Noosa Oyster Ecosystem Restoration Project

Project Restoration Plan

In support of application for development approval from government authorities for oyster ecosystem restoration works in the Noosa River estuary

January 2022

Contents

SECTION 1 – CONTEXT

1.1 Purpose

The purpose of the restoration work is to restore rock oyster ecosystems to the Noosa River estuary and therewith the ecology services and benefits to fish habitats and fisheries resources they provided.

1.2 Objective

Restoration of oyster beds in the Noosa River estuary at locations that historic records, assessments of shell middens and sediments and assessment of a high potential for restoration success indicate.

1.3 Rationale

Rock oysters (*Saccostrea spp.*) are natural and historic residents of the Noosa River. Rock oysters colonise natural hard substrates (e.g. gravel, rock, tree roots) and create three dimensional, rugose, and heterogeneous structures, which are subsequently colonised by successive generations of oysters as well as an array of aquatic flora and fauna.

Rock oyster ecosystems are important ecological system and high value fish habitats that have been lost from the Noosa River estuary and which this project aims to restore.

Historic occurrence

The estuarine environment of the Noosa River was once dominated with extensive rock oyster ecosystems. Oyster ecosystems were largely lost however, in the late 1800s to early 1900s. At the peak of the wild oyster harvest industry (1906-1907), it is estimated that 2-3 million oysters were harvested in the lower estuary each year[1].

The commercial oyster industry in the Noosa River commenced in the 1870's or 1880s, and ceased, having become economically unviable, by the 1940's. Oyster lease areas were dredged intensively for oysters in the early 1900's, resulting in the removal of live oyster beds and the underlying bedrock.

From 1934, oystering locations were recorded by local fisheries officials, and defined by the extent of the oyster lease areas allocated by the government for commercial exploitation[3]. These leases (presented in Figure 1.1) indicate the most probable historical range of extensive oyster beds (intertidal and sub-tidal) within the Noosa River estuary.

[1] Thurston R. 2015. Historical ecology of the Noosa Estuary fisheries. Report to: Noosa Council, The Nature Conservancy and The Thomas Foundation (available on request from TNC).

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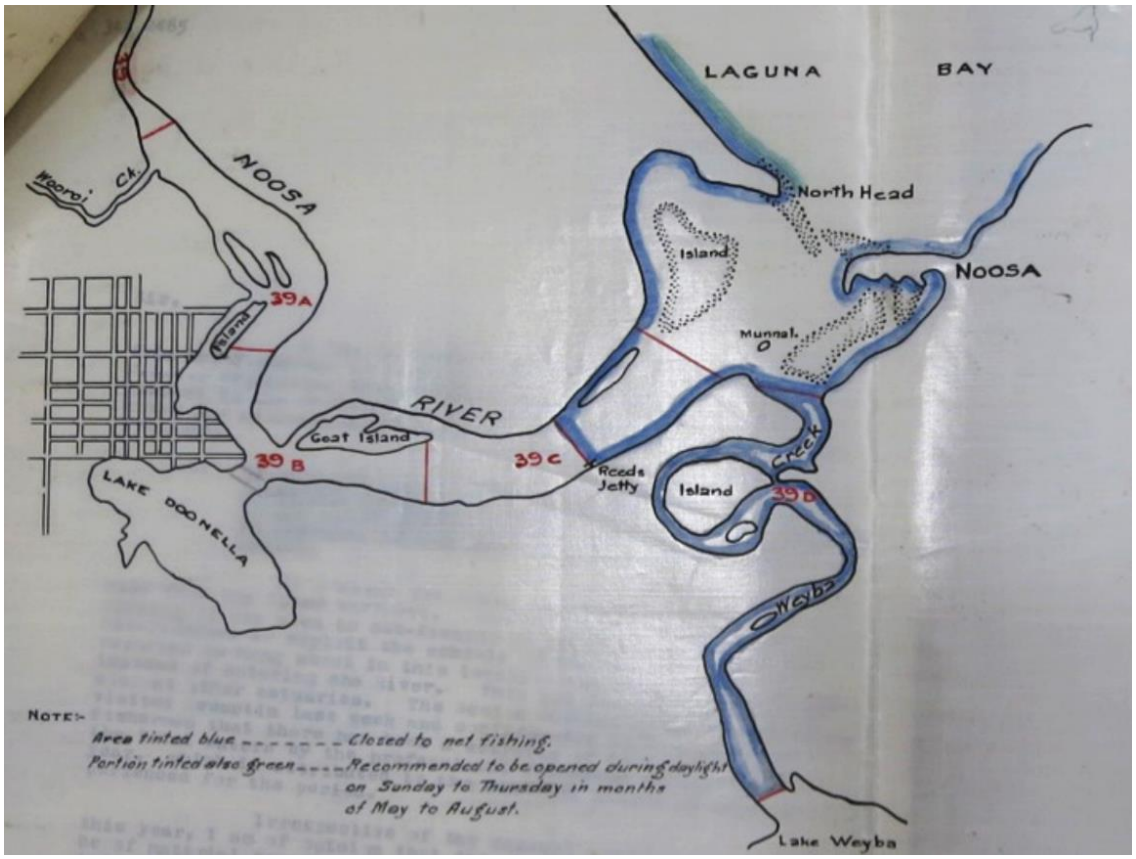


Figure 1.1: Historic commercial oyster leases in the Noosa River Estuary. Hand-drawn chart from 1934, made by the Fisheries Inspector to highlight the areas in the Noosa River closed to net fishing. The red numbers indicate the locations of all known Noosa oyster sections. Source: Queensland State Archives.

Historic records also show extensive shell middens present at Tewantin, Noosaville and Hays Island (now Noosa Sound), and that substantial oyster beds occurred in Lake Weyba[1]. Noosa residents once collected oysters from rock outcrops in Lake Weyba (Figure 1.2), and the extent of oysters in the lake is thought to have been extensive[1], possibly growing on low gravel beds and other hard structures that today are buried under sediment (Simon Walker, ESP, pers com).

Figure 1.2: Lake Weyba Oyster Collecting circa 1914. Source: Sunshinecoast.spydus.com

Of note is the that due to the conversion of Hays Island into the Noosa Sound canal estate in the 1960s, evidence of oyster beds from this area has been lost. Oysters persist though on rocks, gravel and pylons along the southern fringes of Noosa Sound, indicating that oyster spat still settle and grow in the area. The potential for restoration of oysters in the Noosa Sound therefore remains possible (TNC shellfish ecologist, Boze Hancock, pers com).

In 2016, Ecological Service Professionals (ESP) quantified the historic spatial extent of oyster beds in the Noosa River and concluded that it was likely to have been in the range of 41,530m^2 to 207,650 m^2, of which approximately 16,850m2 of old oyster beds and oyster rubble remain buried by sediment in the historical oyster lease areas[2].

The loss of oyster biomass likely resulted in the ecosystem collapsing, with shellfish ecosystems now replaced primarily by soft (sandy and muddy) sediments. Changes to the estuary's physical-chemical condition, canal development and shoreline armouring have also likely contributed to the decline of the ecosystem or inhibited its natural recovery.

Today, no extant rock oyster ecosystems exist in the Noosa River estuary, despite the presence of individual and small populations of rock oysters. The closest known intact oyster-dominated shellfish ecosystem is found near North Stradbroke Island in Morton Bay. Notably, a recent study[3] identified that rock oyster dominated shellfish ecosystems are the most threatened marine ecosystem in Australia, with up to 94 percent of the ecosystem lost throughout Australia since European settlement.

[2] Walker, S. 2016. Assessment of Oyster Habitat in Noosa River Estuary. Report to Noosa Shire Council by Ecological Service Professionals (ESP). October 2016.

[3] Gillies et al. 2018. Australian Shellfish Ecosystems: past distribution, current status and future management. PLoS ONE 13(2):e0190914. https://doi.org/10.1371/journal.pone.0190914

The works proposed in this submission are intended to restore 3,600m2 of oyster beds in phase 1 of the project. That equates to between 1.7 and 9 percent of the original area expected to have been covered by oyster beds in the Noosa River estuary.

Restoration Benefits

The benefits of restoring rock oyster ecosystems to the Noosa River estuary are extensive. Oysters are ecosystem engineer species capable of improving ecosystem function and providing habitat for other organisms[4]. Oyster ecosystems added extensive 'natural infrastructure' to the estuary and provided the estuary with a range of environmental benefits.

These benefits include:

- Providing complex habitats for marine species (the diverse habitats typically consist of fish, invertebrates, corals, ascidians, lace corals, encrusting sponges and algae).
- Filtering water and removing suspended sediment and pollution.
- Processing nutrients; providing bank stabilization and protection.
- Providing complex vertical and horizontal living spaces, and feeding grounds, for a multitude of intertidal and marine creatures.
- Enhancing marine and coastal lifestyle and tourism activities such as fishing, diving and bird watching.

The recognition of the significant contribution of oyster ecosystems led to their recognition as an important wetland habitat type in the Convention on Wetlands of International Importance (The Ramsar Convention – habitat type 'Ga')[5].

1.4 Restoration approach

The restoration approach follows the eight principles for ecological restoration established by the international Society of Ecological Restoration (SER)[6], which have been newly interpreted for shellfish restoration[7]. The project approach is also guided by best-practice ecological restoration and shellfish restoration monitoring guidelines, including the Open Standards for the Practice of Conservation[8], the

[4] Jonathan H. Grabowski, Robert D. Brumbaugh, Robert F. Conrad, Andrew G. Keeler, James J. Opaluch, Charles H. Peterson, Michael F. Piehler, Sean P. Powers, Ashley R. Smyth, Economic Valuation of Ecosystem Services Provided by Oyster Reefs, *BioScience*, Volume 62, Issue 10, October 2012, Pages 900–909, https://doi.org/10.1525/bio.2012.62.10.10

[5] Kasoar, T., zu Ermgassen, P.S.E., Carranza, A., Hancock, B., Spalding, M., 2015. New opportunities for conservation of a threatened biogenic habitat: a worldwide assessment of knowledge on bivalve-reef representation in marine and coastal Ramsar Sites. Mar. Freshw. Res. 66, 981e988.

[6] Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, Hua F, Echeverría C, Gonzales E, Shaw N, Decleer K, Dixon KW (2019) International principles and standards for the practice of ecological restoration. Second edition. Restoration Ecology 27(S1): S1–S46

[7] Fitzsimons, J., Branigan, S., Brumbaugh, R.D., McDonald, T. and zu Ermgassen, P.S.E. (eds) (2019). Restoration Guidelines for Shellfish Reefs. The Nature Conservancy, Arlington VA, USA.

[8] Conservation Measures Partnership (2013) Open Standards for the Practice of Conservation Version 3.0, accessed online via http://cmp-openstandards.org/wp-content/uploads/2014/03/CMP-OS-V3-0-Final.pdf

Society for Ecological Restoration International Standards[6] and TNC's Oyster Habitat Restoration Monitoring and Assessment Handbook[9].

The definition of ecological restoration applied is the *process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed*. The process involves moving a destroyed or degraded ecosystem along a measurable trajectory of recovery that is persistent in the future and reflective of a natural evolutionary path.

Importantly, ecological restoration, as applied in this project, differs from artificial reefs, in that their purpose is to restore oyster ecosystems in areas where they once existed, or are currently degraded, rather than introducing artificial substrates (e.g. concrete reef balls).

This project responds to the loss of natural hard substrates in the Noosa River by re-introducing locally sourced rock in configurations that rock oysters and associated species (e.g. pearl oysters, leaf oysters, hairy mussels, tunicates and macroalgae) readily colonise. The design and placement of the rock substrate considers historic location of oyster beds plus physical features, such as aspect, height, dimensions and rugosity in a way that can help mitigate physical and biological threats to the recovering ecosystem such as smothering, heat, erosion, predation and human disturbance.

To some of the rock substrate, the project adds relatively small volumes of desiccated (cured) oyster shell to create a composite base of rock and shell. The combination of rock and shell mimics the shell 'hash' that would otherwise be formed by generations of oysters recruiting onto themselves, but which has since been lost from the estuary.

Rock substrates are also hand-seeded with oyster shell (cultch) seeded with oyster spat, and/or live oysters. Seeding of the substrate with live oysters ensures the target density of oysters is achieved, effectively 'kick starting' and accelerating the restoration process. Augmentation also acts as an insurance policy against low natural oyster recruitment onto the restoration substrate. Brood stock for oyster seeding is collected from the Noosa River. The seeding process is undertaken in a bio-secure facility in close liaison with government biosecurity officers.

Restoration targets for oysters are presented in Section 8.3 *Environmental Safeguards*. Table 8.3.

1.5 Timeline

Phase I Pilot Phase – 2021-2023

Phase I works involve deploying oyster bed restoration substrates, i.e. rock (augmented with small volumes of oyster shell and seeded oyster 'cultch'), in the following restoration sites:

1. Tewantin
2. Goat Island
3. Noosa Sound East
4. Noosa Sound West

[9] Baggett LP, Powers SP, Brumbaugh R, Coen LD, DeAngelis B, Greene J, Hancock B and Morlock S (2014). Oyster habitat restoration monitoring and assessment handbook. The Nature Conservancy, Arlington, VA, USA. 96 pp.

Construction works (deployment of the restoration substrates) is planned between October and April (2021-2023), subject to permitting. This timeframe takes advantage of natural oyster spawning and recruitment in the Noosa River during this period.

Phase I restoration sites are presented in the plans, and have already been subject to:

a. Detailed bathymetric mapping
b. Detailed habitat mapping
c. River user analysis
d. Habitat suitability modelling
e. Restoration suitability modelling
f. Community consultation
g. Detailed site engineering

Phase II –2022 to 2024

Phase II works will take place the following spring through autumn period (2022-2023), and if resources allow the following spring through autumn (2023-2024). Specific sites for this work have yet to be identified, and authorities will be approached separately to approve plans for Phase II works, possibly as an addendum of some form to this restoration plan approval.

In Phase II, works will entail:

- Augmenting restoration sites 1-4 from Phase I with additional restoration substrate, as required; and,
- Identifying new restoration sites in Restoration Zones 1 to 5 and deploying restoration substrates into those sites in accordance with the restoration processes outlined in this submission.

For phase II works, the process includes:

I. Identifying additional restoration sites using the restoration suitability model and stakeholder discussions
II. Checking, and, if necessary, remapping habitats at the new proposed sites
III. Consulting publicly on the additional proposed restoration sites
IV. Undertaking detailed bathymetric mapping
V. Applying existing engineering and design criteria and mapping restoration substrates onto the sites
VI. Submitting updated restoration plans to agencies
VII. Undertaking construction works
VIII. Applying site demarcation and management measures to the new sites
IX. Submitting 'as built' maps of new substrates to authorities

1.6 Governance

The Noosa Oyster Ecosystem Restoration Project is a partnership between The Nature Conservancy (TNC) and Noosa Shire Council (NSC) formed to deliver oyster ecosystem restoration in the Noosa River.

The Project is framed by a formal partnership agreement between TNC and NSC. This partnership is specified in the Alliance and Funding Agreement, which came into effect on 25th July 2019. The agreement is effective for three years and two months and the project is scheduled to be completed

by 30th September 2022. The terms of the partnership will be reviewed prior to July 2022. Funds for this project are provided by Noosa Shire Council (NSC), TNC, The Thomas Foundation (TTF) and Australian Marine Conservation Society (AMCS).

In September 2020, Noosa Shire Council formally endorsed the *Project Management Plan* for this project. The plan presents the project measures, general construction methodologies, risk assessment and broad monitoring, evaluation and reporting plan. This Project Restoration Plan operationalises the project management plan.

The project is led by TNC.

The Project is overseen by an executive level forum comprising two key Contact Officers, those being the Lead Scientist (TNC) and Director of Environment & Sustainable Development (NSC). The governance of the activities for the project are the responsibility of the Executives of TNC and NSC, or their nominated delegate/s and day-to-day operations the responsibility of TNC and its appointed Project Manager for that purpose.

The TNC-contracted Project Manager is supported by the Noosa Technical Advisory Group (TAG). The TAG's purpose is to:

- Support detailed project planning for the Noosa Oyster Reef Restoration Project that will see reefs re-established in the Noosa River estuary by June 2022.
- Provide ongoing expert advice on the implementation of the Project Plan, and support in overcoming legislative, scientific and practical barriers that occur during the term of the project.
- Ensure that the Project meets all technical, statutory and policy requirements in a timely manner to the satisfaction of relevant decision-making authorities.
- Ensure actions within the Project Plan are effectively delivered and communicated to all stakeholders.

The composition of the Noosa TAG is:

- Department of Agriculture & Fisheries (3) – aquaculture, marine plants and biosecurity experts
- Maritime Safety Queensland (1) – Regional Manager
- Kabi Kabi Traditional Owner (1) – For technical expertise
- Independent aquatic ecologist/biologist (1) – With in depth ecological knowledge of the Noosa River estuary (from Ecological Service Professionals Pty Ltd).
- Noosa Shire Council (1) – Environmental Services Manager
- The Nature Conservancy (3) – Oceans Operations Manager + Oceans Restoration Scientist + QLD Oceans Coordinator (Chair)

The Noosa TAG held its inaugural meeting on the 15th May 2020. TAG meetings are held on a semi-regular basis, as required to drive the project forward. Specialised work is often undertaken out of session including providing advice to TNC QLD Oceans Coordinator on all aspects project implementation.

1.7 Past actions

In recent years, TNC, NSC, TTF and a range of local stakeholders have worked together to build a deeper understanding of the environmental significance and long-term sustainable management options for the Noosa River. The key actions that lead to the formation of the Noosa Oyster Ecosystem Restoration Project are summarised below.

Noosa River Expert Workshop, Powerhouse Museum, 2014

A two-day workshop, hosted by TNC on behalf of TTF and Noosa Parks Association (NPA), comprising 12 academic and NGO estuary scientists. The workshop identified 14 conservation activities that could lead to a healthier Noosa River, with oyster reef restoration listed as a priority action in addition to prawn restocking and sediment management in Kin Kin in the upper Noosa River catchment. These activities (including further scoping studies) were later jointly funded by NSC, Noosa Parks Association, The Thomas Foundation and the Noosa Biosphere Reserve Foundation.

TNC Oyster Restoration Scoping Study, 2015

TNC and Ecological Service Professionals Pty on behalf of NSC and others undertook a short, five-month ecological assessment to quantify oyster densities across 11 intertidal and subtidal sites within the estuary. The study confirmed high densities of oyster recruitment particularly around Weyba Creek, the main channel around Tewantin, and in the narrow channel between Goat Island and Noosa North Shore. The project recommended installing a number of pilot reefs for further assessment.

University of Queensland Historical Ecology of the Noosa Estuary fisheries, 2015

Ruth Thurston from the University of Queensland undertook a historical ecology study on behalf of TNC and NSC in the Noosa River estuary to develop an understanding of historical fisheries productivity, including oysters. The study confirmed oyster reefs used to exist in the estuary and were commercial harvested in the early 1900s. Fish populations were also significantly larger in the past than they are today.

University of Sunshine Coast, Bring Back the Fish, 2018-2020

A three-year study which installed a series of experimental 'oyster habitat restoration units' consisting of coir bags filled with oyster shell at 14 sites across the estuary. The project studied the structural integrity of the units, oyster recruitment, fish and invertebrate community assemblages and human interactions with the trail reefs.

NSC-TNC Partnership Agreement 2019

NSC and TNC, in addition to other organizations with an interest in the River's sustainability (including Noosa Parks Association, The Thomas Foundation and Noosa Biosphere Reserve Foundation), through a series of dialogue and presentations to Noosa Shire Council, have recognized that the strategic priorities of both organisations, and of others, would be more effectively served through a formal partnership, rather than on an individual project basis. This led to the development of *this* Project, and associated formal agreement between NSC and TNC, and is the main delivery mechanism of the TNC-NSC Partnership.

TNC Project Management Plan 2020

The TNC Project Management Plan was formally adopted by the project's Technical Advisory Group (TAG) and Noosa Shire Council in September 2020. The Plan, available on request, broadly scopes the restoration project and includes:

a. Risk Assessment
b. Communications Plan
c. Monitoring, Evaluation and Reporting (MER) Plan

1.8 Definitions

Restoration zone

- An area of the estuary, with distinguishable physical and ecological characteristics in which specific restoration sites are selected.

Restoration site

- A specific area of riverbed where restoration works are undertaken.
- A restoration site is larger than the restoration footprint to allow for the expansion of the restoration footprint in the future.

Restoration footprint

- The area of the rock and/or rock + shell composite substrate in direct contact with the riverbed within a restoration site.
- The footprint comprises a series of oyster reef patches, which are the on-site placement of modular designs.
- The footprint area is the sum of the area of oyster reef patches on a given restoration site, or across restoration sites.
- The footprint area of a restoration site is less than the area of the restoration site in which they site.

Oyster reef patch

- An area rock or rock + shell placed on a restoration site as the foundation for oyster ecosystem restoration, and which is readily discernible from all other oyster reef patches.
- Oyster reef patches are placed in association with each other, to maximise ecological interaction (as a reef complex) and are placed on site to best match the profile and ecological character of a restoration site.
- Oyster reef patches are separated to maximise water flow between and around each patch, to reduce sedimentation potential, reduce erosion potential (of the patch itself – undercutting, and shoreline – by refraction waves), and to not impede fish passage.
- The number of oyster reef patches on a restoration site in a series may vary reflect the site characteristics.
- The number of rows of oyster reef patches may vary to reflect the site characteristics, particularly bathymetry.
- If more than one row of oyster reef patches is placed on a site, the rows of oyster reef patches are offset.

- The distance between oyster reef patches is specified in the engineered drawings for each restoration site. The relief and profile of each patch is specified in the engineered drawings for each restoration site.

Restoration modules

- Engineering concepts to show how oyster reef patches may be placed in association with each other on a restoration site, while meeting specific engineering requirements.

1.9 Summary of restoration targets

An oyster ecosystem restoration site should over time demonstrate an increase in abundance and density of rock oysters and increased diversity of epifauna comparative to the surround sediments. Specifically, within 6-8years of oyster reef patches being deployed, a restoration site should demonstrate:

- Density of rock oysters at restoration site average of > 200 individuals/m^2
- 4+ age classes of rock oysters present at restoration site (= approx. 2 cohorts of oysters reproductive)
    - 5% of rock oyster population at the site is 3+ years old
- Increased density of oyster recruits with 3-4 reproductive cycles
- 5 times more epifauna on oyster habitat than on surrounding sediment[10]

1.10 Qualifications

All information in this submission, and attached code assessments, relating to the design, footprint minimisation, specification, construction, movement, sinkage, stability, erosion minimisation, risks and management and substrate rectifications relating to the restoration substrates (of rock, or rock and shell), are made with the approval of the project's consultant engineers, International Coastal Management (ICM).

All information in this submission, and attached code assessments, relating to oyster ecosystem restoration, fish habitats and marine plants in the Noosa River, have been reviewed by TNC ecologists as well as TNC's independent consultant ecologists, Ecological Service Professionals (ESP).

In 2020, TNC also contracted ESP to map the extend of seagrass and other marine habitats throughout the Noosa River estuary. The results of that work are incorporated into on the restoration drawings and advised the placement of the restoration substrates (the footprint) in each restoration site so as to avoid impact on marine plants, or to cause only temporary impact on marine plants, as is the case at the Tewantin restoration site.

[10] McAfee *et al* 2020. The value and opportunity of restoring Australia's lost rock oyster reefs. Restoration Ecology Volume 28, Issue 2 March 2020. https://doi.org/10.1111/rec.13125

1.11 Guarantees

Bathymetric information

All matters described in this plan, and in the associated government code assessments, related bathymetric/hydrographic information, which was undertaken to MSQ specifications (with MSQ input to the contracting process) have been provided by the project consultants:

NorthGroup Consulting engineers

Contact: Copley@northgroup.com.au

Ecological information

All matters described in this plan, and in the associated government code assessments, related ecological information, have been provided or reviewed by the TNCs professional ecologists and by the project consultants, and specialists in the ecology of the Noosa River estuary:

Ecological Service Professionals Pty Ltd

Contact: swalker@ecosp.com.au

Engineering information

All matters described in this plan, and in the associated government code assessments, and drawings, related to engineering design, engineering specifications or descriptions relating to engineering performance of the restoration substrates (e.g. reef patch positioning, stability, erosion potential) have been provided or reviewed by the project consultant engineers and are certified by them for engineering integrity within the scope of their remit:

International Coastal Management (ICM) – Specialist Coastal Engineers

Contact: icm@coastalmanagement.com.au

SECTION 2 – RESTORATION MODELS

Habitat and restoration suitability modelling are analytical techniques used to select broad restoration zones and local restoration sites that are suitable for oyster ecosystem restoration within an estuary. It is within the restoration sites that restoration substrates (in this case principally rock riprap) is placed to form the foundation of new oyster beds.

2.1 Habitat suitability

Where shellfish ecosystem restoration is conducted often determines how successful an effort is. In Noosa, TNC used standardized habitat suitability indices and geospatial decision support tools to confirm the suitability of the Noosa River estuary for oyster ecosystem restoration.

Known environmental and biological criteria of the dominant rock oyster species, Sydney Rock Oyster (*Saccostrea glomerata*), were compared with the physical parameters of the estuary (i.e. bathymetry, salinity, temperature, dissolved oxygen,). Areas of the estuary which are suitable for rock oyster restoration were then rated for their suitability (Table 2.1) and presented, geospatially, in the Habitat Suitability Model (Figure 2.1).

While the Habitat Suitability Model indicates that large areas of Lake Doonella and Lake Weyba would be suitable for rock oyster restoration, practically, this would not be the case (as per the Restoration Suitability Model presented further on in this submission). Further challenges in the lakes include high sediment loads, high retention of suspended sediments after storms and low flow regimes. These possible limitations would need to be tested as part of Phase II restoration works.

Table 2.1: Habitat suitability parameters and criteria for Sydney rock oysters

PARAMETER	ENVELOPE	CRITERIA (more suitable = 4, less = 0)	Rationale	Source
Bathymetry	0-9 m	0-9m = 4 >9m = 0	Within ecological tolerances. Below LAT weighted higher as subtidal restored oyster ecosystems have been seen to perform better than intertidal ecosystems.	(Powers et al. 2009, Gillies et al. 2018)
Salinity Av	25-35ppt	35-30=4; 30-25=3; <25=0	Within ecological tolerances. Lower salinities scored lower as linked to outbreaks of the protozoan parasite QX (*Marteilia 16ydney*).	(Nell and Gibbs 1986, Nell and Holliday 1988, Holliday 1995, Dove 2003, Butt et al. 2006, Dove and O'Connor 2007, Diggles 2013, Schrobback et al. 2014)
Temperature Max	8-29C	8-24C= 4; 24-28 = 2; >28=0	Within ecological tolerances. Temperatures above 28 °C scored lower as linked to outbreaks of the protozoan parasite QX (Marteilia sydneyi).	(Holliday 1995, Butt et al. 2006, Diggles 2013, Schrobback et al. 2014, Snyder et al. 2017)
DO Av	>4mg/L	>4mg/L = 4; <4mg/L= 0	Within ecological tolerances.	(Schrobback et al. 2014)

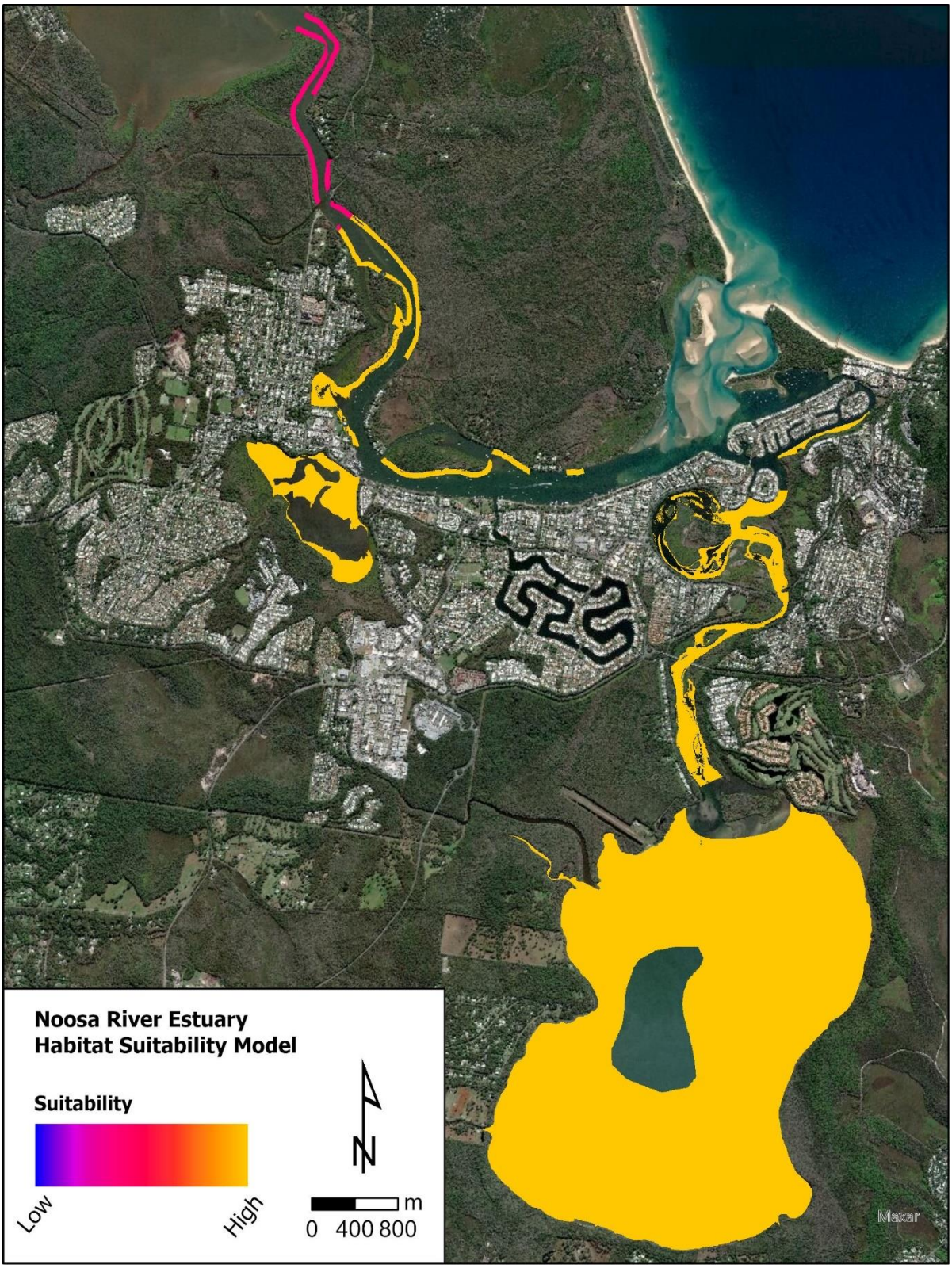


Figure 2.1: Habitat Suitability Model for Sydney rock oysters in the Noosa River estuary

2.3 Restoration suitability

TNC overlayed the Habitat Suitability Model with ecological considerations, logistical constraints, and details of the built infrastructure and human uses of the Noosa River. These parameters were then allocated exclusion criteria, to minimise potential interactions of the river users with restoration sites (e.g. distances from tidal works, foreshore access points, moorings, submarine cables) (Table 2.2). The results of this analysis are presented, geospatially, in the *restoration suitability model* (Figure 2.2). The exclusion criteria where determined in consideration of regulated distances applied to vessels (e.g. distances from moorings) and on practical consideration of river uses (e.g. access to foreshores from the river, distances from navigation channels). This assessment was undertaken in consultation with Maritime Safety Queensland (MSQ) and NSC and reviewed by the Noosa TAG.

Table 2.2: Restoration suitability parameters and exclusion criteria for rock oyster ecosystems in the Noosa River estuary

PARAMETER	ENVELOPE	CRITERIA (more suitable = 4, less = 0)	RATIONALE	SOURCE
Marine plants proximity (including seagrasses)	10m – 500m	Areas within 10-500m buffer =4; all other areas =2	Connectivity to other structured habitats such as seagrass, mangroves, increases diversity. 10m minimum distance used to mitigate damage to marine plants and 2m from mangroves, aerial mangrove roots and fallen timber, but ensuring connectivity.	(Duncan et al. 2019) Confirmed with engineers
Rocky reef proximity	2m – 500m	Areas within 5-500m buffer =4; all other areas =2	Connectivity to other structured habitats increases diversity. 2 metre minimum distance included to mitigate damage to rock substrates while maintaining connectivity. Direct augmentation of degraded rocky reef by permit only.	
Extant oyster ecosystems proximity	2m – 250m	Within 2m – 250m = 4; all other areas = 2	Connectivity to other structured habitats increases biodiversity. Connection to other oyster reefs increases meta-population connectivity, successful reproduction and oyster recruitment. 2 metre minimum distance included to mitigate damage to extant oyster ecosystems but ensuring connectivity.	(Boor et al. 2018, Guy et al. 2018, Duncan et al. 2019)
Historical oyster ecosystem proximity	Within 250 m	Within 250m = 4; all other areas = 2	Sites which have historically supported oyster ecosystems are thought to be able to support future oyster ecosystems. Restoration takes place on the sites of historic oyster ecosystems, which may now be lost, where known and practical.	(Gillies 2018)
Mobile seabed	Exclusion area	Within exclusion area = 0, all other areas = 4	Highly mobile seabeds generally offer unsuitable substrates for shellfish restoration.	Agreed with TNC restoration scientists
Mangroves (including pneumatophores), fallen trees and timber in waterways.	+ 2 m minimum distance	Within exclusion area = 0, all other areas = 4	Minimum distance of 2m maintained between intertidal marine plants and oyster ecosystems to protect plants, as well as fallen trees (which are also important habitats) from works associated with the oyster ecosystem. Relatively close proximity maintained to maximise ecological connectivity.	(Boor et al. 2018, Guy et al. 2018, Duncan et al. 2019). Discussed with engineers

Small craft channels	+ 10 m width channel maintained	Areas within buffer = 0; all other areas = 4	Minimum channel width of 10m in constrained river channels maintained to oyster ecosystems do not impede on safe navigation.	Discussed with MSQ
Tidal Works (pontoons, jetties, boat ramps)	+ 30 m distance maintained	Within 250m = 4; all other areas = 2	Minimum distance of 30m maintained between tidal works and oyster ecosystems. Reduce the chance of damage to the oyster ecosystems, but also protects vessels and ensures general public safety when using these facilities.	Discussed with MSQ
Moorings	+ 30 m distance maintained	Within 30 m = 0, all other areas = 4	Minimum distance of 30m maintained between official moorings and oyster ecosystems to reduce chances of damage to moored vessels oyster ecosystems. The distance also takes into consideration the maximum possible length of a vessel attached to a mooring in the river.	Discussed with MSQ
Foreshore Access (beaches and parks)	+ 10 m distance maintained	Within exclusion area = 0, all other areas = 4	Minimum distance of 10m either side of public foreshore access points maintained for ease of vessel access to useable shorelines.	Discussed with MSQ
In-water urban utilities (submarine cables & pipelines)	+ 5 m distance maintained	Within exclusion area = 0, all other areas = 4	Minimum distance of 5m maintained between submarine cables and pipelines and oyster ecosystems. No anchoring of construction vessels or monitoring vessels within 200m of in-water urban utilities.	Discussed with engineers
In-water transport utilities (cross-river cable barges, ferry terminals, etc.)	+ 30 m distance maintained	Within exclusion area = 0, all other areas = 4	Minimum distance of 30m maintained between in-water transport utilities and oyster ecosystems to maintain safe operation of public transport services in the river.	Discussed with MSQ
Seaward extent	< 30 m* from shorelines	Within exclusion area = 0, all other areas = 4	Sites for oyster ecosystem restoration extend from the intertidal zone to a maximum distance of 30m from the associated shoreline to minimise impacts on river users. Exceptions would be subject to careful assessment and the written approval of Maritime Safety Queensland.	Discussed with MSQ and DAF Fisheries and Boating Patrol
Water depth	< 2m below MLWS	Within exclusion area = 0, all other areas = 4	Oyster ecosystems are only established in water depths less than 2m below the Mean Low Water Spring tidal line at a restoration site. This maximised the chance of restoration success.	(Gillies et al 2018)

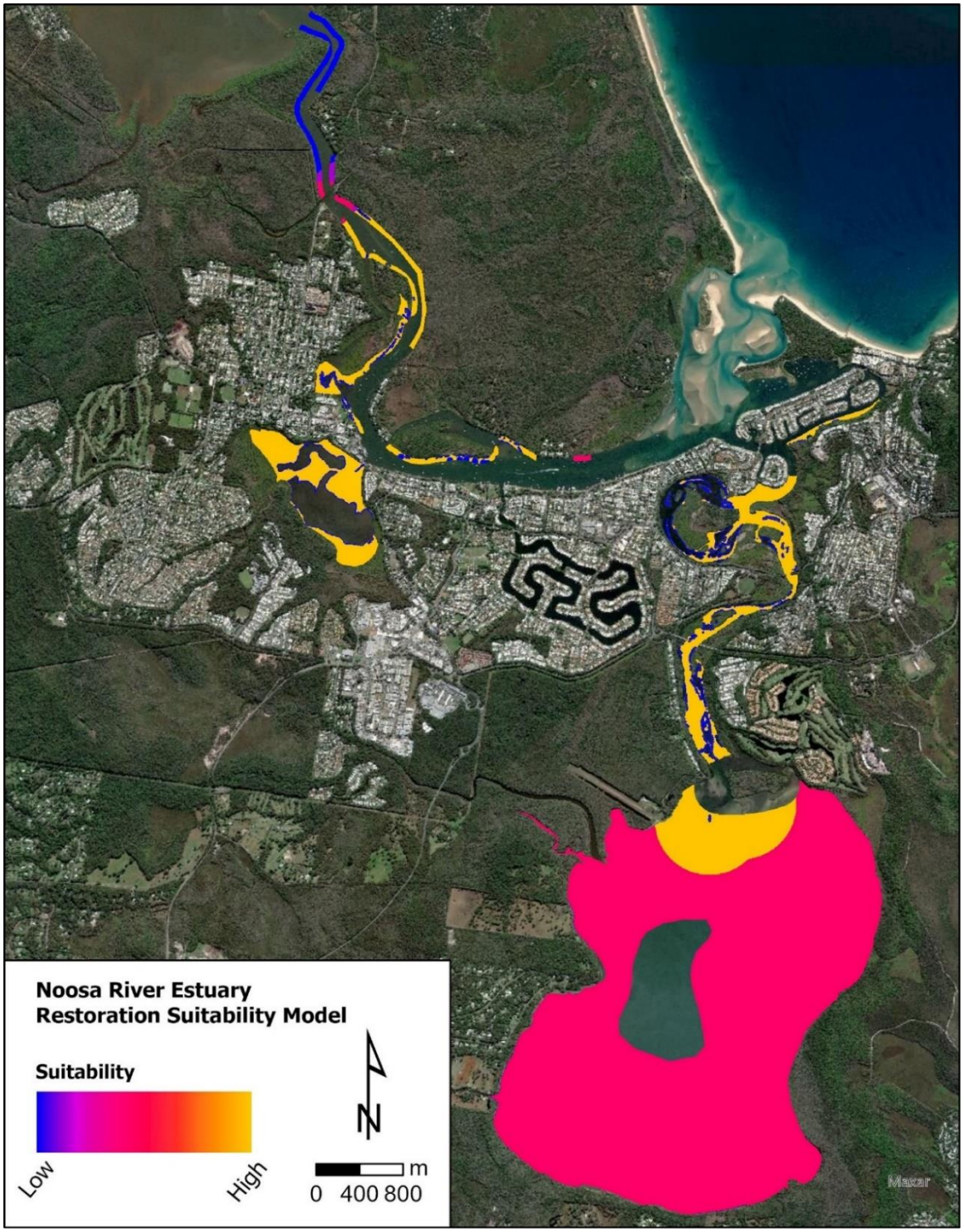


Figure 2.2: Restoration Suitability Model for rock oyster ecosystem restoration in the Noosa River estuary

2.4 Habitat mapping

TNC contracted the consultancy firm Ecological Service Professionals (ESP) to map the extent and condition of marine and fringing habitats adjacent to the proposed restoration sites (see Annex 1: *Noosa River Habitat Survey Report*. This information has been incorporated into the engineered diagrams and layouts of oyster reef patches on the restoration sites developed specialist coastal engineers, International Coastal Management (ICM) who were contracted to this project. The results are presented in Annex: 14: *Engineering Drawings*. The information is also incorporated into the descriptions of the restoration sites under Section 4: *Restoration Sites.*

SECTION 3 – RESTORATION SITES

Restoration works are planned in four restoration sites. These sites are located at Tewantin, Goat Island, Noosa Sound East and Noosa Sound West as indicated in Figure 3.1.

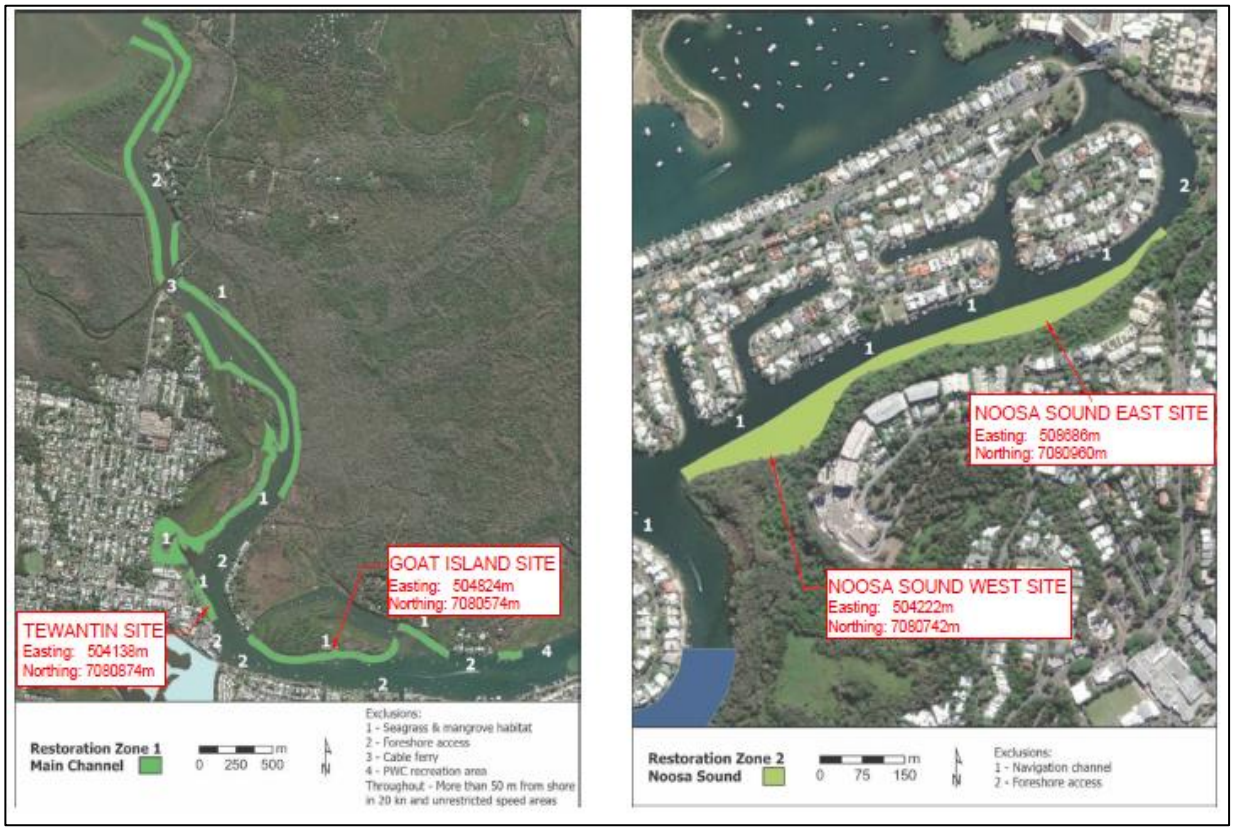


Figure 3.1: *Above left,* Location of the Tewantin and Goat Island restoration sites in the Main Channel Restoration Zone; Above right, Location of the Noosa Sound East and Noosa Sound West restoration sites in the Noosa Sound Restoration Zone. Source: International Coastal Management (ICM)

Marine habitats report

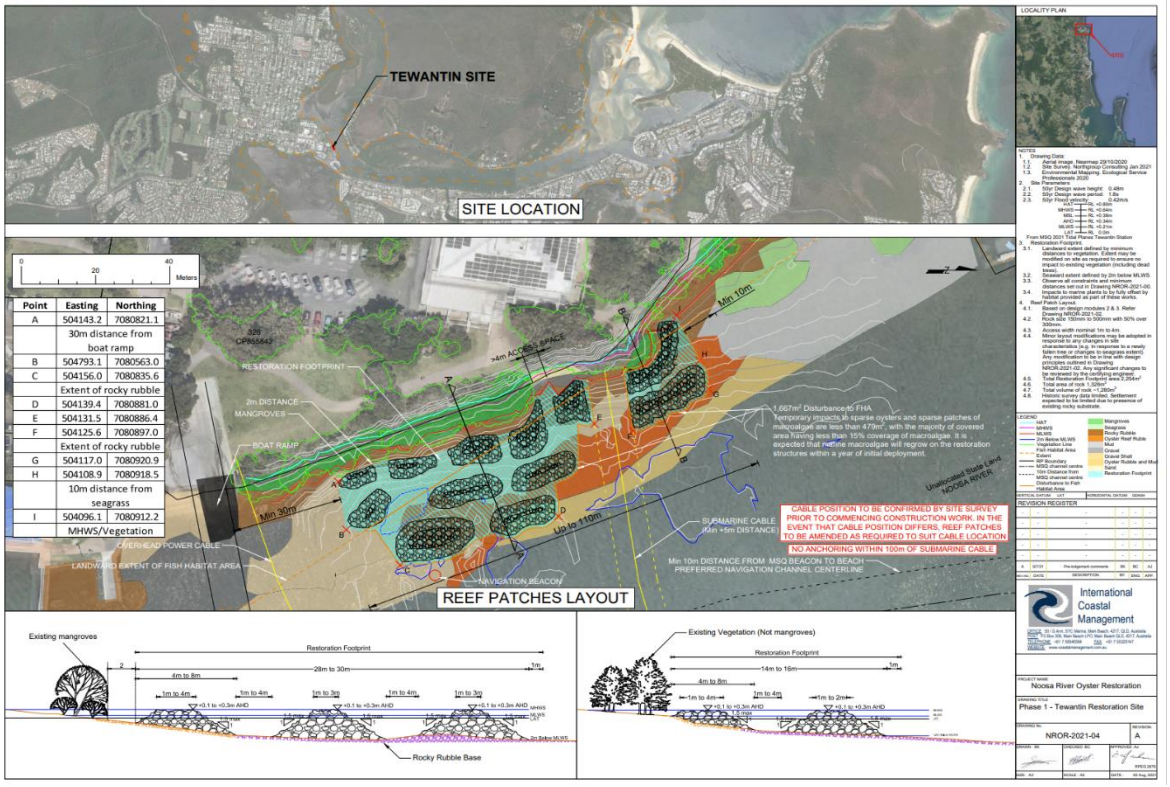
In September 2020, TNC contracted Ecological Service Professionals (ESP) to undertake benthic surveys in the Tewantin, Goat Island and Noosa Sound restoration sites and surrounds, as well as upper and lower Weyba Creek. The report is presented in (Annex 1: *Noosa River Habitat Survey Report*). The Weyba Creek sites are not part of this restoration plan and information specific to the proposed restoration footprints has been extracted and included in the refined restoration site descriptions below.

ESP completed their habitat surveys over four days (7–8 September and 4–5 November 2020). ESP's survey results advised the positioning of the oyster reef patches within the sites. The benthic maps produced by ESP have been incorporated in the site diagrams (Annex 14: *Engineering Drawings*).

The ESP report specifically discusses the Tewantin restoration site, where temporary disturbance of macroalgae is anticipated.

Please note, that in line with the ESP report, no impact to mangroves or seagrass as a result of the works is expected at any of the proposed restoration sites.

3.1 Tewantin



The Tewantin Restoration Site is located along the southern shoreline of the Noosa River. The site lays adjacent to Tewantin Park, more than 100m upstream of the Tewantin boat ramp.

A port channel marker is located seaward at the downstream end of the site. A Telstra-owned submarine telecommunications cable bisects the site at the upstream end. The cable is relatively accurately mapped but its exact position will be confirmed and mapped, by geographic survey, prior to construction work commencing. Exclusions are imposed for the telecommunications cable. A small beach intersects the fringe and has been excluded from the restoration footprint.

A narrow strip (5m wide canopy) of cotton wood (*Hibiscus tiliaceus*), interspersed with grey mangroves (*Avicennia marina)* and river mangroves *(Aegiceras corniculatum*) occupy the shoreline fringe. Mangroves are in moderate condition, growing on rock and gravel on an erosion prone bank. A public walkway lies landwards of the fringing mangroves.

The proposed oyster reef patches would be placed primarily on bare sand and gravel (with dead oyster shell) and on rocky rubble adjacent to marine plants in the intertidal zone. The patches will cover a total area of 1326 m2 and be at least 10 m from seagrass and 2 m away from mangroves (including pneumatophores) to prevent any direct damage to those marine plant assemblages.

As per Annex 1, ESP has confirmed that the oyster reef patches will be placed primarily on bare gravel with dead oyster shell which makes up 42 percent of the 1326 m2 area covered by restoration patches.

In addition, existing patchy rock and rubble, which covers 24 percent of the benthic habitat in the proposed restoration patch areas will be supplemented with additional rock (i.e., Rock Rubble - 246 m2 & Oyster, Rubble & Mud – 77 m2).

ESP also confirmed that a relatively small section of patchy rock was covered by sparse oysters and sparse patches of macroalgae (Padina sp. and turfing algae). Based on this habitat survey, less than 479 m2 of this patchy rock and rubble habitat supporting a degraded macroalgal assemblage would be temporarily disturbed, although the area to be disturbed is likely to be an overestimate as it is planned to place the majority of substrate onto bare gravel and sand between existing rock patches where possible and thereby minimise potential disturbance.

The macroalgal assemblages were also in relatively poor condition due to high sediment loads observed on and around the existing rocky reef and rubble areas, with some sections of reef having a high coverage of fine sediment.

Given the speed at which Padina can colonise hard surfaces (dead oyster shell) elsewhere in the estuary, ESP anticipates that supplementary habitat provided as part of the proposed restoration project would be colonised rapidly within 1 year of deployment, and that coverage would be similar to the current condition within 2 to 3 years post deployment, particularly in sections that remain subtidal and not covered by fine silt. Related images are presented in Figures 3.2 to 3.5 below. Additional images are provided in the ESP report.

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Figure 3.2: Tewantin Restoration Site lies adjacent to this shoreline. Noosa Shire Council chambers is in the background. Public park fringes the site. The Tewantin boat ramp is to the far left behind the trees and 30m from the edge of the restoration site.

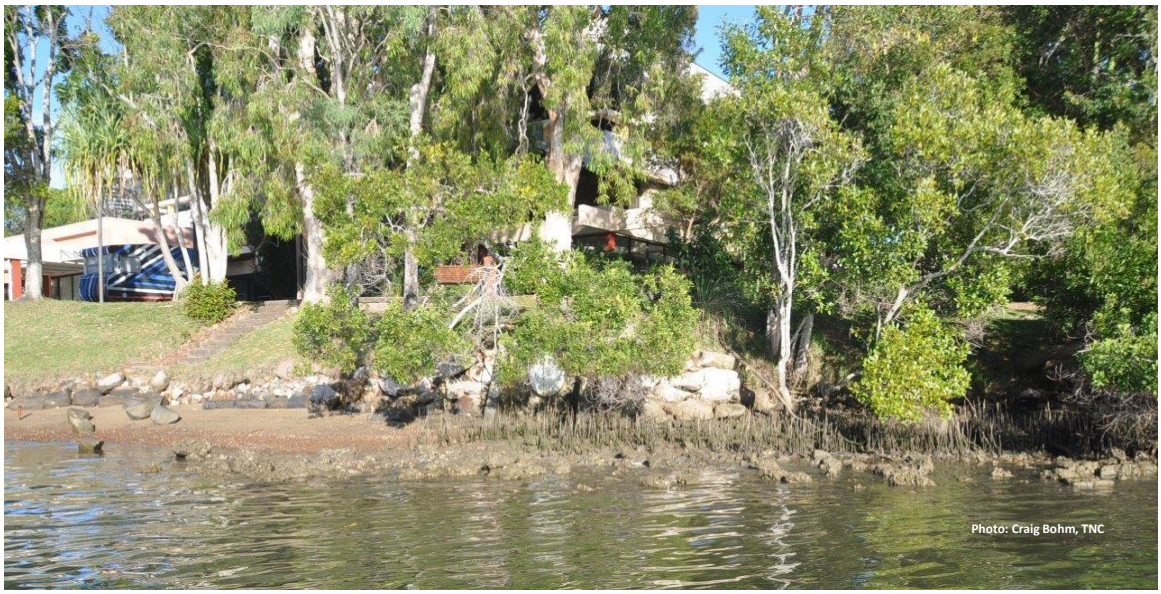


Figure 3.3: Tewantin restoration site looking upriver from the middle of the intertidal section of the site. The intertidal zone is dominated by a rock and rubble base interspersed with loose rock with low density oyster coverage.

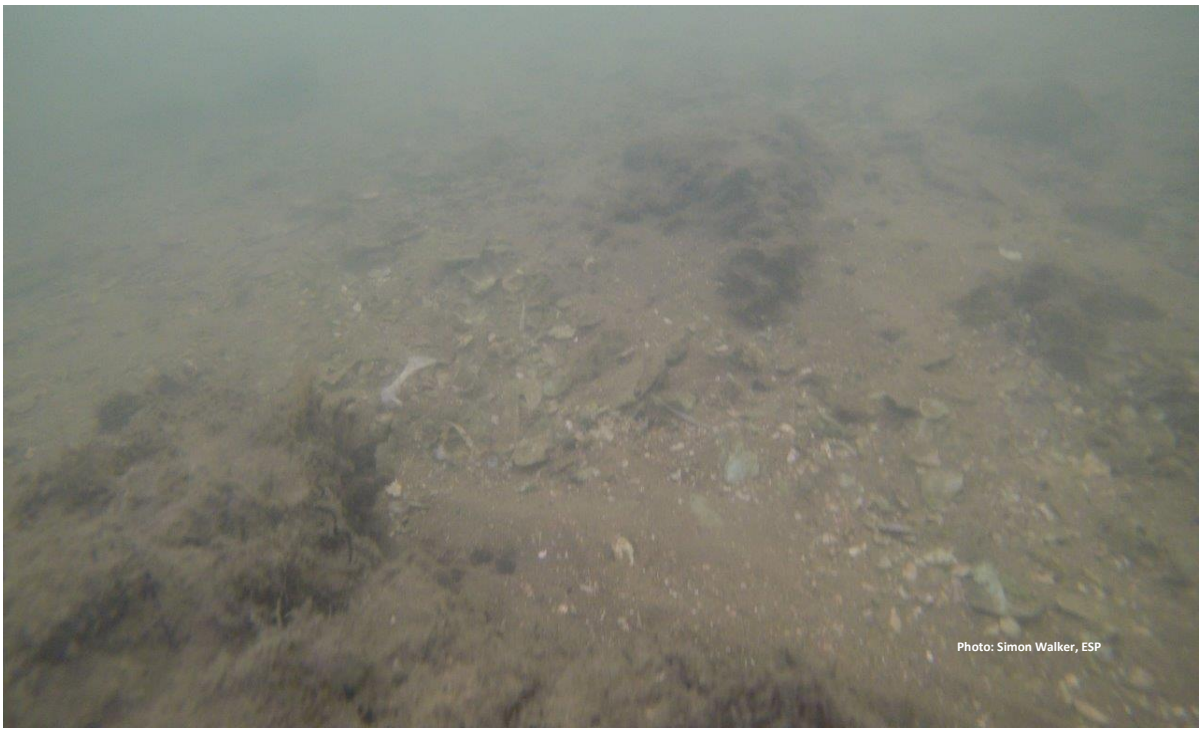


Figure 3.4: Upstream end of the Tewantin Restoration Site. Loose rocks over a rock rubble base dominate the site. Aerial mangrove roots are interspersed by mostly landward of the lose rock. Rock oysters grow on the lose rocks. Source: Simon Walker (ESP)

Figure 3.6: Sub-tidally the habitat is characterised by having patchy small rock outcrops with sparse coverage of foliose and turfing macroalgae (primarily *Padina* and turf forming algae) separated by bare sand, gravel and mud patches. Source: Simon Walker, ESP.

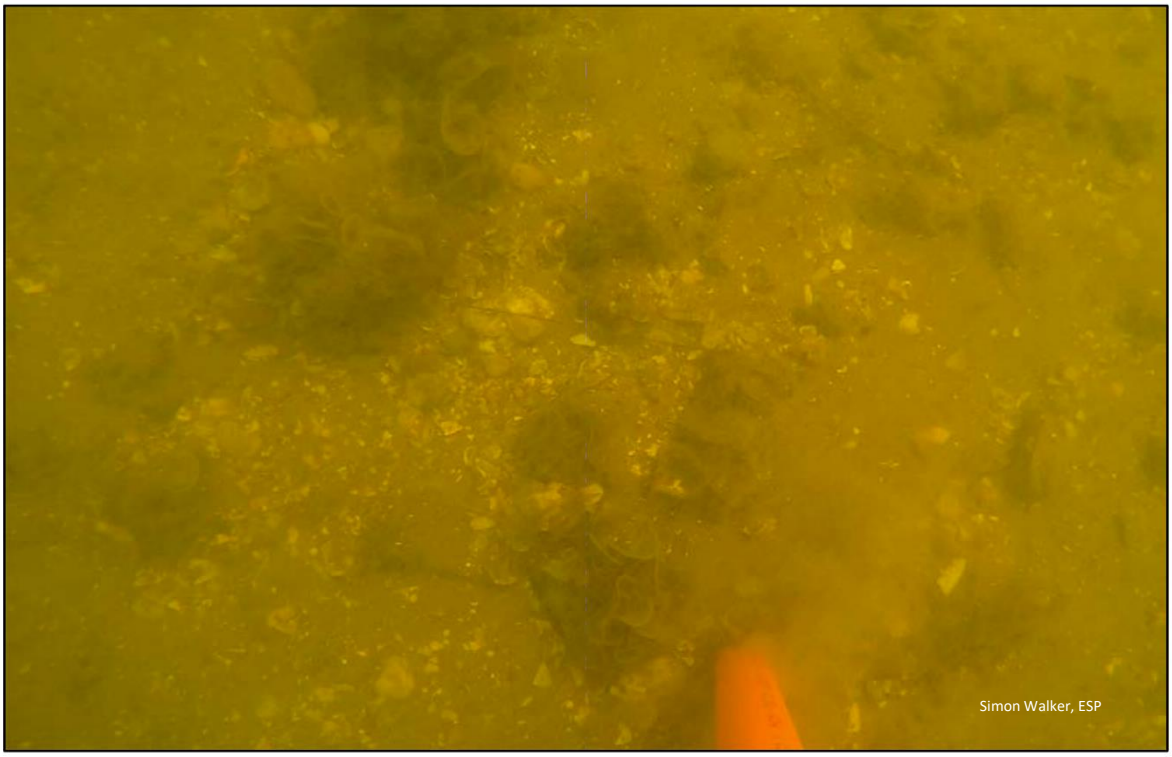


Figure 3.6: Sparse macroalgae (*Padina* sp.) growing on rock at Tewantin restoration site. Source: Simon Walker, ESP.

Matters of State environmental significance (MSES) - Tewantin

Refer to attached plans – MSES (Annex 2), MQ1401 (Annex 3), Noosa River FHA (Annex 4)

- High Ecological Value Waters (wetland)
- High Ecological Significance Wetlands
- Noosa River Declared Fish Habitat (A) Area

High Ecological Value (HEV) Waters (wetland) / High Ecological Significance (HES) Wetlands

The oyster ecosystem restoration works are designed to enhance the values of the wetland by restoring a complex ecosystem to what is currently a degraded aquatic environment.

Mangroves and seagrasses are not within the footprint of this project and will not be impacted.

A small stand of mangroves is shoreward of the proposed restoration footprint. Mangrove areal roots extend into the intertidal zone adjacent to the proposed restoration footprint. Mangrove roots are excluded from the restoration footprint at a minimum distance of 2m. Seagrass is found upstream and outside of the restoration footprint and is excluded from the footprint at a minimum distance of 10m from the footprint.

According to project consultants, ESP, macroalgae growing on rocks, dominated by *Padina sp*. is sparse (less than 15% of the surface area), with a footprint of less than 479m^2. The macroalgal assemblages are in relatively poor condition due to high sediment loads observed on and around the existing rocky reef and rubble areas, with some sections of reef having a high coverage of fine sediment.

ESP also confirmed that given the speed at which Padina can colonise hard surfaces (dead oyster shell) elsewhere in the estuary, it is anticipated that supplementary habitat provided as part of the proposed restoration project would be colonised rapidly within 1 year of deployment, and that coverage would be similar to the current condition within 2 to 3 years post deployment, particularly in sections that particularly in sections that remain subtidal and not covered by fine silt.

The proposed oyster reef patches are designed and certified by engineers. The oyster reef patches are spaced (1-4m apart) so as not to not impede fish passage, cause significant or impact negatively on natural hydrological processes of the waterway. The oyster reef patches are set away from the shoreline and will not interfere with overland flow and runoff as a result of floods.

Water quality will be maintained at the restoration sites during the construction phase in accordance with the sediment management protocol outlined in this Restoration Plan (see Section 6.4: *Sediment Management*). The restored oyster ecosystems will enhance water quality by filtering estuarine water, removing algae and particulate matter from the water column and converting nutrients, such as nitrogen and phosphorus, into biogenic oyster growth as well as binding these into the surrounding sediments[1].

Water quality will be monitored at the restoration sites using standard parameters (pH, temperature, dissolved oxygen, salinity, total dissolved solid) and significant changes reported.

The works will maintain recreational access to shorelines or the waters in which the oyster ecosystems grow. All shorelines with recreational access have been excluded from the selection process. Visual

[1] Kellogg, M. & Cornwell, Jeffrey & Owens, Michael & Paynter, Kennedy. (2013). Denitrification and nutrient assimilation on a restored oyster reef. Marine Ecology Progress Series. 480. 1-19. 10.3354/meps10331.

amenity will be maintained, as less than one third of the reef patch area will be exposed to view at low tide. Signage used to indicate the location of the restoration footprints will be optimised, with agency input, and will generally be considered temporary until the oyster ecosystems are established, at which time most signage, if not all will be removed from the river (as per government direction).

The work also enhances cultural and spiritual connection to place, enjoying the support of Kabi Kabi Traditional Owners. Kabi Kabi Elders are providing the project with valuable cultural and historic information and share the common interest of restoring oyster beds and reefs to the Noosa River system.

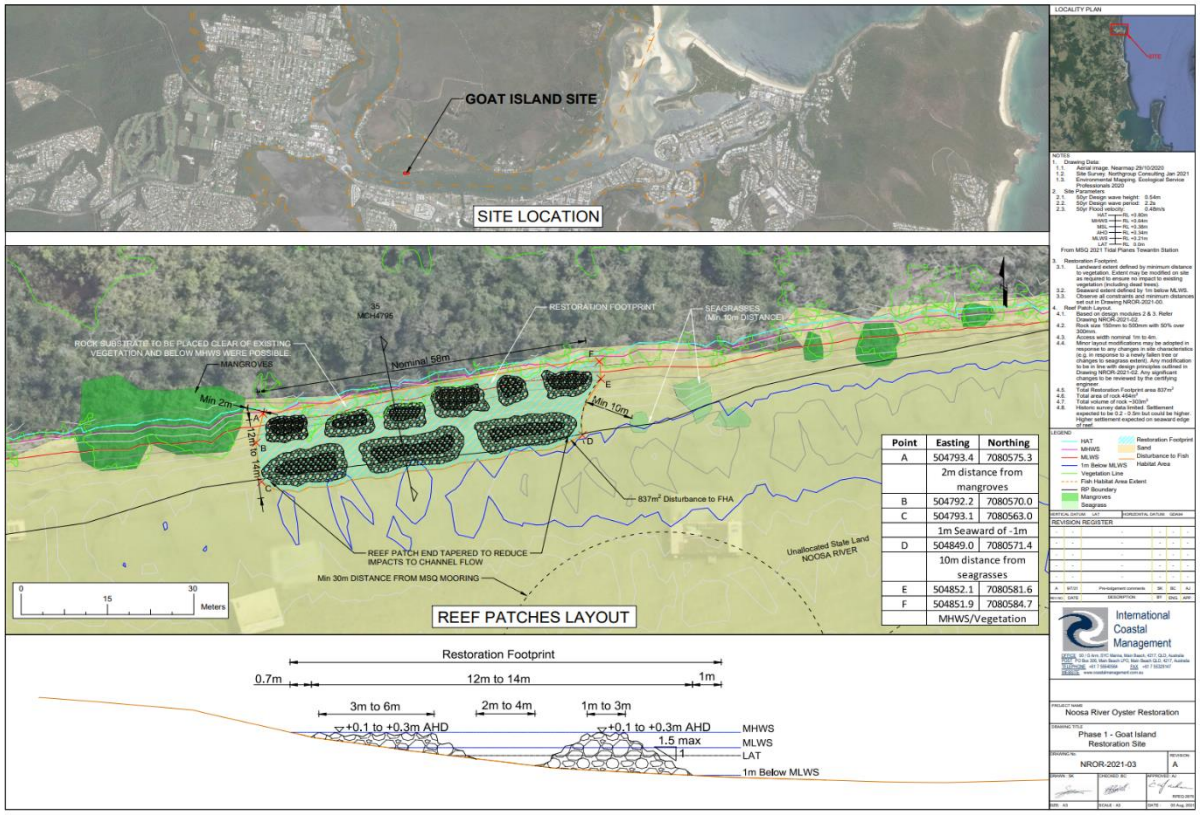
Declared FHA (A areas) – Noosa River

Works propose to restore ecological values and enhance fisheries resources at the site by the restoration of oyster ecosystem to the site, which provide habitat and food resources, breeding sites and nursery areas for marine fish.

The works at the Tewantin restoration site will not impact on mangroves or seagrass. According to project consultants, ESP, macroalgae growing on rocks, dominated by *Padina sp*. is sparse (less than 15% of the surface area), with a footprint of less than 479m^2. The macroalgal assemblages are in relatively poor condition due to high sediment loads observed on and around the existing rocky reef and rubble areas, with some sections of reef having a high coverage of fine sediment.

ESP also confirmed that given the speed at which Padina can colonise hard surfaces (dead oyster shell) elsewhere in the estuary, it is anticipated that supplementary habitat provided as part of the proposed restoration project would be colonised rapidly within 1 year of deployment, and that coverage would be similar to the current condition within 2 to 3 years post deployment, particularly in sections that particularly in sections that remain subtidal and not covered by fine silt.

3.2 Goat Island



The Goat Island Restoration Site lies approximately mid-section along the southern shoreline of Goat Island. The site is shoreward of the main boating channel and sites on a large sand bank that extends along the entire length of Goat Island.

The site avoids public moorings and marine habitats, and these are excluded with minimum distances. The site is within the declared fish habitat (A) management area.

The shoreline is a patchy and narrow fringing mangrove forest between coastal rainforest communities dominated by grey mangrove (*Avicennia marina*). Canopy height of 4 to 6 m. Forest extends to a large low canopy forest to the north-east of the island, away from the restoration site. The mangroves in this reach are in good condition.

Well sorted sand sub-tidally and no epifaunal invertebrates were recorded on the surface of the unvegetated habitats. There was typically a low density of burrows observed in most reaches.

Mangroves and seagrass are excluded from the site. No impact to the mangroves and seagrass is expected.

Related images are presented in Figures 3.7 - 3.9.

Figure 3.7: The Goat Island Restoration Site fringes the southern shoreline of the Goat Island Conservation Reserve.

Figure 3.8: Sub-tidally, the site is dominated by a sand bank with few ecological features. Consolidated soft sand overlaying compact sand fringes the shoreline. Mangroves, aerial mangrove roots and associated vegetation are present along the shoreward margins.

Figure 3.9: Bare sand adjacent to Goat Island. Source: Simon Walker, ESP

Matters of State environmental significance (MSES) – Goat Island

The Goat Island site is within the following MSES:

- High Ecological Value Waters (wetland)
- Declared FHA (A and B areas)
- Protected Area (estates)

High Ecological Value Waters (wetland)

The oyster ecosystem restoration works are designed to enhance the values of the wetland by restoring a complex ecosystem to what is currently a degraded aquatic environment.

Marine plants are not within the footprint of this project and will not be impacted.

A small stand of mangroves is shoreward of the proposed restoration footprint. Mangrove areal roots extend into the intertidal zone adjacent to the proposed restoration footprint. Mangrove roots are excluded from the restoration footprint at a minimum distance of 2m. Seagrass is found outside of the restoration footprint and is excluded from the footprint at a minimum distance of 10m from the footprint.

The proposed oyster reef patches are designed and certified by engineers. The oyster reef patches are spaced (1-4m apart) so as not to not impede fish passage, cause significant erosion or impact negatively on natural hydrological processes of the waterway. The oyster reef patches are set away from the shoreline and will not interfere with overland flow and runoff as a result of floods.

Water quality will be maintained at the restoration sites during the construction phase in accordance with the sediment management protocol outlined in the Restoration Plan (Section 6.4: *Sediment Management*). The restored oyster ecosystems will enhance water quality by filtering estuarine water, removing algae and particulate matter from the water column and converting nutrients, such as

nitrogen and phosphorus, into biogenic oyster growth as well as binding these into the surrounding sediments[1].

Water quality will be monitored at the restoration sites using standard parameters (pH, temperature, dissolved oxygen, salinity, total dissolved solid) and significant changes reported.

The works will maintain recreational access to shorelines or the waters in which the oyster ecosystems grow. All shorelines with recreational access have been excluded from the selection process. Visual amenity will be maintained, as less than one third of the reef patch area will be exposed to view at low tide. Signage used to indicate the location of the restoration footprints will be optimised, with agency input, and will generally be considered temporary until the oyster ecosystems are established, at which time most signage, if not all will be removed from the river (as per government direction).

The work also enhances cultural and spiritual connection to place, enjoying the support of Kabi Kabi Traditional Owners. Kabi Kabi Elders are providing the project with valuable cultural and historic information and share the common interest of restoring oyster beds and reefs to the Noosa River system.

Declared FHA (A and B areas)

Works propose to restore ecological values and enhance fisheries resources at the site by the restoration of oyster ecosystem, which provides habitat and food resources, breeding sites and nursery areas for marine fish.

The works at the Goat Island restoration site will not impact on marine plants.

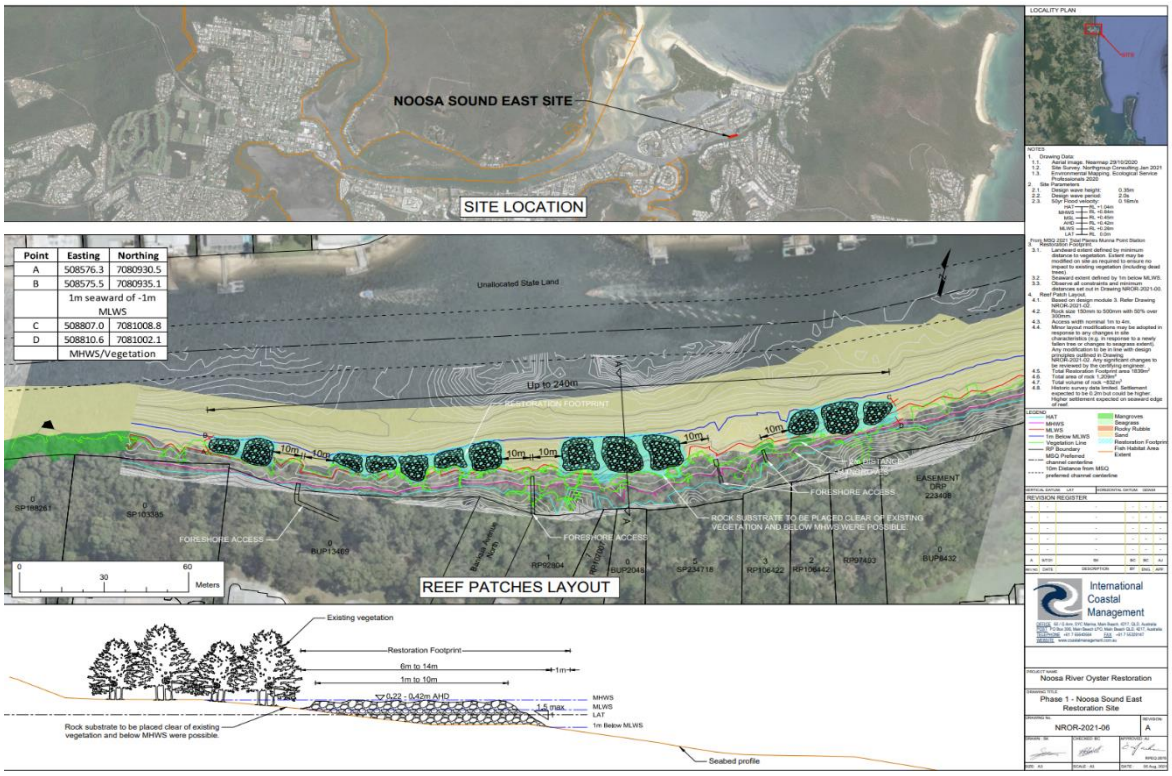
Protected Area (estates)

The Goat Island Conservation Park is a protected area that is estuarine in nature and protects mangroves, related tree communities and tidal flats of Goat Island. The park sits adjacent and landward of the proposed Goat Island restoration footprint. The values of the park are protected from the restoration works as all mangrove and tree communities within the park are outside of the restoration footprints. Aerial mangroves roots, fallen timber and other marine plants encountered on the tidal flats are further protected by a 2m separation area between them and the oyster reef patches as per this Restoration Plan (Section 2.3, Table 2.2., line 1).

The proposed works are designed to minimise the potential for erosion of the park shoreline. On the contrary, it is expected that the works may enhance protection of the park shoreline by attenuating some wave action due to the high rugosity and positioning of the oyster reef patches, which will attenuate wave energy before it reaches the shoreline at all but the highest points of the tidal cycle (see Section 7.4. *Erosion control*).

[1] Kellogg, M. & Cornwell, Jeffrey & Owens, Michael & Paynter, Kennedy. (2013). Denitrification and nutrient assimilation on a restored oyster reef. Marine Ecology Progress Series. 480. 1-19. 10.3354/meps10331.

3.3 Noosa Sound East



The Noosa Sound East Restoration Site is located in an embayment along the south-eastern shoreline of the Noosa River estuary, opposite the Noosa Sound canal estate. The site lies outside of the declared fish habitat area and adjacent to private land. Associated housing lies on a ridgeline above the site and at considerable distance from the shoreline.

Relevant shoreline infrastructure includes a small beach, boat ramp and small wooden jetty associated with the resorts on the ridgeline. All infrastructure is buffered to prevent intrusion of restoration works on these structures and their use.

Narrow fringing mangrove forest between coastal rainforest communities dominated by red and grey mangroves with occasional orange and yellow mangroves. While the mangrove fringe was generally less than 10m wide, it is in good condition.

Well sorted sand, which covered most habitats within each of the reaches investigated particularly in channel habitat. No epifaunal invertebrates were recorded on the surface of the unvegetated habitats during the survey and there was typically a low density of burrows observed in most reaches. Some sections of the sediment in Noosa Sound were covered by benthic microalgae, particularly where there were freshwater inputs.

Isolated seagrass patches but not within 10m of planned restoration footprint. Mangroves and seagrass are excluded from the site. No impact to the mangroves and seagrass is expected.

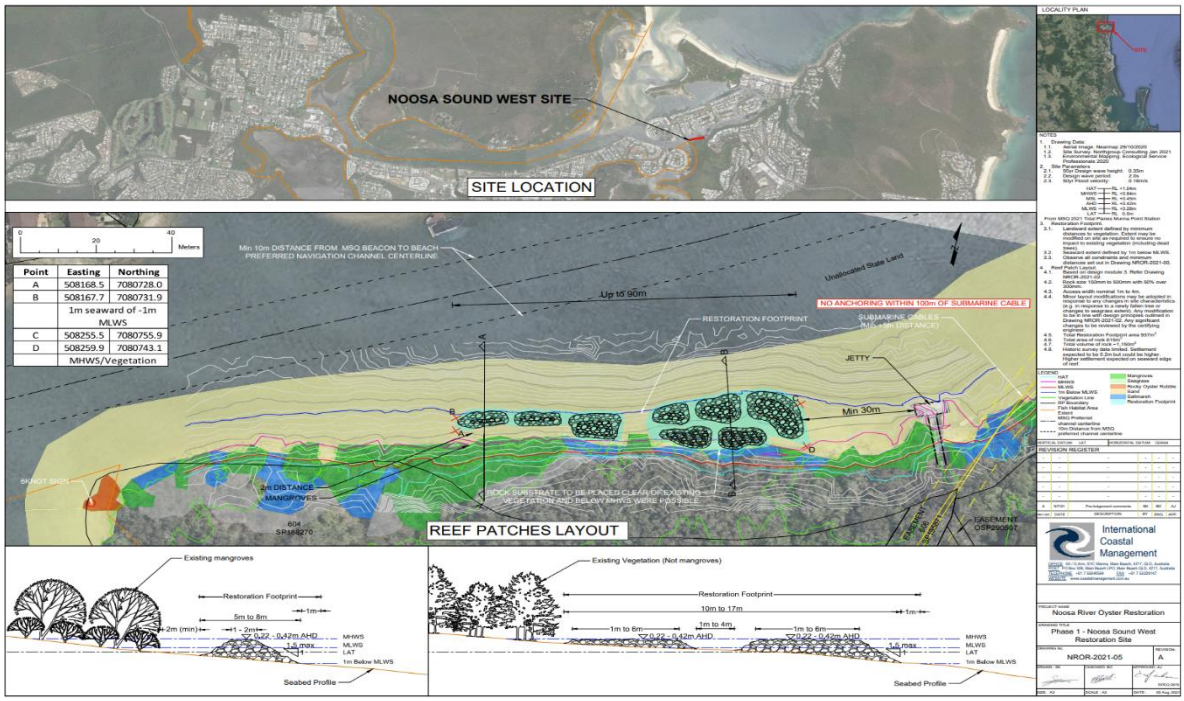
Related images are presented in Figures 3.10-3.12.

Figure 3.10: Noosa Sound East Restoration site lies in the embayment on the right side of the image (facing) up to the white 6 knot sign against the shoreline on the far right. The site avoids the main navigation channel. There is no housing along this shoreline.

Figure 3.11: Landward, the shore is mixed vegetation and mangroves. Sub-tidally, fine sediments overlay a hard base with no distinguishable habitat features.

Figure 3.12: Fallen vegetation occurs in this site and will be protected from construction works with minimum distances to minimise disturbance. Where vegetation falls onto the restoration site from overhanging trees, this will be left where it falls.

3.4 Noosa Sound West



The Noosa Sound East Restoration Site is located in an embayment along the south eastern shoreline of the Noosa Sound upstream of the Noosa Sound East Restoration Site. The site lies adjacent to the Weyba Creek Bushland Reserve. The site lies within the Noosa Sound Restoration Zone and not within a declared fish habitat area.

There is no shoreline infrastructure adjacent to this site. Downstream of the site is a public jetty. The jetty is excluded from the site.

Fringing mangrove forest between coastal rainforest communities dominated by red and grey mangroves with occasional orange and yellow mangroves. While the mangrove fringe was generally less than 10m wide, it is in good condition. The lower canopy dominated by jointed rush (*Juncus kraussii*), rusty sedge (*Fimbristylis ferruginea*), and saltcouch (*Sporobolus virginicus*) occurring particularly towards the mouth of Weyba Creek.

Well sorted sand, which covered most habitats within each of the reaches investigated particularly in channel habitat. No epifaunal invertebrates were recorded on the surface of the unvegetated habitats during the survey and there was typically a low density of burrows observed in most reaches. Some sections of the sediment in Noosa Sound were covered by benthic microalgae, particularly where there were freshwater inputs.

Isolated seagrass patches but not within 10m of planned restoration footprint. Mangroves and seagrass are excluded from the site. No impact to the mangroves and seagrass is expected.

Related images are presented in Figures 4.13 - 4.16.

Figure 4.13: Noosa Sound West Restoration Site lies opposite Noosa Sound canal estate. The image looks along the site downstream from the upstream end of the site towards the public jetty (white area), which lies outside the site.

Figure 4.14: The downstream area of the site features compact sand substrate with fine sediments overlaying. A combination of sedge and mangroves (with aerial roots) occur along the littoral fringe.

Figure 4.15: The mid and upstream sections of the site feature compact sand substrate with fine sediments overlaying. Mangroves with aerial roots dominate the littoral fringe.

Figure 4.16: Bare sand with sparse yabby burrows. Source: Simon Walker (ESP)

3.5 Public land

Detail of public land adjacent the restoration sites is presented in Table 3.1.

Table 3.1: Public land adjacent to restoration sites

Restoration Zone	Tewantin	Goat Island	Noosa Sound East	Noosa Sound West
Lot	326	35		604
Plan	CP855842	MCH4795		SP188270
Property ID	145672	154048		132663
Property Name	Tewantin Park	Goat Island (Noosa River) Conservation Park	Private land. Houses on ridge line	Weyba Creek Bushland Reserve
Lot Area	13280.81	203141.32		62229.91
Address	Council and Boat Ramp Car Park, Pelican St, TEWANTIN QLD 4565	Goat Island, NOOSA NORTH SHORE QLD 4565		1B Serenity Cl, NOOSA HEADS QLD 4567

SECTION 4 - PUBLIC CONSULTATIONS AND ENGAGEMENT

The Noosa community overwhelmingly supports this project and the restoration sites selected.

4.1 Face-to-face meetings

Since February 2020, the project team has met face-to-face with over 70 Noosa stakeholder groups and including local recreational and active commercial fishers, tourism and recreational groups and Noosa Council approved indigenous representatives to discuss the project and to present the proposed restoration sites. The overwhelming feedback from these meetings was supportive.

Traditional owners, senior land claimants from the Kabi Kabi Nation, as identified by Noosa Council, support the project and are involved in project activities. Kabi Kabi elders also provide technical input to the historic assessments of oyster presence and uses in the Noosa River. TNC has been given approval verbally by the traditional owners, and permission to incorporate local indigenous knowledge into the project and its activities.

Commercial, recreational fishers and indigenous elders have already provided invaluable insights to the history of the Noosa River, its uses and current extractive and non-extractive practices. Indigenous engagement actions are planned as part of structured school and community engagement programs that the project is helping resource.

Feedback from these numerous meetings was incorporated into the design process and reported to Noosa Shire Council in the project annual report (2019-2020).

4.2 Community engagement workshop

On the 7th of December 2020, the project also facilitated a community engagement workshop in which 18 participants from local Noosa groups gathered and discussed partnership projects. From the workshop 9 community projects were refined and are being implemented (see Annex 5: *Community Engagement Workshop Report*).

4.3 Public consultation sessions

On the 14th of December 2020, the project facilitated 9 widely publicised public consultation sessions about the project, the restoration projects and the Phase I restoration sites. During these sessions, 38 locals met face-to-face with TNC staff in small groups, and discussed the project purpose, methodology and restoration sites and opportunities for restoration throughout the estuary (see Annex 6: *Public Consultation Sessions Report*).

Most participants expressed overwhelming support for the project. Some 4-6 participants expressed concerns about the need of the project, the integrity of the project's local partners and the transparency in the sources of funding. One concern was expressed about the expected success of the project given that the past oyster restoration project, led by the University of the Sunshine Coast (USC) and Noosa Biosphere Reserve Foundation (NBRF)[11] did not deliver oyster reefs at the end of that project. The project team clearly explained that in that project shell was placed in coir bags but the bags

[11] Gilby, B. et al 2020. Bringing fish life back to Noosa: restoring lost oyster reef habitats in the Noosa Biosphere. Final Project Report. University of the Sunshine Coast, School of Science and Engineering.

rapidly deteriorated or were damaged by anchors, thus preventing the reef formation. The team also explained how in this project, a different methodology was being used.

Most participants were impressed by the tried and tested restoration methodology proposed for this project. Many participants subsequently joined the project mailing list, some with the intention of volunteering in project, while some local community groups are entering into formal and informal partnerships with the project to undertake community outreach activities.

4.4 Recreational fisher engagement

TNC has a formal agreement with Ozfish nationally and works closely with them in Noosa.

4.5 Commercial fisher engagement

Outside of formal consultations, TNC has also regularly engaged the commercial fishing sector in Noosa, keeping them up to date on project progress, sharing information and seeking their input on sites and monitoring criteria.

While TNC would characterise the engagement with the active commercial sector as cordial, and fruitful, the position of four of the six active commercial fishers regarding the project was not supportive. When directly asked if the project would impact on their commercial interests, their responses did not relate to specifically to commercial interests but to broader concerns. These presented in *italics* below, followed by TNC's responses.

Goat Island restoration site would narrow an already narrow section of the river

The width of the Noosa River at its narrowest point in the upper lower section is approximately 160 metres wide. The proposed works extend a maximum of 14 metres from shore, so less than 9 percent of the width of the narrowest part of this section of the river.

The site is also at the northern landward margin of a very wide and shallow sand bank, which extends more than 50 metres out into the estuary. This sand bank generally constrains most boat traffic to the river channel south of the bank, far from the restoration site, leaving the bank available for formal and informal moorings. The restoration site is proposed shoreward of the moorings.

Goat Island restoration site raises environmental concerns over hydrology and sand movement

TNC consultant coastal engineers, ICM, have certified that the oyster reef patches proposed for Goat Island have been designed to minimise impacts to river flows and sand movement. Despite this, the reef patches at Goat Island are anticipated to act as a segmented reef and provide some sheltering to the shoreline from wave action and vessel wake which is anticipated to result in reduced erosion in the lee of the reefs. The reef patches have been aligned with the river flows and incorporate spaces between the reef patches to minimise any impacts on river flows.

Goat Island restoration site poses a navigational hazard

TNC has visited Goat Island on two occasions with Maritime Safety Queensland (MSQ). MSQ has confirmed that the Goat Island site is not a significant navigation hazard, being set against the shoreline away from official moorings and at a reasonable distance from the main navigation channel.

Restoration efforts are unlikely to get oysters to grow

TNC will augment the natural oyster recolonisation process using oyster spat set on shell cultch that is placed on the oyster reef patches (see Section 5: *Substrate augmentation*). This is a tried and tested method of offsetting natural variable recruitment of oysters in restoration projects. Oyster augmentation would be repeated seasonally, if necessary, until recruitment is successful. The oyster reef patches will also naturally attract invertebrates and marine plants such as macroalgae, important components of oyster ecosystems and of benefit to the ecological health of the river.

Salinity and lack of river flow will be the enemy of the restoration effort

The salinity at the proposed restoration sites is well within the tolerances of oyster survivability and growth as per Section 2.1, Table 2.1 *Habitat suitability parameters and criteria for Sydney rock oysters*. Oysters are found growing across the lower estuary, including in relatively proximity to the planned restoration sites.

Potential introduction of new species and structures to an already over used and abused system

The project will only use oyster brood stock sourced from the Noosa River. This brood stock will be used to seed cured oyster shell with oyster spat in a bio secure hatchery. The seeded oyster cultch will then be set onto the oyster reef patches. The methodology complies with strict state biosecurity protocols for shell and live oyster handling. The activity will also occur under the conditions of a general fisheries permit secured for that purpose and with regular communication with state biosecurity officers.

The project uses the oyster reef patches as the structural foundation of oyster ecosystem restoration. The details of what the project will place in the river, and how it is prepared is outlined in detail in Section 5. *Restoration substrate*.

4.6 Riverside homeowners

The TNC/Noosa Integrated Catchment Association (NICA) Oyster Gardening Project has spent the last 6 months talking about the project and oyster gardening with virtually all estuary side jetty owners. The project also held an oyster gardening basket making workshop on Gympie Terrace, Noosaville, where the public could come and discuss the project.

In talking to locals and numerous jetty owners, NICA reports that they have a few people who asked probing questions about where the oyster restoration sites were exactly and the nature of the restoration work. However, most people showed positive interest, or at least will towards the project. No direct animosity about the project has been expressed.

TNC also wrote to three tourism operators who have jetties or boat ramps entering Noosa Sound. TNC sent profiles of the project and requested meetings with the operators, but they did not respond to TNC's requests.

Prior to construction, TNC has agreed with Noosa Council to meet with tourism operators in proximity to the construction load out site on Hilton Esplanade and with households living opposite the Noosa Sound East and Noosa Sound West restoration sites.

4.7 Additional communications

TNC has produced special fact sheets about the project's construction methodology, site designs, shell recycling and biosecurity measures and have distributed these widely. TNC is currently producing a special fact sheet about the biosecurity measures in place for this project. This will also be distributed widely.

TNC and Noosa Council are also collaborating to produce a package of construction communications and TNC will manage a public complaints mechanism during and post construction for the project, whereby requests for information or concerns will come to TNC directly.

4.8 Project-based engagement actions

TNC has also established a series of local partnerships to support the imbedding of this initiative in the Noosa community. These initiatives include:

Noosa Shuck Don't Chuck – shell recycling by 3 local Noosa restaurants, who collect and wash oyster shells for use in oyster seeding, as well as community based shell-washing – where local volunteers help TNC wash, bag and store over 9 tonnes of cured oyster shell ready for use in the project.

Noosa Junior Schools Project – local partner organisation, Noosa Community Biosphere Association, works with local junior schools to deliver activities which celebrate shellfish restoration efforts and conservation of the Noosa River.

Noosa Senior Schools Project – local partner organisation, Noosa Environmental Education Hub works with local senior schools to imbed shellfish restoration activities into curriculum subjects.

Noosa Oyster Gardening Project – local partner organisation, Noosa Integrated Catchment Association, works with local jetty owners and businesses to grow local Noosa oysters in baskets, which are then released onto the project's rocky restoration substrates

Noosa Estuary Sediment Study – local partner organisation, Noosa Parks Association, works with partner ecological firm, Ecological Service Professionals, to map the sediment distribution in the Noosa River (sediment being recognised as one of the major impediments to natural oyster ecosystem formation.

Other actions include presentations to local community groups, working with recreational fishing groups such as Ozfish to collect underwater video footage of the restoration sites, and plans with Tourism Noosa to imbed marine restoration key messages into tourism information products throughout the Noosa Shire.

SECTION 5 – RESTORATION SUBSTRATE

The restoration process involves the deployment of igneous rock, sourced from a local quarry, as the primary restoration substrate. The rock will be augmented, at some sites, with a mix of oyster shell, which forms a composite substrate. Upper surfaces of the rock substrate are augmented with oyster shell, which may be seeded with live oysters and which locks into the rock substrate. Live oysters may also be added to the substrate.

The design specifications and placement of restoration substrates, as described below and presented in the attached specifications and drawings, have been certified by the project's consulting coastal engineers, International Coastal Management (ICM). The rock substrate is stable, and the shell stability has been optimised by hand placement within the rocky matrix. The configuration has been optimised to provide characteristics suitable for the desired habitat and minimises potential impacts on coastal processes and the surrounding environment.

5.1 Rock substrate

The project will use a locally sourced igneous rock as the primary restoration substrate. The rock is in the size range 150-500mm diameter and deployed in configurations, as oyster reef patches, that meet engineering requirements related to movement, stability, erosion avoidance and minimisation of sediment accretion as per the specifications for each restoration site.

Using rock (as opposed to oyster shell) as the primary restoration substrate has many advantages. These include:

- Highly suitable as an oyster settlement substrate (rock oysters settle readily onto rock)
- Resembles natural oyster bed substrates
- Can be readily configured to meet engineering specifications for movement and stability under varying estuarine conditions
- Does not require complex engineering structures to support the shell to create vertical relief
- Can be deployed and configured using standard construction equipment and practices
- Readily meets ecological criteria for heterogeneity and rugosity and provision of habitats historically present in the estuary
- Raises the oysters above the benthic sediments of the river, helping ensure oysters attached to the rock are free from benthic sediments and have maximum exposure to water flow
- Offers multiple habitat opportunities across the intertidal and shallow subtidal ranges for multiple species
- Can be readily augmented with cured oyster shell to enhance rugosity, heterogeneity or chemical cues for oyster spat
- Is economically efficient to use, particularly if restoration is to occur at scale
- More ready passes the 'naturalness' test with stakeholders than shell in bags or cages (for example)

The use of local rock as a restoration substrate has been tried and tested by TNC and its state and local government partners in sub-tidal oyster ecosystem restoration in Victoria, South Australia, Western Australia and by the Department of Primary Industries (DPI) New South Wales in Port Stephens (Figures 5.1 and 5.2) for intertidal rock oyster ecosystem restoration.

Figure 5.1: Rock oyster restoration substrate deployed by DPI NSW in Port Stephens estuary in February 2021. The rock is an igneous andesite in the 100-300mm diameter size range, though some individual rocks are up to 500mm in diameter.

Figure 5.2: Rock oyster recruitment onto the underside of andesite rock in the Port Stephens restoration project after 12 months of rock deployment. Native rock oysters typically recruit to the underside of the restoration substrate, then progressively colonise the upper surfaces over time, where environmental conditions allow. Source: Craig Bohm. TNC.

5.2 Substrate augmentation

The Noosa River estuary experiences some natural oyster recruitment due to the presence of a remnant population of rock oysters (*Saccostrea spp.*). The timing of natural oyster recruitment, however, is highly variable, generally seasonal (occurring throughout the warmer months) and is difficult to predict. The fate of the oyster larvae (where they settle) is also not well understood, and the volume of a given

larval plume may be small. Rapid algal growth and colonisation of newly placed restoration substrates by a range of flora and fauna also competes with the natural recruitment of rock oyster larvae onto the substrate, thus posing some risk to restoration success. The impact of predation on natural oyster recruitment during the larval and young spat stages (by finfish and macro-invertebrates) may also be significant.

For these reasons, the project augments, or 'kick start' the oyster ecosystem restoration process by adding cured (by desiccation) oyster shell and live oysters to the rock substrate.

The cured shell is added as:

a. Seeded cultch – cured oyster shell seeded with oyster spat at the Bribie Island Research Centre (BIRC), and placed in voids in the rock substrate,
b. Unseeded cultch – cured oyster shell placed in voids in the rock substrate to encourage natural recruitment of oyster spat to the shell and rock,
c. Composite substrate – cured oyster shell mixed with rock prior to the rock deployment

Live oysters, grown for this purpose in oyster gardens, are also placed in voids in the rock substrate (see Section 5.5: *Oyster Cultch* for detail).

5.3 Shell recycling

Oyster shells are collected and prepared for use as part of TNC's *Shuck Don't Chuck* shell recycling project (see: https://www.natureaustralia.org.au/what-we-do/our-priorities/oceans/ocean-stories/shuck-dont-chuck-shell-recycling/).

Since September 2020, TNC has been collecting and curing oyster shell at the project's dedicated oyster shell curing site at the Doonan Solid Waste Depot (Figure 5.3). Shell has been supplied in bulk by Mooloolaba Fish Market. She shell is principally half shell from shucked Pacific oysters (*Magallana gigas*) with an average shell diameter of 60mm. Since March 2021, the project has begun collecting rock oyster half shells from local seafood restaurants in Noosa and adding these to the curing site.

Resource Recovery Australia (RRA), who operates a recycling facility at the Doonan Solid Waste Depot, is contracted to TNC to transport the shell from the wholesaler and retailers to the shell curing site.

For this purpose, TNC is a registered as a 'resource provider' with the Department of Environment and Science, as per the Queensland End of Waste Code - Oyster shells (ENEW07278317) and Waste Reduction and Recycling Act 2011. TNC cures the oyster shell against best practice, in compliance with the Code, and in consultation with DAF biosecurity, who also sits on the project's Technical Advisory Group.

Shell curing occurs against the following protocol:

I. Shell is only cured at the designated and sign-posted shell curing site
II. Clean, shucked oyster shell is collected by the contractor from wholesaler/s, in bulk, in 1 tonne food-safe seafood transport containers and delivered to the shell curing site
III. Pre-washed shell is also collected by the contractor from oyster retailers in Noosa in clean 20 litre buckets, and delivered to the designated shell curing site
IV. All containers used for shell transport are thoroughly washed and disinfected before storage and re-use

V. At the shell curing site, shell is placed on the ground in rows separated and sign-posted by month collected
VI. The shell is dried and cured (desiccated) in direct sunlight for 6 months, which is two months more than is required by the End of Waste Code
VII. The shell is also turned after three months of curing, as an additional desiccation measure
VIII. Each shell pile is no higher than 1 metre, which further enhances the desiccation process
IX. The site is regularly monitored and maintained to reduce contamination of the shell piles
X. The curing site is in located in an isolated area of the depot, so the risk of contamination from the depot's other waste management activities is negligible
XI. Once cured, and prior to its removal from the depot, oyster shell may be washed with freshwater to remove any cumulated sediment or dried organic matter, if found
XII. The shell, when needed, is transported in clean containers

Figure 5.3: Oyster shell curing by desiccation in sunlight at shell curing site at the Doonan Solid Waste Depot. *Top left*, The curing site is located in a remote area of the depot and is well sign-posted. *Bottom left,* A tipper truck is used to transport the shell onto site. *Right*, Shell transport contractor, Resource Recovery Australia's manager, Russell Ping, inspects the September 2020 shell pile at the curing site.

5.5 Composite substrate

A small portion (<20 percent) of the restoration substrates will be a mixture of rock and cured oyster shell as per the specifications. This composite is being used to further explore whether oyster recruitment is enhanced by mixing oyster shell with the rock or not. Restoration scientists generally expect that oyster shell provides chemical cues that may attract oyster larvae to settle on a particular restoration site, but this has not yet been fully tested.

The composite mix will comprise up to 10 percent shell. In lower flow locations, such as in Noosa Sound, the proportion of shell may be increased to 20 percent, subject to confirmation of the stability of the structure by engineers. A higher proportion of shell may be considered subject to constructability and monitoring outcomes, as per the specifications.

When used as a composite, the cured oyster shell will be evenly mixed through the rock to achieve good interlocking. The shell will not be placed in alternating layers with rock. Mixing will occur in small volumes on the barge immediately prior to placement to avoid shell damage due to rehandling. An example of a rock oyster restoration substrate displaying a mix of rock and shell is given in Figure 5.5.

Figure 5.5: An example of rock oyster restoration substrate (augite) augmented with oyster cultch (unseeded) in Port Stephens, NSW. Source: Craig Bohm, TNC.

5.5 Oyster cultch

Seeded and unseeded oyster cultch will be added to the rock substrates in volumes up to 10 kilograms of cultch per metre square of rock substrate as per the specifications. The cultch will be interlocked with rock by hand-placing the cultch into voids to minimise displacement. Oyster shell that is displaced more than 5m from a restoration site, is to be removed in the event that it is resulting in negative impacts.

If displaced oyster shell extends more than 5 metres beyond the drawn restoration site, and results in negative impacts to the environment, the displaced shell will be collected by hand, removed from the estuary, or reinstated on the restoration substrate (structure). Shell movement will be monitored six-monthly using visual observation. The risk of shell displacement will reduce over time as the natural oyster bed develops (see Annex 7: *Engineering Specifications, Rectifications Table*, as provided by ICM engineers).

5.6 Hatchery

Oyster cultch will be seeded with oyster spat at the Bribie Island Research Centre (BIRC). The cultch will be sourced exclusively from the project shell curing site and oyster brood stock from the Noosa River.

The hatchery will be responsible for spawning the oysters and seeding the shell cultch with oyster larvae in ponds configured under controlled hatchery conditions. The hatchery will follow all required environmental and biosecurity protocols and will liaise with government biosecurity offers to confirm those protocols.

TNC will be responsible for preparing and supplying the cultch to the hatchery, collecting brood stock from the Noosa River and for the use of the seeded cultch in oyster gardening and deployment onto the restoration substrates in accordance with the conditions of a General Fisheries Permit secured for that purpose.

TNC is currently negotiating with the BIRC to provide hatchery services under contract to TNC.

5.7 Oyster gardening

The project plans to use oyster gardening to further augment the oyster restoration process and to engage with the local Noosa community. In oyster gardening, seeded oyster cultch is supplied by the project to local jetty owners and interest groups, who then grow the oysters in oyster baskets, which are suspended from docks and jetties in the Noosa River.

Once the oysters reach a sufficient size, to minimise losses due to predation, the project will remove the oysters and cultch from the oyster gardens and hand place the oysters and settlement cultch into voids in the restoration substrate.

Oyster gardening will be a community-led project, with oversight from TNC, and occur under the conditions of a General Fisheries Permit secured for that purpose.

TNC has engaged local group the Noosa Integrated Catchment Association (NICA) to help coordinate oyster gardening. The project is already oversubscribed with local jetty owners wishing to be involved in the project (once a permit is secured). Our other partners, Noosa Environmental Education Hub (EEHub) and Noosa Community Biosphere Association (NCBA) who are engaging with local schools and

the general community about the oyster restoration work, are super excited by oyster gardening and the potential opportunities it affords for local awareness raising and education.

Oyster gardeners will be trained and supplied with appropriate equipment and advice and will be registered with the program. The methodology that will be applied is summarised in Table 5.1 below.

Table 5.1 Oyster gardening methodology

Gardening Steps	Description
1. Community register of interest	Interested community members register with the project. Maximum subscription is 40 oyster gardeners. Extra gardeners will join a waiting list.
2. Potential oyster gardeners assessed for suitability by site visit and interview	Every potential oyster gardener will be interviewed for physical ability, suitability of jetty, access, and reason for being involved prior to be invited to participate.
3. Selected oyster gardeners are formally registered with the project	Registration includes: · Personal and household details and location map · Number of baskets to be supplied · Registration number · Permit number
4. Oyster gardeners inducted to the project	Project team (NICA+TNC) supplies oyster gardeners with: · Oyster gardening guidelines. · Rules and obligations, insurances, and permit conditions. · Opportunity to participate in a workshop about oyster gardening.
5. Oyster baskets prepared	Project team prepares oyster baskets with new mooring lines and a wash. The baskets have been provided by the Bribie Island oyster gardening project. The baskets are bio-secure, having been desiccated for 2 years, but will be cleaned again with fresh water prior to issuing to oyster gardeners. Additional baskets will be constructed using the same design, if required. Oyster baskets, when in operation will be secured at the opening with zip ties to prevent loss of seeded cultch.
6. Oyster gardening kits prepared	The project team provides each oyster gardener with a gardening kit including: Gloves, spare rope, tags, zip ties, record sheets, oyster gardening guidelines, rules and obligations, copy of liability and insurance information, safety guidelines.
7. Oyster gardening baskets and kits distributed to oyster gardeners	Project teams delivers each oyster gardener their kit and baskets just prior to, or as they receive their allocation of seeded oyster cultch.
8. Oyster gardens are stocked	The project team delivers 5-10kg of seeded oyster cultch per basket to each oyster gardener direct from the Bribie Island Research Centre and assists the gardener with setting the oyster basket/s in place in the river.

9. Oyster gardeners care for oysters	Oyster gardeners are responsible for: · Monitoring of gardens every couple of days and shaking the baskets to release pseudo-faeces. · Inspecting and hosing down the baskets at least one per month (more often in areas where high algal growth or sedimentation occurs) · Affixing repairs to the mooring lines or baskets, as required. Oyster gardeners may seek assistance from the project team. Oyster gardeners are encouraged to record observations (rate of algae growth, interesting species, any wear and tear of gardens). The project team will inspect oyster baskets periodically and take measurements. Oyster gardeners may assist.
10. Records	Project team will keep accurate records of oyster gardeners, contacts, number of baskets, maintenance activities undertaken and eventual fate of baskets.
11. Decommissioning	Oyster gardens remain in commission for 6 to 12 months. Oyster gardens are then inspected by the project team and the oysters and cultch released onto the oyster restoration sites by TNC as per the project specifications. After the oysters and cult are released, the baskets will be collected by TNC/NICA, dried and repaired for future use, returned to Bribie Island or disposed of at the Doonan Solid Waste Facility.
12. Reporting	Project partner, NICA, is required every 6 months to report to TNC on project progress. TNC reports twice per year on project progress to agencies. TNC remains in close contact with NICA throughout project implementation and assists technically with project implementation.

The oyster gardening techniques applied in Noosa are adapted from the Bribie Island oyster gardening project led by Dr Ben Diggles. Dr Diggles has been consulted during the formation of this project. Dr Diggles has also provided the Noosa project with 70 pathogen free oyster baskets for use in the project. The project also draws on TNC's success with the mussel gardening in Western Australia (https://www.natureaustralia.org.au/newsroom/mandurah-mussel-gardens/) and with oyster gardening caried out by TNC and its partners in the USA.

Shellfish gardening is practiced worldwide, and the methodologies are simple, safe and prevent the spread of disease through simple design and tried and tested methodologies and sound record keeping[12]. An example of a rock oyster garden that will be used in Noosa is presented in Figure 5.5.

[12] Examples: TNC's major mussel gardening project in the Peel/Harvey Inlet, Western Australia with over 100 mussel gardeners engaged (see: https://www.natureaustralia.org.au/what-we-do/our-priorities/oceans/ocean-stories/shellfish-garden/); the *Restore Pumicestone Passage* community alliance who recently ran a successful oyster and mussel gardening project on Bribe Island (see http://restorepumicestonepassage.org/oyster-

Figure 5.5: An example of oyster gardening bag stocked with seeded oyster cultch and ready for deployment and grow out under a jetty on Bribe Island as part of the Save Pumicestone Passage project. Source: Ben Diggles, Digfish Services.

gardening/); the *Maryland Oyster Gardening Program* in Chesapeake Bay, USA (see https://www.cbf.org/how-we-save-the-bay/programs-initiatives/maryland/oyster-restoration/oyster-gardening).

SECTION 6 – CONSTRUCTION

Construction standards applied in this project align with shellfish restoration best practice and the Society for Ecological Restoration (SER) International Principles and Standards for the Practice of Ecological Restoration global guidelines[6].

The construction methodology described here has been successfully employed by TNC construction contractors in shellfish restoration projects in Port Philip Bay (VIC), Adelaide (SA), Albany and Swan River (WA). This methodology was also employed by the Department of Primary Industries (DPI) for the restoration of rock oyster ecosystems in Port Stephens, NSW. TNC also has 25 years of experience in utilising similar deployment methodologies in projects throughout the United States.

6.1 Methodology

The construction contractor engaged to handle and deploy the restoration substrate will have experience with tidal works in the Noosa River, or similar sized estuaries, and preferably have experience with shellfish restoration projects.

The contractor will acquire and manage the rock substrate from its source to its deployment. TNC will supply the cured oyster shell to be used as a composite mixture with rock.

The contractor will stockpile the rock at an agreed load out site, selected with Noosa Shire Council, and managed in accordance with the Site Management Plan and Construction and Environmental Management Plan (CEMP), which meets with permit conditions.

In the appropriate weather window, related to suitable construction safety and operational requirements (so as to avoid any potential damage to the receiving environments as well as staff), the contractor will load the substrate onto a small barge from the load out site, transport the substrate to the restoration site, and deploy the substrate onto site using an excavator (Figure 6.1).

Where a composite of rock and shell is used, the contract will mix this on the barge immediately prior to placement to avoid shell damage due to rehandling (unless another method which achieves the same objective is identified). The contractor will lay the substrate in configurations and clearances specified for the site.

The first deployment of substrate will be closely supervised by the TNC monitoring team and the configuration of the substrate inspected, in-water, to confirm accuracy of placement. Once TNC is satisfied with the accuracy and appropriateness of the deployment technique, the contractor will be permitted to continue with the deployment and subsequent deployments.

The contractor may use GPS, site markers or similar equipment to accurate mark the depositional sites.

The deployment barge only anchors at the restoration site where the minimum distance specifications for marine plants, marine habitats and infrastructure can be met. Sediment plumes are managed in accordance with the management protocol outlined in Section 6.4: *Sediment management*.

Once restoration substrates are in place, and signage and aids to navigation installed, authorities are notified and accurate ‘as constructed’ drawings with RPEQ certification are provided as per permit conditions.

Figure 6.1: The contractor using a shallow-draft barge and excavator to carefully position restoration substrate onto site Port Stephens, NSW. The barge operator uses sponsons to orient the barge, sometimes only setting one sponson, and marker stakes, to help guide the substrate placement. Source: Kirk Dahle, DPI NSW.

6.2 Responsibilities

The contractor will be responsible for:

- Ensuring they have access to the equipment of the appropriate size for operating in the Noosa River estuary, experience with rock construction in the Noosa River estuary, or other constrained estuaries, and preferably will have had exposure to ecological restoration work in the past.
- Acquiring the rock as per the specifications and stockpiling it at designated load out site.
- Managing the oyster shell to be used in the composite mix at the stockpile site.
- Developing and implementing a Site Management Plan for the stockpile and Construction and Environmental Management Plan (CEMP). These will be approved by TNC and meet with any permit conditions, prior to the commencement of works.
- Managing all site marking, load out processes, material transport, works and signage at the restoration site until such time as the restoration substrates are laid and configurations and positions of substrates against the plans are confirmed by engineers as meeting permit conditions.
- Undertaking all construction monitoring, compliance and reporting against permit conditions.
- Posting all construction notifications will be as per permit conditions. TNC will augment these notifications with public media and social media announcements.

6.3 Impact Minimisation

All works undertaken will minimise disturbance to marine plants during and after the construction phase. Any impact to marine plants will be temporary. Any use of temporary equipment, such as sediment curtains, will be placed to avoid contact with marine plants or the impediment of fish passage.

Table 6.1 presents an assessment of the actions, impact minimisation actions and alternatives considered.

Table 6.1: Impact minimisation actions and alternatives considered

Action	Impact minimisation (environmental + social)	Alternatives considered
Site selection	Site selection guided by Restoration Zones and Restoration Suitability Modelling and extensive associated use of minimum distances to minimise negative impact of construction or restoration substrates, once established, on marine species and habitats, navigation, built infrastructure and river access. Extensive liaison and formal consultation processes are used to ensure planned actions meet with community expectations.	Areas unsuitable or inappropriate for oyster restoration are excluded by the selection and consultation processes.
Restoration materials selection	Only locally occurring igneous or metaphoric rock is selected as the primary restoration material, as per the design specifications. This material optimises ecological and physical performance, while minimising risk of introducing foreign materials and pathogens to the river. To minimise contamination, the rock may be treated prior to deployment by cleaning with freshwater, if contamination (most likely lose soil) exceeds 50 percent coverage of each rock per given volume. Oyster shell and oyster shell cultch will be treated as per the QLD End of Waste – Shell Code, and pre-washed prior to use. Live oysters will be handled and deployed as per conditions of a General Fisheries Permit secured for that activity.	Rock oysters are opportunists and will grow on rock, rubble, mangrove roots, oyster shell (etc) and artificial substrates such as tin, concrete, steel. The project objective is to restore oyster ecosystems by providing an ecologically (and engineered) design which mimics natural foundations of oyster ecosystems. The project therefore employs locally occurring natural materials. Oyster shell piled on the riverbed or placed in bags or cages placed on the riverbed are, by design, artificial structures, thus introducing artificial materials and shapes to the estuary. Such materials and shapes may select for certain species mixes or abundances, which may not naturally occur in the estuary. The bag material may exacerbate sedimentation and achieving relief to counter sedimentation challenges is difficult

		and further distorts any potential natural character of the substrate. Placing shell in cages, which decompose by rusting over time, may allow time for oyster shells to cement together by natural biogenic processes, prior to the supporting cage structure disappearing. However, this design is yet to be fully tested and is possibly best suited for sub-tidal environments where the biogenic structures are not subject to high current and wave energy, which may cause movement or erosion of the biogenic reef structures. Not augmenting the restoration substrate with oyster shell and seeded oyster cultch and live oysters risks slow ecological recovery, or possibly low recruitment due to the variable nature of oyster recruitment.
Substrate design engineering	Substrates are designed to maximise stability, durability, rugosity, heterogeneity, prevent impediment to fish passage, avoid pooling, minimise wave refraction, and erosion of shorelines.	Alternative configurations could include larger substrate footprints of continuous rock, but such structures would likely affect river flow, may create barriers to fish passage, enhance the erosion potential and sediment accretion potential of the substrates to the adjacent shoreline and shoreline upstream and downstream of the restoration site.
Works methods	The construction contractor will be responsible for all works, from material storage and load out to construction, construction monitoring, risk management and reporting. The contractor will operate in accordance with the specifications in this plan, Site Establishment and Management Plan and Construction and Environmental Management Plan (CEMP) and all relevant permit conditions. Substrate deployment is timed to coincide with periods of the highest natural oyster	The work methods are standard practice which are refined for each estuary situation. Work methods are adaptively refined, if required, but the conservation of existing habitats is paramount to the methods. The use of larger deployment equipment, deployment of smaller amounts of substrate but this is neither economically efficient nor enables the project to meet minimum restoration targets in an effective timeframe.

	recruitment in the estuary. This period falls over the summer months. Sediment plumes associated with the works will be as per the protocol outlined in Section 6.4: *Sediment management*	Winter deployment considered possible but the risk of the substrate being covered with algae and non-habitat forming species is assessed as high and not desirable.

6.4 Sediment management

Sediment plumes associated with restoration works may impact on seagrass and are principally caused by using substrates (rock /shell) fouled with loose organic and inorganic matter collected by the substrate in its acquisition from the quarry, during storage at the load oust site, or during handling and deployment onto the barge. The resuspension of river sediments caused by the placement of the rock on site may also be an issue but would be temporary and may be insignificant in comparison to the generally very high background suspended sediment load of the estuary.

The construction contractor will be required to implement the following sediment plume minimisation protocol and must incorporate this into the Construction and Environmental Management Plan (CEMP).

The protocol includes the following:

- Preferential selection of rock from the quarry with minimum fracking (if possible).
- Organising the transport of rock to minimise contamination from lose material.
- Washing the rock prior to use, preferably at the quarry, if the rock is contaminated with loose material is greater than 50% by area.
- Managing the rock at the load out site to minimise significant fouling by ground sediments, if detected. This may include measures such as laying a bed of gravel on which the rock sits at the load out site, loading rock directly from the truck onto the barge, minimising the movement of barge equipment on and off the barge to avoid contamination from the tracks of the equipment.
- Washing oyster shells prior to mixing this into a composite substrate with rock. Washing will occur at the Doonan Solid Waste Facility.
- Deploying the rock on site by placing it on site carefully, rather than dumping it off the side of the barge, if plumes are caused.
- Inspection and physical marking of the seagrasses in closest proximity to the site is to be undertaken prior to commencement of works. During works visual monitoring of the sediment plume is to be undertaken. Where the visible plume extends to within 5m of seagrass beds, turbidity monitoring is to be undertaken.
- The extent and duration of the anticipated sediment plume is such that mangrove species are unlikely to be impacted and do not require monitoring unless significant sediment plumes are observed.

  If seagrass remains at risk of sediment smothering (if turbidity monitoring indicates turbidity (NTU) is more than 10% above background), then employ a combination of the following:

- Deployment of silt curtains around the seagrass beds, or in close proximity to the restoration site and/or,

- Deploy substrate down current of the seagrass bed (e.g. on a falling tide for seagrasses located upstream of the works), or within an hour of high or low tide (slack water).
- Ensuring silt curtains do not interact with marine plants and are deployed for the absolute minimum possible soak time required to achieve the rock deployment at the site.
- Constant monitoring of the silt curtains to ensure they to not move and interact with marine plants, impede fish passage or impose unreasonable imposition on other waterway users.
- Review substrate handling protocols and enhance the substrate cleaning/preparation efforts until plumes are minimised.
- Review construction operations procedures and amend as required to minimise potential for impacts.
- Consider implementing additional operational measures.
- Inspect the seagrass beds to determine if there is evidence of sediment smothering compared to pre-works inspection.
- Report any impacts on seagrass to authorities as per permit conditions.

6.5 Load out site management

The proposed load out site is at the western end of Hilton Esplanade, Noosaville (figure 6.5). The load out site is configured in two sections leaving sufficient space for recreational boaters and commercial companies to access the shoreline (Figure 6.5b). The 15.4m long exclusion line between the two sections is to separate the movement of rock between the two sections from boaters using the shoreline. This section will be managed by the contractor using traffic cones, NOT fencing. The cones will be removed when there is no movement of material between the two sections.

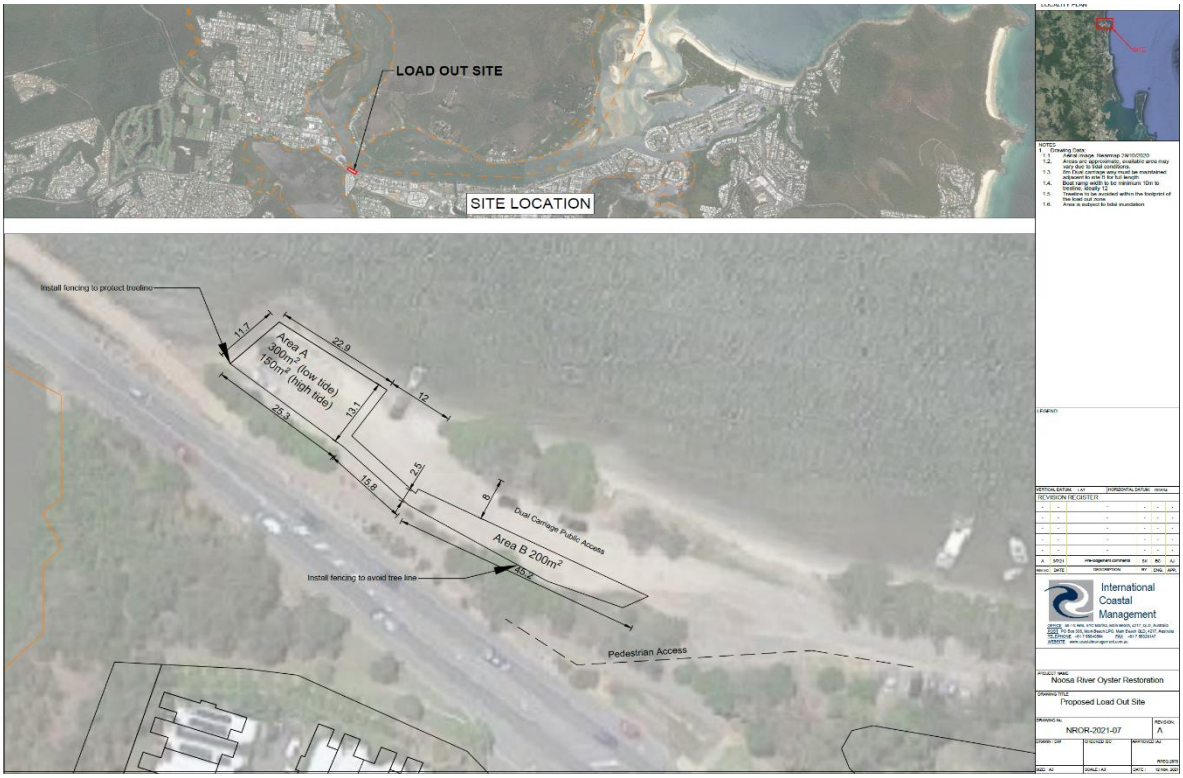


Figure 6.5: Location of proposed load out facility located at the end of Hilton Esplanade, Noosaville

The site will be managed by the project's contracted construction company that is experienced with this work, having previously been contracted to the Department of Primary Industries in NSW to undertake a similar intertidal shellfish restoration project.

The operational parameters for the site are presented in Table 6.2.

Table 6.2 Operational parameters

Parameter	Proposal
Timeframe:	February – April 2022 subject to permits
Duration of use:	40 days including mobilisation, demobilisation and potential stand down days
Management:	Contracted commercial construction company
Site area:	Exclusive use of 540m2 of road reserve (350m2 at high tide) at the end of Hilton Esplanade (Figure 6.5b) Load out area A = 300m2 area (150m2 at high tide) Load out area B = 200m2 area Load out area connection = 40m2 Area A is primarily for rock and equipment loading/unloading operations in association with the barge. Area B is primarily for rock and equipment storage. The load out area connection creates a safe fenced corridor for the movement of the Posi-track loader between Areas A and B.
Nature of uses:	Movement of up to 7 commercial trucks per day to the site to delivery porphyry rock. Storage of up to 90m3 of rock (150mm to 500mm diameter) per day Loading of rock and dried oyster shell onto the barge using an excavator + Posi-track Storage of loading ramps, vehicle and heavy equipment No chemicals, fuels or liquids will be stored at the site.
Frequency of use:	12 hour/day operational. 6am to 6pm including site management. Expected up to 7 truck movements per day along Hilton Esplanade to deliver rock to the load out site per day. Barge will ferry rock to restoration sites as needed from the load out facility with expected 2- 5 loadings per day subject to tides.

Public access:	A dual carriage way with a minimum of 8m width will be maintained to allow access to the boat ramp along Hilton Esplanade. A dual public boat launch area 12m wide will be maintained along the shoreline. Note that the formal dual boat ramp at Tewantin is 10m wide. Adequate vessel reversing area will be maintained between site areas A and B. Access to Hilton Esplanade from Hilton Terrace via the pathway leading from Hilton Terrace will be maintained. Commercial operators wishing to use the ramp may negotiate temporary access to the shoreline directly with the project's construction contractor.
Public safety:	Load out site areas A and B will be fenced using commercial fencing as will a 2.5m corridor joining areas A and B. Signage will be used on the fencing to inform the public about the site, its purpose and cautions. The barge will only come ashore within site area A. The construction company will use standard traffic control methods to ensure the public is separated from truck movements at the end of Hilton Esplanade and operations between site area A and B.
Public notifications	A public notification regarding the works will be printed in the Noosa News two weeks prior to commencement of activities. An announcement will be made in the Noosa Council's circular. Relevant authorities will be notified of works prior to commencement. Public notification signage will be posted at the site and will include a QR code which connects to online information about the construction process: Timeframe, purpose, activities, further information. Tourism facilities adjacent to the site will be specifically notified and met with to explain the work schedule.
Noise management:	Truck movements and barge loading will take place between 7am and 6pm weekdays, and between 8am and 5pm on weekends.
Environmental management:	Trees will be protected from harm from machinery and fencing. Fencing will be placed at a distance from the tree line and visible tree roots will be avoided. The site will be kept clear of debris/refuse. The site will be rehabilitated to its pre-use condition or better.

SECTION 7 – SIGNAGE + AIDS TO NAVIGATION

TNC proposes the installation of moderate signage and essential aids to navigation. To improve visual amenity, the signs may be placed on top of navigation markers, rather than being standalone signs on pole structures. TNC is working with MSQ to refine signage for each site and possibly at boat ramps.

If independent signposts are installed, they would be erected in bare sediment close to the oyster reef patches. Moorings for any buoys used for navigation purposes would also be places onto bare sediment but close to the oyster reef patches. Signage is suggested as per the specifications given (see Figures 7.1 and 7.2) but we would prefer smaller signage, if agreeable to MSQ and other agencies. The size of the signs given here can be amended.

Navigation aids will not impact on tidal fish habitats or marine plant communities and will be positioned or configured to avoid the risk of trimming of marine plants e.g., seagrasses.

The suggested wording for signage includes text for restoration sites inside and outside of the declared fish habitat areas. The wording of the signage; however, could be more 'public friendly' and if permitted, will design this in contact with local MSQ, DAF and NSC offices. The signage also does not have to be Noosa Councils specific.

The suggested signage includes a recommendation for the public not to consume oysters from the restoration sites. While it is legal to eat wild oysters, some oysters on the restoration sites will be derived from oyster culture and oyster gardening. These oysters will not settle naturally on the site and may be selected by the public for consumption. Human consumption of these oysters introduces increased risk to TNC, as the project lead. Appropriate signage can reduce the risk to consumers while also limiting TNC's liabilities associated with food poisoning from eating contaminated oysters. Reducing losses of oysters from the restoration sites, due to collection, is an additional benefit.

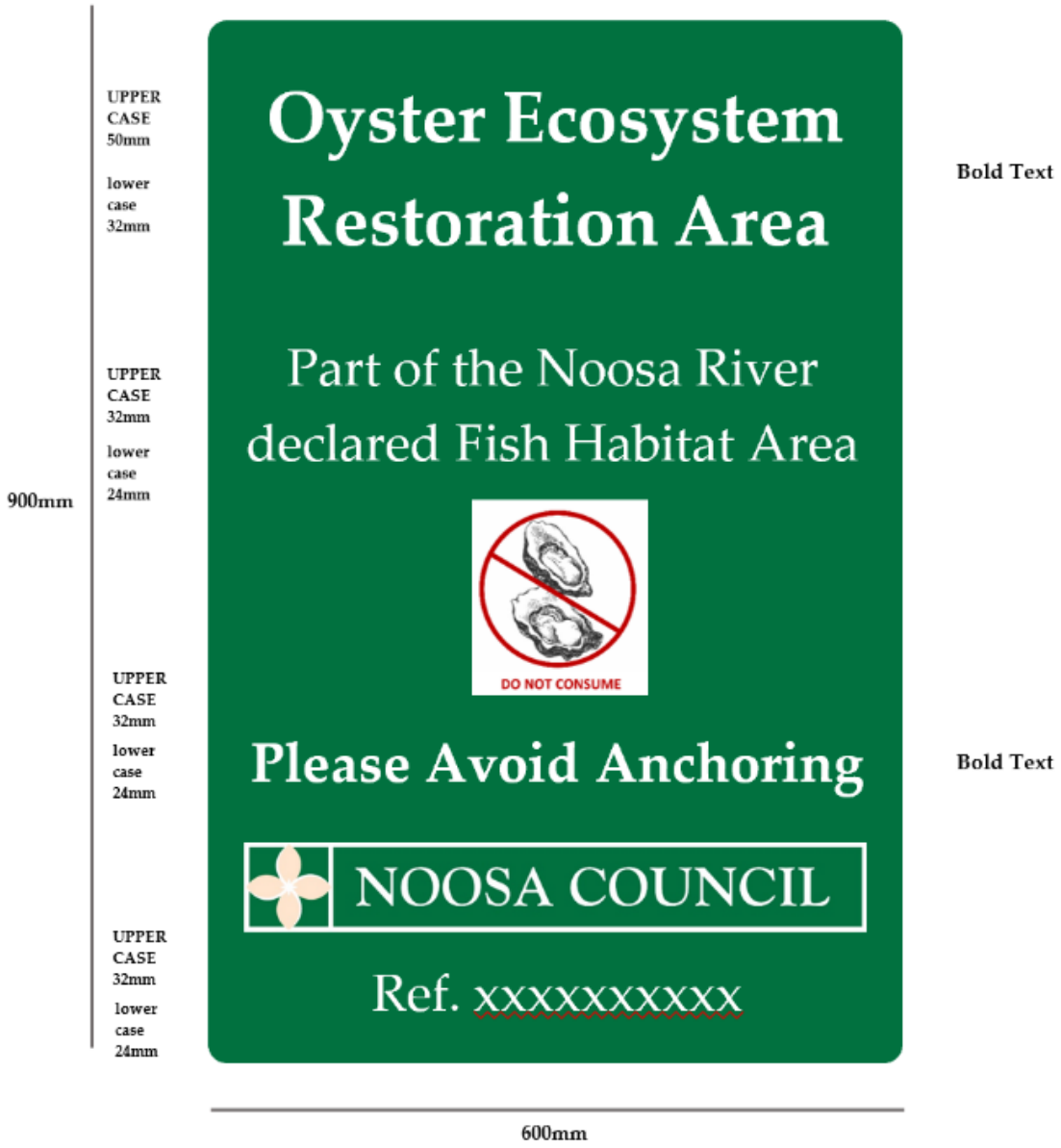
The signage suggested here has been engineered and is RPEQ certified (Registered Professional Engineer of Queensland) and the certification presented in Figure 7.3. The signs are re-purposed from the previous Noosa Oyster Restoration Trial Project implemented between 2016-2020 by the University of the Sunshine Coast (USC) and Noosa Biosphere Reserve Foundation (NBRF). The signs were removed from the Noosa River in 2020, as per permit conditions for that project, and gifted to TNC for use in this project.

Two of these signs have already been repurposed to mark the oyster shell curing site at Doonan Solid Waste Depot (refer to Section 6, Figure 6.3). The signboards, brackets and poles are in near new condition and will not be modified in any way part from changing the wording as per permit conditions. The poles will be cleaned of any lose material and disinfected prior to re-deployment. The signboards and brackets have been stored well and are in clean and good working order.

TNC may also place temporary signage at boat ramps, at least during the construction phase, to better inform river users of the construction activity being undertaken.

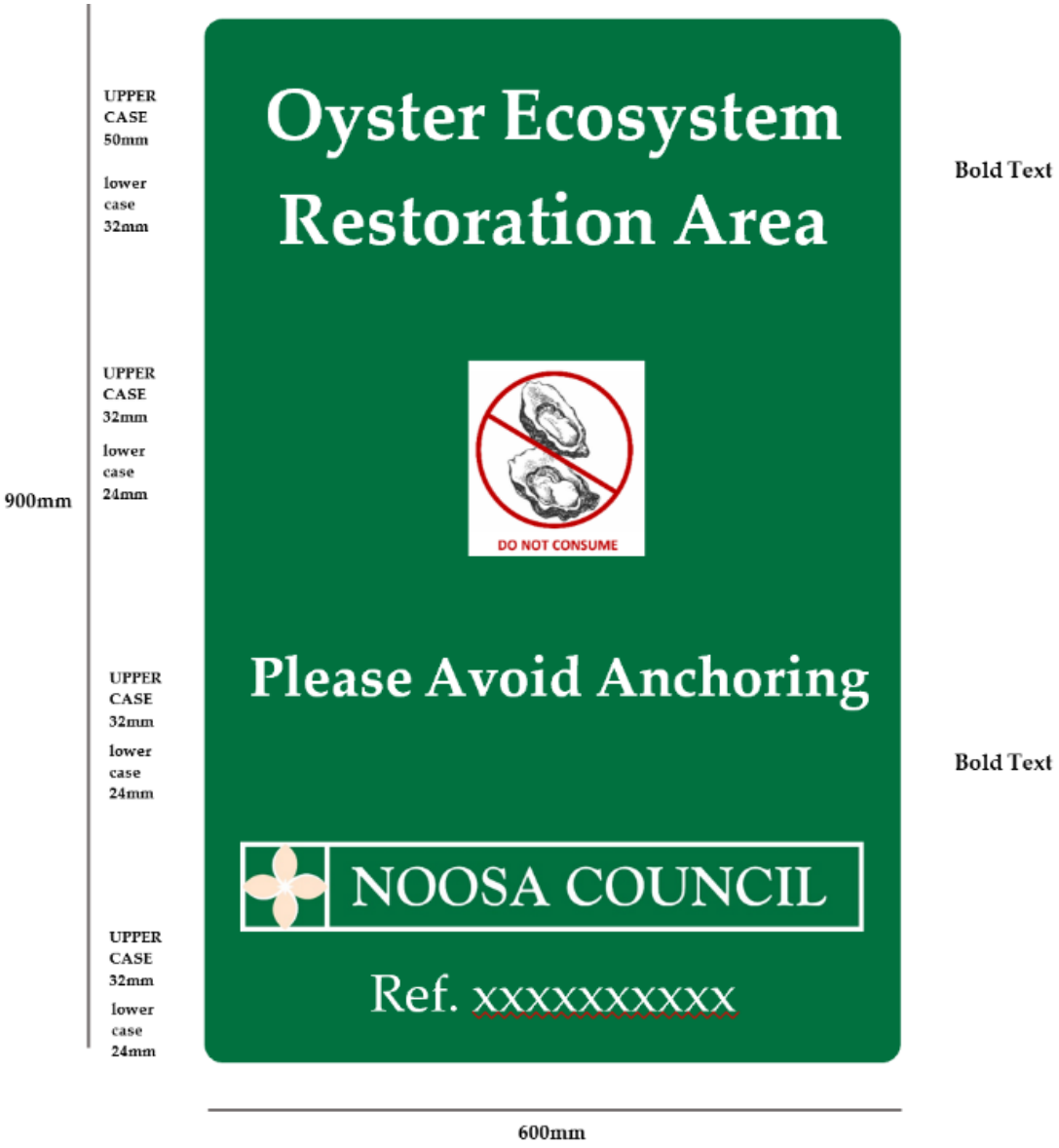
TNC proposes the use of SL – B600 marker buoys (Figure 7.4) as suggested by MSQ as the appropriate aid to navigation (underwater obstruction). One buoy may be placed at each end of a restoration site, and in the middle, but this will be confirmed formally with local MSQ prior to aid selection and deployment.

Aids to navigation and signage shall be placed in close association with the substrate footprint and positioned to minimise impacts on marine plants and habitats. Signage and aids to navigation installed by a qualified contractor and removed as per permit conditions. Once positioned, signage and aids to navigation will be included with 'as constructed' drawings of the restoration substrate footprints and submitted to authorities, as per permit conditions. Signage and aids to navigation will be maintained, removed or relocated during the permit period, as required with the written direction of authorities.



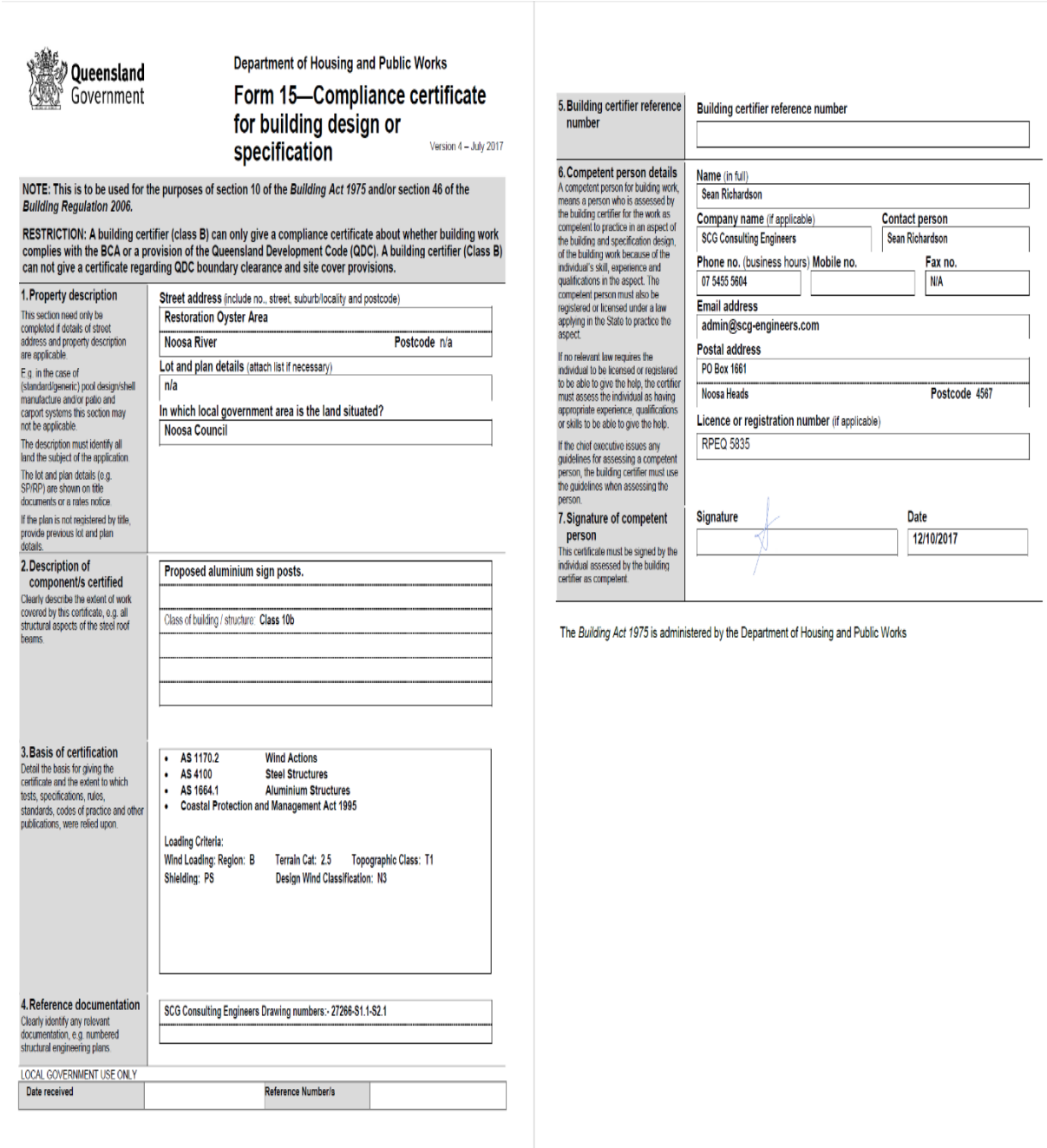
Sign Dimensions: 900mm high x 600 mm wide
Construction Material: Alloy plate (corrosion resistant material)
Colour - Background: Brunswick Green
- Text/lettering: Reflective White
Font: Palatino
Bold where indicated
Regular elsewhere
Font Size: Size as indicated - Large font 200pt
- Small font 150pt
Logo: Standard Noosa Council Logo as depicted

Figure 7.1: Signage specifications proposed for restoration sites that occur in declared fish habitat areas. Signage includes preferred wording.



Sign Dimensions: 900mm high x 600 mm wide
Construction Material: Alloy plate (corrosion resistant material)
Colour - Background: Brunswick Green
- Text/lettering: Reflective White
Font: Palatino
Bold where indicated
Regular elsewhere
Font Size: Size as indicated - Large font 200pt
- Small font 150pt
Logo: Standard Noosa Council Logo as depicted

Figure 7.2: Signage specifications proposed for restoration sites that occur outside declared fish habitat areas. Signage includes preferred wording.



Queensland Government

Department of Housing and Public Works

Form 15—Compliance certificate for building design or specification

Version 4 – July 2017

NOTE: This is to be used for the purposes of section 10 of the *Building Act 1975* and/or section 46 of the *Building Regulation 2006*.

RESTRICTION: A building certifier (class B) can only give a compliance certificate about whether building work complies with the BCA or a provision of the Queensland Development Code (QDC). A building certifier (Class B) can not give a certificate regarding QDC boundary clearance and site cover provisions.

1. Property description

This section need only be completed if details of street address and property description are applicable.

E.g. in the case of (standard/generic) pool design/shell manufacture and/or patio and carport systems this section may not be applicable.

The description must identify all land the subject of the application.

The lot and plan details (e.g. SP/RP) are shown on title documents or a rates notice.

If the plan is not registered by title, provide previous lot and plan details.

Street address (include no., street, suburb/locality and postcode)

Restoration Oyster Area

Noosa River Postcode n/a

Lot and plan details (attach list if necessary)

n/a

In which local government area is the land situated?

Noosa Council

2. Description of component/s certified

Clearly describe the extent of work covered by this certificate, e.g. all structural aspects of the steel roof beams.

Proposed aluminium sign posts.

Class of building / structure: Class 10b

3. Basis of certification

Detail the basis for giving the certificate and the extent to which tests, specifications, rules, standards, codes of practice and other publications, were relied upon.

- AS 1170.2 Wind Actions
- AS 4100 Steel Structures
- AS 1664.1 Aluminium Structures
- Coastal Protection and Management Act 1995

Loading Criteria:

Wind Loading: Region: B Terrain Cat: 2.5 Topographic Class: T1

Shielding: PS Design Wind Classification: N3

4. Reference documentation

Clearly identify any relevant documentation, e.g. numbered structural engineering plans.

SCG Consulting Engineers Drawing numbers:- 27266-S1.1-S2.1

LOCAL GOVERNMENT USE ONLY

Date received		Reference Number/s	

5. Building certifier reference number

Building certifier reference number

6. Competent person details

A competent person for building work, means a person who is assessed by the building certifier for the work as competent to practice in an aspect of the building and specification design, of the building work because of the individual's skill, experience and qualifications in the aspect. The competent person must also be registered or licensed under a law applying in the State to practice the aspect.

If no relevant law requires the individual to be licensed or registered to be able to give the help, the certifier must assess the individual as having appropriate experience, qualifications or skills to be able to give the help.

If the chief executive issues any guidelines for assessing a competent person, the building certifier must use the guidelines when assessing the person.

Name (in full)

Sean Richardson

Company name (if applicable) Contact person

SCG Consulting Engineers Sean Richardson

Phone no. (business hours) Mobile no. Fax no.

07 5455 5604 N/A

Email address

admin@scg-engineers.com

Postal address

PO Box 1661

Noosa Heads Postcode 4567

Licence or registration number (if applicable)

RPEQ 5835

7. Signature of competent person

This certificate must be signed by the individual assessed by the building certifier as competent.

Signature Date

12/10/2017

The *Building Act 1975* is administered by the Department of Housing and Public Works

Figure 7.3: Signage was previously certified by a Registered Professional Engineer of Queensland (RPEQ Certification) and will not be modified from the engineered specifications for use in this project.

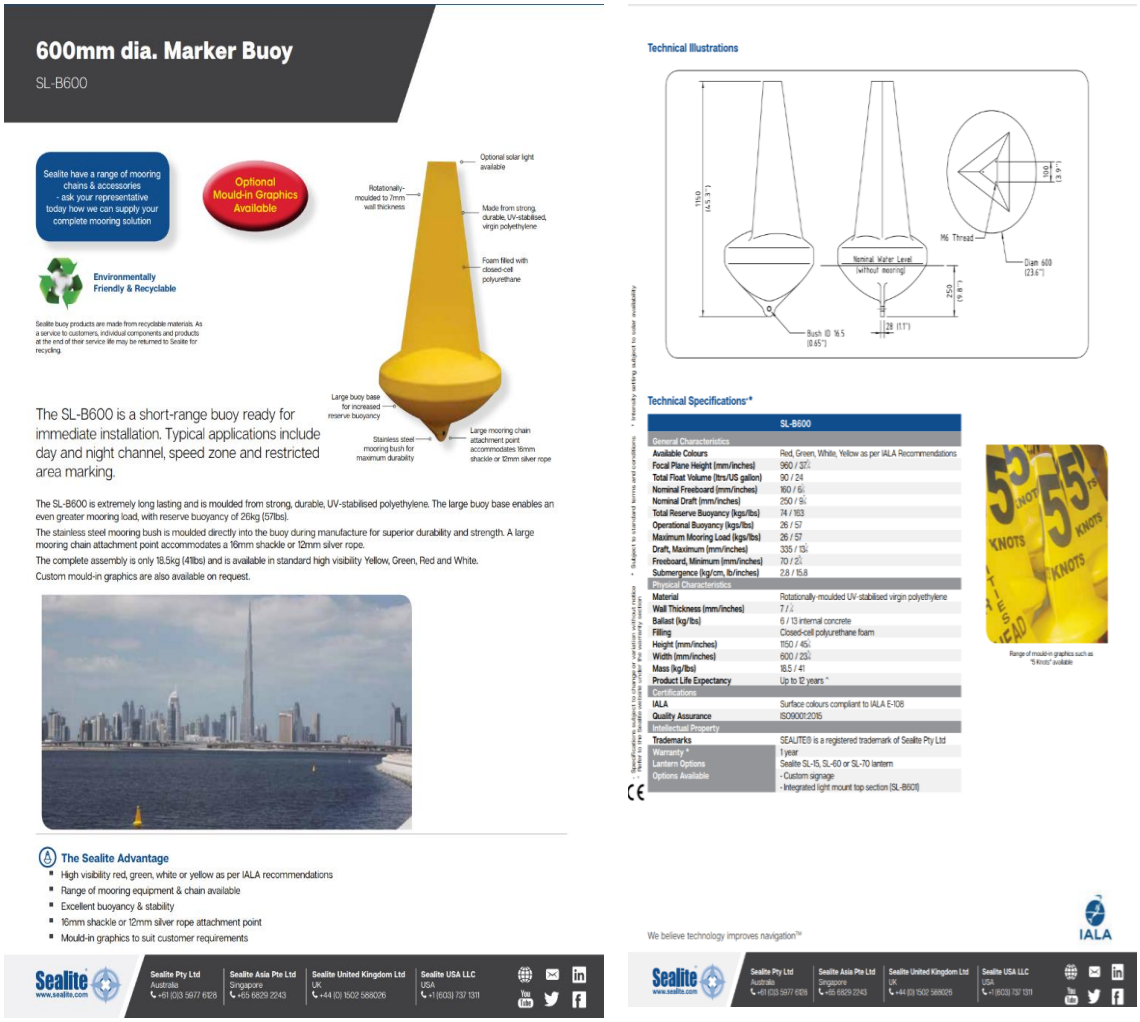


Figure 7.4: Proposed Aid to Navigation – SLB600 Marker Buoy as suggested by Noosa MSQ. Source: SPEC_SL-B600.pdf (sealite.com).

SECTION 8 – PERFORMANCE MEASURES

The objectives of the performance management framework are to:

- Maximise public safety
- Maintain visual amenity of the Noosa River (through optimal signage)
- Enact environmental safeguards to protect marine plants and natural processes
- Monitor for potential erosion
- Monitor and manage community feedback or complaints
- Ensure contingency measures are in place

8.1 Public Safety

The key hazards associated with public safety at the restoration sites during construction and site management, their likelihood and consequence, and proposed treatment are presented in Table 8.1. Public safety is further analysed and presented in Annex 8: *Safety in Design Report*.

Table 1: Primary hazards of restoration substrates to public safety and their treatment

Hazard	Likelihood	Consequence	Treatment
Physical interaction with the restoration substrate (Monitoring Personnel or Public)	LOW	MEDIUM	Gaps around oyster reef patches to be 1m-4m at seabed. Rock stable under its own weight and by interlocking of material. Oyster shell to be placed towards the middle of individual reef patches to minimise potential of displacement from structure. Works to be appropriately signposted in consultation with MSQ. Works to be certified by a coastal engineer on completion as conforming with the specifications.
Works pose a risk to navigation	LOW	MEDIUM	Oyster reef patches laid as per specifications and locations selected with wide consultation and MSQ input. Restoration sites marked as per MSQ requirements. Public information products imbedded locally through public and social media to advise of site locations and hazards including signage at boat ramps or as directed by authorities.
Works pose a risk to public access to river shoreline	LOW	LOW	Restoration sites selected to avoid all known shoreline access points. No works within 10m either side of a public park, shoreline beach (of any size) or shoreline or within 30m of a pontoon or jetty. No site directly adjacent to shoreline houses or public or commercial facilities.

			Gaps between the oyster reef patches gives direct access to shorelines to small and medium vessels (e.g. kayaks, tinnies). Position of works clearly marked with signage.
Members of the public eating oysters from the oyster beds possess health risk	LOW	HIGH	Consumption of oysters in the Noosa River expected to be low but may change. Project signage to discourage oyster consumption at restoration sites. Project brochure, online Q&As and project media encourages consumers to purchase oysters from seafood suppliers, thus supporting local business and reducing risks to health from consumption of wild oysters.
An oyster bed cause erosion to infrastructure such as to cause risk to public safety	LOW	MEDIUM	Coastal fringes and property upstream and downstream within 100m of a given restoration footprint monitored for signs of erosion visually every 6 months and by a comparison of images every 12 months. Significant erosion directly attributable to restoration works will be remediated in consultation with authorities. See Section 8.6 *Contingency Plan*

8.2 Visual amenity

Maintaining the visual amenity of the Noosa River estuary is important to many river users. The project therefore aims to minimise its impact on the visual amenity value of the river during construction and management of the restoration sites.

The project's potential threats to visual amenity and prescribes treatments and rationale are outlined in Table 8.2.

Table 8.2: Threat of oyster restoration to visual amenity and their treatment

Threat	Likelihood	Consequence	Response
Oyster bed construction, monitoring and maintenance works generate public complaints or vandalism due to impact on visual amenity (or undefined reasons)	MEDIUM	MEDIUM	Optimise Construction Environmental Management Plan (CEMP) to minimise noise, dust and disruption to river users Public notifications as per requirements. Public awareness actions about the project purpose and activities produced and distributed (brochure, fact sheets,

			news articles, radio interviews, website and social media presence). Public complaints record, feedback and reporting mechanism operationalised.
Signage and aids to navigation generate public complaints or vandalism due to impact on visual amenity	MEDIUM	LOW	Signage and aids to navigation monitored monthly. Signage and aids to navigation managed as per Section 8.6 *Contingency plan*
Sediment plumes caused by construction or maintenance works	MEDIUM	MEDIUM	Sediment management measures implemented as per Section 6.4 *Sediment management*

8.3 Environmental performance and safeguards

Maintaining environmental safeguards during the site management phase, when oyster beds are in the process of growing, is fundamental. These safeguards are presented in Table 8.3 as part of the projects Monitoring, Evaluation and Reporting (MER) system.

The project also maintains a separate comprehensive MER plan for the project. The MER Plan encompasses a wide range of ecological, social and economic parameters and reporting responsibilities. The subset presented in Table 8.3 are the key MER performance measures relevant to this application. These will be augmented with any subsequent additional permit conditions as required.

Table 8.3: Environmental safeguards

Performance Objective	Monitoring Method/Target	Frequency of Monitoring	Corrective action (where performance objective not met)
1. Restoration bed stability			
Oyster restoration substrate remains within a restoration site	Visually inspect oyster restoration substrates and record the precise GPS position and size of each. Use GIS software to contrast the position, footprint, size and area of each restoration substrate between monitoring events and assess any potential movement.	After deployment (to ensure conformity to the restoration plan). After every 6 months in the first year, then once every year for the following two years.	Any restoration substrate that moves out of the designated restoration site will be rectified as per the specifications. See Annex 7: *Engineering Specifications* Any shell added to a restoration site also monitored.
2. Oyster recruitment – ecosystem formation			
Oysters and associated sessile benthic	Measured against benchmark: %	After every 6 months in the first year, then	Substrate height adjusted to optimise

invertebrates recruit to the restoration substrates[10]	Recruitment > mortality (count/m2) per restoration site Within 6-8years: Density of rock oysters at restoration site average of > 200 individuals/m^2 4+ age classes of rock oysters present at restoration site (= approx. 2 cohorts of oysters reproductive) > 5% of rock oyster population at the site is 3+ years old Increased density of oyster recruits with 3-4 reproductive cycles 5 times more epifauna on oyster habitat than on surrounding sediment	once every year for the following years.	oyster recruitment, as per specifications. See Annex 7: *Engineering Specifications – Rectifications Table* Seeded oyster cultch and live oysters added to rock substrate to augment recruitment as per specifications. Substrate height adjusted to optimise oyster recruitment, as per specifications. See Annex 7: *Engineering Specifications*
3. Community use and enjoyment of oyster restoration sites			
Oyster beds do not significantly impact community safety, access and/or use of the Noosa River estuary including Fish Habitat Areas.	Visually monitor community use of the restoration sites If a site needs closer monitoring, as directed by a public authority, then the project will establish a specific action for that purpose. Maintain records of partner or community feedback and reported evidence of substrate or signage vandalism or vessel strike. Records will include:	Ongoing - report significant complaints or incidents to authorities Annually - report feedback received and responses in project report	Maintain complaints mechanism as per Section 8.5 *Complaints management* Modify oyster reef patch/es or signage, aids to navigation as per Section 8.6 *Contingency plan* Report feedback and adaptive management responses in the project annual report.

	i. Number and type of compliant received ii. The types, number and severity of any acts of wilful vandalism iii. The type and severity of any boat strike		
4. Additional potential affects			
Deleterious interaction with marine plants	Adopt minimum distances between mapped marine plants and construction works as per the specifications	Prior to deployment of substrate check for marine plants visually at the site and adjust works to avoid, if marine plants found Post deployment survey and mapping of 'as built' structures in relation to marine plans and submit to authorities with RPEQ certification Annually - monitor changes in nearby plant communities	Modify oyster reef patches as per Section 8.6 *Contingency plan*. Report changes in associated plant communities and remediation actions in annual report.

8.4 Erosion control

TNC's consultant engineers have confirmed:

The purpose of these works is not to provide erosion protection but to restore rock oyster ecosystems throughout the Noosa River.

Natural erosion can be the result of tidal or flood flows, but in many locations within the Noosa River erosion is strongly influenced by wind waves and vessel wake. Hard structures have the potential to result in reduced (or increased) erosion because of changes to river flows or wave action, changes to sediment transport patterns as well as end effects. Hard structures can also result in shoreline protection that reduces erosion.

Even though the works are not intended to provide erosion protection, the nature of the works are generally expected to result in reduced severity of coastal erosion adjacent to the structures. The oyster reef patches in this project are engineered to reduce any potential for these structures to result in increased erosion of adjacent shorelines, including shorelines upstream and downstream of the works.

Features of the oyster reef patches (the works) that consider coastal processes include:

Concept module layout - Concept Layouts 2 & 3 (segmented longshore modules) show how oyster reef patches are configured to minimise impacts to littoral drift and coastal processes by being aligned with river flows and providing gaps between oyster reef patches. Despite this, the oyster reef patches are anticipated to act as a segmented reef and provide some sheltering to the shoreline from wave action and vessel wake and result in reduced erosion. Reef has been segmented to limit this impact and allow penetration of waves and flows without resulting in pockets of increased erosion.

Concept layout 1 provides habitat that extends out perpendicular from the shore similar to observed development of oyster reef habitats. This layout is only suitable in locations with low sediment transport and not within Restoration Zone 1 Main Channel. In these locations there is limited risk of the works acting as a submerged groyne, which would have the potential to impact on littoral drift, erosion, and accretion patterns (as well as result in undesirable burial of sections of the structure).

Shaped oyster reef patches – Oyster reef patches may be curved or shaped to reflect the local bathymetry and site-specific conditions. Alignment with the shoreline or directing flows away from the shoreline reduces the potential for focussing of tidal or flood flows. Tapering of the reef ends reduces the potential for flow disturbances (such as eddies) to develop.

Crest level – Crest levels are dictated by desirable water depths for the target species and do not extend above MHWS. As with many natural oyster reefs, they are exposed during lower tides and inundated during higher tides (or flood events). When water levels are close to or over the crest of the reef, wave action and vessel wake would be expected to overtop the structure. As such, wave energy reaching the shoreline (especially for Layout 2 & 3) will be reduced but not eliminated. While natural erosion may continue to occur, it is expected to be reduced.

Access space – The provision of an access space facilitates monitoring of the reef habitat, but also provides space for natural flows to occur between oyster reef patches.

Porous rock substrate – waves impacting with the substrate are dissipated into the voids in the substrate, with reduced wave energy impacting on the adjacent shoreline and reduced wave reflection compared with solid structures.

Engineering design by coastal specialist – Final oyster reef patch layout is to be confirmed by the certifying coastal engineer post construction. For Phase 1 sites, this is undertaken by International Coastal Management. For Phase 2 sites, this is a requirement prior to construction (refer Drawing NROR-2021-02 note 1.6).

Erosion monitoring and mitigation

The restoration sites, as well as shoreline 100m upstream and downstream of the sites, will be monitored visually every 6 months to check for signs of exacerbated shoreline erosion. Every 12 months, photographs will be used to compare changes in the shoreline shape. Where significant erosion is detected and is directly attributable to the presence of the restoration works, remedial actions will be undertaken in consultation with authorities, such as the modification of the height or form of related oyster reef patches to reduce the erosion hazard (see Section 8.6 *Contingency plan*).

8.5 Complaints management

TNC has developed a self-explanatory project brochure and answers to Frequently Asked Questions about the project. TNC has also published and distributed site maps and will disseminate information about the construction and most construction management phase via mailouts. These are also made widely available via the TNC website - see https://www.natureaustralia.org.au/what-we-do/our-priorities/oceans/ocean-stories/noosa-river/noosa-faqs/ and will be promoted through project partners and authorities to help spread information about the project and thus help to manage inquiries.

TNC, as the project lead, will manage the response to all complaints in liaison with relevant authorities as well as the contracted construction company. The rating and intended responses to complaints is given in Table 8.5. The complaints record keeping system is as per Table 8.5a.

Complaints and responses will be included, in general terms, in annual reports. Relevant agencies may access the detail of complaints, as per tables.

Table 8.5: Complaint rating and response

Complaint severity	Nature	Response	Timeframe
Low	General concerns and questions about project activities, timeframes or details. General inquires not directly related to the project	Phone call and/or email response giving response or source of information. Refer to appropriate agency	Within 48 hours
Medium	Concerns related to specific project actions and impact on visual amenity or environment, as they occur Specific complaints about the project in general	Phone call and/or formal written response depending on nature. Consultation with relevant agencies regarding the response, if required.	Within 24 hours

		Additional actions, as required	
High	Concerns that a specific project activity is posing an immediate and significant threat to life, property or natural environment	Phone call and/or formal written response depending on nature. Consultation with relevant agencies regarding the response, if required. Additional actions, as required	Within 12 hours

Table 8.5a: Complaints Record Management

Details of Plaintiff	Description of Complaint	Severity	Response/s
Date of complaint Full name of plaintiff Contract details Contact modality (email, phone, etc)	Detailed description including any historic or contextual information	Low/Medium/High	- Date/s taken - Description - Persons involved in the response Chronological log, if multiple actions taken and multiple responses from plaintiff received

8.6 Contingency plan

The contingency plan outlined in Table 8.6 specifies remedial actions that will be undertaken in the event that oysters fail to recruit to the oyster reef patches, vessel strike an oyster reef patch/es, visual amenity is significantly impacted by the presence of the works, or associated signage, or where erosion as a result of the restoration works causes impacts to shorelines or property.

Where remedial action demands changes to an oyster reef patch configuration, these changes will be made consistent with the engineering specifications (Annex 14: *Engineering Drawings*). The engineers will also be consulted prior to any changes being made.

Table 8.6 – Contingency plan

Challenge	Contingency response
Limited oyster recruitment	Oyster reef patches will be seeded with oyster spat settled onto dried oyster cultch, as is described in detail in Section 5.*2 Substrate augmentation*. Reef seeding is used widely in shellfish restoration as a back stop to highly variable natural oyster recruitment. Seeding will be repeated at a restoration site until natural recruitment at the site is achieved and is demonstratable.
Vessel strike on oyster reef patch	Restoration sites will be sign posted, with MSQ guidance, and information about the sites widely distributed. A notice to mariners

	will be issued as required, and the inclusion of restoration sites into local navigational guides explored with MSQ. If an oyster reef patch encounters repeated vessel strikes then signage and information products will be reviewed with MSQ and NSC, and, as a last resort, the height of an oyster reef patch may be lowered, or shape of an oyster reef patch, or patches, modified to reduce the navigation hazard to an acceptable level.
Extensive public complaint about visual amenity of an oyster reef patch or series of reef patches	Where extensive public complaints are received specifically relating to the position or configuration of reef patch/es, or signage, and these concerns are validated by TNC and local authorities, then the respective oyster reef patch/es will be modified in height or shape to alleviate the concerns, once all other avenues to address the concerns have been exhausted.
Erosion caused by oyster reef patches	Where significant erosion is detected within 100m of a restoration site and is shown to be directly attributable to the presence of the oyster reef patches, remedial actions will be undertaken in consultation with authorities. Remedial actions may include modification of the height or form of oyster reef patches, to reduce the erosion hazard, and/or remedial actions to the affected shorelines or property.

SECTION 9 - ANNEXES

Annex 1 - Noosa River Habitat Survey Report - ESP
Annex 2 - Noosa River MSES Map - Tewantin & Goat Island
Annex 3 - Noosa River Environ Values & Water Quality Map
Annex 4 - Noosa River Fish Habitat Area
Annex 5 - Community Engagement Workshop Report
Annex 6 - Public Information Sessions Report
Annex 7 - Engineering Specifications
Annex 8 - Safety in Design Report
Annex 9 - Code 7 - Maritime Safety
Annex 10 - Code 8 - Coastal Development & Tidal Works
Annex 11 - Code 11 - Marine Plants
Annex 12 - Code 12 - Declared fish habitat area
Annex 13 - Schedule 3 - Prescribed Tidal Works
Annex 14 - Engineering Drawings NROR-2021