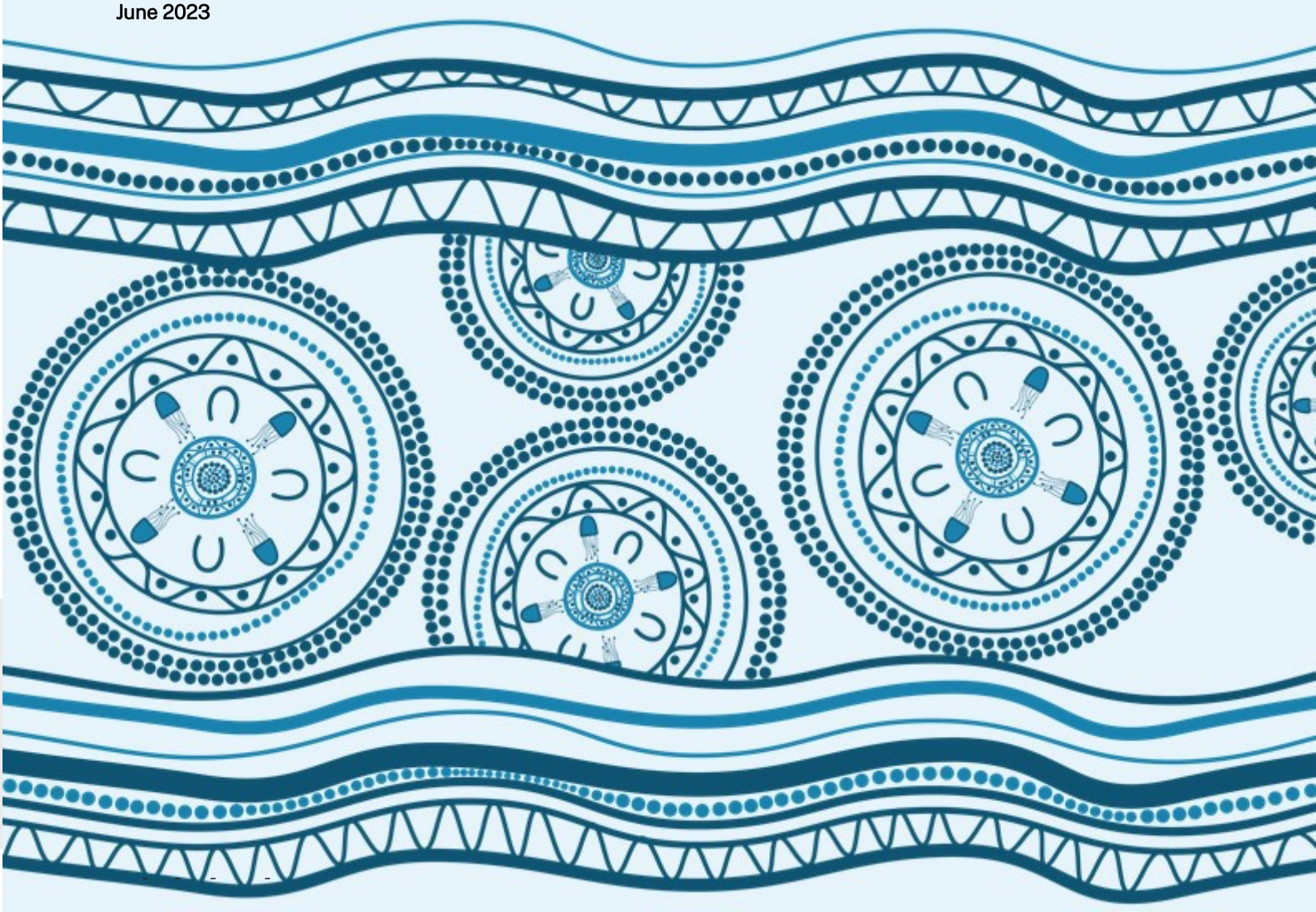
NSW GOVERNMENT

Transport for NSW

Kamay Ferry Wharves

Marine Biodiversity Offset Strategy

June 2023



Acknowledgement of Country

We acknowledge and pay our respects to the Bidjigal and Gweagal clans who traditionally occupied Kamay (Botany Bay). We also wish to acknowledge and pay respects to all Elders, past and present.

Approved by Chris Ingrey, CEO of the La Perouse Local Aboriginal Land Council, June 2021.

Cover artwork

Danielle Leedie-Gray is a self-taught contemporary graphic artist and a descendant of the Bidjara and Wakka Wakka people from south west and east Queensland, Australia. The Illustration tells the story of people coming together to work on a project significant to the local Aboriginal groups, Arup and Transport for NSW. The three main symbols used in the Illustration represent the water flow, people (shown by the U Shapes), and meeting places (shown by concentric circles) around the Kamay Ferry Wharves Project, gathering people together for discussion.

Prepared by

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Disclaimer

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Document review tracking

Draft No.	Date	Comments
Rev 0	October 2021	For inclusion in the Kamay Ferry Wharves Response to Submissions Report
Rev 1	April 2023	Update to include the following: • NSW Government Approval • Department of Climate Change, Energy, the Environment and Water Approval Incorporate MBOS Panel Terms of Reference, updated implementation plans, translocation, rehabilitation, site selection and success criteria
Rev 2	May 2023	MBOS IRP review 1
Rev3	May 2023	MBOS IRP review 2
Rev4	June 2023	MBOS IRP review 3

Executive summary

The Marine Biodiversity Offset Strategy

Transport for NSW has received approval to reinstate the ferry wharves at La Perouse and Kurnell (the Project). The primary purpose of this infrastructure would be to enable the return of the public ferry service between La Perouse and Kurnell. The wharves would also provide supplementary temporary mooring for non-ferry commercial vessels and recreational boating.

Need for the proposal

During the development of the project marine biodiversity offsets have been identified under both Commonwealth and NSW offset policies. As such, this Marine Biodiversity Offset Strategy (MBOS) was prepared to outline the offset requirements as part of the Project's Conditions of Approval.

Marine biodiversity offset

Bank Gurantee

As part of the Conditions of Approval a bank guarantee is required to be provided to DPI Fisheries for the life of the MBOS. The CoA require that 50% of the bank guarantee value be directed to direct offset activities by the Project. A bank guarantee of $1,285,463.16 will be provided to NSW Fisheries, with $2,850,000 to be spent on direct offsets activities equating to approximately 250.73% of the monetary bond.

Posidonia australis

Biodiversity offsets for *Posidonia australis* are diverted into three offset types including translocation, rehabilitation and improvement/protection measures.

Transport for NSW will undertake translocation of *Posidonia australis* from the impacted Project area to sites adjacent, also called rehabilitation sites. This technique will include hand removal of the *Posidonia australis* and planting into the sites using pegs secured to jute meshes.

To increase the area and density, the translocation will be supplemented with the collection and planting of naturally detached *Posidonia australis* fragments from beaches around Botany Bay. The naturally detached *Posidonia australis* would be planted using pegs secured to jute meshes too.

Other measures to offset impacts to *Posidonia australis* would include the installation or replacement of moorings in or near *Posidonia australis* seagrass meadows in the Manning-Hawkesbury ecoregion ecological community to Environmentally Friendly Mooring.

White's Seahorse

A detailed Implementation Plan will be prepared as part of the ongoing development of the MBOs. To offset White's Seahorse Habitat artificial structure such as seahorse hotels are being proposed to be installed in Botany Bay.

Zostera, Halophila and macroalgae

A detailed Implementation Plan will be prepared as part of the ongoing development of the MBOS. The offset activities for Zostera, Halophila and macroalgae would include the installation or replacement of moorings to Environmentally Friendly Mooring.

Additional benefits

The completion of this work would support further research into transplanting seagrass

The successful translocation of seagrass would provide valuable information for the development of feasible restoration programs for the endangered *Posidonia australis* community in Sydney.

The general expenditure of the rehabilitation work would provide research opportunities through the methods applied, the collection of data over time, and application of a physical direct offset for managing impacts to *Posidonia australis*.

Further to research the ongoing engagement with the Aboriginal community and/or business in the implementation of the MBOS.

Implementation and management

The MBOS Implementation Reference Panel has been setup in January 2023 to review and oversee the development and implementation of the MBOS and to meet our CoA. The MBOS Implementation Reference Panel includes an Independent Scientist and representatives from DPI Fisheries Coastal Systems and Threatened Species Division, Transport for NSW and observers from the NSW Department of Planning and Environment.

Reporting of the MBOs will be provided to the MBOS Implementation Reference Panel, NSW Department of Planning and Environment, and the Commonwealth Department of Climate Change, Energy, the Environment and Water during the 10-year life span of the MBOS.

Conclusion

The MBOS has been developed to manage the marine offset requirements as part of the Project approvals. The MBOS will be progressively updated as detailed offset implementation plans are prepared and endorsed by the MBOS Implementation Reference Panel, as well as the rehabilitation and monitoring work is done.

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1. Introduction.

1.1 Purpose of this report

The Kamay Ferry Wharves Environmental Impact Statement (EIS) assessed how likely the project is to impact the area's marine ecology and biodiversity values. The EIS determined that some impacts to marine ecology and biodiversity due to the project could not be fully avoided. The EIS identified the project was likely to result in residual impacts to Key Fish Habitat (KFH), including direct and indirect impacts to *Posidonia australis* Threatened Ecological Community (TEC).

Posidonia australis TEC is protected under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Fisheries Management Act 1994* (FM Act). In order to mitigate these unavoidable, residual impacts, a process known as 'ecological offsetting' is implemented under State and Commonwealth legislations.

A Marine Biodiversity Offset Strategy (MBOS) was developed to provide a strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS. The MBOS identifies appropriate offset requirements under the EPBC Act and FM Act. The MBOS documents how Transport for NSW would meet its marine offset obligations. It also describes how these actions would be implemented in consultation with NSW Department of Primary Industries Fisheries (DPI Fisheries), Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and other stakeholders to result in a net gain in environmental outcomes for Botany Bay as a priority and the Sydney Bioregion more broadly where suitable offset sites are not available in Botany Bay.

The MBOS has an operational life of ten years, and therefore is an adaptive document that would be reviewed and updated as required by Transport for NSW. Revisions to the MBOS would be implemented in consultation with the MBOS Implementation Reference Panel, which comprises representatives from Transport for NSW, DPI Fisheries and an independent scientist. The MBOS Implementation Reference Panel would review the revised MBOS to ensure the updates are consistent with the offset policies and their implementation. Where significant changes to the MBOS have occurred, a copy of the updated MBOS and changes would be distributed to other relevant stakeholders, which may include, UNSW, DCCEEW and NSW Department of Planning and Environment (DPE).

1.2 Project background

The NSW Government is reinstating the wharves at La Perouse and Kurnell to provide a valuable recreational resource for the community, and to allow for future ferry access between both sides of Kamay Botany Bay National Park. The wharves will improve access for locals and visitors in small commercial and recreational boats and for people to swim, dive, fish, walk and enjoy the local sights.

The project forms part of the NSW Government's Kamay Botany Bay National Park, Kurnell Master Plan (stage 1), which aims to improve visitor experience and access to the park. The plan is being delivered by Transport for NSW (Transport) on behalf of and with the NSW National Parks and Wildlife Service.

Importantly, the project recognises the rich culture and ongoing importance of the area to Aboriginal people. Feedback from the community has helped to guide the design and stories of Country have been embedded into elements of the built form. Large scale artworks by two local Aboriginal artists are integrated into the designs of the jetties and the shelter structures at La Perouse and Kurnell.

The project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework. It was also confirmed to be a controlled action under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)

Accordingly, bilateral approval has been sought from the NSW State Government, under the Environmental Planning and Assessment Act 1979 (EP&A Act), and the Australian Government, under the EPBC Act.

An EIS was placed on public exhibition from July to August 2021. A response to submissions report was prepared in October 2021 to address issues raised during public exhibition of the EIS. The project was determined under the EP&A Act by the NSW Minister for Planning in July 2022 and by the Australian Government under the EPBC Act in March 2023.

1.3 MBOS operational life

As per the Conditions of Approval, the MBOS has an operational life of no less than ten years from the date of the commencement of the MBOS activities, unless otherwise agreed by the Planning Secretary in consultation with MBOS Implementation Reference Panel and the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The MBOS will be reviewed and updated during its operational life as required and as recommended by the MBOS Implementation Reference Panel.

2. Requirements for a MBOS

The key objective of the MBOS is to ensure compliance to all NSW and Australian Government Conditions of Approval (CoA), environment management measures, licence and permits requirements relevant to marine biodiversity offsets for the Project as outlined in:

- The Project EIS and Response to Submissions Report (RtS);
- The NSW Ministers Conditions of Approval (MCoA), July 2022 (SSI-10049)
- The EPBC-CoA, March 2023 (2020/8825)

Table 2-1 outlines the reference to where the MBOS meets these requirements

Table 2-1: Commonwealth and NSW Conditions of Approval

Condition reference	Condition requirement	Section in MBOS
NSW Ministers Condition of Approval		
E12	The Proponent must ensure that the proposal is undertaken in accordance with the requirements of DPI Fisheries policy and guidelines, including the Policy and Guidelines for Fish Habitat Conservation and Management 2013, and the NSW Biodiversity Offsets Policy for Major Projects, Fact sheet: Aquatic biodiversity.	4
E13	The Proponent must allow for an additional winter and summer season in which to monitor marine biodiversity within the construction footprint prior to commencement of construction.	6.1.2
E14	The Proponent must satisfy the marine biodiversity offset obligations that specify the required offset size in accordance with the EPBC Act, Environmental Offsets Policy 2012, NSW Biodiversity Offsets Policy for Major Projects – Fact sheet: Aquatic Biodiversity. Evidence of this must be provided to the Planning Secretary, DPI Fisheries and DAWE for information, within 12 months of the commencement of construction.	4
E15	Areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 KFH) and macroalgae (Type 2 KFH) that have been identified for removal or disturbance within the construction footprint at Kurnell and La Perouse must be offset in accordance with the MBOS and as agreed with DPI Fisheries and DCCEEW.	5 6 7 8 9
E16	Prior to the commencement of pre-construction seagrass transplantation, the Proponent must establish a MBOS Implementation Reference Panel to review data collected, including from the marine biodiversity monitoring as required by Condition E13, recommend changes to the MBOS if required, and review the Operational Impact Assessment Report (see Condition	5.2.1 Appendix 2

	E22). The MIRP must comprise representatives from the Proponent, DPI Fisheries-Coastal Systems, DPI Fisheries-Marine Research, DCCEEW, and DPIE Planning and Assessment, and include a suitably qualified, experienced and independent scientist. The MBOS Implementation Reference Panel must be operational for the life of the MBOS or as agreed by the Planning Secretary.	
E17	The MBOS must have an operational life of no less than ten	1.3
E18	The MBOS may be reviewed and updated during its operational life as required and recommended by the MBOS Implementation Reference Panel. At least 50 per cent of the MBOS funding must be allocated to the restoration and rehabilitation of *Posidonia australis* and Zostera seagrass beds in consultation with the MBOS Implementation Reference Panel.	11.2
E19	Prior to marine Works, a bank guarantee to a value identified by the MBOS Implementation Reference Panel must be provided to DPI Fisheries to offset marine biodiversity impacts in accordance with the DPI Fisheries Policy and guidelines for fish conservation and management, and the NSW Biodiversity Offsets Policy for Major Projects, Fact sheet: Aquatic Biodiversity. The MBOS Implementation Reference Panel may use this bank guarantee to manage key fish habitats, threatened species and/or populations if planned activities as agreed under the MBOS are unsuccessful.	6.1.3
E20	An Operational Impact Assessment Report must be prepared on impacts to marine biodiversity following 12 months of the full operation of the ferry wharves. This report must: a) be submitted to the MBOS Implementation Reference Panel for review no later than six (6) months after the 12-month full operation period; b) include the results of before and after monitoring of all seagrass species, Whites Seahorse, populations and habitats impacted by the ferry wharf structures and associated commercial and recreational vessel uses; and c) be used to review the MBOS no later than six (6) months after the submission of the Operational Impact Assessment Report to the MBOS Implementation Reference Panel.	11.1.3

EPBC Conditions of Approval		
10	The approval holder must comply with NSW Approval conditions E12 – E20 related to the requirements of the Marine Biodiversity Offset Strategy (MBOS) to compensate for the clearing of 0.0683 hectares of seagrass meadows and White's Seahorse habitat.	4 6.1.2 4 5 6 7 8 5.2.1 Appendix 2 1.3 12.2 6.1.3 12.1.3
11	To monitor the outcomes of the MBOS for seagrass meadows and White's Seahorse habitat, the approval holder must include a Marine Biodiversity Offset Report as part of the compliance report until at least the 10th anniversary of the commencement of the action, unless otherwise agreed to in writing by the Minister. Each Marine Biodiversity Offset Report must include: a) a progress report on the implementation of the MBOS; b) a list of success metrics; c) details of the monitoring methodology(ies) implemented and the locations of reference sites; d) monitoring results including a comparison against reference sites; e) a summary of any adaptive management measures taken to improve implementation of the MBOS and/or monitoring methodology(ies); and f) a conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.	12.1.2
12	To assess the ongoing success of the MBOS, the approval holder must submit a Rehabilitation Monitoring Review to the department within 6 years of the date of this approval and every 5 years thereafter, unless otherwise agreed to in writing by the Minister. Each Rehabilitation Monitoring Review must include: a) a review of the monitoring methodology(ies) by a suitably qualified person; b) a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are	12.1.4

	unlikely to be met, as determined by a suitably qualified person; and c) if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics: i. a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and ii. justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.	
Revised Environment Mitigation Measures		
MB10	Marine Biodiversity Offset Strategy (MBOS) is prepared in consultation with NSW DPI Fisheries. As a minimum the MBOS will include: a) Pre and post construction seagrass monitoring program to validate construction impacts b) A seagrass translocation and rehabilitation plan c) Investigation of other offset opportunities which may include artificial marine fauna habitat such as seahorse habitat structures, environmentally friendly moorings or research trials on environmentally friendly moorings.	This document

2.1 Key Objectives

The MBOS' key objectives are to:

Identify and offset residual impacts to ensure there is no net marine biodiversity loss in Botany Bay focusing on values protected under State and Commonwealth legislations

- Meet relevant planning approval conditions
- Be consistent with State and Commonwealth biodiversity offset legislative and policy requirements
- Specify management measures and key performance indicators (KPIs).

3. Land description

3.1 Land ownership and management

The offsets will be delivered on land or infrastructure owned and managed by Transport for NSW as described in Table3-1, Figure 3-1 and Figure3-2 below.

Table 3-1: Land ownership

Address	Lot and deposited plan	Ownership
Botany Bay (marine waters)	Lot 3 DP 1165618	State land managed by Transport for NSW.

Figure 3-1: land ownership – La Perouse

* Roads are State Land managed by Randwick City Council

Figure 3-2: Land ownership - Kurnell

* Roads are state land managed by Sutherland Shire Council

4. Statutory framework

There are two main pieces of legislation that protect marine biodiversity at a State and Commonwealth level. The two pieces of legislation that are relevant to the MBOS are as follows.

- NSW *Fisheries Management Act 1994* makes it an offence to harm estuarine macrophytes, such as seagrass, fisheries, threatened species, and resources without an appropriate assessment, inclusion of safeguards, and/or the appropriate permissions to carry out certain work.
- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* protects matter of national environmental significance (MNES) and Commonwealth land values. The Act requires project actions to be controlled under the Act's provisions if they are likely to have a significant impact.

The bilateral agreement between the NSW and Australian Governments (Section 1.1) also covers offset agreements. Regarding the Project, the bilateral agreement states that offsets will be completed in accordance with the objective of the EPBC Act and in conjunction with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013, the 'DPI Fisheries Policy') and the NSW Biodiversity Offsets Policy for Major Projects, Fact sheet: Aquatic biodiversity (DPE, 2014) and Specifically:

- The DPI Fisheries Policy (Section 3.3) provides guidance on addressing and offsetting aquatic impacts
- The NSW Biodiversity Offset Policy for Major Projects Fact Sheet: Aquatic biodiversity
- The offsetting requirements under the EPBC Act are defined under the EPBC Act Environmental Offsets Policy (Section 2.3).

4.1 NSW Offset requirements

4.1.1 DPI Fisheries Policy

The DPI Fisheries Policy requires no net loss of KFH meaning, no overall loss of habitat. Therefore, where "significant [direct and indirect] environmental impacts [cannot be avoided they] are to be offset by environmental compensation". Environmental compensation (non-monetary) is defined as "the creation or enhancement of fish habitats or fisheries resources in order to compensate for anticipated adverse or actual environmental effects of proposed developments."

Environmental compensation is only considered where it is not possible to avoid fisheries resource or habitat loss. This is determined through assessment and consultation. Environmental compensation must also be in the community's best interests.

Any environmental compensation needs to be carried out in accordance with the FM Act, regulations, policies, and guidelines. It also needs to account for direct and indirect impacts to confirm there is no net loss.

The MBOS has been prepared in general accordance with the above Policy (Table 4-1). Where the MBOS differs from the DPI Fisheries Policy is in its view that rehabilitation does not support "seagrass transplanting as an impact compensation measure as the viability of transplanting methods is yet to be scientifically proven for all species." The MBOS proposes the inclusion of seagrass rehabilitation as part of the strategy given the recent success and advances in seagrass rehabilitation within the region (e.g. Operation Posidonia). The workshops held were to work through variations from the policy and confirm what was acceptable.

Table 4-1: Adopted principles of the Policy in the MBOS

Adopted principles as defined in the Policy	Outcome summary	Section in MBOS
Provision of environmental compensation measures to deliver a no net loss outcome.	The strategy has applied the EPBC Offset calculator (DCCEEW, 2012) for *Posidonia australis* and Whites Seahorse to establish a more conservative approach to the area requiring rehabilitation. For all other non-MNES offsets will be completed as required by DPI Fisheries Policy.	5 6 Appendix 1

Payment of a monetary bond to ensure the work is carried out in accordance with the Policy.	A bank guarantee between Transport for NSW and DPI Fisheries to ensure the work is carried out in accordance with MCoA E19.	6
Preparation of an environmental compensation management plan to: • Document replanting, transplanting, and monitoring methods • Prove the suitability and adequacy of the compensation • Define KPIs to measure success of compensation and corrective actions, where the performance is inadequate.	This document was developed in consultation with DPI Fisheries and seagrass specialists (UNSW) on the approach needed to provide more certainty in the methods used for the replanting of seagrass. This MBOS contains the offset plans (Implementation Plans) for all species identified for offsetting as part of this MBOS..	5 6 7 8 9 10 Appendix 4 Appendix 5

The monetary bond is defined in the DPI Fisheries Policy as a payment that is "required to be lodged with NSW DPI Fisheries to ensure the works are completed in accordance with the permit conditions". The rates applied are annually adjusted based on the Consumer Price Index.

The degree of environmental compensation also accounts for the sensitivity and value of the impacted habitat. This is defined under the DPI Fisheries Policy. Table 4-2 below includes the relevant definitions used in tis MBOS taken from Section 3.2 of the NSW Fisheries Policy.

Table 4-2: Key Fish Habitat Sensitivity

Type 1 Highly sensitive	Type 2 Moderately sensitive
Posidonia australis	Estuarine and marine rocky reefs
Zostera, hetero zostera, halophila and ruppia species of seagrass beds >5m2 in area	Marine macroalgae such as ecklonia and sargassum species
Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act	

4.2 NSW Biodiversity Offset Policy for Major Projects – Fact Sheet: Aquatic Biodiversity

The NSW Biodiversity Offset Policy for Major Projects applies to all biodiversity in NSW, including aquatic biodiversity. This fact sheet outlines the steps proponents of major projects, and their ecological consultants should take to assess the impacts of a major project on aquatic biodiversity and, where impacts are unavoidable, determine the offset requirements.

Step 4 Offsetting requirements refers to the DPI Fisheries Policy for the requirements for compensation of aquatic key fish habitats. The fact sheet outlines that offset consideration for site-based offsets should meet the following requirements:

Table 4-3: NSW Biodiversity Offset Policy for Major Projects – Fact Sheet Aquatic biodiversity compliance table

Step 4: Offset requirements for key fish habitats	Outcome summary	Section in the MBOS
The enhancement and/or protection of existing key fish habitats, by avoiding impacts, is preferred, and should always be explored as the first option	An options analysis was undertaken in Chapter 4 of the Project EIS. The analysis included specific criteria to avoid as much as possible impacts on sensitive marine environments.	Project EIS
Site offsets should be undertaken as close as possible to the development site or in the same catchment	Translocation and rehabilitation of *Posidonia australis* will be undertaken directly adjacent to the Project. Seahorse Hotels will be established close to the site, and actions to rehabilitate mooring	7 8 9 10

	impacts to seagrass will be conducted in Botany Bay as a priority where possible, and expended to other areas in the bio-region as needed.	
Pre-development compensation is preferred to post-development compensation	Translocation of *Posidonia australis* and the commencement of fragments collection will occur prior to commencement of construction that would directly impact *Posidonia australis* .	7 8 9 10
Compensation should focus on enhancing or protecting more sensitive or threatened key fish habitats, for example, saltmarsh is a more threatened key fish habitat than mangroves	While a number of key fish habitats would be impacted by the Project, offset efforts would focus on the enhancement of *Posidonia australis* and White's Seahorse habitats	7 8 9 10
A plan of management should be prepared which outlines proposed offset site rehabilitation requirements, including the need for monitoring to achieve proposed performance measures	The MBOS has been developed to outline methodologies, success criteria, monitoring for all direct offsetting activities.	7 8 9 10 Appendix 4 Appendix 5
An environmental bond or a bank guarantee will be required as security to ensure the offset requirements are adequately delivered in accordance with the agreed plan of management.	A monetary bond will be provided to DPI Fisheries. The Project will spend a minimum of 50% on direct offsets.	6

4.2.1 Intertidal protected areas

The Project would cross through the Inscription Point Intertidal Protection Area at Kurnell. This is to protect all species of cunjevoi and invertebrates except abalone, eastern rock lobster (Sagmariasus verreauxi) and southern rock lobster (Jasus edwardsii). It is defined as the area from the 'mean highwater mark to 10 metres seaward'. Most of the wharf at Kurnell would be in line with the existing jetty location and there for minimise the impact to this region.

In addition, the Intertidal Protection Areas are currently managed under the fishing closures, which are defined under Part 2, D1 of the FM Act. These closures "prohibit, absolutely or conditionally, the taking of fish, or of a specified class of fish, from any waters or from specified waters." The Project will not 'take' any fish from this region and the impact in this region does not constitute and offset requirement. However, the Project has sought to minimise the extent of works and the overall footprint to limit the extent of the impact in the region.

There are no Intertidal Protection Areas at La Perouse

4.3 Commonwealth offset requirements

The EPBC Act Environmental Offsets Policy outlines the Commonwealth Government's approach to the offsetting significant impacts on MNES.

The offsets cover:

- Direct actions focussing on delivering a measurable conservation gain. At least 90 per cent of any offset must involve a direct action. A measurable conservation gain includes:
  - Improving existing habitat for the protected matter
  - Creating new habitat for the protected matter
  - Reducing threats to the protected matter
  - Averting the loss of a protected matter or its habitat that is under threat.
- Indirect actions: Other compensatory measures that are expected to lead to beneficial outcomes. These include:

- - research
- - education program funding.

The offset is determined by the:

- Appropriateness of the offset for a given impact
- Specific size and scope of an offsets package.

The Environmental Offsets Policy includes the offsets assessment guide (Appendix 1). This uses a balance sheet to measure impacts and offsets. This creates a decision-making framework to consider the appropriateness and adequacy of proposed offsets (Table 2-3).

Table 4-4: EPBC Act Environmental Offset Policy

The Environmental Offsets Policy identifies that	Outcome summary	Section in the MBOS
7.1 | Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.	The MBOS has applied the EPBC offset calculator to establish a more conservative approach to the area requiring rehabilitation, essentially the result will more than doubled the area impacted. This will meet no net loss for the *Posidonia australis* and White's Seahorse habitat by replacing loss habitat due to the proposed works. As such the FM act policy was not directly applied here.	5 6 Appendix 1
7.2 | Suitable offsets must be built around direct offsets but may include other compensatory measures.	All offsetting would be based around direct offsets but will have indirect benefits as well through research.	5 6 7 8 Appendix 4 Appendix 5
7.2.1 | Tenure for direct offsets.	The 'land' within the bay is under 'State land managed by the proponent, Transport for NSW'	3.1
7.2.2 | Impacting on existing EPBC Act offsets.	Not applicable, there are no other EPBC offsets within the areas proposed for offset locations.	-
7.3 | Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.	The MBOS was developed in consultation with DPI Fisheries and seagrass specialists (UNSW) on the approach needed to provide more certainty in the methods used for translocation, planting of beach fragments and designs of artificial habitat for seahorses.	5
7.4 | Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.	The EPBC offset calculator more than doubles the area required for the *Posidonia australis* to meet a conservation gain.	5 6 Appendix 1
7.5 | Suitable offsets must effectively account for and manage the risks of the offset failing.	The proposed offset method has been prepared is in accordance with the methods of used as part of Operation Posidonia. Where signs of short-term success, 2 years since transplanting *Posidonia australis* have been documented.	7 8 Appendix 4 Appendix 5
7.6 | Suitable offsets must be additional to what is already required, determined by law, or planning regulations, or agreed to under other schemes or programs.	The MBOS will be delivered as additional to mitigation measures already implemented as part of the Project as required by law, planning regulations or agreed under other schemes or programs.	5 6 7 8 Appendix 4 Appendix 5
7.6.1 | Links with state and territory approval processes.	The MBOS looks to work with the DPI Fisheries Policies while providing suitable direct offsets beyond the monetary bond requirement	5 6

The MBOS reviewed the various policies in conjunction to provide suitable and meaningful offsets that would focus on what could be achieved through direct offsetting rather than relying on the monetary bond component. This process has enabled for an offset strategy that will provide a net gain in *Posidonia australis* and White's seahorse habitat which meets the requirements of the EPBC Act policy and exceeds the requirements of the FM Act.

5. Approach

This Section provides and overview of how the MBOS was developed as well as the where the MBOS sits in context to the overall Project, EIS and approval pathway.

5.1 Development phase

Consultation and workshops were undertaken with relevant Government agencies and other stakeholders to develop a draft MBOS to be included in the Project's RtS. The draft MBOS shows a strategy of how Transport for NSW would implement its offset obligations under both NSW and Commonwealth requirements.

During this development phase two consultation workshops were held with the Project team and stakeholders (refer to the list below) between February to August 2021 and additional feedback was also received from agencies and specialists. The first workshop was structured to discuss the ability to develop an MBOS and used to discuss offsetting expectations. The second workshop provided a forum for feedback. This allowed the MBOS to be refined for inclusion in the Response to Submissions Report.

The stakeholders included the following Government agencies and specialists:

- DCCEEW
- DPE
- DPI Fisheries
- NPWS
- School of Biological, Earth and Environmental Sciences, University of New South Wales (UNSW)
- La Perouse Aboriginal Land Council, including the Botany Bay Gamay Rangers.

The consultation allowed for options and concerns to be heard as well as develop inputs to how the MBOS would be structured and what would be included. The stakeholders consulted provided technical specialists, government agencies and traditional knowledge holders. To review the MBOS and provide feedback on the approach taken to deliver suitable direct offsets.

5.2 Implementation phase

5.2.1 MBOS Implementation Reference Panel (MCoA E16)

The primary role of the MBOS Implementation Reference Panel is to provide advice as required by the NSW Infrastructure Approval SSI-10049 and Commonwealth EPBC Approval 2020/88.

Specifically, the MBOS Implementation Reference Panel will advise on:

- Review marine biodiversity monitoring results relating the MBOS;
- Recommend changes to the MBOS during the implementation for the life of the MBOS; and
- Review the Operational Impact Assessment Report.

The MBOS Implementation Reference Panel would hold regular meetings to discuss and provide advice on monitoring data, updates to the MBOS (if required) and monitor the implementation of the MBOS.

A Terms of Reference for the MBOS Implementation Panel has been prepared and is detailed in Appendix 2

5.2.2 Direct offset implementation

The MBOS identifies a staged approach for meeting its offset obligations.

The offset actions including the following:

- Translocation of *Posidonia australis* from areas expected to be impacted during construction of the Project and operations of the wharves to habitats identified as existing degraded within Botany Bay (Appendix 4)
- Rehabilitation of seagrass meadows using naturally detached *Posidonia australis* shoots (Appendix 5).

- Installation of artificial habitats such as seahorse hotels. An implementation plan for the development, installation and monitoring of artificial habitats would be developed by Transport for NSW and endorsed by the MBOS Implementation Reference Panel.

Section 5.6 of this document will outline the proposes methodology for the artificial habitats

- Installation of Environmentally Friendly Moorings, seagrass meadows targeted will include *Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion ecological community, as well as Zostera, Halophila and macroalgae within Botany Bay as a priority and the Hawkesbury Nepean Bioregion more broadly where suitable on-ground offsets sites are not available. To deliver these offsets detailed Implementation Plan will be prepared and endorsed by the MBOS IRP.

Section 5 summaries the direct offset actions that will be undertaken as part of the MBOS with detailed implementation plans provided in the relevant appendices.

5.3 Project controls, mitigations, and contractual deterrents

The Project is committed to maintaining minimal impact to the *Posidonia australis* and other seagrass habitat outside the impact area. This would be achieved by:

- Setting speed limits and access points
- Defining specific procedures for marine protection focused on
- A seahorse relocation plan (inclusive of White's seahorse and weedy seadragons)
- Procedures for marine mammal spotters.

A Construction Environmental Management Plan (CEMP) has been prepared that includes a Marine Biodiversity Management sub plan (BMP). This BMP includes controls and mitigation measures aligned to the above bullet points.

Additional control measures were also included into the documentation used to engage the contractor who will build the wharves. This requires the contractor to avoid impacts on marine biodiversity. These measures include the contractor being financially penalised if it causes any additional impact beyond that approved by the State and Commonwealth. The terms of the financial penalty the contractor is obligated to not increase the financial offset obligation (or monetary bond value).

By working under a CEMP, setting specific contractor specifications, and including financial penalties, there are opportunities to reduce impacts within the 15 meter buffer area

5.3.1 Limitations

The MBOS was developed with a worst-case residual impact. This comprised construction impacts, permanent structure, and ferry vessel impacts. This approach is recognised as the precautionary principle; one of the ecologically sustainable developments (ESD) principles defined under State and Commonwealth legislation. The precautionary principles states that:

"If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Public and private decisions should be guided by careful evaluation to avoid serious or irreversible damage to the environment wherever practicable, and an assessment of the risk-weighted consequences of various options".

The environment of the Project region is highly dynamic. This means its condition and extent of habitat available will change seasonally and after storm events. These changes may be significant. The MBOS attempts to allow for these variations over the Project's life through the implementation of impact monitoring, reporting and continued consultation with MBOS Implementation Reference Panel

6. Offset requirements

6.1Offset requirement

Section 2 above describes those marine ecology and biodiversity values that are protected under State and Commonwealth legislation that would be impacted by the Project and would accordingly need offsetting.

The draft MBOS summarises the draft offset requirements based on the limitations and assumptions described above in Section 3.2.3. These are based on the Project's predicted direct and indirect impacts, namely:

- Direct impacts account for the construction activities carried out in the Project boundary and the predicted scour likely to occur by operational ferries
- Indirect impacts account for incidental construction mooring and limited sediment disturbances across the construction boundary.

The areas provided assume the impact will not exceed the total area calculated.

6.1.1 MBOS calculations (2021) – Environmental Impact Statement

A MBOS was included in the RtS to provide a strategy on how Transport for NSW will deliver its offset obligations under both NSW and Commonwealth legislation.

The draft MBOS was developed using the information within the EIS specifically Section 10 and Appendix H. Importantly, the EIS considered a worst-case scenario where an area of over 24,000m2 of Key Fish Habitat will be impacted and or modified. While it concluded that the Project's design and construction methods could be refined to reduce its impacts (refer to Appendix H, Section 6 of the EIS), the EIS confirmed that marine ecology and biodiversity impacts could not be fully avoided. Where this occurs the State and Commonwealth has put in place a process known as 'ecological offsetting'. This is where the worst-case scenario of construction, ferry access and usage is accounted for by addressing the residual impact and providing offsets as compensation both through direct and monetary means.

The predicted residual impacts to the marine biodiversity values in the area are:

EPBC Act

- Threatened species:
- Seagrass Meadows (*Posidonia australis*) of the Manning-Hawkesbury Ecoregion TEC – endangered
- White's Seahorse (*Hippocampus whitei*) – endangered.

FM Act Listed

Threatened and Key Fish Habitat (KFH):

- Type 1 KFH
  - *Posidonia australis* - *Posidonia australis* seagrass habitat endangered population
  - Zostera, hetero zostera, halophila and ruppia species of seagrass beds >5m2 in area
  - Estuarine and marine rocky reefs
  - Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act (see note 1) (White's Seahorse habitat– endangered.)
- Type 2 KFH
  - Marine macroalgae such as ecklonia and sargassum species

The *Posidonia australis* habitats within the area of impact have multiple values for each habitat type and protected matters, the matters have been allocated to consolidated groups for clearer delineation in this strategy.

The impact assessment concluded the worst-case residual impact would be a loss of (in order of priority):

- 683 m2 of *Posidonia australis* habitat (Type 1 KFH)
- 20,589 m2 of other seagrass habitat (Type 1 KFH)
- 3,683 m2 macroalgae habitat (Type 2 KFH)

Other biodiversity values determined not to be impacted and/or species of value but not listed as threatened, which do not require direct offsetting include:

- Black rockcod, which is listed as vulnerable and protected under the EPBC Act and FM Act, was identified in the SEARs (Table 2 of the APPENDIX H (MBAR) of the EIS). However, as concluded in section 5 of the EIS that there was no habitat within the area that would be lost to the Project.
- Cauliflower soft coral, which is listed as endangered under the EPBC Act, was identified as potentially present. However, as concluded in section 4.5 of the EIS there are no records or indications that this species is present within the Project area.
- Syngnathidae, including the Weedy seadragon, are protected from illegally taking or possessing the species under FM Act. No Weedy seadragons were observed however (Appendix A of the MBAR), their habitat is often associated with kelp dominated macroalgae assemblages which is present on site the habitat protected under KFH policy and is addressed through the offsetting of KFH.

Just because it is illegal to take and possess a species does not mean that species is also threatened and protected under the EPBC and FM Acts. This is the case with Syngnathidae. Therefore, while there is no need to offset any impact on them as a species any impact on their habitat needs offsetting as it classifies as KFH.

Table 6-1: NSW Biodiversity Offset Policy (2021) for Major Projects – Fact Sheet Aquatic biodiversity compliance table

Habitat and species as identified in the EIS	EPBC Act listing	FM Act	Areas m^2	Consolidated groups and areas
Listed habitat and species				
Posidonia australis	Seagrass meadows (*Posidonia australis*) of the Manning-Hawkesbury Ecoregion – TEC Endangered Community	KFH Type 1 | highly sensitive habitat *Posidonia australis* Endangered population	259 m2	*Posidonia australis* (Type 1 KFH) Total area: 683 m2
Posidonia australis mixed with Halophila or Zostera			424 m2	
White's seahorse	Endangered	KFH Type 1 | highly sensitive habitat Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act (see note 1) Endangered	Contained within the above area	
Unlisted habitat and species				

Zostera and Halophila mixed	Not listed under EPBC Act	KFH Type 1 | highly sensitive habitat Zostera, hetero zostera, halophila and ruppia species of seagrass beds >5m2 in area	9,000 m2	Other seagrass (Type 1 KFH) Total area: 20,589 m2
Halophila			11,589 m2	
Marine rocky reefs		KFH Type 2 | moderately sensitive habitat Estuarine and marine rocky reefs	3,683 m2	Macroalgae (Type 2 KFH) Total area 3,683 m2
Macroalgae			Covered in the same area as the rocky reef	

6.1.2 Seagrass Monitoring Program (MCoA E13)

In addition to the baseline survey conducted during the EIS, Appendix 3 describes the seagrass monitoring methodology that was undertaken to meet the requirements of MCoA E13. The Seagrass Monitoring Program includes baseline (pre-construction), construction and operational surveys.

The pre-construction monitoring requires four surveys between 2021 and 2023, which includes two summers and two winters surveys. These surveys were undertaken to obtain a sufficient baseline dataset. It is required to determine baseline areal extent and condition of seagrasses both within and adjacent to the Project boundary to guide final offset requirements and provide for a foundation by which any change in seagrass extent can be monitored.

Baseline results

The pre-construction baseline surveys have found that the Halophila and Zostera seagrass beds that dominate the Survey Areas are highly variable in spatial and temporal extent, all the while having declined substantially over the last two years (Niche, 2023).

In comparison, *Posidonia australis* areal extent and condition remained relatively stable, although declines in shoot density were evident in some areas. The large-scale changes and reductions in seagrass extent in the Survey Area across the Baseline Surveys is attributed to environmental disturbances as a result of extreme weather events that occurred along the Australian East Coast over the last two years.

6.1.3 Updated MBOS calculations based surveys 2022/23

The finding from the baseline surveys discussed in Section 4.2 is used to guide the revised seagrass offset calculations. The seagrass within the Project boundary at both La Perouse and Kurnell are dominated by Halophila and Zostera beds, which have typically declined in areal extent since the start of baseline surveys. *Posidonia australis* seagrass beds have a much lesser contribution to areal extent of seagrass with the Project boundaries at La Perouse and Kurnell.

Table 6-2 below shows the prices set to compensate for the loss of a square meter of marine habitat in 2013, the policy requires that CPI be added to the 2013 price. The approach uses the Reserve Bank of Australia online CPI calculator. The DPI Fisheries Policy also requires compensation to be paid at a minimum 2:1 to account for direct and indirect impacts.

Table 6-2: Compensation rate for marine vegetation

2013		2022	
square meter price	minimum compensation ratio 2:1	square meter price	minimum compensation ratio 2:1
$51/m^2$	$102/m^2$	$62.73/m^2$	$125.46/m^2$

The section below provides an offset calculations and monetary bond estimate using the following methodology.

- The buffer and footprint areas are used to calculate KFH from (Niche 2023)
- The average of the four baseline surveys (Niche, 2023) was used for Zostera, Halophila and macroalgae/marine rocky reef.
- The maximum extent of *Posidonia australis* from the four surveys was used to calculate offset requirements
- A more conservative application for areas of *Posidonia australis* is also reflective through the use of the EPBC offset calculation.

Table 6-3: New Consolidated habitat groups and areas (2023) – MCoA E16 - 4 baseline surveys

Habitat and species as identified in the EIS	EPBC Act listing	FM Act	Areas m^2	Consolidated groups and areas
Listed habitat and species				
Posidonia australis	Seagrass meadows (*Posidonia australis*) of the Manning-Hawkesbury Ecoregion – TEC Endangered Community	KFH Type 1 | highly sensitive habitat *Posidonia australis* Endangered population	268 m2	*Posidonia australis* (Type 1 KFH) Total area: 268 m2
Posidonia australis mixed with Halophila or Zostera				
White's seahorse	Endangered	KFH Type 1 | highly sensitive habitat Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act (see note 1) Endangered	Contained within the above area	
Unlisted habitat and species				
Zostera and Halophila mixed	Not listed under EPBC Act	KFH Type 1 | highly sensitive habitat Zostera, hetero zostera, halophila and ruppia species of seagrass beds >5m2 in area	6537 m2	Other KFH (Type 1 and Type 2) Total area 7520 m2
Halophila				
Marine rocky reefs			2939 m2	

Macroalgae		KFH Type 2 | moderately sensitive habitat Estuarine and marine rocky reefs		

A bank guarantee is required to be provided to DPI Fisheries in accordance with the MCoA E19. Table 6-4 describes the calculations and final bond value to DPI Fisheries. Recently Treasury Direction (TD22-23; December 2022) precludes the issue of a bank guarantee from Transport for NSW to DPI Fisheries, resulting in an administrative impasse.

Due to this administrative impasse, MCoA E19 has been requested to be deferred and approved by DPE for a maximum of 180 days to allow the Treasury Direction (TD22-23); December 2022) to be amended to allow the bank guarantee between Transport for NSW and DPI Fisheries to occur

Table 6-4 Bank guarantee calculation 2023

Habitat	Offset size determination method	Approved Estimated maximum impact (m2)	Required offset size (m2)	Cost (per m2 impact area) 2:1	Full bank guarantee value
Posidonia australis *Posidonia australis*	EPBC offset calculator	268	**770***	$62.73*	$48,302.10*
White's Seahorse	EPBC offset calculator	Contained with *Posidonia australis*		$62.73*	$48,302.10*
Halophila/Zostera	2:1 requirement for KFH	6537	**13,074**	$125.46	$820,132.02
Rock, reef and rubble / macroalgae	2:1 requirement for KFH	2939	**5878**	$125.46	$368,726.94
				Total monetary bond	$1,285,463.16
***Area of offset calculated by EPBC offset calculator, the rate applied was from the DPI Fisheries Policy, a 1:1 rate was applied to the offset area as the offset area has satisfied DPI Fisheries 2:1 requirement**					

MCoA E18 requires that a minimum of 50% of the bank guarantee value of the offsets are to be directed to direct offset activities. Transport for NSW will provide above the required bank guarantee value to DPI Fisheries with an expenditure of direct offset activities being approximately **250.73%** of the bond value.

Table 6-5 describes the value of the direct and indirect spend on offsets of the MBOS to ensure compliance with the MCoA E18.

Table 6-5 Offsetting cost estimate and reinvested bank guarantee contribution.

Offset	Type and Benefit	Location	Estimated value ($)	% of Impact offset for EPBC Act and FM Act Requirements
Rehabilitate and improve existing *Posidonia australis* habitat, including • transplanting materials from the project area; and • fragment collection and planting	Directly improving existing habitat for the protected matter/ *Posidonia australis* KFH	Locations in identified in section 5.4 and Appendix 6	$2,400,000	**100%** endangered *Posidonia australis* habitat listed under EPBC and FM Acts. **100%** endangered White's seahorse habitat listed under EPBC and FM Acts. Spend on direct offsets – **211.15%**
Enhancement of the proposed wharves/artificial habitat to improve threatened species habitat (eg seahorse hotels for White's seahorse).	Direct - improving habitat and reducing threats to a protected matters/ macroalgae KFH.	Botany Bay	$450,000?	100% endangered White's seahorse habitat listed under EPBC and FM Acts. Net gain of 59.45m2 of potential White's seahorse habitat (Section 5.2) Spend of total direct offsets – **39.58%**
Improve and protect existing *Posidonia australis* , Zostera, Halophila and macroalgae habitats	Installation of Environmentally Friendly Moorings	*Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion ecological community Botany Bay	To be determined as part of the detailed Implementation Plans	To be determined as part of the detailed Implementation Plans
Support important research and gains in knowledge and upskilling Gamay Rangers (e.g.,seagrass transplanting and rehabilitation)	Indirect – enhancement of KFH through and/or threatened population through supporting important research	Proposed locations in section	Supporting important research is an indirect benefit of undertaking the MBOS with UNSW and Gamay Rangers	**0%** of original monetary bond requirement for KFH. However, undertakingactivities described in the MBOs will provideopportunities for the research and development as proposed in Section 6
Total			**$2,850,000**	Combine **250.73%**of the monetary bond

7. Direct offset actions – *Posidonia australis*

The following are the direct offset actions to be undertaken to meet the Project offset requirements

Direct offsets are defined as, 'those actions that provide a measurable conservation gain for an impacted protected matter'.

The MBOS focuses on the offsets that will deliver the best and most tangible outcomes. This being invest in *Posidonia australis* translocation, *Posidonia australis* rehabilitation and in artificial reef structures such as seahorse hotels.

7.15.1 *Posidonia australis* translocation and rehabilitation sites

A detailed Site Selection and Validation Report can be found in Appendix 6 and has been prepared by UNSW. This report provides details in the identification of appropriate rehabilitation sites for the translocation and rehabilitation of *Posidonia australis*.

7.25.2 *Posidonia australis* translocation

A detailed Implementation Plan #1 is provided in Appendix 4 which has been prepared by UNSW. This Implementation Plan outlines the strategy, methodology and approach for the translocation of *Posidonia australis* from the project impact area to rehabilitation sites at Kurnell.

7.35.3 *Posidonia australis* rehabilitation

A detailed Implementation Plan #2 is provided in Appendix 5 which has been prepared by UNSW. This Implementation Plan outlines the strategy, methodology and approach for the additional beach collection of naturally detached fragments, storage and planting of *Posidonia australis* to rehabilitation sites at Kurnell.

7.45.4 Success Criteria – *Posidonia australis* translocation and rehabilitation

Measures of success account for the slow growth of *Posidonia australis* and align with the Project approvals.

The success of the *Posidonia australis* offsetting strategy will be assessed against the most appropriate measure for each criterion including:

- the impact area i.e., Kurnell wharf footprint and 15 metre buffer (areal extent and shoot density) based on baseline monitoring results;
- the baseline offset site conditions (shoot density, i.e., zero *Posidonia australis* shoot density in bare, unvegetated boat mooring or cable scars); and reference sites (long-term shoot density).

Note: The three primary success criteria are related to the direct offsetting actions for *Posidonia australis*, while the secondary measure of success is related to indirect offsetting actions that are expected to lead to beneficial outcomes.

Table 7-1: *Posidonia australis* offsetting success criteria and measures over short, mid and long-term period of the restoration program.

Criteria	Measure	Pre construction	Short term success	Criteria	Measure
Primary success criteria					
Removal of all *Posidonia australis* to be impacted	All *Posidonia australis* successfully transplanted from the impact area to offset sites	Removal and recording of all *Posidonia australis* shoots from impact area prior to construction (Kurnell) Storage of shoots for no longer than 72 hours until transplanting is complete.			
Increase in area of *Posidonia.*	Areal extent of restored *Posidonia australis* meets EPBC offset requirements.	-	Areal extent of restored *Posidonia australis* is to a 1:1 ratio of area removed from the impact area.	Areal extent of restored *Posidonia australis* is to a 2:1 ratio of area removed from the impact area.*	Areal extent of restored *Posidonia australis* combined with additional offsetting measures^ meets or exceeds the EPBC offset requirement. *
Goal: 536m^2 .	Minimum value:	-	268m^2	536m^2	536m^2
Maintain *Posidonia australis* density.	Shoot density of restored *Posidonia australis* (based on 0.25m2 quadrats).	-	Increase in shoot density in the offset sites from bare to vegetated at a minimum density of 25 shoots per square meter (>50% of the impact area density).	Maintain *Posidonia australis* density.	Shoot density of restored *Posidonia australis* (based on 0.25m2 quadrats).
Goal: 42 shoots/m^2 (refer to Appendix 6 - Site Selection and Validation Report in the MBOS).	Minimum value:	-	25 shoots/m^2	32 shoots/m^2	42 shoots/m^2
Secondary success criteria					
Support for improved techniques and methodologies in seagrass restoration.	Publication of materials that advance the knowledge of seagrass restoration in NSW.	-	Documentation of successful methodologies and conditions for translocation, planting and monitoring of seagrass shoots.	Documentation of improvements resulting from adaptive approaches leading to higher seagrass density and greater health indicators. *	Development of improved indicators of ecosystem health (e.g. using photogrammetry), documentation of management or operational improvements to achieve indicators of seagrass restoration success. *

** Contributes to meeting Posidonia australis restoration KPI in MBOS*

^ Additional offsetting measures such as installation of Environmentally Friendly Moorings in Posidonia australis meadows are identified in Section 5.7 of the MBOS. An implementation plan and success criteria for additional offsetting measures would be prepared in consultation with the MBOS Implementation Reference Panel and other project stakeholders during 2023.

7.5 *Posidonia australis* seagrass meadow – Environmentally Friendly Moorings Installation

Environmentally Friendly Mooring would be delivered as part of the MBOS in or within 10m of *Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion ecological community. Detailed Implementation Plan would be developed within four months from the date of revision 3 of the MBOS and delivered soon after. The Implementation Plans would be reviewed and endorsed by the MBOS IRP.

8. Direct Offsets - Artificial habitats – Seahorse Hotels

A detailed Implementation Plan will be developed and endorsed by the MBOS IRP prior to thecommencement of any offset works related to the seahorse hotels. The detailed Implemetnation Plan would developed within four months of the endorsing of revision 3 of the MOBS, with the Seahorse Hotels delivered shortly after.

9. Direct Offsets – Zostera, Halophila and macroalgae

Environmentally Friendly Mooring would be delivered as part of the MBOS in or witin 10m to Zostera, Halophila seagrass meadows or marcoalgae. Detailed Implementation Plan would be developed within four months from the date of revision 3 of the MBOS and delivered soon after. The Implementation Plans would be reviewed and endorsed by the MBOS IRP.

10. Additional beneficial outcomes

Other compensatory measures are those actions that do not create a direct offset but are anticipated to lead to benefits for identified offset species such as funding for research or educational programs. The compensatory measures should be established to quantify the effectiveness of compensation measures.

The MBOS would be delivered to provide direct offsets discussed in Section 5, however the implementation and monitoring of the MBOS by a research institute would provide for the further research on the seagrass translocation and artificial habitat for Syngnathid.

The compensatory measures for research and education are outlined in the Commonwealth Environmental Offset Policy and the DPI Fisheries Policy.

10.1 Aboriginal engagement

Throughout this process opportunities have been sought to include, and consult with, the Gamay Rangers and the La Perouse Aboriginal Land Council to ensure their inputs are addressed, including:

- Invitation to the second workshop to review and discuss the MBOS
- Invitation/access to tender for the rehabilitation work
- Continue ongoing communication.

In line with the NSW Government Aboriginal Procurement Policy, Transport for NSW has included a weighted requirement in the tender for the completion of the transplant and rehabilitation work so that the local Aboriginal community involvement continues.

10.2 Research

The completion of the offset work would support further research into transplanting seagrass

The successful translocation of seagrass would provide valuable information for the development of feasible restoration programs for the endangered *Posidonia australis* community in Sydney.

The general expenditure of the rehabilitation work would provide research opportunities through the methods applied, the collection of data over time, and application of a physical direct offset for managing impacts to *Posidonia australis*

.

Delivery of the rehabilitation work would be carried out by a research institute that would use results to provide peer reviewed research.

This offset would be implemented through financial contributions that could be bolstered through grants and collaboration, with potential for attraction of and securing additional Government research funding. The effort in carrying out the rehabilitation work would directly benefit the development of better understanding in *Posidonia australis* and other seagrass research. As such, the cost of completing the proposed rehabilitation would provide the direct seagrass offset and the indirect research contribution as allowed in the EPBC Offset Calculator.

The full breakdown of how the EPBC commitments have been made can be found in section 2.3 and Appendix 1.

11. Success of Offsets

If the measures described in Section 5 are not successful as determined by the MBOS Implementation Reference Panel. Alternative or additional offset measures could be implemented to ensure Transport for NSW meets its offset obligations.

If alternative or additional offsetting measure such as the payment of the bank guarantee is required, the following process would occur:

a) MBOS Implementation Reference Panel would agree that additional offsetting measures or payment of the bank guarantee would be required for Transport for NSW to meet its offset obligations;

b) Additional measures including the full or partial payment of the bank guarantee would be agreed with the MBOS Implementation Reference Panel in consultation with DPE and DCCEEW.

Implementation of the additional offsets or draw down from the bank guarantee as requried at the end of the project or when otherswise determined by the MBOS Implementaiton Panel.

A bank guarantee is required to be provided to NSW Fisheries in accordance with the MCoA E19. Table 6-4 describes the calculations and the bank guarantee to be paid to DPI Fisheries. Recently Treasury Direction (TD22-23; December 2022) precludes the issue of a bank guarantee between government agencies such as between Transport for NSW to DPI Fisheries, resulting in an administrative impasse.

Due to this administrative impasse, a deferral of MCoA E19 requested to be deferred and approved by DPE for a maximum of 180 days to allow the Treasury Direction (TD22-23); December 2022) to be amended to allow the bank guarantee between Transport for NSW and DPI Fisheries to occur.

12. Management and Reporting

12.1 Reporting

12.1.1 Interim Summary Monitoring Report

The first Interim Summary Report would be prepared following the first monitoring event within the overall monitoring program (expected late 2023) and would be repeated for four further monitoring instances with the final report prepared in about late 2027.

The Interim Summary Report would include, but not be limited to the following information:

- Activities undertaken including any translocation, beach collection and planting
- Results from each monitoring site.
- Brief overview of any change in *Posidonia australis* health and overall seagrass habitat condition
- Opportunities to address any changes that were observed
- Post-storm reporting (if any)
- Details of any management issues
- Recommendations to ensure adaptive management and/or corrective actions are considered.

12.1.2 Annual Marine Biodiversity Offset Report

An Annual Marine Biodiversity Offset Report would be prepared and include, but not be limited to the following information:

- Results from each monitoring site, including mortality and survival rates of *Posidonia australis*
- Overview of progress against success criteria detailed in the MBOS
- Details of translocation and/or rehabilitation activities over the 12 month period
- All data and photographs collected over the 12 month period plus, where applicable, comparisons to previous years' data
- Description of rectification works carried out as a result of ongoing monitoring
- Unexpected impact report
- Details of any management issues
- Recommendations and summary of adaptive management and/or corrective actions undertaken or to be considered.
- Any other information requested by MBOS Implementation Reference Panel.

A conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.

The Marine Biodiversity Offset Reports will be provided to the MBOS Implementation Reference Panel and submitted to the DCCEEW as part of the Projects Annual Compliance Report.

The Marine Biodiversity Offset Report will continue until at least the 10th anniversary of the commencement of the action unless otherwise agreed by the MBOS Implementation Reference Panel and in writing by the DCCEEW.

12.1.3 Operational impact assessment report

As part of the MCoA 20 an Operational Impact Assessment Report will be prepared on impacts to marine biodiversity following 12 months of the full operation of the ferry wharves.

This report includes the following:

- results of before and after monitoring of all seagrass species, Whites Seahorse, populations and habitats impacted by the ferry wharf structures and associated commercial and recreational vessel uses

The Operational Impact Assessment Report will be submitted to the MBOS Implementation Reference Panel for review no later than six (6) months after the 12-month full operation period;

The Operational Impact Assessment Report be used to review the MBOS no later than six (6) months after the submission of the Operational Impact Assessment Report to the MBOS Implementation Reference Panel.

12.1.4 Rehabilitation monitoring review

A Rehabilitation Monitoring Review is required to be undertaken as outlined in the Commonwealth CoA 12 to assess the ongoing success of the MBOS.

Each Rehabilitation Monitoring Review will include:

- a review of the monitoring methodology(ies) by a suitably qualified person;
- a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person; and
- if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics:
- a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and
- justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.

The Rehabilitation Monitoring Review will be provided to the MBOS Implementation Reference Panel and submitted to the DCCEEW within 6 years of the approval of the Commonwealth Conditions of Approval (dated 17 March 2023), and every 5 years thereafter.

12.2 Review and Improvement

This section described the commitments around adaptive management and continued consultation with stakeholders

12.2.1 Continuous improvement

The MBOS would be adaptive, meaning it would be reviewed and analysed to determine its effectiveness.

Continuous improvement would be achieved by ongoing site specific evaluation; this may include updating the MBOS, the development of procedures and plans to be attached to the MBOS to ensure the effective implementation.

The MBOS would be updated as required or determined by the MBOS Implementation Reference Panel as described in Section 3.2.1 and Appendix 2.

12.2.2 MBOS update and amendments

The processes described in Section 3.2.1 may result in the need to update or revise the MBOS. This would occur in response to:

- Site specific requirements such as locations, collection, holding, transplanting, and rehabilitate seagrass
- Results of monitoring.
- Requirements of the MCoA and EPBC CoA.
- Improvements in techniques or knowledge that may result in improvement to the MBOS activities

Transport for NSW would review and update the MBOS in consultation with the MBOS Panel and where significant changes to the MBOS have occurred, a copy of the updated MBOS would be distributed to all relevant stakeholders and additional parties as needed

13. Terms and acronyms

Table 12-1 Terms and acronyms

Term / Acronym	Description
BC Act	*Biodiversity Conservation Act 2016* (NSW)
CEMP	Construction Environmental Management Plan
CoA	Conditions of Approval
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DPE	NSW Department of Planning and Environment
DPI Fisheries	NSW Department of Primary Industries Fisheries
EEC	Endangered ecological community
EFM	Environmentally friendly moorings
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FM Act	*Fisheries Management Act 1994* (NSW)
ha	Hectares
Habitat	An area or areas occupied, or periodically or occasionally occupied by a species, population, or ecological community, including any biotic or abiotic component (OEH2014).
KFH	Key Fish Habitat
KPI	Key Performance Indicators
m	meters
m^2	Square meters
MBAR	Marine Biodiversity Assessment Report
MBOS	Marine Biodiversity Offset Strategy
MCoA	NSW Ministers Conditions of Approval
MNES	Matters of National Environmental Significance. MNES are protected by provision ofPart 3 of the EPBC Act.
NSW	New South Wales
NSW Fisheries Policy	Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)
OEH	NSW Office of Environment and Heritage
Project area/ Proposal site	“The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store constructionmaterials” (OEH, 2014). RtS Response to Submission
SEARs	Secretary’s Environmental Assessment Requirements
Seagrass rehabilitation	Inclusive of techniques of transplanting, translocation, replanting revegetating, andplanting.
SSI	State Significant Infrastructure
Study area	“The area directly affected by the development and any additional areas likely to beaffected by the development, either directly or indirectly” (OEH 2014).
TECs	Threatened Ecological Communities
Transport for NSW	Transport for New South Wales
The Project	Kamay Ferry Wharves Project
UNSW	University of New South Wales

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Appendix 1 – EPBC Calculator

Assessment of Suitability

The potential offsets that have been considered against the selection criteria identified in Section 5.4 are detailed in Table A1-1.

The strategy proposed has undertaken a number of reviews through Transport for NSW, Arup and specialist inputs as well as through the consultation with NSW Fisheries and DCCEEW. As such the approach has been modified to focus on the preferred offsetting methods of seagrass rehabilitation and provision of artificial reef structures.

Previous considerations have been left in the table below to show process of other considerations.

The calculated offset provided below are fully achieved through providing direct offsetting of rehabilitation and to not require additional offsets to balance the outcome.

The following offset strategies are considered the most appropriate for the Project:

- Rehabilitation of seagrass habitat – (*Posidonia australis*)
- Creation of artificial habitat (under the proposed wharves for White's Seahorse)
- Support for further research into transplanting seagrass (through grants and collaboration which feeds into the rehabilitation work)

Implementation Assessment

Implementation

The considered strategies and suitability is assessed in Section 5 of this report.

The MBOS meets the 100% direct offset requirements of the EPBC Offset Calculator (Appendix 1), plus additional indirect offsets through research support, under the EPBC Act Policy for the Endangered *Posidonia australis* Ecological Community and potential habitat for the Endangered White's Seahorse (Table A1-4), associated with the *Posidonia australis* Ecological Community. The substantial additional offsets to that required under the EPBC Act Policy will provide assurances, should estimate inputs used to determine the offset requirement (EPBC calculator inputs) be found to be not as favourable as expected and/or additional impacts occur.

Additional information on the EPBC Calculator and inputs can be found here https://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-how-use.pdf

Table A1-1. Assessment of suitability matrix based on EPBC offsetting requirements.

	Rehabilitation of Seagrass Habitat - Transplanting	~~Rehabilitation of Other Aquatic habitats~~	~~Installation of signage and EFM~~	Creation of Artificial Habitat	Support for further research into transplanting seagrass	~~Seagrass Habitat Improvements – Catchment Water Quality and Pollution~~	~~Conservation agreements to protect intertidal and shoreline areas~~
Type of offset	Direct	~~Direct~~	~~Direct~~	Direct	Indirect	~~Direct~~	~~Indirect~~
Location of the offset	Botany Bay	~~Opportunities within Botany Bay~~	~~Can be implemented in Botany Bay~~	Botany Bay	Botany Bay	~~Botany Bay Catchment~~	~~Botany Bay (Taren Point)~~
Like for like offsets	Yes	~~No~~	~~Yes~~	No	Yes, but not directly	~~No~~	~~No~~
Ability for measurable conservation gain	Yes	~~Yes~~	~~Yes~~	Yes	Yes	~~Difficult~~	~~Difficult~~
Timeframe required to achieve conservation gain	1-10 Years	~~3-5 years~~	~~3-5 years~~	1-10 years	1-10 years	~~5-10 years~~	~~5-10 years~~
Level of offset uncertainty	Moderate*	~~Low~~	~~Moderate~~	Moderate	Moderate	~~Moderate~~	~~Low~~

*Based on recent success in Operation Posidonia

Table A1-2. Offset Strategy

Offset	Type	Location	Offset Size / Habitat Gain	Requirement
~~**Seagrass habitat improvements – catchment water quality and pollution (*Posidonia australis* habitat)**~~	~~Direct – reducing threats to a protected matter + improving existing habitat for the protected matter~~	~~Consult with NSW Fisheries - Investigate further recent losses in Quibray Bay~~	~~5 ha of *Posidonia australis* with current stressors from water quality and stormwater. Estimated gain (Net present value) = 0.67 ha*~~	~~Meets and exceeds requirement for direct offsets under the EPBC Act for *Posidonia australis* and White's Seahorse gain to meet offsetting requirements under the FM Act KFH~~
Rehabilitation of seagrass habitat – transplanting and planting naturally detached *Posidonia australis*)	Direct - creating new habitat for the protected matter	Botany Bay (Appendix 6)	Creation of approx. 770 m^2 of new habitat via transplanting and planting of naturally detached *Posidonia australis* (Appendix 4 and Appendix 5). Based on Success Criteria Table 5-2	To meet offsetting requirements under NSW and Commonwealth offset policies.
~~**Installation of signage and EFM**~~	~~Direct - creating new habitat for the protected matter and reducing threats to a protected matter + improving existing habitat for the protected matter~~	~~Consult with NSW Fisheries and UNSW on preferences on types of moorings, private mooring owners, Port of Botany.~~	~~Area dependent on the location and current mooring in place and or if casual moorings have been used. Based on upgrade of 10 moorings (Assumed average impact on KFH per mooring = 255m^2), estimated gain = 0.26 ha.~~	~~To meet offsetting requirements under the FM Act for KFH~~
Creation of artificial habitat (under the proposed wharfs for White's Seahorse)	Direct - creating new habitat for the protected matter	Subject site (proposed La Perouse and Kurnell wharfs)	Approx. 0.1 ha. To be determined following review of detailed design. Estimated gain = 0.1 ha	To meet offsetting requirements under the FM Act for KFH

Offset	Type	Location	Offset Size / Habitat Gain	Requirement
Support for further research into transplanting (through grants and collaboration)	Indirect – would be linked to assisting in delivery and monitoring success of transplant program	Botany Bay (Appendix 6)	N/A.	Provides additional indirect offsets under the EPBC Act for *Posidonia australis* and White's Seahorse. To meet offsetting requirements under the FM Act for KFH.

* refer to Appendix 1 and 2 for quality assumptions used in the EPBC Offset Tool.

Table A1-2. Cost estimate table of offset (now revised in main report).

Offset	Type and Benefit	Location	Estimated value ($)	% of Impact offset for EPBC Act and FM Act Requirements
Rehabilitate and improve existing *Posidonia australis* habitat (including transplanting of materials from the project area).	Direct improving existing habitat for the protected matter/ *Posidonia Australis* KFH	Botany Bay (Appendix 6)	**$2,600,000** Includes the EPBC calculated offset cost – Posidonia australis Direct contribution to rehabilitation effort.	**100%** endangered *Posidonia australis* habitat listed under EPBC and FM Acts. **100%** endangered White's seahorse habitat listed under EPBC and FM Acts. Spend on direct offsets - **187.32%**
~~Installation of signage and EFM~~	~~Direct - improving habitat and reducing threats to a protected matters/ all KFH.~~	~~Consult with NSW Fisheries on preferences for types of moorings, private mooring owners, Port of Botany.~~	~~$325,000~~	~~11.2% of original monetary bond requirement for KFH~~
~~Provision of infrastructure to improve water quality (eg vessel pump out facility)~~	~~Direct – improving water quality, habitat and reducing threats to a protected matters / all KFH.~~	~~Subject site (proposed La Perouse and/or Kurnell wharfs)~~	~~$325,000~~	~~11.2% of original monetary bond requirement for KFH~~

Offset	Type and Benefit	Location	Estimated value ($)	% of Impact offset for EPBC Act and FM Act Requirements
Enhancement of the proposed wharfs/artificial habitat to improve threatened species habitat (eg seahorse hotels for White's seahorse).	Direct - improving habitat and reducing threats to a protected matters / macroalgae KFH.	Subject site (proposed La Perouse and/or Kurnell wharfs)	**$450,000** Includes the EPBC calculated offset cost – Whites Seahorse Direct contribution to rehabilitation effort	**100%** endangered White's seahorse habitat listed under EPBC and FM Acts. Net gain of **59.45m^2** of potential White's seahorse habitat (Section 5.2) Spend of total direct offsets – **32.42%**
Support important research e.g. seagrass transplanting and rehabilitation	Direct and Indirect – enhancement of KFH through and/or threatened population through supporting important research	Botany Bay (Appendix 6)	Supporting important research is an indirect benefit of undertaking the MBOS with UNSW and Gamay Rangers	**0%** of original monetary bond requirement for KFH. However, undertaking activities described in the MBOs will provide opportunities for the research and development as proposed in Section 6
Total			**$3,050,000**	Combine **219.74%** of the monetary bond

Success Criteria – Posidonia australis

Success criteria refer to Section 5.4

Success Criteria – Whites Seahorse

Success criteria refer to Section 5.5.5

2 October 2012

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Potential habitat loss	**Area**	0.027	Hectares	EIS Chapter + Condition thresholds for PS
			Quality	**5**	Scale 0-10	
			Total quantum of impact	0.01	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	FALSE	Adjusted hectares	Seagrass Habitat (P. australis) artifical reef habitats	**Time over which loss is averted (max. 20 years)**	10	**Start area (hectares)**	0.077	**Risk of loss (%) without offset**	50%	**Risk of loss (%) with offset**	25%	0.02	50%	0.01	0.01	0.01	100.07%	Yes	$48,302.10	DPI Fisheries
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.1								
					Time until ecological benefit	3	**Start quality (scale of 0-10)**	**5**	**Future quality without offset (scale of 0-10)**	**3**	**Future quality with offset (scale of 0-10)**	**7**	4.00	50%	2.00	1.93				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0.0134	0.01	100.07%	**Yes**	$48,302.10	N/A	$48,302.10
Area of community	0				$0.00		$0.00
					$48,302.10	**$0.00**	**$48,302.10**

2 October 2012

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	Yes	Loss	**Area**	0.027	Hectares	EIS Chapter + Condition thresholds
			Quality	**5**	Scale 0-10	
			Total quantum of impact	0.01	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes	FALSE	Adjusted hectares	Seagrass Habitat (P. australis) Improvements – Catchment Water Quality and Pollution e.g. WSUD etc	**Risk-related time horizon (max. 20 years)**	10	**Start area (hectares)**	0.077	**Risk of loss (%) without offset**	50%	**Risk of loss (%) with offset**	25%	0.02	50%	0.01	0.01	0.01	100.07%	Yes	$48,302.10	DPI Fisheries
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.1									
					Time until ecological benefit	3	**Start quality (scale of 0-10)**	**5**	**Future quality without offset (scale of 0-10)**	**3**	**Future quality with offset (scale of 0-10)**	**7**	4.00	50%	2.00	1.93					
Threatened species habitat																					
Area of habitat	No				**Time over which loss is averted (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**										
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0									
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**										
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0				$0.00		$0.00
Area of community	0.0134	0.01	100.07%	**Yes**	$48,302.10	N/A	$48,302.10
					$48,302.10	**$0.00**	**$48,302.10**

Appendix 2 – Terms of Reference – MBOS Implementation Reference Panel

Kamay Ferry Wharves Marine Biodiversity Offset Strategy Implementation Reference Panel – Terms of Reference

Background

Transport for New South Wales (Transport for NSW) is reinstating the ferry wharves at La Perouse and Kurnell in Botany Bay (the Project). The project is classified as State Significant Infrastructure (SSI) under the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project was also confirmed to be a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A Marine Biodiversity Offset Strategy (MBOS) has been prepared as part of the project approval to provide a strategy for managing and mitigating the residual impacts of the Project and to comply with the Project Condition of Approval (both State and Commonwealth).

The MBOS documents how Transport for NSW will meet its marine biodiversity offset obligations. It also covers how these actions will be implemented in consultation with relevant agencies and stakeholders.

As part of the implementation of the MBOS, an Implementation Reference Panel is to be established for the life of the MBOS (ten (10) years from the date of MBOS approval).

Role of the MBOS Implementation Reference Panel

The primary function of the MBOS Implementation Reference Panel is to provide advice as required by the in the Project's Infrastructure Approval SSI-10049 .

Specifically, the MBOS Implementation Reference Panel will advise on: :

- Marine biodiversity monitoring as required by Condition E16;
- Recommend changes to the MBOS over the life of the MBOS; and
- Review the Operational Impact Assessment Report required by Condition E20.

In accordance with Condition E16, the MBOS Implementation Reference Panel would hold regular meetings to discuss and provide advice on monitoring data, updates to the MBOS (if required) and implementation of the MBOS.

The role and responsibility of each of the organisations represented on the Implementation Reference Panel are discussed below,

Organisation	Role	Responsibility
Transport for NSW	Transport for NSW is the proponent for the Project..	As the Proponent, Transport for NSW will be responsible for complying with project approval conditions including but not limited to: • Preparation of documents including meeting agendas, minutes of meetings, reports and data;

		• Responding to advice from the MBOS Implementation Reference Panel, relevant agencies and the community • Engaging the Independent Scientist for the life of the MBOS; and • Implementation and financing of the MBOS and associated plan, reports, strategies required by the Infrastructure Approval.
NSW Department of Primary -Fisheries (DPI Fisheries)	DPI Fisheries role is to provide advice on the implementation of the MBOS to ensure the Transport for NSW meets its obligations under the Project conditions of approval.	• Provide general specialist advice and recommendations on the implementation of the MBOS. • Review and provide specific advice on the implementation of Conditions E13, E16, E18 and E20. Note: As per the Conditions of Approval DPE Fisheries will also be consulted on other Conditions of Approval not specifically related to the MBOS as required Infrastructure Approval.
NSW Department of Planning and Environment (DPE)	DPE is the NSW planning consent and regulatory authority for the Project. DPE will be an observer on the MBOS Implementation Reference Panel.	• Ensuring compliance with the NSW Infrastructure Approval • Be an observer on the MBOS implementation Reference Panel; Assist in mediation and resolution of issues (if required).
Commonwealth Department of Climate Change, Energy, Environment and Water (DCCEEW)	DCCEEW is the Commonwealth consent and regulatory authority for the Project. DCCEEW will be an observer on the MBOS Implementation Reference Panel	• Ensuring compliance with the Commonwealth Approval • Assist in mediation and resolution of issues (if required).
Bio-Analysis Pty Ltd	Bio-Analysis Pty Ltd is a specialist in ecological investigations in marine, estuarine and freshwater ecosystems. Bio-Analysis Pty Ltd will provide the Independent Scientist for the MBOS Implementation Reference Panel.	• The independent Scientist identified in Condition E16; • Provide general specialist advice and recommendations on the implementation of the MBOS.

		• Review and provide specific advice on the implementation of Conditions E13, E16, E18 and E20.

Roles and Responsibility of the members of the MBOS Implementation Reference Panel

The membership of the MBOS Implementation Reference Panel is defined in Condition E16 of the Project Infrastructure Approval.

Name	Role	Organisation	Reason for membership	Responsibility
Dr Daniel Roberts	Chair and Independent Scientist	Bio-Analysis	Condition E16 requires that an suitable qualified, experienced and independent scientist to be included in the as part of the MBOS Implementation Reference Panel.	• Arrange Agendas • Lead meetings • Lead decision-making process • Review and provide advice on biodiversity monitoring data (Condition E13) • Review and provide advice on updates to the MBOS (Condition E16 and E18) • Review and provide advice on the Operational Impact Assessment (E20) • Endorse advice from the members of the MBOS Implementation Reference Panel to be provided to Transport for NSW
Sarah Conacher	Member	Department of Primary Industries – Fisheries Coastal Management	DPI Fisheries is responsible for ensuring that fish stocks are conserved and that there is no net loss of key fish habitat upon which they depend.	• Regularly attend and participate in meetings • Contribute their skill, knowledge and experience to the MBOS Implementation Reference Panel • Review and provide advice on biodiversity monitoring data (Condition E13) • Review and provide advice on updates to the MBOS (Condition E16) • Review and provide advice on the Operational Impact Assessment (E20)
Dr Timothy Glasby	Member	Department of Primary Industries –	DPI Fisheries Marine Research delivers scientific information to enable biodiversity conservation	• Regularly attend and participate in meetings

		Marine Research	and sustainable use of the NSW Marine estates including the Marine, Estuarine and Coastal systems.	• Contribute their skill, knowledge and experience the MBOS Implementation Reference Panel • Review and provide advice on biodiversity monitoring data (Condition E13) • Review and provide advice on updates to the MBOS (Condition E16) • Review and provide advice on the Operational Impact Assessment (E20)
Christopher Williams	Member	Transport for NSW	Transport for NSW is the proponent of the Kamay Ferry Wharves Project (SSI-10049).	• Regularly attend and participate in meetings • Contribute their skill, knowledge and experience the MBOS Implementation Reference Panel • Review and provide advice on biodiversity monitoring data (Condition E13) • Review and provide advice on updates to the MBOS (Condition E16) • Review and provide advice on the Operational Impact Assessment (E20)
Alisha Dabonde	Coordinator	Transport for NSW	Transport for NSW is the proponent of the Kamay Ferry Wharves Project (SSI-10049).	• Assist the Chair in the following activities: • Coordinate meeting among member of the MBOS Implementation Reference Panel • Coordinate and chase-up action items • Minutes taking/noting of agreed actions Prepare and circulate documents, reports, data (Condition E13, E16, E20), and agendas, minutes from each meeting.

Should a member leave or not be available to represent their organisation, the Chair will request that organisation to nominate a suitably qualified and experienced alternative member.

Observers

The Chair of the MBOS Implementation Reference Panel may invite observers from relevant agencies and other groups to attend its meetings.

Quorum

A majority of members of the MBOS Implementation Reference Panel must participate in the meetings.

Decision making

Condition E16 requires the MBOS Implementation Reference Panel to review and provide advice on the following:

- Marine biodiversity monitoring data from Condition E13;
- Advice on updates to the MBOS (Condition E16); and
- Review and provide advice on the Operational Impact Assessment (Condition E22).

Advice and recommendation, as endorsed by the Chair, will be distributed to Transport for NSW for consideration and action.

If mediation is required between the MBOS Implementation Reference Panel and Transport for NSW, the issues would be provided to DPE and/or DCCEEW by the Chair for resolution.

Operational arrangements

Meeting details

The MBOS Implementation Reference Panel is expected to meet at the frequencies shown in Table 3:

Meeting dates	Meeting frequency	Key Milestones
November 2022 - June 2023	Monthly	• Review marine biodiversity data (Condition E13) • Update to MBOS (if required)
July 2023 - July 2024	Quarterly	• Annual reporting • Updates to MBOS (if required)
July 2024 - July 2033	Yearly	• Annual reporting • Operational Impact Assessment (Condition E22) • Update to MBOS (if required)

Meeting would be held remotely via Microsoft Teams for approximately 1 hour for each meeting.

Additional meetings may be held at other times as decided by the Chair of the MBOS Implementation Reference Panel.

Communication and information management

The MBOS Implementation Reference Panel Coordinator will as a minimum:

- Coordinate meeting among member of the MBOS Implementation Reference Panel
- Coordinate and chase-up action items
- Minutes taking/noting of agreed actions
- Circulate documents, reports, data (Condition E13, E16, E18 and E20), agendas minutes from each meeting
- Consolidate advice for member of the MBOS Implementation Reference Panel

All reports and data will be provided in a format that can be accessed by each of the members of the MBOS Implementation Reference Panel.

Confidentiality

All information relating to the implementation of the MBOS is communicated to all attendees in the strictest confidence. The release of information to the public (excluding Government agencies) relating to the project should be agreed with Transport for NSW.

Reporting timeframes

It is expected the MBOS Implementation Reference Panel will report to DCCEEW and DPE at the completion of each year and provide a final report at the end of the MBOS implementation (minimum 10 years)

Appendix A – Glossary of terms

Term / Acronym	Description
DCCEEW	Commonwealth Department of Climate Change, Energy, Environment and Water
DPE	NSW Department of Planning and Environment
DPI Fisheries	NSW Department of Primary industries – Fisheries
EPBC Act	*Environment Protection Biodiversity Conservation Act 1999*
EP&A Act	*Environmental Planning and Assessment Act 1979*
MBOS	Marine Biodiversity Offset Package
The Project	As described in the Infrastructure Approval SSI-10049
SSI	State Significant Infrastructure
Transport for NSW	Transport for New South Wales

Appendix B – Marine Biodiversity Offset Strategy – NSW Conditions of Approval

Condition Reference	Condition
E12	The Proponent must ensure that the proposal is undertaken in accordance with the requirements of DPI Fisheries policy and guidelines, including the Policy and Guidelines for Fish Habitat Conservation and Management 2013, and the NSW Biodiversity Offsets Policy for Major Projects, Fact sheet: Aquatic biodiversity.
E13	The Proponent must allow for an additional winter and summer season in which to monitor marine biodiversity within the construction footprint prior to commencement of construction.
E14	The Proponent must satisfy the marine biodiversity offset obligations that specify the required offset size in accordance with the EPBC Act, Environmental Offsets Policy 2012, NSW Biodiversity Offsets Policy for Major Projects – Fact sheet: Aquatic Biodiversity. Evidence of this must be provided to the Planning Secretary, DPI Fisheries and DAWE for information, within 12 months of the commencement of construction.
E15	Areas of seagrass (Posidonia australis) and other seagrass beds (Type 1 KFH) and macroalgae (Type 2 KFH) that have been identified for removal or disturbance within the construction footprint at Kurnell and La Perouse must be offset in accordance with the MBOS and as agreed with DPI Fisheries and DAWE.
E16	Prior to the commencement of pre-construction seagrass transplantation, the Proponent must establish a MBOS Implementation Reference Panel to review data collected, including from the marine biodiversity monitoring as required by Condition E13 , recommend changes to the MBOS if required, and review the Operational Impact Assessment Report (see Condition 20). The MIRP must comprise representatives from the Proponent, DPI Fisheries-Coastal Systems, DPI Fisheries-Marine Research, DAWE, and DPIE Planning and Assessment, and include a suitably qualified, experienced and independent scientist. The MBOS Implementation Reference Panel must be operational for the life of the MBOS or as agreed by the Planning Secretary.
E17	The MBOS must have an operational life of no less than ten (10) years from the date of MBOS approval, unless otherwise agreed by the Planning Secretary.
E18	The MBOS may be reviewed and updated during its operational life as required and recommended by the MBOS Implementation Reference Panel. At least 50 per cent of the MBOS funding must be allocated to the restoration and rehabilitation of Posidonia australis and Zostera seagrass beds in consultation with the MBOS Implementation Reference Panel.
E19	Prior to marine Works, a bank guarantee to a value identified by the MBOS Implementation

	Reference Panel must be provided to DPI Fisheries to offset marine biodiversity impacts in accordance with the DPI Fisheries Policy and guidelines for fish conservation and management, and the NSW Biodiversity Offsets Policy for Major Projects, Fact sheet: Aquatic Biodiversity. The MBOS Implementation Reference Panel may use this bank guarantee to manage key fish habitats, threatened species and/or populations if planned activities as agreed under the MBOS are unsuccessful.
E20	An Operational Impact Assessment Report must be prepared on impacts to marine biodiversity following 12 months of the full operation of the ferry wharves. This report must: a) be submitted to the MBOS Implementation Reference Panel for review no later than six (6) months after the 12-month full operation period; b) include the results of before and after monitoring of all seagrass species, *Whites Seahorse*, populations and habitats impacted by the ferry wharf structures and associated commercial and recreational vessel uses; and c) be used to review the MBOS no later than six (6) months after the submission of the Operational Impact Assessment Report to the MBOS Implementation Reference Panel.

Appendix C - Marine Biodiversity Offset Strategy – Commonwealth EPBC Act Conditions of Approval

Condition Reference	Condition
10	The approval holder must comply with NSW Approval conditions E12 – E20 related to the requirements of the Marine Biodiversity Offset Strategy (MBOS) to compensate for the clearing of 0.0683 hectares of seagrass meadows and White's Seahorse habitat.
11	To monitor the outcomes of the MBOS for seagrass meadows and White's Seahorse habitat, the approval holder must include a Marine Biodiversity Offset Report as part of the compliance report until at least the 10th anniversary of the commencement of the action, unless otherwise agreed to in writing by the Minister. Each Marine Biodiversity Offset Report must include: a) a progress report on the implementation of the MBOS; b) a list of success metrics; c) details of the monitoring methodology(ies) implemented and the locations of reference sites; d) monitoring results including a comparison against reference sites; e) a summary of any adaptive management measures taken to improve implementation of the MBOS and/or monitoring methodology(ies); and a conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.
12	To assess the ongoing success of the MBOS, the approval holder must submit a Rehabilitation Monitoring Review to the department within 6 years of the date of this approval and every 5 years thereafter, unless otherwise agreed to in writing by the Minister. Each Rehabilitation Monitoring Review must include: a) a review of the monitoring methodology(ies) by a suitably qualified person; b) a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person; and c) if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics: i. a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.

Appendix 3 – Seagrass monitoring program

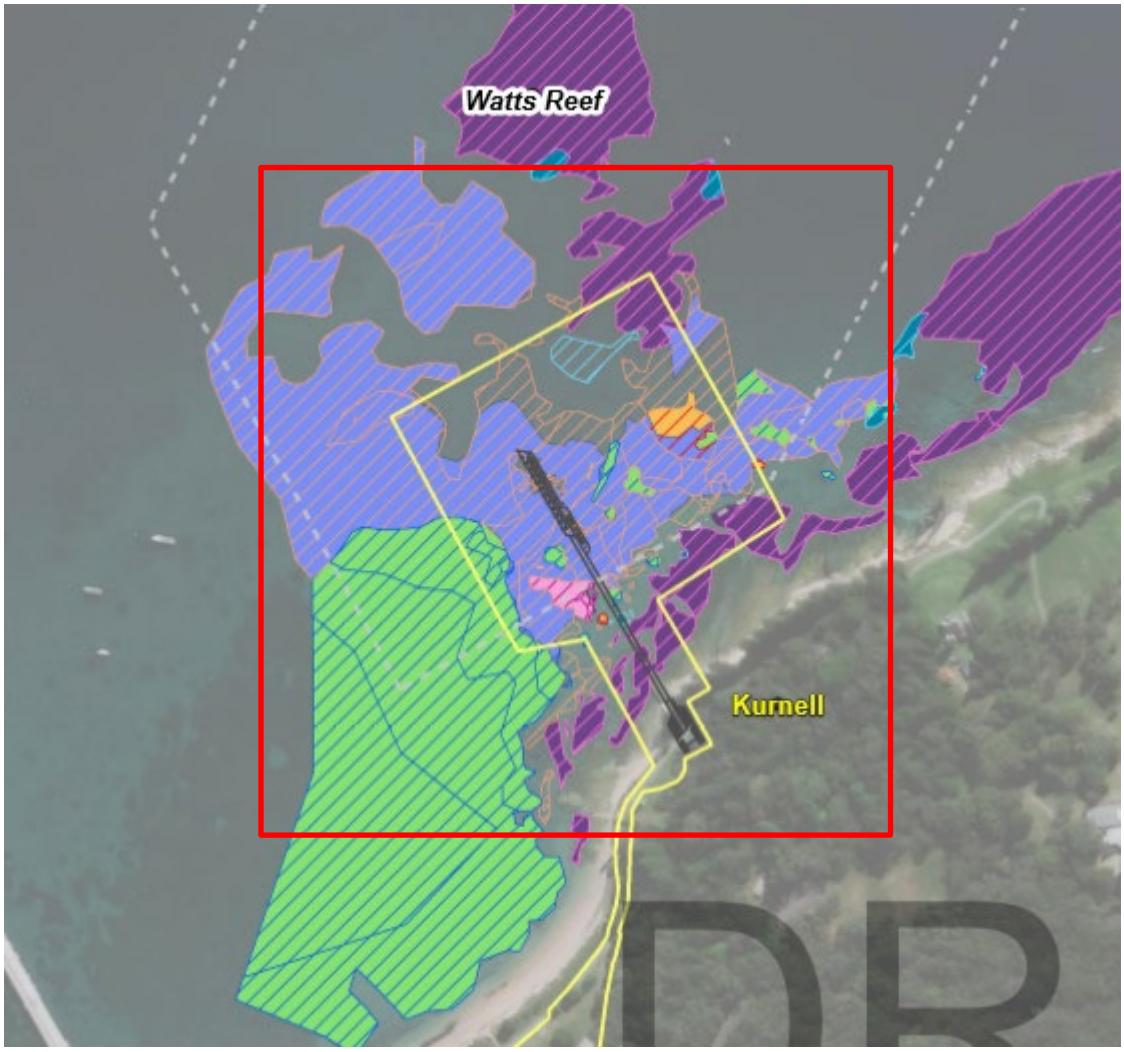
Seagrass Monitoring Methodology
It proposed to utilize a combination of the following:

- Seagrass distribution mapping;
- *Halophila* / *Zostera* bed drop camera surveys;
- Diver seagrass morphology surveys of *Posidonia* beds; and
- Detailed survey of *Posidonia* patches

Seagrass distribution mapping

Objective
To identify any large-scale changes in seagrass composition and distribution within the development area.

Survey Area
Map seagrass composition, distribution and estimated densities within red box. Areas outside development area will assist with understanding changes unrelated to activities within the development area.



Survey Frequency

Every 6 months or within four weeks following a major storm event that has potential to impact on seagrasses in the study area. This will likely result on average 3 surveys each year and potential within season duplication of surveys.

Before	During	After
Every 6 months with a minimum of two surveys before construction commences	Every 6 months with surveys scheduled to occur before and after piling works	Within 12 month of operation (MCoA E20).

Methodology

Preliminary desktop mapping should be undertaken using the latest near map imagery to identify the extend of potential shallow seagrass beds.

Field mapping to include verification of potential shallow seagrass beds identified from aerial imagery, mapping of deeper areas and updating of seagrass boundaries using transect methods e.g. towed camera and GPS accuracy.

Survey effort should include recorded verification with an average distribution of no less than one verification point per 100m^2 with no greater than 30m between two verification points in known seagrass habitat.

Success Criteria

Seagrass distribution within the Project area has not decreased (at rates above acceptable decreases) in comparison with areas outside of the development area.

Posidonia australis distribution has not decreased (at rates above acceptable decreases) in comparison with areas outside the development area.

Acceptable decreases or rates off change should be selected following review of baseline data and any other available data at the completion of baseline surveys to estimate natural / existing variability between the assemblages.

***Halophila* / *Zostera* bed drop camera surveys**

Objective

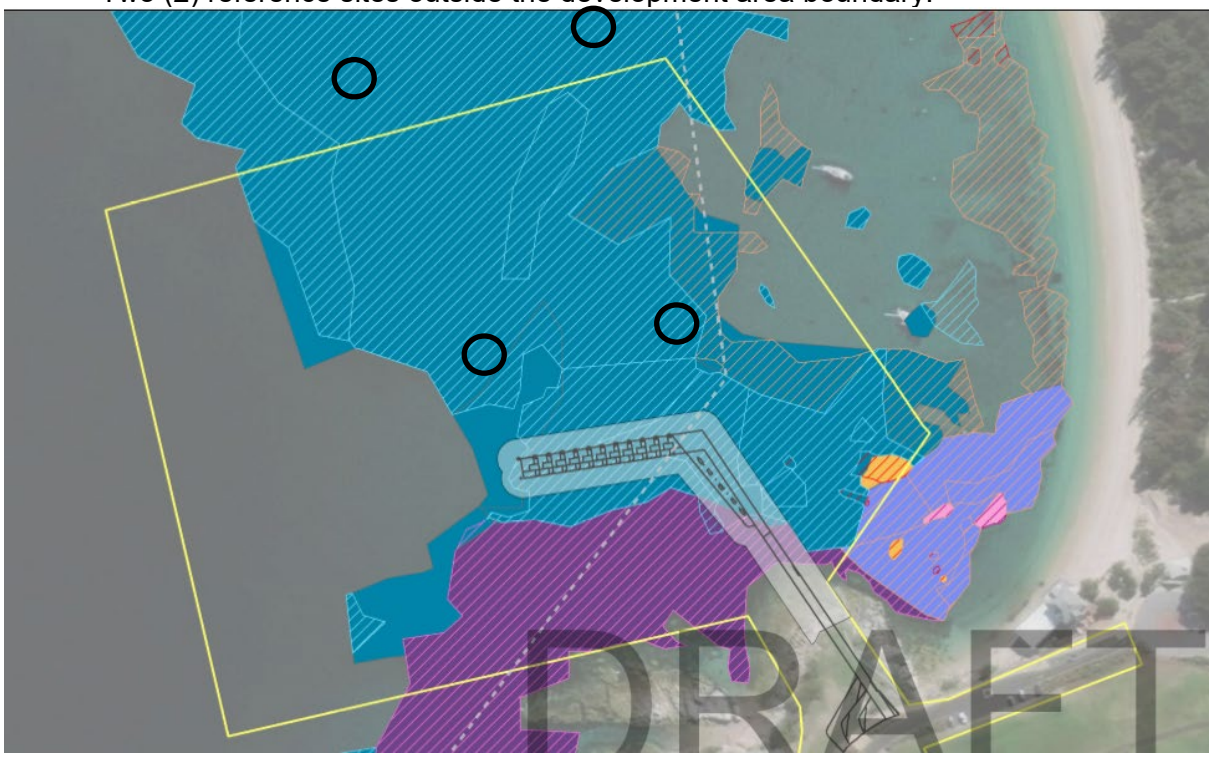
To identify any small-scale changes in community composition and density of *Halophila* dominated seagrass beds (outside of known *Posidonia australis* beds) in the development area during construction and operation of the wharves.

Survey Sites

La Perouse

Establishment of four (4) monitoring sites of approximately 700m^2. To include

- Two (2) potential impact sites within the development area boundary.
- Two (2) reference sites outside the development area boundary.

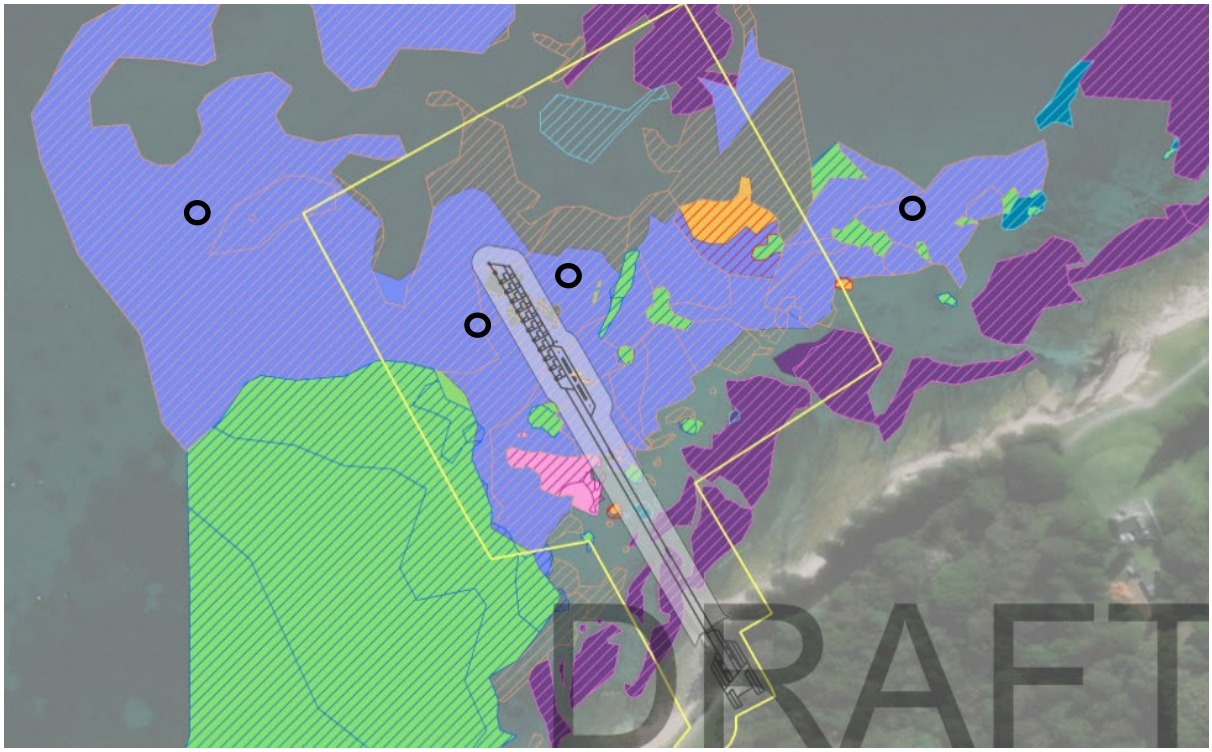


Circles indicate potential monitoring sites.

Kurnell

Establishment of four (4) monitoring sites of approximately 700m^2. To include

- Two (2) potential impact sites within the development area boundary.
- Two (2) reference sites outside the development area boundary.



Circles indicate potential monitoring sites.

Methodology

Seagrass density to be determined via percent cover method targeting *Halophila* dominated areas with low and sparse *Zostera*.

Data collection should include 30 randomly collected 0.25m^2 quadrats. Photo quadrats should not be stratified to seagrass habitat to allow for any seagrass declines to be detected.

Data to be recorded and reported should include:

- Seagrass cover by type
- Sediment/ silt cover
- Macroalgae cover
- Turfing epiphytic algae cover

Differences should be investigated using BACI (Before-After-Control-Impact) framework and appropriate statistical procedures to test statistical significance of any differences.

Power analysis should be undertaken at the completion of the baseline survey to determine the detectable effect size.

Survey Frequency

Before	During	After
Every 6 months with a minimum of two surveys before construction commences	Every 6 months with surveys scheduled to occur before and after piling works	Within 12 month of operation (MCoA E20).

Success Criteria

Seagrass density at sites within the Project area has not significantly decreased in comparison with comparable areas outside of the development area.

Turfing epiphytic algae cover has not significantly increased in comparison with comparable areas and species outside the development area.

Seagrass morphology surveys of *Posidonia* beds

Objective

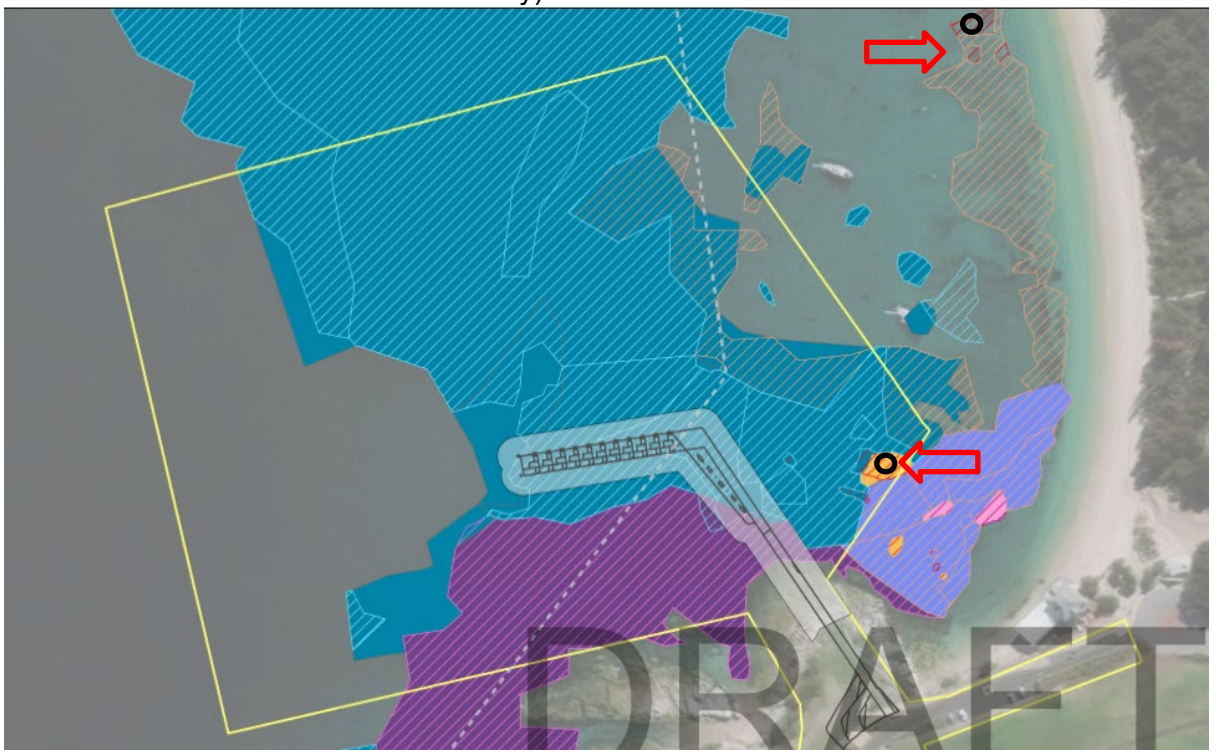
To identify any small-scale changes in community composition biomass and epiphyte cover of areas with *Posidonia australis* in the development area during construction and operation of the wharves.

Survey Sites

La Perouse

Establishment of two (2) monitoring sites with a radius of 15m. To include:

- One (1) potential impact site within the mixed *Posidonia australis* bed within the development area boundary.
- One (1) reference site outside the development area boundary (potentially within the north-eastern area of Frenchman's Bay).

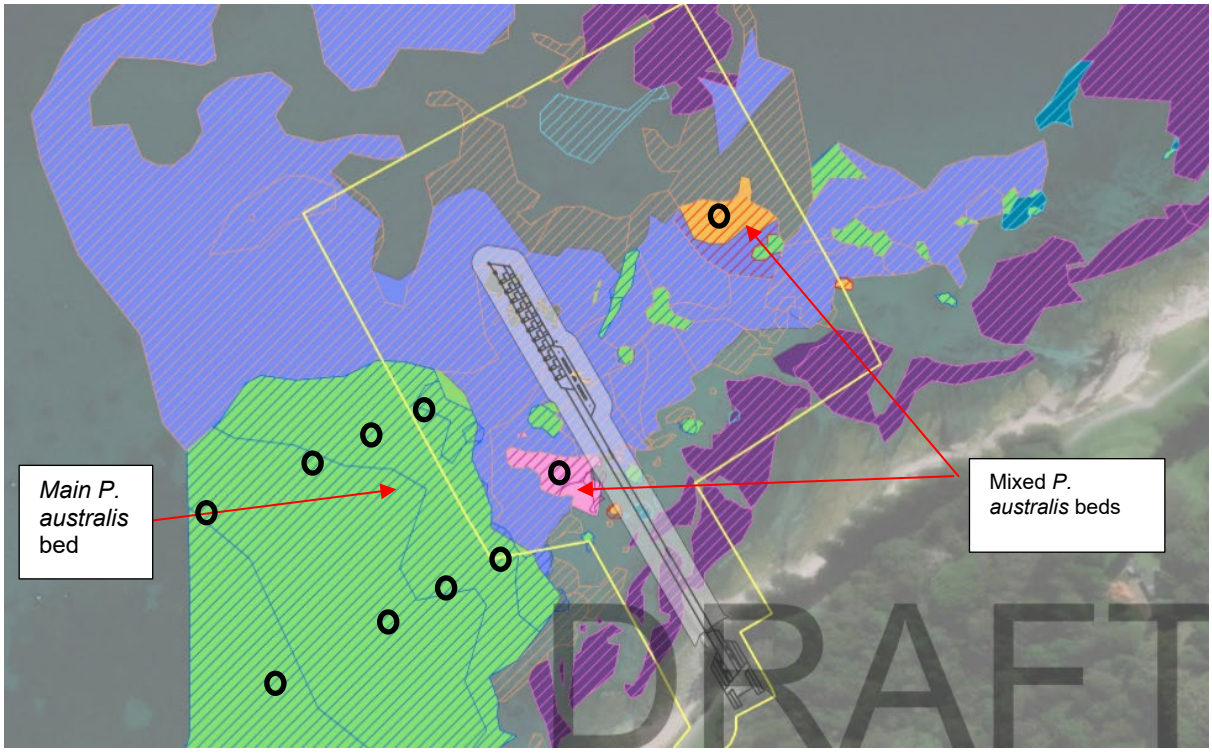


Red arrows indicate potential monitoring sites. Black circles indicate potential monitoring sites in main Posidonia australis bed.

Kurnell

Establishment of eight (8) monitoring sites with a radius of 10m. To include:

- Two (2) potential impact site within the mixed *Posidonia australis* beds (or areas that incorporate more than 1 species of seagrass) within the development area boundary.
- Two (2) reference sites outside the development area boundary within the mixed *Posidonia australis* beds.
- Six (8) monitoring sites within (at least 10m inside) the adjacent main *Posidonia australis* bed along the western boundary of the development area. This will include:
    - Sites spread across two depth transects to allow for sampling to be stratified for depth.
    - Sites to be positioned at four distances (~50m, 80m, 120m and 200m) to allow for investigation of gradient impacts on main *Posidonia australis* bed.
    - Sites at 200m may potentially be used as controls.



Red arrows indicate potential monitoring sites of mixed Posidonia australis beds. Black circles indicate potential monitoring sites in main Posidonia australis bed.

Survey Frequency

Before	**During**	**After**
Every 6 months with a minimum of two surveys before construction commences	Every 6 months with surveys scheduled to occur before and after piling works	Within 12 month of operation (MCoA E20).

Methodology

Surveys to be undertaken using 0.25m^2 quadrats with data collected *in situ* by experienced Scientific Divers undertaking surveys to ADAS diving safety standards.
Data to be collected from 5randomly elected quadrats within the site.
Data to be collected from each quadrat to include the following:

- Number of shoots for each species present
- Leaf length for each species present (10 randomly selected leaves)
- Epiphyte load each species present (10 randomly selected leaves)
- Measure burial of the leaf sheath (10 randomly selected stalks)
- Still image of the entire quadrat.

Three depth of disturbance (DoD) rods are to be installed in each bed to measure any changes in sediment accretion between monitoring surveys.
Differences should be investigated using BACI (Before-After-Control-Impact) framework and appropriate statistical procedures to test statistical significance of any differences.
Power analysis should be undertaken at the completion of the baseline survey to determine the detectable effect size.

Success Criteria

Posidonia australis biomass at sites within the Project area has not significantly decreased in comparison with comparable areas outside of the development area.
Seagrass epiphyte cover has not significantly increased in comparison with comparable areas and species outside the development area.

Detailed survey of *Posidonia* patches

Objective

To track changes in the boundaries and composition of individual patches of *Posidonia australis* inside or within 20m of the construction area during construction and operation of the wharves at Kurnell.

Survey Sites

Only patches that meet the following criteria should be considered for this monitoring component:

- inside or with 15m of the construction footprint
- Shoot density at baseline of at least 2 shoots per $1m^2$
- has a size of at least $10m^2$ and minimum average width of 2m
- *Posidonia australis* is the dominant species
- is not part of the seagrass morphology monitoring.

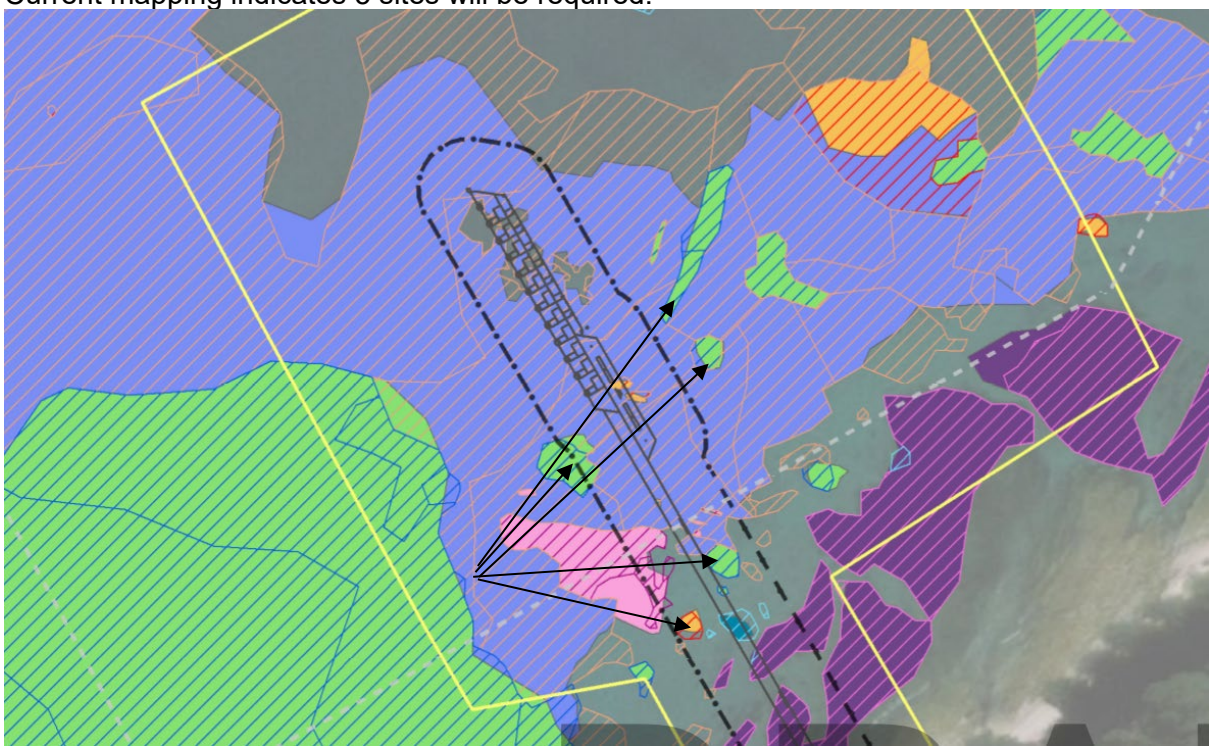
Any additional patches found during baseline mapping which meet the above criteria should be included for *Posidonia* Patch Monitoring

La Perouse

Current mapping indicates 1 site will be required.

Kurnell

Current mapping indicates 5 sites will be required.



Methodology

Preliminary desktop investigations should be undertaken using the latest near map imagery to measure patches with GIS software.

Centre point of patches are to be marked with a depth of disturbance (DoD) rod, which shall also allow for measure of any changes in sediment accretion between monitoring surveys.

Patch sizes to be verified by an in-water measurements from the marked center point. An edge will be identified where no live *Posidonia australis* is found to occur for 2 consecutive metres.

Seagrass morphology will be undertaken in each patch to determine any change sin composition. These surveys to be undertaken using $0.25m^2$ quadrats with data collected *in situ* by experienced Scientific Divers undertaking surveys to ADAS diving safety standards.

Data to be collected from up to 5 randomly elected quadrats within the patch. For small patches replication should be reduced to a rate of 1 x $0.25m^2$ survey quadrat every $3m^2$.

Data to be collected from each quadrat to include the following:

- Number of shoots for each species present
- Leaf length for each species present (10 randomly selected leaves)

- Epiphyte load each species present (10 randomly selected leaves)
- Measure burial of the leaf sheath (10 randomly selected stalks)
- Still image of the entire quadrat
-

Differences between surveys for each patch should be investigated using appropriate statistical procedures to test statistical significance of any differences.

Survey Frequency

Before	During	After
Every 6 months with a minimum of two surveys before construction commences	Every 6 months with surveys scheduled to occur before and after piling works	Within 12 month of operation (MCoA E20).

Success Criteria

Patch size of *Posidonia australis* has not decreased (at rates above acceptable decreases).
Shoot density of *Posidonia australis* has not decreased (at rates above acceptable decreases)..
Acceptable decreases or rates off change should be selected following review of baseline data and any other available data at the completion of baseline surveys to estimate natural / existing variability between the assemblages.

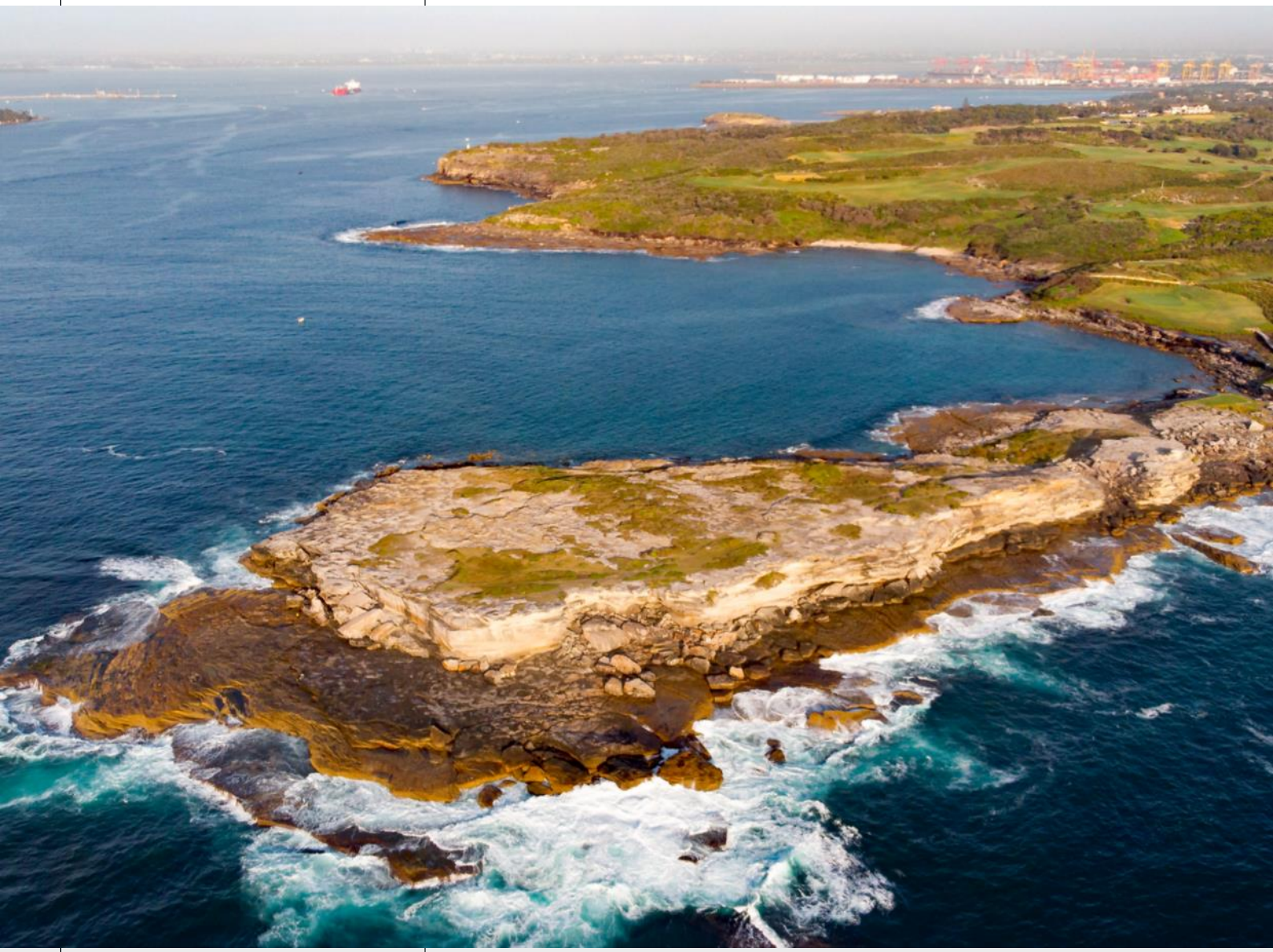
Appendix 4 Implementation Plan – *Posidonia australis* translocation

Transport
for NSW

Kamay Ferry Wharves project

Implementation Plan #1
Posidonia australis translocation

May 2023



NSW GOVERNMENT

transport.nsw.gov.au

Acknowledgement of Country

Transport for NSW acknowledges the Bidjigal and Gweagal clans who traditionally occupied Kamay (Botany Bay).

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Document control

Project	Kamay Ferry Wharves project – seagrass translocation, rehabilitation and monitoring
Document name	Implementation Plan #1 *Posidonia australis* translocation
Document number	
Author	UNSW
Endorsed by	MBOS Implementation Reference Panel
Branch / division	Maritime Infrastructure Delivery Office
Endorsed date	

Versions

Revision	Date	Revision notes	Prepared by	Reviewed by
A	12/12/2022	Draft 1 for review by Transport for NSW	UNSW	TfNSW
00	17/05/2023	Final	UNSW	MBOS Implementation Reference Panel

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1. Introduction

1.1 Overview of the project

The NSW Government is reinstating the wharves at La Perouse and Kurnell to provide a valuable recreational resource for the community, and to allow for future ferry access between both sides of Kamay Botany Bay National Park. The wharves will improve access for locals and visitors in small commercial and recreational boats and for people to swim, dive, fish, walk and enjoy the local sights.

The project forms part of the NSW Government's Kamay Botany Bay National Park, Kurnell Master Plan, which aims to improve visitor experience and access to the park. The plan is being delivered by Transport for NSW (Transport) and the NSW National Parks and Wildlife Service.

Importantly, the project recognises the rich culture and ongoing importance of the area to Aboriginal people. Feedback from the community has helped to guide the design and stories of Country have been embedded into elements of the built form. Large scale artworks by two local Aboriginal artists are integrated into the designs of the jetty and the shelter structures at La Perouse and Kurnell.

The project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework. It was also confirmed to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Accordingly, bilateral approval has been sought from the NSW State Government, under the *Environmental Planning and Assessment Act 1979* (EP&A Act), and the Australian Government, under the EPBC Act.

An environmental impact statement (EIS) was placed on public exhibition from July to August 2021. A response to submissions report was prepared in October 2021 to address issues raised during public exhibition of the EIS. The project was determined under the EP&A Act by the NSW Minister for Planning in July 2022. The project was determined under the EPBC Act by the Australian Minister for the Environment and Water in March 2023.

Construction of the wharves is expected to commence in the first half of 2023 and anticipated to take around 13 months.

1.2 The Marine Biodiversity Offset Strategy

The project EIS assessed how likely the project is to impact on the area's marine ecology and biodiversity values. The EIS determined that some impacts to marine ecology and biodiversity due to the project could not be fully avoided. The EIS identified the project was likely to result in residual impacts to Key Fish Habitat (KFH), including direct and indirect impacts to *Posidonia australis* Threatened Ecological Community (TEC). *Posidonia australis* TEC is protected under both the EPBC Act and *Fisheries Management Act 1994* (FM Act, NSW). In order to mitigate these unavoidable impacts, a process known as 'ecological offsetting' is implemented under State and Commonwealth legislation.

A Marine Biodiversity Offset Strategy (MBOS) was developed to provide a strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS. The MBOS identifies appropriate offset requirements under the EPBC Act and FM Act. The MBOS documents how Transport for NSW would meet its marine offset obligations. It also describes how these actions would be implemented in consultation with NSW Department of Primary Industries Fisheries (NSW DPI Fisheries), Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and other stakeholders to result in a net gain in environmental outcomes for Botany Bay and the community.

The MBOS has an operational life of ten years, and therefore is an adaptive document that would be reviewed and updated as required by Transport for NSW. Revisions to the MBOS would be implemented in consultation with the MBOS Implementation Reference Panel, which comprises representatives from Transport for NSW, NSW DPI Fisheries and an independent scientist. The MBOS Implementation Reference Panel would review the revised MBOS to ensure the updates are consistent with the offset policies and their implementation. Where significant changes to the MBOS have occurred, a copy of the MBOS and changes would be distributed to other relevant stakeholders, which may include DCCEEW and NSW Department of Planning and Environment (DPE).

1.3 Offset requirements

The Secretary's environmental assessment requirements (SEARs) issued for the project required an assessment of the potential impacts of the project on receiving marine habitats and biota be carried out. The SEARs required that the assessment consider whether the project was likely to result in any significant impact on listed threatened species, populations or ecological communities under the FM Act. In particular, the SEARs required that the extent and impact on seagrass beds, especially *Posidonia australis*, from all stages of the project be assessed. To address the SEARs, a Marine Biodiversity Assessment Report was prepared for the EIS. The marine biodiversity studies carried out to support the EIS included habitat mapping of subtidal reefs, together with targeted seagrass surveys that assessed the extent, cover and condition of the seagrass communities and surrounding habitats within and adjacent to the project construction boundary. These studies were conducted during preparation of the EIS in 2020.

The marine ecology and biodiversity impact assessment considered a worst-case residual impact scenario that included direct and indirect impacts from construction, the resulting permanent structure, and operation of vessels. The EIS determined the worst-case residual impact resulting from the project would be a loss of:

- 683 m^2 of *Posidonia australis* habitat (Type 1 KFH)
- 20,589 m^2 of other seagrass habitat (Type 1 KFH)
- 3683 m^2 of macroalgae habitat (Type 2 KFH).

The MBOS identified that rehabilitating all seagrass that would be disturbed would not be logistically feasible and proposed to focus on rehabilitating *Posidonia australis* because of its greater ecological value and importance.

The approach adopted for the MBOS was to apply the EPBC Offset Calculator to determine the draft offset requirements for *Posidonia australis.* The EPBC Offset Calculator provides a more conservative value and offsetting obligation than the no net loss outcome as defined under the NSW Fisheries Policy. The draft offset requirement for *Posidonia australis* under the EPBC Offset Calculator identified in the MBOS was 2000 m^2.

This value is conservative and would result in the rehabilitation and improvement of more than double the area of *Posidonia australis* predicted to be impacted by the project. The proposed offset requirement would also achieve no net loss for White's seahorse (*Hippocampus whitei*) habitat by replacing lost habitat due to the project.

1.4 Offset strategy

Transplanting of seagrass remains the only way to replace and re-establish seagrasses in areas where it has been lost. The MBOS identifies two methods and a staged approach for offsetting *Posidonia australis* impacts:

a) Translocation of *Posidonia australis* from areas expected to be impacted during construction of the project to habitats identified as degraded within Botany Bay (described in Implementation Plan #1)

b) Rehabilitation of seagrass meadows using naturally detached beach-cast *Posidonia australis* fragments (described in Implementation Plan #2).

The MBOS offset strategy proposed to meet the draft EPBC offset requirements would involve harvesting from the impact area (from herein, defined as Kurnell wharf footprint plus 15 metre buffer area) and replanting all the *Posidonia australis* within that area (estimated to be a maximum of 683 m^2 of *Posidonia australis*), and improving at least 2000 m^2 of existing *Posidonia australis* habitat in Botany Bay by collecting and planting naturally detached *Posidonia australis* fragments in unvegetated patches.

The MBOS proposed that the donor *Posidonia australis* material be transplanted to nearby unvegetated areas damaged from historical disturbance within Botany Bay.

A monitoring program would be implemented to monitor the success of the offset strategy over time (refer to Section 7).

The translocation, rehabilitation and monitoring would be carried out using best scientific practice methods and techniques developed and successfully implemented by research scientists in NSW estuaries as well as any future practices.

1.5 Updated offset requirements

The draft offset requirements proposed by the MBOS were initially based on a worst-case scenario of predicted impacts for *Posidonia australis* habitat. Accordingly, the offset requirements proposed by the MBOS were updated in May 2023 in response to site specific requirements, results of additional monitoring, consultation with the MBOS Implementation Reference Panel and other project stakeholders and the conditions of approval (CoA) for the project.

The Commonwealth and State (NSW) CoA relevant to the MBOS are identified in Table 1-1.

Table 1-1: Commonwealth and State (NSW) conditions of approval relevant to the Marine Biodiversity Offset Strategy for the project

CoA	Condition requirement
Commonwealth CoA	
3	Within the project area, the approval holder must not clear more than: a) 0.0683 hectares of seagrass meadows b) 0.0683 hectares of White's Seahorse habitat.
4	The approval holder must comply with NSW Approval conditions E6 – E8 and E11 related to pre-construction surveying and protection measures.
10	The approval holder must comply with NSW Approval conditions E12 – E20 related to the requirements of the Marine Biodiversity Offset Strategy (MBOS) to compensate for the clearing of 0.0683 hectares of seagrass meadows and White's Seahorse habitat.
11	To monitor the outcomes of the MBOS for seagrass meadows and White's Seahorse habitat, the approval holder must include a Marine Biodiversity Offset Report as part of the compliance report until the 10th anniversary of the date of this approval, unless otherwise agreed to in writing by the Minister. Each Marine Biodiversity Offset Report must include: a) a progress report on the implementation of the MBOS; b) a list of success metrics; c) details of the monitoring methodology(ies) implemented and the locations of reference sites; d) monitoring results including a comparison against reference sites; e) a summary of any adaptive management measures taken to improve implementation of the MBOS and/or monitoring methodology(ies); and f) a conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.
12	To assess the ongoing success of the MBOS, the approval holder must submit a Rehabilitation Monitoring Review to the department within 6 years of the date of this approval and every 5 years thereafter, unless otherwise agreed to in writing by the Minister. The approval holder must publish each Rehabilitation Monitoring Review on the website within 15 business days of submission and keep every Rehabilitation Monitoring Review published until this approval expires. Each Rehabilitation Monitoring Review must include: a) a review of the monitoring methodology(ies) by a suitably qualified person; b) a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person; and c) if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics: i) a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and ii) justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.
NSW CoA	
A1	The Proponent must carry out the SSI in accordance with the terms of this approval and generally in accordance with the: (a) *Kamay Ferry Wharves Environmental Impact Statement* (the EIS), dated June 2021 (b) *Kamay Ferry Wharves Response to Submissions Report* (the Submissions Report), dated October 2021; and (c) *Kamay Ferry Wharves Marine Biodiversity Offset Strategy* (the MBOS), dated November 2021.

CoA	Condition requirement
E6	The location of areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 Key Fish Habitat (KFH)) and macroalgae that have been identified for removal and disturbance at Kurnell and La Perouse must be confirmed and recorded by surveying and mapping prior to the commencement of clearing in consultation with DPI Fisheries and DAWE.
E12	The proponent must ensure that the proposal is undertaken in accordance with the requirements of DPI Fisheries policy and guidelines, including the Policy and Guidelines for Fish Habitat Conservation and Management 2012, and the NSW Biodiversity Offsets Policy for Major Project Fact sheet: Aquatic Biodiversity.
E13	The Proponent must allow for an additional winter and summer season in which to monitor marine biodiversity within the construction footprint prior to commencement of construction.
E14	The Proponent must satisfy the marine biodiversity offset obligations that specify the required offset size in accordance with the EPBC Act, Environmental Offsets Policy 2012, NSW Biodiversity Offsets Policy for Major Projects – Fact sheet: Aquatic Biodiversity. Evidence of this must be provided to the Planning Secretary, DPI Fisheries and DAWE for information, within 12 months of the commencement of construction.
E15	Areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 KFH) and macroalgae (Type 2 KFH) that have been identified for removal or disturbance within the construction footprint at Kurnell and La Perouse must be offset in accordance with the MBOS and as agreed with DPI Fisheries and DAWE.
E16	Prior to the commencement of pre-construction seagrass transplantation, the Proponent must establish a MBOS Implementation Reference Panel to review data collected, including from the marine biodiversity monitoring as required by Condition E13, recommend changes to the MBOS if required, and review the Operational Impact Assessment Report (see Condition E20). The MIRP must comprise representatives from the Proponent, DPI Fisheries-Coastal Systems, DPI Fisheries-Marine Research, DAWE and DPIE Planning and Assessment, and include a suitably qualified, experienced and independent scientist. The MBOS Implementation Reference Panel must be operational for the life of the MBOS or as agreed by the Planning Secretary.
E17	The MBOS must have an operational life of no less than ten (10) years from the date of MBOS approval, unless otherwise agreed by the Planning Secretary.
E18	The MBOS may be reviewed and updated during its operational life as required and recommended by the MBOS Implementation Reference Panel. At least 50 per cent of the MBOS funding must be allocated to the restoration and rehabilitation of *Posidonia australis* and *Zostera* seagrass beds in consultation with the MBOS Implementation Reference Panel.

Baseline seagrass monitoring for the project commenced in mid-2021 and was repeated on four occasions before concluding in December 2022. Additional targeted surveys were carried in late 2022 to confirm the location, extent, cover and condition of previously mapped *Posidonia australis* patches within the impact area and main seagrass meadow at Kurnell and inspect the seagrass rehabilitation sites proposed by the MBOS. This work was carried out to meet the requirements of NSW CoAs E6 and E13.

A key objective of the baseline monitoring and additional surveys was to confirm the location and extent of areas of *Posidonia australis* that would be directly impacted by construction of the project and therefore determine the final offset requirements under the MBOS. The final offset requirements identified through this process were confirmed in consultation with the MBOS Implementation Reference Panel and included in the MBOS in May 2023, as required by NSW CoAs E15 and E16. Translocation of *Posidonia australis* from the impact area to rehabilitation sites would be carried out in accordance with the MBOS offset requirements.

Further detail about translocating *Posidonia australis* donor material to recipient sites is provided in Section 5.4.

1.6 What is translocation?

Translocation has become an important biodiversity conservation management tool used to assist in creating or maintaining viable populations of a single species that is under threat due to habitat loss, development, invasive species, climate change or other disturbances (Weeks et al., 2011; Doyle et al., 2022). Translocation involves the deliberate movement of plants or regenerative plant material from one place to another, usually in the wild (Commander et al, 2018), achieved via various techniques, including tissue culturing, seeding, propagation and transplantation of whole plants from one site to another.

Translocation success is generally measured by considering abundance, extent, resilience and persistence of the focal species (Commander et al, 2018; Doyle et al., 2022).

Translocations fall into one of two categories: conservation or mitigation translocation (Commander et al., 2018). While the purpose of conservation translocation is to enhance the viability of recipient populations for long-term conservation benefit, mitigation translocation is implemented to prevent the loss of threatened populations or species due to threats from human activity, often from development (Bradley et al., 2022). Mitigation translocation would be relevant to the project, i.e. moving *Posidonia australis* that would otherwise be lost from the construction impact area. Mitigation translocations are becoming a standard measure to offset residual, unavoidable impacts on populations of threatened species (Germano et al., 2015; Silcock et al., 2019). Regardless of category, the aim of all translocations is to decrease risk of species extinction by creating new self-sustaining populations or augmenting existing ones capable of long-term survival (Commander et al., 2018; Silcock et al., 2019).

Mitigation translocations of terrestrial plants to offset development impacts have been carried out for decades. The approach has not been applied as frequently in marine environments, although a growing number of restoration efforts have been carried out worldwide to compensate or mitigate seagrass losses (Paling et al., 2009). Locally, until recently, seagrass restoration as a measure to compensate for the loss of seagrass habitat resulting from development activities has not been supported under NSW policy (Ganassin and Gibbs, 2008). Recent advances in seagrass restoration have revealed less damaging and more cost-effective approaches to restoring ecologically meaningful areas (Tan et al., 2020; Sinclair et al., 2021). Improvements in transplant success of seagrass using donor material, including *Posidonia australis* (Glasby et al., 2015; Ferretto et al., 2019; 2021) suggest the potential viability of seagrass translocation as an offsetting strategy for marine developments in some circumstances. Documenting the translocation activities and outcomes for the project would be important for further developing this strategy.

1.7 Purpose of Implementation Plan #1

The purpose of Implementation Plan #1 is to document the strategy, method and approach for translocation of *Posidonia australis* from the project impact area to rehabilitation sites at Kurnell. This implementation plan also includes a monitoring program that would be implemented to assess the success of the seagrass translocation and rehabilitation through time (refer to Section 7). This implementation plan has been developed to ensure compliance with the Commonwealth and State conditions of approval for the project.

A separate Implementation Plan #2 would be prepared to describe the strategy, method and approach for the additional planting of *Posidonia australis* to rehabilitation sites using naturally detached shoots collected from Botany Bay.

The implementation plans for seagrass translocation, rehabilitation and monitoring form part of the MBOS. The implementation plans are developed to document how the direct offset actions identified in the MBOS would be carried out and ensure the MBOS is implemented effectively. The implementation plans form part of the MBOS which is endorsed by the MBOS Implementation Reference Panel.

1.8 Program

The MBOS would be operational for ten years. Table 1-2 identifies the anticipated timeline and duration of the seagrass offset work in relation to the expected approval, construction and monitoring requirements.

Table 1-2: Anticipated program for seagrass translocation, rehabilitation and monitoring

	2021		2022				2023				2024				2025				2026				2027				2028				2029				2030				2031				2032				2033			
Activity	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Baseline monitoring																																																
EIS published																																																
Submissions report published																																															
State planning approval																																															
Commonwealth planning approval																																															
Confirmation (summer) survey																																															
MBOS update																																															
Translocation of *P. australis*																																															
Initial survey – Baseline Report																																														
Construction of the project																																															
Planting naturally detached *P. australis*																																															
Seagrass monitoring																																															
Review of monitoring																																															

2. Legislation, policy, guidelines and permits

Legislation, policies, guidelines and permits relevant to Implementation Plan #1 for seagrass translocation include, but are not limited to:

- Project Approval (EPBC 2020/8825) issued on 16 March 2023 by the Australian Minister for the Environment and Water under the EPBC Act sets out the Commonwealth conditions under which the project may be constructed and operated
- Project Infrastructure Approval (SSI 10049) dated 21 July 2022 issued under Section 5 of the EP&A Act 1979 sets out the State (NSW) conditions under which the project may be constructed and operated
- The EPBC Act (Commonwealth) protects matter of national environmental significance (MNES), including endangered species such as *Posidonia australis* and requires project actions to be controlled under the Act's provisions if they are likely to have a significant impact
- The FM Act (NSW) makes it an offence to harm estuarine macrophytes, such as seagrass, without an appropriate assessment, inclusion of safeguards, and/or the appropriate permissions to carry out certain work
- The Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (NSW DPI, 2013) provides guidance on addressing and offsetting aquatic impacts
- The EPBC Act Environmental Offsets Policy outlines the Australian Government's approach to the offsetting significant impacts on MNES
- The MBOS provides the strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS
- Permit issued by NSW DPI Fisheries under Section 37 of the FM Act sets out the conditions under which the seagrass translocation, rehabilitation and monitoring activities can be carried out
- Port of Botany Bay Harbour Master Permission for Disturbance of the Bed of a Special Port Area (PAMAR110-SYD-2022-050) provides conditions under which the seabed of Botany Bay may be disturbed for the seagrass translocation, rehabilitation and monitoring work.

Translocation of *Posidonia australis* would be carried out in accordance with the requirements of the documents identified in this implementation plan and the MBOS.

3. Consultation for Implementation Plan #1

Implementation Plan #1 for translocation was prepared in consultation with the following project stakeholders:

- Port Authority of New South Wales
- Transport for NSW Maritime Operations (Botany Bay) and Project Team
- NSW DPI Fisheries, Fisheries Research
- NSW Department of Planning and Environment
- Sydney Desalination Plant
- MBOS Implementation Reference Panel.

Feedback received from these stakeholders was incorporated into the final version of the implementation plan.

4. Description of the area

4.1 Overview of Kamay (Botany Bay)

Kamay (Botany Bay) is a large, marine-dominated, sheltered embayment located in southern Sydney. The bay has an area of about 40 km^2, with a one kilometre wide opening to the sea. Freshwater flows into the bay via the Georges River and Cooks River. Increased freshwater inflows and stormwater runoff during flood and storm events strongly influence salinity and nutrient levels in Botany Bay (Roy et al., 2001). The tidal range of Botany Bay is about two metres and the embayment is partially flushed during each tidal cycle (Roper et al., 2010). The depth of the bay in the vicinity of the project area varies with the tide but reaches a maximum of about five metres furthest from shore. Surface water temperatures range from 22–24°C in summer to 15–18°C in winter and are generally well mixed with low stratification (Sterling-Wood et al., 2022).

Botany Bay is located in a temperate humid coastal climate that receives about 1000 millimetres of rain annually, with the highest concentration falling in autumn (Bureau of Meteorology (BOM), 2022). Long-term mean maximum air temperatures range from about 17°C in winter (July) to almost 27°C in summer (January) (BOM, 2022). The water temperature of the bay typically ranges from about 16°C in winter to 22°C in summer (IMOS, 2022). Wind affects the wave and current climates in Botany Bay. Winds tend to come from the south and east during summer period, while the dominant wind direction in winter is from the west (Cardno, 2020).

Botany Bay is a highly urbanised waterway that supports numerous industrial, commercial and recreational activities. Port Botany, located on the north-eastern side of Botany Bay, is the largest container port in NSW and the second largest container port in Australia. The port operates 24/7 and commercial vessels regularly move through Botany Bay via shipping channels that traverse the waterway between La Perouse and Kurnell. The Kurnell Port and Berthing Facility is located about 300 metres west of the project area at Kurnell. Botany Bay supports several charter boat operations. Recreational users of Botany Bay include rowers, sailors, fishers, personal watercraft users, snorkelers and divers. Recreational activity levels intensify during the summer months.

The dominant seagrasses in Botany Bay are *Posidonia australis*, *Zostera sp.* and *Halophila sp.* While *Posidonia australis i*s slow-growing and sensitive to environmental change, large seasonal changes in the distribution and density of *Zostera sp.* and *Halophila sp.* occur in Botany Bay (Reid, 2021). Unlike *Posidonia australis, Zostera sp.* and *Halophila sp.* tend to rapidly recolonise and spread across the benthos following disturbance (Larkham and West, 1990). The seagrass meadows perform numerous important ecosystem functions, including provision of habitat for fishes and invertebrates, including commercially important species, sediment stabilisation, nutrient removal and carbon capture (reviewed in Sterling-Wood et al., 2022).

The extensive long-term decline in seagrass distribution in Botany Bay has been attributed to several natural and human-made processes (Larkham and West, 1990). Natural processes such as wave action, sediment movement, nutrient availability, warmer temperatures and herbivory may impact seagrass distribution (Reid, 2021). The main human-made historical and ongoing threats to seagrass persistence in Botany Bay include dredging, water pollution, coastal development, electricity transmission network infrastructure development, and scouring from boat anchors and moorings (Larkham and West, 1990; Glasby et al., 2015; Evans et al., 2018; Glasby and West 2018). The fragmented seagrass meadows observed around the bay provide evidence of disturbance.

4.2 Condition of existing seagrass at Kurnell

Posidonia australis from intact meadows within the impact area at Kurnell would be used as the donor material for revegetating damaged seagrass meadows within Botany Bay (Figure 5-1).

Targeted surveys ("confirmation survey") to locate and assess the areal extent, shoot density and condition of *Posidonia australis* within the impact area and nearby main *Posidonia australis* meadow at Kurnell were carried out during October-November 2022 by Scientific Divers (refer to Site Selection and Validation Report (UNSW, 2023a) in the MBOS). Surveys were carried out at eleven *Posidonia australis* patches distributed within the impact area and three sites within the main *Posidonia australis* meadow located outside the project boundary at Kurnell. The three sites within the main *Posidonia australis* bed at Kurnell were selected as reference sites for monitoring the performance of translocated *Posidonia australis* (refer to Section 7). A further three reference sites within the main *Posidonia australis* bed were identified for monitoring following feedback from the MBOS Implementation Reference Panel.

A summary of descriptive data for *Posidonia australis* areal extent and condition obtained from the most recently available seagrass baseline monitoring report (Niche, 2023) and targeted *Posidonia australis* surveys (UNSW, 2023a) is provided in Table

4-1. All three indicators of *Posidonia australis* cover and condition (i.e. shoot density, leaf length and epiphyte load) were statistically significantly lower for impact relative to reference area sites for the confirmation survey. The mean shoot density of *Posidonia australis* patches within the impact area at Kurnell based on the survey data is estimated to be up to 42 shoots per square metre.

The seagrass composition of the surveyed sites included the presence of all three dominant seagrass species, *Posidonia australis, Halophila sp*. and *Zostera sp.*

Table 4-1: Summary of key *Posidonia australis* characteristics at the impact area and reference sites at Kurnell, Botany Bay

Site type	Distance to impact area (m)	Sites surveyed	Shoot density (mean ±SE) (0.25 m ^{2})	Leaf length (mean ±SE) (cm)	Epiphyte load (mean ±SE) (1 5 scale)
Confirmation survey, October-November 2022 (UNSWa, 2023)					
Impact area	-	11	10.6 (±0.70)	29.0 (±0.74)	2.5 (±0.08)
Reference sites	130–180	3	17.1 (±0.91)	32.6 (±1.04)	3.4 (±0.08)
Seagrass baseline monitoring surveys, December 2022 (Niche, 2023)					
Impact area	-	6	8.0 (±0.64)	30.0 (±1.6)	3.0 (±0.12)
Reference sites	130–180	3	20.5 (±7.4)	32.7 (±5.51)	3.3 (±0.58)

Note: SE=standard error

4.3 Rehabilitation sites

Rehabilitation sites selected for transplanting of *Posidonia australis* donor material are described in the Site Selection and Validation Report (UNSW, 2023a) in the MBOS.

The selection of rehabilitation sites for transplanting *Posidonia australis* was informed by a multi-factorial assessment of suitability and consultation with relevant agencies and stakeholders. Preference was given to sites with shallower depth, zero to spare seagrass cover, even topography and seagrass habitat in the surrounding area. The assessment determined that three sites at Kurnell were considered highest priority for *Posidonia australis* transplanting, with a further three sites at Kurnell considered medium priority subject to changes in existing seagrass cover(Table 4-2 and Figure 5-2). The assessment determined that the remaining four sites at Kurnell and the Penrhyn Estuary site would be of lowest priority for *Posidonia australis* transplanting due to existing seagrass density and other factors, such as depth and sediment instability (Figure 5-2). The four lower priority sites at Kurnell would provide an additional 807 m^2 area for rehabilitation.

Table 4-2: Calculated area of high and medium priority rehabilitation sites at Kurnell

Site ID	Area (m^2)	Priority for rehabilitation
Trench east	144	High
Trench west	223	High
Scar B	43	Medium
Scar C	147	Medium
Scar E	42	Medium
Scar F	20	High
Total	**619**	

5. Approach to translocation of *Posidonia australis*

5.1 Site locations

5.1.1 Harvesting within the project impact area at Kurnell

Initial harvesting efforts would target the eleven previously identified *Posidonia australis* patches within the impact area. Field-based mapping of the Kurnell impact area estimated the total area of the *Posidonia australis* patches was 268 m^2 (Figure 5-1). This value is conservative and represents the maximum mapped areal extent of *Posidonia australis* within the Kurnell impact area detected from the four baseline monitoring events carried out in 2021-2022 (Niche, 2023) and additional targeted surveys carried out in late 2022 (UNSW, 2023a). *Posidonia australis* patch sizes within the impact area ranged from about 2 m^2 to greater than 50 m^2 (UNSW, 2023a).

Following the initial harvesting, thorough searching of the entire impact area (about 0.54 hectares) on snorkel by Scientific Divers would be carried out to locate and harvest any remaining areas of *Posidonia australis.*

Figure 5-1: Kurnell impact area (wharf footprint + 15 m buffer), showing the location of previously mapped *Posidonia australis* patches

5.1.2 Location of rehabilitation sites

Rehabilitation sites suitable for receiving *Posidonia australis* donor material are located at Kurnell. The three sites identified from site surveys as high priority (Trench east, Trench west and Scar F) and further three sites with medium priority for translocation (Scar B, Scar C and Scar E) would provide a total area of 619 m^2 for *Posidonia australis* rehabilitation. Four lower priority rehabilitation sites at Kurnell would provide an additional 807 m^2 of planting area. The rehabilitation sites are located within the main *Posidonia australis* meadow to the west of the project boundary at Kurnell, at distances ranging from 73 metres to more than 300 metres from the impact area (Figure 5-2).

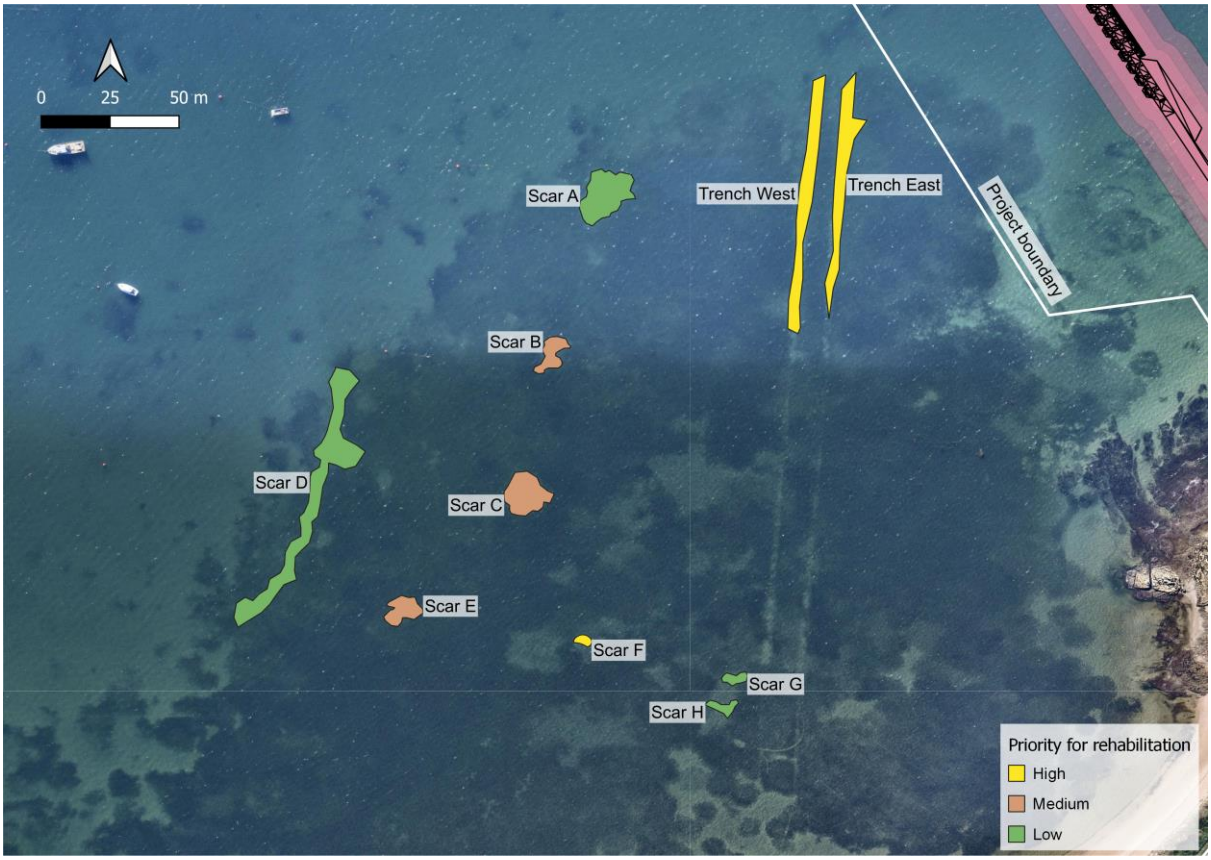

Figure 5-2: Locations of the *Posidonia australis* rehabilitation sites in relation to the impact area at Kurnell

5.2 Access

Translocation of *Posidonia australis* at Kurnell would involve teams of Scientific Divers, research assistants and Gamay Rangers performing fieldwork activities from vessels. Access to the sites at Kurnell would be via vessels launched from Foreshore Road boat ramp, Botany. Foreshore Road boat ramp is located about 5.5 kilometres from the impact area at Kurnell. When travelling between Foreshore Road boat ramp and the project area, the vessel route briefly crosses the shipping channel (Figure 5-3). It is anticipated that several vessels would support the translocation work, potentially requiring multiple vessel movements between the boat ramp and translocation working area during the working day to replenish equipment and other resources. The area at Kurnell where translocation would be carried out is located outside the shipping channel.

Anchoring is not permitted within seagrass meadows in Botany Bay. A courtesy mooring is located north of the main *Posidonia australis* seagrass meadow at Kurnell. Vessels supporting the translocation work would have the option of using the mooring as an alternative to operating vessels live in the water, should it be available.

Kurnell is a popular location for recreational boaters, jet-ski users, fishers and other waterway users. Precautionary safety measures would be implemented to avoid interactions between divers and snorkelers involved in the translocation work and other waterway users in Kurnell. Transport for NSW would notify the community and local users about the translocation work prior to commencement.

To ensure the safety of vessels and crew, vessel masters would be responsible for ensuring compliance with Harbour Master, Transport for NSW Maritime Operations and other relevant rules and regulations.

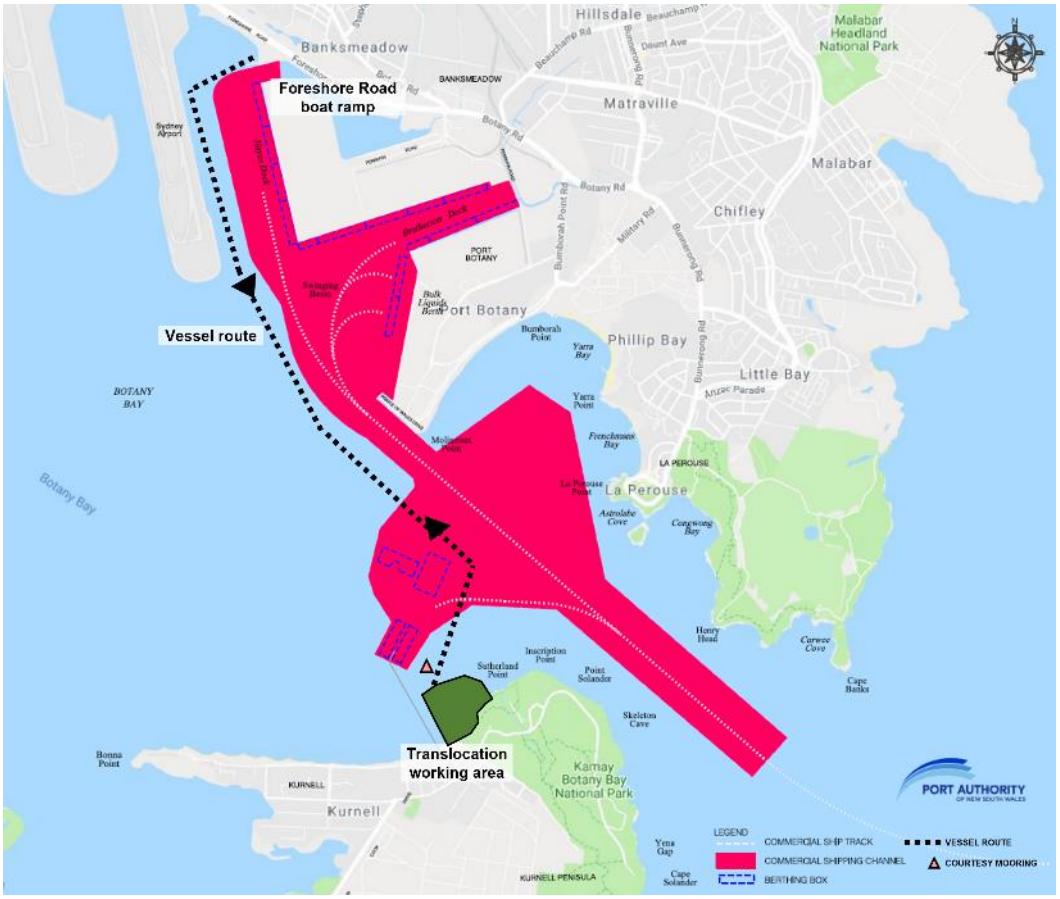

Figure 5-3: Vessel access route between Foreshore Road boat ramp and the *Posidonia australis* translocation area at Kurnell

5.3 Timing

Pending the receipt of all necessary approvals and permits, *Posidonia australis* translocation would be anticipated to begin in May-June 2023 and conclude by the end of July 2023. Translocation of all *Posidonia australis* shoots from the impact area at Kurnell would be completed prior to the start of construction at Kurnell.

Harvesting of donor *Posidonia australis* material from the impact area and replanting in rehabilitation sites would occur simultaneously. Teams of Scientific Divers would be allocated to carry out one of the two key activities (harvesting or replanting), with support team members delivering harvested donor *Posidonia australis* material from the impact area to rehabilitation sites for replanting.

Based on the expected number of harvested *Posidonia australis* shoots (Section 5.4.2) and previous experience translocating *Posidonia australis*, it is anticipated that the translocation process would require a minimum of about 20 to 30 fieldwork days.

5.4 Translocation methods

5.4.1 Best scientific practice translocation methods

Seagrass restoration efforts have been performed in coastal environments around the world, with varying levels of success. The field of seagrass restoration is still relatively young with many knowledge gaps that need to be filled. Marine restoration researchers continue to apply lessons learned into designing successful seagrass restoration efforts (Tan et al. 2020). Research to date indicates that seagrass restoration techniques and design should be tailored to the restoration species, site, environmental conditions, existing threats, motivation for restoration and resources available (Ganassin and Gibbs, 2008; van Katwijk et al., 2016; Tan et al., 2020). The methods proposed for *Posidonia australis* translocation for the project have been developed by examining these factors, and guidelines, methods and experiences reported in the literature from previous efforts to restore *Posidonia sp.* meadows in Australia and internationally.

Internationally, *Posidonia sp.* restoration has mostly occurred in the Mediterranean, where some successful small and larger-scale environmentally-engineered trials have been documented (Boudouresque et al., 2021). In Australia, around 50 seagrass restoration trials have been published to date, and most have involved transplanting mature seagrass shoots (Tan et al., 2020). Historically, published research of restoration of *Posidonia sp.* meadows has been concentrated in Western Australia, where restoration success has improved over time (e.g. Paling et al., 2001; 2007; Campbell and Paling 2003; Bastyan and Cambridge 2008). A few attempts at transplanting *Posidonia australis* in NSW estuaries have occurred, with some early trials failing to meet objectives (e.g. Port Hacking: Meehan and West, 2002; St Georges Basin: Ganassin and Gibbs, 2008), but more recent efforts have shown some success (Glasby et al., 2015; Ferretto et al., 2019, 2021). Specifically, the rehabilitation of damaged seagrass beds at Kurnell that occurred during the laying of electricity cables across Botany Bay (Glasby et al., 2015) suggests that with the correct techniques and favourable environmental conditions, there is potential that the translocation objectives for the project could be achieved.

Some of the key features of successful *Posidonia sp.* restoration highlighted by existing literature that have been incorporated into the translocation methods include:

- Prioritising shallow depths for translocating *Posidonia australis* due to its sensitivity to reductions in light transmission through the water column
- Using an effective and durable rhizome anchoring system to prevent loss of transplanted *Posidonia australis*
- Developing two options (using jute mats and direct planting) for transplanting *Posidonia australis* that can be tailored to suit site-specific conditions and provide research opportunities for the effectiveness of different techniques
- Deploying sediment-stabilising jute mats to reduce mortality and damage of transplanted *Posidonia australis* from sediment erosion and bioturbation
- Investing in translocating across multiple recipient sites to spread the risk and increase the likelihood of translocated *Posidonia australis* experiencing suitable conditions for growth
- Using handling and storing methods that would minimise stress to harvested *Posidonia australis* shoots.

Translocation threats and risks are discussed in Section 6.

5.4.2 Availability of donor material and recipient site transplanting area

Field-based mapping of the Kurnell impact area over the course of the four baseline monitoring events (2021-2022) and additional targeted surveys in October-November 2022 estimated the total area of the eleven identified *Posidonia australis* patches was 268 m^2. The shoot density data and patch area calculations indicated that between about 8200 and 10600 *Posidonia australis* shoots would be available for harvesting as donor material for the translocation process.

Field-based mapping indicated that a total area of 619 m^2 would be available for *Posidonia australis* translocation across the six rehabilitation sites (i.e. high and medium priority) (UNSW, 2023a). The area available for transplanting in the sites ranges from 20 m^2 to 223 m^2. An additional 807 m^2 would be available for rehabilitating across four lower priority rehabilitation sites at Kurnell. Harvested *Posidonia australis* shoots would be translocated to more than one rehabilitation site. This strategy would spread the risk of failure resulting from unforeseeable events such as incidental damage by recreational boat users, loss of jute mats or shoots due to inclement weather conditions or unplanned environmental incidents.

5.4.3 Preparing the rehabilitation sites for translocation

Pre-translocation inspections of the preferred rehabilitation sites at Kurnell (refer to Section 4.3) would be carried out immediately prior to commencement of translocation to assess any changes in site suitability and identify any new or previously undetected constraints. Site dimensions would be reconfirmed to determine the required number of jute mats for each site (where these are to be used) (refer to Section 5.4.5).

The use of jute mats can be an effective tool for restoring *Posidonia australis* due to its sediment stabilising properties (Ferretto et al., 2019; 2021; Glasby et al., 2015). Jute mats (about 1.2 x 2 metres) consisting of biodegradable organic jute mesh material with a loose open weave would be used to stabilise the sediment and provide an anchor for translocated *Posidonia australis* shoots (Figure 5-4). The open weave of the jute mesh would be suitable for threading the *Posidonia australis* shoots through. Reinforcing mesh would be attached to the ends of the jute mats to anchor the mats to the sediment.

Jute mats would be deployed to the rehabilitation sites immediately prior to planting translocated *Posidonia australis* shoots at the site. Jute mats would be lowered from the vessel as close as possible to the site. Divers would swim the mats into

position and partially secure the mats to the sediment using long metal weed mat pins, allowing access for translocated shoots to be manoeuvred under the mats during planting. The jute mats would be expected to be covered by sediment within weeks due to natural wind and wave processes and biodegrade within about 12 months. Pins would naturally break down over time.

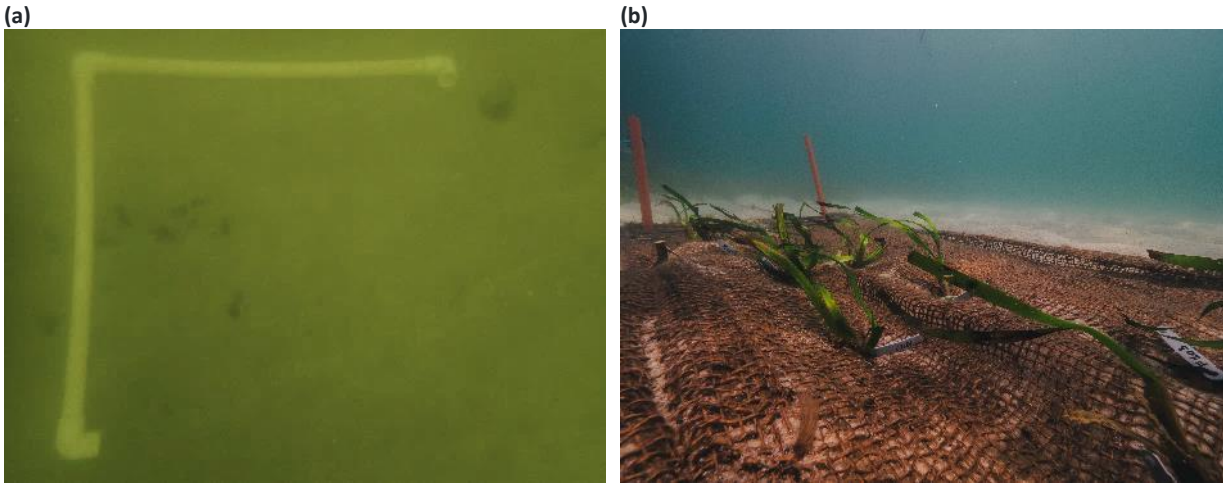

Figure 5-4: Photos showing (a) bare sediment in a rehabilitation site at Kurnell and (b) example of a jute material planted with *Posidonia australis.*

Photo credit: Harriet Spark, Grumpy Turtle Media (b)

To monitor sedimentation and erosion a minimum of two depth of disturbance rods would also be installed at each rehabilitation site that receives translocated *Posidonia australis*. Depth of disturbance rods consist of a vertical metal rod with a loosely fitted washer on the rod (Figure 5-5). Once the rod is securely positioned in the sediment, the length of the exposed section of the rod would be measured and its location recorded. A metal washer would then be placed on the rod so that it rests on the top of the sediment. Changes in the elevation of the washer relative to the top of the rod would provide an indication of erosion or accumulation of sediment. Measurements would be recorded during monitoring of rehabilitated sites.

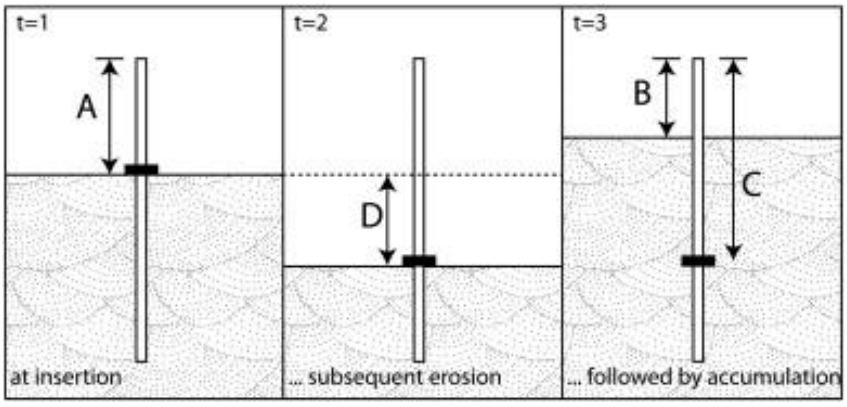

Figure 5-5: Diagram of a typical depth of disturbance rod (Vila-Concejo et al., 2014)

5.4.4 Harvesting of donor *Posidonia australis* shoots

The *Posidonia australis* harvesting effort would initially target the patches within the project impact area previously identified, followed by a thorough sweep of the entire impact area at Kurnell for any remaining donor material. In this second step, sections of the impact area would be marked out and the area comprehensively searched for any remaining *Posidonia australis* shoots. Harvesting would avoid the portions of larger impact area *Posidonia australis* patches that are distributed outside the 15 metre buffer area. Translocation of these intact portions of *Posidonia australis* would be considered should monitoring during construction or operation identify this as the best course of action to preserve *Posidonia australis*. Any management actions would be agreed in consultation with the MBOS Implementation Reference Panel and other stakeholders as necessary.

Harvesting of donor material would involve divers carefully removing *Posidonia australis* from the sediment while aiming to keep rhizomes intact. It is anticipated that harvested *Posidonia australis* would consist of a mix of both plagiotropic (laterally

growing rhizome runners with several shoots) and orthotropic (vertically growing rhizomes). Divers would carefully dig below the sediment using their hands and lift the roots and rhizomes from the sediment. Harvested material would be carefully placed into mesh catch bags underwater, taking care not to overcrowd the catch bags to avoid damaging the donor material.

Catch bags containing harvested shoots would be stored immersed in seawater until being delivered via vessel to divers at the rehabilitation sites for planting.

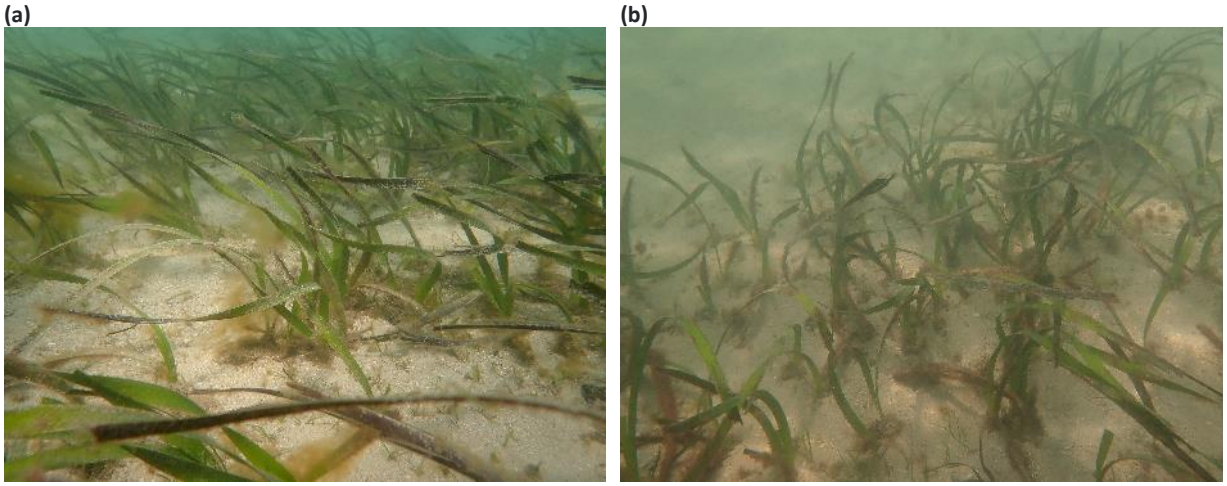

Figure 5-6: Photos of *Posidonia australis* donor material for harvesting from the impact area at Kurnell

5.4.5 Transplanting *Posidonia australis* shoots

Transplanting of harvested *Posidonia australis* shoots to rehabilitation sites would occur concurrently with the harvesting process, or as soon as possible following collection.

Prior to transplanting, the number of harvested shoots would be quantified and recorded. During translocation, the planting strategy would aim to plant all of the harvested *Posidonia australis* rhizomes in the rehabilitation sites to maintain the original shoot density of the impact area patches, about 42 shoots per square metre (UNSW, 2023a).

Following translocation of harvested *Posidonia australis*, supplementary transplanting of naturally detached *Posidonia australis* fragments collected from Botany Bay in rehabilitation sites would occur regularly over about an eight-year period. Supplementary planting using naturally detached fragments would aim to gradually increase the rehabilitated area over time to achieve a minimum of double the estimated area of *Posidonia australis* removed from the impact area at Kurnell (268 m^2). Together, translocation of the donor material and supplementary planting of naturally detached *Posidonia australis* fragments would result in the creation of a minimum of 536 m^2 of restored *Posidonia australis* habitat in Botany Bay. This strategy would be implemented to meet the offset requirements specified in the MBOS and ensure progress towards the success criteria for the offset strategy (refer to Section 8). Transplanting of naturally detached *Posidonia australis* fragments in rehabilitation sites is detailed in Implementation Plan #2 (UNSW, 2023b) in the MBOS.

Two methods would be used for transplanting harvested *Posidonia australis* shoots to rehabilitation sites:

a) Transplanting *Posidonia australis* shoots into jute mats deployed to the seabed

b) Transplanting *Posidonia australis* shoots directly into bare sediment using pins to anchor the rhizomes.

The method/s used at each site would be identified prior to translocation based on an assessment of which method/s is most suitable based on factors such as depth, size and existing seagrass cover. For example, jute mats may be beneficial at shallower sites as these tend to be subject to greater wave and current action and the mesh prevents erosion and scouring. In contrast, jute mats would be less suitable for rehabilitation sites with existing seagrass cover which they would disturb. Harvested *Posidonia australis* shoots would be translocated to rehabilitation sites at approximately like-for-like depths to minimise acclimation effort at the recipient sites.

Method (a) Transplanting *Posidonia australis* shoots into jute mats

Jute mats would be deployed at rehabilitation sites immediately prior to transplanting donor material at the site (refer to Section 5.4.3).

Mesh catch bags containing harvested *Posidonia australis* shoots would be delivered to divers at the rehabilitation sites. Divers would maneuver the harvested rhizomes under the partially pinned down jute mat and thread the leaves between the parted jute mesh, leaving the rhizome secured under the mat. The rhizome would be gently pushed into the sediment and secured under the mat using the same long metal weed mat pins used for securing the jute mats. Pins would corrode over time. Transplanting would be done in rows with about 20 centimetres of space between *Posidonia australis* rhizomes to allow for growth while aiming to maintain the original shoot density of the harvested *Posidonia australis* (about 42 shoots per square metre). Plagiotropic (horizontally) growing rhizomes would be positioned on the outside of the mats with the horizontal rhizome oriented out from the centre of the mat (Molenaar and Meinesz 1995).

Once transplanting of *Posidonia australis* into the mat is complete, the remaining portions of the jute mat would be securely pinned down. Divers would count and record on datasheets the number of shoots planted in each mat.

Markers consisting of metal reinforcing bar or rigid electrical conduit and identifying information attached would be installed in each corner of the jute mats and at regular intervals of about every two to three metres around the perimeter of the planted area of rehabilitation sites to facilitate monitoring. Markers would be at a height of about 20-30 centimetres above the sediment. The location, number and condition of markers installed at each rehabilitation site would be recorded (anticipated to be about 150 in total) and monitored over time and all markers removed at the completion of the monitoring program.

Method (b) Transplanting *Posidonia australis* shoots directly into bare sediment using pins to anchor the rhizomes

Mesh catch bags containing harvested *Posidonia australis* shoots would be delivered to divers at the rehabilitation sites.

Transplanting would be done in rows with about 20 centimetres of space between *Posidonia australis* rhizomes to allow for growth and maintain the original shoot density of the harvested material. Divers would gently excavate the sediment and secure the *Posidonia australis* rhizome with long metal weed mat pins. The pins would be inserted into the sediment directly behind the shoots at the rhizome apex and positioned at an angle pointing towards the prevailing wave direction to maximise stability of the transplanted shoots (Bastyan and Cambridge 2008). Transplanting would avoid vegetated areas and allow about 20 centimetres of space between *Posidonia australis* rhizomes and areas of existing seagrass. Divers would count and record on datasheets the number of shoots transplanted.

Markers would be installed at regular intervals around the perimeter of the planted area of rehabilitation sites to facilitate monitoring as described above.

(a) **(b)**

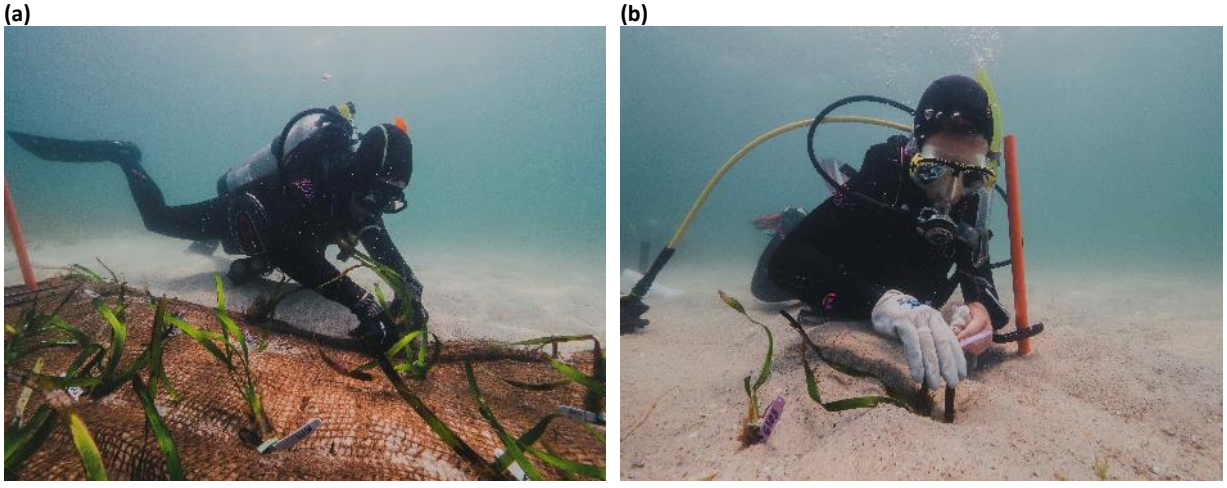

Figure 5-7: Photos depicting the two potential methods for transplanting harvested *Posidonia australis* shoots at rehabilitation sites. (a) transplanting shoots to jute mats and (b) direct planting of shoots into the sediment.

Photo credits: Harriet Spark, Grumpy Turtle Media

5.4.6 Storing harvested *Posidonia australis* material

In the event that harvested *Posidonia australis* shoots are unable to be translocated to rehabilitation sites within the same day, a temporary storage solution would be implemented. Harvested *Posidonia australis* shoots would be stored for no longer than 72 hours.

Should temporary storage of harvested *Posidonia australis* shoots be required, the shoots would either be stored underwater in catch bags near the project area or in dedicated outdoor aquaria at the Sydney Desalination Plant at Kurnell (Figure 5-8). The outdoor aquaria are located within a secure area of the desalination plant and accessible only to personnel inducted by the Sydney Desalination Plant. The aquaria consist of plastic intermediate bulk containers reinforced with metal that are individually plumbed to receive natural seawater that enters the desalination plant system (Figure 5-8). The aquaria contain about 800 litres of filtered natural seawater that enters the desalination plant from intake structures near the seabed off the open coast of Kurnell. Parameters such as flow, temperature, salinity and nutrient levels of the seawater in the aquaria are consistently monitored and maintained at suitable levels by the Sydney Desalination Plant.

Harvested *Posidonia australis* shoots would be deposited into the aquaria either to freely float or in mesh catch bags. Harvested material would be visually inspected by experienced *Posidonia australis* restoration scientists prior to transplanting and any rhizomes deemed non-viable for transplanting (e.g. due to high necrosis) deposited on the shoreline environment.

Aquaria would be visually inspected and maintenance carried out on about a weekly basis to ensure the aquaria maintain optimum conditions for storing *Posidonia australis*.

(a) **(b)**

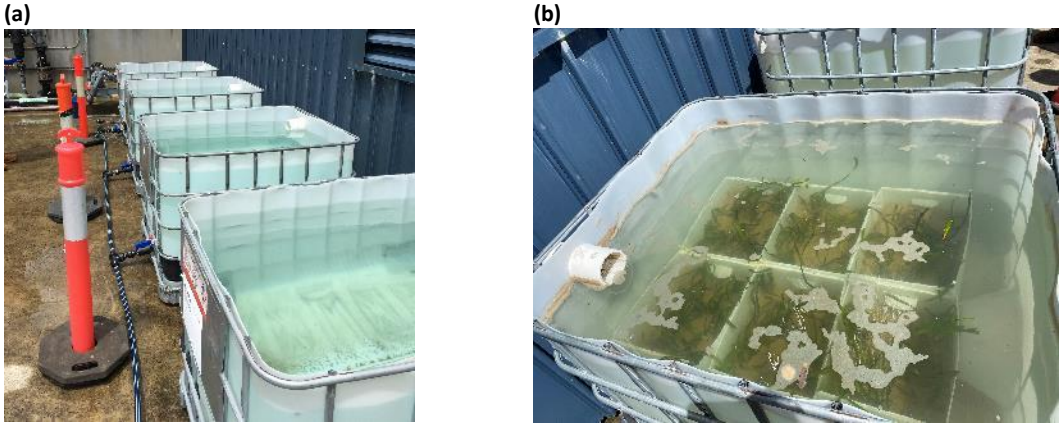

Figure 5-8: Photos showing (a) set up of the outdoor aquaria at the Sydney Desalination Plant for storing collected *Posidonia australis* fragments and (b) *Posidonia australis* fragments planted in boxes in the outdoor aquaria

5.5 Relocation of Syngnathids

Dedicated surveys for Syngnathids would be carried out within *Posidonia australis* beds in the project impact area at Kurnell 24 hours prior to harvesting of *Posidonia australis* donor material, subject to permit conditions which may alter this requirement. Surveys would be carried out by marine scientists experienced in surveying and identifying Syngnathids in Sydney estuaries. Special attention would be paid to safely collect any specimens of the endangered White's Seahorse (*Hippocampus whitei*) found within the *Posidonia australis* beds. Mobile Syngnathids such as Weedy Seadragons (*Phyllopteryx taeniolatus*) that would be capable of moving to suitable habitat outside the impact area would not be relocated.

Syngnathids found within the *Posidonia australis* beds would be relocated to nearby healthy *Posidonia australis* habitat outside the project boundary at Kurnell using methods consistent with the project Construction Environmental Management Plan Syngnathid Relocation Plan (refer to Appendix A). The Syngnathid Relocation Plan would be implemented for any Syngnathids found during harvesting of *Posidonia australis* from the impact area.

Records of animals relocated would be kept and provided to NSW DPI Fisheries in accordance with requirements.

5.6 Initial survey of translocated *Posidonia australis* shoots

Following completion of the translocation process, in-situ mapping and surveying of the rehabilitated areas would be carried out by Scientific Divers to facilitate monitoring. The initial mapping and surveys would be carried out as soon as practicable and within three weeks of completion of translocation.

In-situ mapping would be carried out by Scientific Divers to confirm the areal extent of *Posidonia australis* translocated within the rehabilitation sites at Kurnell. Rehabilitation sites would be located in the field using a GPS and identifying markers installed during the translocation process. A second GPS contained inside a waterproof bag would be attached to a diver-towed float and used to map the area of translocated *Posidonia australis*. Snorkelers would swim the perimeter of the patch,

simultaneously towing the float containing the GPS by hand to accurately record the areal extent of the translocated *Posidonia australis* shoots. Points would be recorded on the GPS at regular intervals during the in-water mapping exercise to provide additional data to assist with area calculations. Alternatively, transect tapes would be used to measure the area delineated by the markers installed during translocation and allow calculation of the planted area.

At each rehabilitation site where translocation was performed, Scientific Divers would carry out underwater surveys to record the density, leaf length and level of epiphyte cover of translocated *Posidonia australis* and species composition of the site. *Posidonia australis* would be surveyed in a minimum of five randomly placed 0.25 m^2 quadrats (0.5 metre x 0.5 metre). The number of quadrats surveyed in rehabilitation sites would be based on the size of the area transplanted within the site, with five quadrats sampled per 50 m^2 of offset area (with a minimum of five quadrats). In each quadrat, the number of *Posidonia australis* shoots would be quantified, and maximum leaf length and epiphyte cover (using a one to five scale, where one indicates minimal and five indicates heavy epiphyte cover) would be recorded for three random leaves per quadrat.

The six reference sites would also be surveyed using the same methods to quantify *Posidonia australis* shoot density, leaf length and level of epiphyte cover in ten randomly placed 0.25 m^2 quadrats per site.

The results of the initial mapping and surveys would be documented in a Baseline Report.

6. Current and future threats, risks and opportunities for *Posidonia australis* translocation

6.1 Achieving persistence of translocated populations

Guidelines developed for the translocation of threatened plants in Australia (Commander et al., 2018) highlight the importance of several attributes necessary for translocated populations to persist in the short-term, including:

- Sufficient numbers of translocated plants to create a viable population and protect against unpredictable variability in genetics, demographics and environmental conditions
- High survival and establishment of translocated plants
- Management and control of existing threats to the translocated population
- Reproduction and growth at rates similar to natural populations.

Monitoring of translocated *Posidonia australis* would be essential to allow evaluation of performance against the attributes suggested by Commander et al. (2018).

6.2 Threats, risks and mitigation measures for *Posidonia australis* translocation

The long-term performance of restoration efforts of *Posidonia australis* is yet to be evaluated in NSW. Reviews of transplantation performance elsewhere in Australia highlight that managing existing threats to *Posidonia australis* in locations where restoration is carried out is essential to improving long-term transplant success (Bastyan and Cambridge, 2008). Some of the key existing threats to *Posidonia australis* in NSW are closely related to the distribution of the species in highly urbanised estuaries. Managing existing human-caused threats to *Posidonia australis* in NSW such as damage from boating activities, eutrophication and construction of foreshore structures (NSW DPI, 2012; Evans et al., 2018) remains a challenge, but solutions are being implemented in some locations (e.g. Demers et al., 2013).

Despite the strong influence of urbanisation and human-caused disturbance on the Botany Bay marine environment, the persistence of *Posidonia australis* meadows in some areas at Kurnell suggests conditions are suitable for *Posidonia australis* growth and survival. However, *Posidonia australis* is slow to recover from disturbance (Meehan and West, 2000; Evans et al., 2018) and until they become established, translocated *Posidonia australis* shoots may be particularly vulnerable to loss. A conservative risk-based approach to translocation of *Posidonia australis* in Botany Bay would be recommended to maximise the potential for survival of translocated seagrass. The translocation approach would focus on transplanting harvested *Posidonia australis* shoots across several rehabilitation sites. This approach follows recommendations by van Katwijk et al. (2015) for increasing transplanting success in dynamic and unpredictable environments, such as the translocation area at Kurnell. Transplanting harvested *Posidonia australis* shoots across several rehabilitation sites would expose the plants to the range of environmental conditions experienced at Kurnell, potentially increasing the chances of ideal growing conditions being satisfied while also spreading the risk of loss of transplanted donor material.

Additional factors emerging from existing literature and experiences of *Posidonia sp.* restoration efforts that would have the potential to influence survival of transplanted *Posidonia australis* shoots in Botany Bay for the project are identified in Table 6-1. Proposed measures that would be implemented to mitigate the identified potential impacts are also provided.

Risks related more broadly to the physical translocation activities would be documented in the risk register for the seagrass translocation, rehabilitation and monitoring project.

Table 6-1: Factors influencing success or survival of transplanted *Posidonia sp.*

Factor	Impact	Proposed strategy	References
Sediment erosion	• Potential to result in burial of *Posidonia sp.* leaves. • Sediment movement of 15-20cm can result in low survival of transplanted shoots.	• Jute mats would help to stabilise sediment at suitable shallower rehabilitation sites where rates of sediment movement are typically greater (Section 5.4.3). • Transplanting of fragments at densities resembling natural meadows would be expected to assist with stabilising the sediment (Section 5.4.5).	Bastyan and Cambridge (2008) Glasby et al. (2015)
Depth	• Reduced light transmission at greater depths has the potential to inhibit *Posidonia sp.* growth.	• Transplanting would prioritise rehabilitation sites at shallower depths (Section 4.3).	Molenaar and Meinesz (1992) Glasby et al. (2015) Larkam (1976)
Planting strategy	• Survival percentage of transplanted *Posidonia sp.* shoots increases with number of shoots initially transplanted – planting of shoots over a larger area increases the chances of meeting environmental conditions suitable for growth. • Population growth rate increases with number of shoots initially transplanted – transplanting at higher density promotes self-sustaining recovery.	• The dynamic environment of Botany Bay suggests the preferred translocation strategy would target planting harvested fragments across multiple recipient sites (Section 6.2).	van Katwijket al. (2015)
Bioturbation	• Burial, shading, erosion, or root damage to transplanted *Posidonia sp.* shoots due to excavation by burrowing marine worms.	• Jute mats would be used to minimise bioturbation impacts (Section 5.4.3).	Bastyan and Cambridge (2008)
Epiphyte loads	• Heavy epiphyte loads may cause shading to *Posidonia sp.* leaves and impact the ability of the plants to photosynthesis and grow.	• Monitoring would quantify changes in shoot density, leaf length and epiphyte loads of transplanted *Posidonia australis.*	Cambridge et al. (1986) Larkam (1976)
Turbidity	• Reduces light transmission through the water column, reducing the photosynthetic ability and growth of transplanted *Posidonia sp.*	• Monitoring would quantify changes in shoot density and leaf length of transplanted *Posidonia australis.*	Larkum (1976)
Substratum environment	• Changes in substratum characteristics may effect recolonisation by transplanted *Posidonia sp.*	• The existing topography of rehabilitation sites is suitable for transplanting *Posidonia australis*. • Gentle excavation by hand during transplanting would minimise disturbance to the natural sediment environment at recipient sites (Section 5.4.5).	Castejon-Silvo and Terrados (2021)
Anchoring system	• A suitable and long-term anchoring system is essential to precent transplanted rhizomes being dragged before natural rooting occurs.	• Jute mats and anchoring pins based on best scientific practice design would be used to anchor transplanted *Posidonia australis* rhizomes to the sediment (Section 5.4.3 and 5.4.5).	Castejon-Silvo and Terrados (2021) Gobert et al. (2005) Ferretto et al. (2021) van Katwijket al. (2015)

Factor	Impact	Proposed strategy	References
Growth form of shoots	• Plagiotropic (horizontally) growing *Posidonia australis* tend to spread more quickly and may speed up recovery of bare areas.	• Both plagiotropic (horizontally) and orthotropic (vertically) growing *Posidonia australis* shoots would be harvested and transplanted. • Where transplanting into jute mats occurs, plagiotropic growing rhizomes would be positioned to encourage correct growth direction away from the mat (Section 5.4.5).	West (1990) Molenaar and Meinesz (1995) Meehan and West (2000)
Season	• Seasonal storm activity may damage jute mats, uproot transplanted *Posidonia sp.* shoots, promote burial due to greater wave action and result in higher stormwater input leading to increases in nutrients and changes in salinity. • Reduced day lengths in autumn-winter results in lower light levels and may inhibit growth and survival of transplanted *Posidonia sp.* • Warmer air/water temperatures have the potential to cause stress to harvested *Posidonia sp.* shoots, leading to mortality.	• Translocation would be expected to occur during autumn-winter. Post-storm monitoring would be carried out to enable early detection of impacts to transplanted *Posidonia australis* shoots. • Jute mats and transplanted shoots would be securely attached to the sediment using best scientific practice design anchoring systems (Section 5.4.5). • Heat stress to harvested *Posidonia australis* shoots would be minimised by transplanting simultaneously with harvesting (Section 5.3 and 5.4.5). • Harvested material would be stored submerged in seawater where temporary storage is necessary (Section 5.4.6).	Meinesz et al. (1992) Paling et al. (2001) Ferretto et al. (2021)

6.3 Opportunities associated with translocating *Posidonia australis*

Successful translocation of *Posidonia australis* for the project would not only result in a net gain of ecologically valuable key fish habitat but would also result in indirect benefits. Some of the benefits and opportunities arising from translocation for the project would include:

- Return of ecosystem functions and services to degraded areas (e.g. habitat provision, nursery grounds, carbon sequestration, sediment stabilisation)
- Support for further research into seagrass transplanting and rehabilitation
- Development of new management techniques and feasible restoration programs for the endangered *Posidonia australis* community in Sydney
- Development of new methodologies for seagrass restoration science and practice
- Potential for attracting and securing additional government research funding
- Increased knowledge of the endangered *Posidonia australis* community in Sydney
- Collaboration with marine restoration practitioners and Traditional Owners (Gamay Rangers)
- Community and stakeholder education
- Continued collaboration on other projects with Transport for NSW – Maritime in order to support delivery of future maritime infrastructure projects in a more sustainable way.

7. Monitoring program

7.1 Introduction to the monitoring program

7.1.1 Why monitor marine restoration projects?

Incorporating monitoring into restoration projects is essential for many reasons. Importantly, monitoring during restoration projects is critical for detecting change. Monitoring programs that are designed to detect change enable restoration practitioners to make decisions and implement management actions that are based on scientific evidence (Short et al., 2015). A lack of long-term monitoring (at least five years) is a shortcoming of many marine restoration efforts worldwide, contributing to the uncertainty in understanding restoration success (Boudouresque et al. 2021; Rezek et al., 2019).

Monitoring is an essential tool in restoration projects because it allows restoration practitioners to measure changes in the status and health of the restoration species over time in restored sites (Commander et al., 2018). Monitoring provides evidence and data for changes in a range of characteristics from structural (e.g. extent) to functional (e.g. biodiversity, productivity) properties (Hendy and Ragazzola, 2021) that can be adapted depending on the restoration project's objectives. When performed over longer time periods, monitoring can provide an understanding of the natural variability and trends in the ecosystem being restored (Wilkinson et al., 2003). Monitoring ensures that restoration methods, techniques and tools are assessed and modified if they are not performing or functioning as expected (Commander et al., 2018). It also allows opportunities to inform restoration, improve the design of future restoration efforts and increase understanding of the biology, habitat requirements and factors that influence the persistence of the restoration species (National Academies of Sciences, Engineering, and Medicine, 2017; Rezek et al., 2019). Incorporating measurements of factors such as cost and effort into monitoring programs enables aspects such as resource use efficiency to be evaluated (Commander et al., 2018). Finally, communicating the results of monitoring to project sponsors, stakeholders and the broader community provides the opportunity to raise awareness, foster care for environments and highlight the value of restoration work (Wilkinson et al., 2003).

Developing a best-practice, scientifically robust monitoring program that documents the objectives, design, methodology (data collection, analysis, interpretation) and evaluation and reporting process for monitoring activities is an important step in the planning process for any restoration project (Society for Ecological Restoration International Science & Policy Working Group (SER), 2004). Review and continuous improvement of monitoring programs should occur throughout the life of the restoration project in response to changes in the environment, regulatory requirements and developments in restoration best practice.

7.1.2 Context of the seagrass monitoring program

The MBOS outlines the need, approach and potential benefits for offsetting impacts to seagrass related to the project.

Seagrass rehabilitation efforts to meet the requirements identified in the MBOS would involve two forms of direct offset actions carried out over two stages at Kurnell, Botany Bay. Stage one would involve translocating harvested *Posidonia australis* shoots from the project impact area at Kurnell to nearby unvegetated areas identified as degraded seagrass meadows. Stage two would involve rehabilitating unvegetated areas at Kurnell by transplanting naturally detached beach-cast *Posidonia australis* fragments collected from shorelines around Botany Bay. Stage one would be anticipated to be carried out from about May-June 2023. Stage two would commence in about July 2023 and transplanting of naturally detached *Posidonia australis* fragments would continue at regular intervals for about eight years.

The MBOS identified the need for establishing a long-term monitoring program to assess the success of the *Posidonia australis* rehabilitation efforts. This monitoring program forms part of the MBOS and has been developed to align with the requirements identified within the MBOS. It has been prepared based on best practice monitoring methods for seagrass restoration projects.

This monitoring program provides the framework for obtaining data on attributes of *Posidonia australis* for comparing between rehabilitation sites and representative sites providing the benchmark against which to judge success of the rehabilitation efforts through time. It has been designed to enable the outcomes of the rehabilitation efforts to be assessed against the key performance indicators identified in the MBOS, and allow the offsetting strategy to be evaluated. Importantly, these indicators not only include structural properties of *Posidonia australis,* but also qualitative attributes related more broadly to the field of seagrass restoration, such as advancing the knowledge of factors influencing the success or failure of *Posidonia australis* translocation and rehabilitation.

The monitoring program would be implemented for the operational life of the MBOS (ten years).

7.1.3 Consultation for the monitoring program

This monitoring program has been developed in consultation with the MBOS Implementation Reference Panel, Transport for NSW and other key project stakeholders. Consultation between key project stakeholders would be ongoing during the life of the monitoring program to review its effectiveness and implement new strategies or processes when identified as necessary.

7.2 Purpose, objectives and measures of success for the seagrass monitoring program

7.2.1 Purpose of the seagrass monitoring program

The purpose of this monitoring program is to describe how changes in the rehabilitation sites and overall success of the rehabilitation efforts would be measured and determined over time. This includes establishing the objectives, success criteria, methodology for monitoring and protocols for data management, analysis and reporting. The monitoring program provides clear instructions and methods for monitoring, including a proforma datasheet, to ensure data collection is consistent over the ten-year life of the program.

7.2.2 Objectives of the seagrass monitoring program

The ultimate objectives of the seagrass rehabilitation efforts for the project would be to facilitate the development of *Posidonia australis* meadows with areal extent, density, condition and function that are assessed to be equal to natural undisturbed meadows at Kurnell. The monitoring program would track progress towards these objectives by providing regular assessments of *Posidonia australis* attributes, using the success criteria as the basis for evaluating progress (refer to Section 7.2.3). Through this process, the monitoring program would also highlight the factors or conditions (e.g. environmental, plant traits, rehabilitation or management methods) that influence successful outcomes for transplanted *Posidonia australis* while also identifying failures and detecting the need for remedial action.

7.2.3 Monitoring success criteria

Success criteria are an essential component of monitoring programs for restoration projects because they provide the empirical basis for determining if restoration objectives have been achieved (SER, 2004). Where the monitoring data indicates that the success criteria have been met, the objectives have been achieved and the restoration efforts can be considered a success (Hendy and Ragazzola, 2021). At this point, the restored species or ecosystem is likely to be resilient enough to need little further management (SER, 2004).

Success criteria for assessing the performance of the *Posidonia australis* rehabilitation efforts over short, mid and long-term time periods are detailed in Section 8. The success criteria provide readily measurable structural attributes that would indicate changes in the status of transplanted and nearby naturally occurring *Posidonia australis* meadows through time: *Posidonia australis* areal extent and shoot density. Monitoring of two additional attributes not directly related to the success criteria, leaf length and epiphyte cover, would provide an indication of the health of transplanted *Posidonia australis*. These are the fundamental indicators of seagrass condition (Short et al., 2015; Hendy and Ragazzola, 2021) that would be measured at every monitoring event over the course of the ten-year monitoring program. Methods for monitoring these attributes are detailed in Section 7.5.

7.3 Monitoring strategy

The strategy for the monitoring program would involve comparing measured *Posidonia australis* attributes with baseline information or nearby healthy natural seagrass meadows (reference sites) to track the progress of transplanted *Posidonia australis* at rehabilitation sites. *Posidonia australis* condition would be assessed using the most appropriate comparison for the individual attributes and time period (short, mid or long-term): either *Posidonia australis* impact area patches, unvegetated rehabilitation sites or reference sites (refer to Table 8-1 in Section 8). Baseline seagrass monitoring carried out during 2021-2022 (Niche, 2023) and additional targeted surveys (UNSW, 2023a) carried in late 2022 in the vicinity of the project area at Kurnell provided the data for determining these attribute qualities. Monitoring results from the initial surveys of the

rehabilitation sites following translocation (refer to Section 5.6) would provide initial measures of *Posidonia australis* condition for comparing over the short to mid-term.

Six reference sites would be monitored throughout the monitoring program for comparison to the rehabilitation sites that receive transplanted *Posidonia australis*. Three reference sites were initially selected for monitoring based on data obtained from the baseline seagrass monitoring and confirmation survey. In consultation with the MBOS Implementation Reference Panel three additional reference sites were selected to ensure representation across the entire depth gradient of the main *Posidonia australis* meadow at Kurnell and a scientifically robust monitoring program design. The six reference sites are located outside the project boundary and distributed to ensure they represent healthy natural *Posidonia australis* meadows with similar exposure, tidal range, depth and physical characteristics to the rehabilitation sites (Figure 7-1).

The rehabilitation sites with transplanted *Posidonia australis* and reference sites would be monitored with the same methods and frequency to allow for direct comparison of the trajectories of the rehabilitated and natural meadows. All rehabilitation sites with transplanted *Posidonia australis* and reference sites would be surveyed at every monitoring event. This strategy of long-term, repeated monitoring at the same sites would ensure that the effects of rehabilitation efforts can be differentiated from natural variability, short-term or extreme events and background environmental trends across the broader area. This approach would also improve statistical power and increase confidence in monitoring results.

7.4 Monitoring timing and frequency

The anticipated program for seagrass translocation, rehabilitation and monitoring is detailed in Table 1-2.

The monitoring program would commence within three months of completion of translocation of harvested *Posidonia australis* to rehabilitation sites at Kurnell and continue for ten years. Monitoring of rehabilitation sites with restored *Posidonia australis* and reference sites would occur four times per year for the first year following translocation and twice per year for the next four years. Monitoring would occur annually after five years. The first monitoring event would be expected to occur in spring 2023 and monitoring would be completed by about the end of 2033.

Because monitoring aims to detect changes in *Posidonia australis* condition, any natural variability that could confound monitoring results should be minimised where possible. Best practice seagrass monitoring suggests that monitoring be carried out in the species' growth season and at the same time of year when monitoring over longer time-periods (Hendy and Ragazzola, 2021). The maximum growth period for *Posidonia australis* occurs in spring and summer (Department of the Environment and Energy, 2018). In line with best practice, at least one monitoring event would occur each year during spring-summer (*Posidonia australis* growth period) for the entire ten-year period.

More frequent monitoring in the initial years reflects the greater risk of loss of transplanted *Posidonia australis* shoots during this period. More frequent monitoring would also help to identify any problems early on so that these can be corrected in consultation with the MBOS Implementation Reference Panel and other relevant stakeholders.

In addition to the regular monitoring, five post-storm monitoring events would occur within five years of completion of *Posidonia australis* translocation. Post-storm monitoring would be carried out within four weeks following a major storm event that has potential to impact on seagrasses in the Kurnell area. The timing of post-storm monitoring events would be agreed in consultation with relevant project stakeholders.

7.5 Methodology for monitoring

7.5.1 Roles and responsibilities for monitoring

Scientific Divers with suitable qualifications and experience carrying out similar seagrass monitoring work would perform the monitoring outlined in this monitoring program. Monitoring sites would be accessed by vessel. Vessels would be operated by suitably qualified and experienced vessel masters.

Monitoring team members would receive training on roles, tasks and safety measures prior to each monitoring event. Quality assurance of monitoring methods would be carried out regularly to ensure monitoring data is collected in a consistent manner and comparable across time.

Monitoring would be carried out in accordance with all Work Health and Safety, Transport for NSW – Maritime, Harbour Master and other relevant requirements. Monitoring activities would be coordinated in consultation with the construction Contractor (for monitoring during project construction) and project Operator (for monitoring post-construction).

7.5.2 Monitoring locations

Translocation, rehabilitation and monitoring of *Posidonia australis* for the project would be carried out in Botany Bay.

Six rehabilitation sites located within the main *Posidonia australis* meadow to the west of the project boundary at Kurnell would be considered high to medium priority for receiving transplanted *Posidonia australis* during the translocation process and/or longer-term transplanting using naturally detached *Posidonia australis* fragments (Figure 7-1). Monitoring would only be carried out at rehabilitation sites that receive transplanted *Posidonia australis*. Because planting of rehabilitation sites with naturally detached *Posidonia australis* fragments would occur over about eight years, monitoring locations would be adjusted over time to incorporate additional sites that have been rehabilitated, including sites located outside of Kurnell should these be identified.

The six reference sites that would be monitored are located at least 130 metres from the project boundary and impacts from the project on the reference sites would be expected to be negligible (Figure 7-1). The location of the reference sites would remain consistent throughout the monitoring program.

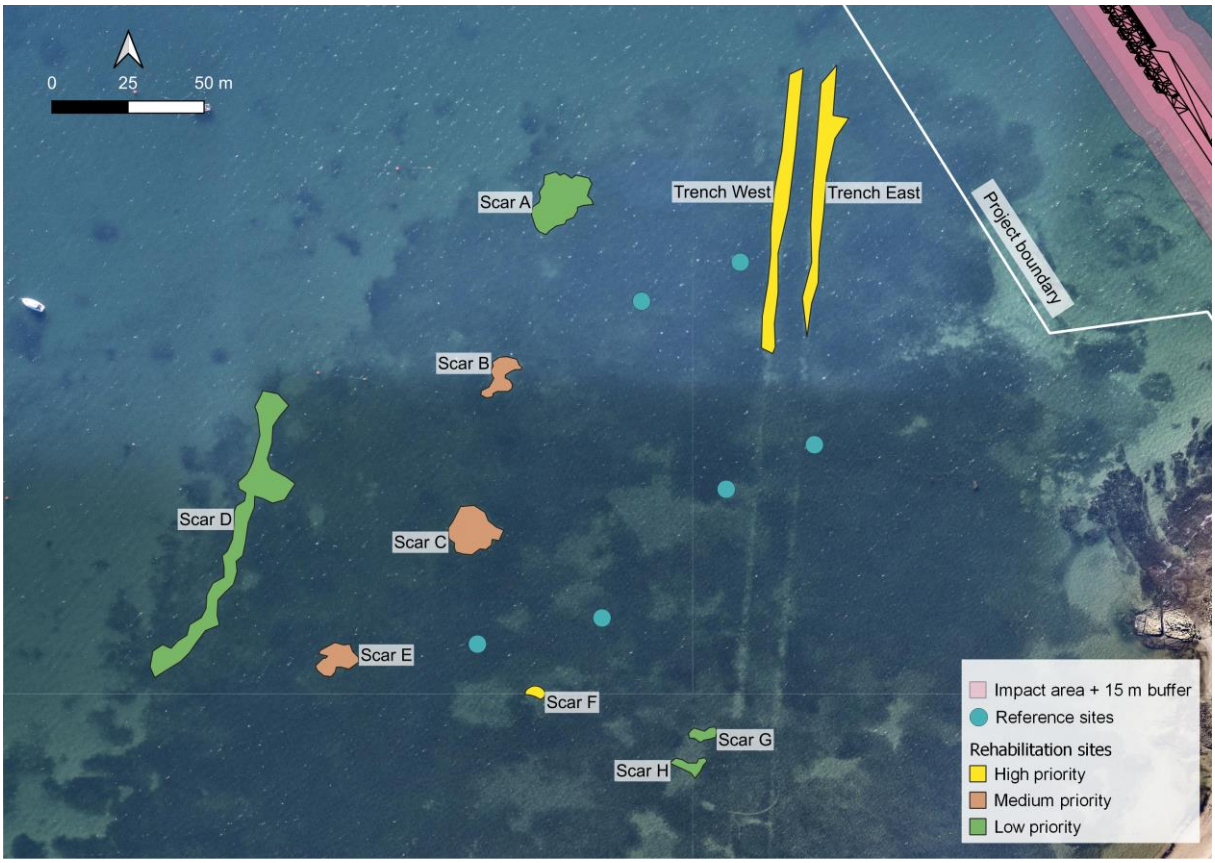

Figure 7-1: Locations of the *Posidonia australis* monitoring program reference sites in relation to the rehabilitation sites at Kurnell

7.5.3 Monitoring extent of *Posidonia australis* at rehabilitation sites

In-situ mapping would be carried out to confirm the areal extent of transplanted *Posidonia australis* located within the rehabilitation sites at Kurnell.

Rehabilitation sites would be located in the field using a GPS. A second GPS contained inside a waterproof bag would be attached to a diver-towed float and used to map the perimeter of the transplanted *Posidonia australis* area. Marker posts previously installed at rehabilitation sites would provide reference points for the mapping exercise. Snorkelers would swim the perimeter of the transplanted area, simultaneously towing the float containing the GPS by hand to accurately record the extent of the area. Points would be recorded on the GPS at regular intervals during the in-water mapping exercise to provide additional data to assist with area calculations. Alternatively, transect tapes would be used to measure the area delineated by the markers installed during translocation and allow calculation of the planted area.

7.5.4 Monitoring *Posidonia australis* density and condition

Monitoring of *Posidonia australis* density and condition (leaf length and epiphyte cover) as well as seagrass cover and species composition would be carried out at rehabilitation sites with transplanted *Posidonia australis* and the six reference sites.

Each site would be located in the field using a GPS and a temporary float would be deployed in the centre of the site.

At each rehabilitation site with transplanted *Posidonia australis* and reference site, Scientific Divers would carry out underwater surveys to quantify the density, leaf length and level of epiphyte cover of *Posidonia australis*. *Posidonia australis* would be surveyed within randomly placed 0.25 m^2 quadrats (0.5 metre x 0.5 metre). The number of quadrats surveyed in rehabilitation sites would be based on the size of the area transplanted within the site, with five quadrats sampled per 50 m^2 of offset area (with a minimum of five quadrats). At reference sites, ten randomly placed quadrats would be surveyed within about a five metre radius of the centre of the site. In each quadrat, the number of *Posidonia australis* shoots would be quantified, and maximum leaf length and epiphyte cover (using a one to five scale, where one indicates minimal and five indicates heavy epiphyte cover, refer to Appendix B) would be recorded for three random leaves per quadrat.

7.5.5 Monitoring seagrass cover and species composition at rehabilitation sites

During the monitoring surveys of rehabilitation sites, a digital camera would be used to record a photograph of each survey quadrat for post-hoc analysis of total seagrass cover and species composition. The photo would be captured from an angle as vertical as possible, ensuring the entire quadrat is within the frame and avoiding shadows and areas of reflection where possible.

7.5.6 Post storm event monitoring

Strong storm activity would have the potential to damage transplanted *Posidonia australis*, especially during the period soon after transplanting when shoots are more vulnerable to disturbance. Post-storm monitoring would be carried out to enable early detection of impacts to transplanted *Posidonia australis* shoots.

Post-storm monitoring would be carried out using the same methods detailed for the regular monitoring program and results included in the interim and annual monitoring reports (refer to Section 7.8).

7.5.7 Recording monitoring data

Survey data collected during monitoring would be recorded by Scientific Divers on pre-prepared datasheets printed on waterproof paper. Datasheets would record details identifying the monitoring site and monitoring event, survey data, as well as any additional information, observations or management actions carried out at the site (e.g. condition of jute mats, evidence of environmental stress).

An example monitoring datasheet is provided at Appendix B.

7.6 Monitoring program data management

All monitoring data would be compiled, checked for quality assurance and filed on a secure server. Raw and processed data would regularly be backed-up on external hard drives.

Electronic copies of datasheets would be made immediately on return from the field. Raw survey data would be entered into databases as soon as practicable following the monitoring event. Digital photographs would be transferred from cameras and filed for later processing and analysis. Data would be transferred from the GPS and filed for later processing in GIS software. Processed data would be stored in easily accessible formats (e.g. excel spreadsheets, GIS shapefiles) and filed using a logical structure.

Relevant electronic data (e.g. digital photographs, GIS shapefiles) would be made available through the reporting process.

7.7 Monitoring program data analyses

7.7.1 Analysing extent of *Posidonia australis* at rehabilitation sites

Preliminary data exploration would involve reviewing the most recent Nearmap imagery of Botany Bay, should an informative image have been captured since the most recent monitoring event. Previously prepared polygons of the rehabilitation sites would be reviewed in GIS software.

The GPS data collected during the in-situ mapping would be reviewed and inspected for accuracy in GIS software. Polygons depicting cover of transplanted *Posidonia australis* would be constructed for each rehabilitation site. Area calculations of transplanted *Posidonia australis* would be carried out from the polygon data using GIS software.

Data on *Posidonia australis* areal extent in rehabilitation sites would be analysed to obtain summary descriptive statistics and plotted for visual interpretation of the results. Progress towards the success criteria for increase in areal extent of *Posidonia australis* in rehabilitation sites would be assessed by analysing trends in cover over time.

Maps of the rehabilitation sites would be produced to provide a visual representation of *Posidonia australis* areal extent in rehabilitation sites.

7.7.2 Analysing *Posidonia australis* condition in rehabilitation sites

Data on *Posidonia australis* shoot density, leaf length and epiphyte cover recorded during the surveys of *Posidonia australis* in the rehabilitation sites and references sites would be analysed to obtain summary descriptive statistics. The mean (± standard error) of these variables would be calculated for each site and plotted for visual interpretation of the results.

Progress towards the success criteria for *Posidonia australis* density would be assessed using ANOVA to statistically test differences between the monitoring results for *Posidonia australis* density in rehabilitation sites with:

- *Posidonia australis* density in rehabilitation sites prior to translocation and rehabilitation (short-term, two years)
- *Posidonia australis* density in the impact area or reference sites (mid and long-term, six to ten years).

Generalised linear mixed models would be used to analyse trends in *Posidonia australis* shoot density in rehabilitation sites over time.

Differences between *Posidonia australis* leaf lengths and epiphyte cover in rehabilitation sites and reference sites would also be assessed using ANOVA.

7.7.3 Analysing seagrass cover and species composition in rehabilitation sites

Digital photographs of quadrats recorded during monitoring events would be analysed for percentage cover using the image analysis program Coral Point Count with Excel extensions (CPCe, Kohler and Gill, 2006). CPCe is a useful tool for determining cover of different benthic organisms and substrates from digital photographs.

Photographs of monitoring survey quadrats would be uploaded to CPCe. Total seagrass cover and species composition for each quadrat would be estimated using the random point method. Thirty random points would be allocated to each photoquadrat and the seagrass species or substrate type under each point would be identified. The total percentage cover of seagrass as well as the mean percentage cover of each seagrass species or substrate type would be calculated for each rehabilitation site. Results would be plotted for visual interpretation.

7.8 Reporting on monitoring

7.8.1 Overview of monitoring reporting requirements

Monitoring reports would detail the results of the monitoring carried out in accordance with this monitoring program. The monitoring reports would be incorporated into the Marine Biodiversity Offset Report that would be submitted annually to NSW DPI Fisheries, DPE and DCCEEW.

All monitoring reports would be provided to the MBOS Implementation Reference Panel for review.

Two types of monitoring reports would be prepared:

1) Interim Summary Reports would generally be prepared following completion of the first monitoring event of the reporting year (refer to Section 7.8.2)
2) Annual Monitoring Reports would be prepared following completion of each annual monitoring event (refer to Section 7.8.3).

The information to be included in the reports is detailed in the following sections.

7.8.2 Interim Summary Monitoring Report

The first Interim Summary Report would be prepared following the first two monitoring events within the overall monitoring program (i.e. after about six months, expected late 2023) and would be repeated for four further monitoring instances with the final report prepared in about late 2027.

The Interim Summary Report would include, but not be limited to the following information:

- Results from each monitoring site
- Brief overview of any change in *Posidonia australis* health and overall seagrass habitat condition
- Opportunities to address any changes that were observed
- Post-storm reporting (if any)
- Details of any management issues
- Recommendations to ensure adaptive management and/or corrective actions are considered.

7.8.3 Annual Monitoring Report

The first Annual Monitoring Report would be prepared after one year of monitoring (expected about mid-2024) and would be repeated for nine further monitoring instances with the final report prepared in about late 2033.

The Annual Monitoring Report would include, but not be limited to the following information:

- Results from each monitoring site
- Overview of progress against success criteria detailed in the MBOS (refer to Section 8)
- Details of translocation and/or rehabilitation activities over the 12 month period
- All data and photographs collected over the 12 month period plus, where applicable, comparisons to previous years' data
- Description of rectification works carried out as a result of ongoing monitoring
- Unexpected impact report
- Details of any management issues
- Recommendations to ensure adaptive management and/or corrective actions are considered.
- Any other information requested by Transport for NSW.

7.9 Review and continuous improvement

All monitoring results would be provided to the MBOS Implementation Reference Panel and other relevant project stakeholders for review. The review process would enable early detection of negative (or positive) trends or indications of *Posidonia australis* status and condition that have the potential to influence the success of the rehabilitation efforts. Should any remedial or management actions be identified from the ongoing reviews of monitoring results, these would be determined in consultation with the MBOS Implementation Reference Panel and other relevant stakeholders.

A formal review of monitoring would be carried out after five years (and every five years thereafter) to assess the ongoing success of the rehabilitation efforts. The review would be documented in a Rehabilitation Monitoring Review and submitted to DCCEEW and the MBOS Implementation Reference Panel. The purpose of the monitoring review would be to:

- Determine if the monitoring method and intervals are adequate
- Provide an assessment as to whether the *Posidonia australis* offsets have been achieved, are likely to be met or are unlikely to be met based on the success criteria
- If the success criteria have not been achieved, identify remediation measures which will be carried out to ensure that the success criteria are achieved and justify how the remediation measures will provide full compensation for the impacts to *Posidonia australis.*

Should the review identify that amendments to the monitoring program are required, these would be developed in consultation with the MBOS Implementation Reference Panel and other relevant stakeholders and documented in subsequent revisions of this monitoring program. The updated monitoring program would be incorporated into the MBOS and distributed to relevant project stakeholders. Personnel involved in the monitoring program would be informed of the amendments and training provided should it be necessary.

8. Success criteria

Monitoring of the performance of any restoration effort should be linked to predefined and agreed standards and/or criteria (Commander et al., 2018). The success criteria for the *Posidonia australis* offsetting strategy are identified in Table 8-1. The success criteria were developed in consultation with the MBOS Implementation Reference Panel and other key project stakeholders. The performance of the offsetting strategy would be evaluated by comparing the monitoring data with these targets.

The success criteria have been developed taking into account the slow growing nature of *Posidonia australis:* rehabilitated sites are expected to take at least five to ten years to achieve shoot densities similar to natural undisturbed meadows (Bastyan and Cambridge 2008). Table 8-1 also identifies additional desirable measures of success such as publishing materials that advance the knowledge of seagrass restoration.

The success of the *Posidonia australis* offsetting strategy would be assessed against the most appropriate measure for each criterion including:

- *Posidonia australis* in the impact area i.e. Kurnell wharf footprint and 15 metre buffer (areal extent and shoot density) based on baseline monitoring results
- Baseline offset site conditions (shoot density, i.e. zero *Posidonia australis* shoot density in bare, unvegetated boat mooring or cable scars)
- Reference sites (long-term shoot density).

Table 8-1: *Posidonia australis* offsetting success criteria and measures over short, mid and long-term period of the restoration program

Criteria	Measure	Pre construction	Short term success (2 years)	Mid term success (6 years)	Long term success (10 years)
Primary success criteria					
Removal of all *Posidonia australis* to be impacted.	All *Posidonia australis* successfully transplanted from the impact area to offset sites.	Removal and recording of all *Posidonia australis* shoots from impact area prior to construction (Kurnell). Storage of shoots for no longer than 72 hours until transplanting is complete.	-	-	-
Increase in area of *Posidonia*.	Areal extent of restored *Posidonia australis* meets EPBC offset requirements.	-	Areal extent of restored *Posidonia australis* is to a 1:1 ratio of area removed from the impact area.	Areal extent of restored *Posidonia australis* is to a 2:1 ratio of area removed from the impact area.*	Areal extent of restored *Posidonia australis* combined with additional offsetting measures^ meets or exceeds the EPBC offset requirement.*
Goal: 536 m^2	Minimum value:	-	268 m^2	536 m^2	536 m^2
Maintain *Posidonia australis* density.	Shoot density of restored *Posidonia australis* (based on 0.25 m^2 quadrats).	-	Increase in shoot density in the offset sites from bare to vegetated at a minimum density of 25 shoots per square meter (>50% of the impact area density).	Mean shoot density in the offset sites is equal to or greater than 32 shoots per square metre (75% of the impact area density) or the reference sites density (if it drops below 32 shoots/m^2).	Mean shoot density of the offset sites is equal to or greater than the impact area or the reference sites density (if it drops below the impact area density).*
Goal[1]: 42 shoots/m^2	Minimum value:	-	25 shoots/m^2	32 shoots/m^2	42 shoots/m^2
Secondary success criteria					
Support for improved techniques and methodologies in seagrass restoration.	Publication of materials that advance the knowledge of seagrass restoration in NSW.	-	Documentation of successful methodologies and conditions for translocation, planting and monitoring of seagrass shoots.	Documentation of improvements resulting from adaptive approaches leading to higher seagrass density and greater health indicators.*	Development of improved indicators of ecosystem health (e.g. using photogrammetry), documentation of management or operational improvements to achieve indicators of seagrass restoration success.*

[1] *Refer to Site Selection and Validation Report at Appendix 6 in the MBOS.*

* *Contributes to meeting Posidonia australis restoration key performance indicator in MBOS.*

^ *Additional offsetting measures such as installation of Environmentally Friendly Moorings in Posidonia australis meadows are identified in Section 5.7 of the MBOS. An implementation plan and success criteria for additional offsetting measures would be prepared in consultation with the MBOS Implementation Reference Panel and other project stakeholders during 2023.*

9. Terms and acronyms

Term /acronym	Description
BOM	Bureau of Meteorology
CoA	Condition of approval
DAWE	Department of Agriculture, Water and the Environment (former)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and the Environment
DPIE	Department of Planning, Industry and the Environment (former)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EIS	Environmental impact statement
FM Act	Fisheries Management Act 1994 (NSW)
KFH	Key fish Habitat
MBOS	Marine Biodiversity Offset Strategy
MIRP	Marine Biodiversity Offset Strategy Implementation Reference Panel
NSW DPI Fisheries	NSW Department of Primary Industries Fisheries
SEARs	Secretary's environmental assessment requirements
SSI	State Significant Infrastructure
TEC	Threatened Ecological Community
Transport for NSW	Transport for New South Wales

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Appendix A

Syngnathid Relocation Plan

Attachment D – Syngnathid relocation plan

The methodology and relocation specifics presented in this section apply to all locations. The methodology is focused on the salvage and relocation of White's Seahorse however, it is also applicable to all other species of Syngnathids. It is not appropriate to relocate mobile Syngnathids such as Weedy Seadragons (*Phyllopteryx taeniolatus*) who are able to move to nearby suitable habitat outside of the construction boundary.

Reporting

Each Syngnathid relocation event must be recorded and reported to NSW DPI Fisheries within two weeks of relocation, including:

- The location of the works
- The date of the relocation activity
- The number of Syngnathids collected and relocated
- The species of Syngnathid, if known
- Where the Syngnathids were moved to, including coordinates
- The type and condition of the habitat at the relocation site.
- A reporting proforma template has been included below.

Records of the threatened White's Seahorse must also be registered in the NSW DPI Fisheries 'Report a threatened species' database (https://www.dpi.nsw.gov.au/fishing/threatened-species/report-it) within the same timeframe as the above reporting requirements.

Receiver sites

Receiver sites are to be established in consultation with DPI Fisheries. Nearby patches of Posidonia, outside the construction boundary at both sites have been identified as likely receiver sites (Figure D1, D2).

If receiver sites are within the construction boundary then exclusion areas are to be established to demarcate all receiver sites that Syngnathids have been relocated to (e.g. marked by buoys or mapped on sensitive area plans) prior to commencement of water-based construction activities.

Figure D 1 White's Seahorse habitat and potential receiver sites (red) at La Perouse

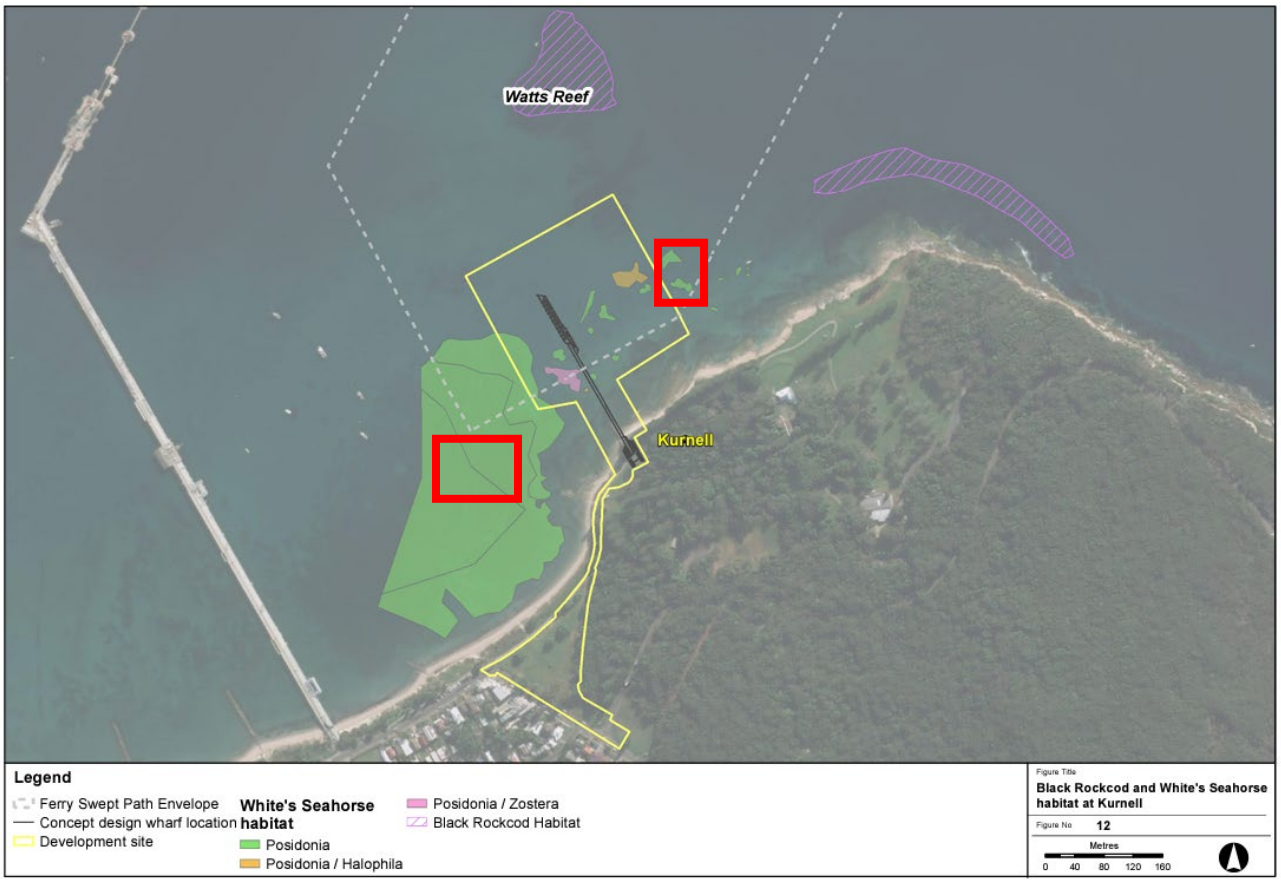

Figure D 2 White's Seahorse habitat and potential receiver sites (red) at Kurnell

Relocation methods

Table E1 presents the two Syngnathid relocation methods in order of preference.

Relocation method	Prepare	Salvage	Release
In-situ	• Zip-lock bags 20x19cm or larger for storing individuals of pairs of Syngnathids. • Catch bags for storing zip-lock bags. • Waterproof paper/tags to label size of individuals and location/habitat where they were salvaged from.	• Two divers search all potential Syngnathid habitat identified as source sites. Divers are to wear gloves when salvaging Syngnathids. • Syngnathids located will be captured by hand and placed	• Salvage divers are to take note of habitat and habitat condition where Syngnathids are found so that individuals can be relocated to like-for-like habitat at receiver sites. • Individuals must be carefully

Relocation method	Prepare	Salvage	Release
	• Underwater pencil and slate.	in an extended catch bag or similar so that individuals are not injured from crushing or abrasion (e.g. storing individuals in zip lock bags filled with water and then placed in the catch bag). • Pairs or nearby groups of individuals are not to be separated and are to be placed in the same bag.	placed in the receiving habitat as close to the seafloor or structure as possible and observed to be responsive to stimulus or have attached to benthic habitat features.
Alternative Relocation Method (for when Syngnathids cannot be safely relocated underwater by divers)	• Zip-lock bags 20x19cm or larger for storing individuals of pairs of Syngnathids. • Catch bags for storing zip-lock bags. • Waterproof paper/tags to label size of individuals and location/habitat where they were salvaged from. • Underwater pencil and slate. • Large buckets (≥20 litres; receiving tanks) filled with water and macroalgae from the source site will be prepared in anticipation of salvaged Syngnathids. • The amount of macroalgae in the receiving tanks should	• Two divers search all potential Syngnathid habitat identified as source sites. Divers are to wear gloves when salvaging Syngnathids. • Syngnathids located will be captured by hand and placed in an extended catch bag or similar so that individuals are not injured from crushing or abrasion (e.g. storing individuals in zip lock bags filled with water and	• Salvage divers are to take note of habitat and habitat condition where Syngnathids are found so that individuals can be relocated to like-for-like habitat at receiver sites. • Individuals must be carefully placed in the receiving habitat as close to the seafloor or structure as possible and observed to be responsive to stimulus or have attached to benthic habitat features.

Relocation method	Prepare	Salvage	Release
	occupy about 25% of the volume of the tank. • Receiving tanks should be aerated and fitted with a digital thermometer. The aerator should not create turbulence in the water. • A dive supervisor on land/onboard will monitor the tanks and complete a water change (from the source location) if water temperatures fluctuate more than 1°C.	then placed in the catch bag). • Pairs or nearby groups of individuals are not to be separated and are to be placed in the same bag. • At the end of each dive, salvaged Syngnathids are to be transferred to receiving tanks, taking care to keep them inundated at all times and handled as less as possible. • The maximum density of one receiving tank is 10 individuals. • If multiple dives are required to salvage Syngnathids, then a second dive team should be deployed to relocate individuals where possible. This is aimed to reduce stress on individuals in the receiving tanks. • The dive supervisor onshore will monitor the captured Syngnathids for	• If salvaged Syngnathids need to be transported by a vessel or vehicle to the receiver site, this should be done as soon as practicable (e.g. deploy a second dive team to release individuals). Care must also be taken during transit to create as little disturbance to the receiving tanks as possible. Receiving tanks are to be covered by perforated lids during transit and remain aerated.

Relocation method	Prepare	Salvage	Release
		signs of stress and complete a water change if stress is detected or water temperatures fluctuate more than one degree Celsius. Water changes should be done with care and not disturb captured Syngnathids.	

Equipment and personnel

Syngnathid relocation must be completed by a qualified marine ecologist or biologist certified as scientific divers or as commercial divers with extensive experience in subtidal habitat surveys and animal handling.

The equipment requirements for Syngnathid relocation include:

- Buckets (≥20 litres)
- Aerators
- Digital thermometers
- SCUBA dive equipment
- Sanitised dive gloves
- Catch bags and zip lock bags
- Underwater slate and pencil
- Relocation records
- Dive camera (optional)
- Vessel/vehicle (if required).

Timing

Inspection dives to salvage Syngnathids are to be completed within 24 hours of the commencement of water-based construction activities unless more than one day of dives are required. The timing of construction activities will be discussed with NSW DPI Fisheries.

Installation of silt curtains (if required to protect receiver sites) must take place immediately after the inspection dive to salvage and relocate Syngnathids. Relocation of Syngnathids should be completed immediately before or after the installation of silt curtains around the

proposal footprint, if proposed. This would prevent any Syngnathids located outside the proposal footprint from dispersing to the proposal footprint during construction activities. This assumes silt curtain installation would not impact (e.g. scour) any marine vegetation outside of the defined proposal footprint.

Adaptive management

Syngnathid relocation is best carried out during clear skies and calm seas. It is not recommended to complete relocation during inclement weather, upon which relocation activities should be delayed until more suitable conditions arise.

All Syngnathid injury or mortality must be reported to NSW DPI Fisheries. Any injured Syngnathids should be taken to SEA LIFE Sydney Aquarium. It is recommended to alert the staff at SEA LIFE Sydney Aquarium of the arrival of injured Syngnathids to avoid delays in treating injuries. Injured individuals should be handled and transported as per the methods above.

Occupational health and safety requirements

Only serviced and fully-operational SCUBA equipment is to be used. All other equipment listed in Section 8.3 are to be cleaned and sanitised before each relocation event (ie at each wharf). Cleaning agents used must be aquarium-grade and safe to use for Syngnathids.

All field work would be undertaken under an appropriate Safe Work Method Statement in accordance with Transport for NSW's health, safety and environment requirements.

Relocation record proforma

Wharf location	La Perouse / Kurnell
Salvage sites	Name: Easting: Northing: Description:

	Name: Easting: Northing: Description:
	Name: Easting: Northing: Description:
Receiver sites	Name: Easting: Northing: Description:

	Name: Easting: Northing: Description:
	Name: Easting: Northing: Description:
Salvage and release team	Diver 1: Diver 2: Diver 3: Diver 4:
Date	
Weather and sea conditions	

Syngnathid records	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:
	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:

	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:
	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:

	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:
	Identifier: Species: Salvage area name: # of individuals: Release area name: Notes:

Appendix B

Example monitoring datasheet

Kamay Ferry Wharves project seagrass rehabilitation monitoring

Site type: Rehabilitation Reference	Observer:	Date:
Site name:	Comments:	

Quadrat #	# Shoots	Leaf Length (cm) (x3)	Epiphyte Score (–5) (x3)	Photo	Notes
		/ /	/ /		
		/ /	/ /		
		/ /	/ /		
		/ /	/ /		
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		/ /	/ /		
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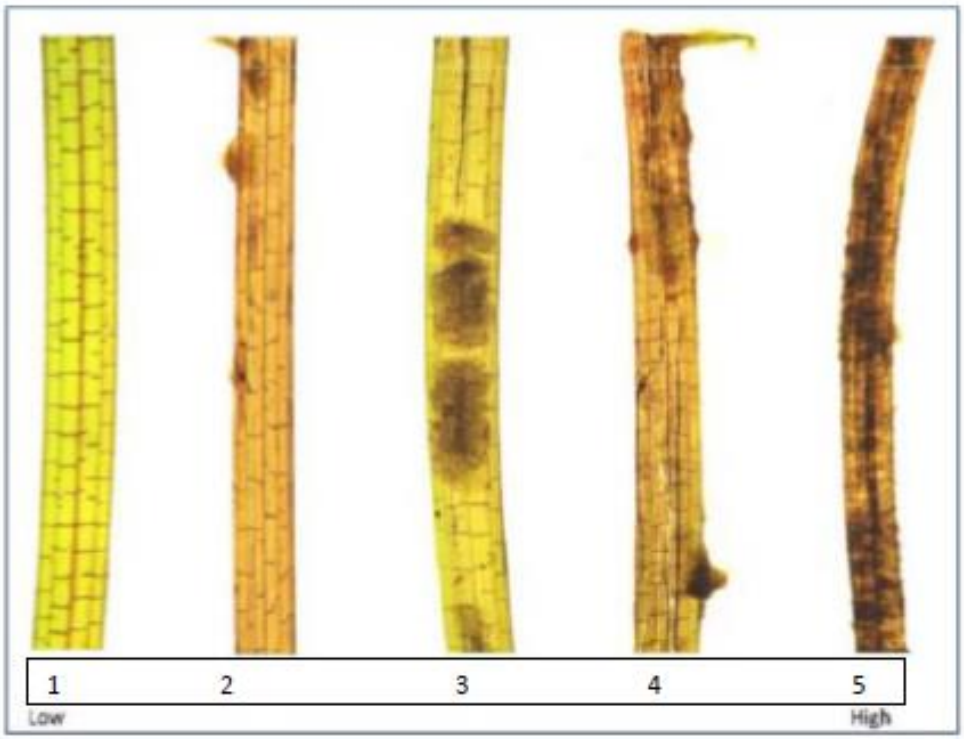
Epiphyte loading scale



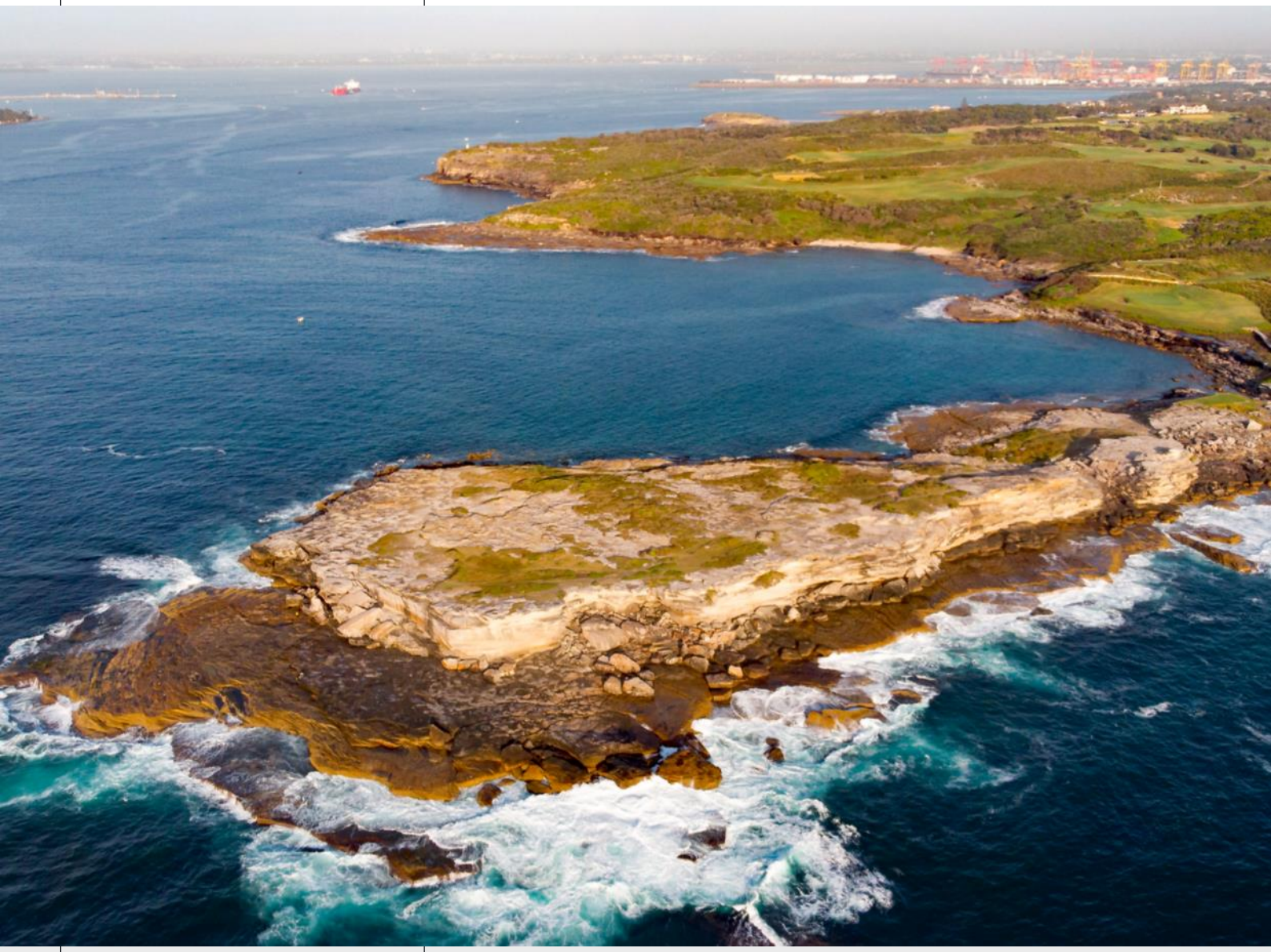
Appendix 5 Implementation Plan – Translocation of naturally detached *Posidonia australis*

Transport
for NSW

Kamay Ferry Wharves project

Implementation Plan #2
Transplanting naturally detached *Posidonia australis*

May 2023



NSW GOVERNMENT

transport.nsw.gov.au

Acknowledgement of Country

Transport for NSW acknowledges the Bidjigal and Gweagal clans who traditionally occupied Kamay (Botany Bay).

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Document control

Project	Kamay Ferry Wharves project – seagrass translocation, rehabilitation and monitoring
Document name	Implementation Plan #2 Transplanting naturally detached *Posidonia australis*
Document number	
Author	UNSW
Endorsed by	MBOS Implementation Reference Panel
Branch / division	Maritime Infrastructure Delivery Office
Endorsed date	

Versions

Revision	Date	Revision notes	Prepared by	Reviewed by
A	7/02/2023	Draft 1 for review by Transport for NSW	UNSW	TfNSW
00	17/05/2023	Final	UNSW	MBOS Implementation Reference Panel

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1. Introduction

1.1 Overview of the project

The NSW Government is reinstating the wharves at La Perouse and Kurnell to provide a valuable recreational resource for the community, and to allow for future ferry access between both sides of Kamay Botany Bay National Park. The wharves will improve access for locals and visitors in small commercial and recreational boats and for people to swim, dive, fish, walk and enjoy the local sights.

The project forms part of the NSW Government's Kamay Botany Bay National Park, Kurnell Master Plan, which aims to improve visitor experience and access to the park. The plan is being delivered by Transport for NSW (Transport) and the NSW National Parks and Wildlife Service.

Importantly, the project recognises the rich culture and ongoing importance of the area to Aboriginal people. Feedback from the community has helped to guide the design and stories of Country have been embedded into elements of the built form. Large scale artworks by two local Aboriginal artists are integrated into the designs of the jetty and the shelter structures at La Perouse and Kurnell.

The project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework. It was also confirmed to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Accordingly, bilateral approval has been sought from the NSW State Government, under the *Environmental Planning and Assessment Act 1979* (EP&A Act), and the Australian Government, under the EPBC Act.

An environmental impact statement (EIS) was placed on public exhibition from July to August 2021. A response to submissions report was prepared in October 2021 to address issues raised during public exhibition of the EIS. The project was determined under the EP&A Act by the NSW Minister for Planning in July 2022. The project was determined under the EPBC Act by the Australian Minister for the Environment and Water in March 2023.

Construction of the wharves is expected to commence in the first half of 2023 and anticipated to take around 13 months.

1.2 The Marine Biodiversity Offset Strategy

The project EIS assessed how likely the project is to impact on the area's marine ecology and biodiversity values. The EIS determined that some impacts to marine ecology and biodiversity due to the project could not be fully avoided. The EIS identified the project was likely to result in residual impacts to Key Fish Habitat (KFH), including direct and indirect impacts to *Posidonia australis* Threatened Ecological Community (TEC). *Posidonia australis* TEC is protected under both the EPBC Act and *Fisheries Management Act 1994* (FM Act, NSW). In order to mitigate these unavoidable impacts, a process known as 'ecological offsetting' is implemented under State and Commonwealth legislation.

A Marine Biodiversity Offset Strategy (MBOS) was developed to provide a strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS. The MBOS identifies appropriate offset requirements under the EPBC Act and FM Act. The MBOS documents how Transport for NSW would meet its marine offset obligations. It also describes how these actions would be implemented in consultation with NSW Department of Primary Industries Fisheries (NSW DPI Fisheries), Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and other stakeholders to result in a net gain in environmental outcomes for Botany Bay and the community.

The MBOS has an operational life of ten years, and therefore is an adaptive document that would be reviewed and updated as required by Transport for NSW. Revisions to the MBOS would be implemented in consultation with the MBOS Implementation Reference Panel, which comprises representatives from Transport for NSW, NSW DPI Fisheries and an independent scientist. The MBOS Implementation Reference Panel would review the revised MBOS to ensure the updates are consistent with the offset policies and their implementation. Where significant changes to the MBOS have occurred, a copy of the MBOS and changes would be distributed to other relevant stakeholders, which may include DCCEEW and NSW Department of Planning and Environment (DPE).

1.3 Offset requirements

The Secretary's environmental assessment requirements (SEARs) issued for the project required an assessment of the potential impacts of the project on receiving marine habitats and biota be carried out. The SEARs required that the assessment consider whether the project was likely to result in any significant impact on listed threatened species, populations or ecological communities under the FM Act. In particular, the SEARs required that the extent and impact on seagrass beds, especially *Posidonia australis*, from all stages of the project be assessed. To address the SEARs, a Marine Biodiversity Assessment Report was prepared for the EIS. The marine biodiversity studies carried out to support the EIS included habitat mapping of subtidal reefs, together with targeted seagrass surveys that assessed the extent, cover and condition of the seagrass communities and surrounding habitats within and adjacent to the project construction boundary. These studies were conducted during preparation of the EIS in 2020.

The marine ecology and biodiversity impact assessment considered a worst-case residual impact scenario that included direct and indirect impacts from construction, the resulting permanent structure, and operation of vessels. The EIS determined the worst-case residual impact resulting from the project would be a loss of:

- 683 m^2 of *Posidonia australis* habitat (Type 1 KFH)
- 20,589 m^2 of other seagrass habitat (Type 1 KFH)
- 3683 m^2 of macroalgae habitat (Type 2 KFH).

The MBOS identified that rehabilitating all seagrass that would be disturbed would not be logistically feasible and proposed to focus on rehabilitating *Posidonia australis* because of its greater ecological value and importance.

The approach adopted for the MBOS was to apply the EPBC Offset Calculator to determine the draft offset requirements for *Posidonia australis.* The EPBC Offset Calculator provides a more conservative value and offsetting obligation than the no net loss outcome as defined under the NSW Fisheries Policy. The draft offset requirement for *Posidonia australis* under the EPBC Offset Calculator identified in the MBOS was 2000 m^2.

This value is conservative and would result in the rehabilitation and improvement of more than double the area of *Posidonia australis* predicted to be impacted by the project. The proposed offset requirement would also achieve no net loss for White's seahorse (*Hippocampus whitei*) habitat by replacing lost habitat due to the project.

1.4 Offset strategy

Transplanting of seagrass remains the only way to replace and re-establish seagrasses in areas where it has been lost. The MBOS identifies two methods and a staged approach for offsetting *Posidonia australis* impacts:

a) Translocation of *Posidonia australis* from areas expected to be impacted during construction of the project to habitats identified as degraded within Botany Bay (described in Implementation Plan #1)

b) Rehabilitation of seagrass meadows using naturally detached beach-cast *Posidonia australis* fragments (described in Implementation Plan #2).

The MBOS offset strategy proposed to meet the draft EPBC offset requirements would involve harvesting from the impact area (from herein, defined as Kurnell wharf footprint plus 15 metre buffer area) and replanting all the *Posidonia australis* within that area (estimated to be a maximum of 683 m^2 of *Posidonia australis*), and improving at least 2000 m^2 of existing *Posidonia australis* habitat in Botany Bay by collecting and planting naturally detached *Posidonia australis* fragments in unvegetated patches.

The MBOS proposed that the donor *Posidonia australis* material be transplanted to nearby unvegetated areas damaged from historical disturbance within Botany Bay.

A monitoring program would be implemented to monitor the success of the offset strategy over time (refer to Section 7).

The translocation, rehabilitation and monitoring would be carried out using best scientific practice methods and techniques developed and successfully implemented by research scientists in NSW estuaries as well as any future practices.

1.5 Updated offset requirements

The draft offset requirements proposed by the MBOS were initially based on a worst-case scenario of predicted impacts for *Posidonia australis* habitat. Accordingly, the offset requirements proposed by the MBOS were updated in May 2023 in response to site specific requirements, results of additional monitoring, consultation with the MBOS Implementation Reference Panel and other project stakeholders and the conditions of approval (CoA) for the project.

The Commonwealth and State (NSW) CoA relevant to the MBOS are identified in Table 1-1.

Table 1-1: Commonwealth and State (NSW) conditions of approval relevant to the Marine Biodiversity Offset Strategy for the project

CoA	Condition requirement
Commonwealth CoA	
3	Within the project area, the approval holder must not clear more than: a) 0.0683 hectares of seagrass meadows b) 0.0683 hectares of White's Seahorse habitat.
4	The approval holder must comply with NSW Approval conditions E6 – E8 and E11 related to pre-construction surveying and protection measures.
10	The approval holder must comply with NSW Approval conditions E12 – E20 related to the requirements of the Marine Biodiversity Offset Strategy (MBOS) to compensate for the clearing of 0.0683 hectares of seagrass meadows and White's Seahorse habitat.
11	To monitor the outcomes of the MBOS for seagrass meadows and White's Seahorse habitat, the approval holder must include a Marine Biodiversity Offset Report as part of the compliance report until the 10th anniversary of the date of this approval, unless otherwise agreed to in writing by the Minister. Each Marine Biodiversity Offset Report must include: a) a progress report on the implementation of the MBOS; b) a list of success metrics; c) details of the monitoring methodology(ies) implemented and the locations of reference sites; d) monitoring results including a comparison against reference sites; e) a summary of any adaptive management measures taken to improve implementation of the MBOS and/or monitoring methodology(ies); and f) a conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.
12	To assess the ongoing success of the MBOS, the approval holder must submit a Rehabilitation Monitoring Review to the department within 6 years of the date of this approval and every 5 years thereafter, unless otherwise agreed to in writing by the Minister. The approval holder must publish each Rehabilitation Monitoring Review on the website within 15 business days of submission and keep every Rehabilitation Monitoring Review published until this approval expires. Each Rehabilitation Monitoring Review must include: a) a review of the monitoring methodology(ies) by a suitably qualified person; b) a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person; and c) if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics: i) a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and ii) justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.
NSW CoA	
A1	The Proponent must carry out the SSI in accordance with the terms of this approval and generally in accordance with the: (a) *Kamay Ferry Wharves Environmental Impact Statement* (the EIS), dated June 2021 (b) *Kamay Ferry Wharves Response to Submissions Report* (the Submissions Report), dated October 2021; and (c) *Kamay Ferry Wharves Marine Biodiversity Offset Strategy* (the MBOS), dated November 2021.

CoA	Condition requirement
E6	The location of areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 Key Fish Habitat (KFH)) and macroalgae that have been identified for removal and disturbance at Kurnell and La Perouse must be confirmed and recorded by surveying and mapping prior to the commencement of clearing in consultation with DPI Fisheries and DAWE.
E12	The proponent must ensure that the proposal is undertaken in accordance with the requirements of DPI Fisheries policy and guidelines, including the Policy and Guidelines for Fish Habitat Conservation and Management 2012, and the NSW Biodiversity Offsets Policy for Major Project Fact sheet: Aquatic Biodiversity.
E13	The Proponent must allow for an additional winter and summer season in which to monitor marine biodiversity within the construction footprint prior to commencement of construction.
E14	The Proponent must satisfy the marine biodiversity offset obligations that specify the required offset size in accordance with the EPBC Act, Environmental Offsets Policy 2012, NSW Biodiversity Offsets Policy for Major Projects – Fact sheet: Aquatic Biodiversity. Evidence of this must be provided to the Planning Secretary, DPI Fisheries and DAWE for information, within 12 months of the commencement of construction.
E15	Areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 KFH) and macroalgae (Type 2 KFH) that have been identified for removal or disturbance within the construction footprint at Kurnell and La Perouse must be offset in accordance with the MBOS and as agreed with DPI Fisheries and DAWE.
E16	Prior to the commencement of pre-construction seagrass transplantation, the Proponent must establish a MBOS Implementation Reference Panel to review data collected, including from the marine biodiversity monitoring as required by Condition E13, recommend changes to the MBOS if required, and review the Operational Impact Assessment Report (see Condition E20). The MIRP must comprise representatives from the Proponent, DPI Fisheries-Coastal Systems, DPI Fisheries-Marine Research, DAWE and DPIE Planning and Assessment, and include a suitably qualified, experienced and independent scientist. The MBOS Implementation Reference Panel must be operational for the life of the MBOS or as agreed by the Planning Secretary.
E17	The MBOS must have an operational life of no less than ten (10) years from the date of MBOS approval, unless otherwise agreed by the Planning Secretary.
E18	The MBOS may be reviewed and updated during its operational life as required and recommended by the MBOS Implementation Reference Panel. At least 50 per cent of the MBOS funding must be allocated to the restoration and rehabilitation of *Posidonia australis* and *Zostera* seagrass beds in consultation with the MBOS Implementation Reference Panel.

Baseline seagrass monitoring for the project commenced in mid-2021 and was repeated on four occasions before concluding in December 2022. Additional targeted surveys were carried in late 2022 to confirm the location, extent, cover and condition of previously mapped *Posidonia australis* patches within the impact area and main seagrass meadow at Kurnell and inspect the seagrass rehabilitation sites proposed by the MBOS. This work was carried out to meet the requirements of NSW CoAs E6 and E13.

A key objective of the baseline monitoring and additional surveys was to confirm the location and extent of areas of *Posidonia australis* that would be directly impacted by construction of the project and therefore determine the final offset requirements under the MBOS. The final offset requirements identified through this process were confirmed in consultation with the MBOS Implementation Reference Panel and included in the MBOS in May 2023, as required by NSW CoAs E15 and E16. Transplanting of *Posidonia australis* in rehabilitation sites would be carried out in accordance with the MBOS offset requirements.

Further detail about transplanting *Posidonia australis* donor material to recipient sites is provided in Section 5.4.

1.6 Why should we restore seagrass meadows?

Seagrass meadows are highly ecologically valuable habitats that provide numerous ecosystem functions and services, from sequestering carbon to supporting commercial fisheries species (Costanza et al., 1997; Orth et al., 2006; Swadling et al., 2022). Seagrasses are also highly sensitive to disturbance and seagrass habitat degradation is a widespread concern affecting many coastal environments around the world (Waycott et al., 2009). Although seagrass persistence may be influenced by natural processes such as storms (Larkham and West, 1990), their distribution in close proximity to highly populated urbanised and industrialised areas means they are often exposed to a range of human-caused disturbances (Orth et al., 2006; Waycott et al., 2009; Evans et al., 2018). Human activities that reduce water quality (Cambridge et al., 1986; Short and Wyllie-Echeverria,

1996; Kendrick et al., 2002), coastal development (Orth et al., 2006) and boating activities (Glasby and West, 2018) have resulted in the degradation of seagrass habitats in estuaries and coastal areas in Australia and elsewhere. Human-caused pressures on nearshore habitats such as seagrass meadows are expected to increase as human populations continue to expand along coastlines, highlighting the urgent need for conservation.

Natural recovery of degraded seagrass habitats by slow-growing, large meadow-forming species like *Posidonia australis* is likely to take decades to centuries, if it occurs at all (Meehan and West, 2000; Kendrick et al., 2002; Evans et al., 2018). Practical measures for reversing losses of seagrass habitat therefore generally focus on efforts to actively rehabilitate damaged meadows via replanting or seeding (Bastyan and Cambridge, 2008; Balestri et al., 2011; Statton et al., 2013; Sinclair et al., 2021). While seagrass rehabilitation can be effective over small spatial scales (Tan et al., 2020), ensuring the persistence of vulnerable seagrasses such as *Posidonia australis* requires support from conservation strategies to protect remaining meadows (Sinclair et al., 2021).

Revegetating areas with terrestrial plants to offset development impacts have been carried out for decades. The approach has not been applied as frequently in marine environments, although a growing number of rehabilitation efforts have been carried out worldwide to compensate or mitigate seagrass losses (Paling et al., 2009). Locally, until recently, seagrass restoration as a measure to compensate for the loss of seagrass habitat resulting from development activities has not been supported under NSW policy (Ganassin and Gibbs, 2008). Recent advances in seagrass restoration have revealed less damaging and more cost-effective approaches to restoring ecologically meaningful areas (Tan et al., 2020; Sinclair et al., 2021). Improvements in transplant success of seagrass using naturally detached donor material, including *Posidonia sp.* (Balestri et al., 2011; Ward et al., 2020; Ferretto et al., 2021; Piazzi et al., 2021), suggest the potential viability of replanting seagrass as an offsetting strategy for marine developments in some circumstances. Documenting the transplanting activities and outcomes for the project would be important for further developing this strategy.

1.7 Purpose of Implementation Plan #2

The purpose of Implementation Plan #2 is to document the strategy, method and approach for transplanting naturally detached *Posidonia australis* fragments collected from shorelines around Botany Bay to rehabilitation sites at Kurnell. This implementation plan has been developed to ensure compliance with the Commonwealth and State conditions of approval for the project.

Implementation Plan #1 (UNSW, 2023a) describes the strategy, method and approach for translocation of harvested *Posidonia australis* from the impact area to rehabilitation sites at Kurnell (refer to the MBOS). Implementation Plan #1 also details the monitoring program for the *Posidonia australis* rehabilitation efforts for the project. Translocation of *Posidonia australis* from the impact area to rehabilitation sites would occur prior to the commencement of transplanting of naturally detached fragments.

The implementation plans for seagrass translocation, rehabilitation and monitoring form part of the MBOS. The implementation plans are developed to document how the direct offset actions identified in the MBOS would be carried out and ensure the MBOS is implemented effectively. The implementation plans form part of the MBOS which is endorsed by the MBOS Implementation Reference Panel.

1.8 Program

The MBOS would be operational for ten years. Table 1-2 identifies the anticipated timeline and duration of the seagrass offset work in relation to the expected approval, construction and monitoring requirements.

Table 1-2: Anticipated program for seagrass translocation, rehabilitation and monitoring

	2021		2022				2023				2024				2025				2026				2027				2028				2029				2030				2031				2032				2033			
Activity	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Baseline monitoring																																																
EIS published																																																
Submissions report published																																															
State planning approval																																															
Commonwealth planning approval																																															
Confirmation (summer) survey																																															
MBOS update																																															
Translocation of *P. australis*																																															
Initial survey – Baseline Report																																														
Construction of the project																																															
Planting naturally detached *P. australis*																																															
Seagrass monitoring																																															
Review of monitoring																																															

2. Legislation, policy, guidelines and permits

Legislation, policies, guidelines and permits relevant to Implementation Plan #2 for transplanting naturally detached *Posidonia australis* include, but are not limited to:

- Project Approval (EPBC 2020/8825) issued on 16 March 2023 by the Australian Minister for the Environment and Water under the EPBC Act sets out the Commonwealth conditions under which the project may be constructed and operated
- Project Infrastructure Approval (SSI 10049) dated 21 July 2022 issued under Section 5 of the EP&A Act 1979 sets out the State (NSW) conditions under which the project may be constructed and operated
- The EPBC Act (Commonwealth) protects matter of national environmental significance (MNES), including endangered species such as *Posidonia australis* and requires project actions to be controlled under the Act's provisions if they are likely to have a significant impact
- The FM Act (NSW) makes it an offence to harm estuarine macrophytes, such as seagrass, without an appropriate assessment, inclusion of safeguards, and/or the appropriate permissions to carry out certain work
- The Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (NSW DPI, 2013) provides guidance on addressing and offsetting aquatic impacts
- The EPBC Act Environmental Offsets Policy outlines the Australian Government's approach to the offsetting significant impacts on MNES
- The MBOS provides the strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS
- Permit issued by NSW DPI Fisheries under Section 37 of the FM Act sets out the conditions under which the seagrass translocation, rehabilitation and monitoring activities can be carried out
- Port of Botany Bay Harbour Master Permission for Disturbance of the Bed of a Special Port Area (PAMAR110-SYD-2022-050) provides conditions under which the seabed of Botany Bay may be disturbed for the seagrass translocation, rehabilitation and monitoring work.

Transplanting of naturally detached *Posidonia australis* fragments in rehabilitation sites would be carried out in accordance with the requirements of the documents identified in this implementation plan and the MBOS.

3. Consultation for Implementation Plan #2

Implementation Plan #2 for transplanting naturally detached *Posidonia australis* was prepared in consultation with the following project stakeholders:

- Port Authority of New South Wales
- Transport for NSW Maritime Operations (Botany Bay) and Project Team
- NSW DPI Fisheries, Fisheries Research
- NSW Department of Planning and Environment
- Sydney Desalination Plant
- MBOS Implementation Reference Panel.

Feedback received from these stakeholders was incorporated into the final version of the implementation plan.

4. Description of the area

4.1 Overview of Kamay (Botany Bay)

Kamay (Botany Bay) is a large, marine-dominated, sheltered embayment located in southern Sydney. The bay has an area of about 40 km^2, with a one kilometre wide opening to the sea. Freshwater flows into the bay via the Georges River and Cooks River. Increased freshwater inflows and stormwater runoff during flood and storm events strongly influence salinity and nutrient levels in Botany Bay (Roy et al., 2001). The tidal range of Botany Bay is about two metres and the embayment is partially flushed during each tidal cycle (Roper et al., 2010). The depth of the bay in the vicinity of the project area varies with the tide but reaches a maximum of about five metres furthest from shore. Surface water temperatures range from 22–24°C in summer to 15–18°C in winter and are generally well mixed with low stratification (Sterling-Wood et al., 2022).

Botany Bay is located in a temperate humid coastal climate that receives about 1000 millimetres of rain annually, with the highest concentration falling in autumn (Bureau of Meteorology (BOM), 2022). Long-term mean maximum air temperatures range from about 17°C in winter (July) to almost 27°C in summer (January) (BOM, 2022). The water temperature of the bay typically ranges from about 16°C in winter to 22°C in summer (IMOS, 2022). Wind affects the wave and current climates in Botany Bay. Winds tend to come from the south and east during summer period, while the dominant wind direction in winter is from the west (Cardno, 2020).

Botany Bay is a highly urbanised waterway that supports numerous industrial, commercial and recreational activities. Port Botany, located on the north-eastern side of Botany Bay, is the largest container port in NSW and the second largest container port in Australia. The port operates 24/7 and commercial vessels regularly move through Botany Bay via shipping channels that traverse the waterway between La Perouse and Kurnell. The Kurnell Port and Berthing Facility is located about 300 metres west of the project area at Kurnell. Botany Bay supports several charter boat operations. Recreational users of Botany Bay include rowers, sailors, fishers, personal watercraft users, snorkelers and divers. Recreational activity levels intensify during the summer months.

The dominant seagrasses in Botany Bay are *Posidonia australis*, *Zostera sp.* and *Halophila sp.* While *Posidonia australis i*s slow-growing and sensitive to environmental change, large seasonal changes in the distribution and density of *Zostera sp.* and *Halophila sp.* occur in Botany Bay (Reid, 2021). Unlike *Posidonia australis, Zostera sp.* and *Halophila sp.* tend to rapidly recolonise and spread across the benthos following disturbance (Larkham and West, 1990). The seagrass meadows perform numerous important ecosystem functions, including provision of habitat for fishes and invertebrates, including commercially important species, sediment stabilisation, nutrient removal and carbon capture (reviewed in Sterling-Wood et al., 2022).

The extensive long-term decline in seagrass distribution in Botany Bay has been attributed to several natural and human-made processes (Larkham and West, 1990). Natural processes such as wave action, sediment movement, nutrient availability, warmer temperatures and herbivory may impact seagrass distribution (Reid, 2021). The main human-made historical and ongoing threats to seagrass persistence in Botany Bay include dredging, water pollution, coastal development, electricity transmission network infrastructure development, and scouring from boat anchors and moorings (Larkham and West, 1990; Glasby et al., 2015; Evans et al., 2018; Glasby and West 2018). The fragmented seagrass meadows observed around the bay provide evidence of disturbance.

4.2 Rehabilitation sites

Rehabilitation sites selected for transplanting of *Posidonia australis* donor material are described in the Site Selection and Validation Report (UNSW, 2023b) in the MBOS.

The selection of rehabilitation sites for transplanting *Posidonia australis* was informed by a multi-factorial assessment of suitability and consultation with relevant agencies and stakeholders. Preference was given to sites with shallower depth, zero to spare seagrass cover, even topography and seagrass habitat in the surrounding area. The assessment determined that three sites at Kurnell were considered highest priority for *Posidonia australis* transplanting, with a further three sites at Kurnell considered medium priority subject to changes in existing seagrass cover (Table 4-1 and Figure 5-2). The assessment determined that the remaining four sites at Kurnell and the Penrhyn Estuary site would be of lowest priority for *Posidonia australis* transplanting due to existing seagrass density and other factors, such as depth and sediment instability (Figure 5-2). The four lower priority sites at Kurnell would provide an additional 807 m^2 area for rehabilitation.

Any decision to rehabilitate additional damaged *Posidonia australis* meadows in Botany Bay located outside of the Kurnell area would be carried out following a detailed site assessment, review of monitoring or other existing data and in consultation with

the MBOS Implementation Reference Panel and other relevant stakeholders. Details of any new rehabilitation sites would be provided in the MBOS.

Table 4-1: Calculated area of high and medium priority rehabilitation sites at Kurnell

Site ID	Area (m^2)	Priority for rehabilitation
Trench east	144	High
Trench west	223	High
Scar B	43	Medium
Scar C	147	Medium
Scar E	42	Medium
Scar F	20	High
Total	**619**	

5. Approach to additional planting of *Posidonia australis*

5.1 Site locations

5.1.1 Locations for collecting naturally detached *Posidonia australis* fragments in Botany Bay

Naturally detached *Posidonia australis* donor fragments would be collected from shorelines around Botany Bay (Figure 5-1). These locations have been previously identified as wash-up locations for naturally detached *Posidonia australis* fragments (Liddell, unpublished data). Beach cast *Posidonia australis* fragments would be collected from Botany Bay shorelines via dedicated regular surveys by the Gamay Rangers and marine scientists (refer to Section 5.4.4).

Collected *Posidonia australis* fragments would be either planted on the same day of collection or temporarily stored prior to transplanting, either underwater near the project area or in dedicated outdoor aquaria located at the Sydney Desalination Plant in Kurnell (refer to Section 5.4.5). The outdoor aquaria are easily accessible from the *Posidonia australis* rehabilitation area at Kurnell (2.6 kilometres by road; Figure 5-1).

Figure 5-1: Locations in Botany Bay for collecting and storing naturally detached *Posidonia australis* fragments

5.1.2 Location of rehabilitation sites

Rehabilitation sites suitable for transplanting of naturally detached *Posidonia australis* fragments would be located in Botany Bay. Three sites identified from site surveys as high priority (Trench east, Trench west and Scar F) and a further three sites with medium priority for rehabilitation (Scar B, Scar C and Scar E) would provide a total area of 619 m^2 for *Posidonia australis* rehabilitation in Kurnell. The rehabilitation sites are located within the main *Posidonia australis* meadow to the west of the project boundary at Kurnell, at distances ranging from 73 metres to more than 300 metres from the impact area (Figure 5-2). Four lower priority rehabilitation sites at Kurnell would provide an additional 807 m^2 of planting area.

Figure 5-2: Locations of the *Posidonia australis* rehabilitation sites in relation to the impact area at Kurnell

5.2 Access

Transplanting naturally detached *Posidonia australis* fragments at Kurnell would involve a team consisting of Scientific Divers, research assistants and Gamay Rangers performing underwater fieldwork activities from vessels. Access to the rehabilitation sites at Kurnell would be via vessel launched from Foreshore Road boat ramp, Botany. Foreshore Road boat ramp is located about 5.5 kilometres from the rehabilitation site area at Kurnell. When travelling between Foreshore Road boat ramp and the project area, the vessel route briefly crosses the shipping channel (Figure 5-3). It is anticipated that a single vessel would be used for each transplanting event in most instances. The area at Kurnell where transplanting would be carried out is located outside the shipping channel.

Anchoring is not permitted within seagrass meadows in Botany Bay. A courtesy mooring is located north of the main *Posidonia australis* seagrass meadow at Kurnell. The vessel supporting the transplanting work would have the option of using the mooring as an alternative to operating the vessel live in the water, should it be available.

Kurnell is a popular location for recreational boaters, jet-ski users, fishers and other waterway users, particularly during the summer months. Precautionary safety measures would be implemented to avoid interactions between divers and snorkelers involved in the transplanting work and other waterway users in Kurnell. Transport for NSW would notify the community and local users about the transplanting work prior to commencement.

To ensure the safety of the vessel and crew, vessel masters would be responsible for ensuring compliance with Harbour Master, Transport for NSW Maritime Operations and other relevant rules and regulations.

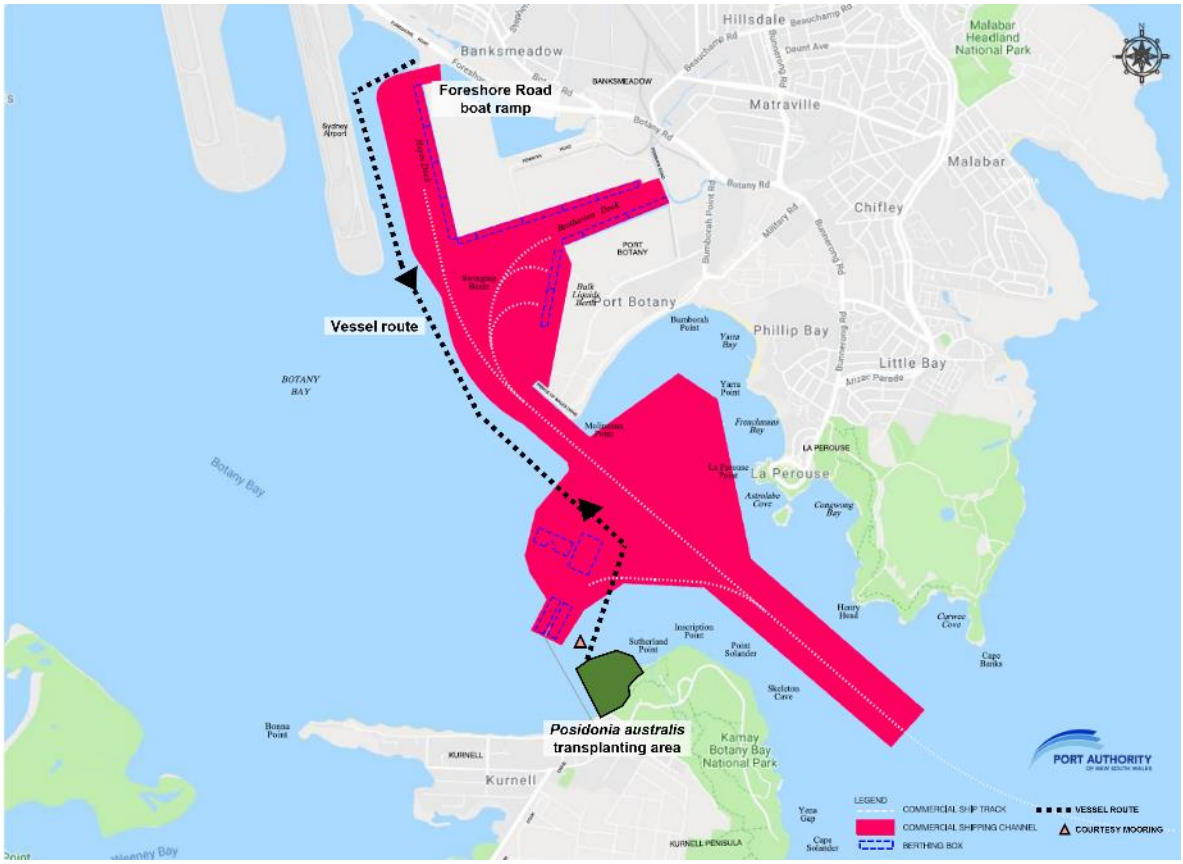


Figure 5-3: Vessel access route between Foreshore Road boat ramp and the *Posidonia australis* transplanting area at Kurnell

5.3 Timing

Posidonia australis rehabilitation efforts for the project would comprise a two stage process. Stage one would involve translocating harvested *Posidonia australis* fragments from the project impact area at Kurnell to nearby rehabilitation sites. The commencement of Stage two, transplanting naturally detached *Posidonia australis* fragments in rehabilitation sites, would be contingent on the timing of completion of the Stage one *Posidonia australis* translocation process.

It is anticipated that translocation of harvested *Posidonia australis* from the impact area at Kurnell would be completed by about the end of July 2023. Transplanting of naturally detached *Posidonia australis* fragments in rehabilitation sites would commence within four weeks of completion of translocation, about July to August 2023. Transplanting would continue at regular intervals of about every three weeks for about eight years until about mid-2031 (subject to any increase in effort being identified through review of monitoring results). Each planting event would occur over one to two days.

Dedicated beach surveys to collect naturally detached *Posidonia australis* fragments would commence in about May 2023. Dedicated beach surveys would take place for about 48 weeks of the year over about eight years until about mid-2031. Surveys would take place about weekly, for about four hours at a time, allowing time to access and thoroughly survey the most appropriate locations (Figure 5-1). Survey frequency or effort would be higher during about the first three years after translocation when transplanted *Posidonia australis* fragments would be more susceptible to becoming detached from rehabilitation sites, or as an adaptive management action in response to monitoring results. Additional surveys at targeted locations may also occur after significant weather events that would be likely to lead to a large accumulation of *Posidonia australis* fragments (refer to Section 5.4.4).

Collected *Posidonia australis* fragments would be recorded and either planted on the same day, or temporarily stored either underwater near the project area or in outdoor aquaria (refer to Section 5.4.5) and transplanted within about three weeks.

5.4 Methods for transplanting naturally detached *Posidonia australis* fragments

5.4.1 Best scientific practice for transplanting naturally detached seagrass fragments

Seagrass restoration efforts have been performed in coastal environments around the world, with varying levels of success. Generally, seagrass restoration efforts have involved selectively removing seagrass material from healthy donor meadows and transplanting it in restoration plots. However, some seagrass restoration practitioners have highlighted the potential impact of harvesting seagrass from healthy intact meadows for donor material in seagrass transplanting efforts, especially when restoration involves a threatened species or population (Paling et al., 2009; Balestri et al., 2011).

In response to these concerns, some restoration practitioners have pivoted from sourcing seagrass restoration material from intact meadows to using naturally detached seagrass fragments collected from shorelines. Seagrass fragments may become detached from existing meadows due to natural processes such as storms or human activities such as anchoring or dredging. Several *Posidonia sp.* restoration projects in the Mediterranean and Australia have used naturally detached fragments washed ashore or drifting along shorelines as donor material for replanting degraded areas (Balestri et al., 2011; Ferretto et al., 2019; 2021; Ward et al., 2020; Piazzi et al., 2021). Existing evidence from these restoration efforts suggests the positive potential of this transplanting method. There are also several advantages of using this technique as an alternative to more traditional restoration methods, including the potential to collect substantial quantities of donor material throughout the year using less effort and financial resources, and without disturbing existing intact meadows (Christensen et al., 2004).

Nevertheless, the long-term viability of seagrass restoration projects using naturally detached transplants may be strongly influenced by seagrass fragment collection success. A key step during the planning process for seagrass restoration projects using this technique is identifying favourable collection conditions based on environmental factors such as exposure to winds, swell and tides (Balestri et al., 2011; Ferretto et al., 2021). The next step is identifying easily accessible sites exposed to these conditions where fragments are likely to accumulate. This information is crucial for determining if the availability of fragments is likely to be sufficient to meet restoration demands (Piazzi et al., 2021).

The methods proposed for transplanting naturally detached *Posidonia australis* fragments for the project have been developed by examining guidelines, methods and experiences reported in the literature from previous efforts to restore *Posidonia sp.* meadows in Australia and internationally.

Some of the key features of successful *Posidonia sp.* restoration highlighted by existing literature that have been incorporated into the methods for additional planting of *Posidonia australis* include:

- Developing a strategy for collecting donor material based on the predicted availability of naturally detached *Posidonia australis* fragments
- Collecting and transplanting only healthy, freshly detached beach-cast *Posidonia australis* fragments
- Prioritising shallow depths for transplanting *Posidonia australis* due to its sensitivity to reductions in light transmission through the water column
- Using an effective and durable rhizome anchoring system to prevent loss of transplanted *Posidonia australis*
- Investing in transplanting fragments across multiple recipient sites to spread the risk and increase the likelihood of transplanted *Posidonia australis* experiencing suitable conditions for growth
- Using handling and storing methods that would minimise stress to collected *Posidonia australis* fragments.

Threats, risks and opportunities associated with transplanting naturally detached *Posidonia australis* fragments are discussed in Section 6.

5.4.2 Availability of recipient site transplanting area

Field-based mapping indicated that a total area of 619 m^2 across six rehabilitation sites (i.e. high and medium priority) would be available for *Posidonia australis* rehabilitation efforts at Kurnell. Rehabilitation sites vary in areal extent from about 20 m^2 to 223 m^2. An additional 807 m^2 would be available for rehabilitating across four lower priority rehabilitation sites at Kurnell. Transplanting of naturally detached fragments would occur across multiple rehabilitation sites.

Naturally detached *Posidonia australis* fragments would initially be transplanted to rehabilitation sites where translocation has occurred to supplement any losses at these sites. Transplanting of naturally detached *Posidonia australis* fragments would

subsequently occur at selected additional rehabilitation sites, either at Kurnell or in other locations within Botany Bay should this be deemed a suitable strategy. The supplementary planting approach would be to maintain rehabilitated areas with shoot densities that closely match that of the *Posidonia australis* patches translocated from the impact at Kurnell, about 42 shoots per square metre (UNSW, 2023b). Continued long-term transplanting of naturally detached *Posidonia australis* fragments would aim to gradually increase the overall rehabilitated area over time to achieve a minimum of double the estimated area of *Posidonia australis* removed from the impact area at Kurnell (268 m^2), while maintaining shoot densities resembling natural meadows. Together, translocation of donor material from the impact area at Kurnell and supplementary planting with naturally detached fragments would result in the creation of a minimum of 536 m^2 of restored *Posidonia australis* habitat in Botany Bay. This strategy would be implemented to meet the offset requirements specified in the MBOS and ensure progress towards the success criteria for the offset strategy (refer to Section 8 for further details about success criteria for the rehabilitation efforts).

The strategy of transplanting *Posidonia australis* over multiple rehabilitation sites would spread the risk of failure resulting from unforeseeable events such as incidental damage by recreational boat users, loss of jute mats or fragments due to inclement weather conditions or unplanned environmental incidents.

5.4.3 Preparing the rehabilitation sites for transplanting

Preparation of rehabilitation sites for receiving naturally detached *Posidonia australis* fragments would have largely been carried out during the translocation stage. Rehabilitation sites where translocation occurred would consist either of jute mats or bare sediment planted with *Posidonia australis* (Figure 5-4). The jute mats would be expected to be covered by sediment within weeks due to natural wind and wave processes and biodegrade within about 12 months.

It is not anticipated that additional jute mats would be installed in rehabilitation sites after completion of the translocation stage. However, extending the use of jute mats would be considered should monitoring of rehabilitation sites detect a significant positive effect of jute mats on transplanting success.

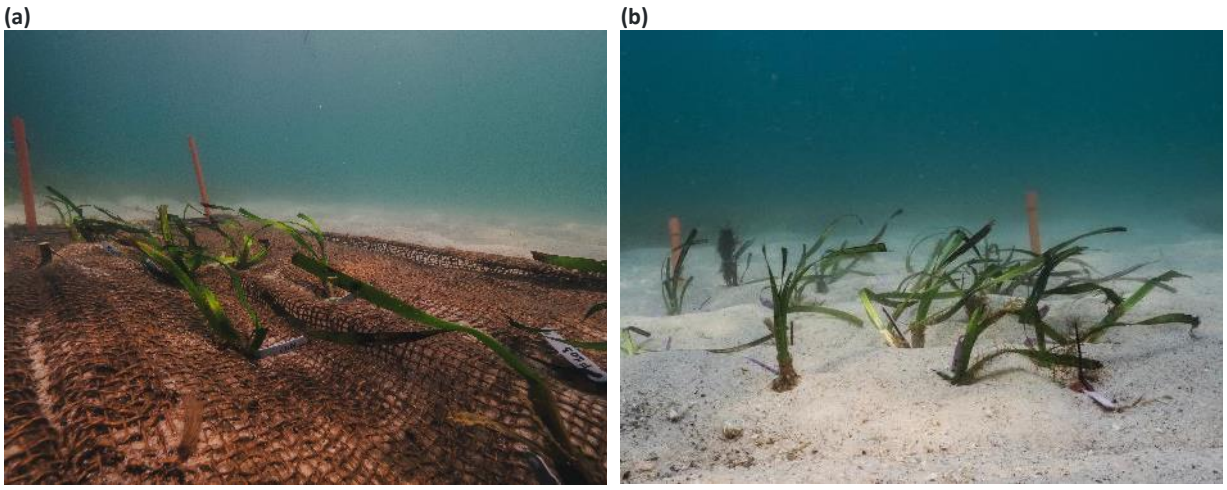


Figure 5-4: Photos showing examples of (a) jute mat planted with *Posidonia australis* and (b) *Posidonia australis* planted directly into bare sediment

Photo credits: Harriet Spark, Grumpy Turtle Media

5.4.4 Collecting naturally detached *Posidonia australis* fragments

Posidonia australis fragments for transplanting in rehabilitation sites would be collected from shorelines around Botany Bay (Figure 5-1). Surveys to collect *Posidonia australis* fragments would be carried out by marine scientists and the Gamay Rangers. The Gamay Rangers are a group within the La Perouse Local Aboriginal Land Council working under the Indigenous Ranger Program. The Gamay Rangers carry out natural and cultural resource management activities on cultural areas within Botany Bay, including patrolling waters, marine mammal awareness and protection, cultural heritage protection and conservation, threatened species management, and cultural and environmental awareness. The team is qualified in marine operations and regularly collaborates with environmental agencies, research institutions and corporations that operate on or around Botany Bay.

Survey success would be enhanced by monitoring local (Botany Bay) weather conditions. Weather conditions (e.g. wind direction) can be a reliable predictor of locations in Botany Bay where greater quantities of naturally detached fragments would be more likely to accumulate (Liddell, unpublished data). Onshore winds may result in greater quantities of naturally detached *Posidonia australis* fragments being deposited on beaches in Botany Bay (Liddell, unpublished data). Botany Bay weather patterns would be monitored and more intensive or targeted surveys would be carried out at locations where conditions are favourable for accumulating beach-cast *Posidonia australis* fragments.

Surveys to collect naturally detached *Posidonia australis* fragments would involve traversing beach shorelines and placing fragments in buckets containing seawater. Beach surveys would be carried out during the morning and preferably following high tide to optimise collecting freshly deposited fragments. Collected fragments would be stored submerged in seawater and shaded from direct sun until being transported either directly to the project area or the outdoor storage aquaria at the Sydney Desalination Plant in Kurnell (refer to Section 5.4.5). Surveys would be coordinated logistically to minimise the amount of time between collecting from the beach and either transplanting or depositing in the outdoor aquaria.

Posidonia australis fragments would be identified as viable for transplanting based on the condition of the leaves and rhizome. Fragments deemed viable for transplanting would be characterised by bright green leaves growing upward from an intact rhizome (Figure 5-5). Beach-cast fragments with high levels of necrosis (browning), significant damage or lacking an attached rhizome would be excluded from collection and left on the beach or shoreline as natural wrack material.

Beach surveys to collect *Posidonia australis* would be carried out by Gamay Rangers and marine scientists trained and experienced in identifying suitable survey locations based on weather and tidal conditions, identifying and collecting viable beach-cast *Posidonia australis* fragments as well as best practice transport, storage and data collection methods.

Figure 5-5: Photos of naturally detached beach-cast *Posidonia australis* fragments suitable for transplanting in rehabilitation sites

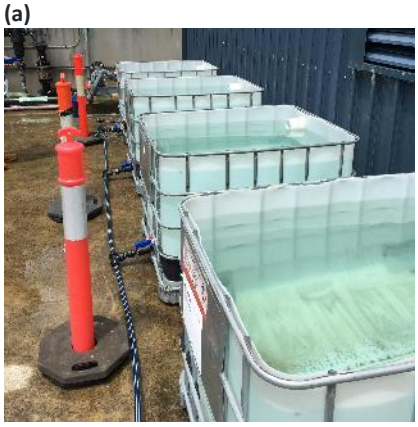
5.4.5 Storing naturally detached *Posidonia australis* fragments

Posidonia australis fragments collected during beach surveys may either be planted on the same day of collection, stored underwater near the project area (if replanting within about 72 hours is possible) or in natural seawater in dedicated outdoor aquaria at the Sydney Desalination Plant at Kurnell. The outdoor aquaria are located within a secure area of the desalination plant and accessible only to personnel inducted by the Sydney Desalination Plant. The aquaria consist of plastic intermediate bulk containers reinforced with metal that are individually plumbed to receive natural seawater that enters the desalination plant system. The aquaria contain about 800 litres of filtered natural seawater that enters the desalination plant from intake structures near the seabed off the open coast of Kurnell. Parameters such as flow, temperature, salinity and nutrient levels of the seawater in the aquaria are consistently monitored and maintained at suitable levels by the Sydney Desalination Plant.

Aquaria would hold multiple Coreflute® boxes containing building sand (about 80 millimetres deep) mixed in with seagrass wrack into which the *Posidonia australis* fragments would be planted (following Ferretto et al., 2021). *Posidonia australis* fragments would be transplanted in rehabilitation sites within about three weeks of collection. Fragments would be visually inspected by experienced *Posidonia australis* restoration scientists prior to transplanting and any fragments deemed non-viable for transplanting (e.g. due to high necrosis) returned to the shoreline environment.

Aquaria would be visually inspected and maintenance carried out on about a weekly basis to ensure the aquaria maintain optimum conditions for storing *Posidonia australis*.

(a)



(b)

Figure 5-6: Photos showing (a) set up of the outdoor aquaria at the Sydney Desalination Plant for storing collected *Posidonia australis* fragments and (b) *Posidonia australis* fragments planted in boxes in the outdoor aquaria

5.4.6 Transplanting naturally detached *Posidonia australis* fragments

Initial transplanting efforts would focus on planting naturally detached *Posidonia australis* in rehabilitation sites that received translocated *Posidonia australis* to compensate for any losses. Continued transplanting would aim to gradually increase the overall planted area of *Posidonia australis* while maintaining shoot densities that closely match the original density of the impact area patches, about 42 shoots per square metres (UNSW, 2023b) (refer to Section 8). Transplanting naturally detached *Posidonia australis* fragments in additional rehabilitation sites would commence once monitoring data indicates this to be a feasible strategy or as an adaptive management measure in response to observations.

Naturally detached fragments may be planted on the same day of collection or following storage underwater. Stored fragments would be kept submerged in seawater in containers or in moistened catch bags until ready for transplanting underwater.

Prior to transplanting, the number of shoots would be quantified and recorded to facilitate monitoring changes in shoot density.

Mesh catch bags containing naturally detached *Posidonia australis* fragments would be delivered to divers at the rehabilitation sites. *Posidonia australis* fragments would initially be transplanted directly into the bare sediment or spaces within jute mats previously planted with translocated *Posidonia australis* donor material to supplement lost fragments and maintain shoot densities. Jute mats deployed during the translocation process would be expected to be covered in sediment and the mats would not be disturbed when transplanting with naturally detached fragments. At each position either in the bare sediment or within a jute mat that requires planting, divers would gently excavate the sediment and secure the rhizome of the new *Posidonia australis* fragment with long metal weed mat pins. The pins would be inserted into the sediment directly behind the fragments at the rhizome apex and placed at an angle pointing towards the prevailing wave direction to maximise stability of the transplanted fragments (Bastyan and Cambridge 2008). Transplanting would be done in rows with about 20 centimetres of space between *Posidonia australis* rhizomes to allow for growth and would maintain about 20 centimetres of space from areas of existing seagrass (Figure 5-7).

The same planting method would be used for transplanting naturally detached *Posidonia australis* fragments in new areas within partially planted rehabilitation sites and at additional rehabilitation sites.

During each transplanting event, divers would count and record on datasheets the number of shoots transplanted. Markers consisting of metal reinforcing bar or rigid electrical conduit and identifying information attached would be installed at regular intervals of about every two to three metres around the perimeter of the planted area of rehabilitation sites to facilitate monitoring. Markers would be at a height of about 20-30 centimetres above the sediment. The location, number and condition of markers installed at each rehabilitation site would be recorded (anticipated to be about 150 in total) and monitored over time and all markers removed at the completion of the monitoring program.

Figure 5-7: Photo depicting naturally detached *Posidonia australis* fragments being transplanted directly into bare sediment

Photo credit: Harriet Spark, Grumpy Turtle Media

6. Current and future threats, risks and opportunities for transplanting naturally detached *Posidonia australis* fragments

6.1 Threats, risks and mitigation measures for transplanting naturally detached *Posidonia australis* fragments

Implementation Plan #1 (UNSW, 2023a) identified a range of factors with the potential to influence the survival of translocated *Posidonia australis* fragments in Botany Bay (refer to the MBOS). These factors and the approach to minimising their influence would be similarly applicable to transplanting naturally detached *Posidonia australis* fragments. A summary of these factors and proposed strategies to mitigate their impact is provided in Table 6-1.

Table 6-1: Factors influencing success or survival of transplanted *Posidonia sp.*

Factor	Impact	Proposed strategy	References
Donor material availability	• Insufficient numbers of transplants collected.	• The strategy for collecting naturally detached fragments has been informed by current research into increasing the predictability of collecting accumulated beach-cast fragments (Section 5.4.4). • Beach surveys to collect fragments would be carried out highly frequently (Section 5.3).	Balestri et al. (2011)
Sediment erosion	• Potential to result in burial of *Posidonia sp.* leaves. • Sediment movement of 15-20cm can result in low survival of transplanted fragments.	• Jute mats deployed during translocation would help to stabilise sediment at suitable shallower rehabilitation sites where rates of sediment movement are typically greater (Section 5.4.3). • Transplanting of fragments at densities resembling natural meadows would be expected to assist with stabilising the sediment (Section 5.4.6).	Bastyan and Cambridge (2008) Glasby et al. (2015)
Depth	• Reduced light transmission at greater depths has the potential to inhibit *Posidonia sp.* growth.	• Transplanting would prioritise rehabilitation sites at shallower depths (Section 4.2).	Molenaar and Meinesz (1992) Glasby et al. (2015) Larkam (1976)
Planting strategy	• Survival percentage of transplanted *Posidonia sp.* fragments increases with number of fragments initially transplanted – planting of fragments over a larger area increases the chances of meeting environmental conditions suitable for growth. • Population growth rate increases with number of fragments initially transplanted – transplanting at higher density promotes self-sustaining recovery.	• The dynamic environment of Botany Bay suggests the preferred transplanting strategy would target transplanting natural detached *Posidonia australis* fragments across multiple recipient sites (Section 4.1).	van Katwijket al. (2015)

Factor	Impact	Proposed strategy	References
Bioturbation	• Burial, shading, erosion, or root damage to transplanted *Posidonia sp.* fragments due to excavation by burrowing marine worms.	• Jute mats deployed during translocation would assist in minimising bioturbation impacts (Section 5.4.3).	Bastyan and Cambridge (2008)
Epiphyte loads	• Heavy epiphyte loads may cause shading to *Posidonia sp.* leaves and impact the ability of the plants to photosynthesis and grow.	• Monitoring would quantify changes in shoot density, leaf length and epiphyte loads of transplanted *Posidonia australis.*	Cambridge et al. (1986) Larkam (1976)
Turbidity	• Reduces light transmission through the water column, reducing the photosynthetic ability and growth of transplanted *Posidonia sp.*	• Monitoring would quantify changes in shoot density and leaf length of transplanted *Posidonia australis.*	Larkum (1976)
Substratum environment	• Changes in substratum characteristics may effect recolonisation by transplanted *Posidonia sp.*	• The existing topography of rehabilitation sites is suitable for transplanting *Posidonia australis*. • Gentle excavation by hand during transplanting would minimise disturbance to the natural sediment environment at recipient sites (Section 5.4.6). • Jute mats deployed during translocation would not be disturbed when transplanting naturally detached fragments (Section 5.4.6).	Castejon-Silvo and Terrados (2021)
Anchoring system	• A suitable and long-term anchoring system is essential to prevent transplanted rhizomes being dragged before natural rooting occurs.	• Anchoring pins based on best scientific practice design would be used to anchor transplanted *Posidonia australis* rhizomes to the sediment (Section 5.4.6).	Castejon-Silvo and Terrados (2021) Gobert et al. (2005) Ferretto et al. (2021) van Katwijket al. (2015)
Season	• Seasonal storm activity may damage jute mats, uproot transplanted *Posidonia sp.* fragments, promote burial due to greater wave action and result in higher stormwater input leading to increases in nutrients and changes in salinity. • Reduced day lengths in autumn-winter results in lower light levels and may inhibit growth and survival of transplanted *Posidonia sp.* • Warmer air/water temperatures have the potential to cause stress to *Posidonia sp.* fragments, leading to mortality.	• Transplanting would occur throughout the year. • Post-storm monitoring would be carried out to enable early detection of impacts to transplanted *Posidonia australis* fragments. • Jute mats and transplanted fragments would be securely attached to the sediment using best scientific practice design anchoring systems (Section 5.4.6). • Heat stress to collected *Posidonia australis* fragments would be minimised by storing fragments submerged in seawater (Section 5.4.5).	Meinesz et al. (1992) Paling et al. (2001) Ferretto et al. (2021)

6.2 Opportunities associated with transplanting *Posidonia australis*

Successful transplanting of *Posidonia australis* for the project would not only result in a net gain of ecologically valuable key fish habitat but would also result in indirect benefits. Some of the benefits and opportunities would include:

- Return of ecosystem functions and services to degraded areas (e.g. habitat provision, nursery grounds, carbon sequestration, sediment stabilisation)
- Support for further research into seagrass transplanting and rehabilitation
- Development of new management techniques and feasible restoration programs for the endangered *Posidonia australis* community in Sydney
- Development of new methodologies for seagrass restoration science and practice
- Potential for attracting and securing additional government research funding
- Increased knowledge of the endangered *Posidonia australis* community in Sydney
- Collaboration with marine restoration practitioners and Traditional Owners (Gamay Rangers)
- Community and stakeholder education
- Continued collaboration on other projects with Transport for NSW – Maritime in order to support delivery of future maritime infrastructure projects in a more sustainable way.

7. Monitoring program

The MBOS identified the need for establishing a long-term monitoring program to assess the success of the *Posidonia australis* rehabilitation efforts. A monitoring program was developed during preparation of Implementation Plan #1 (UNSW, 2023a) for translocation of *Posidonia australis* (refer to the MBOS). The monitoring program included the success criteria for assessing the performance of the *Posidonia australis* rehabilitation efforts over short, mid and long-term time periods (refer to Section 8). The success criteria provide readily measurable structural attributes that would indicate changes in the status of transplanted and nearby naturally occurring *Posidonia australis* meadows through time. The monitoring program outlines the strategy, methods, data analysis and reporting approach for monitoring the *Posidonia australis* rehabilitation efforts.

The monitoring program detailed in Implementation Plan #1 (UNSW, 2023a) would be implemented throughout the period that transplanting of naturally detached *Posidonia australis* fragments would be carried out and continue for a total of ten years. The approach and methods for monitoring the performance of transplanted naturally detached *Posidonia australis* fragments would be consistent with the monitoring program detailed in Implementation Plan #1.

All monitoring results would be provided to the MBOS Implementation Reference Panel and other relevant project stakeholders for review. The review process would enable early detection of negative (or positive) trends or indications of *Posidonia australis* status and condition that have the potential to influence the success of the rehabilitation efforts. Should any remedial or management actions be identified from the ongoing reviews of monitoring results, these would be determined in consultation with the MBOS Implementation Reference Panel and other relevant stakeholders.

A formal review of monitoring would be carried out after five years (and every five years thereafter) to assess the ongoing success of the rehabilitation efforts. Should the review identify that amendments to the monitoring program are required, these would be developed in consultation with the MBOS Implementation Reference Panel and other relevant stakeholders and documented in subsequent revisions of this monitoring program. Refer to Implementation Plan #1 (UNSW, 2023a) in the MBOS for further details.

8. Success criteria

Monitoring of the performance of any restoration effort should be linked to predefined and agreed standards and/or criteria (Commander et al., 2018). The success criteria for the *Posidonia australis* offsetting strategy are identified in Table 8-1. The success criteria were developed in consultation with the MBOS Implementation Reference Panel and other key project stakeholders. The performance of the offsetting strategy would be evaluated by comparing the monitoring data with these targets.

The success criteria have been developed taking into account the slow growing nature of *Posidonia australis:* rehabilitated sites are expected to take at least five to ten years to achieve shoot densities similar to natural undisturbed meadows (Bastyan and Cambridge 2008). Table 8-1 also identifies additional desirable measures of success such as publishing materials that advance the knowledge of seagrass restoration.

The success of the *Posidonia australis* offsetting strategy would be assessed against the most appropriate measure for each criterion including:

- *Posidonia australis* in the impact area i.e. Kurnell wharf footprint and 15 metre buffer (areal extent and shoot density) based on baseline monitoring results
- Baseline offset site conditions (shoot density, i.e. zero *Posidonia australis* shoot density in bare, unvegetated boat mooring or cable scars)
- Reference sites (long-term shoot density).

Table 8-1: *Posidonia australis* offsetting success criteria and measures over short, mid and long-term period of the restoration program

Criteria	Measure	Pre construction	Short term success (2 years)	Mid term success (6 years)	Long term success (10 years)
Primary success criteria					
Removal of all *Posidonia australis* to be impacted.	All *Posidonia australis* successfully transplanted from the impact area to offset sites.	Removal and recording of all *Posidonia australis* shoots from impact area prior to construction (Kurnell). Storage of shoots for no longer than 72 hours until transplanting is complete.	-	-	-
Increase in area of *Posidonia*.	Areal extent of restored *Posidonia australis* meets EPBC offset requirements.	-	Areal extent of restored *Posidonia australis* is to a 1:1 ratio of area removed from the impact area.	Areal extent of restored *Posidonia australis* is to a 2:1 ratio of area removed from the impact area.*	Areal extent of restored *Posidonia australis* combined with additional offsetting measures^ meets or exceeds the EPBC offset requirement.*
Goal: 536 m^2	Minimum value:	-	268 m^2	536 m^2	536 m^2
Maintain *Posidonia australis* density.	Shoot density of restored *Posidonia australis* (based on 0.25 m^2 quadrats).	-	Increase in shoot density in the offset sites from bare to vegetated at a minimum density of 25 shoots per square meter (>50% of the impact area density).	Mean shoot density in the offset sites is equal to or greater than 32 shoots per square metre (75% of the impact area density) or the reference sites density (if it drops below 32 shoots/m^2).	Mean shoot density of the offset sites is equal to or greater than the impact area or the reference sites density (if it drops below the impact area density).*
Goal[1]: 42 shoots/m^2	Minimum value:	-	25 shoots/m^2	32 shoots/m^2	42 shoots/m^2
Secondary success criteria					
Support for improved techniques and methodologies in seagrass restoration.	Publication of materials that advance the knowledge of seagrass restoration in NSW.	-	Documentation of successful methodologies and conditions for translocation, planting and monitoring of seagrass shoots.	Documentation of improvements resulting from adaptive approaches leading to higher seagrass density and greater health indicators.*	Development of improved indicators of ecosystem health (e.g. using photogrammetry), documentation of management or operational improvements to achieve indicators of seagrass restoration success.*

[1] *Refer to Site Selection and Validation Report at Appendix 6 in the MBOS.*

* *Contributes to meeting Posidonia australis restoration key performance indicator in MBOS.*

^ *Additional offsetting measures such as installation of Environmentally Friendly Moorings in Posidonia australis meadows are identified in Section 5.7 of the MBOS. An implementation plan and success criteria for additional offsetting measures would be prepared in consultation with the MBOS Implementation Reference Panel and other project stakeholders during 2023.*

9. Terms and acronyms

Term /acronym	Description
BOM	Bureau of Meteorology
CoA	Condition of approval
DAWE	Department of Agriculture, Water and the Environment (former)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and the Environment
DPIE	Department of Planning, Industry and the Environment (former)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EIS	Environmental impact statement
FM Act	*Fisheries Management Act 1994* (NSW)
KFH	Key fish Habitat
MBOS	Marine Biodiversity Offset Strategy
MIRP	Marine Biodiversity Offset Strategy Implementation Reference Panel
NSW DPI Fisheries	NSW Department of Primary Industries Fisheries
SEARs	Secretary's environmental assessment requirements
SSI	State Significant Infrastructure
TEC	Threatened Ecological Community
Transport for NSW	Transport for New South Wales

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Appendix 6 Site Selection and Validation report – *Posidonia australis* translocation and naturally detached shots

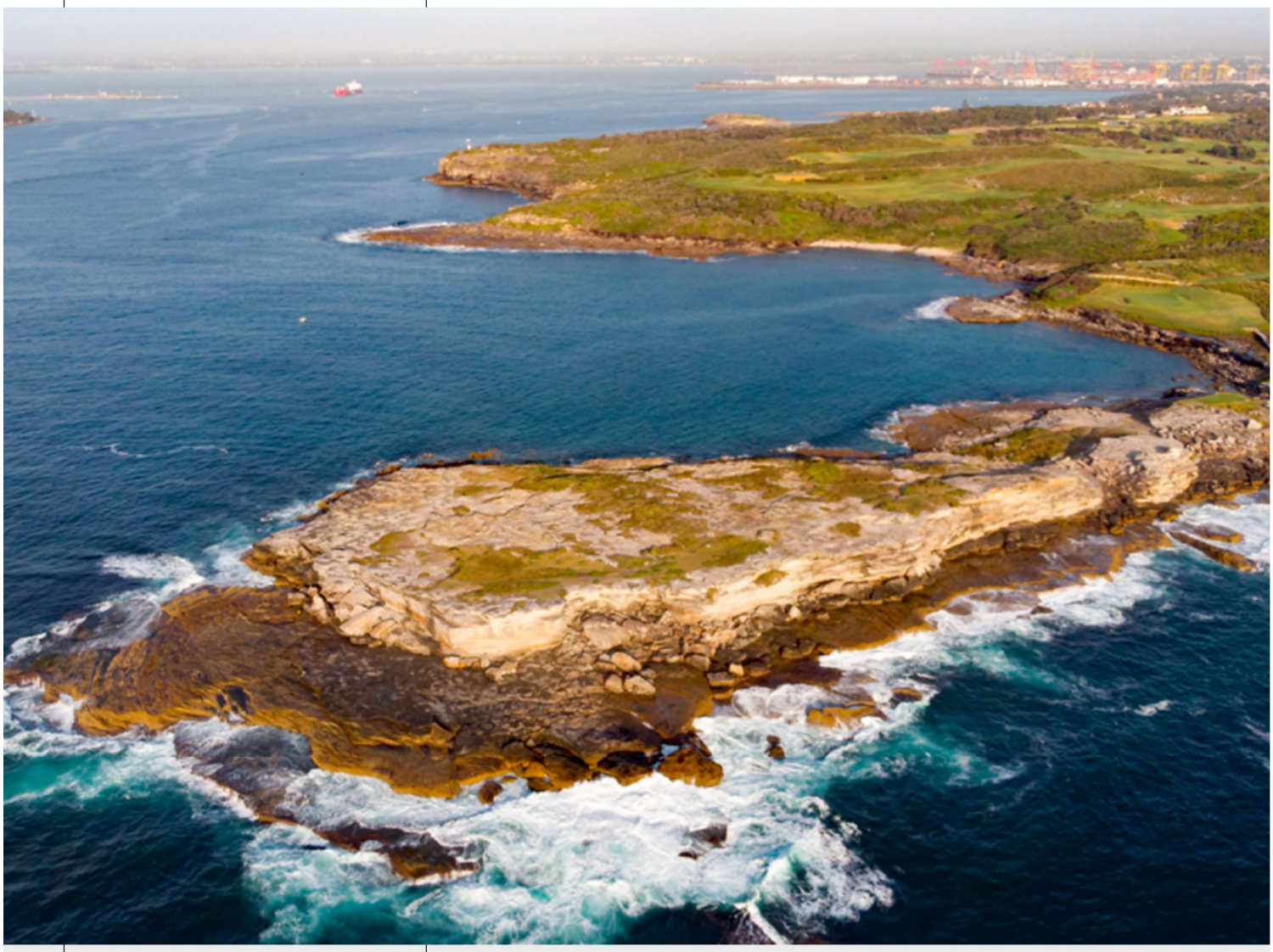
Transport
for NSW

Kamay Ferry Wharves project

Seagrass Translocation, Rehabilitation and Monitoring

Site Selection and Validation Report

March 2023



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Acknowledgement of Country

Transport for NSW acknowledges the Bidjigal and Gweagal clans who traditionally occupied Kamay (Botany Bay).

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.

Document control

Project	Kamay Ferry Wharves project – seagrass translocation, rehabilitation and monitoring
Document name	Site Selection and Validation Report
Document number	
Author	UNSW
Endorsed by	MBOS Implementation Reference Panel
Branch / division	Maritime Infrastructure Delivery Office
Endorsed date	

Versions

Revision	Date	Revision notes	Prepared by	Reviewed by
A	25/11/2022	Draft 1 for review by Transport for NSW	UNSW	TfNSW
00	31/03/2023	Final	UNSW	MBOS Implementation Reference Panel

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1. Introduction

1.1 Overview of the project

The NSW Government is reinstating the wharves at La Perouse and Kurnell to provide a valuable recreational resource for the community, and to allow for future ferry access between both sides of Kamay Botany Bay National Park. The wharves will improve access for locals and visitors in small commercial and recreational boats and for people to swim, dive, fish, walk and enjoy the local sights.

The project forms part of the NSW Government's Kamay Botany Bay National Park, Kurnell Master Plan, which aims to improve visitor experience and access to the park. The plan is being delivered by Transport for NSW and the NSW National Parks and Wildlife Service.

Importantly, the project recognises the rich culture and ongoing importance of the area to Aboriginal people. Feedback from the community has helped to guide the design and stories of Country have been embedded into elements of the built form. Large scale artworks by two local Aboriginal artists are integrated into the designs of the jetty and the shelter structures at La Perouse and Kurnell.

The project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework. It was also confirmed to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Accordingly, bilateral approval has been sought from the NSW State Government, under the *Environmental Planning and Assessment Act 1979* (EP&A Act), and the Australian Government, under the EPBC Act.

An environmental impact statement (EIS) was placed on public exhibition from July to August 2021. A response to submissions report was prepared in October 2021 to address issues raised during public exhibition of the EIS. The project was determined under the EP&A Act by the NSW Minister for Planning in July 2022. The project was determined under the EPBC Act by the Australian Minister for the Environment and Water in March 2023.

Construction of the wharves is expected to commence in the first half of 2023 and anticipated to take around 13 months.

1.2 The Marine Biodiversity Offset Strategy

The project EIS assessed how likely the project is to impact on the area's marine ecology and biodiversity values. The EIS determined that some impacts to marine ecology and biodiversity due to the project could not be fully avoided. The EIS identified the project was likely to result in residual impacts to Key Fish Habitat (KFH), including direct and indirect impacts to *Posidonia australis* Threatened Ecological Community (TEC). *Posidonia australis* TEC is protected under both the EPBC Act and *Fisheries Management Act 1994* (FM Act, NSW). In order to mitigate these unavoidable impacts, a process known as 'ecological offsetting' is implemented under State and Commonwealth legislation.

A Marine Biodiversity Offset Strategy (MBOS) was developed to provide a strategy for managing and mitigating the residual impacts on marine ecology and biodiversity identified in the EIS. The MBOS identifies appropriate offset requirements under the EPBC Act and FM Act. The MBOS documents how Transport for NSW would meet its marine offset obligations. It also describes how these actions would be implemented in consultation with NSW Department of Primary Industries Fisheries (NSW DPI Fisheries), Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW)and other stakeholders to result in a net gain in environmental outcomes for Botany Bay and the community.

The MBOS has an operational life of ten years, and therefore is an adaptive document that would be reviewed and updated as required by Transport for NSW. Revisions to the MBOS would be implemented in consultation with the MBOS Implementation Reference Panel, which comprises representatives from Transport for NSW, NSW DPI Fisheries and an independent scientist. The MBOS Implementation Reference Panel would review the revised MBOS to ensure the updates are consistent with the offset policies and their implementation. Where significant changes to the MBOS have occurred, a copy of the MBOS and changes would be distributed to other relevant stakeholders, which may include Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and NSW Department of Planning and Environment Planning (DPE).

1.3 Offset requirements

The Secretary's environmental assessment requirements (SEARs) issued for the project required an assessment of the potential impacts of the project on receiving marine habitats and biota be carried out. The SEARs required that the assessment consider whether the project was likely to result in any significant impact on listed threatened species, populations or ecological communities under the FM Act. In particular, the SEARs required that the extent and impact on seagrass beds, especially *Posidonia australis*, from all stages of the project be assessed. To address the SEARs, a Marine Biodiversity Assessment Report was prepared for the EIS. The marine biodiversity studies carried out to support the EIS included habitat mapping of subtidal reefs, together with targeted seagrass surveys that assessed the extent, cover and condition of the seagrass communities and surrounding habitats within and adjacent to the project construction boundary. These studies were conducted during preparation of the EIS in 2020.

The marine ecology and biodiversity impact assessment considered a worst-case residual impact scenario that included direct and indirect impacts from construction, the resulting permanent structure, and operation of vessels. The EIS determined the worst-case residual impact resulting from the project would be a loss of:

- 683 m^2 of *Posidonia australis* habitat (Type 1 KFH)
- 20,589 m^2 of other seagrass habitat (Type 1 KFH)
- 3683 m^2 of macroalgae habitat (Type 2 KFH).

The MBOS identified that rehabilitating all seagrass that would be disturbed would not be logistically feasible and proposed to focus on rehabilitating *Posidonia australis* because of its greater ecological value and importance.

The approach adopted for the MBOS was to apply the EPBC Offset Calculator to determine the draft offset requirements for *Posidonia australis.* The EPBC Offset Calculator provides a more conservative value and offsetting obligation than the no-net loss outcome as defined under the NSW Fisheries Policy. The draft offset requirement for *Posidonia australis* under the EPBC Offset Calculator identified in the MBOS was 2000 m^2.

This value is conservative and would result in the rehabilitation and improvement of more than double the area of *Posidonia australis* predicted to be impacted by the project. The proposed offset requirement would also achieve no net loss for White's seahorse (*Hippocampus whitei*) habitat by replacing lost habitat due to the project.

1.4 Offset strategy

Transplanting of seagrass remains the only way to replace and re-establish seagrasses in areas where it has been lost. The MBOS proposed two methods for offsetting *Posidonia australis* impacts:

a) Translocation of *Posidonia australis* from areas expected to be impacted during construction of the project to habitats identified as degraded within Botany Bay

b) Rehabilitation of seagrass meadows using naturally detached beach-cast *Posidonia australis* fragments.

The MBOS offset strategy proposed to meet the draft EPBC offset requirements would involve harvesting from the impact areas (from herein, defined as Kurnell wharf footprint plus 15 metre buffer area) and replanting all the *Posidonia australis* within that area (estimated to be a maximum of 683 m^2 of *Posidonia australis*), and improving at least 2000 m^2 of existing *Posidonia australis* habitat in Botany Bay by collecting and planting naturally detached *Posidonia australis* fragments in unvegetated patches.

The MBOS proposed that the donor *Posidonia australis* material be transplanted to nearby unvegetated areas damaged from historical disturbance within Botany Bay.

A monitoring program would be implemented to monitor the success of the offset strategy over time.

The translocation, rehabilitation and monitoring would be carried out using best practice methods and techniques developed and successfully implemented by research scientists in NSW estuaries as well as any future practices.

1.5 Baseline monitoring program

The draft offset requirements proposed by the MBOS were based on a worst-case scenario of predicted impacts for *Posidonia australis* habitat. Accordingly, the offset requirements proposed by the MBOS would be updated in response to site specific requirements, results of additional monitoring and the conditions of approval (CoA) for the project.

The Commonwealth and State (NSW) CoA relevant to the MBOS are identified in Table 1-1.

The EIS identified the need for a pre-construction seagrass monitoring program to collect baseline survey data on seagrass distribution, composition and condition within the project boundary. The baseline data would inform the final offset requirements under the EPBC Act and FM Act. The survey area for the baseline monitoring program is displayed in Figure 3-1.

Baseline seagrass monitoring was carried out winter 2021 and summer 2022. Two additional baseline monitoring events were carried out in winter 2022 and summer 2022/2023 to meet the project's obligations under NSW CoA E13. The baseline monitoring would fulfill the project's obligations under NSW CoA E6 to confirm the location of areas of seagrass that have been identified for removal and disturbance. The data obtained from the baseline monitoring program would guide the final offset requirements under the MBOS in consultation with the MBOS Implementation Reference Panel, as required by NSW CoAs E15 and E16.

Table 1-1: Commonwealth and State (NSW) conditions of approval relevant to the Marine Biodiversity Offset Strategy for the project

CoA	Condition requirement
Commonwealth CoA	
3	Within the project area, the approval holder must not clear more than: a) 0.0683 hectares of seagrass meadows a) 0.0683 hectares of White's Seahorse habitat.
4	The approval holder must comply with NSW Approval conditions E6 – E8 and E11 related to pre-construction surveying and protection measures.
10	The approval holder must comply with NSW Approval conditions E12 – E20 related to the requirements of the Marine Biodiversity Offset Strategy (MBOS) to compensate for the clearing of 0.0683 hectares of seagrass meadows and White's Seahorse habitat.
11	To monitor the outcomes of the MBOS for seagrass meadows and White's Seahorse habitat, the approval holder must include a Marine Biodiversity Offset Report as part of the compliance report until the 10th anniversary of the date of this approval, unless otherwise agreed to in writing by the Minister. Each Marine Biodiversity Offset Report must include: a) a progress report on the implementation of the MBOS; b) a list of success metrics; c) details of the monitoring methodology(ies) implemented and the locations of reference sites; d) monitoring results including a comparison against reference sites; e) a summary of any adaptive management measures taken to improve implementation of the MBOS and/or monitoring methodology(ies); and f) a conclusion as to whether the outcomes, as measured against the success metrics, have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person.
12	To assess the ongoing success of the MBOS, the approval holder must submit a Rehabilitation Monitoring Review to the department within 6 years of the date of this approval and every 5 years thereafter, unless otherwise agreed to in writing by the Minister. The approval holder must publish each Rehabilitation Monitoring Review on the website within 15 business days of submission and keep every Rehabilitation Monitoring Review published until this approval expires. Each Rehabilitation Monitoring Review must include: a) a review of the monitoring methodology(ies) by a suitably qualified person; b) a conclusion based on the success metrics as to whether the environmental offsets for seagrass meadows and White's Seahorse habitat have been achieved, are likely to be met or are unlikely to be met, as determined by a suitably qualified person; and c) if environmental offsets for seagrass meadows and White's Seahorse habitat have not been achieved based on the success metrics: i) a list measurable and time-bound remediation measures which will be undertaken to ensure the success metrics are achieved; and

CoA	Condition requirement
	ii) justification for how the remediation measures will provide full compensation for the impacts to seagrass meadows and White's Seahorse habitat.
NSW CoA	
A1	The Proponent must carry out the SSI in accordance with the terms of this approval and generally in accordance with the: (a) *Kamay Ferry Wharves Environmental Impact Statement* (the EIS), dated June 2021 (b) *Kamay Ferry Wharves Response to Submissions Report* (the Submissions Report), dated October 2021; and (c) *Kamay Ferry Wharves Marine Biodiversity Offset Strategy* (the MBOS), dated November 2021.
E6	The location of areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 Key Fish Habitat (KFH)) and macroalgae that have been identified for removal and disturbance at Kurnell and La Perouse must be confirmed and recorded by surveying and mapping prior to the commencement of clearing in consultation with DPI Fisheries and DAWE.
E12	The proponent must ensure that the proposal is undertaken in accordance with the requirements of DPI Fisheries policy and guidelines, including the Policy and Guidelines for Fish Habitat Conservation and Management 2012, and the NSW Biodiversity Offsets Policy for Major Project Fact sheet: Aquatic Biodiversity.
E13	The Proponent must allow for an additional winter and summer season in which to monitor marine biodiversity within the construction footprint prior to commencement of construction.
E14	The Proponent must satisfy the marine biodiversity offset obligations that specify the required offset size in accordance with the EPBC Act, Environmental Offsets Policy 2012, NSW Biodiversity Offsets Policy for Major Projects – Fact sheet: Aquatic Biodiversity. Evidence of this must be provided to the Planning Secretary, DPI Fisheries and DAWE for information, within 12 months of the commencement of construction.
E15	Areas of seagrass (*Posidonia australis*) and other seagrass beds (Type 1 KFH) and macroalgae (Type 2 KFH) that have been identified for removal or disturbance within the construction footprint at Kurnell and La Perouse must be offset in accordance with the MBOS and as agreed with DPI Fisheries and DAWE.
E16	Prior to the commencement of pre-construction seagrass transplantation, the Proponent must establish a MBOS Implementation Reference Panel to review data collected, including from the marine biodiversity monitoring as required by Condition E13, recommend changes to the MBOS if required, and review the Operational Impact Assessment Report (see Condition E20). The MIRP must comprise representatives from the Proponent, DPI Fisheries-Coastal Systems, DPI Fisheries-Marine Research, DAWE and DPIE Planning and Assessment, and include a suitably qualified, experienced and independent scientist. The MBOS Implementation Reference Panel must be operational for the life of the MBOS or as agreed by the Planning Secretary.
E17	The MBOS must have an operational life of no less than ten (10) years from the date of MBOS approval, unless otherwise agreed by the Planning Secretary.
E18	The MBOS may be reviewed and updated during its operational life as required and recommended by the MBOS Implementation Reference Panel. At least 50 per cent of the MBOS funding must be allocated to the restoration and rehabilitation of *Posidonia australis* and *Zostera* seagrass beds in consultation with the MBOS Implementation Reference Panel.

1.6 Purpose of the Site Selection and Validation Report

The purpose of the Site Selection and Validation Report is to document the results of detailed in-situ surveys and mapping that were carried out to:

- Survey, accurately quantify and confirm the area of *Posidonia australis* likely to be removed from the impact area
- Survey and confirm suitability of the proposed rehabilitation sites identified in the MBOS
- Survey and identify three suitable reference sites not predicted to be impacted by the project's construction
- Identify any new potential rehabilitation sites, if required.

The surveys would assist Transport for NSW to meet the obligations of NSW CoA E6 which requires confirmation of the location of areas of *Posidonia australis* that have been identified for removal and disturbance at Kurnell by surveying and mapping prior to the commencement of seagrass translocation.

The observations, results and recommendations presented in this report would be incorporated into the revised MBOS in consultation with MBOS Implementation Reference Panel. It would further inform the offset requirements for *Posidonia australis* under the EPBC Act and FM Act.

The survey and mapping methods are detailed in Section 3.

1.7 Program

The MBOS would be operational for ten years. Table 1-2 identifies the anticipated timeline and duration of the seagrass offset work in relation to the expected approval, construction and monitoring requirements.

Table 1-2: Anticipated program for seagrass translocation, rehabilitation and monitoring

Activity	2021		2022				2023				2024				2025				2026				2027				2028				2029				2030				2031				2032				2033			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Baseline monitoring																																																
EIS published																																																
Submissions report published																																															
State planning approval																																															
Commonwealth planning approval																																															
Confirmation (summer) survey																																															
MBOS update																																															
Translocation of *P. australis*																																															
Initial survey – Baseline Report																																														
Construction of the project																																															
Planting naturally detached *P. australis*																																															
Seagrass monitoring																																															
Review of monitoring																																															

2. Consultation

This report was prepared in consultation with the following project stakeholders:

- Port Authority of New South Wales
- Transport for NSW Maritime Operations (Botany Bay) and Project Team
- Ausgrid
- NSW DPI Fisheries, Fisheries Research
- MBOS Implementation Reference Panel.

Site constraints and other recommendations identified by the stakeholders guided the development of the Site Selection and Validation Report. This included feedback on the suitability of proposed rehabilitation and reference sites received from representatives from Port Authority of NSW, Transport for NSW Maritime Operations (Botany Bay) in October 2022 and MBOS Implementation Reference Panel in March 2023.

Recommendations for safe working in the Ausgrid cable trenches, should they be selected as rehabilitation sites, were provided by the Ausgrid Asset Protection team.

A copy of this report would be provided to the MBOS Implementation Reference Panel for review and updating of the MBOS.

3. Methods

3.1 Overview of the confirmation survey

The objective of the confirmation survey was to confirm:

a) Suitability of the seagrass rehabilitation sites proposed by the MBOS, including location, area, topography, seagrass density and any other constraints

b) Suitability of three *Posidonia australis* reference sites, including: location, species composition, shoot density and morphological traits

c) Locations, areal extent, shoot density and condition of *Posidonia australis* within the impact area (inside Kurnell wharf footprint and 15 metre buffer).

The survey and mapping methods implemented were generally in accordance with the methods described in the MBOS. Data were obtained via a combination of:

- Desktop review and update, where necessary, of previous mapping of proposed rehabilitation sites, reference sites and areas of *Posidonia australis* within the impact area
- Consultation with stakeholders to identify any sites that may be considered unsuitable due to various constraints
- In-situ underwater surveys of rehabilitation sites, reference sites and areas of *Posidonia australis* within the impact area
- In-situ mapping of rehabilitation sites and areas of *Posidonia australis* within the impact area.

The location of the areas surveyed and mapped are shown Figure 3-1 and Figure 3-2.

A desktop review of existing data was carried out in October 2022 prior to the commencement of field-based activities. Fieldwork for the confirmation survey was conducted over five days in October and November 2022.

All fieldwork was carried out by Scientific Divers experienced in surveying and mapping seagrass and other benthic habitats in Sydney estuaries.

3.2 Description of the survey area

Kamay (Botany Bay) is a large, marine-dominated, sheltered embayment located in southern Sydney. The bay has an area of about 40 km^2, with a one kilometre wide opening to the sea. Freshwater flows into the bay via the Georges River and Cooks River. Increased freshwater inflows and stormwater runoff during flood and storm events strongly influence salinity and nutrient levels in Botany Bay (Roy et al., 2001). The tidal range of Botany Bay is about two metres and the embayment is partially flushed during each tidal cycle (Roper et al., 2010). The depth of the bay in the vicinity of the project area varies with the tide but reaches a maximum of about five metres furthest from shore. Surface water temperatures range from 22–24°C in summer to 15–18°C in winter and are generally well mixed with low stratification (Sterling-Wood et al., 2022).

Botany Bay is a highly urbanised waterway that supports numerous industrial, commercial and recreational activities. Port Botany, located on the north-eastern side of Botany Bay, is the largest container port in NSW. The port operates 24/7 and commercial vessels regularly move through Botany Bay via shipping channels that traverse the waterway between La Perouse and Kurnell. The Kurnell Port and Berthing Facility is located about 300 metres west of the project area at Kurnell. Botany Bay supports several charter boat operations. Recreational users of Botany Bay include rowers, sailors, fishers, personal watercraft users, snorkelers and divers. Recreational activity levels intensify during the summer months.

The dominant seagrasses in Botany Bay are *Posidonia australis*, *Zostera sp.* and *Halophila sp.* While *Posidonia australis i*s slow-growing and sensitive to environmental change, large seasonal changes in the distribution and density of *Zostera sp.* and *Halophila sp.* occur in Botany Bay (Reid, 2021). Unlike *Posidonia australis, Zostera sp.* and *Halophila sp.* tend to rapidly recolonise and spread across the benthos following disturbance (Larkham and West, 1990). The seagrass meadows perform numerous important ecosystem functions, including provision of habitat for fishes and invertebrates, including commercially important species, sediment stabilisation, nutrient removal and carbon capture (reviewed in Sterling-Wood et al., 2022).

The extensive long-term decline in seagrass distribution in Botany Bay has been attributed to several natural and human-made processes (Larkham and West, 1990). Natural processes such as wave action, sediment movement, nutrient availability, warmer temperatures and herbivory may impact seagrass distribution (Reid, 2021). The main human-made historical and

ongoing threats to seagrass persistence in Botany Bay include dredging, water pollution, coastal development, electricity transmission network infrastructure development, and scouring from boat anchors and moorings (Larkham and West, 1990; Glasby et al., 2015; Evans et al., 2018; Glasby and West 2018). The fragmented seagrass meadows observed around the bay provide evidence of disturbance.

3.3 Desktop review

A desktop review of existing data included a review of the location and mapped extent of *Posidonia australis* rehabilitation sites provided in the MBOS, and mapped seagrass habitat polygons obtained from the most recently available baseline monitoring surveys carried out in winter 2022 (Niche 2022a). Data documented in previous seagrass baseline monitoring reports (Niche 2021, 2022a, 2022b) was reviewed to gain an understanding of changes in seagrass cover over the two-year monitoring period. A literature review of peer-reviewed papers and reports documenting restoration of *Posidonia australis* in NSW was also carried out (e.g. Botany Bay: Glasby et al. 2015; Port Hacking: Meehan and West, 2002; Port Stephens: Ferretto et al., 2019, 2021).

High resolution aerial imagery of Botany Bay captured by Nearmap on 2 August 2022 was displayed in GIS software (QGIS). The rehabilitation sites proposed by the MBOS were located and analysis of the areal extent of each site was performed by overlaying polygons. The calculated areas were compared to those provided in the MBOS. GPS coordinates were obtained for each of the potential rehabilitation sites to enable field-based surveys to be done. The rehabilitation sites proposed by the MBOS were located at Kurnell (ten sites), Frenchman's Bay (seven sites) and Penrhyn Estuary (one site). A review of historical (2009) to present day (2022) Nearmap aerial imagery was carried out to identify changes in the areal extent of rehabilitation sites over time.

Seagrass habitat polygon data obtained from the winter 2022 seagrass baseline monitoring surveys (Niche 2022a) was overlaid on Nearmap imagery in GIS software. Analysis of the habitat polygon data was used to determine the distribution and areal extent of *Posidonia australis* within the project impact areas at La Perouse and Kurnell. The data review indicated there was no presence of *Posidonia australis* within the project impact area at La Perouse. The GPS coordinates of *Posidonia australis* patches within the impact area at Kurnell were obtained from the GIS software to enable field-based surveys to be carried out.

A review of the Nearmap imagery and seagrass baseline monitoring reports (Niche 2021, 2022a, 2022b) was also used to select locations for potential *Posidonia australis* reference sites within the main *Posidonia australis* meadow at Kurnell. GPS coordinates of the potential reference sites at Kurnell were obtained for the field-based surveys.

3.4 Field-based surveys

3.4.1 Location and timing of field surveys

Existing data indicated no direct impact of the project on *Posidonia australis* at La Perouse, and the surveys to quantify and confirm the exact area of *Posidonia australis* likely to be impacted by the project were therefore only carried out at the Kurnell impact area (Figure 3-1).

Proposed rehabilitation sites at Frenchman's Bay identified in the MBOS were not surveyed for this report, following feedback received from Port Authority of NSW and Transport for NSW Maritime Operations (Botany Bay) which indicated various constraints that would limit their suitability. The constraints identified for Frenchman's Bay included the risk of damage to rehabilitation sites from vessel anchors, high traffic or vessels becoming beached on the bay. Surveys were conducted to inspect the suitability of the remaining rehabilitation sites at Kurnell (ten sites) (Figure 3-1) and Penrhyn Estuary (one site) (Figure 3-2).

Due to the distribution of impacted areas of *Posidonia australis* and rehabilitation sites being concentrated at Kurnell, this location was considered the most representative for the *Posidonia australis* reference sites. The selected reference sites would be distributed within the main *Posidonia australis* bed at Kurnell and located outside the project impact area (Figure 3-1).

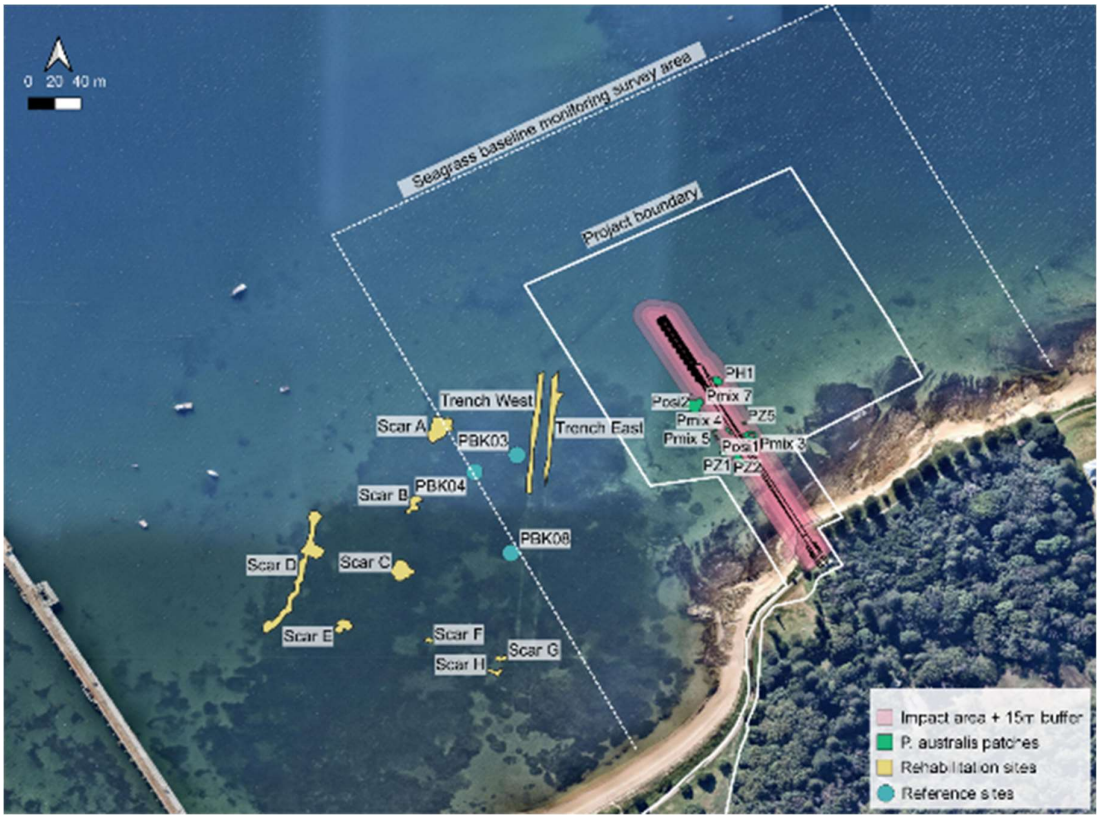

Figure 3-1: Overview of survey area at Kurnell

Figure 3-2: Location of surveyed rehabilitation site at Penrhyn Estuary

3.4.2 Surveys of *Posidonia australis* in the impact area

A total of ten previously mapped *Posidonia australis* patches distributed within the impact area (Niche 2022a) were located in the field using a handheld GPS (Garmin eTrex®, accuracy three metres) (Figure 3-3). A temporary float was deployed in the centre of the patch and the presence of *Posidonia australis* was confirmed by snorkeling by a Scientific Diver.

At each identified *Posidonia australis* patch, Scientific Divers carried out underwater surveys to record the density, leaf length and level of epiphyte cover of *Posidonia australis* and species composition of the patch. *Posidonia australis* was surveyed within up to ten randomly placed 0.25 m^2 quadrats (0.5 metre x 0.5 metre). A reduced number of replicate quadrats were surveyed in patches of limited size or cover of *Posidonia australis.* In each quadrat, the number of *Posidonia australis* shoots was quantified, and maximum leaf length and epiphyte cover (using a one to five scale, where one indicated minimal and five indicated heavy epiphyte cover) was recorded for three random leaves per quadrat. The presence of other seagrass species (*Halophila sp*. and *Zostera sp*.) and macroalgae was also noted for each quadrat.

3.4.3 Surveys of *Posidonia australis* reference sites

Three potential *Posidonia australis* reference sites distributed within the main *Posidonia australis* bed at Kurnell located west of the project boundary were selected for surveying (Figure 3-4). Once located, a temporary float was deployed in the centre of the site. At each reference site, Scientific Divers quantified *Posidonia australis* shoot density, leaf length, epiphyte cover and species composition in ten randomly placed 0.25 m^2 quadrats within about a five-metre radius of the centre of the site, using the same methods as described for the impact area patches.

3.4.4 Surveys of potential *Posidonia australis* rehabilitation sites

The ten potential rehabilitation sites located at Kurnell (Figure 3-4) and single site at Penrhyn Estuary (Figure 3-2) proposed by the MBOS were inspected for suitability for *Posidonia australis* transplanting.

At Kurnell, each site was located in the field using a handheld GPS and temporary floats were deployed to delineate the site boundaries. Scientific Divers carried out underwater surveys of the Kurnell rehabilitation sites and recorded visual and photographic observations. Observations were made of the presence of *Posidonia australis* or other seagrass (*Halophila sp*. and *Zostera sp*.), topography and any other characteristics that may influence the site's suitability for *Posidonia australis* transplanting.

Poor water conditions during the confirmation survey period prevented an underwater survey being carried out for the rehabilitation site at Penrhyn Estuary and this site was visually inspected from the vessel. The shallow water environment at the site enabled observations of presence of seagrass and topography.

3.5 Field-based mapping

3.5.1 Mapping of *Posidonia australis* in the impact area

In-situ mapping was carried out to confirm the areal extent of *Posidonia australis* located within the impact area at Kurnell (Figure 3-3). Each *Posidonia australis* patch was located in the field using a handheld GPS. A second handheld GPS (Garmin eTrex®, accuracy three metres) contained inside a waterproof bag was attached to a diver-towed float and used to map the perimeter of the patches. Snorkelers swam the perimeter of the patch, simultaneously towing the float containing the GPS by hand to accurately record the patch extent. Points were recorded on the GPS at regular intervals during the in-water mapping exercise to provide additional data to assist with area calculations.

3.5.2 Mapping of *Posidonia australis* reference sites

No mapping was carried out for the reference sites within the main large *Posidonia australis* at Kurnell, as the sites were contained within the extent of the existing bed outside the project boundary. The main *Posidonia australis* bed covers an area of about nine hectares and comprises mostly contiguous cover of *Posidonia australis*.

The performance of the seagrass offset strategy for meeting the criterion of increasing *Posidonia australis* area would be assessed using the area of *Posidonia australis* removed from the impact area at Kurnell because this would represent the most appropriate measure. However, long-term measures of offset strategy success such as *Posidonia australis* density and condition may be assessed by comparing with the reference sites if these are deemed appropriate measures.

3.5.3 Mapping of potential *Posidonia australis* rehabilitation sites

In-situ mapping was carried out for the *Posidonia australis* rehabilitation sites considered suitable for transplanting based on the site suitability inspections carried out previously.

The methods used for mapping the extent of the rehabilitation sites were the same as those used for mapping *Posidonia australis* within the impact area.

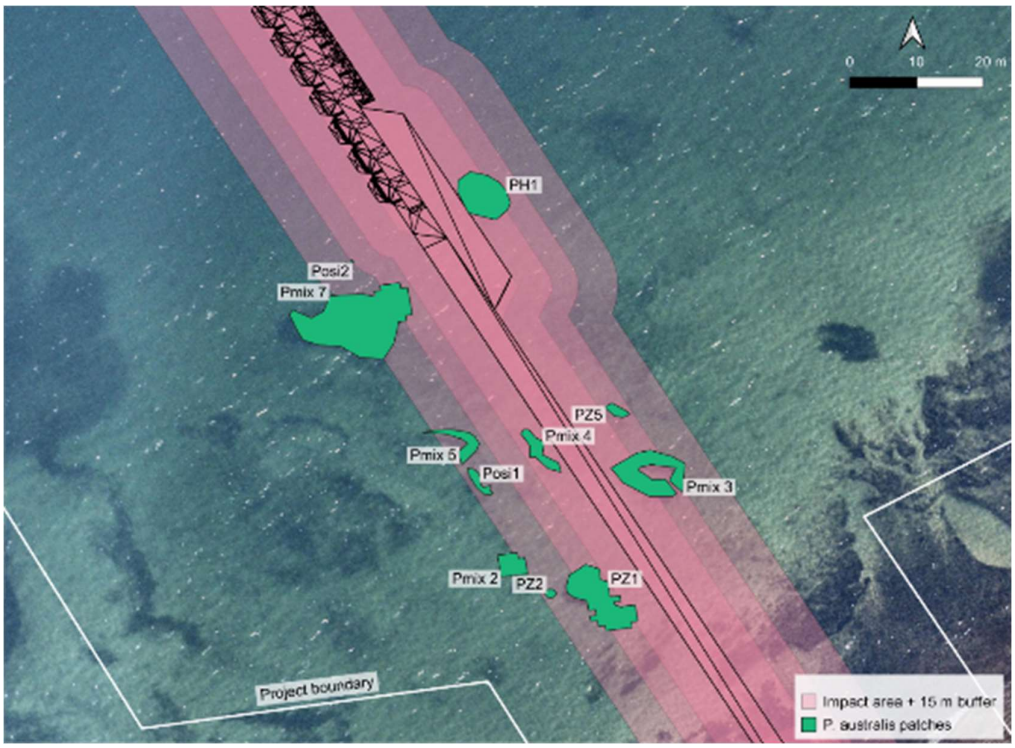

Figure 3-3: Location of surveyed *Posidonia australis* patches within the impact area at Kurnell.
Shown are the habitat polygons obtained from the winter 2022 seagrass baseline monitoring surveys (Niche, 2022a).

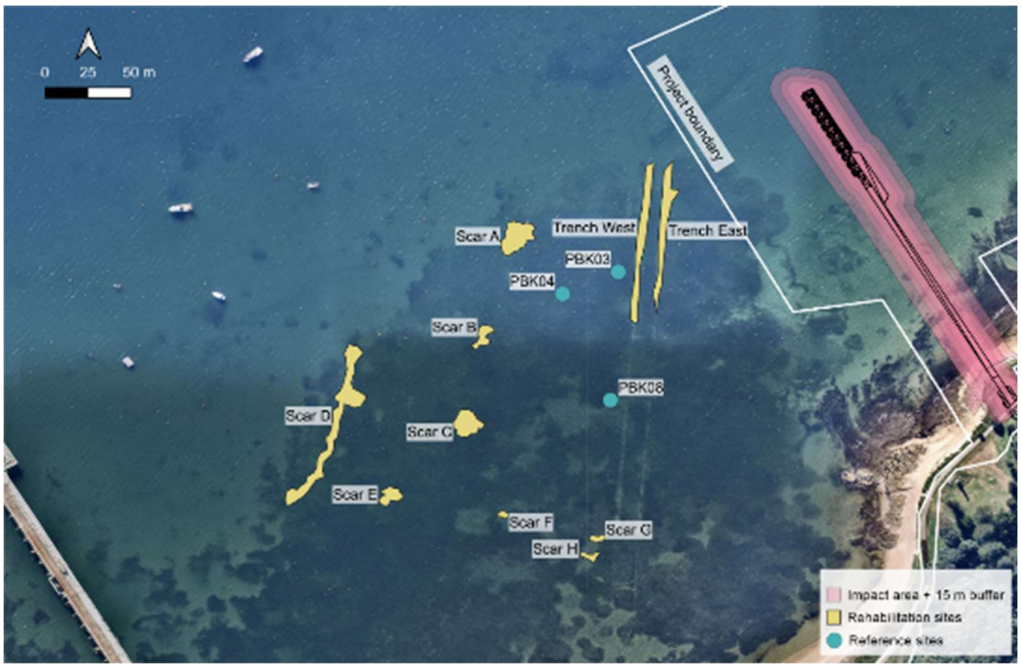

Figure 3-4: Location of surveyed *Posidonia australis* reference sites and rehabilitation sites at Kurnell

3.6 Analysis

3.6.1 *Posidonia australis* characteristics

Data on *Posidonia australis* shoot density, leaf length and epiphyte cover recorded during the surveys of *Posidonia australis* in the impact area and references sites were analysed to obtain summary descriptive statistics. The mean (± standard error) of these variables were calculated for each site and plotted for visual interpretation of the results. Analysis of variance (ANOVA, two factor: site type (impact area or reference) and site (nested within site type) was used to test for statistical differences in *Posidonia australis* shoot density, leaf length and epiphyte cover between impact area and reference sites.

3.6.2 Location and extent of impact area *Posidonia australis* patches and rehabilitation sites

The GPS data collected during the in-situ mapping was reviewed in Garmin Basecamp. The accuracy of the in-situ mapping was inspected and area calculations were made for the *Posidonia australis* patches in the impact area and rehabilitation sites. These calculations were further refined by defining polygons based on the GPS mapping in GIS software (QGIS). The in-situ GPS-mapped *Posidonia australis* polygon data were qualitatively compared to the *Posidonia australis* polygon data obtained from the winter 2022 seagrass baseline monitoring surveys (Niche 2022a). The in-situ GPS-mapped rehabilitation site polygon data were compared to the area calculations in the MBOS. The polygon data for the impact area *Posidonia australis* patches and rehabilitation sites were visually inspected for variation from the high resolution Nearmap imagery captured in August 2022.

The total area of *Posidonia australis* within the impact area and the total area of rehabilitation sites considered suitable for transplanting were calculated.

3.6.3 Suitability of rehabilitation sites and reference sites

The suitability of the rehabilitation sites and references sites was assessed. The assessment considered existing data, data obtained during the in-situ surveys and inspections, feedback received from stakeholders and any other identified constraints.

4. Results

4.1 Survey conditions

The three-month period leading up to the confirmation survey was exceedingly wet, with the 482 millimetres of rainfall recorded at Sydney Airport (Bureau of Meteorology (BOM) station 66037, located 8.5 kilometres from Kurnell) between July and September being more than twice the long-term mean (BOM, 2022). Weather conditions were relatively dry and stable during the confirmation survey period (mid-October to November 2022). The period of low precipitation during October and November resulted in a noticeable improvement in water quality over time at Kurnell. While tidal patterns and wind action also influence water quality in Botany Bay, the reduced input of freshwater river flows and stormwater to the bay likely contributed to the improved conditions underwater. As a result, underwater visibility increased from less than two metres to about five metres by the end of the survey period.

4.2 *Posidonia australis* at Kurnell

4.2.1 *Posidonia australis* density and condition at impact area and reference sites at Kurnell

A summary of the overall mean values for *Posidonia australis* shoot density, leaf length and epiphyte load at the ten surveyed impact area patches and three reference sites is provided in Table 4-1. Values from the winter 2022 seagrass baseline monitoring report are also provided for comparison. Additional data is provided in Appendix B. Photographs are provided in Appendix C.

Mean *Posidonia australis* shoot density was significantly lower (ANOVA, p=<0.001) within the impact area patches (10.6 per 0.25 m^2) than the reference sites within the main *Posidonia australis* meadow (17.1 per 0.25 m^2). Mean shoot densities at the impact area sites were highly varied and ranged from less than five to more than 20 shoots per 0.25 m^2 (Figure 4-1a). Less variation in shoot density was observed in reference sites (Figure 4-1b). There was little difference in the overall mean shoot density for impact area *Posidonia australis* patches quantified by the confirmation survey and winter 2022 baseline monitoring report (Niche 2022a) (Table 4-1). Differences in reference site shoot densities quantified by the confirmation survey and winter 2022 seagrass baseline monitoring report (Niche 2022a) appeared to be largely driven by variation between individual sites (Table 4-1).

Posidonia australis leaf lengths were significantly shorter (ANOVA, p=0.002) in impact area patches than reference sites. In general, less sediment burial of *Posidonia australis* was visually observed for the patches within the impact area than the reference sites. Mean leaf lengths varied between sites by a maximum of about 10 centimetres (Figure 4-2).

Mean epiphyte loads for *Posidonia australis* were lower in the impact area patches than reference sites (ANOVA, p=<0.001) (Table 4-1). Epiphyte loads quantified by both the confirmation survey and winter 2022 seagrass baseline monitoring surveys (Niche, 2022a) could generally be described as moderate for all sites (Figure 4-3).

Table 4-1: Summary of key *Posidonia australis* characteristics quantified at the impact area and references sites at Kurnell, Botany Bay

Site type	Distance to impact area (m)	Sites surveyed	Shoot density (mean ±SE) (0.25 m^2)	Leaf length (mean ±SE) (cm)	Epiphyte load (mean ±SE) (1 5 scale)
Confirmation survey					
Impact area	0	10	10.6 (±0.70)	29.0 (±0.74)	2.5 (±0.08)
Reference	130–180	3	17.1 (±0.91)	32.6 (±1.04)	3.4 (±0.08)
Seagrass baseline monitoring surveys, winter 2022 (Niche 2022a)					
Impact area	0	5	11.6 (±2.0)	24.5 (±2.0)	3.6 (±0.26)
Reference	130–180	3	22.3 (±7.0)	21.5 (±2.0)	3.5 (±0.01)

Note: SE=standard error

With the exception of one site within the impact area, the seagrass composition of the surveyed sites included the presence of small amounts of all three dominant seagrass species, *Posidonia australis, Halophila sp*. and *Zostera sp.* Of the two seasonal seagrass species, *Zostera sp.* was more frequently recorded than *Halophila sp*.

The naming convention for the *Posidonia australis* impact area sites in this report is indicative of the dominant seagrass species identified by the habitat polygon data obtained from the winter 2022 seagrass baseline monitoring surveys (Niche 2022a), where:

- P/Posi = *Posidonia australis*
- H = *Halophila sp*.
- Z = *Zostera sp.*
- mix = *Halophila sp*. and *Zostera sp*.

Although densities of *Halophila sp*. and *Zostera sp.* were not quantified in the confirmation survey, a review of the species presence/absence data collected from the surveys confirmed the accuracy of the adopted impact area site names in terms of seagrass composition.

The three reference sites selected have been monitored as part of the seagrass baseline monitoring survey program, and the site names have been retained for ease of reference.

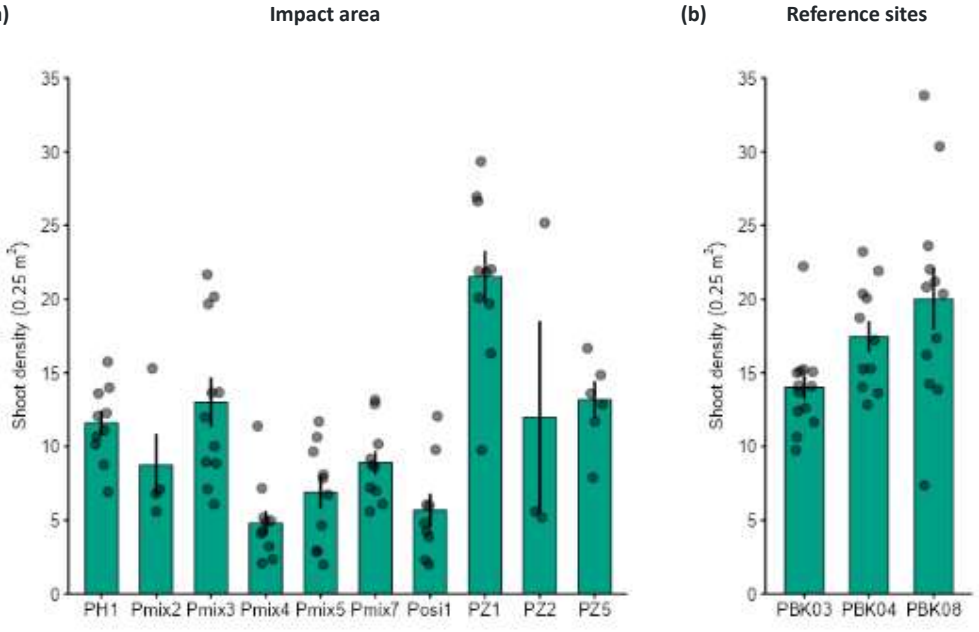

Figure 4-1: Mean *Posidonia australis* shoot density at Kurnell (a) impact area and (b) reference sites
Error bars indicate standard error of the mean.

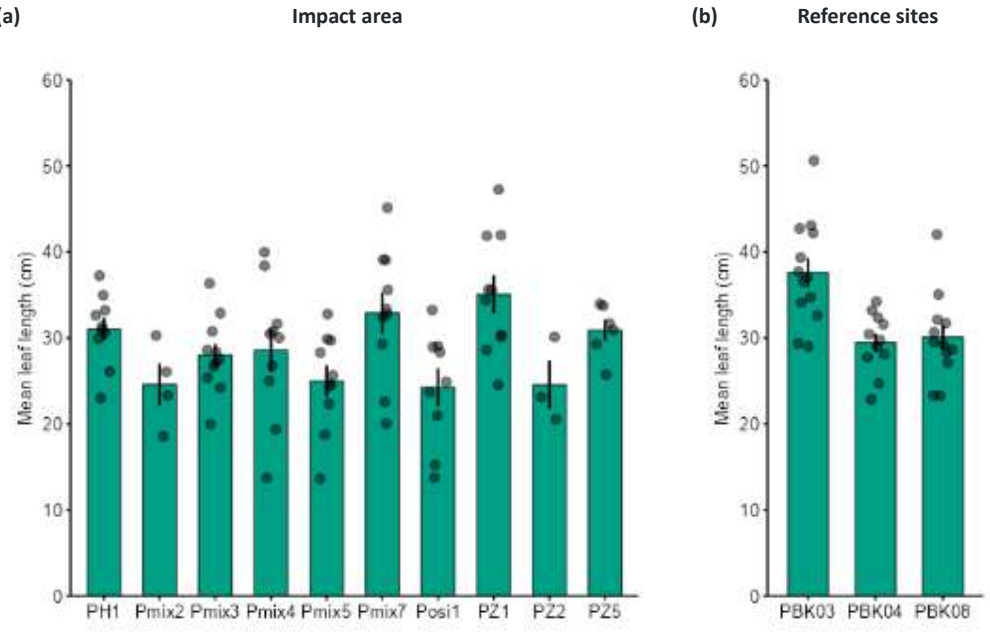

Figure 4-2: Mean *Posidonia australis* leaf length at Kurnell (a) impact area and (b) reference sites
Error bars indicate standard error of the mean.

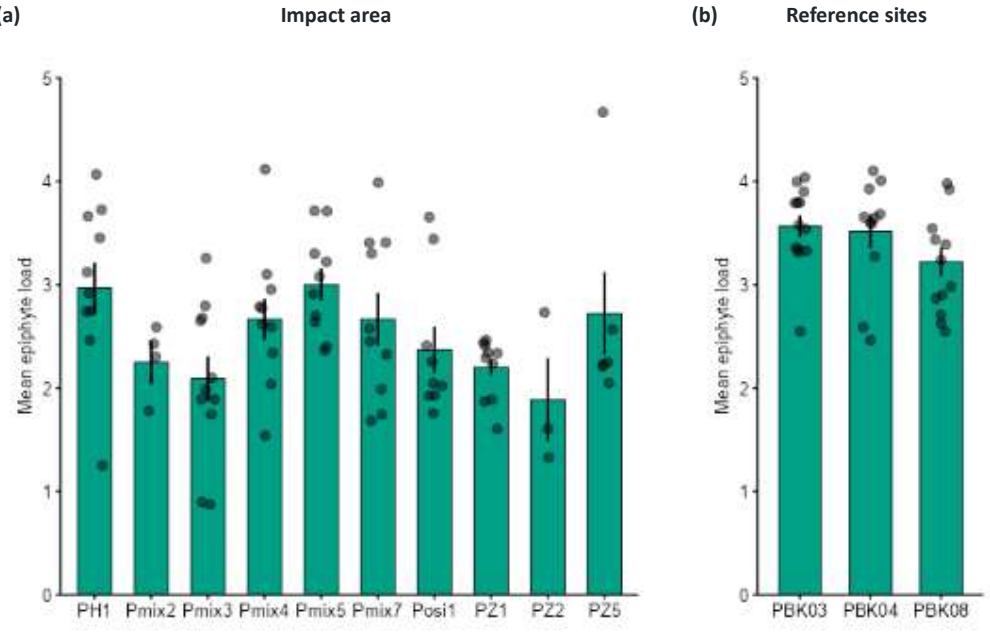

Figure 4-3: Mean *Posidonia australis* epiphyte load at Kurnell (a) impact area and (b) reference sites
Error bars indicate standard error of the mean.

4.2.2 *Posidonia australis* extent within the impact area at Kurnell

Field-based mapping was carried out for the ten previously mapped (Niche 2022a) *Posidonia australis* patches identified within the impact area at Kurnell (Figure 3-3). A small (about 1.5 m^2) patch of *Posidonia australis* not previously mapped was incidentally located within the impact area during mapping for the confirmation survey. This patch (Posi2) was included in the impact area calculations.

The areal extents of the *Posidonia australis* patches calculated from the confirmation survey mapping are provided in Table 4-4. The area calculations obtained from the habitat polygon data prepared for the winter 2022 seagrass baseline monitoring report (Niche 2022a) are also provided for comparison.

The total area of the eleven *Posidonia australis* patches located within the impact area that were mapped during the confirmation survey was 184.5 m^2 (Table 4-4). *Posidonia australis* patch sizes within the impact area ranged from 1.5 m^2 to greater than 50 m^2. Area calculations for patches only partially located within the impact area were estimated using GIS software.

The mapped areal extent of *Posidonia australis* recorded by the confirmation survey (184.5 m^2) was smaller than the 292 m^2 total area calculated from habitat polygon data obtained from the winter 2022 seagrass baseline monitoring survey (Niche 2022a). The discrepancy in area calculations could be explained by the different techniques used for in-situ mapping (refer to Section 5.1).

The shoot density data and patch area calculations obtained from surveying and mapping of *Posidonia australis* patches within the impact area at Kurnell indicate that about 8200 *Posidonia australis* shoots would be available for harvesting as donor material for the translocation process.

Table 4-2: Calculated area of *Posidonia australis* patches located within the impact area at Kurnell

Site ID	Winter 2022 seagrass baseline monitoring survey (m^2)	Confirmation survey (m^2)
PH1	50	33
Pmix2	3	10
Pmix3	55	31
Pmix4	15	10
Pmix5	15	14
Pmix7	76	52
Posi1	7	3
Posi2	-	1.5
PZ1	64	21
PZ2	2	2
PZ5	5	7
Total	**292**	**184.5**

4.3 Potential *Posidonia australis* rehabilitation sites

4.3.1 Rehabilitation site location, topography, seagrass density and constraints

Ten potential rehabilitation sites located at Kurnell and a single site at Penrhyn Estuary were inspected during the confirmation survey. A brief description of the rehabilitation sites is provided in Table 4-3 and photographs are included at Appendix C.

The potential rehabilitation sites at Kurnell are distributed across an area of about nine hectares within existing seagrass meadows to the west of the project boundary. The locations of the rehabilitation sites at Kurnell are shown in Figure 4-5 and the Penrhyn Estuary site in Figure 3-2. The shape of rehabilitation sites at Kurnell suggests the majority are a result of historical damage from scouring caused by mooring chains and boat anchoring (Figure 4-4).

Inspections revealed that the topography of the rehabilitation sites at Kurnell was flat with no significant trenches, obvious scouring or other features that would inhibit transplanting *Posidonia australis.* Site depths increased with distance from shore at Kurnell, ranging from about 1.5 to four metres depth. The proposed rehabilitation site at Penrhyn Estuary was visually inspected from the vessel. The site is located in very shallow water about 50 metres from the Foreshore Beach shoreline and was observed to have *Zostera sp.* exposed above the water surface.

The rehabilitation sites were primarily composed of bare sediment. Nonetheless, the presence of seagrass, generally *Halophila sp*. and *Zostera sp.* but occasionally sparse *Posidonia australis,* was observed in almost all the rehabilitation sites inspected: eight of ten sites at Kurnell and the single Penrhyn Estuary site (Table 4-3).

In summary, based on inspection of the 11 potential rehabilitation sites:

- Three of the ten sites at Kurnell were considered high priority for *Posidonia australis* transplanting (Trench east, Trench west and Scar F)
- Three further sites at Kurnell were considered medium priority for transplanting *Posidonia australis* (Scar B, Scar C and Scar E)
- The remaining four sites at Kurnell (Scar A, Scar D, Scar G and Scar H) and the Penrhyn Estuary site were considered lowest priority for rehabilitation due to depth, existing seagrass density and other factors.

Figure 4-5 displays the priority rating for rehabilitation of the sites at Kurnell.

Table 4-3: Description of the potential rehabilitation sites inspected during the confirmation survey

Site ID	Distance to impact area (m)	Description	Seagrass density	Site constraints	Suitability
Trench east	73	• Created during laying of Ausgrid electricity cables across Botany Bay. • Partial recovery due to *Posidonia australis* transplanting efforts and natural seagrass recovery (about 30% of area) since 2011.	• Patchy cover of *Posidonia australis, Halophila sp*. and *Zostera sp*. within some areas. • Seagrass encroaching in some places, sometimes across width of trench.	• Partially vegetated. • Transplanting methods would need to consider the fragmented nature of suitable bare areas within the scar. • Partially located in deeper water. • Safe working conditions must be addressed (minor risk of contacting Ausgrid cables).	• High priority for rehabilitation in shallower sections. • Suitable for jute mats and directly transplanting into sediment. • Suitable for transplanting of naturally detached fragments.
Trench west	91	• As noted for Trench east.	• As noted for Trench east.	• As noted for Trench east.	• As noted for Trench east.
Scar A	164	• Boat mooring scar. • Seagrass damage evident from at least 2010. • No change in areal extent.	• No seagrass cover.	• Located in deeper water. • Located near edge of meadow.	• Lowest priority for rehabilitation. • Suitable for jute mats and directly transplanting into sediment. • Suitable for transplanting of naturally detached fragments.
Scar B	219	• Boat mooring scar. • Seagrass damage evident from at least 2014. • Partial natural recovery (about 50% of area).	• Very sparse cover of *Halophila sp*.	• Partially vegetated. • Located at mid-depth water.	• Medium priority for rehabilitation. • Suitable for jute mats and directly transplanting into sediment. • Suitable for transplanting of naturally detached fragments.

Site ID	Distance to impact area (m)	Description	Seagrass density	Site constraints	Suitability
Scar C	256	• Boat mooring scar. • Seagrass damage evident from at least 2012. • Scar gradually expanded over 10 years. • Located in shallow water.	• Medium cover of *Halophila sp*. and *Zostera sp*. at edges and sparse to very sparse patchy cover throughout scar. • Very low cover of *Posidonia australis.*	• Partially vegetated.	• Medium priority for rehabilitation. • Suitable for jute mats and transplanting directly into sediment. • Suitable for transplanting of naturally detached fragments.
Scar D	298	• Partially comprised of a boat mooring scar. • Northern section historically bare (> 10 years). • Narrow southern section gradually lost seagrass cover and remained unvegetated for > 5 years.	• No seagrass cover.	• Scar varies in width. • Located at edge of meadow. • Located in deeper water.	• Lowest priority for rehabilitation. • Suitable for transplanting in targeted sections of the scar. • Suitable for transplanting of naturally detached fragments.
Scar E	323	• Boat mooring scar. • Seagrass damage evident from at least 2013. • Partial natural recovery (about 50% of area). • Located in shallow water.	• Medium cover of *Halophila sp*. • Low cover of *Zostera sp*.	• Partially vegetated.	• Medium priority for rehabilitation. • Suitable for directly transplanting into sediment. • Suitable for transplanting of naturally detached fragments.

Site ID	Distance to impact area (m)	Description	Seagrass density	Site constraints	Suitability
Scar F	275	• Boat mooring scar. • Seagrass damage evident from at least 2013. • Partial natural recovery (about 50% of area). • Located in shallow water.	• Very sparse scattered cover of *Halophila sp*. and *Zostera sp*.	• Small area. • Partially vegetated.	• High priority for rehabilitation • Suitable for jute mats and directly transplanting into sediment. • Suitable for transplanting of naturally detached fragments.
Scar G	231	• Historically bare area (>10 years). • Natural seagrass recruitment into area over time (about 70% of area). • Located in shallow water.	• Medium cover of *Halophila sp*. and *Zostera sp*. • Sparse cover of *Posidonia australis.*	• Small area. • Partially vegetated. • Historically area of bare sediment.	• Lowest priority for rehabilitation.
Scar H	226	• Historically bare area (>10 years). • Natural seagrass recruitment into area over time (about 70% of area). • Located in shallow water.	• Medium cover of *Halophila sp*. and *Zostera sp*.	• Small area. • Partially vegetated. • Historically area of bare sediment.	• Lowest priority for rehabilitation.
Penrhyn Estuary	>5,000	• Seagrass loss due to expansion of Port Botany, groyne construction and natural erosion since 2008. • Limited recovery of *Zostera sp*. • Located in shallow water.	• Patchy cover of *Zostera sp*.	• Shallow, with existing seagrass exposed at low tide. • Partially vegetated. • High sediment movement. • Safe working conditions must be addressed (pollution levels).	• Lowest priority for rehabilitation.

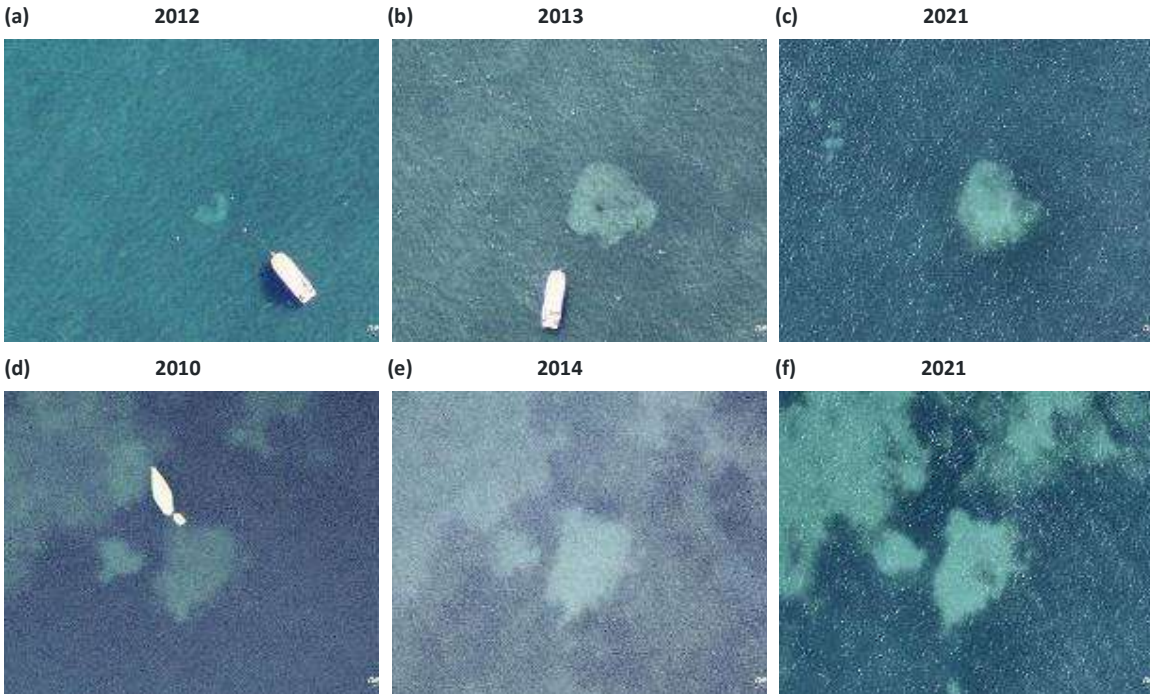

Figure 4-4: Timeline of Nearmap aerial imagery showing damage to seagrass due to boat moorings at Kurnell.
Images show Scar C in (a) August 2012, (b) August 2013, and (c) December 2021; Scar A in (d) April 2010, (e) June 2014, and (f) December 2021.

4.3.2 Rehabilitation site mapped extent

Field-based mapping to confirm the areal extents of the rehabilitation sites was carried out only for those sites identified from the site inspections as most suitable for *Posidonia australis* transplanting. The rehabilitation site areas calculated from the confirmation survey mapping are provided in Table 4-4. The area calculations prepared for the MBOS are also provided for comparison.

The total area available within rehabilitation sites at Kurnell that would be considered high or medium priority for transplanting *Posidonia australis* is 619 m^2. This is equivalent to about four times the area of *Posidonia australis* anticipated to be removed from the impact area at Kurnell.

Table 4-4: Calculated area of high and medium priority rehabilitation sites at Kurnell

Site ID	MBOS mapped area (m^2)	Confirmation survey mapped area (m^2)
Trench east	190	144
Trench west	217	223
Scar B	68	43
Scar C	166	147
Scar E	47	42
Scar F	20	20
Total	**707**	**619**

Total area calculations for the six sites are similar between the confirmation survey and MBOS. Variation between individual rehabilitation site area calculations could be explained by:

a) Methods used for mapping – desktop calculations using GIS software and Nearmap imagery for the MBOS and in-situ mapping for the confirmation survey.

b) Timing of mapping - the MBOS area calculations were obtained using Nearmap imagery captured in December 2021, while the confirmation survey in-situ mapping was carried out in November 2022. Changes in seagrass distribution and sediment movement during this time period would have the potential to alter the extent of the rehabilitation sites.

c) Detailed mapping of the trench east and west scars carried out for the confirmation survey allowed accurate area calculations that included only areas identified as bare, unvegetated sediment within the entire trench scars.

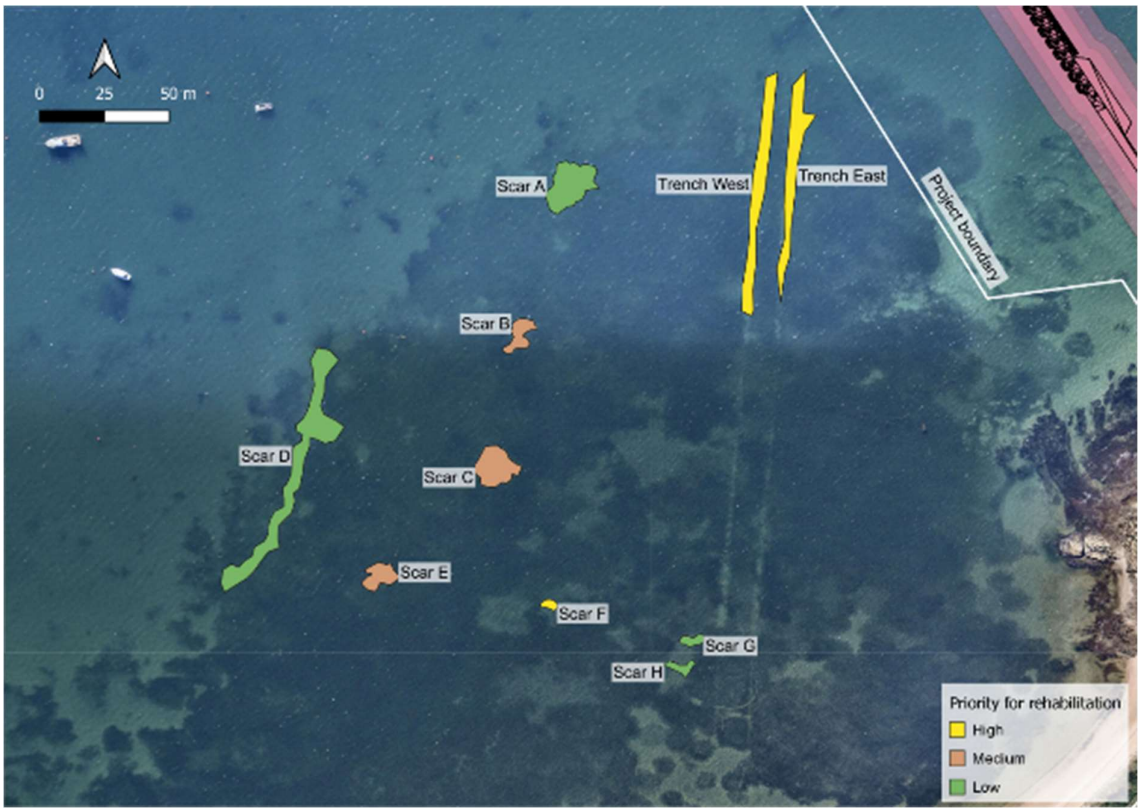

Figure 4-5: Map of rehabilitation sites at Kurnell showing priority rating for rehabilitation based on site assessments. Note that the Penrhyn Estuary site is not shown but was considered low priority for rehabilitation.

5. Discussion

The confirmation survey used a combination of desktop-based data review and mapping, in-situ underwater surveys and mapping, and stakeholder consultation to:

- Locate and quantify the areal extent and condition of *Posidonia australis* within the impact area at Kurnell
- Identify and assess the suitability of reference sites for the seagrass rehabilitation monitoring program
- Assess the suitability of rehabilitation sites for transplanting *Posidonia australis*.

A discussion of the confirmation survey findings for each of the above-mentioned items is provided in the following sections.

5.1 Suitability of *Posidonia australis* reference sites

The three reference sites inspected during the confirmation survey were located outside the project boundary and spaced within the main *Posidonia australis* meadow. The sites are located at least 130 metres from the project boundary and impacts from the project on the reference sites are expected to be negligible. The reference sites are distributed among the potential rehabilitation sites and located within a minimum distance of about nine metres to a maximum of about 160 metres from the rehabilitation sites. The three reference sites are positioned at distances from shore similar to the rehabilitation sites and therefore would experience a similar range of depths.

Posidonia australis density and condition was consistent across the three reference sites surveyed, indicating that they are representative of the overall meadow condition. *Posidonia australis* density and leaf length in the selected reference sites were significantly greater than the impact area patches.

The selected reference sites would be considered suitable "control" sites for monitoring project impacts and providing a baseline for measuring the performance of the *Posidonia australis* rehabilitation work.

5.2 *Posidonia australis* within the impact area

Posidonia australis within the impact area occurred at significantly lower density and with shorter leaf lengths than at the reference sites in the main *Posidonia australis* meadow located outside the project boundary. Patches were fragmented with often sparse cover of *Posidonia australis*. *Posidonia australis* epiphyte loads, one measure of seagrass condition, were lower for impact area patches than reference sites, and on visual inspection appeared to be less buried.

A substantial bloom of epiphyte growth, mostly filamentous algae, was observed in the seagrass meadows at Kurnell on the final day of mapping for the confirmation survey in early November. Similar observations have been reported from other areas of Botany Bay. The bloom could be attributed to a combination of factors, including reduced precipitation and flushing leading to an increase in water clarity in combination with ongoing high nutrient input entering Botany Bay from previous months. This event provides evidence of the dynamic nature of the environment of Botany Bay and susceptibility of its marine biota to changes in conditions. The duration and effect of the excessive epiphyte growth on seagrass condition in Botany Bay should be considered as part of the final (summer 2022/2023) seagrass baseline monitoring surveys.

The total area of *Posidonia australis* available for harvesting donor material from the impact area at Kurnell is around 184.5 m^2, providing about 8200 shoots.

The discrepancy in area calculations for *Posidonia australis* within the impact area between the confirmation survey and winter 2022 seagrass baseline monitoring survey (Niche 2022a), being about 110 m^2 in this report, could be explained by the different techniques used for in-situ mapping. Whereas the seagrass baseline monitoring survey mapping used techniques suitable for habitat mapping across a broad area, the mapping techniques used for the confirmation survey were highly targeted towards providing accurate area measurements of the ten previously identified *Posidonia australis* patches within the impact area. The mapping methods included in-water visual observations and measurements by Scientific Divers to verify the presence of *Posidonia australis* and confirm patch distributions.

Mapping of seagrass distribution carried out to date has verified the location of a number of *Posidonia australis* patches in the impact area at Kurnell. There is the potential that small areas or individual shoots of *Posidonia australis* may not have been detected during the surveys. As a management measure to ensure all viable *Posidonia australis* is salvaged from the impact

area, it is suggested that Scientific Divers carry out detailed surveys of the entire impact area during the harvesting stage of the translocation process.

5.3 Suitability of rehabilitation sites

5.3.1 Overview of rehabilitation site suitability assessment and areal extent

The total area available for *Posidonia australis* transplanting within the assessed rehabilitation sites would be about 619 m^2. This area comprises three sites at Kurnell considered most suitable for *Posidonia australis* transplanting (Trench east, Trench west and Scar F). It also includes three sites at Kurnell (Scar B, Scar C and Scar E) that would be medium priority for rehabilitation subject to changes in the existing seagrass cover and method selected for transplanting, for example direct planting into sediment rather than the jute mat method proposed by the MBOS.

Sizes of individual rehabilitation sites suitable for *Posidonia australis* transplanting vary widely, from small 20 m^2 scars to sites with areas more than ten times larger. The benefit of identifying multiple suitable rehabilitation sites is the opportunity to be selective when transplanting *Posidonia australis*. The transplanting strategy would transplant shoots across several rehabilitation sites to target the most suitable site conditions while simultaneously providing the opportunity to identify factors influencing rehabilitation success and tailor future plans. This strategy would also spread the risk of failure resulting from unforeseeable events such as incidental damage by recreational boat users, loss of jute mats or shoots due to inclement weather conditions or unplanned environmental incidents.

The assessment determined that four sites at Kurnell (Scars A, D, G, H) and the Penrhyn Estuary site would be of lowest priority for *Posidonia australis* transplanting due to existing seagrass density and other factors, such as depth and sediment instability.

The factors guiding the assessment of rehabilitation site suitability are described in the following sections.

5.3.2 Seagrass distribution influences on rehabilitation site suitability

The rehabilitation site suitability assessment took into account the presence and density of seagrass within the sites. Preference was given to rehabilitation sites that had large portions of unvegetated area (Trench east, Trench west) or sparse cover of seasonal *Zostera sp.* and *Halophila sp.* seagrass (Scar B and Scar F). Transplanting within the large cable trench scar sites would be targeted to avoid vegetated areas identified during the mapping process.

Due to the highly seasonal nature of distribution and biomass of *Zostera sp.* and *Halophila sp.*, inspections of seagrass cover would be carried out immediately prior to preparing the sites for rehabilitation. Rehabilitation sites that contained medium seagrass cover at the time of surveying would be reassessed for suitability immediately prior to transplanting (Scar C and Scar E). Direct planting of *Posidonia australis* shoots into the sediment at these sites would be used as the preferred strategy rather than the jute mat transplanting method. Rehabilitation sites that were identified from historical Nearmap aerial imagery (dating back to 2009) as being naturally unvegetated areas or areas that appear to have achieved little natural recovery since initial disturbance were also considered lowest priority for rehabilitation (Scars A, D, G and H).

5.3.3 Environmental influences on rehabilitation site suitability

Topography, depth and wave energy are three of the key environmental factors to consider when carrying out seagrass rehabilitation with *Posidonia australis*. The assessment of rehabilitation sites considered if there was obvious evidence of scouring or uneven areas that could lead to burial of rehabilitated seagrass and would be considered unsuitable for long term success of transplanted *Posidonia australis.* Topography was not considered a constraint for any of the potential rehabilitation sites.

Depth can be a limiting factor for successful transplanting of *Posidonia australis* (Glasby et al., 2015). Early studies of *Posidonia australis* in Botany Bay noted a depth limit for growth of three metres below mean low tide level (SPCC, 1978). The shallow growth limit was likely due to relatively high turbidity in the bay. More recent efforts to rehabilitate *Posidonia australis* at Kurnell and Port Stephens found depth had a negative influence on survival of transplanted shoots (Glasby et al., 2015; Ferretto et al., 2021). The depth gradient across the rehabilitation sites at Kurnell ranges from less than two to up to four metres furthest from shore but varies throughout the day due to tidal influences. The six rehabilitation sites identified as high or medium priority for transplanting are located in mid-depth to shallow waters at Kurnell. Transplanting of *Posidonia australis* to these sites would be targeted towards shallower sections.

Wave energy would be similar at all rehabilitation sites at Kurnell. The presence of seagrass habitat in the area surrounding the rehabilitation sites may increase survival of transplanted *Posidonia australis* by reducing water movement (Ferretto et al., 2021). Most of the rehabilitation sites are positioned within the extensive seagrass meadow at Kurnell and the surrounding seagrass habitat would provide a buffering function for the sites. Some sections of the two cable trench scars and Scar D are positioned on the edge of main seagrass meadow where there would be limited buffering effect from surrounding seagrass and greater sand movement, increasing the potential for smothering of transplanted shoots. These meadow-edge areas of the rehabilitation sites would be given lower priority for *Posidonia australis* transplanting than areas surrounded by seagrass.

Penrhyn Estuary is shallow, heavily tidal, prone to stormwater runoff and raw sewage overflows following rain events and sediment movement following storms, despite previous work to stabilise the sediment. These factors constrain the site's suitability for rehabilitation.

5.3.4 Social and other influences on rehabilitation site suitability

Kurnell is a popular location for recreational boaters, jet-ski users, fishers and other waterway users, particularly during the summer months. The potential impacts of waterway users on work processes and success of the *Posidonia australis* translocation, rehabilitation and monitoring would be a potential constraint equally relevant to all rehabilitation sites at Kurnell.

Water quality monitoring at Foreshore Beach within Penrhyn Estuary carried out under the NSW Department of Planning, Industry and Environment Beachwatch program (www.environment.nsw.gov.au/beachapp/botanybulletin.aspx) grades the suitability of Foreshore Beach as very poor, with water quality frequently unsuitable for swimming. Work health and safety for Scientific Divers potentially operating in polluted waters was identified as an important factor constraining the suitability of this site for *Posidonia australis* rehabilitation.

6. Conclusion

The Site Selection and Validation Report has confirmed and described the areas of the *Posidonia australis* likely to be directly impacted by construction of the project at Kurnell. It has identified and described three suitable reference sites at Kurnell that would act as control sites for the monitoring stage of the seagrass rehabilitation. Finally, the report assessed the suitability of the rehabilitation sites proposed by the MBOS and provided recommendations for priority of transplanting *Posidonia australis* at the rehabilitation sites.

This report's findings would be reviewed by the MBOS Implementation Reference Panel who would identify any necessary revisions to the MBOS based on the information and recommendations provided by the report.

The findings detailed in this report would be incorporated into implementation plans that would be prepared to describe the strategy for *Posidonia australis* translocation, transplanting of naturally detached *Posidonia australis* fragments and monitoring.

8. Terms and acronyms

Term /acronym	Description
BOM	Bureau of Meteorology
CoA	Condition of approval
DAWE	Department of Agriculture, Water and the Environment (former)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and the Environment
DPIE	Department of Planning, Industry and the Environment (former)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EIS	Environmental impact statement
FM Act	*Fisheries Management Act 1994* (NSW)
KFH	Key fish Habitat
MBOS	Marine Biodiversity Offset Strategy
MIRP	Marine Biodiversity Offset Strategy Implementation Reference Panel
NSW DPI Fisheries	NSW Department of Primary Industries Fisheries
SEARs	Secretary's environmental assessment requirements
SSI	State Significant Infrastructure
TEC	Threatened Ecological Community
Transport for NSW	Transport for New South Wales

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Appendix A

Survey site locations

Table A-1: Location details for *Posidonia australis* impact area patches, reference sites and rehabilitation sites for the confirmation survey (October-November 2022)

Site location	Site type	Site ID	Latitude (°S)	Longitude (°E)
Kurnell	Rehabilitation	Trench east	34.002988	151.21569
Kurnell	Rehabilitation	Trench west	34.003006	151.215567
Kurnell	Rehabilitation	Scar A	34.003108	151.214746
Kurnell	Rehabilitation	Scar B	34.00373	151.214583
Kurnell	Rehabilitation	Scar C	34.004288	151.214468
Kurnell	Rehabilitation	Scar D	34.004341	151.21361
Kurnell	Rehabilitation	Scar E	34.004739	151.213979
Kurnell	Rehabilitation	Scar F	34.004849	151.21448
Kurnell	Rehabilitation	Scar G	34.004925	151.215253
Kurnell	Rehabilitation	Scar H	34.005105	151.215123
Penrhyn Estuary	Rehabilitation	Penrhyn Estuary	33.957536	151.198036
Kurnell	Reference	PBK08	34.004118	151.215373
Kurnell	Reference	PBK04	34.003443	151.215073
Kurnell	Reference	PBK03	34.003308	151.215431
Kurnell	Impact area	PH1	34.002696	151.217079
Kurnell	Impact area	Pmix2	34.003291	151.217131
Kurnell	Impact area	Pmix3	34.003128	151.217402
Kurnell	Impact area	Pmix4	34.003096	151.217174
Kurnell	Impact area	Pmix5	34.003084	151.217053
Kurnell	Impact area	Pmix7	34.002907	151.216889
Kurnell	Impact area	Posi1	34.003157	151.217076
Kurnell	Impact area	Posi2	34.002793	151.216870
Kurnell	Impact area	PZ1	34.00338	151.2173
Kurnell	Impact area	PZ2	34.003336	151.217195
Kurnell	Impact area	PZ5	34.003036	151.217306

Appendix B

Posidonia australis survey and mapping results

Table B-1: Survey and mapping results for *Posidonia australis* reference sites and impact area patches from the confirmation survey (October-November 2022)

Site type	Site ID	Depth (m)	Area (m^2)	Mean			Species composition		
				Shoot density ($0.25m^2$)	Leaf length (cm)	Epiphyte load (1 5 scale)	Halophila	Zostera	Macroalgae
Reference	PBK08	2.3	-	20.00	30.08	3.22	Y	Y	N
Reference	PBK04	3	-	17.45	29.45	3.52	Y	Y	N
Reference	PBK03	3.1	-	14.00	37.62	3.56	Y	Y	N
Impact area	PH1	4.2	33	11.60	31.03	2.97	Y	Y	N
Impact area	Pmix2	2.6	10	8.75	24.58	2.25	Y	Y	N
Impact area	Pmix3	2.5	31	13.00	28.00	2.09	Y	Y	N
Impact area	Pmix4	2.8	10	4.80	28.57	2.67	Y	Y	N
Impact area	Pmix5	3.1	14	6.90	25.00	3.00	Y	Y	Y
Impact area	Pmix7	4.0	52	8.90	32.90	2.67	Y	Y	N
Impact area	Posi1	2.9	3	5.67	24.26	2.37	Y	Y	N
Impact area	Posi2	2.8	1.5	-	-	-	N	N	N
Impact area	PZ1	2.7	21	21.50	35.07	2.20	Y	Y	Y
Impact area	PZ2	3.2	2	12.00	24.56	1.89	N	Y	N
Impact area	PZ5	3.4	7	13.17	30.89	2.72	Y	Y	Y

Appendix C

Site photographs

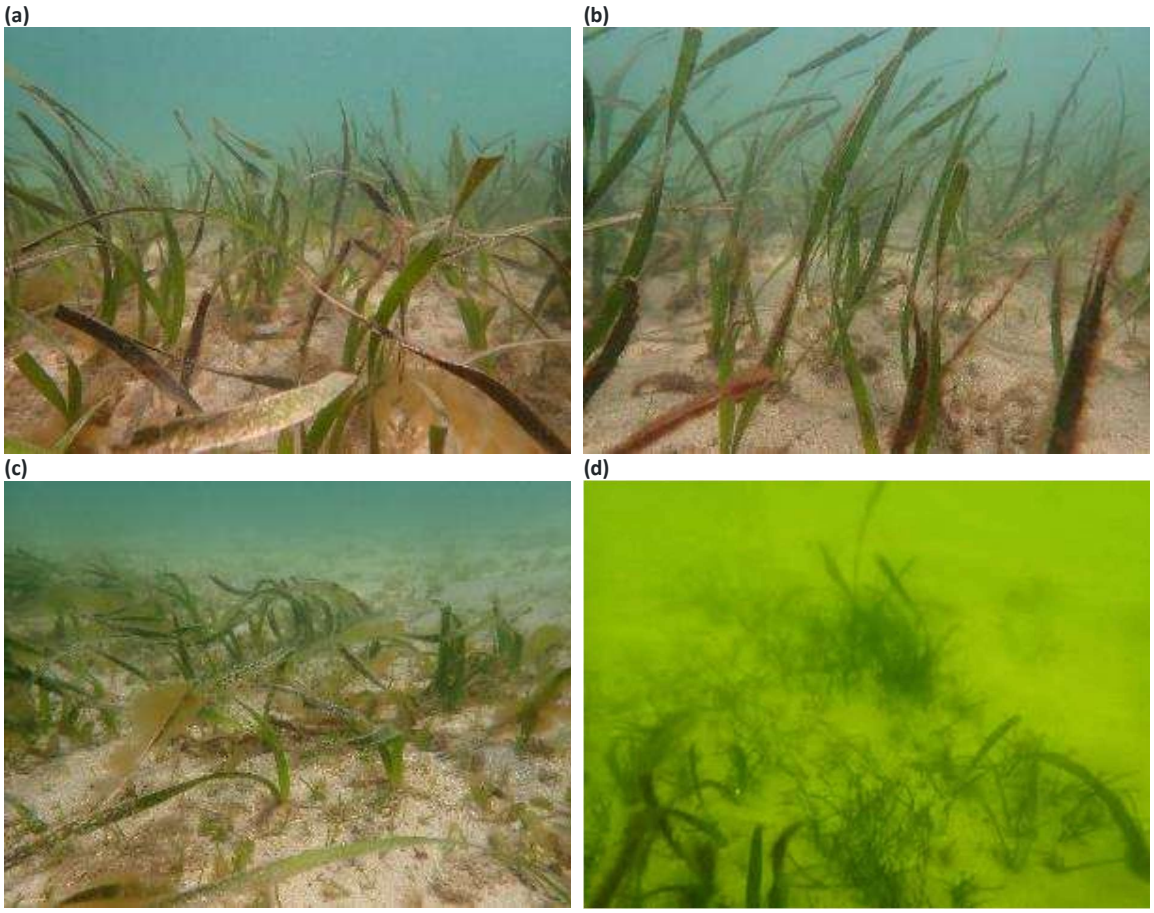

Figure C-1: Photographs captured by Scientific Divers during the confirmation survey (October-November 2022) showing *Posidonia australis* patches located within the impact area at Kurnell: (a) patch PZ1, (b) patch PH1, (c) patch PZ2 and (d) patch Pmix 3.

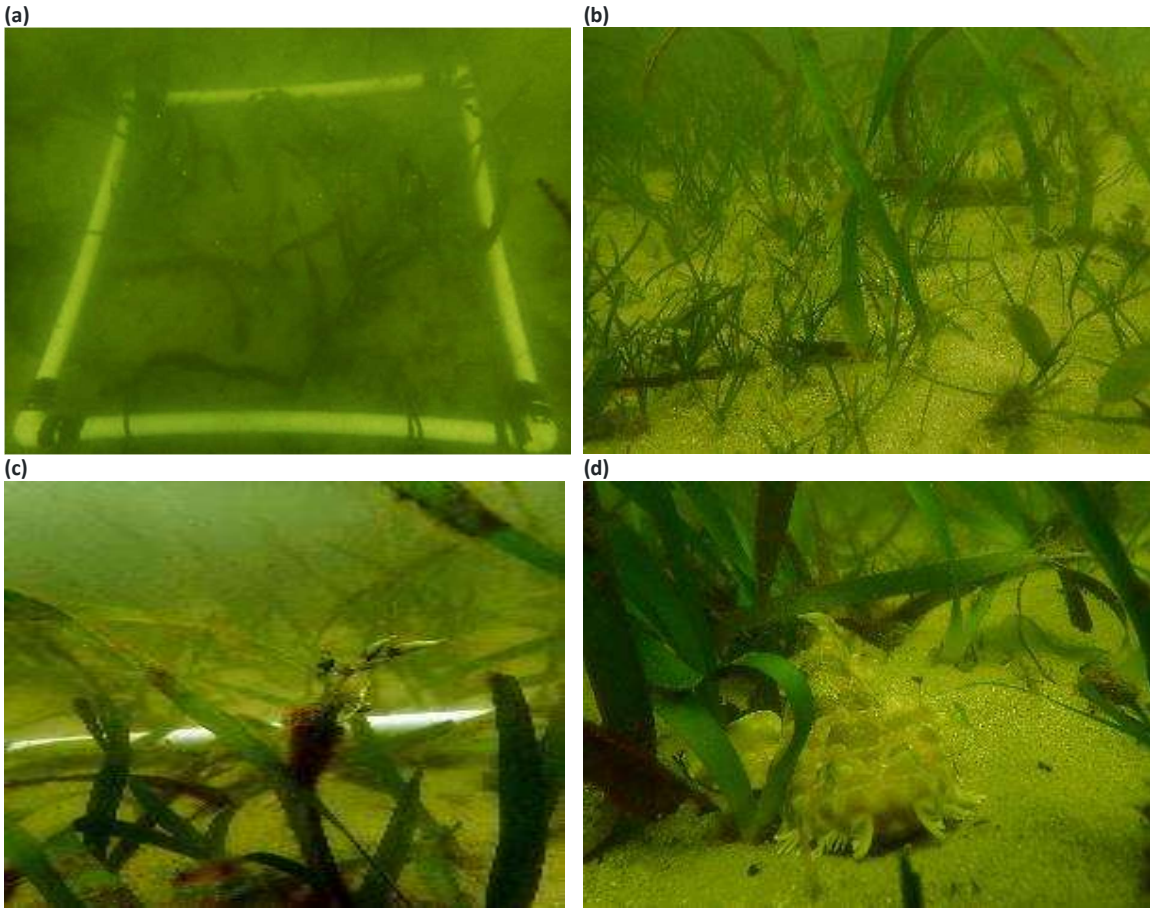

Figure C-2: Photographs captured by Scientific Divers during the confirmation survey (October-November 2022) of the *Posidonia australis* reference sites at Kurnell: (a) Quadrat with *Posidonia australis* at site PBK08, (b) Mix of *Posidonia australis, Zostera sp*. and *Halophila sp*. at site PBK08, (c) Flowering *Posidonia australis* shoot at site PBK04, (d) Juvenile Wobbegong shark refuging in *Posidonia australis* at site PBK03.

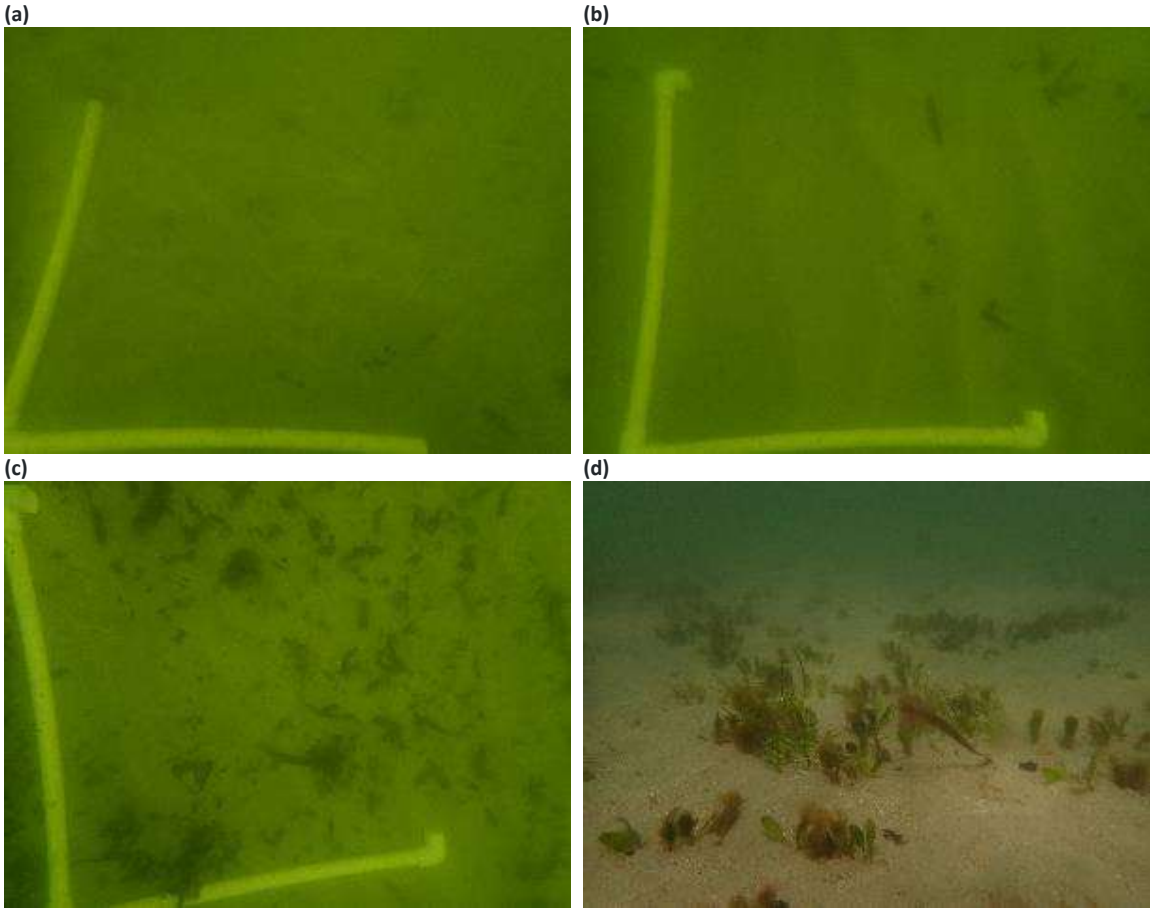

Figure C-3: Photographs captured by Scientific Divers during the confirmation survey (October-November 2022) showing examples of rehabilitation sites at Kurnell: (a) Bare sediment within Trench west, (b) Bare sediment within Scar B, (c) A mix of *Posidonia australis, Zostera sp.* and *Halophila sp.* distribution in Scar C making it medium priority for rehabilitation, (d) *Halophila sp.* growing within site Scar E making it medium priority for rehabilitation.

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