nutrient concentrations which can result in moderate to high chlorophyll *a* concentrations in comparison with outer Port Curtis areas. Exceedances of the WQOs of ammonia and nitrogen oxides can often be recorded in several zones such as The Narrows as well as exceedances of chlorophyll *a* particularly in inner areas (Vision Environment, 2020a). Moreover phosphorus can also be found above the WQOs in the PoG with previous monitoring within Port Curtis suggesting that total phosphorus in the water column is sourced from resuspension of benthic sediments (Vision Environment, 2020a), which contain natural phosphorus deposits (Donchak and Holmes, 1991). The dominance of mangrove habitats as well as the presence of seagrass meadows within the inner harbour areas provide a source of nitrogen to the waters of Port Curtis (Vision Environment, 2013; 2013a).

- **Metal(loid)s:** Similar to nutrients, concentrations of metal(loid)s in the PoG are generally significantly higher during the wet season. In fact, metals concentrations can also increase due to rainfall events and related fluvial inputs in the harbour with these preferentially binding to the suspended particles and organic matter that contain a large surface charge and numerous binding sites (Simpson *et al.* 2005; 2013). This has been a common finding during historical sampling conducted within Port Curtis (Vision Environment 2020; 2020a; 2015c). Spatial variation is also marked with higher concentration at inshore sites decreasing towards the outer harbour. Concentrations higher than the suggested 95% species protection AWQG for total aluminium are recorded in the vast majority of zones during each sampling event. Elevation of copper, zinc and chromium above the DGVs have also been recorded (Vision Environment, 2020a; 2015c).

## 4.4 Hydrodynamics and sediment dynamics

Comprehensive studies and monitoring of hydrodynamics and sediment dynamics have been undertaken at the PoG as part of various impact assessments such as for the PoG Maintenance Dredging and CVIP as well as studies such as the Sustainable Sediment Management (SSM) Project. As part of the latter a range of comprehensive studies were conducted to gain a better understanding of sediment dynamics and thus be able to efficiently manage maintenance dredging operation at the PoG.

In Gladstone Harbour, tides propagate from the south of Facing Island, from the East through the entrance between Facing and Curtis Island and from the north from Keppel Bay into The Narrows. This results in complex interactions with tidal currents and waves meeting near the centre of The Narrows (Aurecon, 2019). An extensive network of rivers, creeks, mud banks, shoals, islands and channels are present within the harbour with substantial intertidal mangroves and saltpan areas also present; these are inundated at higher tide levels. Therefore, the large tidal range and extensive intertidal banks result in changes to the available storage area at different tidal elevations. In turn, the estuary shows a non-linear behaviour for larger tides with varying tidal flow velocities and rate of level rise and fall being dependant on coverage extent of mangroves and saltpan areas.

Moreover, due to the large tidal storage offered by these areas and amplification effects on water levels, good tidal flushing and high tidal current velocities are generally observed in particular within the main channels of the harbour. During spring tides, current velocities in the dredged channels can reach up to a maximum of ~2m/s in localised areas. These are in the vicinity of the Gatcombe and Golding Cutting Channels, particularly around ebb tide where current velocities tend to be higher than flood tide on the same tidal range. Similarly, tidal velocities during spring tides are much higher than during neap tides. Due to these strong currents, the water column within the estuary is usually well mixed with stratification not significant with the exception of periods of major flooding (Aurecon, 2019). The high energy environment described above deeply affects natural bed remobilisation processes and in turn turbidity and total suspended solids (TSS) patterns. Different processes control the sediment transport within the PoG, with the inner harbour region dominated by tidal currents and the outer region by a combination of offshore waves, wind and tidal currents (PCS, 2019; Vision Environment, 2019a).

Moreover, turbidity at the Gladstone Harbour entrances is also primarily controlled by tidal conditions and higher on ebb tides during spring tides as a result of the higher tidal current velocities. Turbidity peaks increase with tidal range indicating that the higher current speeds and inundation of shallow intertidal regions resulting from larger spring tides (i.e. overbank tides) increase the resuspension of sediment within the Gladstone Harbour (PCS, 2019). This dynamic is particularly relevant and important for the WB and thus REMP area where extensive mud banks are present. Here fine sediments are resuspended, in particular during spring tides and thus greater inundation and flushed generating considerable turbidity especially during ebb tide. Due to its geomorphology, type of sediments (refer Section 4.5) and hydrodynamic characteristics, the WB region displays the highest sedimentation rates within the PoG together with the Golding, Boyne and Wild Cattle Cuttings.

## 4.5 Sediments

Sediments within PoG have been thoroughly studied and monitored throughout the years as part of far-field long-term programs such as PCIMP and the SSM study as well as dredging projects. In the latter instance, all available data is reviewed and sediment sampled in targeted areas during the Sediment Analysis Plan (SAP) (design and implementation phase respectively) of capital dredging project such as CVIP and the WBDDP. Moreover, in line with the NAGD and commitments as part of the Long-term Maintenance Dredging Management Plan (LMDMP), every 5 years a SAP of the maintenance dredging footprint is undertaken.

Sediment composition varies throughout the PoG with the outer harbour characterised predominantly by sandy sediment. The Clinton, Auckland and Gatcombe Channels are instead mainly characterised by gravel whilst in the inner and upstream regions such as the WB and thus the REMP area, more silt and clay sediments are present (PCS, 2019). Far-field long-term programs indicate that from 2013 to 2019, the sediment quality, metal(loid)s and nutrients, within Port Curtis has remained fairly consistent. Generally and in line with water samples, sediment quality exhibits a spatial pattern of higher inner harbour concentrations decreasing towards the outer harbour. This is likely attributable to the higher fine particle contents of these areas to which metal(loid) ions bind strongly (Vision Environment, 2020a). However, overall sediments within the harbour have been below ANZECC/ARMCANZ (2000) guidelines for a number of years with very good scores in the Gladstone Harbour Report Card (GHHP, 2020; 2019). This is corroborated by data collected as part of the last PoG maintenance dredging SAP in 2017, when all organic and inorganic contaminants of concern were found below their respective screening levels (as per NADG, 2009) in all samples collected throughout the PoG main channels.

Moreover, a SAP in the REMP area along the boundaries of the proposed NLEP Southern and Northern Reclamation Area was also undertaken in 2020, following relevant guidelines as well as regulators' recommendations. The extensive sampling program showed that all contaminants of concern were below the respective NADG screening levels with the exception of five samples that exceeded threshold values for Arsenic. As discussed in Section 4.3 and found in previous sediment samples, the presence of Arsenic appears to be related to the geological formation in the area instead of anthropogenic inputs (Angel *et al.* 2012). Despite not being included in the NADG, samples were also analysed for PFAS with results returning all below laboratory limit of reporting (Butler Partners, 2020). These results suggest a very low level of geochemical risk from sediment disturbance associated with NLEP bund wall construction activities (Butler Partners, 2020).

## 4.6 Aquatic flora

### 4.6.1 Seagrass

This section summarises the findings of the previous seagrass and macroalgae monitoring programs undertaken at the Port of Gladstone up to 2022.

4.6.1.1 Previous seagrass monitoring programs (2002 to 2022)

Seagrasses are marine flowering plants which can form extensive meadows in shallow to relatively deep (up to ~60m) coastal waters. Seagrass meadows provide important ecosystem services such as primary productivity, carbon sequestration, nursery habitats for commercial and recreational significant vertebrate and invertebrate species, food source for turtles and dugongs and prevention of coastal erosion by trapping sediment through their extensive rhizome systems (Nordlund *et al.* 2018; Scott *et al.* 2018). Seagrasses are sensitive to light reduction and to changes in a range of water quality parameters especially if these, such as turbidity, affect light penetration.

Seagrass meadows are found throughout the PoG and are one of the key habitats within the Port Curtis region. As seagrass meadows are crucial for the health of the PoG with several fauna species relying on them for habitat provision and/or food source, seagrass monitoring has been undertaken since 2002 and at an annual frequency since 2004. The program has been adapted and changed over the years following requirements and developments with the current program in line with GPC commitments and obligations under the PoG LMDMP. This includes yearly monitoring and mapping of 14 coastal seagrass meadows and 5 yearly mapping of all coastal and deepwater seagrass within the Port Curtis region. Additional research and monitoring have complemented the annual monitoring and built further knowledge on the Port Curtis seagrass meadows (refer Section 7.3).

During the annual survey, the 14 monitoring meadows are assessed and their condition is reported based on changes in three key metrics: biomass, area and species composition. The monitoring meadows selected are representative of the range of seagrass meadows present in the Port Curtis region. Results from the program show that in 2018, Port Curtis seagrasses exhibited signs of recovery after several years of poor condition. This trend continued in 2019 when overall seagrass condition was good for all the 14 monitoring meadows. This condition was the best recorded in the past decade and one of the best recorded in the 18 years of the monitoring program. Across the region 16,880ha of seagrass was mapped reflecting the good and heathy state of the seagrasses in the PoG. This area is the largest area of seagrass recorded since the start of the monitoring program in 2002 (Smith *et al.* 2020a). The seagrass meadow at Pelican Banks is the only in the Port Curtis Region that remains in poor overall condition. As this is the result of continued low biomass and poor species composition, it is possible that this is due to the high levels of herbivory pressure (Smith *et al.* 2020a).

The seagrass monitoring program has demonstrated considerable inter- and intra-annual variability in the seagrass meadows' key metrics across the whole Port Curtis region. Seagrass condition in fact varies according regional and local climate and weather conditions (Chartrand *et al.* 2012; 2009). Moreover, seagrasses are highly seasonal with the Gladstone seagrass displaying two broad seasons: the growing season spanning from July to January and the senescent season going from February to June. During the growing season, meadows typically show an increase in biomass and area due to favourable conditions for growth such as high light levels and optimal water temperature. In the senescent season instead, meadows usually retract and rely on carbohydrate stores in their rhizomes or seeds to persist following wet season conditions such as flooding, poor water quality and light reduction (Chartrand *et al.* 2016). Understanding of these patterns has shown and reinforced that seagrasses are more sensitive to high turbidity and light reduction during the growing season when compared to the senescent season. A further factor that new studies have shown to be able to affect and shape seagrass meadows in the PoG is grazing pressure (Scott *et al.* 2020). Herbivory by megafauna such as turtles and dugongs can in fact significantly modify seagrass meadows characteristics by reducing aboveground biomass and shoot height. Seagrasses can also be affected by anthropogenic activities such as agricultural and urban run-off and related eutrophication, coastal development and dredging (Erftemeijer and Lewis, 2006; York and Smith, 2013). However, in the PoG environmental conditions such as climate, rainfall and river discharge are the key drivers of seagrass condition (Smith *et al.* 2020a; McCormack *et al.* 2013).

Seagrass species composition in the PoG is dominated by *Zostera muelleri* which is a large and persistent seagrass species that can grow at rates of 7 to 8mm per day (Kerr and Strother, 1989). This factor is important as seagrass species composition is an important modifier of seagrass meadow state. A shift in species composition towards more colonising ones can be an important indicator of disturbance such as reduced light conditions and of meadows recovering from pressures (Smith *et al.* 2020a). Other species found in the PoG are *Halodule uninervis*, *Halophila ovalis*, *Halophila decipiens* and *Halophila spinulosa*. Different species have different light requirements and thus can occur at different depths, for example *H. decipiens* and *H. spinulosa* are pioneering species with much lower light requirements than *Z. muelleri* and can therefore occur at greater depth where their presence is usually ephemeral.

In the REMP area, a seagrass meadow has been historically present (Meadow 8) showing large fluctuations since the monitoring program commencement in 2002. Meadow 8 has increased in seagrass biomass but has decreased in area since the initial WBDDP established a reclamation over part of the meadow in 2011.

A total of 149 sites were surveyed in the monitoring survey area in October 2022 and extent of seagrass is shown in Figure 2.

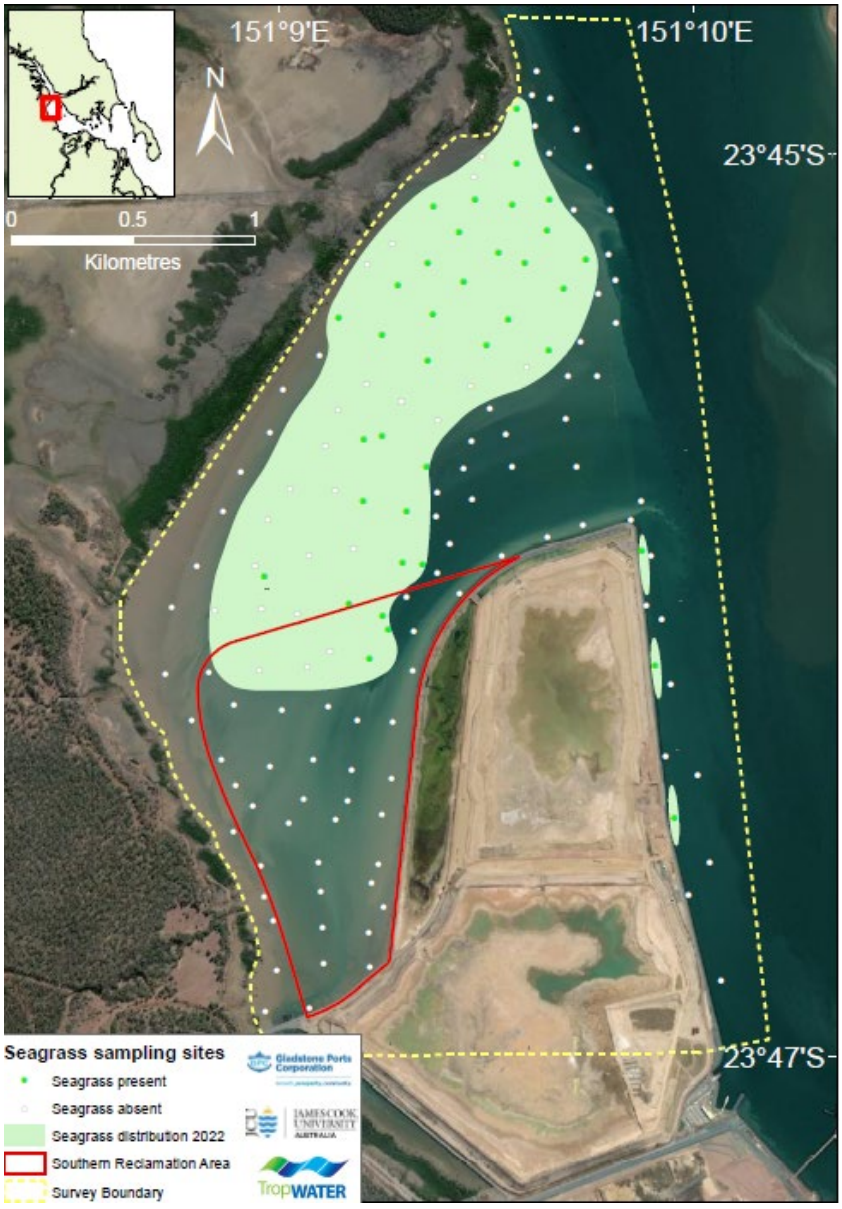


*Figure 2: Seagrass distribution and sampling sites across the survey area in October 2022*

**Source**: Smith et al. (2022)

In 2022, meadow biomass decreased to the lowest since 2015 but was still greater than pre WBDDP reclamation levels. Meadow area in 2022 also decreased compared to 2021 but was still greater than the period post WBDDP construction from 2010 to 2018 (Smith *et al.* 2022).

The large fluctuations in species composition and dominance observed at Meadow 8 since the start of the monitoring program are important and suggest unstable and changing light conditions at the site with light levels not able to always sustain species requiring higher light levels such as *Z. muelleri* (Smith *et al.* 2022).

Changes in seagrass observed in Meadow 8 between 2020 and 2022 were broadly similar to the changes observed in the two nearby reference meadows for the project (Meadow 5 and 6 south of Fisherman's Landing) where decreases in meadow area and biomass were also recorded (Smith *et al.* 2022).

Seagrass meadows more broadly in Port Curtis and Rodds Bay tend to follow similar trends in meadow biomass, area and species composition driven by prevailing environmental conditions. In 2022, rainfall was greater than average for the first time in four years and the greatest since 2012 while flow from the Calliope River was close to the long-term average after 4 years of below average flow. These conditions are less favourable for seagrass growth than the previous four years where below average rainfall, river outflow and tidal exposure led to high seagrass area and biomass throughout Port Curtis (Smith *et al.* 2022).

#### 4.6.1.2 Previous macroalgae monitoring programs to 2022

Macroalgae are photosynthetic marine plants that can occur in a wide range of forms, from simple crusts or filamentous to complex and habitat forming (depending on species). Macroalgae can provide habitat to various fauna species and act as a food source for megafauna species such as turtles. The majority of macroalgae grow attached to hard surfaces as they lack roots which would have otherwise allowed them to anchor to sediments. Therefore, they generally cannot occur where the benthic substrate is composed by mud or sand. The latter is the reasons why in the PoG, macroalgae especially complex and habitat building species are overall scarce or absent from estuary, enclosed-coastal water zones such as the WB and thus the REMP area. Here in fact sediments are predominantly characterised by silt and clay (refer Section 4.5). The only main macroalgae species found here are filamentous. Broad scale macroalgae surveys undertaken at subtidal locations of the PoG in 2013 reported no high density macroalgal communities with all macroalgal communities occurring in the outer harbour.

Concurrently to the 2020 seagrass monitoring, macroalgae were also surveyed within and adjacent to the REMP area. The monitoring shows there is very little habitat forming macroalgae in the area (Smith *et al.* 2020b). Erect and calcareous macroalgae were in fact found along the deep edge of the seagrass meadow in very low percentage cover. Amongst the 127 monitoring sites, macroalgae percentage cover was less than 3% at the majority of sites sampled. Higher algae cover was only observed at three sites, where algae present were highly ephemeral and unstructured filamentous and turf algae. These species can quickly colonise disturbed habitats especially during abundance of nutrients, however their persistence and habitat value is poor when compared to larger habitat forming macroalgae (Wernberg and Connell, 2008). Moreover, fast growing ephemeral macroalgae can compete for available nutrients and are capable of replacing slower growing primary producers such as perennial macroalgae and seagrasses (Pedersen and Borum, 1996).

During the October 2022 survey, macroalgae were found within the survey area, comprising exclusively of low cover ephemeral brown algae. Macroalgae were common throughout the eastern survey area within and outside the seagrass meadow but never had greater than 10% cover (refer Figure 3). Macro-algae covered an additional 31.6ha outside of the seagrass Meadow 8 with the total area of marine plants (seagrass and macroalgae combined) being 207.03 ± 1.36ha. Within the NLEP SRA, macro-algae covered 1.79ha outside meadow 8 including two small isolated patches leading to a combined area of marine plants (seagrass and macroalgae) in the NLEP SRA of 21.15 ± 0.43ha (Smith *et al.* 2022).

Considering the above, macroalgae in the REMP area not a main sensitive receptor. Moreover, adaptive monitoring for seagrass is deemed adequate to also protect the small amount of opportunistic macroalgae species found, due to the lower light requirements of the latter (Nielsen *et al.* 2002; Markager and Sand-Jensen, 1992). In fact, seagrasses have particularly high light requirements (Zimmerman, 2006).

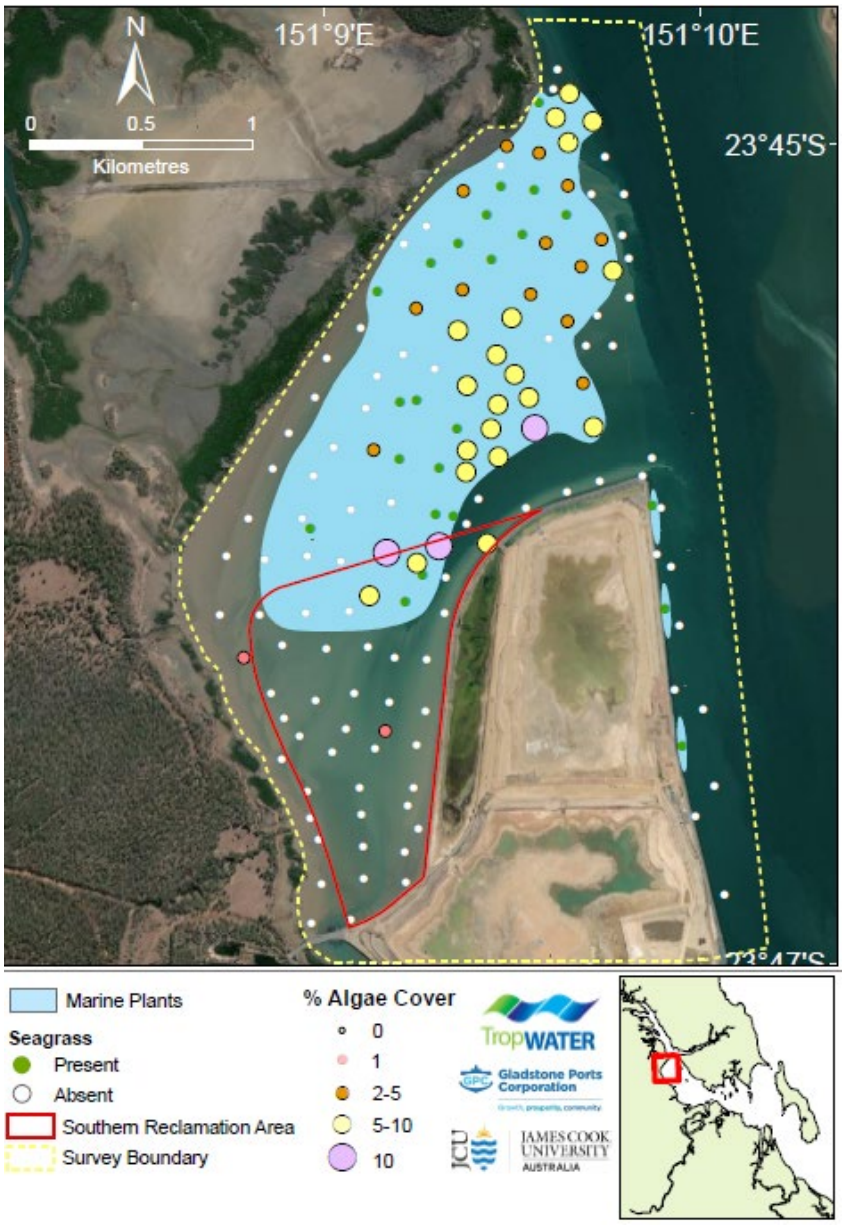


*Figure 3: Percentage brown macro-algae cover at each site in the survey area in 2022*

Source: Smith et al. (2022)

### 4.6.2 Mangroves

Mangroves are flowering trees and shrubs adapted to brackish and marine conditions. They occur in fact in tidal wetlands with their root systems providing important habitat and nursery areas for recreationally and commercially significant vertebrate and invertebrate species as well as birds and other species. Mangroves can also prevent coastal erosion and are important primary producers for carbon sequestration and export. Climate, in particular rainfall and severe flooding with associated large and sharp changes in water quality as well as sea level rise can affect mangroves and their spatial distribution. In the PoG, mangroves are widespread along the extensive tidal wetlands and saltpans regions particularly in inner estuary areas such as the WB area and hence the REMP area. Previous surveys have shown that mangroves in the PoG are in overall satisfactory condition, whilst in particular in the WB area they are in poor condition (GHHP, 2019).

Within the REMP area mangrove condition monitoring commenced in 2011 with the 2016 survey reporting mangrove communities to be generally stable and condition indicators within ranges of previous surveys. The study reported relatively dense mangrove canopy, low leaf litter, abundant presence of crabs and seedlings indicating a healthy community (Houston *et al.* 2016).

### 4.6.3 Saltmarshes and foreshore

Within the PoG, saltmarshes occupy portions of the high tidal zone and thus, similarly to mangroves, can be influenced by climate and sea level rise changes. These habitats are characterised by plants such as reeds, grasses, succulent herbs and shrubs able to tolerate high soil salinity as well as brackish water inundation. In Port Curtis these habitats have been found to provide habitat for fish species of commercial and recreation importance, despite generally having lower species richness than other habitats such as seagrass meadows and mangroves (Sheaves *et al*. 2007).

During the mangrove survey conducted at the end of 2020 and start of 2021 (refer Section 7.4.1.2), saltmarsh and foreshore habitats were also surveyed (refer Figure 16). Zonation patterns of the intertidal vegetation were similar in both areas with a narrow fringe of saltmarsh vegetation along the landward edge followed by salt flats where vegetation was scarce or absent. The salt flats lead to the main mangrove stands (Anastasi *et al.* 2020).

Saltmarsh vegetation in PoG is dominated by marine couch *Sporobolus virginicus* and Austral seablite (*Suaeda australis*). Other common saltmarsh species include Sea purslane (*Sesuvium portulacastrum*), sedges of *Fimbristylis* sp. and Beaded samphire (*Sarcocornia quinqueflora*). Saltmarsh cover was overall also scarce and only extensive at one monitoring transect within the historical survey area (Anastasi *et al.* 2021).

## 4.7 Reefs

Reefs and associated coral communities are important habitats as they support high biodiversity, provide spawning, nursery and feeding grounds for a multitude of recreationally and commercially important species. Moreover, reefs provide ecosystems services such as nutrient recycling and carbon sequestration. These habitats, in particular when coral communities are present, are susceptible to high freshwater flows, flooding, extreme weather events, sea level rise and sedimentation as well as urban and agricultural run-off in particular when the latter results in eutrophication.

Within the PoG, extensive reefs occur along almost the entire length of the eastern side of Facing Island. Smaller offshore reef systems occur to the north and south of Facing Island, at Rundle Island and Seal Rock respectively. In the inner estuary, some small reef systems are also present in the mid and outer harbour zones (BMT WBM, 2018). Within the PoG, these various reef habitats differ greatly in their physical setting, size, water depth, geological setting, wave exposure and hydrodynamic setting as well as water quality characteristics and tolerances to freshwater and flood plumes. As a result, coral coverage and species distribution also differ accordingly. In fact, the PoG waters within the harbour especially in inner zones are generally turbid with higher turbidity levels in the summer wet season (refer Section 4.3) when rivers discharge high sediment loads and are thus not offering an ideal environment for coral communities. Generally, reefs within Port Curtis and thus the PoG are predominantly intertidal rocky shores or shallow subtidal reefs.

The 2023 GHHP Report Card technical report revealed an overall very poor score for corals. Coral cover at the PoG reefs has in fact been very low for the past six years following severe impacts from the 2013 floods (GHHP, 2023; Thompson *et al.* 2016). Moreover, recent data suggests that within the Gladstone Harbour reefs communities are shifting from coral to macroalgal dominance. An event such as coral mortality following a flood event can offer the opportunity to macroalgae to settle, competing for space and preventing coral recovery. In the outer areas of the PoG in fact, persistent high macroalgae cover may be affecting coral recruitment processes by competing for available space for juvenile settlement.

Furthermore, the widespread presence of the bio-eroding sponge *Cliona orientalis* continues to be the most significant contributor to coral mortality within the harbour compounded with coral bleaching in 2020 due to high water temperature (GHHP, 2023).

In the WB and thus the REMP area, reefs are not present, in fact as discussed in Section 4.3 and Section 4.5, the WB is a naturally highly turbid area with sediments mostly characterised by silt and clay and thus not offering the right substrate for coral settlement. Moreover, the REMP area is characterised by a shallow bathymetry with the larger part of the area becoming exposed at spring low tide. Considering this, reefs will not be considered further in this document and in the monitoring program related to the Project. However, reefs long-term monitoring programs as part of GHHP and the PoG LMDMP will continue under the maintenance dredging framework.

## 4.8 Aquatic fauna

### 4.8.1 Turtles

Marine turtles are important within oceanic ecosystems throughout the world as they act as prey, consumer, competitor and host. These animals serve also as conduits for nutrients and energy transfer within and among ecosystems.

A range of turtle monitoring programs and research projects have been undertaken within the Port Curtis region. Six species of marine turtle have been observed in the region: green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricate*), olive ridley turtle (*Lepidochelys olivacea*) and leatherback turtle (*Dermochelys coriacea*). The first four species listed are the most common within the Port Curtis region. Nesting has only been recorded for green, flatback and loggerhead turtles with the most prevalent and thus well studied species within the PoG being the green turtle. Species such as olive ridley have instead been seldom recorded throughout the harbour or broader area with no record of this species breeding in eastern Australia (Limpus *et al.* 2013).

- **Green turtle:** Green turtle is the most common species of marine turtle found within the harbour utilising the area for feeding on seagrass, algae and mangrove fruits (Limpus *et al.* 2013). Despite feeding on a range of sources, studies suggest that algae constitute the main food source for many green turtles in the area (Limpus *et al.* 2013). Results have shown that Port Curtis is not a significant area for aggregation of breeding green turtles for courtship and mating. The green turtle nesting season spans from mid to late October, peaking in late December to early January and concluding in late March to early April (Limpus *et al.* 2013). However, whilst this species has been recorded nesting within the Port Curtis region on Curtis and Facing Island beaches, offshore islands of the Great Barrier Reef are the preferred locations for this purpose (Limpus *et al.* 2006).

  Tagging studies conducted within the harbour show that green turtles display a high degree of site fidelity to foraging habitat with Pelican Banks being utilised by many of the tagged turtles (Hamann *et al.* 2015). These findings corroborate the explanation for the poor state of the Pelican Banks meadow due to herbivory pressure (refer Section 4.6.1). Further studies in 2016 and 2017 indicated that green turtles were most abundant at Pelican Banks and Wiggins Island with juvenile turtles mostly found around shallow intertidal areas bordering mangroves or rocky reef habitats (Limpus *et al.* 2017). Overall, juvenile individuals of this species are in fact mostly encountered in the shallow parts of the harbour, whilst mature individuals occupy deeper, sub-tidal waters (Limpus *et al.* 2013). Although green turtles would utilise the REMP area, studies have shown this area to be an unlikely key feeding ground for this species especially considering the main food source of this species is algae. In fact, the survey conducted in the REMP area in December 2020 shows minimal algal presence (refer Section 4.6.1).

- **Flatback turtle:** Flatback turtles also display a high degree of site fidelity with low density nesting occurring along the East coast from Port Douglas to Bundaberg. Within Port Curtis, flatback turtles are the main nesting species with nesting known to occur on Facing Island, Tannum Sands and Curtis Island (Limpus *et al.* 2013). As well as using the outer areas of the harbour for nesting, flatback turtles enter inner areas during part of their inter-nesting period (Limpus *et al.* 2013). This is corroborated by tagging studies, however, only a small proportion of the tagged flatback turtles entered port limits going as far as the mid-harbour or Southern Entrance. The study concluded that waters around Curtis and Facing Islands and between Facing Island and the mainland were important habitats for interesting flatback turtles (Hamann *et al.* 2017). Post hatchlings flatback turtles forage on plankton in deep pelagic waters whilst sub-adult individuals usually forage in deeper and complex habitats ranging from 60m and 90m depth. Therefore, WB area or the REMP area are not thought to be important areas for this species which also does not rely on seagrass or algae as direct food source. Flatback turtles are in fact carnivorous with their diet including soft corals, jellyfish, cuttlefish, sea-pens and sea-cucumbers.

- **Other turtle species:** The Port Curtis region provides a potential foraging resource for breeding loggerhead turtles with individuals of this species occasionally breeding on the beaches of Curtis Island and Facing Island (Limpus *et al.* 2013). Loggerhead turtles have also been occasionally recorded within port limits, although no studies on their presence within the harbour have been conducted (Limpus *et al.* 2013). Loggerhead turtles move to coastal benthic zones from the open ocean just before reaching adulthood. Similar to flatback turtles, seagrass and algae habitats do not constitute a direct food source as their diet is carnivorous, constituting of a broad range of taxa such as gastropods and bivalve molluscs.

  Outside of the northern Great Barrier Reef and Torres Strait, the hawksbill turtle is not known to utilise any beach in Queensland for nesting. This species is present in significant numbers in the coral reefs offshore Port Curtis and might also forage within Port Curtis, however this has not been shown by any study. Olive ridley and leatherback turtles are only recorded occasionally and rarely respectively within Port Curtis. In particular, olive ridley turtles commonly forage in deeper subtidal habitats characterised by soft substrates and they rarely occur in shallow intertidal seagrass meadows such as those found within and in proximity to the REMP area.

  The information derived from scientific research detailed in this section shows that most turtles species that occur in Port Curtis are unlikely to utilise the REMP area. Nevertheless, an appropriate program to prevent any potential harm to megafauna will be implemented during Project construction activities (refer Project CEMP Section 19.5).

### 4.8.2 Dolphins

Three species of dolphins are present within Port Curtis: the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), the Australian humpback dolphin (*Sousa sahulensis*), and the Australian snubfin dolphin (*Orcaella heinsohni*) (Cagnazzi, 2017). Both the Australian humpback and snubfin dolphins are listed as ‘vulnerable’ in Queensland under the Nature Conservation Act (1992). They are also protected under the EPBC Act as ‘cetaceans’ and ‘migratory species’ and are listed as ‘vulnerable’ internationally by the International Union for Conservation of Nature, with declining global population trends.

Humpback dolphins occur throughout the whole Port Curtis, from Port Alma to Rodds Bay, with an estimated population of 140 to 160 adults plus ~36% juveniles and calves between 2014 and 2016. Observations of individuals of this species indicate significant movement between the inner harbour zones and Rodds Bay and limited movement between Port Alma and the inner harbour. Distribution of the Australian snubfin dolphin in Port Curtis is instead limited to Port Alma, with an estimated population of 110 to 140 adults plus ~17% juvenile and calves between 2014 and 2016 (Cagnazzi, 2017). Indo-Pacific bottlenose dolphins have only been observed sporadically within the PoG and occur mostly in open waters, hence no population estimates have been made to date (Cagnazzi, 2017).

### 4.8.3 Dugongs

The dugong, *Dugong dugong*, is a large herbivorous marine mammal that occurs at tropical and sub-tropical locations of the Indo-West Pacific region. This species is listed by the EPBC Act as a marine and migratory species. Moreover, Queensland *Nature Conservation Act 1992* lists this species as vulnerable.

Within the PoG, dugongs are predominantly associated with seagrass meadows, as seagrass is the main component of their diet which can also include algae and invertebrates. No clear preference for one seagrass species as primary food source has been determined (Marsh *et al.* 2011). Studies within the PoG have found that the harbour as well as Rodds Bay provide important habitat for a relatively small population of dugongs. The limited observations and data available on this species prevent formulating statistics for the population found within the harbour (GHHP, 2019). Recent studies on dugong feeding trails (DFTs) suggest a sustained feeding activity throughout the year with no consistent temporal patterns among sites. Sites located towards the inner harbour such as Wiggings Island, South Trees and Pelican Banks had higher levels of DFTs than meadows at Rodds Bay (Rasheed *et al.* 2017). Whilst DFTs are present at Meadow 8 (refer Section 4.6.1), within the REMP area, the majority of dugong sightings reported within studies occur in the outer zones of the harbour (Limpus *et al.* 2018).

### 4.8.4 Fish

Fish are one of the most important social, economic and ecological resources within the PoG. Moreover, they are important for nutrient cycling and ecosystem regulation. Within the PoG, seagrass meadows, reefs, mangrove, saltmarshes and tidal flats support fish communities which can vary markedly among these habitats. Whilst excessive freshwater inputs with related sharp decrease in conductivity can exert considerable stress on fish potentially making them more prone to diseases, freshwater flows in Port Curtis are also beneficial for productivity and thus for fish growth by injecting nutrients. Studies within the harbour found an estuarine gradient spanning from The Narrows to the outer harbour and thus open coastal waters with fish assemblages changing accordingly. Differences in fish communities can be due to several factors such as habitat features, physicochemical parameters and tidal flow which can influence abundance of new recruits (Currie and Connolly, 2004). Moreover, a strong positive correlation between fish and turbidity was also found (Connolly *et al.* 2006). In fact, Currie and Smith (2005) found positive correlations between abundance and richness of benthos and turbidity concluding that high turbidity provided favourable conditions for benthic communities which also provide habitat and food source for fish.

Within the WB area and in particular the REMP area, seagrass meadows, mangroves and extensive intertidal mudflats are present supporting fish and invertebrate communities when these areas are inundated. Seagrass meadows are widely used by juvenile stages of fish, however large predatory species can be present at night (Alquezar, 2011). Similarly, mangroves are key habitats for fish and prawn species also acting as nursery habitats for juvenile stages as they can offer protection from predators. Intertidal mudflats are generally less productive for fish compared to seagrass or mangrove habitats.

However, when adjacent to these habitats and at a tidal state when they are not exposed, fish can utilise intertidal mudflats as alternative habitats. Moreover, mudflats contain high biodiversity of invertebrates that can serve as food source for commercially and recreationally important species. The fish health condition has been assessed by the GHHP since 2019 and has remained “good” for five consecutive years. The Mud crab score was “satisfactory” in 2023, which improved from a “poor” grade for the last five years (GHHP 2023).

## 4.9 Shorebirds

Thirty-seven (37) species of migratory shorebirds are listed under the EPBC Act and thus are matters of national environmental significance (MNES). These species visit Australia regularly by crossing the East Asian-Australasian Flyway (EAAF) from their northern hemisphere breeding grounds in Northern Asia and North America (Alaska) to their wintering grounds which includes the region between India, Australia, New Zealand and the Western Pacific (Bamford *et al.* 2008). A migratory shorebird site in the EAAF is considered of international significance if it supports >1% of the flyway estimated population. Biggest threats to migratory shorebirds within this flyway have been identified as loss of tidal flat habitat due to coastal development (mostly outside Australia), and climate change.

The Gladstone sub zone contributes to approximately 6% of the total population of migratory shorebirds in Queensland with an average population size in excess of 22,500 birds (IMEMS, 2013). Most of the shorebird species on the Curtis Coast use banks, bars, spits and beaches while some use trees and rocks. By international standards, on the Curtis Coast, migratory shorebird food is present at low density with preys having low digestible contents. Moreover, food is patchy across the tidal flats and across the tidal cycle with many of the best foraging areas only exposed at the lowest tides for a short period of time (Choi *et al.* 2017). Therefore, the Curtis Coast appears to be close to carrying capacity, harbouring close to the maximum number of birds that can be supported by the amount of food present. Surveys conducted in 2019 reported abundance of migratory shorebirds on the Curtis Coast to be declining compared to surveys in earlier years, whilst species richness had remained fairly stable. The decline in abundance was similar to overall declining population trends for these species in the EAFF which was attributed primarily to the loss of tidal flat habitat outside Australia.

Habitats within and adjacent to the REMP area were found to be used by Eastern curlew, Sharp-tailed sandpiper, Little Curlew, Whimbrel and Caspian tern. Furthermore, two locations in proximity to the REMP area were identified as important roosting sites for the Eastern curlew, with one site located at Friend Point on Kangaroo Island. Whilst Friend Point has been identified as locally important and preferentially used by migratory shorebirds as a roosting site, birds have been recorded to move further inland to the clay pan area when this shoreline roosting site is inundated at spring high tides (Wildlife Unlimited, 2015).

The shoreline and clay pan roosting sites at Friend Point were estimated to have a combined capacity in excess of 150 birds. Due to the regular occurrence of Eastern curlew in and adjacent to the REMP area, this species will be included in the monitoring program detailed in Section 8.7. Beach stone curlew was not included in this document as assessment by an appropriate expert has reported very low occurrence of this species not only in the REMP area, but in the whole Port Curtis region with any impact from the Project construction activities deemed unlikely (Fuller, 2021).

## 4.10 Water mouse (Yirrkoo)

The Water mouse or Yirrkoo (*Xeromys myoides*) is a small native rodent occurring in costal marshland, saline reed-beds and grass land, mangroves and coastal freshwater wetlands. This species is listed as vulnerable under the EPBC Act and in Queensland its distribution span from Proserpine area to near the border between Queensland and New South Wales. Main threats to the Water mouse are habitat loss and degradation as well as site-specific impacts such as habitat modification and changes in soil chemistry.

## 4.11 Receiving waters

As per Project CG Report (Department of State Development, Manufacturing, Infrastructure and Planning, 2020), 'receiving waters' concerns relating to dredged material tailwater discharge from the NLEP SRA will not occur during the construction of the NLEP SRA bund wall. Therefore, this aspect will not be considered further in the present document with receiving waters' characteristics and monitoring being covered under Sections 7.1 and 8.1, respectively.

# 5 Receiving environment conceptual models

To summarise the receiving environment values in Section 4 and the Project baseline environmental monitoring in Section 7, and meet regulatory conditions, a conceptual model of the PoG system was prepared. This conceptual model shows the natural and anthropogenic factors that can influence stressors resulting in possible impacts on receiving environment and sensitive receptors, and is presented in Figure 4.

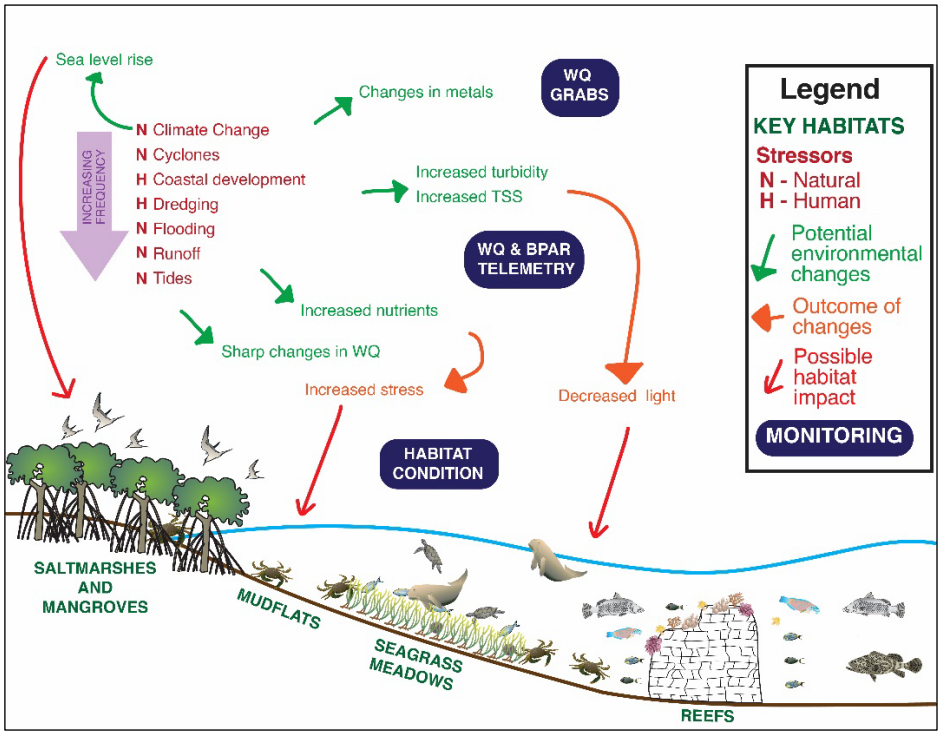


*Figure 4: PoG conceptual model showing natural and anthropogenic factors that can influence stressors resulting in possible impacts on receiving environment and sensitive receptors*

**Figure note:** Symbols sourced from: Integration and Application Network, University of Maryland Centre for Environmental Science (ian.umces.edu/imagelibrary/).

As clear from the information reported in the above sections, the PoG is a high energy and complex system where many factors combine to change conditions that can have impacts on the receiving environment and sensitive receptors. Factors and stressors that can cause impacts can be biotic or abiotic, environmental or anthropogenic as well as a combination of these.

As reported in Section 4.6.1, environmental factors such as flooding, tides and runoff are the main elements causing shifts in stressors such as turbidity and resulting reduced light conditions that can affect sensitive receptors such as seagrasses. Instead, the extensive studies and monitoring conducted, such as telemetry monitoring, plume studies and seagrass monitoring around PoG Maintenance Dredging and capital dredging projects such as CVIP have demonstrated that these activities can be conducted in a manner that does not impact sensitive receptors.

An also complex, but slightly simplified system representing the REMP area and the information reported in Section 4 is depicted in Figure 5. Here some of the stressors as well as sensitive receptors have been removed as not applicable to this Project. The main stressors will be environmental factors such as tides, rainfall and associated runoff and severe weather events. The only anthropogenic stressor which has the potential to impact sensitive receptors through turbid plumes is bund wall construction. Stressors will be appropriately monitored through a range of programs (refer Section 8).

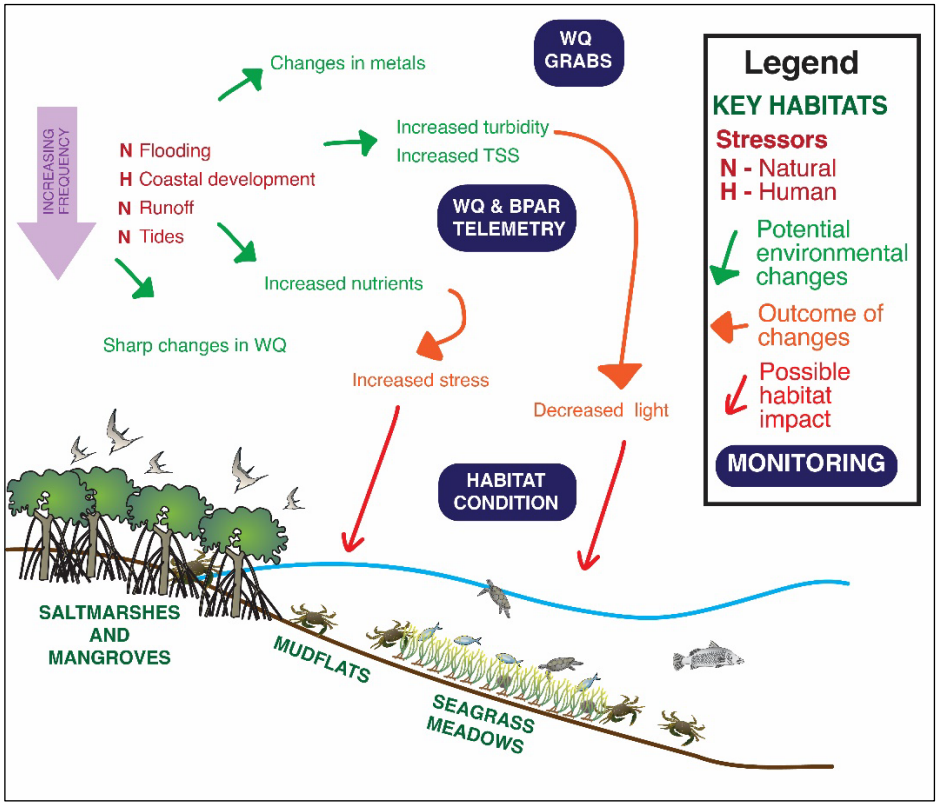


*Figure 5: REMP area conceptual model showing natural and anthropogenic factors that can influence stressors resulting in possible impacts on receiving environment and sensitive receptors.*

**Figure note:** Symbols sourced from: Integration and Application Network, University of Maryland Centre for Environmental Science (ian.umces.edu/imagelibrary/).

# 6 Impact assessment and REMP area

As per government guidelines and best practice, Project construction associated modelling and impact assessment was undertaken to define the area in which potential impacts could be expected and thus define the REMP area. The latter has been in fact defined from modelling, resulting in ZOI and Zone of Influence derivation outputs as the largest combined area to which any degree of impact (low, medium and high) might occur (refer Appendix B). A buffer of approximately 100m has also been allowed. This was utilised to support the design of an appropriate monitoring program capable of detecting any changes in water quality, in particular turbidity, from construction activities and thus prevent, minimise and manage any impact to sensitive receptors.

## 6.1 Impact assessment methodology

The same principles and models utilised in the Project EIS were adopted for the NLEP SRA construction. Full details on model setup and validation are presented in the Project EIS Appendix G (BMT, 2019). The PoG TUFLOW FV hydrodynamic model and SWAN wave model were updated to represent the proposed geometry of the NLEP SRA. Model bathymetry was also updated to incorporate the most updated WB flats survey conducted in March 2020 and the CVIP post-dredge survey. It is important to consider that the bund was modelled as an impermeable barrier and thus with no flow of water through the bund. However, this assumption is conservative in terms of potential plume generations as modelled water velocities and bed sheer stress through the bund wall opening will be higher than in reality, leading to higher estimates of plume concentrations (BMT, 2021).

Three configurations were modelled for the NLEP SRA bund construction, 12 hours and 24 hours construction operations related impact assessment (refer Figure 6):

- **Scenario 1A:** This scenario considers the start of bund construction with placement of rock on two fronts at the start of rock placement;
- **Scenario 1B:** This scenario concerns mid-bund construction with placement of rock on two fronts approximately 900m from the start of rock placement; and
- **Scenario 1C:** This scenario considers construction activities prior to bund closure with placement of rock on two fronts approximately 70m from completion of the NLEP SRA.

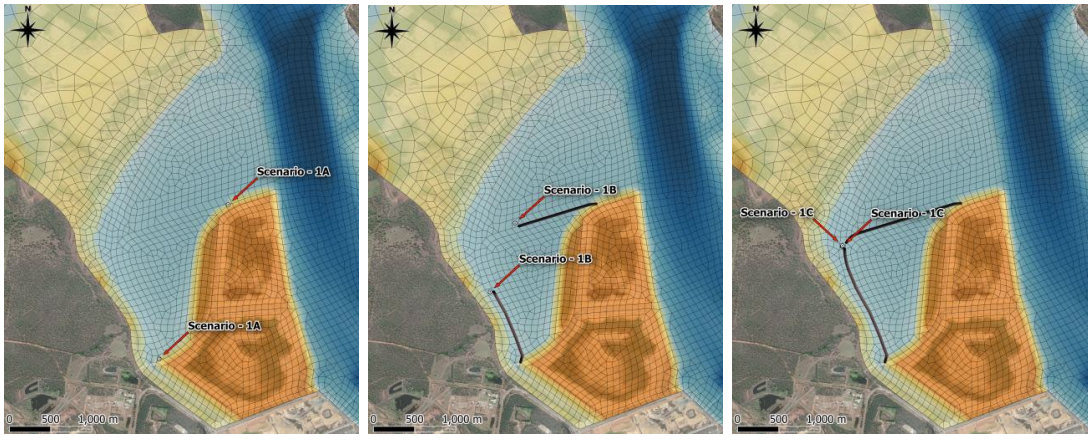


*Figure 6: The configurations modelled, from left to right: Scenario 1A, 1B and 1C*

As it is unlikely that bund construction operations will span more than 12 hours, only related outputs are reported in this REMP. For full and thus also 24 hours model output, please refer to BMT (2021). A 30 day simulation was run for each scenario targeting a large tidal range; for full details on model assumptions refer to the technical report (BMT, 2021). Following the Project EIS methodology, construction effects were assessed based on modelled increases in suspended sediment concentration (SSC) and sedimentation above background levels. The predictive model was used to resolve both ambient and construction generated signals allowing to obtain information on both construction-related increases in SSC and sedimentation relative to ambient conditions.

### 6.1.1 Percentile analysis

Spatial representations of SRA construction impacts were produced from percentile analysis of model results. These were derived by applying a 14 day moving window over a 30 day simulation period. The 14 day window was adopted as meaningful in a physical hydrodynamic context as it represents the approximate duration of a spring-neap tidal cycle. Moreover, it is also meaningful ecologically for assessing impacts to key sensitive receptors such as seagrass meadows (refer Section 8.2). This window was moved forward by 5 day increments from the start to finish of the 30 day simulation period ensuring full coverage of the simulation.

The plots generated present predicted increases in turbidity and sedimentation rates above ambient conditions attributable to NLEP SRA construction activities. Impacts at each percentile level were calculated for every 14 day window with the maximum increase for any window at each location in the model domain presented. The percentile values presented are 95$^{th}$ and 50$^{th}$ which correspond to exceedance duration of 17 hours (5%) and 7 days (50%), respectively within the 14 day window. The first percentile corresponds to relatively ephemeral (episodic) increases in turbidity and sedimentation rates while the latter to sustained, but still overall temporary increases.

It is important to consider that different locations within the model would experience the worst period in increased turbidity and sedimentation rates at different times during the simulation with different percentile statistics potentially occurring during different 14 day windows. Therefore, they are representations of turbidity statistics over long periods of time rather than snapshots of levels of turbidity with impact plots showing potential changes to those statistics (refer Section 6.2). Outputs of this analysis are presented for the ‘’base case’’ corresponding to ambient only, ‘’with construction’’ corresponding to ambient and construction operations and ‘’difference’’ corresponding to construction only increases in turbidity. All outputs are described in Section 6.2, however only the 50$^{th}$ percentile ’difference’ plots are reported in this document as prolonged increase in turbidity are the most concerning for sensitive receptors such as seagrass meadows. For full percentile analysis output plots, turbidity and sedimentation rates, refer to BMT (2021).

### 6.1.2 Zones of impact derivation

Modelled impacts to turbidity were compared to threshold values derived from representative background data to assess potential impacts to marine water quality and sensitive receptors. As required by Commonwealth EIS guidelines, the results of this analysis are presented as ZOIs, including Zone of Influence. The latter are based on dredging environmental assessment guidelines produced by the Environmental Protection Authority (EPA) of Western Australia in 2011:

- **Zone of High Impact:** Excess turbidity from construction activities most likely to cause water quality to deteriorate beyond natural variation;
- **Zone of Moderate Impact**: Excess turbidity from construction activities likely to cause water quality to deteriorate beyond natural variation;
- **Zone of Low Impact**: Excess turbidity from construction activities may cause water quality to deteriorate beyond natural variation; and

- **Zone of Influence:** Extent of detectable plume (as measured by instrumentation) but no predicted ecological impacts.

A combination of referential and biological tolerance methods were used to determine threshold values to derive the ZOIs. Baseline water quality data were used to set initial threshold values which were compared to literature biological tolerances in order to verify if these were biologically meaningful. Threshold values for different percentiles were utilised to obtain an interpolated grid of threshold values for the whole of the PoG (BMT, 2021). Modelled increases for 20$^{th}$, 50$^{th}$ and 80$^{th}$ turbidity percentiles in each cell of the model were compared to local threshold values. Each cell of the model was then included in a certain ZOI or Zone of Influence if any of the threshold values for that zone at that location were exceeded.

## 6.2 Modelling results

Modelled increases in 95$^{th}$ percentile turbidity during 12 hours construction operations for Scenario 1A (start of bund construction) showed minor increases in this parameter within close proximity of the sediment source located in the south-western part of the NLEP SRA. The other source, located eastwards, showed a lower increase in turbidity due to higher ambient flow velocity at this location. The 50$^{th}$ percentile turbidity plot showed that the prolonged influence of bund construction activities is minor due to low flow rate plume release in this scenario (refer Figure 7).

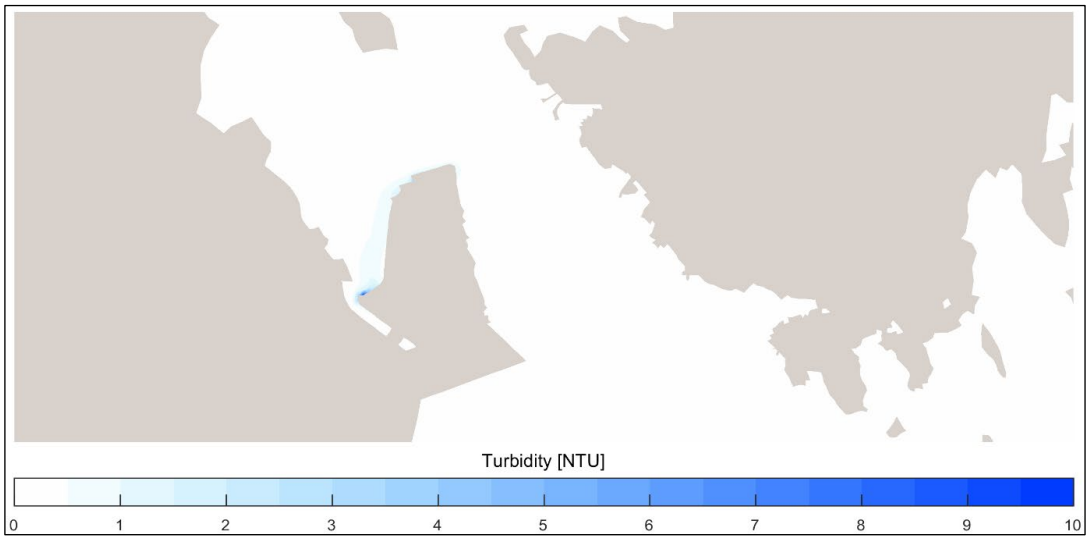


*Figure 7: Scenario 1A, start of bund construction, 12 hours operations, 50$^{th}$ percentile turbidity 'difference' plot*

Moreover, predicted effects of bund construction on sediment deposition rates were minor across the REMP area with modelled increase in 95$^{th}$ and 50$^{th}$ percentiles showing low deposition rates limited to an area in close proximity of the source locations (data not shown, but for details see BMT, 2021).

When the modelled increases in turbidity percentiles are compared against threshold values derived from baseline data collection (refer Section 6.1.1), the ZOIs derived are confined to very small areas immediately adjacent to the source locations. The Zone of Influence is also limited to areas adjacent to the NLEP SRA footprint (refer Figure 8).

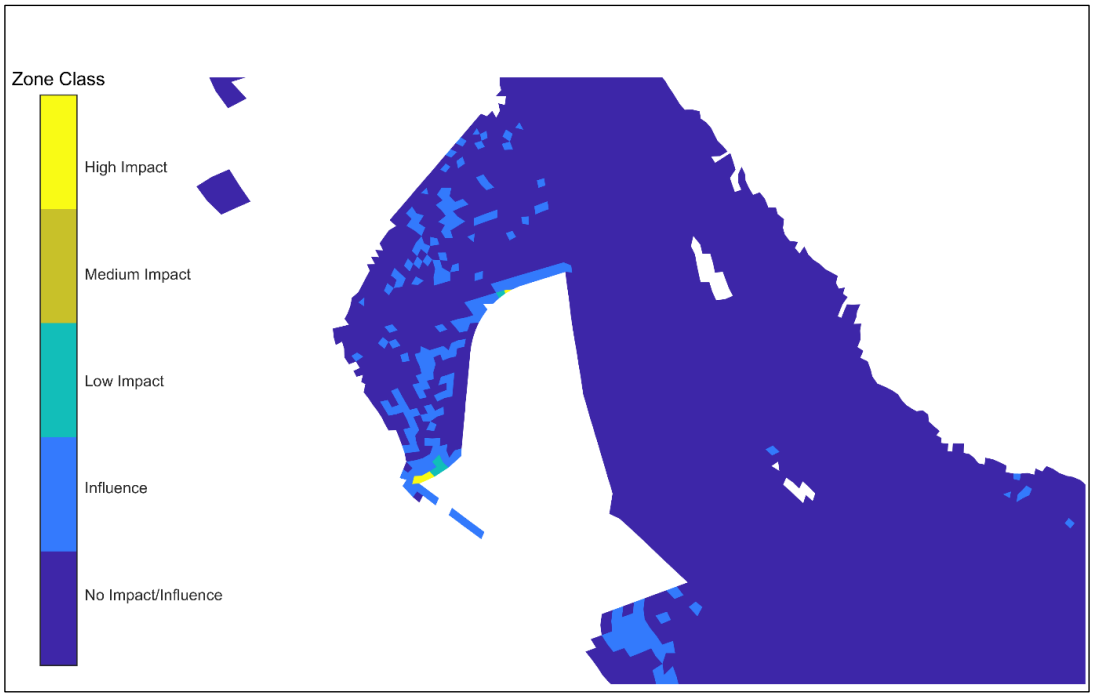


*Figure 8: ZOIs and Zone of Influence for Scenario 1A, start of bund construction, 12 hours operations*

Similarly to Scenario 1A, the modelled increases in 95$^{th}$ and 50$^{th}$ turbidity percentiles for Scenario 1B, mid bund construction, are restricted to areas adjacent to the NLEP SRA as well as the mudflat to the north of the latter and are thus within the REMP area (refer Figure 9).

Sediment deposition rates are instead slightly more widespread than Scenario 1A due to the constriction of the eastern bund and the resulting changes to the flow distribution within the WB area. Despite this, impacts remain contained within the area immediately adjacent to the NLEP SRA and the REMP area (BMT, 2021).

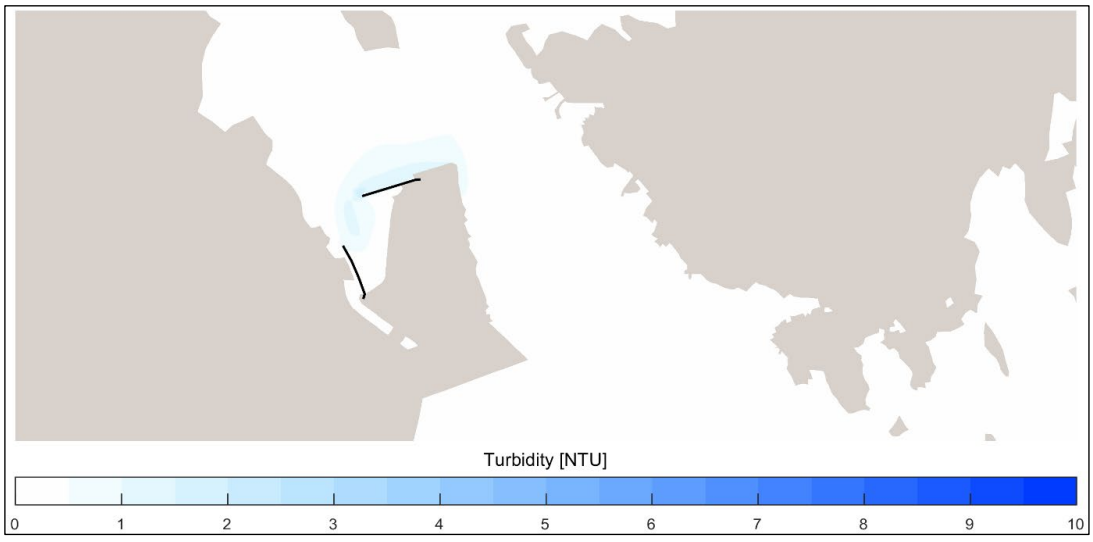


*Figure 9: Scenario 1B, mid bund construction, 12 hours operations, 50$^{th}$ percentile turbidity 'difference' plot*

Zones of Impact related to Scenario 1B show a very small Zone of Low Impact in the immediate proximity of the western of the NLEP SRA constructed bund. The Zone of Influence is slightly smaller than in Scenario 1A extending adjacently to the SRA boundary and mudflats to the north of it (refer Figure 10).

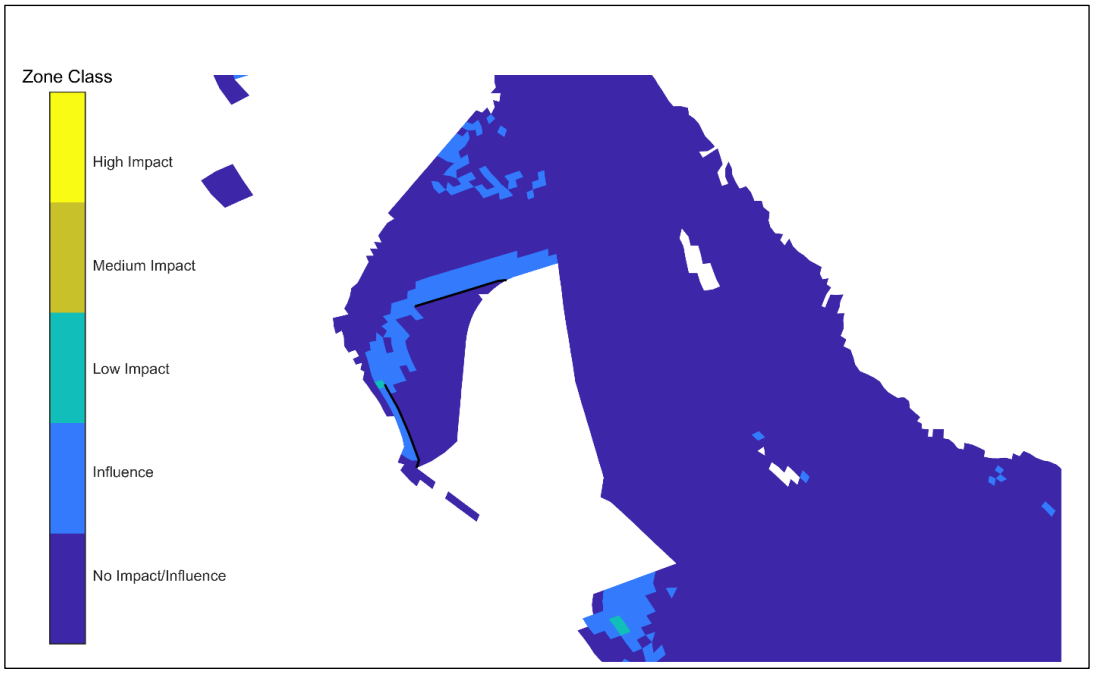


*Figure 10: ZOIs and Zone of Influence for Scenario 1B, mid bund construction, 12 hours operations*

Scenario 1C and thus near-closure of NLEP SRA bund was resolved with a gap corresponding to the minimum cell width of the model of approximately 70m; this was due to mesh sizing constraints (BMT, 2021).

Short term turbidity impacts, and thus 95$^{th}$ percentile, are observed along the northern extent of the constructed bund as well as at a contained area of the mudflats to the north of the NLEP SRA. Minor impact are also observed in the 50$^{th}$ percentile turbidity plot indicating minor but longer influence on turbidity levels. Impacts are however limited to the northern extent of the bund and do not extend to the mudflats to the north (refer Figure 11). Deposition rates for this scenario are again associated to the bund construction plume and limited to small areas adjacent to the NELP SRA bund (data not shown, but for details see BMT, 2021).

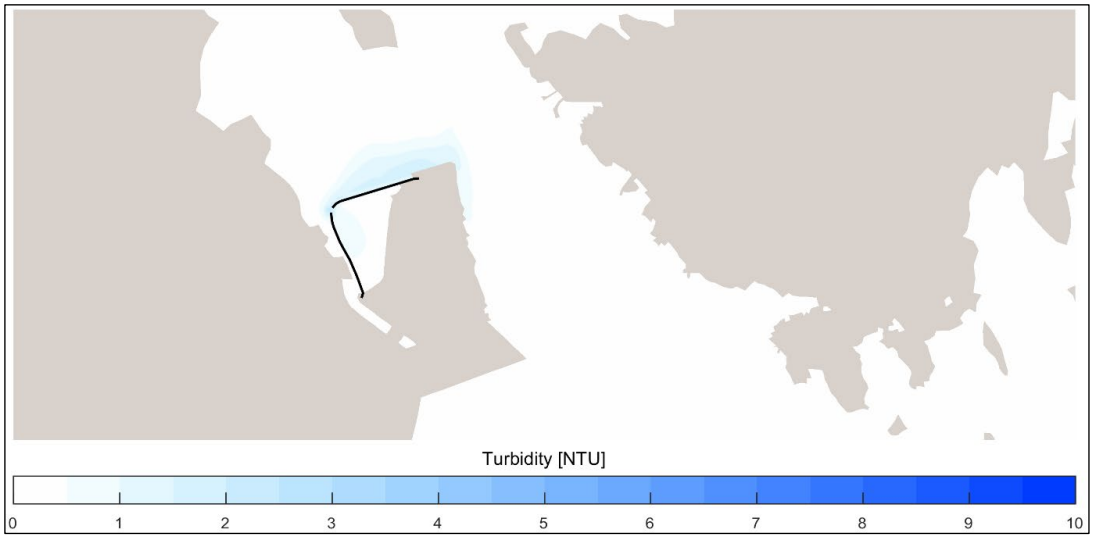


*Figure 11: Scenario 1C, prior to bund closure, 12 hours operations. 50$^{th}$ percentile turbidity 'difference' plot*

Scenario 1C ZOIs, in particular the Zone of Influence, cover the largest extent out of the three scenarios due to the increased velocities (up to 2.5m/s) associated with the constricted bund opening and generated suspended sediment plumes combining with the other modelled plume sources (BMT, 2021). Despite covering the largest area, only a small Zone of Low Impact is present in by the bund opening with the Zone of Influence still limited to areas adjacent to the NLEP SRA and mudflats to the north of it (refer Figure 12).


*Figure 12: ZOIs and Zone of Influence for Scenario 1C, prior to bund closure, 12 hours operations*

In conclusion, modelling results indicate that the predicted increases in turbidity and deposition rate associated with NLEP SRA construction activities are likely to be minor and unlikely to cause ecological impacts on seagrass[2] or other sensitive receptors as the ZOIs, including the Zone of Influence, are limited to the immediate vicinity of the anticipated plume release locations (BMT, 2021).

[2] This is with the exception of the area enclosed by the bund wall that overlaps with the seagrass meadow (refer Figure 2), which will be lost under the direct footprint of the reclamation.

# 7 Summary of the Project baseline studies' monitoring findings

## 7.1 Water quality

### 7.1.1 Project baseline water quality monitoring program

Guided by hydrodynamic modelling and impact assessment, appropriate monitoring site locations were selected in order to protect the receiving environment and sensitive receptors through adaptive management. The impact assessment and modelling identified small zones of impact adjacent to the NLEP SRA bund wall construction footprint.

Therefore, three water quality monitoring sites (NW60, WB20 and WB50) and three BPAR monitoring sites (FL8, WB25 and WI) in the lower Narrows and WB area were established in November 2020. An additional control physicochemical water quality monitoring site (C3) was added to the monitoring program in July 2023. Dual instruments were deployed at all stations. Telemetered data were uploaded to a live dashboard every 15 minutes for GPC viewing. Figure 13 shows the location of the baseline water quality monitoring sites.

The Project baseline water quality monitoring program was implemented from 1 November 2020 to 29 February 2024. The program involved real time (telemetered) monitoring of physicochemical parameters at one site (NW60) and telemetered monitoring of BPAR at one site (FL8) for the entire period.

During the initial eight months of the baseline program (November 2020 to June 2021), an extended monitoring program was operational, with monitoring of two additional sites each for water physicochemical parameters (WB20 and WB50), and BPAR (WB25 and WI). Site FL8 was also monitored continuously (non-telemetered) for sedimentation rates, and discrete monthly sampling for physicochemical parameters, nutrients and contaminants at the three water sites was also carried out.

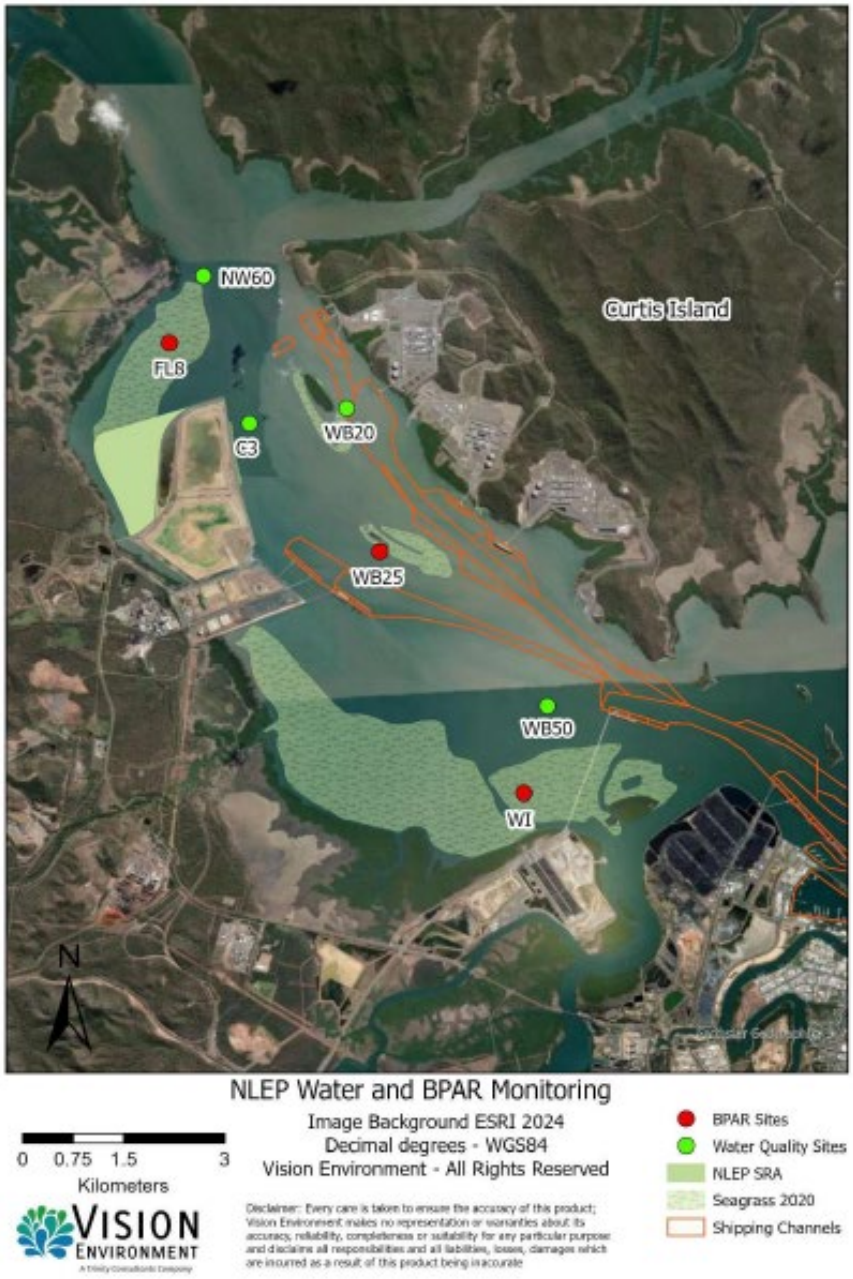


*Figure 13: Project baseline water quality and BPAR monitoring sites*

### 7.1.2 Summary of Project baseline water quality monitoring results

7.1.2.1 Baseline continuous turbidity monitoring results

Baseline turbidity means were calculated for each Wet and Dry Season (refer Table 6). Mean turbidity values were higher during the Wet Seasons (5.7 to 8.5 NTU) than during the Dry Seasons (3.6 to 6.7 NTU), which is typical for Port Curtis (Vision Environment, 2015b, a, 2016, 2017c, b, a, 2018, 2019b, a, 2020c, b, a, 2021b, a, 2022, 2024a). Higher turbidity during the Wet Season can be attributed to the greater rainfall and subsequent stormwater runoff entering the harbour, as well as overall higher windspeeds (Vision Environment, 2024b).

*Table 6: Continuous turbidity (NTU) statistics for monitoring sites during the baseline water quality monitoring program*

| Season | Statistic | NW60 | WB20 | WB50 | C3 |
|---|---|---|---|---|---|
| Wet Season 2020 - 2021 | Mean ± se | 5.8 + 0.0 | 5.7 ± 0.0 | 6.7 + 0.0 | - |
| | Range (n) | 2 – 49 (14446) | 2 – 27 (14445) | 2 – 25 (14267) | - |
| | EWMA Range (n) | 2 – 14 (604) | 2 – 12 (604) | 2 – 17 (602) | - |
| | Turbidity 80th, 95th, 99th % | 8, 12, 16 | 8, 11, 14 | 10, 15, 19 | - |
| | EWMA 80th, 95th, 99th % | 8, 11, 13 | 8, 10, 11 | 10, 13, 15 | - |
| Dry Season 2021 | Mean ± se | 3.6 + 0.0 | 4.2 + 0.0 | 5.3 + 0.0 | - |
| | Range (n) | 1 – 30 (17544) | 2 – 36 (8700) | 2 – 28 (8714) | - |
| | EWMA Range (n) | 1 – 12 (732) | 2 – 13 (364) | 2 – 17 (364) | - |
| | Turbidity 80th, 95th, 99th % | 5, 7, 11 | 6, 9, 13 | 7, 12, 17 | - |
| | EWMA 80th, 95th, 99th % | 5, 7, 9 | 6, 9, 11 | 7, 13, 15 | - |
| Wet Season 2021 - 2022 | Mean ± se | 6.8 + 0.0 | - | - | - |
| | Range (n) | 1 – 45 (17240) | - | - | - |
| | EWMA Range (n) | 2 – 20 (722) | - | - | - |
| | Turbidity 80th, 95th, 99th % | 10, 17, 24 | - | - | - |
| | EWMA 80th, 95th, 99th % | 10, 15, 18 | - | - | - |
| Dry Season 2022 | Mean ± se | 6.4 + 0.0 | - | - | - |
| | Range (n) | 1 – 63 (17270) | - | - | - |
| | EWMA Range (n) | 2 – 19 (722) | - | - | - |
| | Turbidity 80th, 95th, 99th % | 9, 14, 19 | - | - | - |
| | EWMA 80th, 95th, 99th % | 9, 12, 14 | - | - | - |
| Wet Season 2022 - 2023 | Mean ± se | 8.5 + 0.0 | - | - | - |
| | Range (n) | 1 – 139 (17355) | - | - | - |
| | EWMA Range (n) | 2 – 27 (724) | - | - | - |
| | Turbidity 80th, 95th, 99th % | 12, 19, 29 | - | - | - |
| | EWMA 80th, 95th, 99th % | 12, 17, 24 | - | - | - |
| Dry Season 2023 | Mean ± se | 5.9 + 0.0 | - | - | 6.7 + 0.0 |
| | Range (n) | 2 – 49 (17523) | - | - | 2 – 35 (6827) |
| | EWMA Range (n) | 2 – 17 (732) | - | - | 2 – 16 (285) |
| | Turbidity 80th, 95th, 99th % | 8, 13, 18 | - | - | 9, 13, 18 |
| | EWMA 80th, 95th, 99th % | 8, 12, 14 | - | - | 9, 12, 15 |
| Wet 2023 - 2024 | Mean ± se | 7.1 + 0.0 | - | - | 8.0 + 0.0 |
| | Range (n) | 1 – 50 (14555) | - | - | 2 – 37 (14166) |
| | EWMA Range (n) | 2 – 27 (608) | - | - | 3 – 21 (590) |
| | Turbidity 80th, 95th, 99th % | 10, 16, 27 | - | - | 10, 16, 23 |
| | EWMA 80th, 95th, 99th % | 9, 16, 22 | - | - | 10, 15, 19 |
| All Wet Seasons | Turbidity 80th, 95th, 99th% | 10, 17, 26 | 8 ,11 ,14 | 10, 15, 19 | 10, 16, 23 |
| | EWMA 80th, 95th, 99th% | 10, 15, 21 | 8, 10, 11 | 10, 13, 15 | 10, 15, 19 |
| All Dry Seasons | Turbidity 80th, 95th, 99th% | 7, 12, 17 | 6, 9, 13 | 7, 12, 17 | 9, 13, 18 |
| | EWMA 80th, 95th, 99th% | 7, 11, 14 | 6, 9, 11 | 7, 13, 15 | 9, 12, 15 |
| Wet Season | 80th percentile TV | 25 | - | - | - |
| | 95th percentile TV | 40 | - | - | - |
| Dry Season | 80th percentile TV | 13 | - | - | - |
| | 95th percentile TV | 35 | - | - | - |

**Source:** Vision Environment (2024b)

**Table note**: EWMA = Exponentially Weighted Moving Average
No trigger values are relevant to WB20, WB50 and C3 due to their status as control sites. EWMA turbidity values are highlighted where individual values were higher than trigger values, although this does not equate to exceedance of Alert Levels.

At all sites, turbidity was higher during spring tide periods. Higher tidal ranges during spring tides permit a greater level of mixing and resuspension of particles within the water column. When tidal ranges were lower (such as during neap tides associated with the quarter moon phases), turbidity decreased accordingly (Vision Environment, 2024b).

Periods of elevated wind speeds can also result in higher turbidity via increased resuspension induced by wave action, which has been recorded previously in Port Curtis (Vision Environment, 2015b, 2015a, 2016, 2017c, 2017b, 2017a, 2018, 2019b, 2019a, 2020c, 2020b, 2020a, 2021b, 2021a, 2022, 2024). The highest EWMA turbidity value at NW60 during the Baseline period (27 NTU) was recorded both in late February 2023 and mid-February 2024, during a spring tide (>4m tidal range) and easterly winds of greater than 40km/h (Vision Environment, 2024b).

### 7.1.2.2 Baseline continuous BPAR monitoring results

Mean daily BPAR values were calculated for all Wet and Dry Seasons (refer Table 7). Mean ambient PAR, as recorded by the VB unit, was higher during the Wet Seasons (43.3 to 55.2mol/m$^2$/day) than during the Dry Seasons (29.3 to 36.6mol/m$^2$/day). This is likely due to the shorter day lengths experienced during the Dry Seasons (10.5 to 11.5 hours) compared to the Wet Seasons (12.5 to 13.5 hours) (Vision Environment, 2024b).

*Table 7: Daily light (PAR) statistics for benthic and ambient monitoring stations during the Project baseline water quality monitoring program*

| Site (Depth above LAT) | Season | Total Daily PAR (mol/m$^2$/day) | | 14-day RA (mol/m$^2$/day) | |
|---|---|---|---|---|---|
| | | Mean ± SE | Range | Mean ± SE | Range |
| VB (CT) | Wet 20/21 | 47.2 ± 0.9 | 12.6 – 59.8 | 47.1 ± 0.4 | 33.4 – 55.3 |
| | Dry 21 | 30.1 ± 0.9 | 6.0 – 43.1 | 31.4 ± 0.5 | 22.7 – 40.5 |
| | Wet 21/22 | 44.0 ± 0.8 | 11.3 – 58.1 | 43.9 ± 0.3 | 34.5 – 52.1 |
| | Dry 22 | 29.3 ± 0.7 | 2.9 – 47.3 | 29.5 ± 0.4 | 17.7 – 42.5 |
| | Wet 22/23 | 43.3 ± 0.8 | 7.7 – 65.8 | 43.1 ± 0.3 | 30.6 – 51.9 |
| | Dry 23 | 36.6 ± 0.8 | 6.0 – 58.5 | 36.1 ± 0.6 | 24.6 – 54.7 |
| | Wet 23/24 | 55.2 ± 1.0 | 11.4 – 69.2 | 55.1 ± 0.4 | 39.2 – 62.7 |
| FL8 (1.3 m) | Wet 20/21 | 10.3 ± 0.5 | <0.1 – 32.2 | 10.4 ± 0.3 | 3.1 – 15.3 |
| | Dry 21 | 11.5 ± 0.4 | <0.1 – 27.7 | 11.3 ± 0.2 | 4.4 – 19.6 |
| | Wet 21/22 | 9.2 ± 0.5 | <0.1 – 27.6 | 9.3 ± 0.2 | 4.0 – 16.3 |
| | Dry 22 | 12.5 ± 0.5 | <0.1 – 28.6 | 12.4 ± 0.2 | 7.3 – 18.8 |
| | Wet 22/23 | 10.3 ± 0.5 | 0.7 – 35.6 | 10.4 ± 0.3 | 2.4 – 18.5 |
| | Dry 23 | 10.0 ± 0.4 | 0.7 – 26.4 | 10.3 ± 0.3 | 1.3 – 17.4 |
| | Wet 23/24 | 9.3 ± 0.6 | <0.1 – 31.8 | 9.4 ± 0.3 | 2.0 – 17.3 |
| WB25 (0.8 m) | Wet 20/21 | 7.2 ± 0.4 | <0.1 – 23.5 | 7.4 ± 0.2 | 2.9 – 11.1 |
| | Dry 21 | 6.6 ± 0.4 | 0.1 – 14.0 | 6.8 ± 0.1 | 4.2 – 9.2 |
| WI (1.5 m) | Wet 20/21 | 12.6 ± 0.6 | <0.1 – 35.1 | 13.0 ± 0.3 | 4.2 – 20.7 |
| | Dry 21 | 12.6 ± 0.6 | 1.7 – 23.7 | 12.9 ± 0.2 | 9.1 – 16.1 |

**Source:** Vision Environment (2024b)
**Table note**: Values are means ± SE (n = 141 to 182 and 91 to 183 for Wet and Dry phases, respectively). LAT = Lowest Astronomical Tide.

### 7.1.2.3 Continuous temperature, pH, conductivity and dissolved oxygen

At each site, mean temperature, pH, conductivity, and dissolved oxygen were calculated for each season, and compared to WQO, where applicable. As expected, mean temperatures were higher at all sites during the Wet Seasons (27.1 to 28.0°C), than during the Dry Seasons (21.5 to 22.5°C). Water temperatures fluctuated over the Project baseline monitoring period in line with ambient air temperatures. Short-lived decreases in temperature were often evident after rainfall periods (Vision Environment, 2024b).

Baseline monitoring of pH demonstrated no seasonal variation for pH with NW60 consistently recording mean pH of 7.8 to 7.9, with slightly higher pH at site C3 (7.9 to 8.0). During the initial 8 month baseline period significant ($P < 0.05$) spatial variation was evident, with lower pH at NW60 than at WB20 and WB50 (8.0). The spatial pattern of pH increases from the more estuarine Narrows through the Western Basin and then offshore has been recorded in numerous prior projects (Vision Environment, 2015c, 2015b, 2016, 2017c, 2017b, 2017a, 2018, 2019b, 2019a, 2020c, 2020b, 2020a, 2021b, 2021a, 2022, 2023, 2024). Lower pH is commonly found in more estuarine areas as a result of higher organic material availability and resulting decomposition, which is typical of intertidal habitats (Apte *et al*. 2005).

Conductivity fluctuated across the Wet and Dry Seasons due to varying rainfall and resultant runoff. Highest mean conductivity (56.5 to 57.0mS/cm) was recorded during Wet Season 2020/2021, while NW60 exhibited lowest conductivity (51.2mS/cm) during Dry Season 2022, likely due to the higher than typical rainfall experienced during that period (Vision Environment, 2024b).

Wet and Dry Season dissolved oxygen concentrations were similar, ranging from 94% to 96% saturation. Similar ranges were recorded across the sites. Dissolved oxygen exhibited typical diurnal fluctuations, as well as fluctuations corresponding with tidal phases. Significant rainfall events often resulted in short-lived periods of lower dissolved oxygen. Mean dissolved oxygen values typically remained within WQO recommended ranges, although mean dissolved oxygen at NW60 and C3 (96%) was occasionally above the WQO 80th percentile value of 95% saturation (Vision Environment, 2024b).

## 7.2 Fine-grained sediment

### 7.2.1 Seabed fine-grained sediment characteristics

Particle size distribution data from the Project geotechnical investigation were used to determine the percentage of fine-grained sediment (FGS) of each borehole sample (i.e. the fraction that was finer than 15.6 micron (refer Table 8)).

*Table 8: Percentage of fine-grained sediment (<15.6 µm) in NLEP SRA boreholes*

| Borehole | Percentage of sample less than 15.6 micron |
|---|---|
| WBE-BH02 | 74 |
| WBE-BH10 | 57 |
| WBE-BH12 | 50 |

### 7.2.2 Overall impact of NLEP SRA on sediment resuspension

The completion of the NLEP SRA will result in the reclamation of approximately 108ha of intertidal seabed that is presently exposed to tidal currents and wave action. The sediment that comprises the seabed in this area is presently available for resuspension, and will not be available for resuspension following completion of the NLEP SRA, since the constructed bund will include two geotextile fabric layers that will prevent the transport of sediment from the NLEP SRA to the estuary. Therefore, the construction of the NLEP SRA will have the net effect of reducing the overall amount of sediment available for resuspension in the sedimentary system (BMT, 2024b).

The Project geotechnical investigation borehole data within the NLEP SRA footprint (i.e. WBE-BH04 and WBE-BH12) shows that the top one metre of the sedimentary profile is very soft material, and therefore could possibly be resuspended in the event of cyclonic wind and wave conditions combined with spring tidal currents. If it is assumed that the top one metre of sediment is currently available for resuspension, the total amount of sediment currently available for resuspension that will be removed from the active system would be approximately 1,080,000 tonnes (area 1,080,000$m^2$ x 1m depth x 1 tonne/$m^3$ dry density). The material in the top one metre of the profiles at WBE-BH02 and WBE-BH10 is described as firm/stiff clay, but since these boreholes are closer to the shoreline and outside the reclamation footprint they are less representative of the typical material near the surface within the NLEP SRA reclamation footprint than the other two boreholes. In any case, if conditions were extreme it is expected that the top one metre of material in those locations could still be subject to erosion.

## 7.3 Seagrass and macroalgae

### 7.3.1 Project baseline seagrass and macroalgae survey methodology

The Project baseline and other previous seagrass and macroalgae surveys have been designed and undertaken by the Seagrass Ecology Group at JCU's Centre for TropWATER. The surveys have been designed and led by Professor Michael Rasheed (JCU), with over 29 years' experience leading successful research programs on tropical marine habitats with a focus on seagrass ecology. Survey fieldwork and reporting is coordinated by Dr Tim Smith (JCU), a marine ecologist with a range of research interests in coastal ecosystems and fisheries with a particular focus on seagrass habitats.

Intertidal areas were surveyed at low tide using a helicopter. GPS was used to map the position of meadow boundaries and sites were scattered haphazardly within each meadow. Sites were surveyed as the helicopter hovered within one metre above the substrate. Shallow subtidal meadows were sampled by boat using camera drops and a 0.0625$m^2$ van Veen grab. The appropriate number of sites required to detect seagrass change for each monitoring meadow was informed by power analysis (Rasheed *et al*. 2003).

Seagrass above-ground biomass was determined using a 'visual estimates of biomass' technique (Mellors, 1991; Kirkman, 1978). At each coastal site, a 0.25$m^2$ quadrat was placed randomly three times. An observer assigned a biomass rank to each quadrat while referencing a series of quadrat photographs of similar seagrass habitats where the above-ground biomass had previously been measured. Two separate ranges were used – low biomass and high biomass. The percentage contribution of each species to each quadrat's biomass was also recorded.

At the survey's completion, the observer ranked a series of calibration quadrat photographs representative of the range of seagrass biomass and species composition observed during the survey. These calibration quadrats had previously been harvested and the above-ground biomass weighed in the laboratory. A separate regression of ranks and biomass from the calibration quadrats was generated for each observer and applied to the biomass ranks recorded in the field. Field biomass ranks were converted into above-ground biomass estimates in grams dry weight per square metre (g DW $m^{-2}$) for each of the replicate quadrats at a site. Site biomass, and the biomass of each species, is the mean of the replicates.

All survey data were entered into a Geographic Information System using ArcGIS 10.8®. Three GIS layers were created to describe seagrass in the survey area: a site layer, a biomass interpolation layer and a meadow layer.

### 7.3.2 Project baseline seagrass and macroalgae survey findings

In October 2023, Meadow 8 comprised of the seagrass species *Zostera muelleri, Halophila ovalis, H. spinulosa* and *H. decipiens* consistent with previous surveys. Total seagrass area in Meadow 8 was 235.22 ± 4.36ha, an increase of 54.35ha since the previous survey in January 2023 and 59.79ha since October 2022. Mean seagrass biomass decreased to 0.82 ± 0.15g DW $m^{-2}$ from 2.11 ± 0.29g DW $m^{-2}$ in January 2023 and 1.68 ± 0.47g DW $m^{-2}$ in October 2022 (Smith *et al*. 2024).

Changes in seagrass observed in Meadow 8 and the NLEP SRA between annual monitoring surveys in 2020, 2021, 2022 and this survey were broadly similar to the changes observed in the two nearby reference meadows (Meadows 5 and 6 south of Fisherman's Landing (refer Figure 14). Meadow area in all three meadows has remained relatively similar across all surveys. Seagrass biomass decreased across all meadows between January 2023 and this survey and while there was a small decrease in biomass in Meadow 8 between October 2022, biomass in Meadow 6 decreased by more than 50% (Smith *et al*. 2024).

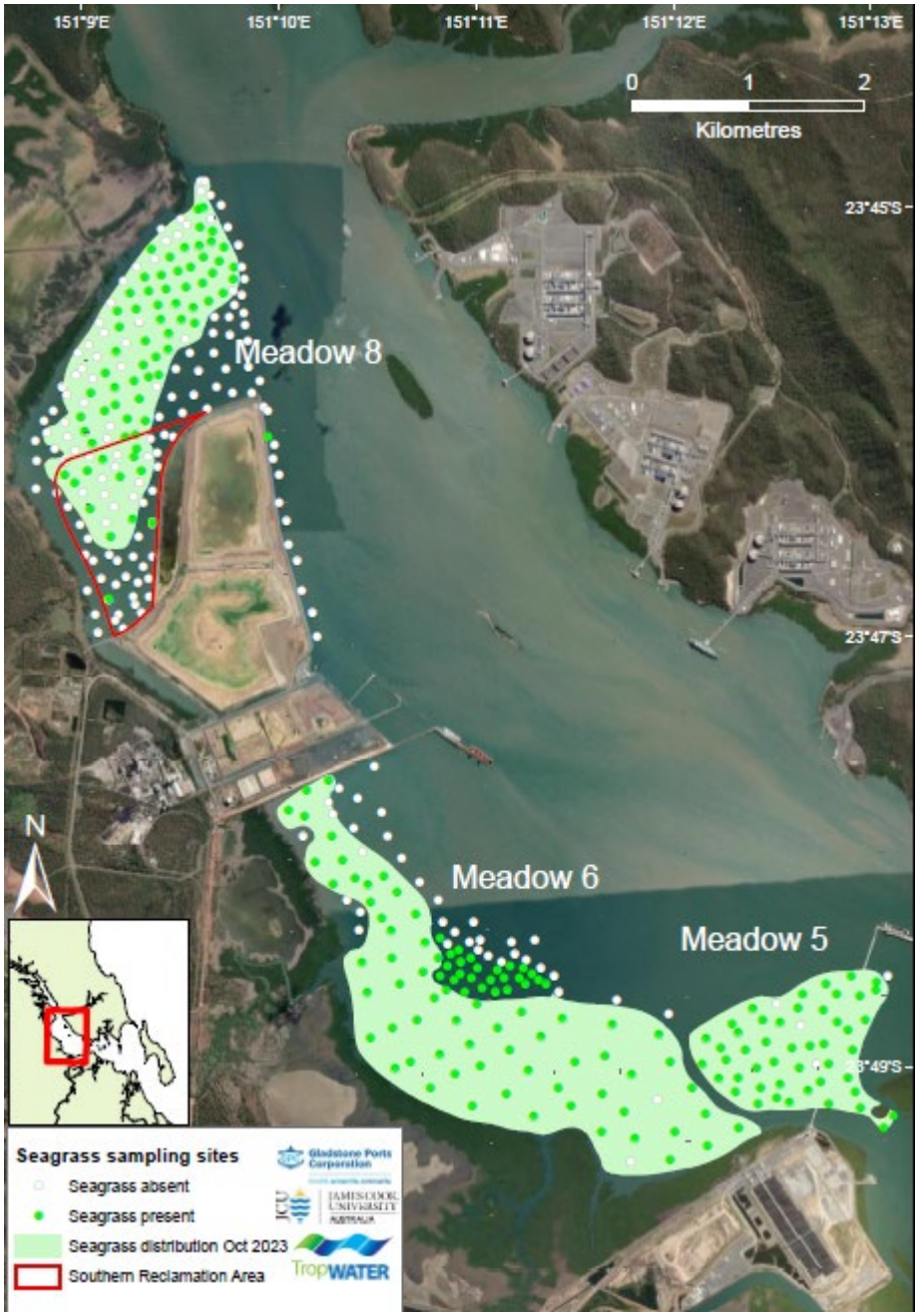


*Figure 14: Seagrass distribution and sampling sites across the survey area in October 2023*

Macroalgae were recorded throughout the northern part of Meadow 8 consisting of filamentous algae (northern and eastern part of meadow), erect macroalgae (eastern part of meadow) and some turf algae (refer Figure 15). Macroalgae covered < 5% of area at the majority of sites where they were recorded (Smith *et al*. 2024).

The number of sites where algae were recorded was much greater in October 2023 than January 2023 but similar to surveys in 2020 and 2022 (refer Figure 15) (Smith *et al*. 2024).

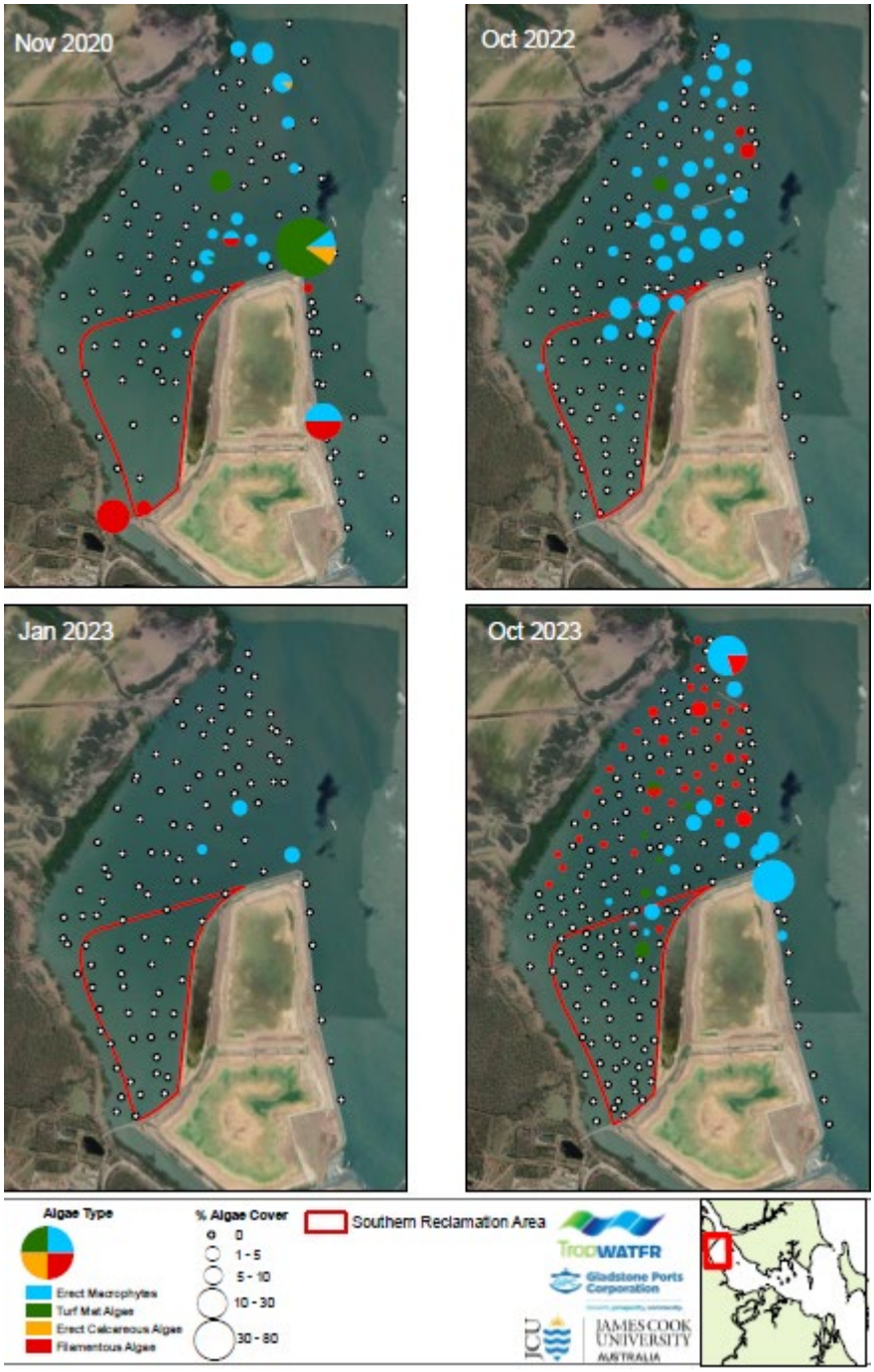


*Figure 15: Algae % cover ant type at sites in the NLEP SRA in November 2020, October 2022 and January and October 2023*

**Source:** Smith *et al*. (2024)

## 7.4 Mangrove and other foreshore marine plants

7.4.1.1 Project mangrove and other foreshore marine plant survey methodology

Project baseline mangrove and other foreshore marine plant surveys were undertaken in Spring 2020 (26 October to 28 October 2020 for the WBRA bunded area – five sites (historic survey area), and 23 November to 24 November 2020 for the WBE adjacent survey area – five sites (new survey area). Autumn 2021 sampling was undertaken between 17 May to 24 May 2021 across all sites at both the WBRA bunded area and the WBE adjacent survey area. The survey areas are shown in Figure 16.


*Figure 16: Historical and the Project mangrove and foreshore vegetation 2020 and 2021 baseline surveys areas*

The monitoring sites were established as permanent monitoring areas that can be monitored during future monitoring events. Where possible, the same transects and plots that were established in the WBRA bunded area for earlier monitoring were used (Houston *et al.* 2016).

The mangrove survey was carried out in accordance with the Department of Environment, Science and Innovation's (DESI's) Monitoring and Sampling Manual 2018: Environment Protection (Water) Policy 2009, Version 2 June 2018 – Biological assessment: Monitoring mangrove forest health (DES, 2018), with modifications to transect size to allow for direct comparison with previous studies in the area (Houston *et al.* 2016). Sites that are representative of the mangroves in the area were selected.

Transects were used to provide a broad overview of the range and distribution of mangrove communities present, along with species composition and overall condition. Transects extended between the highest astronomical tide and the seaward margin of the mangroves to ensure that complete coverage of the saltmarsh, salt flat and mangrove communities was obtained. As the seaward margin of mangroves is generally slightly above mean sea level due to inundation tolerances by mangrove species, the seaward margin of the mangroves was standardised to mean sea level. Permanent plots, enabling more detailed data to be gathered, were also placed in the main mangrove stand along each transect, typically of *Rhizophora stylosa* which is the dominant species in this region. Transects and permanent plots were marked, and GPS co-ordinates recorded (Anastasi *et al.* 2021).

Satellite remote sensing of mangroves within the survey areas was also undertaken using the freely available Planet Labs 'cube-sat' multispectral, optical, imagery. The images were acquired from the Planet Labs archive portal on, or as close as possible to, the environmental monitoring survey dates, depending on availability of images (mainly due to cloud cover decreasing image quality) (Anastasi *et al.* 2021).

Water quality parameters (i.e. turbidity, pH, temperature, dissolved oxygen and conductivity) were measured at the seaward end of each mangrove transect using a YSI EXO1 multi-parameter water quality sonde. This meter was tested and calibrated prior to field sampling. Three readings were taken at 10cm depth in the water adjacent to areas surveyed (NLEP SRA adjacent survey area and the WBRA bunded area) at the north and south ends of the areas sampled (Anastasi *et al.* 2021).

To monitor erosion/accretion, the establishment of the feldspar plots and erosion/accretion stakes were used to identify the baseline ground level at the time of placement in Spring 2020. Three erosion/accretion stakes were placed approximately 3m apart at the four standard positions along each transect. Typically, each erosion/accretion stake was driven into the substrate such that 30cm was protruding. To evaluate accretion or erosion of mangrove substrates, the height of the erosion/accretion stake above the substrate was measured. This height was subtracted from 30cm and the values for each transect location averaged. Positive values show accretion and negative values indicate erosion (Anastasi *et al.* 2021).

At the landward fringe of each transect, a feldspar plot was established. Each feldspar plot measured 1m$^2$ with feldspar laid to a depth of ~5mm or until the ground was covered. To evaluate accretion at feldspar plots, a small spade was inserted in the substrate and levered to expose substrate layers at five points within the feldspar plot. The depth to feldspar was averaged for each location where feldspar was observed in Autumn 2021. As feldspar plots only measure accretion, feldspar was not observed at all plots (Anastasi *et al.* 2021).

7.4.1.2 Summary of Project baseline mangrove and other foreshore marine plant survey findings

The seaward edge of the WBRA bunded area has a higher density of seedlings and saplings in 2020 and 2021 compared to in 2016. The remnant fallen line of frontal *Rhizophora stylosa* mangrove trees observed in 2016 is still present along the length of the WBRA bunded area, though seedlings and saplings are now also present in this area, particularly on the seaward fringe (Anastasi *et al.* 2021).

There is a marked difference in mangrove structure between the NLEP SRA adjacent survey area and the WBRA bunded area. The mangrove stands in these areas vary in width and density, along with other key mangrove indicators. Unlike the continuous zone of mangroves in the WBRA bunded area, mangroves in the NLEP SRA adjacent survey area are more fragmented, forming discrete dense patches (Anastasi *et al.* 2021).

All water quality measurements in the WBRA bunded area and on the seaward fringe of the WBE adjacent survey area were within ranges observed in previous surveys and did not exceed WQOs, though dissolved oxygen was below the lower WQO (DEHP, 2014) in November 2020 (Anastasi *et al.* 2021).

During the Autumn 2021 survey, erosion/accretion measurements were taken at each transect, following establishments of feldspar plots and erosion/accretion stakes in Spring 2021. Erosion was observed at most of the standard positions along each of the transects. Erosion ranged from < 1 to 5.5cm. Accretion was observed within six of the transects, at the plot and/or seaward positions. Accretion, where observed was minimal, ranging from < 1 to 2.3cm. Minimal erosion/accretion was observed across all transects within both the WBRA bunded area and the WBE adjacent survey areas over the period between the Spring 2020 survey and the Autumn 2021 survey (Anastasi *et al.* 2021).

## 7.5 Shorebird summer count and Eastern curlew behavioural monitoring

### 7.5.1 Monitoring objectives

The objectives of the Project baseline shorebird summer count and Eastern curlew behavioural monitoring study were to:

- Conduct behavioural monitoring of Eastern curlew foraging on the tidal flat between Fisherman's Landing and Friend Point at low tide over one full tide cycle (i.e. spring tide, neap tide and intermediate tide) during the summer season of 2023/24; and

- Conduct a summer count of all shorebirds roosting at high tide at a network of known shorebird roost sites in Port Curtis in 2023/24.

### 7.5.2 Monitoring study approach

The behavioural monitoring of Eastern curlew comprised three days of field observations at different stages of the tidal cycle (e.g. spring tide, neap tide, intermediate tide) between 31 January and 22 February 2024. Each survey commenced between 2.5 and 3 hours before low tide and ended 3 to 4 hours after low tide once Eastern curlew left for roost sites. Eastern curlews were monitored from suitable vantage points on land using high-powered Swarovski STS 80 HD spotting telescopes mounted on sturdy tripods. The behavioural time budget of Eastern curlew during their time spent on the tidal flats was quantified using the focal individual sampling technique, whereby each bird was monitored for 15 minutes at a time, split into three consecutive 5-minute intervals, recording the time spent on each of six different categories of behaviour: foraging; resting/preening; alert to disturbance; walking away from disturbance; and put to flight by disturbance. Where Eastern curlews were foraging close enough to be confident of detecting all prey items consumed, the total number of prey items consumed by each bird during each 15-minute observation period was recorded.

The summer count was undertaken over four consecutive days 20 February to 23 February 2024 and involved visiting a total of 52 roost sites by land or boat to count the total number of individuals of all shorebird and waterbird species using the roost sites within the 4 hour period 2 hours either side of high tide.

### 7.5.3 Summary of behavioural monitoring of Eastern curlews foraging at low tide (2023)

Eastern curlews feeding on the tidal flat were confirmed to be using roost sites in the WBRA during the neap and intermediate tide surveys, but this was not confirmed during the spring tide survey. Eastern curlews started foraging on the tidal flat around 3 hours before low tide and returned to their roost sites between 3 and 3.5 hours after low tide.

Between 5 and 13 Eastern curlews were recorded foraging on the tidal flat between the WBRA and Friend Point, and the approximate positions of Eastern curlews at low tide were mapped on each survey.

A total of 44 15-minute focal observations of Eastern curlews on the tidal flats at low tide were recorded during the three surveys that encompassed one full tide cycle (neap, intermediate and spring tide) before construction. Overall, the monitored Eastern curlew spent 70% of their time foraging, 28% resting or preening, 2% alert to disturbance or potential disturbance and less than 1% being put to flight by disturbance, with no observations of aggressive interaction or walking away from disturbance. Only three instances of birds being put to flight by disturbance were observed, two in response to overflight of the area by a White-bellied sea-eagle (a potential predator) and one in response to overflight by a helicopter from south to north over the study area.

It was possible to monitor feeding rates during a total of 18 of the 15-minute focal observation periods. The average feeding rate across all observations was 0.8 ± 0.4 food items per minute of foraging time. All prey items that were large enough to be identified at the distances monitored were confirmed to be crabs.

### 7.5.4 Summary of behavioural monitoring of Eastern curlews foraging at low tide (2024)

Eastern curlew feeding on the tidal flat were confirmed to be using roost sites in the WBRA. Eastern curlew started foraging on the tidal flat around 3 hours before low tide and returned to their roost sites between 3 and 3.5 hours after low tide. Between 4 and 31 Eastern curlews were recorded foraging on the tidal flat between the mainland shoreline, the WBRA and the pipeline crossing at Friend Point, and the approximate positions of Eastern curlew at low tide were mapped on each survey (BAAM, 2024).

A total of 61 15-minute focal observations of Eastern curlew on the tidal flats at low tide were recorded during the three surveys that encompassed one full tide cycle (neap, intermediate and spring tide). Overall, the monitored Eastern curlews spent 69.4% of their time foraging, 28.7% resting or preening, 0.6% alert to disturbance or potential disturbance, 0.4% engaged in aggressive interactions with other birds, 0.2% being put to flight by natural sources of disturbance, and 0.7% in flight moving between locations. Only two instances of birds being put to flight by disturbance were observed, one in response to overflight of the area by a White-bellied sea-eagle (a potential predator) and the other with no apparent source of disturbance. The observed Eastern curlew time budget in February 2024 was similar to that observed in March 2023 (BAAM, 2024).

It was possible to monitor feeding rates during a total of 23 of the 15-minute focal observation periods. The average feeding rate (± 1 standard deviation, a measure of variability) across all observations was 1.07 ± 0.97 food items per minute of foraging time. This was slightly greater than the average feeding success rate of 0.79 ± 0.39 food items per minute of foraging time recorded in early March 2023. The two seasons of focal observations of Eastern curlew on the tidal flats at low tide that characterised the time budget of foraging birds as well as feeding success rates under conditions of minimal human disturbance provide a good baseline against which to compare future data (BAAM, 2024).

### 7.5.5 Summary of summer count of roost sites in Port Curtis at high tide (2024)

A total of 3,851 migratory shorebirds of 14 species and 483 resident shorebirds of seven species were recorded within Port Curtis in February 2024, representing the largest counts of both migratory and resident shorebirds from the 26 surveys conducted since the Ecosystem Research and Monitoring Program monitoring began in January 2011. Shorebirds were found roosting at five locations not previously surveyed, comprising two large claypan roosts as well as two mangrove roosts and a rocky shoreline roost adjoining these new claypan roosts; a total of 46 Eastern curlews (16% of the total of 294 recorded in Port Curtis) were roosting at the new claypan roosts (BAAM, 2024).

## 7.6 Water mouse (Yirrkoo)

### 7.6.1 Project baseline Water mouse survey methodology

Three Project baseline surveys for Water mouse (*Xeromys myoides*) were undertaken in 2020, 2021 and 2023 utilising a combination of radiometric thermal mapping and ground truthing to allow for targeted placement of motion triggered camera traps within the same survey areas used in the Project baseline mangrove and other foreshore marine plant surveys (refer Figure 16) (Anastasi *et al.* 2024). The surveys were undertaken in accordance with the Referral Guidelines for the Vulnerable Water mouse (Department of Environment, 2015).

The Water mouse surveys were coordinated by Dr Amie Anastasi, a CQUniversity researcher with over 16 years' experience in environmental studies, and, Professor Emma Jackson, CMERC Director and marine ecologist with over 21 years' experience in ecological studies.

The radiometric thermal mapping was completed by Darren Jeacocke and his team from Queensland Aerial.

Ground truthing and camera trapping was completed by CQUniversity CMERC staff Leif Black, a CQUniversity researcher with over 17 years' experience in field and laboratory-based ecology, specialising in fauna ecology, and Lorelle Campbell a CQUniversity researcher with over 20 years' experience in environmental research, specialising in fauna and flora surveys. Additional field support was provided by CMERC research support worker Megan Bouch, and Gidarjil Development Corporation coordinator (Saranne Giudice) and Gidarjil sea rangers (Brendan Fletcher, Kailu Craigie, and Codey Stowe).

Licensed drone pilots from Queensland Aerial completed low altitude radiometric thermal mapping of the survey area to map nocturnal Water mouse activity. The surveys were carried out over a total of two nights. The drone was flown at an altitude of 50m above ground level, giving a ground resolution of 5cm per pixel. Thermal images were calibrated using a known positive control reference. The reference used were mugs of 30°C water, placed in known areas. This reference provided a known temperature signal for comparisons. All photographs were inspected for thermal heat spots less than 20cm in length (Anastasi *et al.* 2024).

The coordinates of possible small mammal 'heat spots' identified from the radiometric thermal mapping, in conjunction with ground truthing of the areas around the heat spots, were used to inform sites for deployment of trail cameras. All cameras were battery operated, had external SD cards, night sensors, are motion activated, and took pictures when activated by movement (Anastasi *et al.* 2024).

CQUniversity CMERC staff visited the identified possible sites using a handheld GPS device to find the coordinates of the selected hot spot sites, complete ground truthing, to identify sites for cameras, and deploy the cameras. An appropriate location to deploy the camera was chosen to face the heat spot, usually this involved attachment to a trunk of a reasonably sturdy tree. The camera was turned on and activated to ensure it was working. All cameras were retrieved and the photos downloaded for review and identification (Anastasi *et al.* 2024).

### 7.6.2 Summary of Project baseline Water mouse survey findings

The three Project baseline Water mouse surveys undertaken in 2020, 2021 and 2023 did not observe any Water mouse within the Project survey areas. The surveys found an abundance of potential Water mouse prey, however did not find any evidence of characteristic Water mouse nest structures, shelter sites or breeding places and did not confirm the presence of Water mouse in the Project study areas. The baseline surveys confirmed that Water mouse habitat in the Project study areas were confined to mangrove and saltmarsh vegetation communities in the intertidal zone, where abundant prey resources were also present (Anastasi *et al*. 2024).

Potential threats to Water mouse and Water mouse habitat were observed during the Water mouse surveys. The site is heavily impacted by cattle and evidence of predator species was evident. These disturbances have the potential to impact on the nesting habits of the Water mouse.

# 8 NLEP SRA environmental monitoring program

The monitoring program for the NLEP SRA bund construction activities was designed based on knowledge of the PoG marine environment, sensitive receptor locations and dynamics that drive changes in the main parameters able to put these habitats under stress (refer Sections 4 and 5) as well as modelling and impact assessment (refer Section 6) from which the REMP area was defined (refer Figure 1). As discussed throughout Sections 4 and 7, the only sensitive receptors present within the REMP area are seagrass meadows and mangroves. However the ZOIs do not extend to these habitats, with only the Zone of Influence reaching them and thus whilst turbid plumes are expected to reach these habitats, no ecological impact is predicted in these areas.

This section summarises the NLEP SRA environmental monitoring program to be implemented prior (approximately 1 month), during and post NLEP SRA bund construction. The monitoring program includes the following environmental parameters:

- Water quality (refer Section 8.1);
- Light (BPAR) at seagrass meadows (refer Section 8.2);
- Seagrass and macroalgae (refer Section 8.3);
- Mangrove and saltmarsh, including Water mouse (refer Section 8.4);
- Megafauna (refer Section 8.5);
- Aquatic fauna salvage during and post bund wall closure (refer Section 8.6);
- Eastern curlew and other shorebirds (refer Section 8.7);
- Bed level change (refer Section 8.8);
- Hydrodynamic changes (refer Section 8.9);
- Fine-grained sediment (FGS) (refer Section 8.10); and
- Bund wall integrity (refer Section 8.12).

Appropriately qualified and experienced persons will monitor, review, record and interpret all environmental monitoring programs/plans indicators that are required to be monitored by this REMP.

As per the NLEP Communications and Stakeholder Engagement Plan, Project engagement with local First Nations peoples is ongoing. The primary mechanism for ongoing engagement and consultation is through the GPC Port Curtis Coral Coast people (PCCC) Relationship Committee. This includes Project REMP consultation with PCCC representatives. To meet the Project EIS commitments, there is ongoing engagement with First Nations people in accordance with the Cultural Heritage Protocol (e.g. if an unknown item of tangible cultural heritage is uncovered during construction, work will cease until First Nations peoples are consulted as per the procedures in the Cultural Heritage Protocol). PCCC representatives are invited to be involved with the implementation of the REMP. There will also be re-engagement with members of the Stakeholder Representative Group. For details, the NLEP Communications and Stakeholder Engagement Plan will be published on www.gpcl.com.au/news-and-resources/resources/.

The Project monitoring programs/plans will be reviewed and revised (if needed) annually to assess the effectiveness and appropriateness of the monitoring programs/plans.

## 8.1 Water quality monitoring program

### 8.1.1 Water quality monitoring sites

A range of water quality sites were selected adjacent to and further away from the Zone of Influence (refer Section 6 and Appendix B) to monitor physical-chemical parameters in real time (refer Figure 17 and Table 9).

At each of the water quality sites, two (dual) multi-parameter sondes (YSI EXO3), each encased in a copper plated cage, will be placed into secured antifouled PVC tubes attached to the base of a modified special marker buoy. The sondes will record turbidity (NTU), temperature (°C), conductivity (mS/cm), pH and dissolved oxygen (% saturation) every 15 minutes at approximately 0.75m below the water surface, with a central wiper cleaning the sonde probes prior to each data log. The sondes will be attached to solar powered telemetry units installed within the buoy, with data transferred via telemetry to the cloud-based database every 15 minutes.

All sondes will be maintained at a minimum of monthly, or as required based on examination of real time data. Each sonde will be calibrated, and log-tested prior to deployment as per Health Safety Environment and Quality, and Management System protocols.

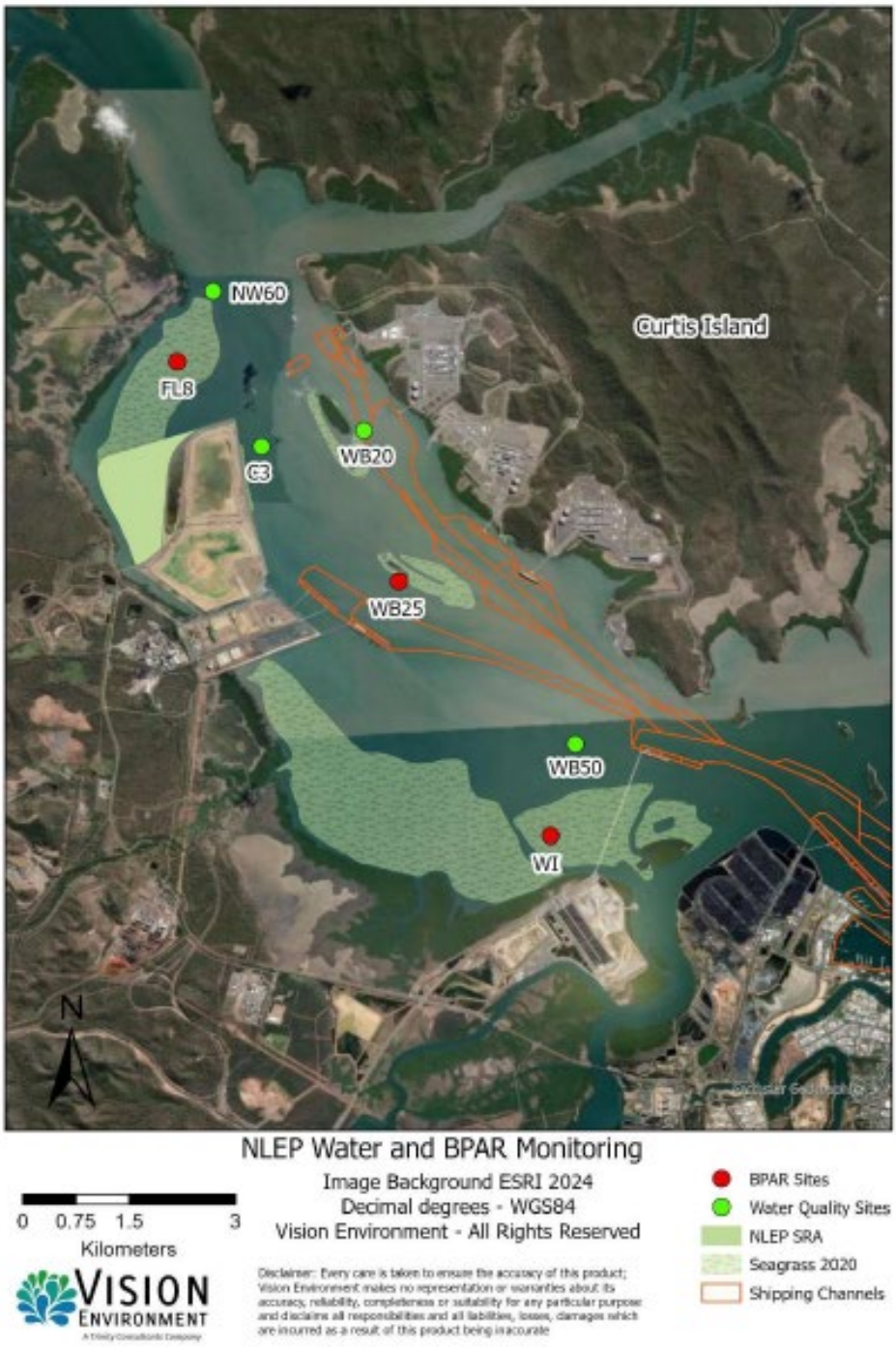


*Figure 17: Project water quality and BPAR monitoring sites*

This monitoring will be undertaking prior, during and post NLEP SRA bund construction operations. Even though all water quality monitoring selected sites are located outside the Zone of Influence due to practical reasons such as the shallow bathymetry of the REMP area, site NW60 (QE4) will be treated as a concern site as this lies in close proximity to the extent of Meadow 8 as mapped in the 2023 survey (refer Section 7.3).

Here, turbidity levels (as an EWMA) will be screened against triggers developed from baseline data collection for compliance purposes (refer Section 8.1.3). Turbidity is in fact the key water quality parameter and the only one that can be influenced by bund construction operations. At control sites, and thus sites well outside the modelled Zone of Influence, turbidity and related EWMA will also be closely monitored for due diligence and comparative purposes only in order to confirm and highlight patterns and dynamics and thus isolate potential impacts

from NLEP SRA bund construction activities. At control sites, turbidity EWMA values will not be assessed against triggers, but the data from these sites will be used in the evaluation of any trigger exceedances at the concern site if they occur.

In addition to turbidity, the whole remaining suite of standard physical-chemical parameters (temperature, EC, pH and DO) will be recorded as supporting information and utilised in data analysis and trending. At all water quality monitoring sites, modified buoys equipped with dual multiparameter sondes and telemetry system will be installed and maintained. These will log readings every 15 minutes, which will be transmitted in near real time by the telemetry system. All equipment will be appropriately serviced and maintained. All water quality monitoring site locations and names will be consistent with PCIMP.

*Table 9: Project water quality monitoring locations*

| Site | Status | Description and water area | EPP (Water) management intent/ level of protection | Water quality zone of impact |
|---|---|---|---|---|
| NW60 (QE4) | Concern | Adjacent to Friend Point and Meadow 8. The Narrows (SD2441). | Slightly disturbed | Outside Zone of Influence (adjacent) |
| WB50 (P2B) | Control | Outside the mouth of the Calliope River and adjacent to the Wiggins Island Coal Terminal and Wiggins Island seagrass meadows. Western Basin (MD2421). | Moderately disturbed | Outside Zone of Influence |
| WB20 (P14) | | Passage Island, Western Basin (MD2421). Adjacent to the navigation channel and the Passage Island seagrass meadow. | | |
| C3 | | Adjacent to existing Western Basin Bund wall. | Moderately disturbed | Outside Zone of Influence |

**Table note**: Site names in parenthesis correspond to historical site names derived using a different name convention.

### 8.1.2 In-situ water quality sampling

Monthly grab samples for metal(loid)s, nutrients, chlorophyll *a* and TPH will also be undertaken at the water quality monitoring sites pre, during and post bund construction operations (refer Table 10). All monitoring equipment will be calibrated for each monitoring round and monitoring will be conducted in accordance with the latest version of DESI's Monitoring and Sampling Manual.

Samples will be analysed by a NATA accredited laboratory holding the accreditation for the analyses required. A replicate water sample for all parameters will be collected at one site per survey as per established protocols, with a field blank (FB) and laboratory blank (LB) also collected per survey. Analytical laboratory quality control measures will include laboratory duplicates, method blanks, analysis of certified reference material and matrix spikes.

Results will be screened against the relevant WQOs (refer Table 10). Table 10 also shows relevant WQOs for 95% and 99% protection of marine species in moderately disturbed and slightly disturbed (NW60 (QE4) only) waters, respectively.

*Table 10: Analytes that will be tested at water quality monitoring locations once a month before, during and after Project construction activities*

| Analyte | Unit | ANZECC/ARMCANZ 95% protection marine species in MD waters | ANZECC/ARMCANZ 99% protection marine species in SD waters |
|---|---|---|---|
| TSS | mg/L | - | - |
| Total Nitrogen | mg/L | - | - |
| Total Phosphorous | mg/L | - | - |
| Chlorophyll *a* | µg/L | - | - |
| Ammonia (nitrogen) | µg/L | - | - |
| Aluminium (dissolved) | µg/L | 24[1] | 2.1[1] |
| Arsenic (III) (dissolved) | µg/L | - | - |
| Arsenic (V) (dissolved) | µg/L | - | - |
| Cadmium (dissolved) | µg/L | 5.5[,2] | 0.7[1,2] |
| Chromium (VI) (dissolved) | µg/L | 4.4[1,2] | 0.14[,2] |
| Copper (dissolved) | µg/L | 1.3[1,2] | 0.3[,2] |
| Lead (dissolved) | µg/L | 4.4[1,2] | 2.2[,2] |
| Mercury (dissolved) | µg/L | 0.4[,2] | 0.1[,2] |
| Nickel (dissolved) | µg/L | 70[,2] | 7[1,2] |
| Silver (dissolved) | µg/L | 1.4[,2] | 0.8[,2] |
| Zinc (dissolved) | µg/L | 15[1] | 3.3[,2] |
| TPH | mg/L | - | - |

**Table notes**: 1 = WQO is from DEHP (2014); 2 = WQO is from ANZG (2018) and confirmed via search of Water Quality Guidelines Search for toxicant default guideline values on 29 May 2024.

### 8.1.3 EWMA and turbidity triggers

Turbidity triggers were developed using historical datasets from the Project EIS baseline and CVIP.

- **80th percentile**: internal alert when turbidity EWMA values exceed trigger values for >36 consecutive hours; and

- **95th percentile**: external notification when turbidity EWMA values exceed trigger values for >24 consecutive hours.

Turbidity triggers (refer Table 11) were calculated from turbidity EWMA data by a third party expert and will be implemented based on the application of a 6 hourly EWMA to the raw turbidity (de-confounded) data collected via telemetry. The latter will undergo appropriate preliminary QA/QC procedures. The de-confounding process includes automatic algorithm-based and manual validation processes. The EWMA is a smoothing technique that takes into consideration background levels so that readings increase and decrease gradually avoiding false readings and alarms (both on and off).

Therefore, when values exceed triggers or go below triggers they will not be expected to invert their trends suddenly. The 6 hour turbidity EWMA is calculated by using a 60:40 weighting system, where the current EWMA (Zi) is computed by adding 60% of the mean turbidity readings during the preceding 6 hours (i) to 40% of the preceding 6 hour EWMA value (Zi-1). Mathematically, 6 hourly values of the EWMA statistic are computed using the following equation:

$$Zi = 0.6\ i + 0.4Zi\text{-}1$$

Within the equation i is the mean of the data for the ith period (in this case, the current 6 hour period).

*Table 11: EWMA turbidity triggers and related details at all water quality monitoring locations, concern and control*

| Site | Status | Wet season triggers (01 Oct – 31 Mar)* | Dry season triggers (01 Apr – 31 Sep)* | Data details |
|---|---|---|---|---|
| NW60 (QE4) | Concern | 29 NTU (80$^{th}$ %ile of the 6 hour EWMA applied to background turbidity data – internal alert trigger) | 17 NTU (80$^{th}$ %ile of the 6 hour EWMA applied to background turbidity data – internal alert trigger) | Data logged every 15 mins. Real-time (telemetry) feed; water quality automatically de-confounded data + 6 hourly EWMA plot feed for turbidity |
| | | 40 NTU (95$^{th}$ %ile of the 6 hour EWMA applied to background turbidity data – external notification trigger) | 35 NTU (95$^{th}$ %ile of the 6 hour EWMA applied to background turbidity data – external notification trigger) | |
| WB50 (P2B) | Control | N/A | N/A | |
| | | N/A | N/A | |
| WB20 (P14) | Control | N/A | N/A | |
| | | N/A | N/A | |
| C3 | Control | N/A | N/A | |
| | | N/A | N/A | |

**Table notes**: Site names in parenthesis correspond to previous site names derived using a different name convention. Note that no turbidity triggers are applicable to control monitoring locations.
* trigger values applicable during baseflow conditions only which are defined as flow events at the Castlehope gauging station (lat -23.984983, long 151.097564) that are <100m$^3$/second (DEHP, 2014).

As discussed in Section 8.1.1, EWMA turbidity values collected in real time at the concern and control locations will be screened against EWMA turbidity triggers with any elevation recorded and investigated by GPC Environmental Specialist for Monitoring (ESM) with support from a third party water quality expert when required and appropriate. However, this will be conducted for compliance purposes only at the concern site with external reporting only occurring in the instance turbidity EWMA is above related trigger for more than 24 consecutive hours and the full investigation shows that this is due to NLEP SRA bund construction activities.

The full suite of physical-chemical parameters collected in real time at the monitoring location will be utilised in the analysis as well as data from the control sites, weather and environmental parameters and visual observations conducted at the construction site (refer Project CEMP Section 19.11). Monitoring will be implemented together with an adaptive management framework ensuring a process is undertaken in case of turbidity exceedances to prevent or minimise any impact to the receiving environment and sensitive receptors (refer Section 9).

## 8.2 BPAR monitoring program

### 8.2.1 BPAR monitoring history and background

As mentioned in Section 4.6.1, light is a key abiotic factor for seagrass survival and growth. In particular, measurement of the light reaching the benthos or BPAR is the crucial monitoring parameter to assess and determine whether sufficient light is reaching seagrass meeting its growth and health requirements. Levels of (underwater) light reaching the seabed and thus to the seagrass canopy can be impacted directly by turbidity, but also by a range of other environmental factors such as cloud cover and tidal range increasing the depth of water that light has to travel through in order to reach the seafloor.

Among the extensive monitoring and studies undertaken on seagrass at the PoG, GPC and the JCU seagrass ecology team developed light requirement values specific to Port Curtis seagrass meadows. This was the result of laboratory and field studies undertaken for a number of years prior and during the WBDDP (Chartrand *et al.* 2016; 2012). Such studies were initially undertaken for *Z. muelleri* as it is the seagrass species with the highest light requirement occurring within the PoG. These studies demonstrated that at intertidal locations, *Z. muelleri* requires 6mol/$m^2$/day on a 14 day rolling average (RA) of photosynthetically active radiation (PAR) (as Total Daily PAR (TDP)) and management actions need to be considered after seven consecutive days of RA below threshold (i.e. <6mol/$m^2$/day) (refer Table 13).

This light requirement value will be adopted in this REMP and related seagrass monitoring program as the 2020 seagrass survey found *Z. muelleri* within Meadow 8. This threshold is the most conservative one. In fact, further studies have confirmed that other seagrass species light requirements are lower; for example for *H. uninervis* the recommended value is 5mol/$m^2$/day on a 14 day RA. Within Meadow 8, *H. ovalis* was also found, this species has a light requirement of 2mol/$m^2$/day on a 14 day RA when occurring in turbid environments such as the WB. The change in species composition observed in this meadow throughout the years (refer Section 4.6.1) indicates that light conditions at the site might not be always stable, with periods of low light resulting in shifts in species composition to opportunistic or colonising species that have lower light requirements such as *H. ovalis*.

The light requirement for *Z. muelleri* and other seagrass species in Port Curtis was established during the WBDDP for the growing season only (July to January for Port Curtis). It is important to note that the NLEP SRA construction activities will be conducted during both the seagrass growing season as well as during the senescent season. During the latter, seagrass light requirements are greatly reduced (February to June) and the BPAR trigger is not necessarily applicable (Chartrand *et al.* 2012, Collier *et al.* 2016). The BPAR monitoring triggers and methodology has been adopted and reported in several guidelines, including DESI's Monitoring and Sampling Manual 2018. This methodology has been implemented by GPC for several years and is included also in the monitoring detailed herein. However, the equipment utilised differs from the original method as the latter employs Odyssey light sensors which are self-logging only. GPC instead will utilise Li-Cor light sensors which can be easily integrated into real-time systems; this is crucial for effectively and timely managing construction operations to prevent and avoid any potential harm to sensitive receptors and the receiving environment. Employing different equipment and adaptation of Li-cor equipment in the methodology is acknowledged in the DESI's Monitoring and Sampling Manual 2018 (page 252).

### 8.2.2 BPAR monitoring sites

The BPAR monitoring will be undertaken prior, during and post NLEP SRA bund construction operations. This will be conducted at multiple seagrass meadows, inside and outside the REMP area and thus Zone of Influence (refer Table 12). At BPAR monitoring sites, PAR sensors mounted on benthic frames will be installed, commissioned and maintained. In order to minimise data loss, the frames will be equipped with dual PAR sensors at each site, as detailed in the above-mentioned methods.

Moreover, the light sensors will be set up within the boundaries of the meadows where suitable locations are identified and mounted in line with the seagrass canopy to ensure BPAR measurements represent the actual amount of light received by the plants. A control site (CT) will also be set up on land in an appropriate elevated location to record daily ambient changes in total available PAR. Such inclusion will allow for variations in daily ambient PAR due to factors such as cloud cover assisting in the analysis and interpretation of BPAR levels at the monitoring sites.

*Table 12: Project BPAR monitoring locations*

| Site | Status | Description and water area | EPP (Water) management intent/ level of protection | Water quality zone of impact |
|---|---|---|---|---|
| FL8 | Concern | Fisherman's Landing, Western Basin. Within Meadow 8 and the REMP: shallow intertidal, large area, low biomass meadow composed by *Z. muelleri* and *H. ovalis*. | Moderately disturbed | Within Zone of Influence |
| WB25 | Control | Passage Island. Predominantly intertidal meadows dominated by *H. ovalis* followed by *Z. muelleri.* | | Outside Zone of Influence |
| WI | | Wiggins Island. Intertidal meadow adjacent to Wiggins Island dominated by *Z. muelleri*. | | |

### 8.2.3 BPAR trigger and management

Taking into consideration light requirements of the seagrass species found at the concern BPAR monitoring location (refer Table 12), a mean minimum daily light requirement for *Z. muelleri* of 6mol/m$^2$/day (Chartrand et al. 2016; 2012) – to be assessed as a 14 day RA and related management timeframes – will be implemented. This is the most conservative threshold for Queensland seagrasses and thus will also protect species with lower light requirements found at the monitoring sites such as *H. ovalis*.

Light triggers are incorporated into an adaptive management framework which follows a multi staged approach (refer Section 9). Following the latter, management response to reduced light conditions will occur well before environmental harm to sensitive receptors is potentially caused (refer Table 13). Management triggers and related responses will only be applied during NLEP SRA bund construction operations. Moreover, as for water quality, BPAR values collected by real time monitoring stations at the control locations will not be assessed against the BPAR trigger value, but will be closely monitored and used in trending and analysis. Thus, investigations and related management responses will only be undertaken at the concern site for compliance purposes. External reporting will only occur in instances when BPAR values are below the trigger value for seven consecutive days and the full investigation shows that this is due to NLEP SRA bund construction activities (refer Section 9).

*Table 13: BPAR management light threshold for FL8 (numbers refer to the number of consecutive days that the 14 day RA daily BPAR is below 6mol $m^{-2}$)*

| Site | Internal alarm and investigation | External notification (DESI and DCCEEW). Review of initial corrective actions. Modification and/or addition of corrective actions | Review of corrective actions. Modification and/or addition of corrective actions. Time to potential impact |
|---|---|---|---|
| FL8 | 1 (equivalent to 14 days of low light) | 7 (equivalent to 21 days low light) | 14 (equivalent to 28 days low light) |

**Table notes**: BPAR management light triggers for *Z. muelleri* (6mol/$m^2$/d over a 14 day RA) at FL8 adapted from Collier *et al.* (2016) with related investigation and management actions at different consecutive days of BPAR 14 day RA below threshold. No compliance management light trigger analysis will be applied to data from the control sites or from before and after bund construction activities.

## 8.3 Seagrass and macoalgae monitoring program

### 8.3.1 Key elements of the monitoring strategy

The Project seagrass and macroalgae monitoring program has been designed and prepared by Professor Michael Rasheed (JCU), with over 29 years' experience in developing and leading successful research programs on topical marine habitats with a focus on seagrass ecology.

Seagrass monitoring locations for the Project were selected in areas where there is a long (>20 year) history of monitoring data to more effectively ascertain the condition of seagrasses relative to historical variability and between impact and reference meadows. This adds an important element to assessing compliance with the Project EPBC Act controlled action conditions and ERA 16 EA conditions, and greater certainty around the expected condition of seagrasses, placing any changes occurring into a historical perspective and providing strong statistical support for determining if impacts have occurred from the construction of the NLEP SRA bund wall.

The monitoring program examines seagrasses at a spatial scale that is sufficient to incorporate the known variability that occurs within seagrass meadows in the area. This is critical as results from >20 years of monitoring in the Port of Gladstone have shown substantial shifts of where biomass hotspots occur within meadow boundaries as well as spatial change in the footprint of where seagrass meadows occur from year to year. Larger 'meadow-scale' monitoring assures that an accurate picture of seagrass condition is obtained rather than the danger of simply measuring within the 'noise' of variability that can occur with smaller fixed site monitoring. Seagrass meadows adjacent to the Project have been surveyed intensely over the previous 4 years to build a detailed baseline of seagrass conditions to complement the previous >20 years of monitoring. Seagrass meadows adjacent to the NELP have low biomass and show inter- and intra-annual variation. Seagrass area has remained relatively consistent over this period, covering between 180ha and 235ha.

The proposed seagrass monitoring program for the Project will use a set of standard, proven and peer-reviewed metrics for measuring seagrass change. This will allow results to be compared with historical data from the REMP area and - for context - with other seagrass monitoring conducted in the region and Queensland-wide as well as regional reporting as part of the GHHP.

Suitable concern and control meadows and monitoring locations have been identified from within and outside the Zone of Influence to resolve any Project-related changes from non-Project-related natural changes to seagrasses and light (PAR). The Project's construction and post construction seagrass monitoring survey area is shown in Figure 18.

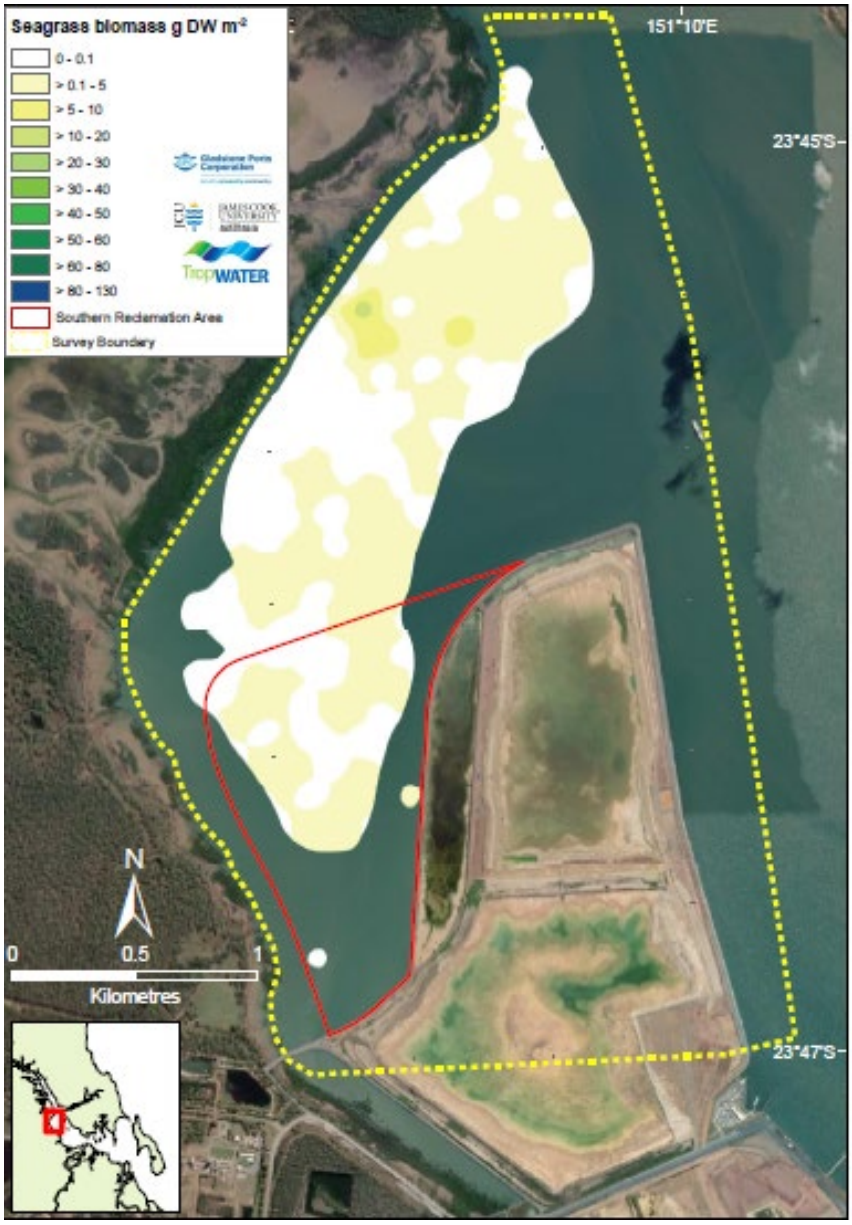


*Figure 18: Project construction and post construction seagrass monitoring survey area and seagrass meadow area and biomass distribution*

### 8.3.2 Monitoring design approach

Given the above considerations, a two-part monitoring approach will be undertaken, including monitoring seagrass condition in the meadow within the Zone of Influence and two nearby reference meadows with similar seagrass species composition and history of seagrass change and trends, to assess any potential Project impacts. The monitoring approach includes:

- Quarterly assessment of the seagrass meadow that lies within the Zone of Influence of construction and two nearby reference meadows with similar characteristics and historical trends from 3 months prior to start of works to 6 months post completion.

- Continued assessment of the Project Zone of Influence and reference monitoring meadows as part of the annual seagrass monitoring program each November for two years post completion of the works.

- Light conditions within the Zone of Influence and at reference meadows will be compared to observed seagrass condition to identify potential light-related stress and changes in seagrass condition.

While macroalgae are not specifically highlighted in the approach, macroalgae were considered a relatively minor feature of the REMP area of interest (Smith *et al*. 2020a; 2021; 2022 and 2023a) and maintenance of light for seagrass, by default would likely also provide suitable conditions for any macroalgae. Macroalgae type and percent cover will also be collected as part of this seagrass monitoring program.

### 8.3.3 Location of primary impact and reference monitoring meadows

The only seagrass predicted to be within the Zone of Influence lies entirely within the meadow on the intertidal bank adjacent to the NLEP SRA to the north of the Fisherman's Landing reclamation (refer Appendix B). The monitoring design examines this Zone of Influence meadow and two reference meadows outside of the Zone of Influence that have similar species compositions; South Fisherman's (Meadow 6) and Wiggins Island (Meadow 5) (refer Figure 19).

All of the meadows selected have a long history of monitoring, with at least annual monitoring conducted for the last 18 years. This enables an excellent ability to place changes within a historical context. All three meadows are intertidal and have a very similar mixed-species composition and a similar low biomass. Importantly, all three meadows show similar trends of variability in biomass, species composition and area over time which means they are ideal reference sites to one another.

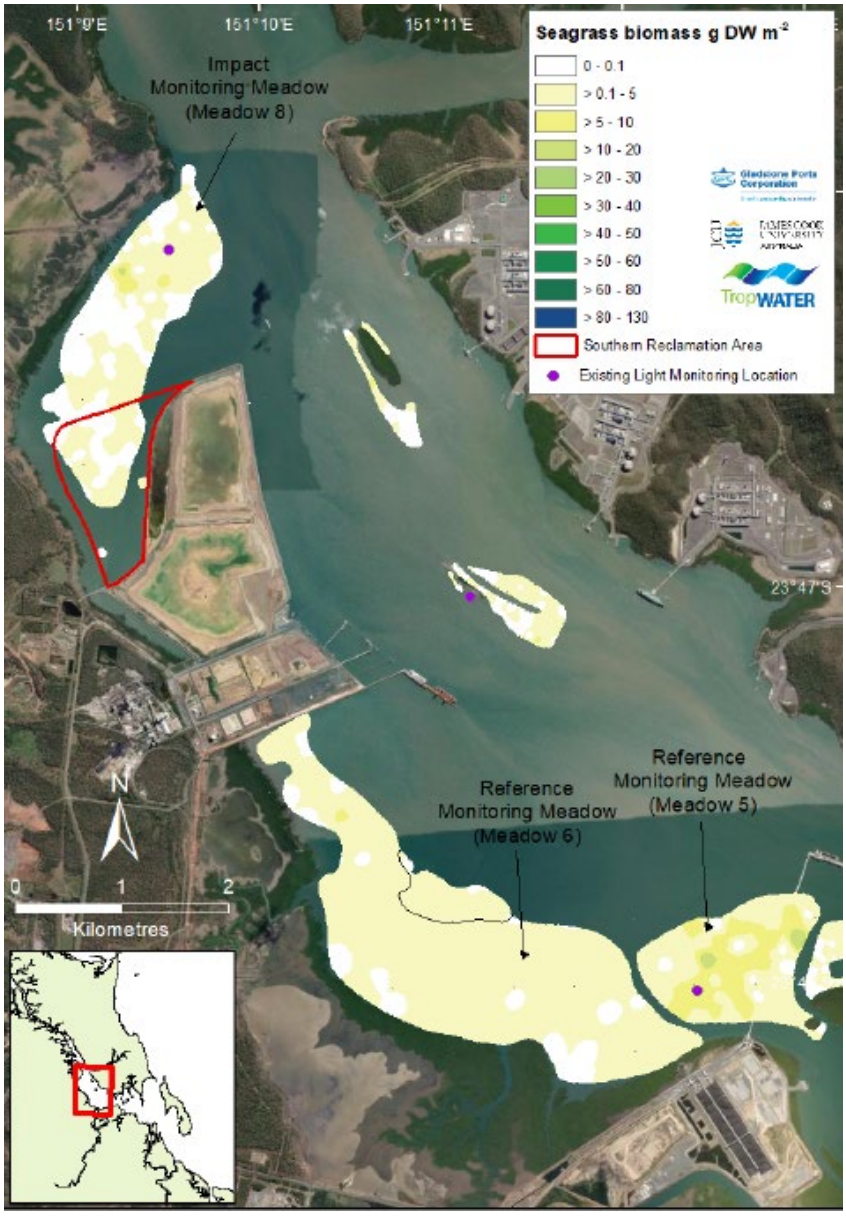


*Figure 19: Location of suggested impact and reference meadows for the Project seagrass monitoring*

### 8.3.4 Broader annual monitoring assessment context

In addition to the proposed specific Project monitoring and frequency of sampling (refer below), all three of the selected monitoring meadows form part of the Port Curtis long-term annual seagrass monitoring program, which examines seagrass meadows more broadly throughout the port limits and in Rodds Bay in November each year (Smith *et al*. 2020a). These annual surveys provide additional scope for reference to examine changes in the SRA meadows against all 17 seagrass meadows that form part of the broader long-term program. This will provide two sampling occasions during construction (assuming an 18 month construction phase) where the changes could be placed in a broader regional perspective as well as a broader network for comparison during the two years of postconstruction monitoring.

### 8.3.5 Monitoring frequency

For the monitoring program we are assuming that Stage 1 construction will take approximately 18 months. Higher (quarterly) frequency of sampling will begin 3 months prior to the commencement of works and will continue throughout construction and for 6 months post construction to ensure adequate frequency to detect potential impacts associated with the works, as well as immediate pre- and post-works monitoring. Following that, monitoring reverts to the annual sampling each November as part of the long-term monitoring program (at the peak of seasonal seagrass abundance). This will, at the same time, satisfy the requirement for 2 years of post-works monitoring under the EPBC Act's 'controlled action' approval conditions. Previous experience from monitoring of these meadows - as part of the WBDDP - indicates that a 3 month frequency is appropriate to capture changes associated with potential impacts (Chartrand *et al*. 2017).

### 8.3.6 Monitoring methods and sampling techniques

Three principal indicators of seagrass condition will be assessed, including seagrass biomass, species composition, and meadow area. These are fundamental indicators used to answer questions surrounding seagrass condition. The importance of these indicators in seagrass habitat and health assessments was highlighted by the Seagrass Expert Group's recommendations for monitoring seagrass within the Reef 2050 Integrated Monitoring and Reporting Program (Udy *et al*. 2018) and form the key indicators of seagrass condition in the GHHP regional report card (Carter *et al*. 2023). The monitoring methods, analysis and assessments used in previous surveys (e.g. Smith *et al*. 2023, Carter *et al*. 2023) will be followed as part of this monitoring program.

Monitoring techniques used in the long-term Port Curtis annual seagrass surveys and throughout the Queensland Ports Seagrass Monitoring Program as applicable to the Project will be implemented include:

- For intertidal seagrass: helicopter surveys of exposed banks during low tide – assessment sites are scattered throughout the seagrass meadow and sampled when the helicopter comes into a low hover <1m from the substrate. Boundary of meadows is mapped from the helicopter at low tide; and

- For shallow subtidal seagrass: boat-based camera drop surveys.

All of the meadows in the NLEP program are part of the existing monitoring program and power analysis techniques have already determined the appropriate number of sampling sites for each meadow in order to detect seagrass meadow change (Quinn and Keough, 2002).

Spatial data for each survey collected is incorporated into a Geographic Information System (GIS) in ArcGIS®. The site GIS layer includes:

- Site number;

- Sampling date;

- Sediment type;

- Latitude and longitude;

- Seagrass total above-ground biomass in grams dry weight per square metre (g DW $m^{-2}$). This is determined using the "visual estimate of biomass" technique (see Kirkman, 1978; Mellors, 1991);

- Species above-ground biomass for each species. This is calculated using the percent contribution of each species to a site's total biomass;

- Macroalgae % cover and functional groups; and
- Comments.

Seagrass meadow boundaries are defined using meadow edge mapping waypoints entered during helicopter surveys. Meadows are mapped as polygons in ArcGIS®. The meadow GIS layer includes seagrass meadow characteristics (i.e. meadow ID number, area + R (hectares) where R is a measurement of error, mean biomass + standard error, mean biomass of each species, community type based on species composition using nomenclature developed for Queensland seagrass meadows, and density categories (light, moderate, dense) based on above-ground biomass of the dominant species).

### 8.3.7 Statistical design and analysis

The statistical design and analysis will incorporate an assessment against existing meadow baseline conditions that have already been established for the three meadows identified for the Project as part of the annual long-term monitoring program for Port Curtis (see Smith *et al*. 2020a; Carter *et al*. 2023; Bryant *et al*. 2014). A typical before-after, control-impact (BACI) design analysis commonly used in impact assessment (before-during-after and control-impact) focused on the three targeted meadows over the time period of the monitoring program will also be applied. Seagrass data in tropical Queensland rarely meets the assumptions required to conduct standard statistical analysis used in BACI impact assessments, such as ANOVA. The existing seagrass monitoring program incorporates advanced statistical techniques used to deal with difficult data, including generalised linear mixed models, logistic regression, zero-inflated models and zero-altered gamma models and these will likely need to be applied in the data analysis of the Project monitoring. The number of days that BPAR is under the threshold for *Z. muelleri* growth and function (6mol $m^{-2}$ $day^{-1}$ over a 14 day RA) will be reported on and compared to seagrass biomass and area using models suggested above.

### 8.3.8 Reporting

The findings of the Project's seagrass and macroalgae monitoring surveys will be provided in annual reports.

A seagrass and macroalgae monitoring completion report will be submitted to the DCCEEW within 6 months following the completion of the second year of post construction monitoring.

Within 6 months of completing the Project seagrass and macroalgae monitoring completion report, GPC will engage a suitably qualified ecologist to prepare a report (for the Minister for the Environment and Water's approval) that quantifies the significant residual impacts on protected matters based on observed impacts (if any) on seagrass and macroalgae as determined by the Project seagrass and macroalgae monitoring program.

## 8.4 Mangrove and saltmarsh monitoring program, including Water mouse monitoring program

### 8.4.1 Mangrove and saltmarsh monitoring program

Despite the fact that impacts to mangroves and other foreshore marine plants from NLEP SRA construction activities are considered highly unlikely based on the findings of the Project EIS, monitoring of mangroves and foreshore habitat condition adjacent to the construction activities will be undertaken to fully ensure these do not have any adverse impact.

The mangrove research hub at JCU's Centre for TropWATER has designed and prepared the Project mangrove and saltmarsh monitoring program, including an 'Alert-to-Action' management program. The program has been developed based on using the extensive knowledge gained by Dr Norm Duke and Dr Adam Canning for the rigorous assessment of mangrove condition and health gained over many decades. The implementation of the program will include Dr Norm Duke and Dr Adam Canning, with the collaboration of local traditional owner land and sea rangers of the Gidarjil Development Corporation.

The Project mangrove and saltmarsh monitoring program comprises two components: a monitoring and inspection program and an 'Alert-to-Action' program.

8.4.1.1 Monitoring and inspection program

This program component comprises field work divided into two parts to span a period of 6 years, since the program is required to operate until at least 5 years post construction works. This program component is required for field validation of specific monthly changes and fluctuations in mangrove and saltmarsh vegetation at scales matching empirical proxies measured from satellite imagery.

**Mangrove and saltmarsh long term plots**

The mangrove and saltmarsh long term plots will utilise, as its basis, 10 transect plots established in 2020 and 2021 by GPC (Stokes & Bucher, 2012, 2014; Houston *et al*. 2016). The monitoring program will compare the condition of mangroves and saltmarsh in three treatment sub-areas (refer Figure 20), including:

- Western Basin Reclamation Area mangroves in the bunded area (WBRA) – 'critical', as the shoreline mangroves at highest risk;
- Western Basin Expansion adjacent mangroves in northern survey area (WBEA) - 'vulnerable', as the adjacent threatened shoreline mangroves; and
- Western Basin southern comparative mangroves nearby (WBSC) – 'comparative', as the adjacent shoreline mangroves (outside the Zone of Influence).

For the mangrove monitoring, three representative 20m x 10m fixed plots will be established in each sub-area which will be assessed in Year 1, and again in Year 5. Data will be collected on forest structure (i.e. species, tree density and basal area) and biomass (i.e. kg woody material per hectare) for the respective areas over the longer-term. As these locations represent otherwise common shoreline settings, these data are required to quantify any underlying differences between the three sub-areas.

For the saltmarsh monitoring, three representative 10m longer-term transect plots will be established within each sub-area across saltmarsh-pan vegetation to quantify vegetation cover and condition (i.e. species and cover). Each plot will be assessed under this program twice during the 6 year program.


*Figure 20: Project mangrove and saltmarsh monitoring program survey areas*

**Mangrove litterfall and shoot observations**

Data on mangrove litterfall and shoot observations will be collected in each of the mangrove long-term monitoring plots using 6 x 1m$^2$ litterfall traps and six shoot observation stations (30 tagged canopy leafy shoots) in each of the three sub-areas.

For litter traps, content will be collected each month for 12 months minimum in the first year, which will be repeated again in the 5$^{th}$ year. Each monthly sample collected will be sorted, dried and weighed to determine dry weight. Sorting involves separation of leaves, stipules, reproductive parts, wood and debris. Further field canopy condition measures include below-canopy light meter readings. These data are required for quantification of variability in canopy condition through annual seasonal cycles, and for validation of changes in density for comparison with satellite sensing units. With each 12 month record of canopy condition, data will be used to derive allometric equations to define satellite vegetation indices (see below) for use as proxies of the field measures of canopy condition. Accordingly, specific correlative relationships will enable satellite measures of canopy condition to be used for the monitoring of mangrove canopy health based on definable thresholds as agreed action triggers. These are defined in the 'Alert-to-Action' program below.

If Project construction activities are observed to be resulting in Project-related dust covering adjacent foreshore vegetation during the above field surveys, the NLEP SRA Project Manager will be advised and the CEMP and Project Air Quality Management Plan corrective actions will be implemented (refer CEMP Section 19.3 and Appendix 4).

8.4.1.2 'Alert-to-Action' program

The 'Alert-to-Action' program focuses on using vegetation indices derived from satellite measures of canopy condition of both mangroves and saltmarsh. Measures will be compiled on a monthly basis during the Project construction works and afterwards for 5 years. These remote measures will be compared with field site observations described in the section above, such as litterfall, shoot observations and sub-canopy light readings. This will provide direct comparison between measures recorded in the field with remote measures from satellite data.

The use of remote measures of canopy condition at specific point locations has been developed and proven by Duke *et al.* (2020b) as a highly beneficial and targeted tool for monitoring canopy condition.

For this program, data will be recorded each month during the 6 year program. Remote sensing data will be classified and evaluated according to three criteria, including a species-specific risk matrix, appropriate trigger criteria, and linked to an agreed Alert-to-Action protocol.

**Risk matrix for each marine plant type**

The plant types considered with this program are mangroves and salt marsh as key vegetation types of tropical shoreline tidal wetlands. Mangrove canopy condition can vary notably on a monthly basis (refer Figure 21). This defines a range of normal annual canopy variability of roughly ~0.6 (Normalised Difference Vegetation Index units, which quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs)). By contrast, catastrophic canopy decline post 2016 saw values drop to ~0.05 (or canopy condition as a green fraction of 5%).

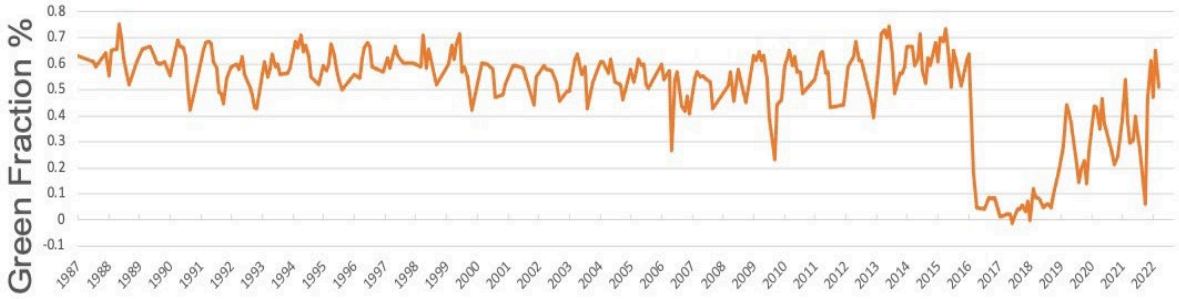


*Figure 21: Monthly green fraction timeseries data (1987 to 2022) from satellite imagery showing changes in mangrove canopy condition at a Fisherman's Landing monitoring site, Port Curtis (Duke et al. 2022)*

Any level of change in access of this natural variability, as classified in the risk matrix, will trigger some agreed management response that is considered appropriate to deal with the particular level of change (impact) and its abruptness. If changes are equally present in all treatment groupings (including the comparative area), then Project construction works will be allowed to continue without a management response.

**Trigger criteria**

The relevant criteria levels applicable for the monitoring program (canopy condition as a green fraction shown as a percentage) are proposed to be as follows:

a) 0-10 as **catastrophic**;
b) 10-30 as **severe**;
c) 30-60 as **threatening**;
d) 60-80 as **notable**; and
e) 80-100 as **normal**.

The impact criteria and this risk matrix will be reviewed after 6 months of program start-up. While the hierarchy of severity ratings will remain, it is anticipated that management responses may need to be re-evaluated and amended upon mutual agreement with key stakeholders. The objective will be to ensure that altered mangrove conditions in the pertinent treatment groups have the appropriate type and degree of management response in order to minimise and avoid longer term and/or catastrophic environmental harm from the Project construction works.

**'Alert-to-Action' protocol**

Alerts and proposed responses for mitigation intervention of construction works, will be linked to the full ranking of likely impacts. An action response will be implemented once a specified trigger criteria has been met or exceeded. The actual trigger criteria links will be established after 6 months from program start-up for the first 6 monthly report. The management responses will be ranked according to the range of damage severity classifications (especially for critical and vulnerable sites) as follows:

a) **Catastrophic** – cease construction works, conduct detailed assessment of the cause of damage and apply mitigation actions to reduce further harm. Construction works will resume post detailed assessment;
b) **Severe** – cease construction work, conduct detailed assessment of the cause of damage and its mitigation. Construction works will resume post detailed assessment;
c) **Threatening** – moderate level alert; implement some mitigation actions to reduce potentially harmful work activities;
d) **Notable** – initial alert with a watching brief on potentially harmful work practices; and
e) **Normal** – business as usual.

Any work responses will also depend on whether the impact was derived from Project construction works, or from an external source, such as a severe cyclone. A decision tree schematic will be developed that will clearly depict and structure how responses will address the issues at hand. Where the mangrove canopy loss is unrelated to the Project activities (e.g. cyclone, storm or other), stopping or amending the Project works will not be required.

### 8.4.2 Water mouse monitoring program

The monitoring program has been designed and prepared by Dr Penn Lloyd (Principal Ecologist, BAAM Ecological Consultants), with extensive experience in the development and implementation of Water mouse surveys.

The NLEP mangrove and saltmarsh monitoring program will be supplemented with a Water mouse monitoring program that is capable of accurately monitoring and quantifying any changes to the extent, and location of Water mouse habitat, including foraging habitat and breeding places, during Project construction and until 2 years following completion of construction.

The Project Water mouse monitoring area will include two sub-areas, including:

(1) The critical bunded area in the immediate vicinity of the WBRA; and

(2) The nearby vulnerable area adjacent to the NLEP SRA (refer Figure 20).

The extent, location and condition of the Water mouse foraging habitat will be monitored on an annual basis during construction and for two years following the completion of construction, using the results of the remote sensing vegetation indices outlined in the 'Alert-to-Action' program (refer Section 8.4.1.2) within the Water mouse monitoring area. The remote sensing data will be classified and evaluated according to three criteria, including a species-specific risk matrix, appropriate trigger criteria, and linked to an agreed Alert-to-Action protocol, as outlined in Section 8.4.1.2.

To monitor the location and extent of Water mouse breeding places, a survey will be conducted once each year during construction and for two years following the completion of Project construction. The survey will be conducted on foot during low tide, whereby a suitably qualified ecologist (as defined under the Project EPBC Act controlled action approval (EPBC 2012/6558)) will search the area of mangroves and saltmarsh and along the supralittoral bank throughout the Water mouse monitoring area for the characteristic signs of Water mouse shelter and breeding sites as outlined in DCCEEW (2022). Since Water mouse may have reduced activity during the colder winter months (DCCEEW, 2022), the shelter site surveys will be conducted within the period September to April inclusive. Shelter site searches are a recommended targeted survey method for Water mouse (DCCEEW, 2022). The locations of any sites that display characteristics consistent with Water mouse presence will be recorded using GPS and documented (i.e. description of habitat and site, with photographs).

A stand-alone Water mouse monitoring report will be prepared at the end of each year of monitoring to report the monitoring methods and relevant findings and outcomes of the Water mouse monitoring, including performance against the Alert-to-Action protocol (refer Table 14). Each monitoring report will include a review of the effectiveness and appropriateness of the Water mouse monitoring program for meeting the requirements of the Project EPBC Act controlled action approval (EPBC 2012/6558) condition 14 (d).

A Water mouse monitoring completion report will be submitted to the DCCEEW within 6 months following the completion of the second year of post construction monitoring.

Within 6 months of completing the Project Water mouse monitoring completion report, GPC will engage a suitably qualified ecologist to prepare a report (for the Minister for the Environment and Water's approval) which quantifies the significant residual impacts on protected matters based on the Water mouse habitat impacted as determined by the Project Water mouse monitoring program.

*Table 14: Summary of Water mouse monitoring program*

| Component | Monitoring method | Monitoring frequency and timing | Annual reporting measures |
|---|---|---|---|
| Extent and location of the Water mouse foraging habitat | Mapping the extent of mangroves and saltmarsh using remote sensing vegetation indices | Once per year during construction and for two years post construction, at the optimal time for the vegetation indices | Map of the extent of mangroves and saltmarsh within the monitoring area.<br>Area (hectares) of mangroves and saltmarsh within the monitoring area, and comparison with previous survey results.<br>Alert-to-Action protocol assessment results. |
| Extent and location of Water mouse breeding places | Water mouse shelter site search | Once per year during construction and for two years post construction, within the period September to April inclusive | Map showing the locations of any sites consistent with Water mouse breeding places within the monitoring area, and comparison with previous survey results.<br>Description of the sites and supporting habitat. |

## 8.5 Megafauna and marine turtle monitoring

As discussed in Section 4.8, some of the megafauna and marine turtle species described could utilise the REMP water quality and seagrass and macroalgae monitoring area, and the REMP area and adjoining intertidal areas for foraging when the tidal state allows it. In fact, the REMP area bathymetry is shallow with most of the area becoming exposed at average low tidal ranges (between neap and spring tides) with the remaining area (north-east corner of the REMP) only covered by approximately 0.7m. Considering this factor and the activity being undertaken, the risk of megafauna and marine turtles being directly impacted by construction activities is low. However, measures will be put in place to observe and record the presence of potential megafauna and marine turtles visiting the area during construction and to ensure that bund construction activities do not impact these animals. Full details on the megafauna and marine turtle monitoring and systems related to this aspect are provided in the CEMP (refer Section 19.5).

## 8.6 Aquatic fauna salvage operations

At the end of SRA bund construction and thus during bund closure operations, measures and systems will also be in place to ensure all megafauna as well as fish and mud crabs are not entrapped in the bund. The Project Aquatic Salvage Plan has been developed by Dr Daryl McPhee and a suitably qualified fish ecology expert, taking into consideration the specific characteristics and challenges of the area, such as the shallow bathymetry. Moreover, the document was prepared in accordance with the Department of Agriculture and Fisheries Fish Salvage Guidelines.

Careful consideration was adopted in developing the Project Aquatic Salvage Plan with a range of alternative approaches identified. Approaches that could lead to fish mortality by increasing stress by handling were deemed impractical or unsuitable. The selected salvage approach utilises the natural shallow bathymetry of the area, engineering of structures and deployment of fishing gears where appropriate and required. This approach has the objective to reduce fish handling and related stress by directing fauna into a deep pocket within the bund and consequently out into the harbour via the existing WBRA ‘’polishing pond’’.

The Project Aquatic Salvage Plan will be implemented during the NLEP SRA outer bund wall closure.

## 8.7 Project Eastern curlew and other shorebird monitoring program

### 8.7.1 Overview of monitoring program

To address the Project EPBC Act controlled action conditions, an Eastern curlew and other shorebird monitoring program has been designed by Professor Richard Fuller of the University of Queensland. The monitoring program has been designed and prepared Dr Penn Lloyd (Principal Ecologist, BAAM Ecological Consultants) and Dr Colin Trainor (Senior Ecologist, BAAM Ecological Consultants), who are both experienced in shorebird surveys.

The Project Eastern curlew and other shorebird monitoring program will incorporate the following three components, which were included in a technical memorandum from Professor Richard Fuller (Fuller, 2022):

- **Acute phase monitoring** – Monitoring of direct and indirect project impacts in the vicinity of the project area that has been assessed as being exposed to impacts from project activities, based on monthly counts and disturbance observations of migratory shorebirds and Beach Stone-curlews at high tide roosting sites (encompassing Friend Point, the Passage Islands, the WBRA and any suitable roosting habitat that may newly emerge during the works in the NLEP SRA) from one month prior to construction to one month post construction.

- **Long-term monitoring** – A broader and longer-term assessment of any changes in roost site usage by shorebirds in Port Curtis, based on surveys of high tide roost sites twice annually (summer, winter), covering high tide roosts at Friend Point, the Passage Islands, the WBRA, southern Curtis Island and Facing Island, following exactly the methods used in previous surveys under the Ecosystem Research and Monitoring Program to achieve maximum comparability with previous data. The monitoring will continue for at least five years post construction to ensure sufficient time to detect any changes in bird numbers or distribution.

- **Eastern curlew behavioural monitoring** – Monitoring the number and density of foraging Eastern curlews, their behavioural time budget (including responses to disturbance), position on the tidal flats between the NLEP SRA and Friend Point, how this changes over the tidal cycle, and where they fly to roost.

If Project construction activities are observed to be resulting in the displacement of Eastern curlews or other shorebirds within the adjacent foreshore areas during the above field surveys, the NLEP SRA Project Manager will be advised and the CEMP corrective actions will be implemented (refer CEMP Sections 19.3 and 19.5).

### 8.7.2 Data analysis framework

The approach to analysing the monitoring data to test whether the Project results in impacts on the population and behaviour of the Eastern curlew is summarised in Table 15.

*Table 15: Summary of the monitoring data analysis framework*

| Objective | Monitoring indicator | Trigger for investigation | Frequency |
|---|---|---|---|
| Test for an impact of the Project on the Eastern curlew population | Counts of Eastern Curlew at roost sites in the vicinity of the NLEP-SRA ('impact' area) and across the rest of Port Curtis ('control' area) within the period October-February | A significant difference ($p<0.05$) in Eastern curlew roost counts in the BACI design tested using a generalised linear model (GLM) | Once, at the completion of the long-term monitoring program. |
| | Counts of Eastern Curlew at roost sites in the vicinity of the NLEP SRA ('impact' area) within the period October-February | A significant difference ($p<0.05$) in Eastern curlew roost counts in the impact area between time periods (before, after impact) tested using a GLM | Annually during the construction phase |
| Test for an impact of the Project on Eastern curlew behaviour | Proportion of time Eastern curlews spend on activities such as foraging, resting/preening and responding to anthropogenic disturbance | A significant difference ($p<0.05$) in the time spent on the relevant activity between time periods (before, after impact), controlling for the potential influence of tide (neap, intermediate, spring) using a GLM | Annually during the construction phase and once post construction |
| | Eastern curlew feeding rates | A significant difference ($p<0.05$) in feeding rate between time periods (before, after impact), controlling for the potential influence of tide (neap, intermediate, spring) using a GLM | Annually during the construction phase and once post construction |
| | Number of Eastern curlews feeding in the behavioural monitoring area at low tide | A significant difference ($p<0.05$) in Eastern curlew counts at low tide between time periods (before, after impact) using a GLM | Annually during the construction phase and once post construction |

### 8.7.3 Reporting

An annual monitoring report will be prepared to report the results of monitoring for the reporting year, comparison with previous results, review of the effectiveness and appropriateness of the monitoring program in meeting the monitoring program objectives, recommendations to inform relevant management plans to adaptively manage and mitigate impacts to Eastern curlew, where new or increased impacts as a result of the action have been identified, and recommendations to inform the development and delivery of environmental offsets for any significant residual impacts on Eastern curlew, where relevant. At the end of the final year of monitoring, the annual monitoring report shall be prepared as a completion report that will be submitted to the DCCEEW within 6 months following the completion of the monitoring program.

Any incidents of disturbance to Eastern curlew due to Project activities will be reported to GPC within 24 hours of the incident(s) to inform adaptive management measures.

## 8.8 Bed level change

In proximity to the FL8 BPAR monitoring location, dual acoustic altimeters mounted on a benthic frame will be installed, commissioned and maintained in order to obtain sediment flux and bed level change data. The equipment will be deployed on the benthos as close as possible to BPAR sensors. The exact locations of such instruments will have to be defined upon inspection as a suitable subtidal location, where the instruments can be submersed at all times without wave (bubbles) and other physical disturbances that can influence the readings will have to be identified. These instruments will be set up to record instantaneous sediment change by logging at 15 minutes intervals. Cumulative bed level change from the original baseline reading will be calculated in order to obtain long-term sediment erosion or deposition patterns at these sites. This component of the monitoring program will be undertaken pre, during and post NLEP SRA bund construction operations as above compliance and thus not related to any condition. Moreover, this equipment will not be telemetered thus data will be downloaded during maintenance and it will be fully analysed at the end of the Project related environmental monitoring, 2 months post NLEP SRA bund construction activities completion.

Management of altimeter data was undertaken as per Health Safety Environment and Quality, and Management System protocols, with erroneous data removed from the dataset. Like dual sondes and LI-CORs, the use of duplicate altimeters assists in validating data.

This study will complement the FGS validation monitoring plan (refer Section 8.10) as well as the interpretation of BPAR monitoring (refer Section 8.2) and seagrass surveys (refer Section 8.3).

## 8.9 Hydrodynamic changes monitoring plan

A Project hydrodynamic changes monitoring plan has been developed to monitor and quantify impacts of hydrodynamic/morphological changes, including erosion, sedimentation, and channelisation, which may occur as a result of the construction of the NLEP SRA. Specifically, this monitoring program was developed to address the Project EPBC Act controlled action (EPBC 2012/6558) approval condition 14 c.

The monitoring program has been designed and prepared by Dr Paul Guard (BMT), with over 20 years of experience in the numerical modelling of coastal processes and holds a PhD in coastal engineering and an honours undergraduate degree in civil engineering, both through the University of Queensland.

The monitoring program will be implemented to measure any observed impacts (i.e. morphological changes) in the channel adjacent to the completed NLEP SRA and along the adjacent shoreline. The most important method that will be used to assess morphological changes will be regular boat-based surveys of the channel to the west of the NLEP SRA and the mudflats to the north of the NLEP SRA. This will be supplemented by LiDAR or drone surveys of the shoreline to the west of the NLEP SRA (BMT, 2024a). The proposed area to be surveyed is shown in Figure 22.

*Figure 22: Project hydrodynamic changes survey area extent*

**Figure note**: Green shaded area represents the Project hydrodynamic changes survey area extent

To assess the extent of any changes to the shoreline position and to the seabed elevation near the high tide mark, LiDAR or drone-based surveys will be undertaken immediately post construction and at six-monthly intervals after that (BMT, 2024a).

A report outlining any initial changes observed following completion of the NLEP SRA construction will be provided within 6 months of the construction completion date and assess the likelihood and potential implications of future changes. The need for additional future reporting will be assessed at that time. Performance objectives are provided in Table 16 (BMT, 2024a).

*Table 16: Project hydrodynamic/morphological changes performance objectives*

| Monitoring activity | Performance objective |
|---|---|
| LiDAR and Boat-Based Survey | Demonstrate that the measured changes in bathymetry have not caused significant impacts to protected matters |
| Shoreline Assessment Using LiDAR or Drone Survey | Demonstrate that the measured shoreline changes (if any) have not caused significant impacts to protected matters |

Within 6 months of completing the Project hydrodynamic changes monitoring report, GPC will engage suitably qualified ecologist and/or marine sediment expert to prepare a report (for the Minister for the Environment and Water's approval) which quantifies the significant residual impacts on protected matters based on the quantification of the Project hydrodynamic impacts identified in the Project hydrodynamic changes monitoring report.

At the conclusion of an initial 2 year period a revised plan will be submitted as per the Project EPBC Act controlled action approval condition 71 which will make recommendations for future monitoring based on whether morphological equilibrium has been reached. Monitoring will continue on a 6 monthly basis until the revised plan is approved by the Commonwealth Minister for the Environment and Water in writing (BMT, 2024a).

## 8.10 Fine-grained sediment validation monitoring program

A Project fine-grained sediment (FGS) validation monitoring program has been developed to provide an estimate of the total amount of FGS that will be released to the marine environment due to the NLEP SRA bund wall construction, that was not previously available for resuspension. FGS is defined as sediment particles that are less than 15.6 micron in diameter. Specifically the monitoring plan has been developed to address the Project EPBC Act controlled action (EPBC 2012/6558) approval condition 14 f.

The Project FGS validation monitoring plan has been designed and prepared by Dr Paul Guard (BMT), with over 20 years of experience in the numerical modelling of coastal processes and holds a PhD in coastal engineering and an honours undergraduate degree in civil engineering, both through the University of Queensland. The monitoring plan has been reviewed by Dr Andy Symonds (Director, Port and Coastal Solutions), with over 20 years of experience in port and coastal projects, specialising in numerical modelling and marine data analysis, and extensive experience in sediment transport, FGS validation monitoring plans and dredging projects.

The overall impact of NLEP SRA on sediment resuspension is provided in Section 7.2.2.

### 8.10.1 Amount of FGS released to the marine environment due to construction of the NLEP SRA

8.10.1.1 FGS not previously available for resuspension

No material with particles finer than 15.6 micron in diameter will be used in the construction of the new SRA perimeter bund wall. The finest-grained component of the construction material is fine sand, which will be composed of sediment grains larger than 75 microns in diameter (BMT, 2024b).

Any existing seabed material that is displaced or relocated during construction will be soft surface material that is already available for resuspension (BMT, 2024b).

Therefore, construction of the SRA will not result in the release of any fine-grained sediment (less than 15.6 micron) that was not already available for resuspension (BMT, 2024b).

8.10.1.2 FGS previously available for resuspension

BMT (2024b) provides details on FGS previously available for resuspension and estimated amount of FGS released to the marine environment due to construction of the NLEP SRA outer bund wall. Table 17 summarises the estimated total amount of FGS potentially released during construction of the NLEP SRA outer bund wall that was already available for resuspension.

*Table 17: Total amount of FGS release during construction of the NLEP SRA that was already available for resuspension*

| Source | Estimated amount of release |
|---|---|
| Rock placement | 27,750 tonnes (range: 14,000-55,000 tonnes) |
| Bed erosion | 83,500 tonnes (range: 41,000-167,000 tonnes) |
| **Total** | **111,250 tonnes (range: 55,000-222,000 tonnes)** |

### 8.10.2 FGS monitoring plan

8.10.2.1 Overall methodology

The rate of release of sediment into the marine environment during construction is expected to be very low relative to the levels of ambient suspended sediment. It is therefore expected that sediment released to the environment as a result of construction will not be distinguishable from baseline sediment levels, despite accurate monitoring techniques. This is because the instruments that are used to measure turbidity cannot distinguish between turbidity that is generated by the construction activity and the natural ambient (background) turbidity. The ambient turbidity is naturally high during spring tidal periods due to the high-energy tidal environment, so the additional turbidity generated by the construction activity will comprise only a small proportion of the total turbidity (BMT, 2024b).

The additional turbidity generated during construction is expected to cause only a modest increase in the peak turbidity at locations near the bund. Modelling estimates suggest that peak turbidity during construction would be approximately 43 NTU, compared to a background turbidity of 36 NTU. The difference between these values is small (7 NTU) relative to the variability in the ambient background turbidity. Therefore, it is unlikely that any instrumentation could reliably detect the influence of construction on the turbidity level if the actual construction effects are indeed similar to those that have been modelled. During neap tides, the construction-related signal is much smaller, so it would be even harder to detect (BMT, 2024b).

The validation of the overall sediment release estimate will therefore involve analysing the data that is collected as part of this REMP (refer WB50 (P2), WB20 (P14) and NW60 (QE4) sites shown on Figure 23) to confirm that the measured turbidity during bund construction was in line with expectations given the estimated quantity of fine sediment release. Measurements of turbidity and particle size distribution will also be undertaken at an additional site close to the edge of the mudflat to provide additional data for the analysis. Baseline measurements of the flux of sediment entering the estuary from the mudflats to the north of the WBE will be undertaken using a boat-mounted ADCP, and additional measurements will be undertaken during similar tidal and weather conditions during construction to allow a comparison of the sediment fluxes (BMT, 2024b).

8.10.2.2 Summary of proposed monitoring methods

Additional measurements of turbidity will be undertaken at the site ‘FSM01’ (refer Figure 23) for a one-month period prior to commencement of construction and for two additional one-month periods during construction (one at the start of the construction activity, and another towards the end of the bund construction as the gap in the bund approaches final closure). This location was chosen because aerial photography indicates that sediment plumes generated along the edge of the reclamation tend to advect past this location.

A set of baseline ADCP transect measurements will be undertaken over a full tidal cycle (12.5 hours) along a transect to the north of the existing WB reclamation (refer to the red line on Figure 23 for location). The measurements will be undertaken during spring tidal conditions, since the largest increases in turbidity associated with construction are expected to occur during spring tidal periods. This is because most of the construction-related increases in turbidity will be generated by spring tide currents eroding the seabed when water goes in and out of the partially-closed NLEP SRA bund. Within Gladstone Harbour, the spring-neap tidal cycle is the dominant driver of sediment dynamics, and seasonal influences are much less significant. It is therefore not necessary to undertake baseline measurements in different seasonal conditions.

A summary of the proposed monitoring methods is provided in Table 18. A more detailed turbidity monitoring plan is provided in BMT (2024b).


*Figure 23: Water quality monitoring locations and proposed ADCP transect measurement location*

*Table 18: Summary of proposed monitoring methods*

| Measurement method | Method of implementation | Comment on data obtained |
|---|---|---|
| Turbidity measurement as per the REMP (refer Section 8.1) | The data collected during implementation of the REMP will be analysed to confirm turbidity levels were in line with expectations and below turbidity triggers | This will serve to confirm the adequacy of the estimate of the quantity of fine sediment release due to bund construction |
| ADCP | Sediment concentration and sediment flux will be measured across a transect both before and during construction | The transect TSS and flux measurements, once properly calibrated, provide a good description of the sediment flux at the edge of the mudflat |
| Optical sensor | Optical sensor profile measurements will be undertaken during ADCP transecting using LISST and OBS instruments. A LISST instrument will also be deployed at FSM01 | The optical sensor profile measurements are used to calibrate the conversion of ADCP backscatter into equivalent TSS<br>The LISST PSD measurements are used to characterise suspended sediment particle sizing |
| Water sampling | A number of water samples will be collected during ADCP transecting measurements using a pump sampler, as well as at site FSM01 | These water samples will be analysed for TSS and PSD. The TSS measurements are used to calibrate the optical sensor measurements (NTU to TSS) and ADCP backscatter |

| Measurement method | Method of implementation | Comment on data obtained |
|---|---|---|
| Drone photography | Drone photography will be undertaken at a known state of tide, elevation and orientation both before and during construction | This photography will help to identify the extent of any construction-related plumes |
| Satellite photograph | Photography will be obtained for snapshots at times available both before and during construction | This photography may help to identify the extent of any construction-related plumes |
| Numerical hindcast modelling | The numerical modelling will be used to assess the likely construction plume source rates by comparing modelled and measured TSS | The numerical modelling will be useful since it accounts differences in tidal conditions and allows for plume advection, dispersion and settling between the point of discharge and the measurement transect |

#### 8.10.2.3 Reporting

The Project FGS monitoring validation plan report will be submitted to the DCCEEW within 6 months following the completion of the Project FGS monitoring validation.

Within 6 months of completing the Project FGS monitoring validation plan report, GPC will engage a suitably qualified marine sediment expert to prepare a report (for the Minister for the Environment and Water's approval) which quantifies the amount of fine-grained sediment returned to the marine environment that was not previously available for resuspension monitored in the Project FGS monitoring validation plan.

## 8.11 Mud wave management

Due to the displacement of soft sediments during NLEP SRA bund wall construction operations, in particular rocks placement, a mud wave might be generated. The latter has the potential to displace potential acid sulphate soils which could cause environmental harm through the mobilisation of acidity and other oxidation products.

In order to appropriately manage this aspect, a management plan has been developed by a suitably qualified expert and will be submitted to the relevant regulators prior to commencement of the NLEP SRA bund construction activities. Further details on this component are also provided in the Project CEMP (refer Section 19.4).

## 8.12 NLEP SRA bund wall integrity monitoring program

A bund wall integrity monitoring program has been developed to monitor the integrity of the NLEP SRA bund wall to address the Project EPBC Act controlled action (EPBC 2012/6558) approval condition 14 b. The monitoring program has been prepared by suitably qualified and experienced Aurecon engineers who are registered professional engineers of Queensland. Registered professional engineers of Queensland will be involved in the implementation of the monitoring program during and post bund wall construction.

The NLEP SRA rock wall bund has been designed to contain dredged material placed within the reclamation area. A risk assessment has been completed to identify hazards that could affect the short-term and long-term integrity of the rock wall bund during its construction and post construction (prior to reclamation works) and reclamation works, future development and end use stages of the bund wall lifecycle. The risk assessment process also identified mitigation actions that have been and will be applied during the construction and post construction phases, which will reduce or eliminate the probability of the hazards occurring.

During the construction phase, the bund wall integrity monitoring program includes the preparation of a Project quality plan, approved by a registered professional engineer of Queensland, which addresses all the requirements of the civil and earthworks specification and geofabric installation works specification, including:

- Organisation and management responsibilities during construction;
- Inspection and test plans;
- Hold points and witness points to be inspected by a registered professional engineer of Queensland;
- Planned audits;
- A schedule and program of all quality documentation to be prepared during construction;
- Undertaking baseline monitoring in accordance with civil and earthworks specification to establish the baseline behaviour of the ground or bund. Baseline readings will be carried out immediately after installation and before adjacent construction commences; and
- Continual visual inspection of the bund walls to provide assurance that the material compaction is adequate such that bund stability is not compromised during construction by the presence of paleochannels.

During the post construction phase, the bund wall integrity monitoring program includes:

- Geotechnical stability of the bund wall and condition monitoring of the external facing rip rap rock and internal facing rock by visual inspections of the external facing rip rap rock and internal facing rock and individual rocks (signs of distress and an indication of a lower factor of safety) and periodic measurements of the amount of movement on the bund wall at the crest using GPS surveys at 15 monitoring points regularly spaced along the rock wall bund structure. Stability of the bund wall and rip rap and rock berm undertaken at low tide (surveys at 3 months, 9 months and 2 years and 9 months after the completion of the bund wall, and a survey every 5 years thereafter).
- Periodic unmanned aerial vehicle surveys to enable a review of the 3D view of the bund wall, including the position and condition of individual rocks. Individual rocks will include unstable rocks, new voids (holes) in the structure and exposure of rock filter, core rock and geotextile filtration system.
- Settlement of the bund wall monitoring (surveys and visual inspections) at 15 monitoring points regularly spaced along the rock wall bund structure to ensure a maximum settlement of less than 300mm. Settlement of the bund wall (surveys at 6 months and 2.5 years after the completion of the bund wall, and a survey every 5 years thereafter).
- Excessive release of sediment/turbidity through the bund wall (weekly visual inspections during the first month post construction and if no issues monthly inspections for next 11 months thereafter, and water quality monitoring buoys for 2 months post construction in accordance with the Project water quality monitoring program).
- If the results of monitoring surveys show non-compliances in the detailed design specifications (i.e. detailed design drawings, civil and earthworks specification and geofabric installation works specification), corrective actions will be undertaken (e.g. maintenance of wearing course and subgrade, geotextile filtration system and revetment remedial works, other remedial actions developed in consultation with a registered professional engineer of Queensland).

- Additional post construction bund wall integrity monitoring surveys will be undertaken following severe and extreme weather events, such as a cyclone, dangerous thunderstorms, strong winds, heavy rain, lighting and/or hail, that are triggered under the GPC Emergency Response Plan.

## 8.13 Environmental monitoring program summary

The environmental monitoring program described in the above sections, will be conducted prior, during and post NLEP SRA bund construction operations (refer Table 19 and Table 20).

*Table 19: NLEP SRA bund construction environmental monitoring phases (water quality, BPAR and sediment deposition only)*

| Phase | Duration (months) | Approximate start date |
|---|---|---|
| Pre-construction | 1 | 1 month prior to bund wall construction activities commencement |
| Construction | >18 | |
| Post construction | 2 | 2 months post bund wall construction activities completion |

Monitoring of water quality, BPAR and sediment deposition is primarily useful and relevant during and around bund construction activities and thus will terminate 2 months after completion of the bund wall construction activities. Other environmental monitoring programs/plans will continue as specified in each monitoring programs/plans. A summary of all environmental monitoring programs/plan to be implemented around the Project is presented in Table 20.

*Table 20: Summary of NLEP SRA monitoring programs*

| Monitoring aspect | Monitoring details | Data/sample collection details | Sites | Construction phase monitored | Monitoring interval |
|---|---|---|---|---|---|
| Water quality – telemetry | Dual multiparameter sondes water quality buoys. EWMA applied to turbidity data set and screened against triggers (concern site only) | Full standard physical-chemical parameters suite. Continuous real-time data, 15 mins logging interval | • NW60 (concern)<br>• WB20 (control)<br>• WB50 (control)<br>• C3 (control) | Pre<br>During<br>Post | Continuous real-time |
| Water quality – grab samples | Sub-surface pole sampler. Results screened against ANZECC 95% and 99% (MD and SD areas) protection marine species and WQOs for Gladstone Harbour Zones | Water samples to be analysed by a NATA-accredited laboratory for TSS, nutrients, chlorophyll *a*, metals and TPH | • NW60 (concern)<br>• WB20 (control)<br>• WB50 (control)<br>• C3 (control) | Pre<br>During<br>Post | Monthly |
| BPAR – telemetry | Benthic frames with dual PAR sensors. TDP and 14 days RA to be applied to the data set. 14 days RA screened against BPAR threshold (concern site only) | Continuous real-time data, 15 mins logging interval | • CT (land-based control)<br>• FL8 (concern)<br>• WB25 (control)<br>• WI (control) | Pre<br>During<br>Post | Continuous real-time |
| Bed level (above compliance) | Acoustic altimeters deployed sub tidally in proximity (where suitable) of BPAR monitoring sites | Sediment flux and bed level change. Instantaneous sediment change and cumulative bed level change | • - FL8 | Pre<br>During<br>Post | Continuous |
| Seagrass condition | Established techniques from JCU TropWATER's Ecology Team Queensland-wide<br>seagrass monitoring programs (refer Section 8.3) | Key metrics: biomass, area, species composition and macroalgae %. Data and statistical analysis producing a comprehensive report | • Meadow 8 – North Fisherman's Landing (concern)<br>• Meadow 6 – South Fisherman's (control) | Pre<br>During<br>Post | • Once as baseline (Pre)<br>• Quarterly (During and Post for 6 months only)<br>• Annual concurrently to the PoG annual seagrass program for 2 years |

| Monitoring aspect | Monitoring details | Data/sample collection details | Sites | Construction phase monitored | Monitoring interval |
|---|---|---|---|---|---|
| | | | • Meadow 5 – Wiggins Island (control) | | |
| Mangrove and saltmarsh condition | Mangrove and inspection program, including mangrove and saltmarsh long term plots, and mangrove litterfall and shoot observations<br>'Alert-to-Action' program using vegetation indices derived from satellite measures of canopy condition of both mangroves and saltmarsh | Field work at long term plots<br><br>Remote sensing data compared to field sites observations | • WBRA mangroves in the bunded area<br>• WBEA adjacent mangroves in northern survey area<br>• WBSC comparative mangroves nearby | Pre<br>During<br>Post | • Monthly (remote sensing, field validation and related analysis)<br>• Concluding 5 years post construction completion<br>• Litter traps collected each month for 12 months minimum in the first year, then again in the 5th year |
| Water mouse monitoring | Water mouse field surveys | Field survey conducted in accordance with DCCEEW (2022) | • WBRA mangroves in the bunded area<br>• WBEA adjacent mangroves in northern survey area | Pre<br>During<br>Post | • Annually<br>• Concluding 2 years post construction |
| Shorebirds | Combination of acute phase, long-term and behavioural monitoring techniques | Bird counts and disturbance observations, long-term changes in roosting site usage, and number and density of foraging Eastern curlews, position on tidal flats, how this changes over the tidal cycle and where they fly to roost | Acute phase monitoring – high tide roosting sites (Friend Point, Passage Islands, WBRA, and others if determined during surveys)<br>Long-term monitoring – high tide roosting sites (Friend Point, Passage Islands, WBRA, and southern | Pre<br>During<br>Post | **Acute phase monitoring**<br>• Commence 1 month prior to construction<br>• Monthly<br>• End monthly monitoring 1 month after construction<br>**Long-term monitoring**<br>• Twice annually (summer and winter)<br>• Concluding 5 years post construction |

| Monitoring aspect | Monitoring details | Data/sample collection details | Sites | Construction phase monitored | Monitoring interval |
|---|---|---|---|---|---|
| | | | Curtis Island and Facing Island)<br>Eastern curlew behavioural monitoring – NLEP SRA construction area and Friend Point | | **Eastern curlew behavioural monitoring**<br>• Twice annually (summer and winter)<br>• Once post construction |
| Hydrodynamic changes | Combination of techniques including LIDAR, boat- and drone surveys | LIDAR, boat-based surveys and drone surveys | Channel adjacent to the completed NLEP SRA and along the adjacent shoreline | Post | • Post construction<br>• Six monthly after post construction survey for 2 years<br>• Revised program after initial 2 year period to confirm need and scope of future monitoring |
| Fine-grained sediment (FGS) | Combination of techniques and monitoring methods | ADCP transect measurements and water sampling, optical sensor profile measurements, drone photography, satellite photography analysis, water quality, BPAR and sediment deposition monitoring already implemented, and hindcast modelling | REMP area, ACDP transect, and water quality (WB50 (P2B), NW60 (QE4) and WB20 (P14)) and sediment deposition monitoring sites, and additional turbidity and PSD measurement site (FSM01) | Pre<br>During<br>Post | • ADCP transect and water sampling – baseline pre-construction, and once during construction<br>• Drone and satellite photography – baseline pre-construction, and once during construction<br>• Water quality and sediment deposition monitoring as per above |
| Bund wall integrity (construction) | Visual inspections, test pits and hold points and witness points inspected by a registered professional engineer of Queensland, and audits | Observations will be compared to the detailed design drawing, specifications and Project quality plan | Several monitoring sites at regular intervals along the completed sections of the bund wall | During | • Monthly during construction<br>• Once post construction after 6 month and then annually for 3 years |

| Monitoring aspect | Monitoring details | Data/sample collection details | Sites | Construction phase monitored | Monitoring interval |
|---|---|---|---|---|---|
| | | | | | • Survey after severe and extreme weather events, such as a cyclone, dangerous thunderstorms, strong winds, heavy rain, lighting and/or hail, that are triggered under the GPC Emergency Response Plan. |
| Bund wall integrity (post construction) | Surveys and visual inspections | Settlement of the bund wall, stability of the bund wall and rip rap and rock berm undertaken at low tide, and excessive release of sediment/ turbidity through the bund wall | 15 monitoring points regularly spaced along the rock wall bund structure | Post | • Settlement of the bund wall (surveys at 6 months and 2.5 years after the completion of the bund wall, and a survey every 5 years thereafter)<br>• Stability of the bund wall and rip rap and rock berm undertaken at low tide (surveys at 3 months, 9 months and 2 years and 9 months after the completion of the bund wall, and a survey every 5 years thereafter)<br>• Excessive release of sediment/turbidity through the bund wall (weekly visual inspections during the first month post construction and if no issues monthly inspections for next 11 months thereafter, and water quality monitoring buoys for 2 months post construction in accordance with the Project water quality monitoring program). |

| Monitoring aspect | Monitoring details | Data/sample collection details | Sites | Construction phase monitored | Monitoring interval |
|---|---|---|---|---|---|
| | | | | | • Additional post construction bund wall integrity monitoring surveys will be undertaken following severe and extreme weather events, such as a cyclone, dangerous thunderstorms, strong winds, heavy rain, lighting and/or hail, that are triggered under the GPC Emergency Response Plan. |

**Table notes**: This table reports both compliance and above compliance aspects of the environmental monitoring related to the NLEP SRA construction activities as well as both concern and control sites, in particular for water quality and BPAR. Control sites are not related to any management action or regulatory limit, but will be closely monitored and used as early warnings and will assist in the analysis of data and environmental patterns. For full details on the different components of the environmental monitoring refer to the relevant sections above.

# 9 Adaptive management framework

The knowledge and extensive data sets collected on the PoG receiving environment attributes as well as related stressors (refer Sections 4 and 5) have allowed to obtain a very good understanding on how the different attributes respond and behave under certain conditions. The PoG is a high energy and complex system where multiple factors interact resulting in changes that can affect water quality and sensitive receptors. This knowledge together with modelling and impact assessment has been applied to design a monitoring program for the Project (refer Section 7). During construction activities, this program will be applied together with an adaptive management framework which will allow to detect, prevent and manage any elevation in turbidity EWMA and BPAR allowing to avoid or minimise any impacts from bund wall construction activities to receiving environment and sensitive receptors. Turbidity EWMA and BPAR are in fact the only parameters that can be affected by SRA construction operations, turbidity EWMA directly and BPAR indirectly. As shown by the recent SAP undertaken in 2020 along the NLEP SRA bund wall footprint, no metal(loid)s or other contaminants are present in the sediment, therefore the risk of construction activities causing temporary resuspension of sediment-associated contaminants is very low. Moreover, any temporary increase is usually in the total fraction indicating that the metal(loid)s are bound to sediments and thus in particulate form.

To allow for the implementation of mitigating measures, an adaptive management process has been designed for turbidity EWMA and BPAR. In the instance any of these above-mentioned parameters exceed internal or external trigger levels for certain durations, steps will be undertaken to adaptively manage elevations and prevent any impacts from the SRA construction activities. As detailed in Sections 8.1 and 8.2, elevations will be investigated at all sites (concern and control), however external reporting will only occur in the case of elevations that are due to NLEP SRA construction activities and adaptive management actions will only be implemented at concern sites. Therefore, in the below sections only concern sites will be considered. All elevations and investigations will be recorded within GPC's systems together with a briefing that explains the likely causes of the elevation above the established trigger level and any corrective measures (to be) taken.

## 9.1 Baseline monitoring (no adaptive management required)

Turbidity EWMA and BPAR data will be monitored at all sites (concern and control), but assessed for compliance purposes at concern sites only; all related data will be managed according to Section 7. When EWMA turbidity values at water quality sites remain below the Internal Alert Level 1 triggers for less than consecutive 36 hours, no investigation into the cause of turbidity changes (if any) will be conducted and no management actions are required. Similarly, when daily BPAR, as 14 day RA of TDP, values remain above the trigger value of 6mol/$m^2$/day, no investigation into the cause of BPAR changes (if any) will be conducted and no SRA operations management interventions are required.

## 9.2 EWMA turbidity elevation adaptive management

### 9.2.1 EWMA Turbidity Internal Alert Level 1

The EWMA Turbidity Internal Alert Level 1 is reached when turbidity EWMA at the designated concern water quality monitoring site exceeds the 80$^{th}$ percentile trigger continuously for 36 hours (six consecutive EWMA turbidity values). In turn, Response 1 is activated where the GPC ESM or delegate initiates an investigation to determine the causes of the elevation (refer Figure 24). Whenever deemed appropriate and required, the GPC ESM seeks support from the suitably qualified water quality expert engaged for the duration of the Project's environmental monitoring. The investigation will commence within 24 hours of becoming aware of the elevation and will consider the following:

- Review of telemetry data;

- Communication with monitoring contractor to investigate monitoring equipment status to determine if any interference or malfunction such as particles or debris lodged within the sensors, sensors fouling or failure has occurred;

- Establish communication with bund construction site and obtain information on any visible plumes, extent and direction. Obtain any information related to rock placement such as rate. If deemed appropriate and required, a drone survey will be undertaken and imagery captured and analysed by GPC ESM or delegate; and

- Analyse telemetry data against environmental conditions such as tides, rainfall and wind; and, if required, baseflow conditions. Check any anthropogenic influence non-related to SRA construction activities occurring within the PoG and in particular in proximity to the REMP area.

### 9.2.2 EWMA Turbidity Adaptive Management Level 1

In the instance that GPC ESM, with the support from the water quality expert (whenever required or appropriate), deems the elevation in EWMA turbidity above the 80$^{th}$ percentile trigger for 36 consecutive hours to be predominantly not attributable to external conditions, GPC Environmental Compliance Specialist (ECS) and other GPC stakeholders such as the Project Manager will be consulted. The consultation will deliberate any management measure to be implemented to mitigate the observed construction-related impacts on turbidity. The investigation and management measures will remain in place until construction-related turbidity no longer activates the Internal Alert Level 1 trigger. Mitigating measures may include, but will not be limited to the following:

- Reduction in rock placement rates at any of the two placement locations with efforts being redirected as appropriate;

- Progress of new work front only at low tide;

- Progress with construction at one work front; and/or

- Working on the higher bund wall lift areas.

If, instead, the above-mentioned investigation shows that the likely causes of elevation of turbidity EWMA are driven by external conditions (e.g. environmental) no actions will be taken, Water quality monitoring will continue with the investigation remaining open until the EWMA turbidity value has either increased to the 95$^{th}$ percentile trigger or returned below the 80$^{th}$ percentile trigger value.

### 9.2.3 EWMA External Alert Level 2

The EWMA External Alert Level 2 is reached when turbidity EWMA at the designated concern water quality monitoring site exceeds the 95$^{th}$ percentile trigger continuously for 24 hours (four EWMA values). In turn, Response 2 is activated whereby the GPC ESM conducts an investigation, continuing the Internal Alert Level 1 investigation if turbidity EWMA values have increased from the 80$^{th}$ percentile trigger reaching the next threshold, as detailed in Section 9.2.1.

### 9.2.4 EWMA Turbidity Adaptive Management Level 2

Adaptive Management Level 2 will follow the steps detailed in Section 9.2.2. However, if the investigation deliberates the increase in turbidity EWMA to be predominantly not attributable to external conditions, GPC ECS will notify DESI and DCCEEW within two business days of becoming aware of the elevation and adaptive management measures will be implemented (refer Section 9.2.2). Contrarily, if the abovementioned investigation shows that the likely causes of elevation of turbidity EWMA are driven by external conditions, no actions will be taken, the investigation will remain open, however it will remain internal. Moreover, whether the elevation is due to environmental or construction activities, whenever turbidity EWMA values return below 95$^{th}$ percentile trigger, no further management measures will be considered or taken, the investigation will be closed and water quality monitoring status will go back to general monitoring.

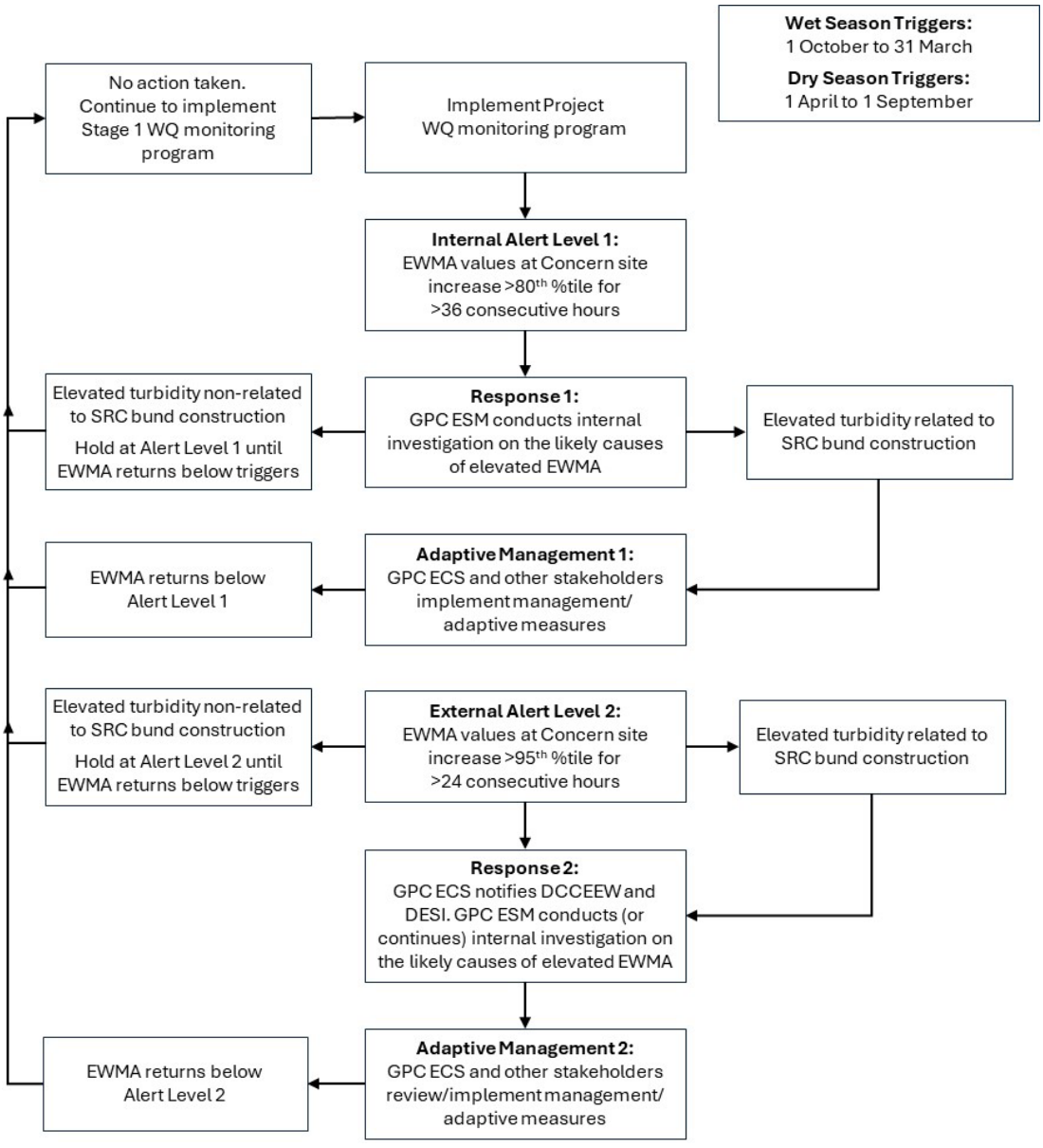


*Figure 24: EWMA turbidity adaptive management flowchart*

**Figure note**: EWMA turbidity adaptive management flowchart will be implemented at the concern site during the NLEP SRA bund construction phase (refer Figure 24), for full details and description refer to Section 9.2.

## 9.3 BPAR elevation adaptive management

### 9.3.1 BPAR Internal Alert Level 1

The BPAR Internal Alert Level 1 is reached when BPAR at the designated concern benthic light monitoring site falls below the 6mol/$m^2$/day threshold for 1 day (one 14 day RA value). This will in turn initiate Response 1 where GPC ESM, with support from the water quality expert, whenever required or appropriate, will initiate an investigation to determine the causes of the reduced BPAR conditions at the site. The investigation will commence within 24 hours of becoming aware of the reduced BPAR levels, it will follow the same principles and steps as detailed in Section 9.2.1 and it will remain open until BPAR values return above threshold (refer Figure 25).

### 9.3.2 BPAR Adaptive Management 1

In the instance GPC ESM, with support from the water quality expert, whenever required or appropriate, deems the reduced light level conditions and 14 day RA below threshold to be predominantly not attributable to external conditions, GPC ECS will follow the same steps and consult stakeholders as per Section 9.2.2 deciding on any appropriate adaptive management action in order to reduce turbidity levels and in turn help BPAR values to return above threshold (refer Figure 25).

Whenever the investigation finds decreased light levels not to be due to increased turbidity from NLEP SRA construction activities, the decrease in light levels will be considered the result of environmental factors which will be investigated and identified. Moreover, if the investigation shows that likely causes of BPAR values below threshold are environmental conditions no adaptive management actions will be taken, monitoring will continue with the investigation remaining open until the BPAR 14 day RA returns above threshold. When the elevation is due to environmental or construction activities no further management measures will be considered or taken, the investigation will be closed and monitoring status will go back to general monitoring.

### 9.3.3 BPAR External Alert Level 2

The BPAR External Alert Level 2 is reached when this parameter at the designated concern benthic light monitoring site remains below the 6mol/$m^2$/day threshold for 7 consecutive days (seven BPAR 14 day RA values) (refer Table 13). This will in turn initiate Response 2 where the GPC ESM or delegate will continue the investigation commenced during the BPAR Alert Level 1 phase (refer Section 9.3.1).

### 9.3.4 BPAR Adaptive Management 2

BPAR adaptive Management Level 2 will follow the principles and steps detailed in Section 9.3.2, however if the investigation deliberates the reduced light conditions to be predominantly not attributable to external conditions, GPC ECS will notify DESI and DCCEEW within two business day of becoming aware of the issue. Moreover, the management measures implemented during the BPAR Adaptive Management 1 phase will be reviewed and modified or new measures will be added if deemed appropriate. Adaptive management measures (refer Section 9.2.2) will remain in place until BPAR 14 day RA returns above the threshold.

However, if the investigation shows that the likely causes of continued (7 continuous days) BPAR 14 day RA below threshold are driven by environmental conditions, no actions will be taken, the investigation will remain open and held at Level 2 until it either progresses to the next Alert phase (refer Section 9.3.5) or BPAR 14 day RA returns above threshold. In this instance, when the light reduction is due to environmental or construction activities, no further management measures will be considered or taken, the investigation will be closed and water quality monitoring status will go back to general monitoring.

### 9.3.5 BPAR Alert Level 3

In line with Table 13, BPAR Alert Level 3 is reached when BPAR at the concern benthic light monitoring site remains below the 6mol/$m^2$/day threshold for 14 consecutive days (i.e. 14 consecutive BPAR 14 day RA values, respectively). The processes and actions described in the above BPAR adaptive management sections will be repeated following the same principles. Adaptive management measures (refer Section 9.2.2) will remain in place until the BPAR 14 day RA returns above the threshold.

Management measures implemented during the BPAR Adaptive Management 1 and 2 phases will be reviewed and modified or new measures will be added if deemed appropriate. However, if the investigation shows that the likely causes of continued 14 consecutive days of BPAR 14 day RA below threshold) low light conditions are driven by external factors no actions will be taken, the investigation will remain open with the monitoring status remaining at the respective Alert Level (3) until the BPAR 14 day RA returns above threshold (refer Figure 25).

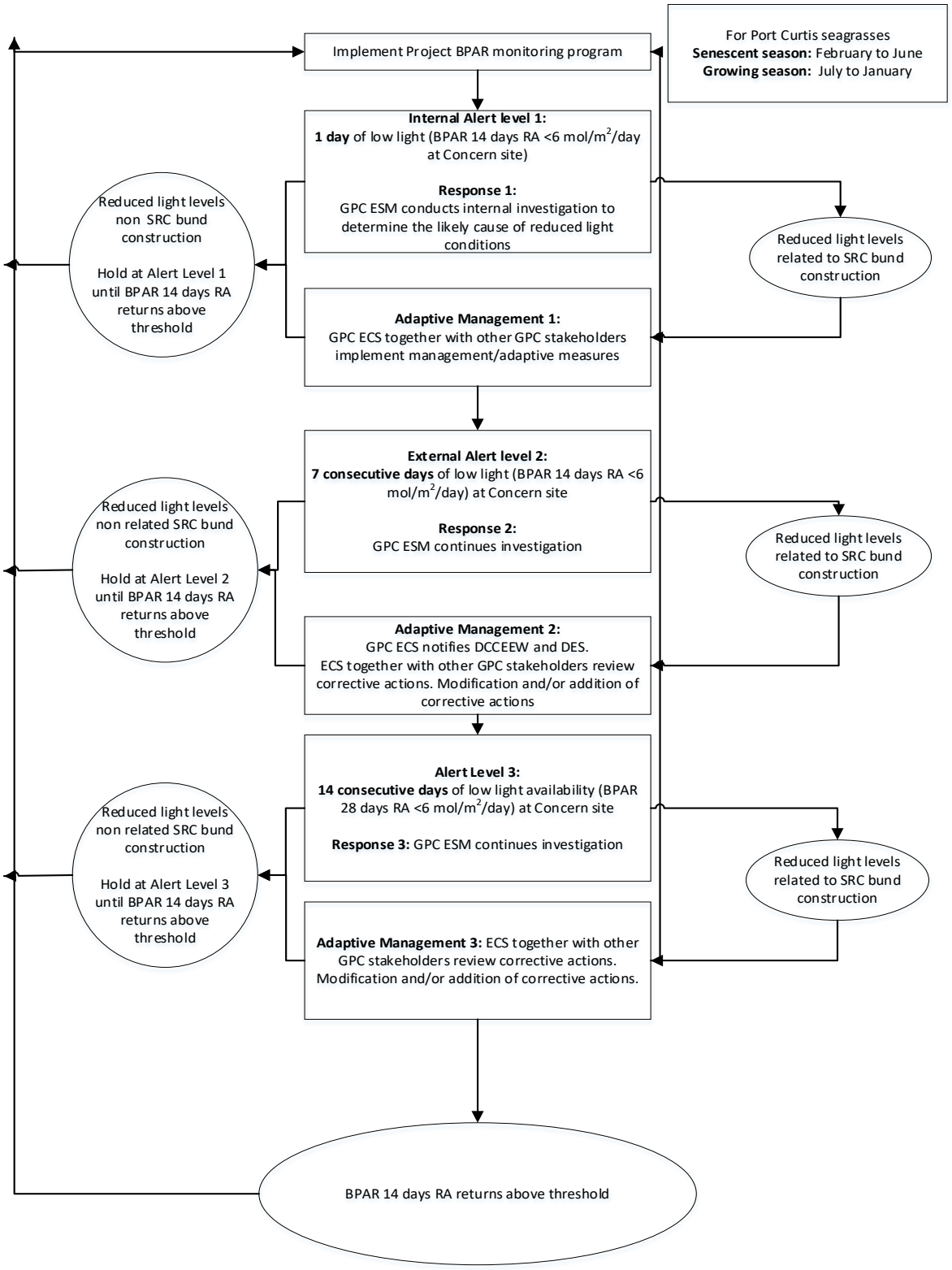


*Figure 25: BPAR growing and senescent season adaptive management flowchart*

**Figure note**: BPAR growing and senescent season adaptive management flowchart will be implemented at the concern site during the NLEP SRA bund construction phase, for full details and description refer to Section 9.3.

# 10 Reporting and review requirements

The environmental monitoring detailed in this REMP has a range of associated reporting requirements which will be submitted to regulators during NLEP SRA construction activities and following monitoring programs completion.

In summary, reporting to the DCCEEW includes:

- Project baseline survey reports for seagrass and macroalgae, and Water mouse reported on within 10 business days of completion of the survey results and the report submitted to the DCCEEW within 10 business days of the completion of the final report of the survey (as required under EPBC Act controlled action approval condition 13 d);
- Project monitoring programs/plans for Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae and FGS submitted for the Minister for the Environment and Water's approval prior to the commencement of the NLEP SRA construction (as required under EPBC Act controlled action approval condition 17 b);
- Reporting to DCCEEW within two business days of becoming aware of the EWMA turbidity adaptive management level 2 occurring at water quality monitoring site NW60 (QE4);
- Reporting to DCCEEW within two business days of becoming aware of the BPAR adaptive management level 2 light threshold occurring at BPAR monitoring site FL4;
- Submission to DCCEEW of annual Project monitoring programs/plans reports for Eastern curlew, bund wall integrity, hydrodynamic changes, Water mouse, seagrass and macroalgae and FGS;
- Submission to the DCCEEW of the completed Project monitoring programs/plans reports for Eastern curlew, bund wall integrity, hydrodynamic changes, and FGS within 6 months following the completion of each monitoring program (as required under EPBC Act controlled action approval condition 13 d); and
- Submission to DCCEEW of the completed Project seagrass and macroalgae, and Water mouse monitoring completion reports within 6 months following the completion of the second year of post construction monitoring.

GPC will maintain accurate and complete compliance records for the Project. A Project compliance report will be prepared for each 12 month period following the date of commencement of Project construction (first placement of rock into the marine environment) in accordance with the Project EPBC Act controlled action condition 65, which requires GPC to:

- Publish each compliance report on the website within 60 business days following the relevant 12 month period;
- Notify the DCCEEW by email that a compliance report has been published on the website and provide the weblink for the compliance report within 5 business days of the date of publication;
- Keep all compliance reports publicly available on the website until this approval expires;
- Exclude or redact sensitive ecological data from compliance reports published on the website; and
- Where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the DCCEEW within 5 business days of publication.

As required by the Project ERA 16 EA condition WT5, a report outlining the findings of the REMP, including all monitoring results and interpretations, will be prepared and made publicly available on GPC's website annually, within one month of its completion and remain accessible for the duration of the action. The first report is this REMP, Section 7 of this document describes the outcomes of the baseline monitoring programs. Section 8 of this document outlines the monitoring programs to be implemented. The REMP will be published prior to the commencement of Project construction activities. Reports completed after commencement must include a comparison between conditions before and after commencement of the activity for all indicators.

Details on other Project reporting requirements and timelines are detailed within the CEMP (refer CEMP Section 18).

This REMP, in particular the operation and implementation of Section 8 (NLEP SRA environmental monitoring program) and Section 9 (adaptive management framework), will be reviewed, amended and continually improved based on the following:

- Findings of internal and external audits (refer CEMP Section 11);
- Findings and annual review of the effectiveness and appropriateness of the monitoring programs/plans; and
- Findings of a review of the effectiveness of the avoidance and mitigation measures in meeting the outcomes, targets or management measures proposed in the REMP in the event that an outcome and/or performance indicator/target are not achieved, and at least annually.

Any changes to this REMP will be approved by DCCEEW and the Assessment Manager (GPC) prior to implementation.

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# 12 Appendix A: NLEP SRA ERA 16 EA conditions

**Table WT2 Water quality monitoring names and locations**

| Grouping[1] | Monitoring site name used in Project EIS baseline monitoring | Monitoring site name used in Project Environmental Monitoring Procedure (refer AEIS Appendix H) | Location (WGS84) | Zone[2] | Timing of monitoring[3] | Location description |
|---|---|---|---|---|---|---|
| Offshore | CD1 | CD1 | S23 57.469 E151 30.115 | Open coastal waters | | Adjacent to Seal Rocks |
| | CD2 | CD2 | S23 52.017 E151 24.380 | Open coastal waters | | Off East Point off Facing Island |
| | CD3 | MH60 (PCIMP site) | S23 54.989 E151 21.569 | Mid Harbour[4] | | Located outside the mouth of the Boyne River |
| | CD4 | CD4 | S23 46.269 E151 22.639 | Open coastal waters | | Off the eastern side of Facing Island, adjacent to Pearl Ledge |
| | CD5 | CD5 | S23 50.187 E151 27.153 | Open coastal waters | | Off the eastern side of Facing Island, 3 km northwest of East Banks DMPA |
| Inshore | P5/MH10 | MH10 (PCIMP site) | S23.78382 E151.30647 | Mid Harbour[4] | | Adjacent to Pelican Banks seagrass meadows |
| | P2B/WB50 | WB50 (PCIMP site) | S23.70204 E151.13865 | Western Basin | | Outside the mouth of the Calliope River |
| | QE3 | NW50 (PCIMP site) | S23.70204 E151.13865 | The Narrows | | Adjacent to Worthington Island in The Narrows |
| | Not applicable | C3 | S23.76748 E151.16817 | Western Basin | | Adjacent to Western Basin reclamation area |

| | | | | | | |
|---|---|---|---|---|---|---|
| Reference site | Not applicable | RB1 | S24.06795 E151.650883 | Rodds Bay | | Rodds Bay (as part of Baffle Basin) |

Table notes:

- [1] Type refers to the general term used to group the Project EIS water quality monitoring sites
- [2] Water zones in accordance with EPP (Water) Schedule 1 – Plan WQ1312 (EHP 2014c)
- [3] Timing of monitoring in this column to be populated in relation to project staging •
- [4] While CD3 and P5/MH10 were both located in the Mid Harbour Zone they were grouped as 'inshore' and 'offshore', respectively. CD3 was located close to the edge of the Mid Harbour and Outer Harbour Zone boundaries and baseline water quality appeared to show more wind and wave influences. Conversely P5/MH10 was located in a more enclosed coastal location showing a more tidally influenced, well-mixed water column.

**Table WT3 Water quality trigger values**

| Site # | Status | Zone | Parameter | Wet Season triggers (01 Oct to 31 Mar)* | Dry Season triggers (01 Apr to 31 Sep)* | Data requirements |
|---|---|---|---|---|---|---|
| WB50 | Compliance | Western Basin | Turbidity (NTU) / Telemetry | **Internal alert 19.39 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 15.37 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 35.61 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | **External exceedance notification 22.79 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |
| MH10 | Compliance | Mid Harbour | Turbidity (NTU) / Telemetry | **Internal alert 11.45 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 6.73 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 19.23 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – | **External exceedance notification 11.36 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | external notification trigger) | external notification trigger) | |
| MH60 | Compliance | Mid Harbour | Turbidity (NTU) / Telemetry | **Internal alert 5.40 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 7.05 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 9.04 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | **External exceedance notification 10.87 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |
| QE3 | Compliance | The Narrows | Turbidity (NTU) / Telemetry | **Internal alert 27.51 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 9.39 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 59.25 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external alert trigger) | **External exceedance notification 10.70 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external alert trigger) | |
| CD1 | Compliance | Outer Harbour | Turbidity (NTU) / Telemetry | **Internal alert 3.01 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 2.32 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot |
| | | | | **External exceedance notification 4.83 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external | **External exceedance notification 4.30 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | notification trigger) | | |
| CD2 | Compliance | Outer Harbour | Turbidity (NTU) / Telemetry | **Internal alert 3.02 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 3.60 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot |
| | | | | **External exceedance notification 5.04 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | **External exceedance notification 5.76 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |
| CD4 | Compliance | Outer Harbour | Turbidity (NTU) | **Internal alert 2.54 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 1.78 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 4.00 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | **External exceedance notification 3.72 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |
| CD5 | Compliance | Outer Harbour | Turbidity (NTU) | **Internal alert 1.95 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | **Internal alert 1.50 NTU** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | **External exceedance notification 6.45 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external | **External exceedance notification 2.47 NTU** (95th %ile of the 6 hr EWMA applied to background turbidity data – external notification trigger) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | notification trigger) | | |
| C3[a] | Compliance | Western Basin | Turbidity (NTU) | **Internal alert TBD** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Internal alert **TBD** (80th %ile of the 6 hr EWMA applied to background turbidity data – internal alert trigger) | Real time data feed to GPC. De-confounded data + 6 hourly EWMA plot. |
| | | | | External exceedance notification TBD (95th %ile of the 6 hr EWMA applied to background turbidity data – external alert trigger) | External exceedance notification TBD (95th %ile of the 6 hr EWMA applied to background turbidity data – external alert trigger) | |

Table note:

- [a] Denotes specific turbidity monitoring sites that lack historic data, and their water quality monitoring triggers will be developed from 6 months of pre-Project monitoring (refer AEIS Appendix H, Table 8) and using EWMA methodology. Turbidity triggers for C3 will be determined upon receipt of the 6 months of water quality data (prior to Project construction commencing).

**Table WT4 Management light trigger values**

| Species | Meadow type | Monitoring site / meadow # | Management threshold (mol photons m-2 d-1) | Integration time (days)[a] (mol photons m-2 d-1) | Internal notification time (days Rolling average below threshold) | External notification time (days)[b] (mol photons m-2 d-1) | Modify activities (days)[c] (mol photons m-2 d-1) | Time to impact (days)[d] (mol photons m2 d-1) |
|---|---|---|---|---|---|---|---|---|
| *Halophila species** | Deep water transitory | CD1<br>CD2<br>CD4<br>CD5 | 1.5 to 2 (July to Dec only) | 7* | 1 (7)* | 3 (10)* | 5(12)* | 7 (14)* |
| *Zostera muelleri* | Coastal endurin g | PBN<br>PBS<br>WI<br>BS<br>ST<br>WB | 6 | 14 | 1 (14) | 7 (21) | 10 (24) | 14 (28) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Halodule uninervis* | Coastal endurin g | QI<br>ST<br>TS<br>CI | **5** | **14** | 1 (14) | 14 (21) | 18 (28) | 26 **(40)** |

Table notes:

Value in brackets represent the total number of days of light below the threshold incorporating the days of integration for the Rolling average (7 for *Halophila*, 14 for other species).

Values in bold font in table are the values identified in Collier *et al*. (2016)

- [a] Averaging time to describe light history and as first signal to trigger adaptive management plan – Internal Alert Level (Level 1 trigger)
- [b] This is the number of days light can remain below threshold levels before external notification is required. At this stage an inference assessment would begin to compare with reference sites and to determine if BPAR levels are due to dredging or other (natural) cause
- [c] If inference assessment determines BPAR levels are being influenced by Project activities, modification of Project activities would occur by this time
- [d] Time to impact expected – External notification and additional management measures should be implemented before this time
- * For transitory deep water *Halophila* sites management actions are suggested only during July and December when these species and meadows are likely to be present as part of annual growth cycles.

# 13 Appendix B: Modelled scenarios

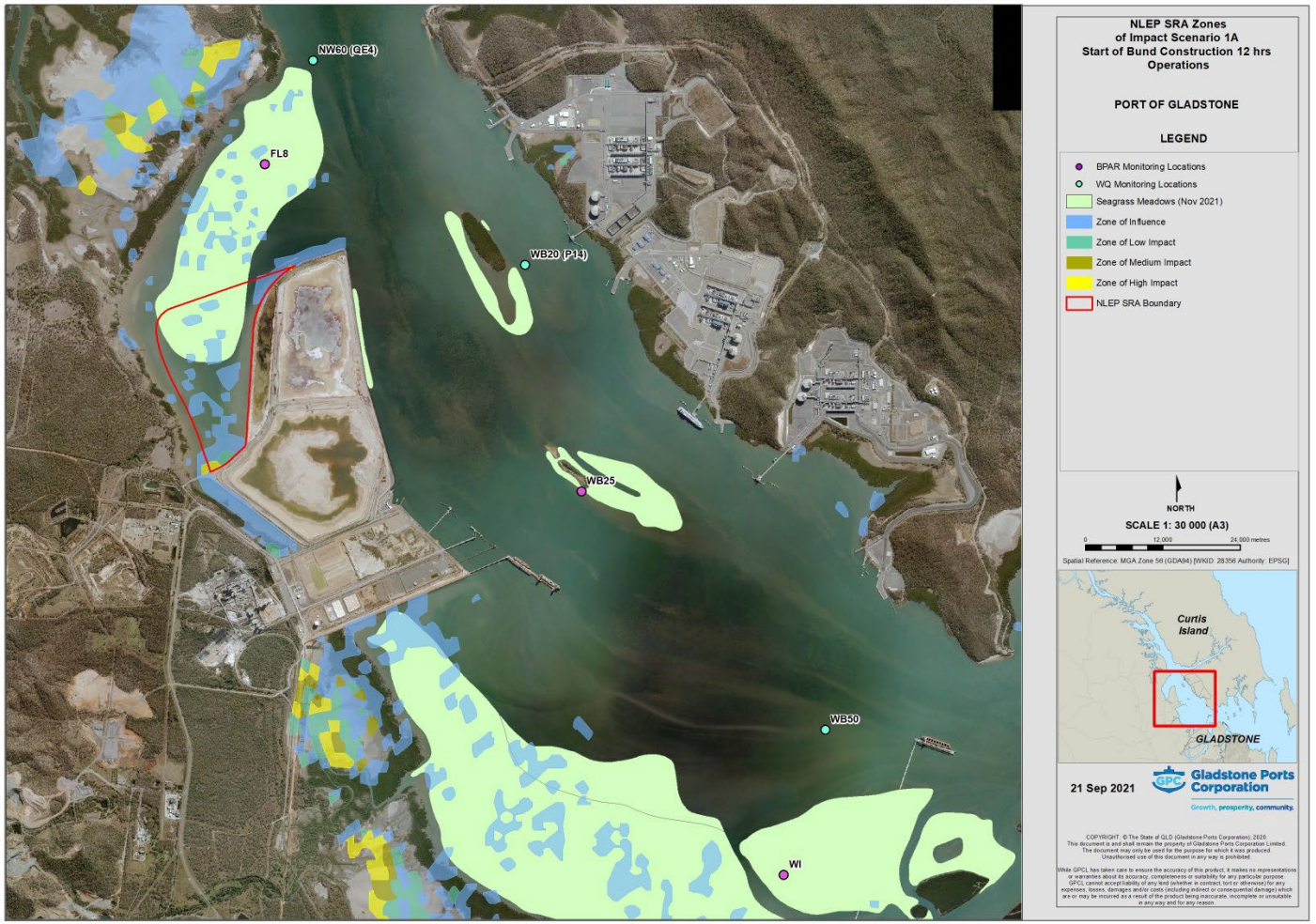


*Figure B1: Scenario 1A, 12 hours construction operations and related ZOIs and Zone of Influence, seagrass meadows (2020 survey) and water quality and BPAR monitoring sites*

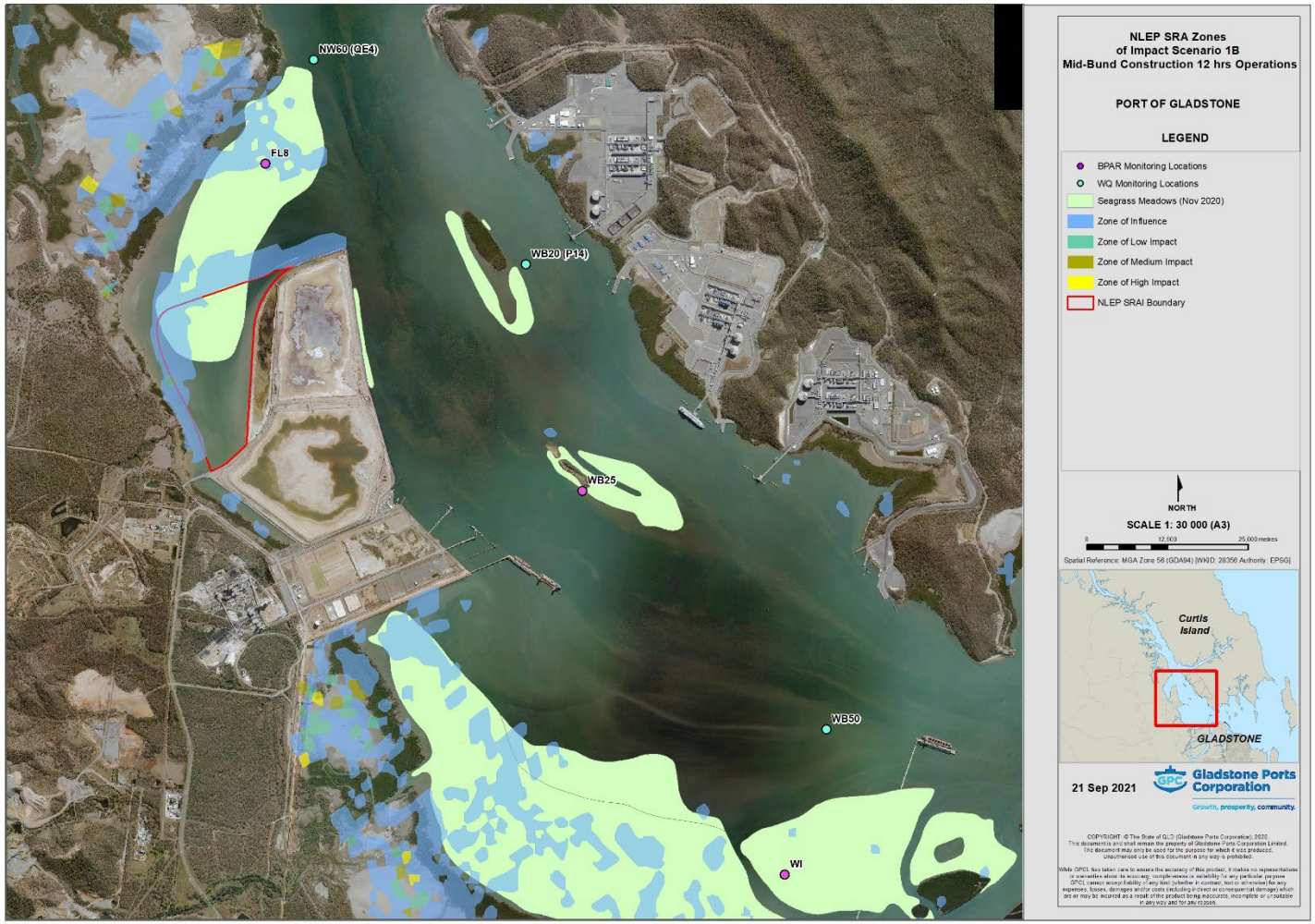


*Figure B2: Scenario 1B, 12 hours construction operations and related ZOIs and Zone of Influence, seagrass meadows (2020 survey) and water quality and BPAR monitoring sites*

# NLEP - Receiving Environment Monitoring Plan

Final Audit Report 2026-06-17

| | |
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## "NLEP - Receiving Environment Monitoring Plan" History

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