Northern Land Expansion Project Southern Reclamation Area

Bund Wall Integrity Monitoring Program

Gladstone Ports Corporation Limited

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Document control record

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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 Benjamin Hayden

Full name (please print) BENJAMIN HAYDEN

Organisation (please print) GLADSTONE PORTS CORPORATION LIMITED

Date 06/11/2024

Executive summary

This bund wall integrity monitoring program applies to the construction and post-construction monitoring of the southern reclamation area (SRA) bund wall for the Northern Land Expansion Project (NLEP). It describes the monitoring of short and long-term integrity of the NLEP SRA bund wall up to 2045 or the commencement of NLEP SRA reclamation works (Phase C), whichever is earlier, in accordance with the design reports and drawings, and technical specifications.

The NLEP SRA bund wall construction forms part of the Gatcombe and Golding Cutting Channel Duplication Project (CD Project) which was subject to an Environmental Impact Statement (EIS) process to meet Commonwealth and State government requirements. Specifically, this monitoring program has been prepared to address the CD Project EPBC Act controlled action condition 14 (b), which requires a program capable of accurately monitoring the integrity of all the Western Basin Expansion (WBE) reclamation area bund walls (now referred to as the NLEP SRA bund wall) and promptly detecting any failure, including appropriate monitoring locations, methods, and frequency, for the period of effect of the approval.

The NLEP SRA bund wall was designed to safely contain dredged material placed within the reclamation area and to reduce the suffusion of fine sediment through the bund walls and minimise migration to the marine waters of Port Curtis. The main hazards were assessed using the Gladstone Ports Corporation Limited's (GPC's) Risk Mapping Matrix in consideration of the design criteria. Based on the risk assessment, potential mitigation actions based on monitoring results were developed to minimise the hazards / risks.

Monitoring of the bund wall is required during the following 3 phases of the bund wall lifecycle:

Phase A - Construction

Phase B - Post-construction, prior to reclamation works

Phase C - Reclamation works, future development and end use.

Monitoring during Phase A is the responsibility of GPC who will undertake surveys and measurements to confirm construction compliance in accordance with the design reports, drawings, specifications, the Project Quality Plan and the Inspection and Test Plans. The certifying registered professional engineer of Queensland (RPEQ) Engineer will review the surveys and measurements to confirm compliance.

Monitoring during Phase B is the responsibility of GPC who will undertake surveys and measurements to confirm post-construction compliance to the design intent until 2045 or the commencement of Phase C, whichever is earlier.

Monitoring during Phase C may be based on the requirements of this plan. However, because the detail of reclamation works, future development and end use are currently unconfirmed, the use of this monitoring plan will require a review, revisions, and updates of this plan to ensure that methodologies and frequencies are appropriate to the changes in hazards / risks. Any amendments to this plan, including monitoring conducted during Phase C will be subject to obtaining written approval from the Minister for the Environment and Water prior to commencement of dredged material placement within the NLEP SRA.

The proposed monitoring is capable of accurately monitoring bund wall integrity and to promptly detect bund wall failure. During Phases A and B, any deterioration of the bund wall is likely to occur gradually and the monitoring plan is designed to enable comparison of measurements at consistent locations over time so that deterioration can be identified at an early point, allowing GPC to plan repairs and respond in a timely manner.

The types of monitoring and measurements that will be undertaken include orthometric / bathymetric surveys by an unmanned aerial vehicle (UAV), measurements of bund design profiles using a global positioning system (GPS) fitted on machinery and equipment (recording of surface heights across the profile, layer thicknesses, and alignment) with data point intervals along the length of the structure, independent check surveys, periodic surveys (at fifteen monitoring points on the bund wall and UAV topographical surveys), real-time water turbidity monitoring with instrumented buoys, and visual inspections with documented

records. Additional surveys will be undertaken following severe weather events or if triggered by visual inspections.

GPC will produce a summary of the monitoring results (copies of all report(s) will be available for regulatory inspection) and review this bund wall integrity monitoring program annually during construction and at least once every 2 years post-construction for a period of 4 years, followed by once every 5 years provided no issues were identified, to ensure the document remains relevant and functional, and to allow for new or changing environmental risks and mitigation actions to be addressed.

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1 Scope

This bund wall integrity monitoring program (BWIMP) applies to the monitoring during construction (to ensure quality and prevent bund wall failure) and post-construction monitoring of the short and long-term integrity of the southern reclamation area (SRA) bund wall for the Northern Land Expansion Project (NLEP) in accordance with the following:

- Design Reports
- Design Drawings
- Civil and Earthworks Specification
- Geofabric Installation Works Specification.

The proposed monitoring procedures within the BWIMP are capable of accurately monitoring bund wall integrity and to promptly detect bund wall failure. Deterioration of the bund wall is likely to occur gradually, and the monitoring is designed to enable comparison of measurements at consistent locations over time so that deterioration can be identified at an early point, allowing Gladstone Ports Corporation Limited (GPC) to plan repairs and respond in a timely manner.

The NLEP SRA bund wall is located within the approved tenure area on the north-western side of the existing Western Basin reclamation area seawall as shown in Figure 1.

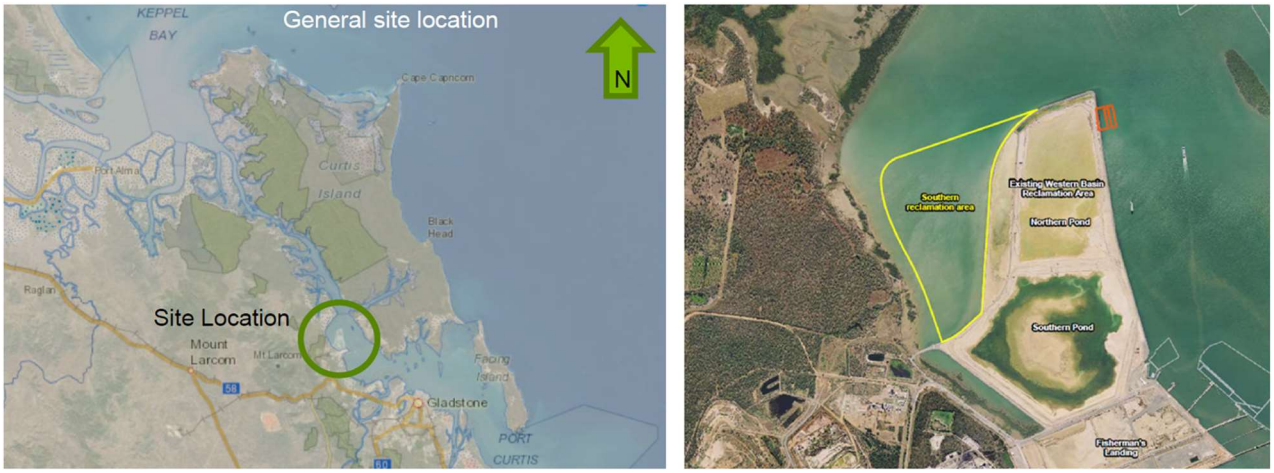

Figure 1 Site location

2 Legislative overview and obligations

The NLEP SRA bund wall construction forms part of the Gatcombe and Golding Cutting Channel Duplication Project (CD Project) which was subject to an Environmental Impact Statement (EIS) process to meet Commonwealth and State government requirements. The following approvals have been obtained for the CD Project:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) controlled action approval obtained on 24 December 2020
- Queensland Coordinator-General's approval for a Coordinated Project under the *State Development and Public Works Organisation Act 1971* on 8 July 2020
- NLEP SRA bund wall construction environment and planning approvals under the *Planning Act 2016* on 13 April 2024, and environmental authority for Environmentally Relevant Activity 16 under the *Environmental Protection Act 1994* on 3 April 2024.

Specifically, this monitoring program has been prepared to address the CD Project EPBC Act controlled action condition 14 (b) which states:

"14 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:

(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."

Project Stage 1 referenced in the above condition includes the construction of the NLEP SRA bund wall.

This BWIMP has been prepared by Chris Bridges and Eugene Lim, both of whom are included as registered professional engineer of Queensland (RPEQ). Both Chris Bridges and Eugene Lim are considered to be suitably qualified to design and implement (via Hold Points and Witness Points reviews) the BWIMP due their professional qualifications, training, skills and experience related to bund wall engineering and can give authoritative independent assessment, advice and analysis on performance relative to the bund wall integrity matters using the relevant protocols, standards, methods and/or literature. In addition, Stephen Cole has assisted in the preparation of the BWIMP to ensure appropriate linkages to the NLEP SRA Receiving Environment Monitoring Program (REMP).

NLEP SRA construction works will not commence until the Minister for the Environment and Water has approved this BWIMP and approved all other NLEP SRA monitoring programs and plans relevant to Project Stage 1 as required under the Project EPBC Act controlled action conditions 14, 15 and 16.

Table 1 provides the BWIMP section and/or REMP section that addresses the relevant Project EPBC Act controlled action approval conditions compliance.

Table 1 BWIMP section and/or REMP section that addresses the relevant Project EPBC Act controlled action conditions compliance

Ref	Cond. no.	EPBC Act controlled action condition requirement relevant to the BWIMP	BWIMP and/or REMP reference	How the BWIMP and/or REMP addresses condition requirements and commitments made in this program to address condition requirements
1	14 (b)	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: (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;	This BWIMP and the NLEP SRA REMP	This BWIMP and the NLEP SRA REMP.
2	17 (a)	All monitoring plans and programs required under conditions 14, 15 and 16 must: (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	BWIMP Section 2	The following summarises how the condition 17 (a) requirements have been addressed: ■ The BWIMP has been prepared by Chris Bridges and Eugene Lim, both of whom are included as RPEQ ■ A RPEQ will implement (via Hold Points and Witness Points reviews) the monitoring program during and post bund wall construction.
3	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: ■ GPC has submitted the BWIMP to Department of Climate Change, Energy, the Environment and Water (DCCEEW) within the timeframe required by this condition.
4	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	BWIMP Section 7.5	The following summarises how the condition 17 (c) requirements have been addressed: ■ Submission to the DCCEEW of the findings and outcomes of implementing the BWIMP will occur at the following frequencies: – Construction (Phase A) – Annually (reporting will occur as part of the Project EPBC Act controlled action approval annual compliance reporting) – Post-construction (Phase B) – Once every 2 years for a period of 4 years, followed by once every 5 years provided no issues were identified (reporting will occur as part of the Project EPBC Act controlled action approval annual compliance reporting). ■ If requested by the DCCEEW and/or other regulators, all monitoring data and information related to the BWIMP will be submitted within 30 business days of the request, or within a timeframe agreed by the relevant regulator in writing ■ Submitting the completion BWIMP report within 6 months following the completion of the post-construction monitoring program.
5	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)	BWIMP Section 7.5	The following summarises how the condition 17 (d) requirements have been addressed: ■ Commitment to submit the completion BWIMP report within 6 months following the completion of the post-construction monitoring program.

Ref	Cond. no.	EPBC Act controlled action condition requirement relevant to the BWIMP	BWIMP and/or REMP reference	How the BWIMP and/or REMP addresses condition requirements and commitments made in this program to address condition requirements
6	17 (e)	(e) inform relevant management plans required by this approval to adaptively manage and mitigate impacts to protected matters	BWIMP Section 7.4.3 and NLEP SRA REMP Section 9.2	The following summarises how the condition 17 (e) requirements have been addressed: ■ An adaptive management process has been designed for turbidity exponentially weighted moving average (EWMA) and benthic photosynthetically active radiation (BPAR) within the NLEP SRA REMP. In the instance any of these parameters exceed internal or external trigger levels for certain durations, steps will be undertaken to adaptively manage elevations and prevent any impacts on protected matters from the NLEP SRA construction activities ■ The trigger level elevations will be investigated at all monitoring sites (concern and control), however adaptive management actions will only be implemented for elevations at concern sites if they are driven by construction activities ■ NLEP SRA REMP links to the BWIMP include EWMA turbidity internal alert levels and adaptive management levels, where communication and investigation with the NLEP SRA bund wall construction site will occur to determine if the source of the turbidity level exceedance is caused from bund wall construction and/or bund wall integrity impacts, and if found to be the source, implement appropriate adaptive management measures contained in the NLEP SRA REMP.
7	17 (f)	(f) be used to inform the development and delivery of environmental offsets for protected matters	Not applicable to the BWIMP NLEP SRA REMP Section 8.3.8 (seagrass and macroalgae), Section 8.4.2 (Water mouse), Section 8.9 (hydrodynamic changes), and Section 8.10.2.3 (fine-grained sediment)	The following summarises how the condition 17 (f) requirements have been addressed: ■ The findings of the NLEP SRA seagrass and macroalgae; Water mouse; hydrodynamic changes; and fine-grained sediment validation monitoring programs will be incorporated into the assessment and reporting to determine if the NLEP SRA has resulted in a significant residual impact to protected matters (refer NLEP SRA Project Stage 1 Offset Strategy for further details) ■ The updated significant residual matter assessment may trigger an amendment of the NLEP SRA Project Stage 1 Offset Strategy which will be resubmitted to the Minister for the Environment and Water for approval.
8	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 16. The approval holder must implement each approved monitoring program and plan as relevant to that Project Stage	BWIMP Section 2	The following summarises how the condition 18 requirements have been addressed: ■ GPC will not commence NLEP SRA works until the Minister for the Environment and Water has approved the BWIMP and approved all other NLEP SRA monitoring programs and plans relevant to Project Stage 1 as required under the Project EPBC Act controlled action conditions 14, 15 and 16 ■ GPC will implement the BWIMP as approved by the Minister for the Environment and Water.
9	62	The approval holder must maintain accurate and complete compliance records.	BWIMP Section 7.5	The following summarises how the condition 62 requirements have been addressed: ■ GPC will comply with this condition as specified in Section 7.5.

3 Definition of terms and abbreviations

Table 2 provides the definition of terms and abbreviations that apply in this BWIMP.

Table 2 Definition of terms and abbreviations

Term	Definition
AS	Australian Standard
ASTM	American Society for Testing and Materials
BPAR	benthic photosynthetically active radiation
BUF	barge unloading facility
Bund	Refers to the seawalls which will form the perimeter of the southern western basin expansion reclamation area, formed by placement and compaction of fill material. Subsequent filling with dredge spoil material will be carried out behind the bund
BWIMP	bund wall integrity monitoring program
CD Project	Gatcombe and Golding Cutting Channel Duplication Project
Certifying RPEQ Engineer	Suitably qualified person who has professional qualifications, training, skills and/or experience related to the nominated subject matter and can give authoritative independent assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods and/or literature. Person who is registered with the Board of Professional Engineers of Queensland.
CH	chainage
Civil and Earthworks	Scope of works as detailed in the Civil and Earthworks Specification that includes the following elements: ■ Filling to form the reclamation outer bund wall ■ Rip rap rock protection and reshaping rock protection layers ■ The bund wearing course ■ Construction monitoring ■ Tie-in to the existing Western Basin Reclamation Area bund (excluding geotextile)
Civil and Earthworks Specification	Technical Specification for the on-site civil and earthworks for the southern reclamation outer bund wall for the NLEP SRA Project. The scope of works contained in this Specification is for the design (where nominated), supply, delivery to site, installation, and commissioning of civil works for the NLEP SRA outer bund wall. This document is the main specification pertaining to the site.
CPTu	Piezocone Penetration Test (i.e. Cone Penetration Test with pore water pressure measurement)
Cth	Commonwealth
c_v	coefficient of consolidation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EN ISO	European Standard International Standards Organisation
EWMA	exponentially weighted moving average

Term	Definition
FoS	factor of safety
Geofabric Contractor	The selected contractor that will undertake the Geofabric Installation Works
Geofabric Failure	Excessive migration of fine sediments through the Bund into the marine waters of Port Curtis causing a visible change in water turbidity beyond natural background levels
Geofabric Installation Works	Scope of works as detailed in the Geofabric Installation Works Specification
Geophysical Investigation	Refers to the methods used to study the physical properties of earth materials.
GPC	Gladstone Ports Corporation Limited
GPS	global positioning system
ITP	Inspection and Test Plans
ISO	International Standards Organisation
kg	kilograms
M	modulus
m	metre
mm	millimetres
mS/cm	millisiemens per centimetre
mol/m^2/day	moles of photons per square metre per day
MP	Monitoring Point
NLEP	Northern Land Expansion Project
NTU	nephelometric turbidity unit
Paleochannel	An infilled former river channel
Pleistocene	The geological epoch from 2.6 million BCE to 11,700 BCE
PQP	Project Quality Plan
PVC	polyvinyl chloride
Q2b	coarse-grained layer of Pleistocene
R1	residual material
REMP	Receiving Environment Monitoring Program
RPEQ	registered professional engineer of Queensland
Settlement Outside Design Criteria	Settlement of the bund surfaces exceeds the design criteria (300 millimetres (mm)) and timely rectification is required
Soft	Soil consistency, as described in AS1726:2017
Spoil	Comprising surplus material or any materials, which cannot be used in the Civil and Earthworks for any reason
SPT	Standard Penetration Test
SRA	Southern Reclamation Area
Stability failure	Non-compliant factor of safety (FoS) of the Bund against the various modes of instability as identified in the bund Design Criteria (509991-2000-REP-JJ-2000)
UAV	unmanned aerial vehicle
WBE	Western Basin Expansion

4 Reference information

The following information has been referenced in this BWIMP.

- Project-specific documentation (refer Table 3)
- Standards (refer Table 4).

Table 3 Project-specific documentation

Item	Title
1	Southern Reclamation Bund Wall Design Criteria (refer GPC website for a copy of this report)
2	Southern Reclamation Area – Design Report (refer GPC website for a copy of this report)
3	Southern Reclamation Area – Geofabric Installation Works Specification (this document is classified as 'commercial-in-confidence')
4	Southern Reclamation Area – Civil and Earthworks Specification (this document is classified as 'commercial-in-confidence')
5	Southern Reclamation Area and BUF – Geotechnical Interpretive Report (this document is classified as 'commercial-in-confidence')

Table 4 Standards

Item	Standard	Title
1	AS 1726	Geotechnical site investigations
2	ASTM D5101	Standard Test Method for Measuring the Filtration Compatibility of Soil-Geotextile Systems
3	ISO 10772	Geotextiles — Test method for the determination of the filtration behaviour of geotextiles under turbulent water flow conditions

5 Risk and mitigation actions

The NLEP SRA bund wall was designed to safely contain dredged material placed within the reclamation area and to reduce the suffusion of fine sediment through the bund walls and minimise its migration to the marine waters of Port Curtis. The main hazards that could affect the integrity of the bund wall during construction and post-construction until 2045 or the commencement of reclamation works, whichever is earlier, were assessed using GPC's Risk Mapping Matrix (refer Appendix A). The findings of the risk assessment are shown in Table 5, where mitigated risk ratings of hazards / risks are presented followed by the associated likelihoods and consequences in brackets.

Potential mitigation actions to minimise the hazards / risks are also presented in Table 5 together with references to the relevant technical sections of this document. Mitigation actions which have already been completed e.g. field investigations and design are listed but do not form part of this BWIMP. Mitigation actions relevant to this BWIMP include observations and measurements that are focused on assessing the construction and post-construction performance and condition of the bund wall against the potential risks presented in Table 5. The relationship between these risks and the monitoring actions are described in Section 7 and summarised in Table 10.

Where a Contractor is specified an action and/or responsibility within Table 5, GPC will ensure the relevant commitments are fulfilled.

Table 5 Identified hazards and mitigation actions

Risk ID	Identified hazard	Resulting consequence	Mitigation actions	Mitigated Risk Rating	Report Section
1	Stability failure of the Bund	▪ Local bund stability failure requiring remediation. ▪ Release of reclamation material into the marine environment and associated impact costs.	▪ Undertake adequate ground investigation work [1] ▪ Design the bund wall with an adequate factor of safety against stability failure [1] ▪ Ensure that construction is carried out in accordance with the design and recognised industry standards [2] ▪ During construction, undertake surface measurement surveys using machinery and equipment fitted with global positioning system (GPS) to detect movements indicative of failure [2] ▪ Monitor the outer bund wall to check for movements indicative of failure. Implement remediation where required. [2, 3]	Medium (Possible x Significant)	6.2, 6.3
2	Excessive migration of fine sediments through the bund into the marine waters of Port Curtis due to the Geofabric Failure	▪ Release of fine sediment into the marine environment and associated impact costs ▪ Increase in turbidity in the marine environment and associated impacts on sensitive receptors (e.g. seagrass, marine fauna habitat) ▪ Remediation and environmental costs ▪ Negative community reaction.	▪ Ensure that an adequate geotextile filtration system is specified to reduce the suffusion of fine material through the bund wall and minimise its migration to the marine waters [1] ▪ Prior to ordering the geotextile filtration system, GPC and/or the Geofabric Contractor will demonstrate that the proposed product conforms to the Geofabric Installation Works Specification and relevant drawings, for review and approval, including adequate performance for the following technical aspects. [2] – Filtration in accordance with EN ISO 10772:2012 – Anti-clogging in accordance with ASTM D5101-2012 – Geotextile and geocomposite material properties to mitigate the risk of damage during placement, construction of the overlying rock reshaping berm, and during its design life. ▪ Prior to construction, GPC and/or the Geofabric Contractor will undertake site trials to demonstrate that the surface preparation for the proposed geotextile filtration system suits the installation methodology and does not cause damage to it [2] ▪ Ensure that the geotextile filtration system is placed in accordance with the agreed outcomes of the site trials, the Geofabric Installation Works Specification, relevant drawings, and the manufacturer's recommendations, including adequate overlaps and anchorage [2] ▪ Ensure that reshaping rock protection layer is promptly implemented onto the geotextile filtration system to secure the geotextile in accordance with design requirements and manufacturers recommendations [2] ▪ Visual inspections of turbidity in the water (beyond natural background levels) [2, 3] ▪ Implement the NLEP SRA REMP which includes real-time water quality monitoring during construction and every month for the initial two months post-construction [2, 3] ▪ Visual inspections and survey of the external rip rap and internal rock protection to monitor for movements and loss of material. Implement remediation where required. [3]	Medium (Possible x Significant)	6.4
3	Settlement failure due to long-term consolidation and creep settlement of the substrata	Deterioration of the wearing course and subgrade, and slumping of the revetment, requiring remediation	▪ Undertake adequate ground investigation work [1] ▪ Design the bund wall to limit post-construction settlement over the design life [1] ▪ Ensure that the construction is carried out in accordance with the design and recognised industry standards [2] ▪ During construction, undertake surface measurement surveys using machinery and equipment fitted with GPS to detect movements indicative of failure [2] ▪ Monitor surface of bund for depressions. Implement remediation where required. [3]	Low (Possible x Minor)	6.5
4	Bund constructed over paleochannels filled with soft material, causing loss of sediment through the bund structure and into the material beneath the structure daylighting downstream	▪ Release of fine sediment into the marine environment and associated impact costs ▪ Poor marine water quality leading to issues with negative impacts ▪ Remediation and environmental costs.	▪ Carry out geophysical investigations focussed on identifying paleochannels within the bund footprint [1] ▪ Undertake probing in advance of filling to reduce the risk of paleochannels not being identified [2] ▪ Compress the soft materials in the paleochannels by infilling with Type 1 Core material until the stiff Pleistocene deposits, Unit Q2 is reached. [2]	Low (Rare x Significant)	6.4, 6.6

Notes:

1. *This mitigation action has been completed.*
2. *Performed during construction by GPC or the Geofabric Contractor in accordance with the drawings, specifications, Project Quality Plan and Inspection and Test Plans, and in conjunction with reviews from the Certifying RPEQ Engineer.*
3. *Performed post-construction by GPC who will undertake surveys and measurements to confirm compliance to the design intent until 2045 or the commencement of reclamation works, whichever is earlier.*

6 Design criteria

This section describes the design criteria for the design elements associated with the main hazards / risks presented in Section 5. It outlines the key performance criteria that must be achieved to mitigate risks, through the application of the monitoring plan presented in Section 7.

6.1 Design life

The design life is defined as the period over which the NLEP SRA must safely fulfil the intended function without major refurbishment or significant maintenance. A design life of 50 years will apply to the bunds (refer to the Design Criteria Report).

6.2 Geotechnical model and design parameters

The geotechnical model and design parameters used in the design were based on the ground investigation works in these areas, laboratory testing on samples recovered from boreholes, interpretation of Piezocone Penetration Test (CPTu) probes and geophysical investigations within or relatively close to the locations of the bund.

The site investigations and their interpretation are document in the Geotechnical Interpretive Report which presents the following information:

- A summary of the available ground investigation results
- An assessment of the subsurface conditions along the proposed NLEP SRA bund alignment
- Geotechnical models for the geotechnical units encountered including groundwater
- An assessment of the design parameters for the geotechnical units.

6.3 Geotechnical stability design criteria

The design philosophy for geotechnical stability of the bund wall is documented in the Design Criteria Report Ref. 509991-2000-REP-JJ-2000. A global factor of safety approach was adopted in consideration of the following modes of instability. The acceptance criterion for each case is documented in the report.

- Short term static case – during construction
- Short term static case – with placement of dredge spoil
- Long term static case – with placement of dredge spoil
- Rapid drawdown – high and low water level combination with dredge spoil in place
- Uplift of geotextile case.

Detailed design of the bund wall is documented in the Design Report. Slope stability analyses were carried out for numerous sections of the bund wall to assess the factor of safety (FoS) against the various modes of instability.

Two sets of analyses were carried out, the first considering the soil shear parameters in the Geotechnical Interpretive Report and a second set using lower bound estimates of shear strength to reflect the variable nature of ground conditions at the site.

From the analyses set using the Geotechnical Interpretive Report design parameters, it was found that the Bund wall meets the acceptance criteria. From the analyses set using lower bound estimates of shear strength, it was found that the Bund wall in the paleochannel areas (refer Section 6.6) returned FoS values below the minimum FoS acceptance criterion, albeit still above 1.0.

The monitoring plan (refer Section 7) was designed to provide periodic checks of surface levels and trigger actions to maintain the geotechnical stability of the bund. To mitigate the lower FoS in Paleochannel areas, increased monitoring of the bund wall in these areas has been incorporated.

6.4 Filtration of fine sediments

The filtration design is documented in the Design Criteria Report and includes a seepage analysis using proprietary software Geoslope SEEP/W (by Seequent) to assess the seepage paths across the Bund and determine where the most critical flow will occur.

The following seepage paths were analysed.

- Seepage through the bund structure and daylighting on the downstream face – Case 1
- Seepage through the bund structure and into the material beneath the structure daylighting downstream – Case 2
- Seepage primarily underneath the bund structure – Case 3.

The analyses returned the following results:

- Case 1 is the most probable seepage path. As such, a suitable geofabric will be installed on the reclamation side of the bund structure to act as a filtration system
- Case 2 can be mitigated to a rare likelihood if the following measures are undertaken:
  - Compress the underlying soft materials by infilling with core material to the depth of the stiff Pleistocene deposits
  - Undertake probing in advance of filling to reduce the risk of paleochannels not being identified.
- Case 3 is not probable due to the stiff fine-grained Pleistocene deposits, which was ubiquitously found within the NLEP SRA.

As part of the bund wall design, a suitable geotextile filtration system has been specified to ensure that any release of fine sediment to the tidal waters via Case 1 is minimised in accordance with the State Government development approval conditions.

The requirements for the geotextile filtration system are specified in the Geofabric Installation Works Specification, and includes requirements for the following aspects:

- Material properties
- Filtration performance
- Anti-clogging
- Surface preparation including placement trials
- Installation requirements including:
  - Overlaps
  - Anchorage
  - Placement of overlying rock reshaping berm
- Conformance testing
- Ordering, delivery, and storage
- Protection from ultraviolet, wave action and other environmental effects
- Certification.

The monitoring plan (refer Section 7) was designed to provide periodic visual inspections of turbidity in the waters and real-time monitoring of the turbidity using an instrumented buoy in accordance with the requirements of the NLEP SRA REMP. Trigger actions are provided to investigate the source of any elevated turbidity levels so that remediation works can be applied, where required.

6.5 Settlement design criteria

The design philosophy for settlement of the bund wall is documented in the Design Criteria Report. The design was undertaken to limit the post-construction settlement (deformation) to less than 300 millimetres (mm) over the design life.

Settlement was assessed using proprietary software Settle3 (by Rocscience) based on a combination of laboratory consolidation data, CPTu data, and Standard Penetration Test (SPT) data from the ground investigation works. Ground conditions at the site are variable. To address this variability, the following scenarios were considered to assess possible upper bound settlement magnitudes under different combinations of soil parameters, drainage conditions and loading that may be present along the Bund alignment:

- Case 1: An analysis using the lower bound constrained modulus (M) of the in-situ soils with a reasonably conservative upper-bound coefficient of consolidation (c_v) and one-way drainage. In the context of this assessment upper-bound refers to a high numerical value of c_v. This scenario allows for the presence of more compressible soils and shorter time for consolidation to occur
- Case 2: Reasonably conservative values of constrained modulus (M), a lower bound coefficient of consolidation (c_v) and one-way drainage. In the context of this assessment lower-bound refers to a low numerical value of c_v. This scenario allows for less settlement to occur during the construction period (i.e., increased settlement post construction)
- Case 3: Similar input to Case 1 but allowing for 1 metre (m) increase in bund height at end of construction phase (top up for settlements occurring and allowing for future modifications / maintenance to the Bund and construction error). This will increase the stress applied on the in-situ soils and subsequently increase the magnitude of settlement
- Case 4: An analysis using the lower bound values of constrained modulus (M) and an upper bound coefficient of consolidation (c_v) with two-way drainage (i.e. allowing for presence of a coarse-grained layer of Pleistocene (Q2b) or residual material (R1) at depth that may accelerate consolidation settlements). This scenario allows for maximum primary and secondary consolidation settlement to occur over the design life
- Case 5: A lower bound constrained modulus (M) with a lower bound coefficient of consolidation (c_v) and one-way drainage. This scenario allows for increased magnitude of settlement to occur post construction during the 50-year design life.

From the analyses, it was found that the anticipated post-construction settlements are likely to be in the range of 200 mm to 300 mm over the design life for all cases, except for Case 4 where estimated settlement is up to 350 mm. Since settlement is expected to occur gradually, the monitoring should ensure that excessive settlement is identified and rectified as early as practicable. The monitoring plan (refer Section 7) was designed to provide periodic checks of surface levels and trigger actions to maintain the design minimum crest level as deformation occurs.

6.6 Paleochannel affected areas

The extent and morphology of paleochannels in the vicinity of the bund is described in Geotechnical Interpretive Report. Based on results of the site investigation the paleochannel morphology suggests that the bund wall encroaches paleochannel affected areas at the following locations:

- CH-2215 to CH-2305 (Length = 90 m)
- CH-2410 to CH-2545 (Length = 135 m).

At these locations the thickness of very soft and soft soils is significantly greater than in surrounding areas and so the depth to suitable founding layers is increased. Heterogenous soil properties and soil profiles are anticipated at these locations.

During construction, GPC will implement a program of probing on 25 m chainage intervals in advance of filling, to establish the thickness of very soft and soft soils present prior to filling and to detect and identify the paleochannel affected areas. GPC will submit their probe testing methodology to determine the thickness of very soft and soft soils and the extent of the paleochannels with sound geotechnical basis to the Certifying RPEQ Engineer for review and approval. Upon encounter of paleochannels, GPC will construct a trial embankment which will be witnessed and approved by the Certifying RPEQ Engineer.

To mitigate settlements above 300 mm in the paleochannel affected areas, the initial fill will consist of a Rip Rap type crushed rock (Type 1 Fill) which will be used to consolidate (and displace) the very soft and soft soils. Type 1 Fill material will comply with the following properties:

- A sound igneous, metamorphic, or sedimentary rock or a combination of these rock groups and that will not disintegrate in water or when exposed to the weather. Strength of rock clasts will be classified as Medium Strength or higher, as defined in AS1726:2017 – Table 19 Rock Material Strength Classification
- The material will not contain more than 50% by mass of stone particles with a length to thickness (L/d) ratio greater than 2, and 95% of the particles will have a L/d ratio less than 3. The dimension L is defined as the greatest dimension of the rock particle, while the dimension d is defined as the minimum width between parallel planes through which the particle could pass.
- Grading requirements for the Type 1 Fill material will comply with Table 2 of BS EN 13383-1:2013 for category LMA15/300 as presented in Table 6.

Table 6 Grading acceptance criteria for Type 1 Fill material

Characteristic **Category A Light Standard Grading**	**Target % Passing** **Category LMA 15/300**
Average mass 45 kilograms (kg) to 135 kg	
Equivalent size 250 mm to 370 mm	
550 mm (450 kg)	97 to 100
480 mm (300 kg)	70 to 100
170 mm (15 kg)	0 to 10
100 mm (3 kg)	0 to 2
Notes: *Refer to BS EN 13383-1:2013, 4.2.2, Table 2 and Annex B.2.3, BS EN 13383-2:2019, 4.5 and 4.6*	

GPC will place the Type 1 Fill material with plant / equipment capable of pushing rock through, the soft Holocene sediment down to the top of the pre-Holocene / Pleistocene layer. GPC will compact the Type 1 Fill material in accordance with the mechanical interlock compaction method until no further reduction of the layer surface height occurs.

While use of the Type 1 Fill material to consolidate (and displace) the very soft and soft soils will reduce the total magnitude of settlement, notwithstanding, it is likely that maintenance (topping) up the Bunds will be required to maintain compliance with the EIS and minimise Settlement Outside Design Criteria. As such, effective monitoring during construction is required and may indicate that more favourable settlement performance of the Bunds than the worst-case estimates.

The monitoring program will minimise Settlement Outside Design Criteria and ensure that the Berm height is maintained at the required levels such that the minimum freeboard for dredge spoil storage is present, as required by the EIS (and so storage capacity is not affected), and to avoid increased frequency of overtopping of the bund wall.

7 Monitoring plan

Monitoring of the bund wall will be undertaken during the following 3 phases of the bund wall lifecycle:

Phase A - Construction

Phase B - Post-construction, prior to reclamation works

Phase C - Reclamation works, future development and end use.

During Phase A, GPC will undertake surface measurement surveys using GPS to confirm construction compliance in accordance with the design reports, drawings, specifications, the Project Quality Plan (PQP) and the Inspection and Test Plans. The certifying RPEQ Engineer will review the surveys and measurements to confirm compliance.

During Phase B, GPC will undertake surveys and measurements to confirm post-construction compliance to the design intent until 2045 or the commencement of reclamation works (Phase C), whichever is earlier.

This monitoring plan, developed prior to construction, is intended for monitoring of the bund wall during Phase A and Phase B.

Where a Contractor is specified an action and/or responsibility within this section, GPC will ensure the relevant commitments are fulfilled.

During Phase C, GPC will monitor based on the requirements of this plan. However, because the detail of reclamation works, future development and end use are currently unconfirmed, the requirements of this monitoring plan will be reviewed, and if required revised and updated to ensure that methodologies and frequencies are appropriate to the changes in hazards / risks.

The Phase C BWIMP will be submitted to the Minister for the Environment and Water for written approval in accordance with the Project EPBC Act controlled action condition 71. Phase C of the NLEP SRA (i.e. reclamation works, future development and end use) will not commence until the Minister for the Environment and Water has approved the Phase C BWIMP.

7.1 Purpose and objectives

Deterioration of the bund wall is likely to occur gradually due to the movement of rock or changes in the geotechnical conditions beneath the structure. This monitoring plan was developed with the purpose of identifying and mitigating any defects and resulting hazards during Phase A and Phase B. The proposed monitoring is capable of accurately monitoring bund wall integrity and to promptly detect bund wall failure. The monitoring requirements enable comparison of key measurements at consistent locations over time so that deterioration can be identified at an early point, allowing GPC to plan repairs and respond in a timely manner.

This monitoring plan is designed to:

- Conduct the monitoring in a consistent manner, which meets the requirements of the appropriate environmental approvals, design reports and drawings, specifications, and any industry standards
- Identify areas of potential concern, which may require maintenance or design adaptations
- Establish a spatial dataset which allows the identification of trends across a range of parameters to inform discussions with regulators and provide supporting information for ongoing performance.

7.2 Phase A – Construction

7.2.1 Quality monitoring

Civil and earthworks

GPC will undertake quality monitoring and remediation in accordance with the requirements of the Civil and Earthworks Specification. The key monitoring requirements are summarised as follows:

- GPC will prepare a PQP which covers all the Civil and Earthworks (both on site and off site) and at a minimum will include the following.
  - GPC's organisation and management responsibilities
  - Inspection and Test Plans (ITPs)
  - Hold Points and Witness Points
  - Planned audits
  - A schedule and program of all quality documentation to be prepared during the progress of the Civil and Earthworks.
- GPC will submit the PQP to the Certifying RPEQ Engineer for approval prior to the start of the Civil and Earthworks or whenever changes are made to the PQP.
- During construction, GPC will undertake quality audits in accordance with the approved PQP. GPC will set up an appropriate regime of inspection and testing for the Civil and Earthworks in ITPs to cover all necessary activities and components.
- ITPs will include for the documentation and recording of sufficient test and inspections to ensure that the Civil and Earthworks comply with the design and specifications, and will include the following information:
  - Who carries out the inspection or test
  - The method of inspection or test
  - The specified acceptance criteria
  - The form of record of results
  - The frequency and timing of the tests
  - Details of what is to be inspected
  - Details of Witness Points for the Civil and Earthworks
  - Details of Hold Points for the Civil and Earthworks
  - Details of audits to be carried out by GPC's quality assurance team.
- ITPs will provide for testing at least at the frequencies specified in the Civil and Earthworks Specification. GPC will perform any additional tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the Civil and Earthworks
- GPC will record the results of process control tests. GPC will record the location of the test on suitable sketches. All records will be properly and clearly indexed and filed. Updated copies of GPC's file index will be copied to the Certifying RPEQ Engineer. The record system will contain at least the following:
  - Records of ITPs
  - Records of non-conformances
  - Records of corrective and preventive actions
  - Records of audits

- Original records of certification and approvals by statutory authorities
- Certificates and warranties of manufacturers and suppliers
- Material quality records and analyses
- Records of surveys.

- The Certifying RPEQ Engineer will inspect the Civil and Earthworks at the Hold Points and Witness Points. The Hold Points and Witness Points for the Civil and Earthworks are presented in Table 7 and Table 8, respectively.

Table 7 Hold points for the Civil and Earthworks

No.	Title	Section [1]	Description
1	Paleochannel affected areas	3.4	Upon initial identification / encounter of paleochannel affected area, GPC will submit their methodology to determine the thickness of very soft and soft soils and the extent of the paleochannels to the Certifying RPEQ Engineer for review and approval.
2	Project Quality Plan	5.1.1	GPC will prepare a PQP for the Works and submit it to the Certifying RPEQ Engineer.
3	Non-conformance Report	5.1.5	All non-conforming Works detected by GPC's Quality System will be reported to the Certifying RPEQ Engineer using a Non-conformance Report.
4	Unsuitable Material	7.6	Unsuitable Material or potentially Unsuitable Material encountered on the site, will be notified to the Certifying RPEQ Engineer.
5	Construction of site trials	7.8.4	Approval of the site trials and/or reporting.
6	Fill material and rip rap and rock filter material properties	7.13, 8.5	The following information will be supplied to the Certifying RPEQ Engineer for approval of the fill materials. ■ Location of source from which the material is obtained. ■ A summary of test results indicating that the material complies with all the requirements specified herein and endorsed by a laboratory that is accredited by the National Association of Testing Authorities for the performance of such tests.

Note:

1. *Relevant sections in the Civil and Earthworks Specification*

Table 8 Witness points for the Civil and Earthworks

No.	Title	Section [1]	Description
1	Paleochannel affected areas	3.4	Upon initial encounter of paleochannels, GPC will construct a trial embankment which must be witnessed and approved by the Certifying RPEQ Engineer (or alternate nominated person).
2	Non-conformance Report	5.1.5	Corrective action of a Non-conformance Report will be witnessed and approved by the Certifying RPEQ Engineer.
3	Mechanical interlock method of compaction	7.11.2	Compaction of the Type 1 and Type 2 material will be demonstrated by proof rolling to the Certifying RPEQ Engineer.
4	Fill	7.11.1	Density compliance test of fill will be witnessed by the Certifying RPEQ Engineer.
5	Northern Tie-In	n/a	Design conformance will be witnessed by the Certifying RPEQ Engineer.
6	Southern Tie-In	n/a	Design conformance will be witnessed by the Certifying RPEQ Engineer.

Note:

1. *Relevant sections in the Civil and Earthworks Specification*

Geofabric installation works

The Geofabric Contractor will undertake quality monitoring and remediation in accordance with the requirements of the Geofabric Installation Works Specification. The key monitoring requirements are summarised as follows:

- The Geofabric Contractor will plan, establish, implement, and maintain a quality management system for the relevant construction works, to meet the requirements of AS/NZS ISO 9001:2016.
- The Geofabric Contractor will prepare a PQP that covers all the Geofabric Installation Works and will include the following:
  - Geofabric Contractor's organisation and management responsibilities
  - ITPs
  - Hold Points and Witness Points
  - Planned audits
  - A schedule and program of all quality documentation to be prepared during the progress of the Geofabric Installation Works.
- The Geofabric Contractor will submit the PQP to the Certifying RPEQ Engineer for approval prior to the start of the Geofabric Installation Works or whenever changes are made to the PQP.
- During Construction, the Geofabric Contractor will undertake quality audits in accordance with the approved PQP. The Geofabric Contractor will set up an appropriate regime of inspection and testing of the Geofabric Installation Works in ITPs to cover all necessary activities and components.
- ITPs will include for the documentation and recording of sufficient test and inspections to ensure that the construction works comply with the design and specifications, and will include the following information:
  - Who carries out the inspection or test
  - The method of inspection or test
  - The specified acceptance criteria
  - The form of record of results
  - The frequency and timing of the tests
  - Details of what is to be inspected
  - Details of Witness Points for the Geofabric Installation Works
  - Details of Hold Points for the Geofabric Installation Works
  - Details of audits to be carried out by the Geofabric Contractor's quality assurance team.
- ITPs will provide for testing at least at the frequencies specified in the Geofabric Installation Works Specification. The Geofabric Contractor will perform any additional tests of the type and frequency necessary to adequately control the materials and processes used in the construction of the Geofabric Installation Works.
- The Geofabric Contractor will record the results of process control tests and will record the location of the test on suitable sketches. All records will be properly and clearly indexed and filed. Updated copies of the Geofabric Contractor's file index will be copied to the Certifying RPEQ Engineer. The record system will contain at least the following:
  - Records of ITPs
  - Records of non-conformances

- Records of corrective and preventive actions
- Records of audits
- Original records of certification and approvals by statutory authorities
- Certificates and warranties of manufacturers and suppliers
- Material quality records and analyses
- Records of surveys.

- The Certifying RPEQ Engineer will inspect the Geofabric Installation Works at the Hold Points and Witness Points, respectively.
- The following are the Hold Points for the Geofabric Installation Works in accordance with the Geofabric Installation Works Specification:
  - Submission of the Contractor's PQP
  - Where the Contractor makes changes to the PQP that affect the Contract Works either directly or indirectly, the proposed changes will be subject to the prior written approval of the Certifying RPEQ Engineer
  - Where Contract Works are to be covered up after conformance has been actioned, preparation of the conformance report prior to covering will be required
  - Preparation of the conformance report prior to covering up
  - Submission of a Non-Conformance Report
  - Prior to ordering the geotextile filtration system, the Contractor will submit to the Certifying RPEQ Engineer documentation which demonstrates that the proposed product conforms to this Specification, for review and approval
  - The Contractor will submit documentation explaining the proposed installation methodology for the geocomposite for the approval of the Certifying RPEQ Engineer
  - The Contractor will notify the Certifying RPEQ Engineer when installation of the geocomposite is to be carried out
  - Conformance testing on the material properties and filter performance of the geocomposite delivered to the site will be carried in accordance with the minimum test frequencies specified herein. The geocomposite from each lot will not be placed prior to acceptance of the test results by the Certifying RPEQ Engineer
  - Prior to construction, the Contractor will undertake trials to demonstrate that the placement of reshaping rock berm does not cause damage to the geocomposite so as to inhibit its function, to the satisfaction of the Certifying RPEQ Engineer
- The following are the Witness Points for the Geofabric Installation Works in accordance with the Geofabric Installation Works Specification:
  - Prior to construction, the Contractor will undertake trials to demonstrate that the surface preparation for the proposed geocomposite suits the installation methodology and does not cause damage to the geocomposite so as to inhibit its function
  - During construction, the Certifying RPEQ Engineer will verify that the Contractor has adequately prepared the receiving surface prior to installation of the geotextile filtration system
  - Prior to covering up any rectification work, the work will be approved by the Certifying RPEQ Engineer.

7.2.2 Monitoring during construction

During construction, GPC will undertake baseline monitoring in accordance with the 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. Following establishment of the baseline, the monitoring will be achieved by combination of some or all of the following:

- Orthometric / bathymetric surveys by drone
- Bund design profiles data uploaded into machine GPS systems
- GPS recording of finished surface heights across the profile as required by the Specification
- GPS recording of finished layer thicknesses and alignment as required by the Specification
- Data point intervals along the length of the structure.

GPC will implement continual visual inspection of the bunds to provide assurance that the material compaction is adequate such that bund stability is not compromised during construction by the presence of Paleochannels.

GPC will undertake monitoring of the turbidity and light (BPAR) in the water by implementing the monitoring requirements of the NLEP SRA REMP (refer Section 7.4).

Monitoring records of visual observations and measurements will be kept by GPC as part of daily report regime and filed on site and electronically and accessible by authorised personnel for review and reference.

The Certifying RPEQ Engineer will provide advice to GPC, as and when required, regarding the monitoring of bund wall deformation. If monitoring thresholds are triggered, the Certifying RPEQ Engineer will provide advice to GPC in relation to investigating the cause of the failure and remediation actions.

7.3 Phase B – Post-construction

7.3.1 Monitoring locations

Bund wall integrity monitoring will be conducted at several monitoring points, regularly spaced around the structure. The indicative GPS coordinates for all monitoring locations are included in Table 9 and shown in Figure 2. This will be updated as the bund wall is constructed.

Table 9 Location of monitoring points

Monitoring Point ID	Chainage [m] [1]	Eastings [m] [2]	Northings [m] [2]
MP01	0	311714.6610	7368630.1292
MP02	250	311637.3710	7368867.9277
MP03	500	311549.2202	7369101.5132
MP04	750	311441.6723	7369326.8973
MP05	1000	311334.0195	7369552.6472
MP06	1250	311266.5906	7369793.6079
MP07	1500	311274.0638	7370042.9062
MP08	1750	311465.9594	7370192.2605
MP09	2000	311702.3188	7370273.7112
MP10	2215	311905.5879	7370343.7589
MP11	2315	312000.1317	7370376.3391
MP12	2415	312094.6755	7370408.9194

Monitoring Point ID	Chainage [m] [1]	Eastings [m] [2]	Northings [m] [2]
MP13	2515	312189.2192	7370441.4997
MP14	2615	312283.7630	7370474.0800
MP15	2865	312520.1225	7370555.5307

Notes:

1. *Chainages are provided with reference to Drawing No.: 509991-2000-DRG-JJ-2010*
2. *Eastings and Northings are provided in accordance with Zone56 GDA2020.*

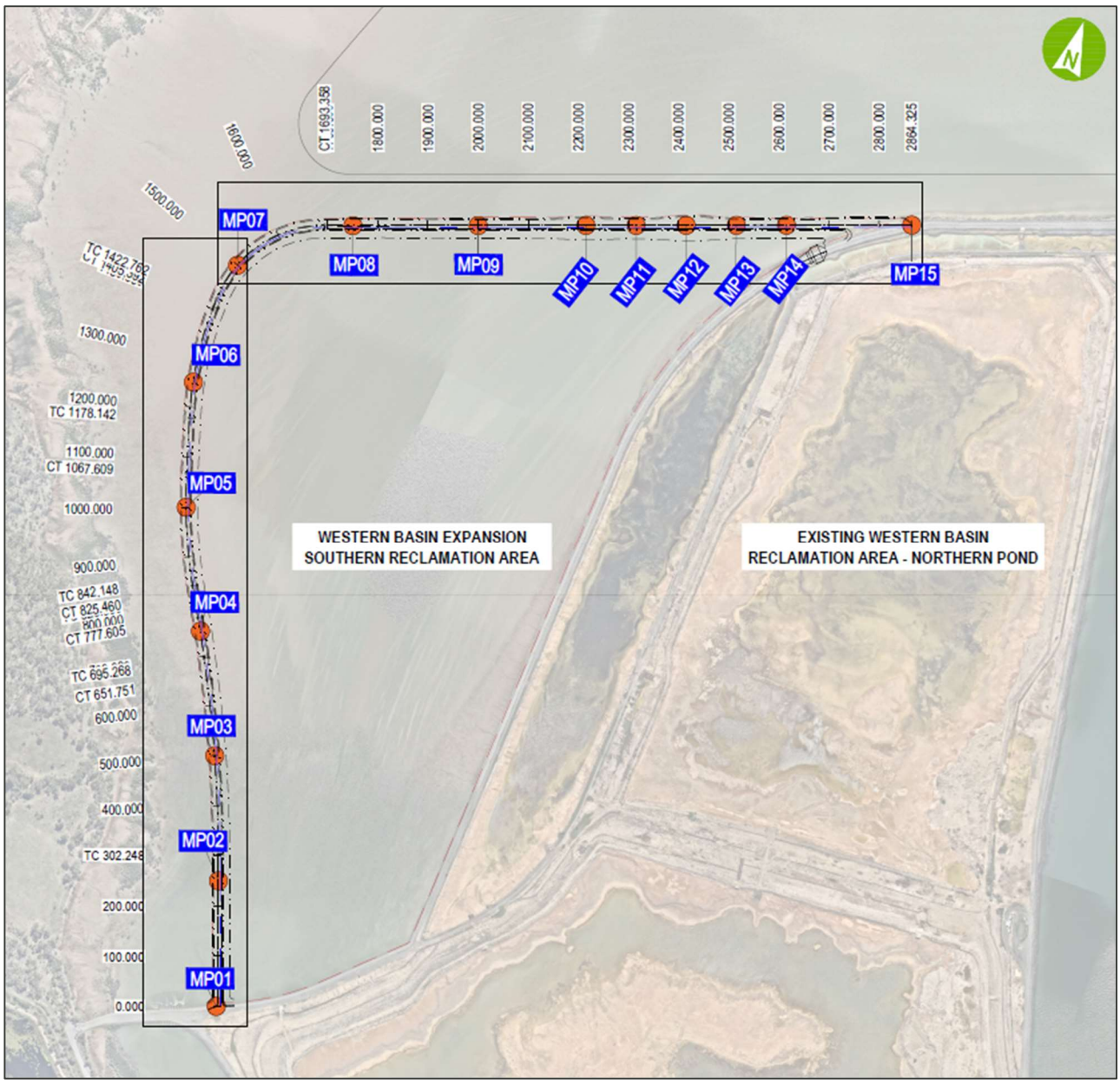

Figure 2 Layout plan of the monitoring points

7.3.2 Methodology and frequency

GPC will undertake monitoring observations and measurements that are focused on assessing the performance and condition of the bund wall after construction against the potential risks as identified in Table 5 and the relationships between these risks and the monitoring actions are presented in Table 10.

Monitoring observations and measurements will include the following:

- Geotechnical stability of the bund wall and condition of the external facing rip rap rock and internal facing rock will be gauged 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 the Monitoring Points along the bund wall (Figure 2 and Table 9). Further, periodic UAV surveys will 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 / geotextile filtration system.

- Post-construction settlement of the bund wall to ensure a maximum settlement of less than 300 mm. GPS surveys at the Monitoring Points along the bund wall (Figure 2 and Table 9) will enable GPC to measure settlement periodically and ensure that this design criteria is not exceeded. If periodic surveys indicate that more than 300 mm has occurred, GPC can repair the wearing course and subgrade to ensure an even trafficable surface is maintained and ensure that the height of the bund wall is kept to the design specifications. If excessive settlement is triggered at the same location more than once in 6 months, undertake further investigation with the assistance of an RPEQ engineer and if required action remedial measures.
- Real-time monitoring of the turbidity and light (BPAR) in the water will be as follows:
  - Implement the NLEP SRA REMP (refer BWIMP Section 7.4 and NLEP SRA REMP (Sections 8.1 and 8.2) for further details on monitoring)
  - Perform weekly visual inspections of turbidity in the water (beyond natural background levels) during the first one month after completion of bund wall construction. If no issues are identified, perform visual inspections every 6 months for a period of 3 years. If no issues are identified within the 3 years after construction, the frequency of visual inspections will be reduced to every 2 years.

The types of monitoring and measurement that will be undertaken are summarised as follows:

- Surveys
  - Survey of fifteen monitoring points on the bund wall using GPS technology in accordance with Table 10.
  - Survey by UAV topographical surveys to provide a 3D view of the bund wall, in accordance with Table 10.
  - Additional surveys will be undertaken following every cyclone or severe storm event or if triggered by visual inspections.
- Real-time water quality and light (BPAR) monitoring with instrumented buoys during post-construction and for at least 2 months after construction of the bund wall is completed (refer BWIMP Section 7.4 and NLEP REMP Sections 8.1 and 8.2).
- Visual inspections with documented records of the following in accordance with Table 10:
  - Turbidity in the water
  - Significant movements in the rip rap and rock berm
  - The position and condition of individual rocks.

Table 10 Summary of post-construction monitoring plan

Monitoring aspect	Risk / hazard measured	Method	Frequency	Trigger	Mitigation action
Settlement of bund	1, 3	Surveying at 16 monitoring points (Figure 2 and Table 9)	▪ One survey at construction completion and handover ▪ One survey 6 months after construction of the bund wall ▪ One survey 2 years and 6 months after construction of the bund wall ▪ One survey ever 5 years thereafter; provided no issues were identified.	300 mm of settlement	▪ Maintenance of wearing course and subgrade ▪ Assess whether global stability has been impacted and if required action remedial measures ▪ If excessive settlement is triggered at the same location more than once in 6 months, undertake further investigation with the assistance of an RPEQ engineer and if required action remedial measures.
Excessive release of sediment/turbidity through the bund wall	2, 4	Visual observation from bund wall and NLEP SRA water quality monitoring program Real-time water quality monitoring buoy	▪ Weekly visual inspection during the first month post-construction and if no issues monthly visual inspection for next 11 months. ▪ Water quality monitoring buoys: Every month for the two months post-construction of the bund wall (as per NLEP SRA REMP)	▪ Visual observation of turbidity in the water (beyond natural background levels) ▪ NLEP SRA REMP – exceedance of EWMA Adaptive Management Levels 1 and 2.	▪ Follow the trigger actions of the REMP. ▪ Visual observations and UAV survey to assist with identification of the location of the source ▪ Conduct investigation of the cause of the issue in liaison with an RPEQ Engineer ▪ Undertake geotextile filtration system and revetment remedial works, if required.
Stability of the bund wall and rip rap and rock berm	1, 2	Visual observation	Visual inspection at low tide by RPEQ at 3 months, 9 months, and 2 years 9 months post-construction, and every 5 years thereafter; provided no issues were identified.	▪ Significant changes in the position and condition of the individual rocks. ▪ Significant movement of the rip rap or rock berm. ▪ Significant loss of thickness of rock berm in any location, or crest rock settlement/loss of 300mm or more.	▪ Additional survey at the relevant monitoring points and individual rocks.
		UAV survey of the position of individual rocks above the waterline	Survey at low tide at 3 months, 9 months, and 2 years 9 months post-construction, and every 5 years thereafter; provided no issues were identified. Additional survey only as required if issues identified during other monitoring and visual inspections.	▪ Significant changes in the position of the individual rocks. ▪ Significant loss of thickness of rock berm by more than 20% in any location, or crest rock settlement/loss of 300 mm or more.	▪ Assess survey to identify movements of individual rocks ▪ Assess whether the risk of stability failure has been impacted and if required action remedial measures. ▪ Assess whether rock loss requires maintenance work

7.4 REMP

The NLEP SRA REMP will be implemented at the same time as the BWIMP. The NLEP SRA REMP water quality and light (benthic photosynthetically active radiation (BPAR)) monitoring (refer REMP Section 8.1 and REMP Section 8.2, respectively) and the NLEP SRA REMP adaptive management framework (refer REMP Section 9) will be implemented to ensure that bund wall integrity impacts on protected matters are identified early and adaptively managed and mitigated.

A summary of the NLEP SRA REMP water quality and light monitoring and adaptive management framework are provided below.

7.4.1 Water quality monitoring program

A range of water quality sites have been selected adjacent to and further away from the NLEP SRA Zone of Influence to monitor physical-chemical parameters in real time (refer Figure 3).

Figure 3 NLEP SRA water quality and BPAR monitoring sites

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 polyvinyl chloride (PVC) tubes attached to the base of a modified special marker buoy. The sondes will record turbidity (nephelometric turbidity unit (NTU)), temperature (°C), conductivity (millisiemens per centimetre) (mS/cm)), pH and dissolved oxygen (% saturation) every 15 minutes at approximately 0.75 m 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.

At the water quality sites, turbidity levels (as an EWMA) will be screened against triggers developed from baseline water quality data collection for compliance purposes (refer NLEP SRA REMP Section 8.1.3 for details on the water quality trigger values).

7.4.2 BPAR monitoring program

BPAR monitoring will be undertaken at a number of seagrass meadows (refer Figure 3), inside and outside the NLEP SRA Zone of Influence. At BPAR monitoring sites, PAR sensors will be mounted on benthic frames and in order to minimise data loss, the frames will be equipped with dual PAR sensors at each site.

Taking into consideration light requirements of the seagrass species found at the concern BPAR monitoring location, a mean minimum daily light requirement for *Zostera muelleri* of 6 moles of photons per square metre per day (mol/m^2/day), to be assessed as a 14-day rolling average 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 *Halophila ovalis* (NLEP SRA REMP Section 8.2 for details on the BPAR monitoring and trigger values).

7.4.3 Adaptive management framework

To allow for the implementation of mitigation measures, an adaptive management process has been designed for turbidity EWMA and BPAR. In the instance any of these parameters exceed internal or external trigger levels for certain durations, steps will be undertaken to adaptively manage elevations and prevent any impacts on protected matters from the NLEP SRA construction activities. The trigger level elevations will be investigated at all sites (concern and control), however external reporting to DCCEEW and other regulators (if required) will only occur in the case of elevations that are due to NLEP SRA construction activities and adaptive management actions will only be implemented for elevations at concern sites.

NLEP SRA REMP links to the BWIMP include EWMA turbidity internal alert levels and adaptive management levels, where communication and investigation with NLEP SRA bund wall construction site will occur to determine if the source of the turbidity level exceedance is caused from bund wall construction and/or bund wall integrity impacts, and if found to be the source, implement appropriate adaptive mitigation actions contained in Section 7.3, and the adaptive management measures contained in NLEP SRA REMP (refer Section 9.2).

7.5 Reporting

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. Further details on environmental management and compliance reporting are provided in the Section 10 of the NLEP SRA REMP.

Submission to the DCCEEW of the findings and outcomes of the implementation of the BWIMP will occur at the following frequencies:

- Construction (Phase A) – Annually (reporting will occur as part of the Project EPBC Act controlled action approval annual compliance reporting)

- Post-construction (Phase B) – Once every 2 years for a period of 4 years, followed by once every 5 years provided no issues were identified (reporting will occur as part of the Project EPBC Act controlled action approval annual compliance reporting).

If requested by the DCCEEW and/or other regulators, all monitoring data and information related to the BWIMP will be submitted within 30 business days of the request, or within a timeframe agreed by the relevant regulator in writing.

GPC also commits to submitting the completion BWIMP report within 6 months following the completion of the post-construction monitoring program.

7.6 Continuous improvement

This BWIMP will be reviewed at the following frequencies:

- Construction (Phase A) – Annually
- Post-construction (Phase B) – Once every 2 years for a period of 4 years, followed by once every 5 years provided no issues were identified.

Updates and amendments, where necessary, will be undertaken to ensure the document remains relevant and functional, whilst allowing for new or changing environmental risks and mitigation actions to be addressed. Learnings from any incidents, complaints, and the monitoring results will be incorporated to reflect the knowledge gained.

This BWIMP will be triggered for ad hoc review under the following scenarios:

- Changes in operations or management.
- Changes in environmental legislation and/or policies.
- New information from the construction monitoring results.

7.7 Ministerial approval

Changes to this plan will be submitted to the Minister for the Environment and Water for review and approval in accordance with the Project EPBC Act controlled action condition 71 and the requirements of Section 143A of the EPBC Act. If the Minister approves the revised BWIMP then, from the date specified, GPC will implement the revised BWIMP in place of this BWIMP.

It is important to note that the Phase C BWIMP will be submitted to the Minister for the Environment and Water for written approval in accordance with the Project EPBC Act controlled action condition 71 and the requirements of Section 143A of the EPBC Act. Phase C of the NLEP SRA (i.e. reclamation works, future development and end use) will not commence until the Minister for the Environment and Water as approved the Phase C BWIMP.

8 Conclusion

GPC has developed this BWIMP to demonstrate that the key design risks (refer Section 5) associated with the construction and post-construction phases of the bund wall have been assessed against the design criteria (refer Section 6) and that a robust monitoring plan (refer Section 7) is in place to mitigate or minimise these risks. The method used to develop this BWIMP consisted of a risk-based approach with consideration of the identified risks and potential mitigation actions. Proposed monitoring methods and frequencies are provided in the monitoring plan.

GPC will undertake quality monitoring during construction to confirm construction compliance to the Civil and Earthworks Specification and the Geofabric Installation Works Specification, respectively, and the corresponding PQPs and ITPs. Where a Contractor is specified an action and/or responsibility within this BWIMP, GPC will ensure the relevant commitments are fulfilled.

The certifying RPEQ Engineer will review the surveys and measurements to confirm compliance.

Post-construction monitoring will be the responsibility of GPC who will conduct surveys and measurements to confirm post-construction compliance to the design intent until 2045 or the commencement of reclamation works (Phase C), whichever is earlier.

Whilst monitoring during the reclamation works, future development, and end use (detail is currently unconfirmed) may be based on the requirements of this plan, it will require a review, revisions, and updates of this plan to reflect the changes in hazards / risks and is therefore excluded from the scope of this document.

This BWIMP requires review at least annually during construction and once every 2 years post-construction (for a period of 4 years, followed by once every 5 years provided no issues were identified) to ensure the document remains relevant and functional, whilst allowing for new or changing environmental risks and mitigation actions to be addressed.

Appendix A
GPC Risk Mapping Matrix

Consequence Rating- Consequence is rated for the most likely degree of consequence

	Minor (1)	Moderate (2)	Significant (3)	Major (4)	Critical (5
WH&S (injury or illness	First aid treatment, low level short term physical effects. No medical treatment.	Short term reversible disability or impairment &/or medical treatment injury	Reversible disability or impairment or medical treatment injuries requiring hospital admission	Moderate irreversible disability or impairment requiring specified treatment for intensive care	Single or Multiple Fatality or sever or total irreversible disability & severe impairment
Environment	Localised & controlled incident with nil or rapidly reversible harm / nuisance	Localised & controlled with short term harm / nuisance requiring no additional resources	Significant localised incident requiring additional resources to remediate harm / nuisance on site; or or offsite short term reversible harm	Large uncontrolled event requiring additional resources. Residual onsite harm or medium term remediation / recovery offsite	Large offsite event triggering significant response by external agencies or major onsite residual environmental harm requiring permanent dedicated resources
Security	Repeated breaches of GPC site – no identified intent for disruption or operations	Intentional breach of site – some intent to disrupt operations	Intentional breach of restricted access area- intent to disrupt operations	Intentional breach of restricted access area- intent to cause major damage / business disruption or poses threat to workers, customers or public	Extensive damage to critical infrastructure & personnel by terrorist attack or issue motivated groups
Regulatory Compliance	Court Action – resulting in fine <$10K	Court Action – resulting in fine $10K to $75K	Court Action – resulting in fine $75K to $250K	Court Action – resulting in fine > $250K	Court Action – resulting in jail sentence or order to cease major component of GPC operations
Financial	Losses of <$100K	Losses of $100K to $500K	Losses of $500K to $2M	Losses of $2M to $3M	Losses of greater than $3M
GPC Reputation	Repeated complaints from single complainant	Multiple complaints on issue / activity &/or issue reported in local media	Multiple complaints of interest groups reported in State media	Influences of interest groups result in major delay to operations or approvals or feature in national / international media	Influences of interest groups curtail critical business operations or major development proposals
Cargo Hand;ling / Service Delivery	Unplanned event causes loss of the equivalent of one loading or unloading stream for < 4hrs	Unplanned event causes loss of the equivalent of one loading or unloading stream for 4 to 24 hrs	Unplanned event causes loss of the equivalent of one loading or unloading stream for 24 hrs to 1 week	Unplanned event causes loss of the equivalent of one loading or unloading stream for 1 to 3 weeks	Unplanned event causes loss of the equivalent of one loading or unloading stream for > 3 weeks
Marine Operations	Marine operation disruption 12 to 24 hours	Marine operation disruption 12 to 24 hours	Marine operation disruption 24 to 48 hours	Marine operation disruption > 72 hours	Marine operation disruption > 72 hours
Project Delivery (<$10M)	Project Cost overrun <2% or <3% completion delay	Project Cost overrun 2-5% or 3-8% completion delay	Project Cost overrun 5-10% or 8-17% completion delay	Project Cost overrun 10 to 15% or 17 to 50% completion delay	Project Cost overrun >15% or > 50% completion delay
	Impact value < $100K	Impact value $100K to $500K	Impact value $500K to $2M	Impact value $2M to $3M	Impact value > $3M

Project / Time variable costs	
Time variable Costs	Calculate loss of $ for 1 day delay. E.g. For design 1 day = $50K, Construction $150K/day. This provides a metric for delays from a financial perspective. For example using the metric above 10 days Construction delay = $1.5M = Major Impact.

GPC Risk Mapping Matrix & Likelihood

LIKELIHOOD		CONSEQUENCE				
		Minor (1)	Moderate(2)	Significant (3)	Major (4)	Critical (5)
Almost Certain (5)	The risk is expected to occur in most circumstances	Medium (6)	Medium (7)	High (8)	High (9)	Extreme (10)
Likely (4)	The risk will probably occur in most circumstances (ML to occur in 1 to 2 years)	Low (5)	Medium (6)	Medium (7)	High (8)	High (9)
Possible (3)	The risk might occur at some time (Most likely to occur in next 2 to 5 years)	Low (4)	Low (5)	Medium (6)	Medium (7)	High (8)
Unlikely (2)	The risk could occur at some time (Most likely to occur once in the next 25 years)	Very Low (3)	Low (4)	Low (5)	Medium (6)	Medium (7)
Rare (1)	The risk may only occur in exceptional circumstance (Not likely to occur within the next 25 years)	Very Low (2)	Very Low (3)	Low (4)	Low (5)	Medium (6)

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Final Audit Report 2024-11-06

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