Appendix L Navigational risk assessment

Ngāi Tahu Seafood Resources Limited

Hananui Aquaculture Project

Navigational Risk Assessment

Evidence of Geraint R Bermingham regarding the *Hananui Aquaculture Project, Navigational Risk Assessment* and Proposed Conditions

Geraint Bermingham
11-11-2025

Introduction

My name is Geraint Bermingham

My role in relation to the Hananui Aquaculture Project ("**HAP**") has been to provide expert evidence in relation to maritime navigational risk. I wrote / was the lead author of the *Hananui Aquaculture Project, Navigational Risk Assessment date 01 September 2025* which is provided within **Appendix L** of the application.

This evidence has been prepared to accompany the application by Ngāi Tahu Seafood Resources Limited ("**NTS**") for approvals required for the HAP under the Fast-track Approvals Act 2024 ("**FTAA**"). It has been prepared on the understanding that the process for determining applications under the FTAA does not require a hearing to be held, and accordingly the purpose of this evidence is to confirm that, relative to my area of expertise, the *Hananui Aquaculture Project, Navigational Risk Assessment date 01 September 2025* provides an appropriate description of the relevant maritime navigational environment, the proposed activities comprising the effects of the HAP on that environment, and the way those effects are proposed to be managed.

My findings are set out in full in the *Hananui Aquaculture Project, Navigational Risk Assessment date 01 September 2025* included within **Appendix L** of the application.

While this application is not being considered by the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and that I have complied with it when preparing this evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Qualifications and Experience

I am a director of Navigatus Consulting, a risk management specialist consultancy and have held various maritime related roles including Otago Regional Council Harbourmaster and naval marine engineer officer.

I graduated from Royal Navy Engineering College Manadon (UK) and hold or have held various maritime related qualifications including BEng (Hons) and marine engineering charge qualification, coastal yacht master, and vessel officer of the watch. I have also been the New Zealand representative on the ISO committee that prepared the global risk management standard (ISO 31000) and assisted the Australian committee with the related risk analysis standard (ISO31010)

My professional background includes 20 years in the Royal Navy serving at sea on warships and submarines as well as roles supporting large vessel salvage and related operations.

As a consultant, I have also undertaken or been directly involved in a range of maritime and navigational risk projects, including a number related to fish farm development.

In providing this evidence in relation to maritime navigational risk, I have considered the following matters as relevant to that topic:

- The project description provided by NTS as set out in section 6 of the application;
- The description of the existing navigational environment, the effects of the HAP on that environment and their significance, and the proposed management and mitigation measures to manage those effects all as set out in the assessment of environmental effects accompanying the application;
- Material and information sources, used in preparing the navigational assessment has included: vessel traffic tracks and information, nautical charts, the New Zealand Pilot, tidal information, and relevant national and international maritime guidance and regulations.

Confirmation of Contents of Report and Proposed Conditions

I confirm that in my opinion the *Hananui Aquaculture Project, Navigational Risk Assessment date 01 September 2025* contains an accurate and appropriate description of the environment, the actual and potential effects of the HAP, and the recommended actions to manage those effects within my area of expertise.

I confirm that in my opinion the contents of the *Hananui Aquaculture Project, Navigational Risk Assessment date 01 September 2025* may be relied on in making a decision on the approvals sought for the HAP and confirm that provided effects within my area of expertise are managed as proposed in the application those effects will not be unacceptable and will be managed to a standard that I consider meets good practice.

I confirm that I have reviewed the conditions that NTS proposes for the approvals being sought as they relate to my area of expertise. I confirm that in my opinion, those proposed conditions are appropriate.

[redacted]

Geraint Bermingham

11.11.2025

Hananui Aquaculture Project

Navigational Risk Assessment

Prepared for Ngāi Tahu Seafood Limited

by

Navigatus Consulting

06 November 2025

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Hananui Aquaculture Project - Navigational Risk Assessment

Prepared for Ngāi Tahu Seafood Limited

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Revision	Revision Type	Date	Authorised By
Ver 0	Developed draft for client review	7 June 2025	G. Bermingham *(MS Word version – not signed)*
Ver 1	Release incorporating changes prompted by Client comments	22 Aug 2025	*(MS Word version – not signed)*
Ver 2	Finalised - released	1 Sept 2025	
Ver 2.1	Figs 2.1, 8.3, 8.4, 8.5 updated	6 Nov 2025	G Bermingham [redacted]

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Glossary

Term	Definition
AtoN	Aid(s) to navigation.
AIS	Automatic Identification System.
ALARP	As low as reasonably practicable.
CATZOC	Category Zone of Confidence.
GT	Gross tonnage – a measure of a ship's total internal volume, reflecting its overall size.
MHWN	Mean High Water Neaps – the average levels of each pair of successive high waters during that period of about 24 hours in each semi-lunation when the range of the tide is least (neap range).
MHWS	Mean High Water Springs – a tidal level representing the average of the levels of each pair of successive high waters during that period of about 24 hours in each semi-lunation when the range of the tide is greatest (spring range).
MLWN	Mean Low Water Neaps – the average levels of successive low waters during that period of about 24 hours in each semi-lunation when the range of the tide is least (neap range).
MLWS	Mean Low Water Springs – a tidal level representing the average of the levels of each pair of successive low waters during that period of about 24 hours in each semi-lunation when the range of the tide is greatest (spring range).
MSL	Mean Sea Level – the average level of the sea surface over a long period or the average level which would exist in the absence of tides.
Nautical mile	NM – a measure used by navigators for distance. 1 nautical mile is 1.852 kilometres.
VHF radio	Very High Frequency radio – most widely used as marine radios for ship to ship and ship to land communications.

1 Executive Summary

Ngāi Tahu Seafood Limited (NTS) propose to undertake a two-stage coastal salmon farming project titled the *Hananui Aquaculture* Project (the Project). The Project consists of establishing a farm development within the coastal marine area off Murray Beach, on the north-eastern coast of Stewart Island/Rakiura. Within this area, NTS propose to operate four salmon farms.

This navigational risk assessment follows the risk management process set out in ISO 31000:2018. It considers the navigational context of the Project including the natural environment and the existing navigational activity in the area.

Each farm, whether in terms of structure, equipment, or fish stock, represents a significant investment for the owners. While this report considers navigational risk, it should be noted that there are also investment and reputational consequences from any incident and hence risk. The mitigation of navigational risk, whether by careful design, proper marking of structures, or sound safety management, also acts to mitigate investment risk for the owner and operator.

The key risk scenarios considered by the assessment are:

- Interactions between third-party small vessels and the marine farm.
- Interactions between workboats and marine farm structures.
- Causes and effects of a large vessel passing close by or impacting a marine farm.
- Causes and effects of a large vessel dragging anchor and impacting a marine farm.
- Causes and effects of large vessels choosing to drift while awaiting access to South Port.
- Causes and effects of a farm or parts thereof breaking free or being lost and creating risk for vessels and other water users.

The outcome scenarios that were assessed are:

- Allision (large vessel).
- Allision (small vessel).
- Collision (large vessels).
- Collision (small vessels).
- Structural failure (break-way).
- Loose objects.

The assessment concludes that the proposed farm Project area off Murray Beach, Stewart Island/Rakiura, located in an area that has established large vessel anchorages in close proximity to and overlapping the proposed site, creates a notable development conflict. However, this conflict can be adequately mitigated by relocating the designated anchorages to other suitable locations in the surrounding area.

Having carried out the assessment of the hazards of the proposed Project, it is concluded that provided that the risks associated with the Project are properly mitigated, then the risk will be as low as reasonably practicable (ALARP) and acceptable.

The key mitigations can be summarised as consisting of:

Navigational

- The area in which the Project is located is suitably indicated with a full set of four lit cardinal buoys.
- Each farm set is properly marked with special marks, some of which should be lit.
- The position of the Project is properly charted.

Design

- Design criteria includes for normal metocean conditions and extreme events (including reasonably predictable natural hazards).
- Assurance of the secure mooring of the farm (through design and engineering peer review processes).

Management

- Policies and procedures to ensure monitoring of the mooring condition and performance (real-time and through life inspection).
- Sound management of work activity associated with the farms.

2 Introduction

2.1 The Project

Ngāi Tahu Seafood Limited (NTS) propose to undertake a two-stage coastal salmon farming project titled the *Hananui Aquaculture* Project (the Project). The Project consists of establishing a farm development within the coastal marine area off Murray Beach, Stewart Island/Rakiura. Within this area, NTS propose to operate four salmon farms. The farms are proposed to be located and laid out as indicated in Figure 2.1.

Stage 1 of the Project involves a feed discharge of 15,000 tonnes per annum and the establishment of a block of ten sea pens, arranged in a five-by-two configuration, at each of the four marine farming sites.

Stage 2 of the Project increases the overall feed discharge to 25,000 tonnes per annum with the introduction of an additional set of ten sea pens at each of the four marine farming sites.

Navigatus Consulting have been engaged to undertake a navigational risk assessment of the Project to assist NTS and other parties to understand the viability of the site from a navigational safety perspective.

The term *navigational hazard/risk* used in this assessment refers to the hazards/risks the Project presents or may present under failure situations to marine craft and vessels and the associated maritime activity and the hazards to farm staff from vessels operating nearby.

This navigational risk assessment will be used as part of the resource consent application and to enable ongoing support of the marine farms.

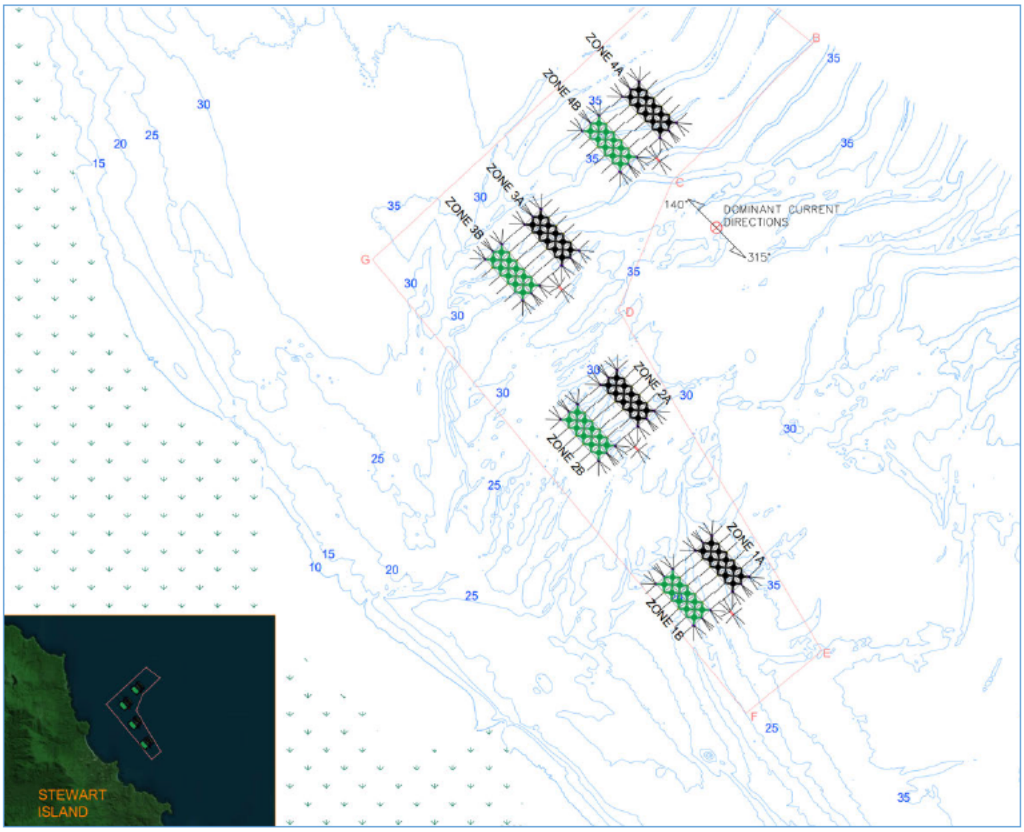


Figure 2.1: Proposed area and layout of occupied water space and marine farming sites.

2.2 Scope

Risk is defined as *"the effect of uncertainty on objectives"*. In this case, the objectives are to construct and operate four marine farms, across two stages, in water offshore from the north-east coast of Stewart Island/Rakiura.

This risk assessment is limited to the navigational risk associated with operating marine farms within the proposed consent area. Any other potential hazards and risks associated with the Project are not considered unless there is the potential for these to influence navigational safety, which are noted within this report as being included in the assessment.

2.3 Methodology

The risk assessment follows the risk management process set out in ISO 31000:2018[1] (Figure 2.2). The first step establishes the scope, context, and criteria. This is outlined in Sections 3 and 4.

The second step, risk identification, analysis, and evaluation, are presented in Sections 5, 6, and 7.

Finally, risk treatments, are proposed in Section 8.

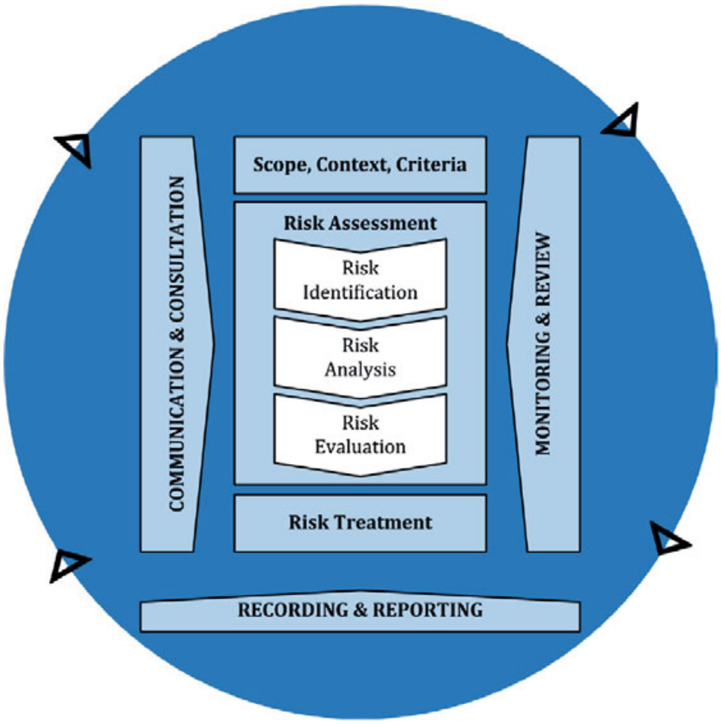


Figure 2.2: Risk management process (source: Figure 4, ISO 31000:2018 Risk management - Guidelines).

[1] International Organization for Standardization. (2018). *Risk management – Guidelines* (ISO Standard No. 31000:2018). https://www.iso.org/standard/65694.html

In addition, the assessment draws on the guidance provided in the Maritime New Zealand (Maritime NZ) Marine Farm Guidelines[2], particularly the key factors for navigation related matters as follows:

- Local conditions to consider:
  - Water depth, tides, currents and seabed composition.
  - Headlands.
  - Prevailing weather, sea state and swell conditions.
  - Safe havens and recognised or recommended anchorages.
  - Navigational routes and vessel traffic.
  - Narrow channels.
- Other water and neighbouring users:
  - Use of bays.
  - Existing marine farms.
  - Fishing activities.
  - Recreational activities.
  - Working traffic and access to shore.
  - Dwellings – access and amenity values.
  - Other uses generally.
- Marine farm design and structure:
  - Design plan for the layout and structures, including navigational aids.
  - Construction and removal phases.
  - Anchorages, moorings.
  - Access for small craft between and around marine farms.
  - Marine farms arranged in blocks or simple shapes.
  - Manoeuvring area.
  - Seasonal changes in shape and location.
  - Maintenance plan for the moorings, navigational lighting and associated equipment.
  - Design and manufacturing standards of the structure and aids to navigation (AtoN).

[2] Maritime New Zealand. (2018). *Marine farm guidelines: navigational safety*. https://www.maritimenz.govt.nz/media/ikmklfsj/marine-farm-guidelines-navigational-safety.pdf

- Other:
  - Vessel traffic generated by the marine farm itself.
  - Existing AtoN.
  - Responding to emergency events.

3 Context

The context of the maritime navigational risk assessment of the Project is as described in the sub-sections below.

3.1 Guidance, Regulation, and Legislation

The following list summarises the key legislation pertinent to the Project and navigational safety matters.

- **Resource Management Act 1991[3]:** under section 89A of the Resource Management Act, Maritime NZ is required to report on any navigation related matters that it considers relevant to an application, including any conditions that it considers should be included in the consent for the purpose of ensuring navigational safety.
- **Maritime Transport Act 1994[4]:** Section 200 ensures international obligations are met through a specific approval process for AtoN.
- **Maritime Transport Act 1994:** Section 33M provides the authority to the regional council to make bylaws for the purpose of navigational safety.
- **Southland Regional Council Navigation Safety Bylaws 2009 (revised 2015)[5]:** the document used to manage navigational safety in the Southland region.
- **Maritime Rules Part 22[6]:** Rule 22.40 is the same as Rule 2 of the International Regulations for Preventing Collisions at Sea 1972 (also known as Collision Regulations – COLREGs). This emphasises the responsibility of the navigator to be safe.
- **Port & Harbour Marine Safety Code New Zealand[7]: t**he main focus of the Code is on the safe movement of ships within commercial port and harbour areas, but it also covers the interactions of all ships and other users using those waterways. Here, a harbour is referred to as an area of enclosed or coastal waters where ships can shelter and includes natural and artificial harbours.
- **Maritime New Zealand Marine Farm Guidelines:** this document provides guidance to those involved in marine farms, particularly regarding AtoN and associated matters of navigational safety. Refer to Section 2.3.
- **International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA[8]) guidelines:** IALA publish standards, recommendations, and guidelines regarding the design and implementation of AtoN. These documents set

[3] Resource Management Act 1991. https://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html
[4] Maritime Transport Act 1994. https://www.legislation.govt.nz/act/public/1994/0104/latest/DLM334660.html
[5] Southland Regional Council. (2015). *Navigation Safety Bylaws 2009 (revised 2015)*. https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/bylaws/navigation%20safety%20bylaws/documents/navigation_safety_bylaws.pdf
[6] Maritime New Zealand. (2021). *Maritime Rules Part 22: Collision Prevention*. https://www.maritimenz.govt.nz/media/vu5bafi0/part22-maritime-rule.pdf
[7] Maritime New Zealand. (2020). *Port & Harbour Marine Safety Code New Zealand*. https://www.maritimenz.govt.nz/media/d55gj0tp/nz-port-harbour-marine-safety-code.pdf
[8] Previously the International Association of Lighthouse Authorities.

out the standards which will be required of any AtoN utilised in the Project such as the IALA Guideline G1162 for The Marking of Offshore Man-Made Structures[9].

3.2 Local Geography

This section discusses the geography of both land and water in the vicinity of the proposed Project area. In addition to the physical attributes of the area which are described in the following subsections, the cultural context is critical to understanding how the area is perceived.

Ngāi Tahu are tangata whenua and hold ahi kā, mana whenua, and mana moana over the area. The area remains treasured for its biodiversity and as a home, meeting place, and sanctuary for practising mahinga kai. Many of the water users have Ngāi Tahu whakapapa.

3.2.1 Motupōhue / Bluff

Aotearoa New Zealand's southernmost commercial deep-water port, South Port NZ (South Port), is located in Motupōhue / Bluff. South Port services the Southland region's import and export industries including aluminium, timber, fisheries, dairy, meat, wood chips, cement, fertiliser, and petroleum products. The port offers a range of marine services for cargo and container shipping. Ships visiting South Port can seek anchorage off the northeast coast of Stewart Island/Rakiura before or after their port call (refer Section 3.4.1).

A local commercial fishing fleet and chartered fishing operate from bases in Motupōhue / Bluff in addition to the regular ferry service between Stewart Island/Rakiura and the South Island.

3.2.2 Te Ara-a-Kiwa / Foveaux Strait

Te Ara-a-Kiwa / Foveaux Strait is the body of water between the South Island of Aotearoa / New Zealand and Stewart Island/Rakiura. It ranges from approximately 7.5 to 27 nautical miles (~14 – 50km) in width (Figure 3.1) with the width in the area of the Project being approximately 15 nautical miles (~28km). The depth ranges from 20 to 120 metres, generally deepening from east to west. The prevailing winds are westerly, and the conditions are often rough and stormy.

[9] IALA. (2021). *G1162 The Marking of Offshore Man-Made Structures*. https://www.iala.int/product/g1162/

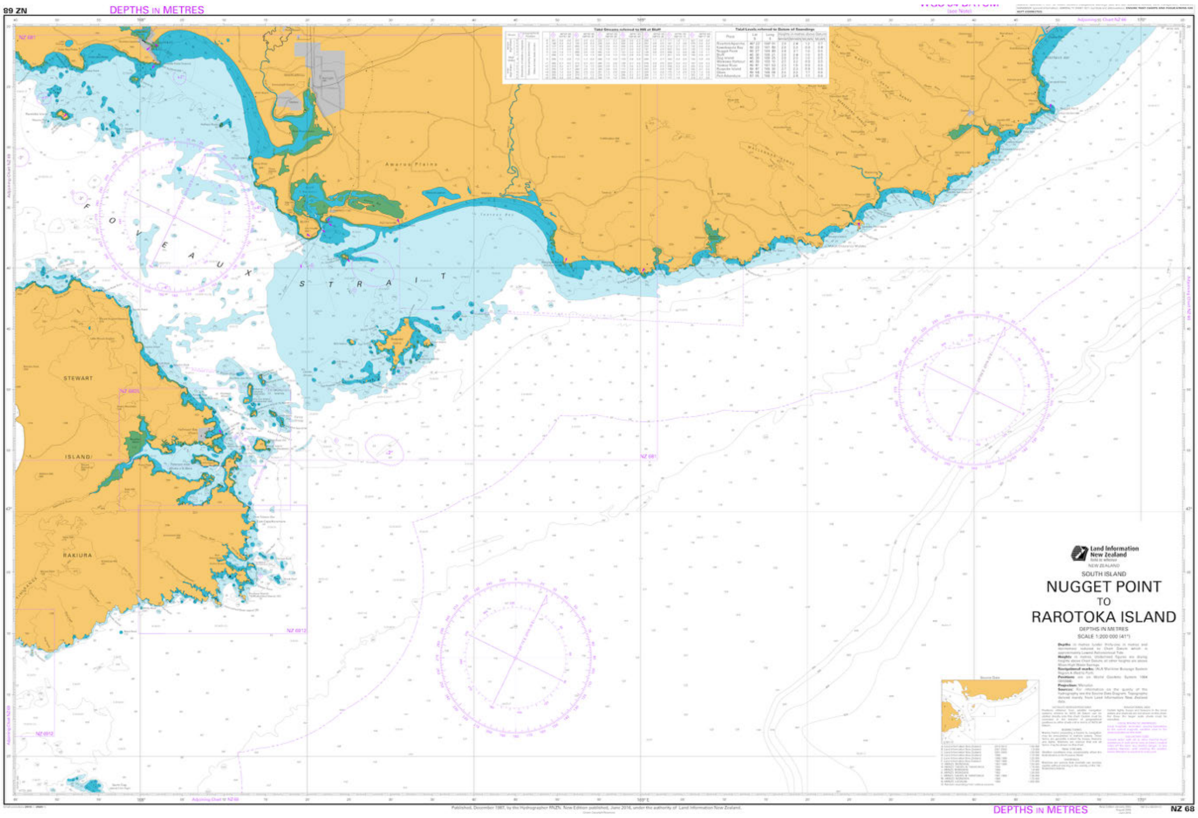


Figure 3.1: Overview of coastal area covering Stewart Island/Rakiura and Foveaux Strait.

3.2.3 Rakiura / Stewart Island

Stewart Island/Rakiura is the third largest island of Aotearoa / New Zealand and is located about 15 nautical miles (~35km) south of the South Island across Te Ara a Kiwa / Foveaux Strait. As such, the island is accessible by flight or ferry with several operators offering travel services from Motupōhue / Bluff, Waihōpai / Invercargill, or Tahuna / Queenstown.

3.2.4 Proposed Farm Location

The proposed marine farms are to be located off Murray Beach on the north-east coast of Stewart Island/Rakiura north of Horseshoe Bay, Halfmoon Bay, and Whaka a Te Wera / Paterson Inlet. The proposed consent area is located 0.175 nautical miles (~325m) north of the ‘Stewart Island pilotage area’ declared in Maritime Rule Part 90[10] for vessels of 500 gross tonnage (GT) or greater (Figure 3.2).

While there is no specific definition of a “coastal” or “offshore” marine farm in the Maritime New Zealand guidelines, the proposed farm location does correspond to the direction that those farms that are not within enclosed or sheltered waters are to be considered “offshore”.

[10] Maritime New Zealand. (2020). *Maritime Rule Part 90: Pilotage.* https://www.maritimenz.govt.nz/media/yuibmk2d/part90-maritime-rule.pdf

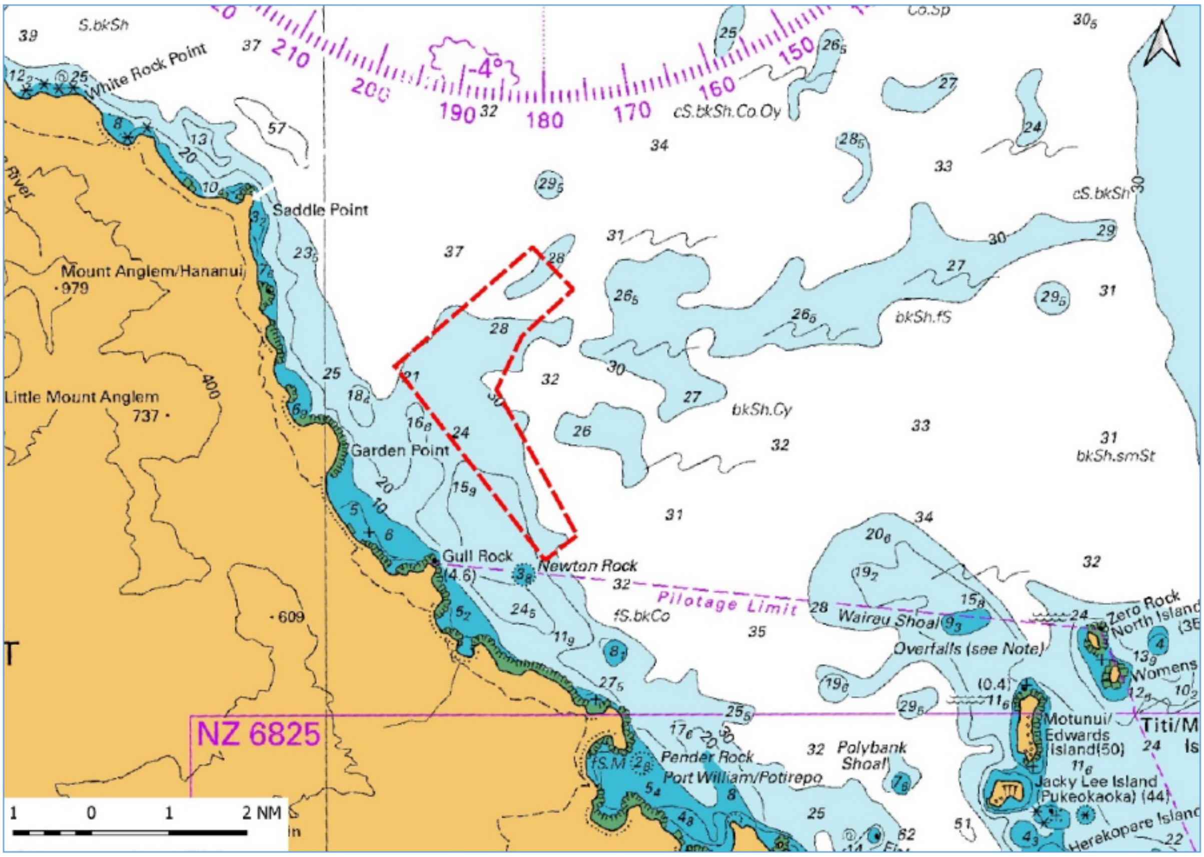


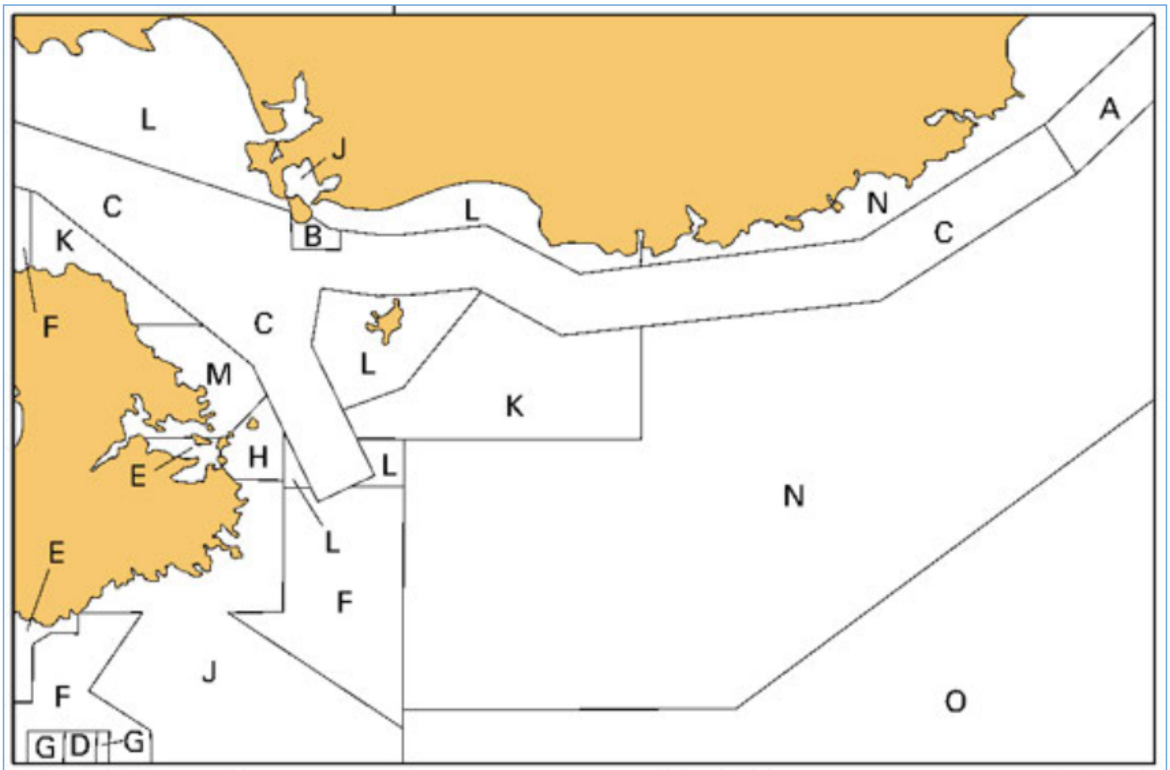
Figure 3.2: Proposed consent area with NZ Chart 68 showing Stewart Island pilotage area to the south.

3.2.5 *Charting Accuracy*

A Category Zone of Confidence (CATZOC) specifies the procedures and accuracies applied when the positional and depth data was captured. The area surrounding the proposed marine farms is designated a Category Zone of Confidence (CATZOC) of Bravo (B)[11]. This indicates that a full area search of the seafloor was not achieved and that uncharted features hazardous to surface navigation are not expected but may exist.

The source data for NZ Chart 68 and NZ Chart 681 for the water space in the vicinity of the proposed marine farms originates from HMNZS MONOWAI across 1980 to 1982 (Figure 3.3).

[11] Category Zone of Confidence (CATZOC) values are assigned to geographical areas to indicate whether data meets a minimum set of criteria for position, depth accuracy and seafloor coverage. The Zone of Confidence (ZOC) value is dependent on the positional and depth accuracy of the survey.



A. Land Information New Zealand	2012-2013	1:50 000
B. Land Information New Zealand	2001-2003	1:9 000
C. Land Information New Zealand	2001-2003	1:50 000
D. Land Information New Zealand	1999	1:10 000
E. Land Information New Zealand	1998-1999	1:25 000
F. Land Information New Zealand	1997-1999	1:75 000
G. HMNZS MONOWAI	1997-1998	1:50 000
H. HMNZS TAKAPU & TARAPUNGA	1984	1:18 000
J. HMNZS MONOWAI	1984	1:6 000
K. HMNZS MONOWAI	1982	1:36 000
L. HMNZS TAKAPU & TARAPUNGA	1981-1984	1:36 000
M. HMNZS MONOWAI	1980	1:72 000
N. HMNZS LACHLAN	1950	1:200 000
O. Random soundings from various sources		

Figure 3.3: Source data for NZ Chart 68.

3.3 Offshore Marine Farms

3.3.1 Offshore Marine Farming

Aquaculture operations have typically been undertaken in enclosed bays and sheltered waters. For example, most operations in Aotearoa / New Zealand are located in the Te Tauihu-o-te-Waka / Marlborough Sounds.

However, factors such as pollution, water space, and warming waters are compromising coastal fish farm developments. As a result, offshore aquaculture operations are being more frequently considered, and development progressed. Various examples of successful offshore operations can be found in Norway, Scotland, Canada and Australia. In Aotearoa / New Zealand, the Blue Endeavour farm in Te Moana-o-Raukawa / Cook Strait, being developed by NZ King Salmon, has been recently consented.

Each farm, whether in terms of structure, equipment, or fish stock, represents a significant investment for the owners. While this report considers navigational risk, it should be noted that there are also investment and reputational consequences from any incident and hence risk. The mitigation of navigational risk, whether by careful design, proper marking of structures, or sound safety management, also acts to mitigate investment risk for the owner and operator.

3.3.2 Responsible Parties

Marine farms are generally fixed structures with a considerable amount of the structures submerged in the water. The marine farm structures for the proposed Project are described in Section 2.1. Once in place, these structures are charted and clearly marked as per international and local guidance to mitigate the risk of physical conflict between the farm and other water users occurring.

By long established international convention, the operator of a vessel is responsible for ensuring safe navigation of that vessel and avoiding hazards and preventing collisions with obstacles, including marine farms.

However, parties who create or place an obstacle, such as a marine farm, are responsible for ensuring that they do not create a hazard to navigation, or if they do, that appropriate and compliant measures are taken to mitigate the navigational risk to an acceptable level. For example, a farm that is not properly marked and charted creates an undue risk to the safe navigation of vessels, as does one that has broken free from its moorings and is no longer within the charted and marked location. Such risks are discussed in the risk assessment (Section 6).

Similarly, loose items that may result from the construction, operation, or maintenance of the marine farms, such as ropes, buoys, or nets that float or drift away also create a hazard that must be avoided.

It therefore follows that farms must be properly constructed and maintained and items accounted for by the marine farm operator. This to ensure they do not interfere with other maritime activity or endanger other mariners or the environment. This likewise helps to protect the considerable investment by NTS that the Project represents.

3.3.3 Hananui

The Project, will utilise a fish pen system consisting of a floating collar and a cylindrical, single-net pen. Navigatus has been advised the pens will have the following characteristics:

- 168m circumference float collar with sufficient strength and buoyancy to withstand current and projected loads while supporting the designated netting system.
- Net structures are to be submerged to a depth between 17 and 22m below the surface, with a minimum clearance of 5m from the seabed (Figure 3.5).
- Seal jump fences will extend 3–3.5 m around the perimeter of the floating collars.
- Bird-netting will be used to prevent birds from accessing the pen with the netting connected to 65mm support poles which extend 5.9 m above the floating collars.
- One feed barge per marine farm is proposed.

The cylindrical, single-net design is claimed to offer improved management of predators, preventing marine mammal entanglement, and to be less prone to rips and tears than earlier designs. A more detailed description of the intended farm design is available in the engineering report by DSA Ocean[12].

With regard to structural requirements:

- A mooring system will be designed to an internationally accepted standard that requires it to withstand maximum expected currents, waves, and projected loading and tidal ranges without break-away or pen failure (Figure 3.6).
- Given New Zealand's tsunami hazard profile, the mooring system will also need to be shown to be able to withstand a rare but credible tsunami event. Navigatus has recommended a tsunami event with return period representing a 10% chance of occurrence over the expected life of the farm as a suitable design criterion.

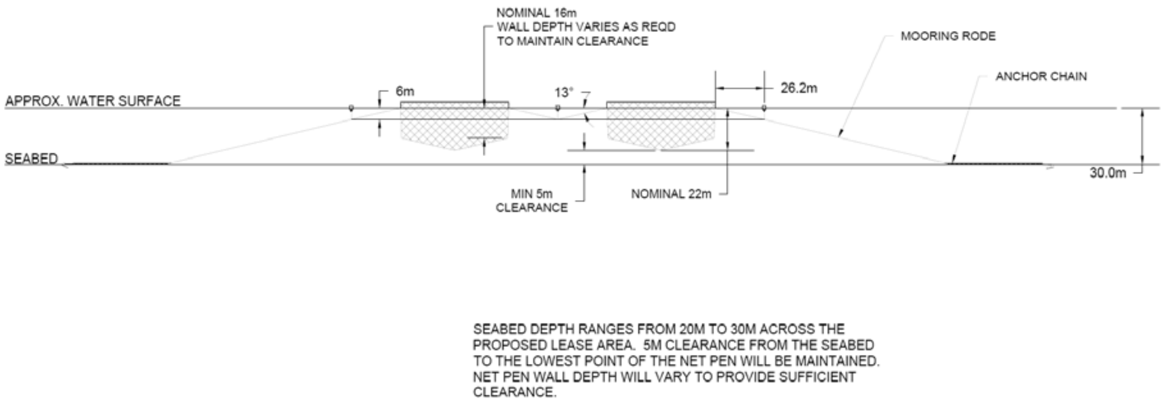


Figure 3.4: Profile view of single-net pens. (Source: DSA Ocean drawing number DSA-NAGI-25FEED-REVC.0).

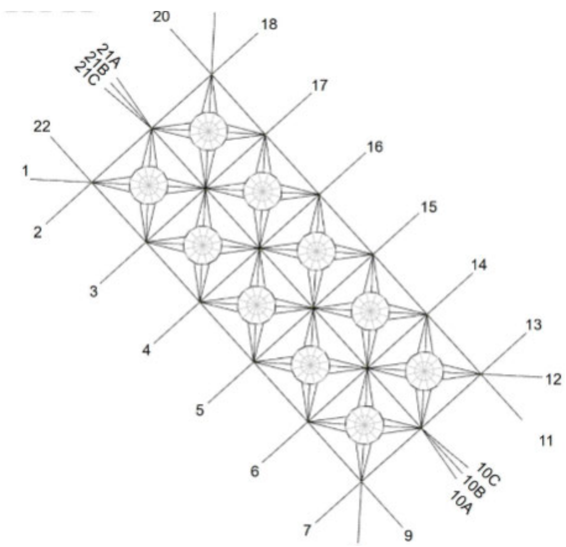


Figure 3.5: Plan view of single-net pens. (Source: Steinke, D. (2025). Hananui Aquaculture Site – Front-End Engineering Design Report Rev B).

[12] Steinke, D. (2025). *Hananui Aquaculture Site – Front-End Engineering Design Report Rev B*.

It is understood that bird netting is proposed to be installed to prevent birds from accessing fish in the pen. The netting connects to the float collar through 5.9m high poles. This mesh system is above the waterline and so is only subject to wind loads. Due to the relative density of air compared to sea water and the low drag profile of the bird netting, DSA Ocean has neglected the loads from the bird netting in their analysis. Navigatus considers this simplification to be reasonable.

The design report indicates that each single-net pen will be connected to a conventional, high-strength, flexible high-density polyethylene (HDPE) floating collar which supplies buoyancy to the pen. As downward forces from bridles and mooring lines tend to pull floating collars under the water under high loading conditions, the designers have incorporated the use of a large diameter (630mm) HDPE pipe in the design.

The mooring lines of the proposed marine farms are to be designed to resist significant movement of the farm system. They will need to be anchored to the seabed in a manner that ensures that the integrity and function of floatation of the system and structures is not compromised under the site's full tidal range, surface and sub-surface currents, and wave and wind induced conditions (typically referred to as 'metocean conditions'). The design will also need to be capable of withstanding reasonably credible non-normal conditions that could occur during the life of the Project – tsunami being of note for the New Zealand coastline. The mooring system will use the well-established method of anchor chains, whereby the chains are lifted off the seabed in higher tides and current forces and return to the seabed at lower tides and slack conditions.

The engineering design report states that the sandy seabed at the proposed marine farm location is ideal for the use of dual-shank drag embedment anchors. The holding power of these anchors is dependent on the depth of the sediment and the angle at which the mooring lines connect to the anchor. If the angle is too high, the vertical pull on the anchor may allow the anchor to become loose and drift. This will be combatted by connecting concrete or steel sinkers close to the anchor end of the anchor chain – thus ensuring a low angle of pull under all conditions. Again, this is a well-established and proven methodology.

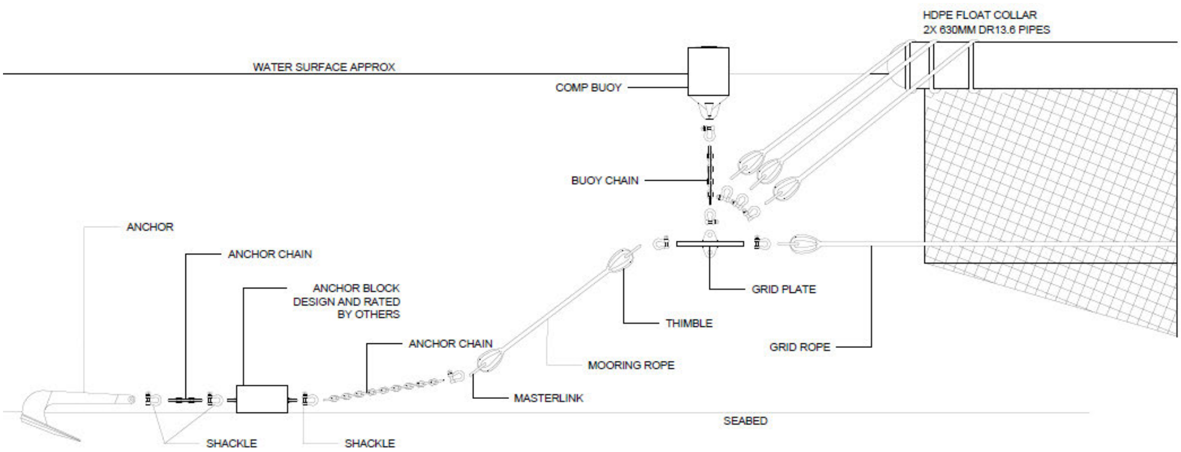


Figure 3.6: Part copy of DSA Ocean drawing number DSA-NAGI-25FEED-REVC.0 Sheet 4 of proposed lead mooring anchoring system.

It is proposed that one feed barge, positioned between the marine farms but slightly offset from them, will serve each pair of marine farms (four feed barges total). A schematic of how these are to be positioned from the DSA Ocean report is presented as Figure 3.7.

The final specification of the feed barges is yet to be confirmed but it is understood that a feed barge model with the following details is being considered:

- Overall length (LOA): 40.0m
- Beam: 12.0m
- Draught (max): 2.0m
- Depth: 3.42m
- Design displacement: 850.0 tonnes
- Design sea state, H_s: 6.5m

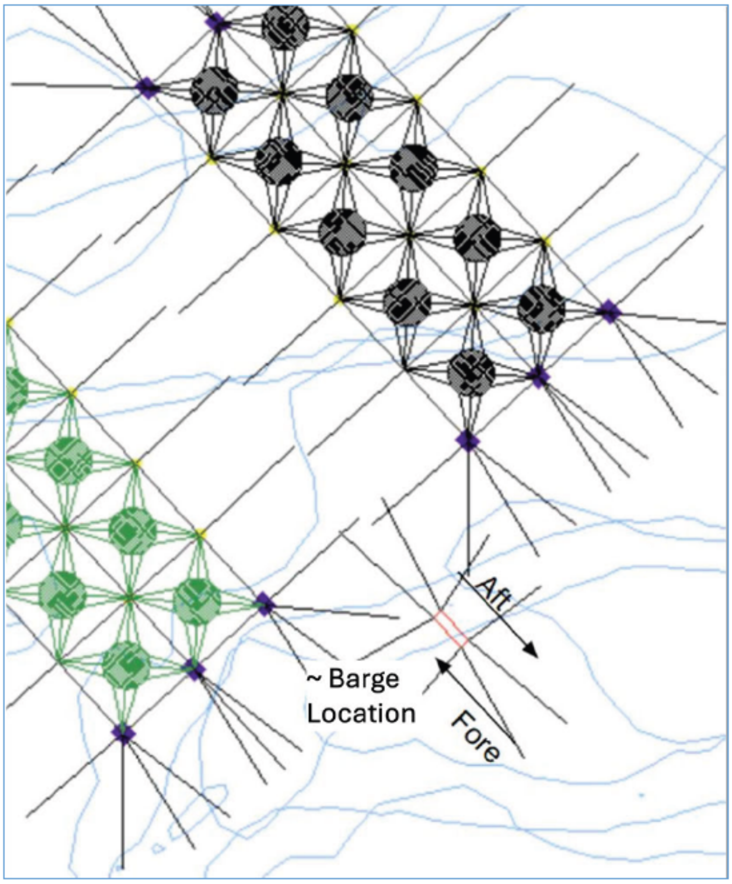


Figure 3.7: Schematic of marine farm positioning with feed barge relative to farms (Sourced and annotated from: Steinke, D. (2025). Hananui Aquaculture Site – Front-End Engineering Design Report Rev B).

The cadence of operations at the proposed marine farms will be such that each farm is stocked on a rotational basis. That is, whilst one farm is having stock introduced, another is at grading, another at harvest, and another at fallow. The associated working traffic is discussed further in Section 3.4.9.

3.4 Navigational Context

The marine farm guidelines prepared by Maritime NZ provide recommendations and good practice examples on matters of navigational safety, particularly for AtoN on marine farms. These are matters that are required to be considered for consent and associated conditions. Local regional councils may also refer to AtoN placement in their waters and so may also be relevant. That noted, Maritime NZ are the approving authority for the need for, design, and placement of AtoN.

This section establishes the context for each of the matters set out in the guidelines as it relates to the Project.

3.4.1 Safe Havens and Recognised or Recommended Anchorages

Recognised / Charted Anchorages

The Maritime NZ guidelines describe a recognised anchorage as one that is referred to in a cruising guide, pilot book, or similar publication as being suitable shelter for small/larger craft in adverse weather.

The New Zealand Pilot – a publication carried by the navigators of large vessels and used by them for passage planning – describes the water between Saddle Point and Port William as an area in which "Vessels can anchor as convenient off the coast between Saddle Point and West Head, clear of the dangers lying offshore". The text notes that "The quietest anchorage is off the sandy beach between Garden Point and Gull Rock". These anchorages are charted.

A sailing guide[13] for Stewart Island/Rakiura – the document most likely to be referred to by recreational sailors when planning their trips – states:

"Between Saddle Point and West Head there is little to attract a cruising sailor other than the scenery, there being no anchorages to speak of…. Inside West Head is the excellent anchorage of Port William, south of which the coast becomes more hospitable."

This guide also lists anchorages for larger yachts and multihulls around Stewart Island/Rakiura with the nearest recognised anchorages to the proposed marine farms being Port William and Horseshoe Bay – 3 and 6 nautical miles (~5.5km – 11km) to the south respectively.

In summary, the proposed Project location is in close proximity to recognised anchorages for large vessels. These vessels will typically be awaiting entry to Bluff Harbour.

Recommended Anchorages

A "recommended anchorage" is an anchorage marked on a nautical chart. There is no anchorage charted within the boundary of the proposed farm Project area.

However, two recommended anchorages marked on NZ Chart 681 Approaches to Bluff and Riverton / Aparima match the descriptions of recognised anchorages in proximity to the proposed marine farming location in the New Zealand Pilot (Figure 3.8).

[13] Walker, A. (2022). *Stewart Island / Rakiura A Sailors Guide to Cruising and Anchorages.* https://otagoyachtclub.org.nz/wp/wp-content/uploads/2022/09/Stewart-Island-Rakiura-Cruising-Guide-2022.pdf

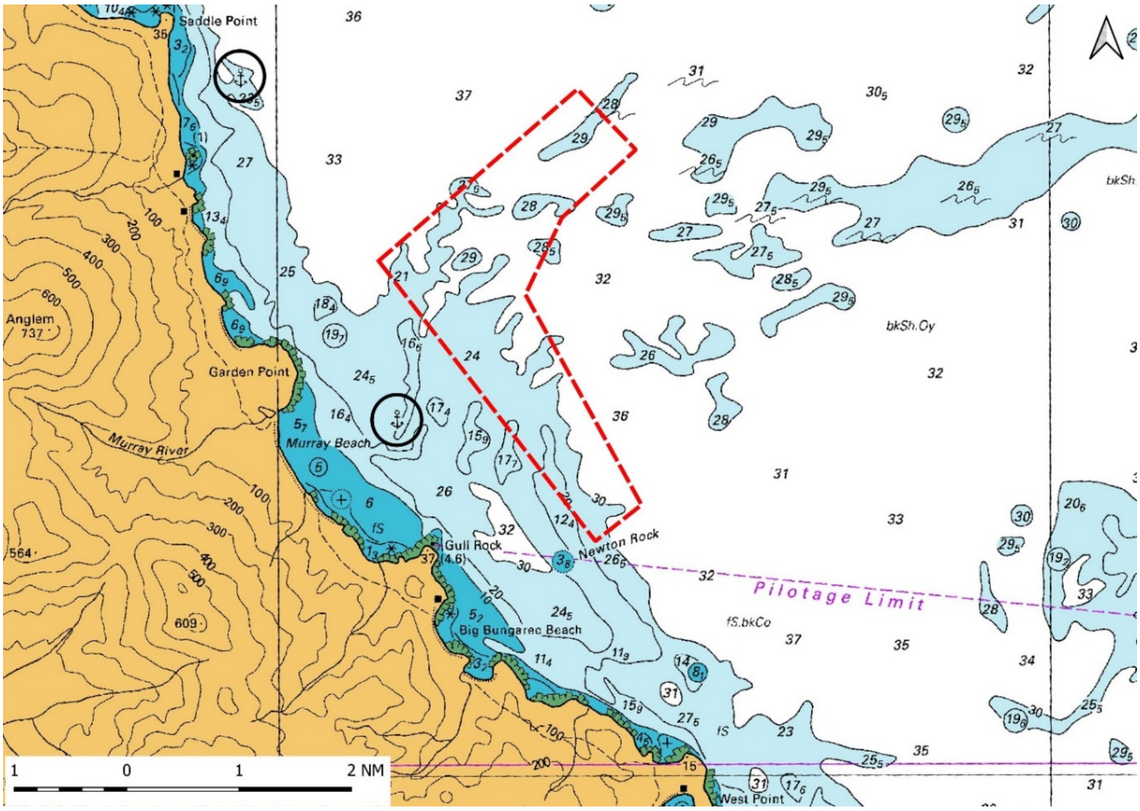


Figure 3.8: Proposed farm Project area overlaid on Chart NZ681 with recognised and recommended anchorages shown circled in black.

3.4.2 Navigational Routes and Vessel Traffic

Routes to consider include ones used by commercial vessels to and from ports as well as pleasure craft routes normally used to navigate between popular destinations.

There are several commercial navigation routes in the vicinity of the proposed marine farm location, none of which pass directly through it. These routes can be seen through the density maps generated from Automatic Identification System (AIS) data and presented for individual vessel types in Appendix A. Vessel traffic is primarily comprised of cargo, container, and tanker vessels transiting Foveaux Strait or visiting South Port in Bluff and is otherwise primarily comprised of fishing and passenger vessels.

3.4.3 Narrow Channels

There is no exact definition of a "narrow channel" in either Maritime Rules Part 22 or the International Regulations for Prevention of Collision at Sea[14] and, notably, a channel is not defined by length or breadth. When deciding if a stretch of water is a narrow channel or not, regard is given to the way in which ships navigate the locality. As such, the proposed marine farm location should not be considered to be in a narrow channel.

3.4.4 Existing Marine Farms

There are no marine farm operations adjacent to the proposed location. There are, however, other aquaculture operations around Stewart Island/Rakiura - these being inside the shelter

[14] Cockcroft, A. N., & Lameijer, J. N. F. (2011). *A Guide to the Collision Avoidance Rules* (7th ed.). Butterworth-Heinemann.

of Big Glory Bay and Paterson Inlet/Whaka a Te Wera. The water space and operations of these farms have no direct impact on the proposed location from a navigation perspective.

3.4.5 Fishing Activity

In addition to recreational fishing (discussed in Section 3.4.6), the water in and around the proposed Project area is used by commercial fishing boats engaging in bottom trawl effort, dredge effort, mid-trawl effort, potting effort, and net setting effort. Refer to Hananui aquaculture project: Characterisation and assessment of potential impacts on commercial fishing Prepared by Nici Gibbs, Fathom Consulting Ltd for Ngāi Tahu Seafood Resources Ltd DRAFT: 28 May 2025 for fuller details.

3.4.6 Recreational Activity

Recreational activities undertaken by tourists are described in Section 3.4.7. Recreational use of the water space in the area surrounding the proposed marine farming site is primarily in the form of fishing, diving, and kayaking. Ngāi Tahu interests in traditional food and other natural resources are encapsulated through “mahinga kai”. Many engage in fishing and other, similar activities in the coastal waters of Stewart Island/Rakiura.

Other activities include hunting and tramping inland and the North-West Circuit of Stewart Island/Rakiura is a trail which passes the coastline alongside the proposed marine farming area.

3.4.7 Tourist Activity

Stewart Island/Rakiura promotes many outdoor and adventure activities for tourists. These include tramping, birding, fishing, diving, and kayaking. There are several boat charters and adventure cruise operators based in and around Halfmoon Bay and Paterson Inlet/Whaka a Te Wera. These typically travel to Ulva Island in Paterson Inlet/Whaka a Te Wera to the south of Oban but may on occasion travel elsewhere.

The North West Circuit Track includes the north-east coastline of Stewart Island/Rakiura with Bungaree Hut and Christmas Village Hut being on the southern and northern ends of the coastline alongside the proposed marine farming area. Water taxi services are available to transport people to and from these areas, however these are not regularly scheduled.

3.4.8 Cruise Ships

Cruise ships generally visit Stewart Island/Rakiura in the warmer months between October and March (Figure 3.9).

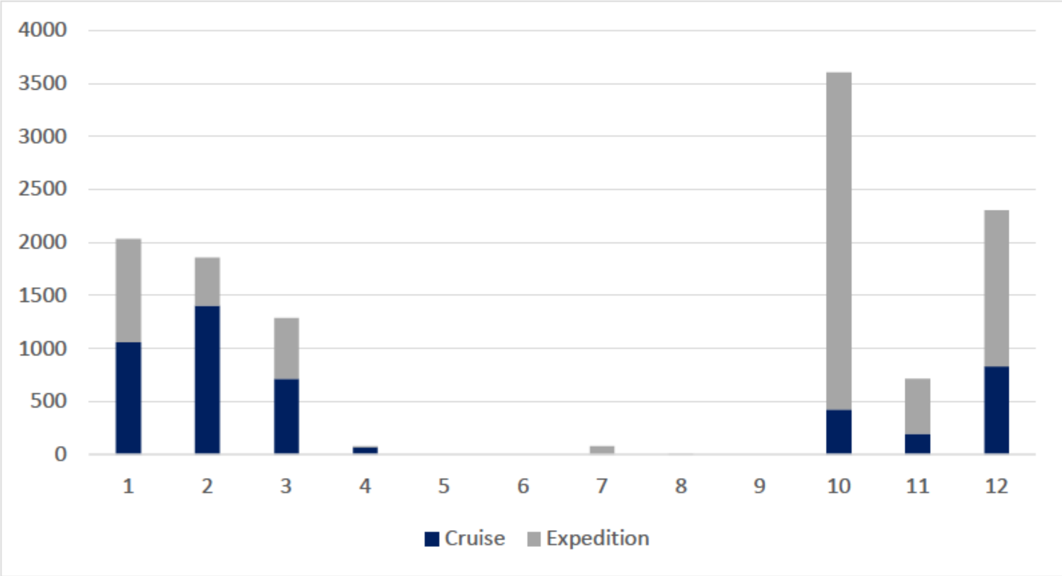


Figure 3.9: Counts of AIS datapoints for cruise and expedition ships in 2024 by month.

These ships tend to navigate north and east of the proposed Project area as they transit to or from Paterson Inlet/Whaka a Te Wera (Figure 3.10). At times, some of these vessels have navigated through the proposed Project area.

However, as they are close to the coast and/or their destination, these vessels can be expected to be making way at a slower rate.

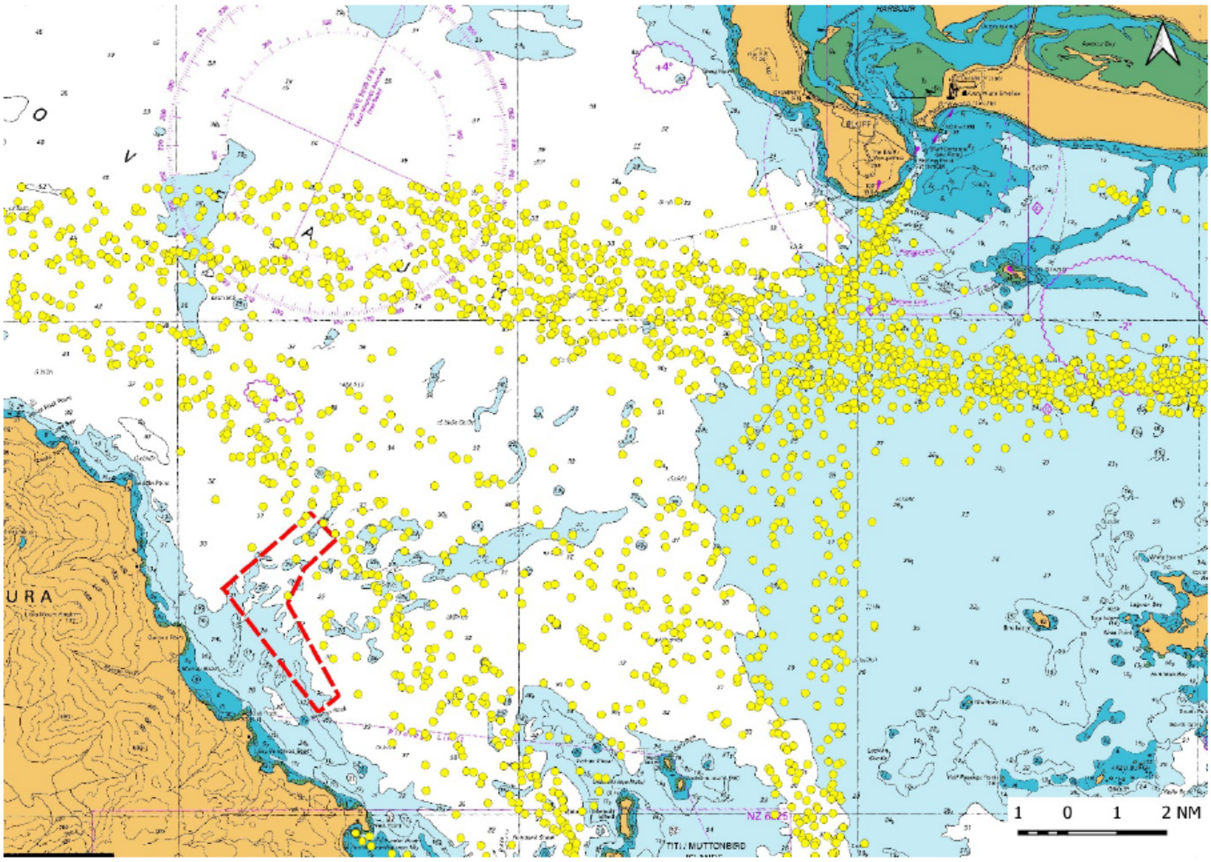


Figure 3.10: AIS datapoints for cruise/expedition ships in 2024.

3.4.9 Working Traffic

Additional marine traffic will be generated by the proposed marine farms in the form of workboats used for construction and ongoing operations and servicing. Feed barges will be permanently moored at each of the marine farms. The workboat activity will have a limited impact on the current marine traffic in the proposed location and will join the regular flow of traffic across Foveaux Strait between Bluff and Stewart Island/Rakiura.

As discussed in Section 3.4.5, there is commercial fishing activity in and around the proposed marine farming area which contributes to the working traffic in the area.

3.4.10 Dwellings – Access and Amenity

There are several Department of Conservation huts along the coastline alongside the proposed marine farming location including Bungaree Hut, Murray Hunters Hut, Christmas Village Hut and Christmas Village Hunters Hut. There are water taxi services available to transport hunters and trampers to and from these locations.

Visual amenity is not within the scope of this report. However, it is noted that navigational safety aspects of the Project, such as lighting and marking of structures, may impact visual amenity. This report comments on the navigational safety related impacts on visual amenity. Please refer to the report by Isthmus[15] or further discussion on the visual amenity impacts of the Project.

3.4.11 Site Plan

As described in the introduction (Section 2.1), the Project proposes to construct and operate marine farms in two stages:

- Stage 1 of the Project involves a feed discharge of 15,000 tonnes per annum and the establishment of a block of ten sea pens, arranged in a five-by-two configuration, at each of the four marine farming sites.
- Stage 2 of the Project increases the overall feed discharge to 25,000 tonnes per annum with the introduction of an additional set of ten sea pens at each of the four marine farming sites.

These pens are proposed to be sited as set out in Figure 3.11.

[15] Hananui Aquaculture Project. (August 2025). *Natural Character, Landscape and Visual Assessment Report*. Te Ara a Kiwa, Rakiura.

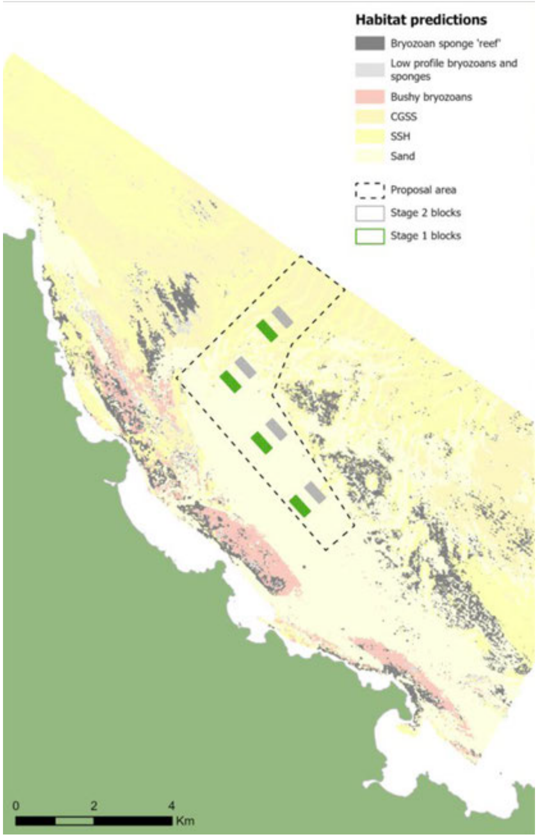


Figure 3.11: Site plan for the Hananui Project (note exact location of farms relative to development area tbc).

3.4.12 Regulatory

Relevant regulations are listed in Section 3.1. The proposed farm Project area does not directly conflict with any of the requirements given in any maritime regulation.

The proposed farm structures and operations must be designed to meet relevant standards and not create undue or unacceptable risk. Standard requirements include clause 200(2) of the Maritime Transport Act regarding the need for lighting and navigational marks. These must comply with IALA guidelines. In addition, it is required that suitable anchorages remain available for commercial shipping and that all relevant changes are documented and incorporated into appropriate navigation charts and sailing directions through Toitū Te Whenua Land Information New Zealand (LINZ).

The design of the farms, discussed in Sections 3.3.3 and 3.6, must be fit for purpose for the predicted extreme weather conditions for the proposed farming location.

3.5 Environmental Context

3.5.1 Introduction

The purpose of this section is to describe the impact that the environment may have on the proposed marine farms as opposed to an assessment of the environmental impact of the farms on the surrounding environment.

Whilst the environmental conditions at the proposed farm area as described here can inform the farm design criteria, this report is not intended to replace the formal engineering design process that is being undertaken separately by other subject matter experts to define the design criteria and associated structural limits.

3.5.2 Prevailing Weather, Sea State, and Swell

Wind

Data for a point in the more exposed northern end of the proposed marine farming area was assessed and is displayed in the form of a wind rose in Figure 3.12.

The prevailing wind is a westerly with some north-westerlies and south-westerlies. Northerlies through to southerlies occur less than a third of the time.

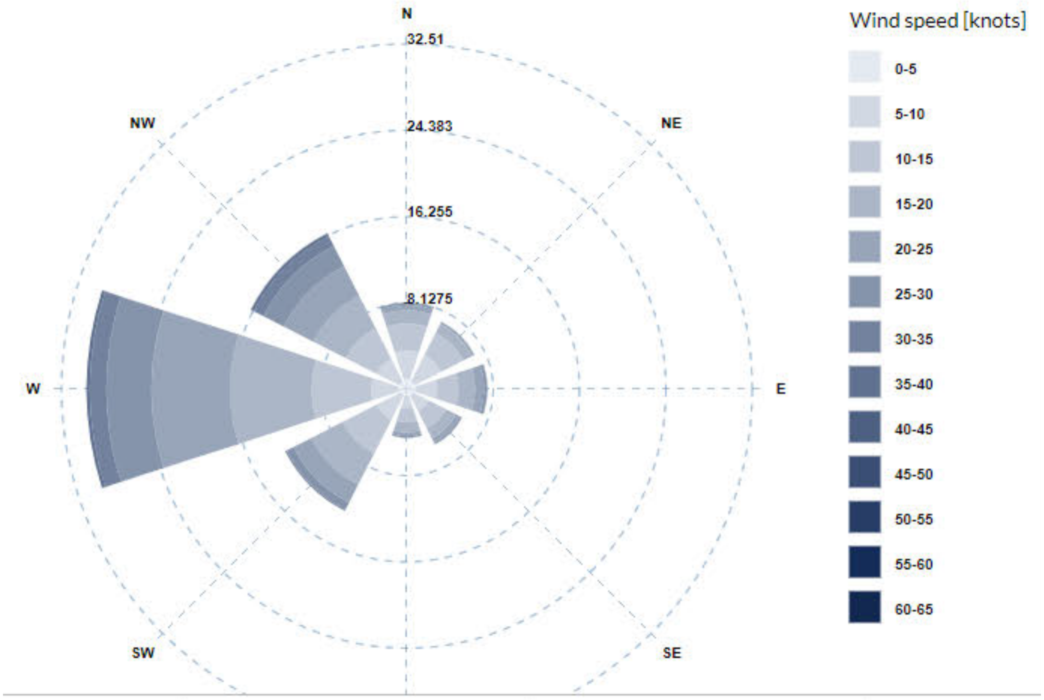


Figure 3.12: Wind rose for a point in proximity to the proposed marine farms (Source: Metocean portal 2019).

The mean wind speeds at the proposed marine farming location are displayed in Figure 3.13. These range between approximately 14 and 17 knots.

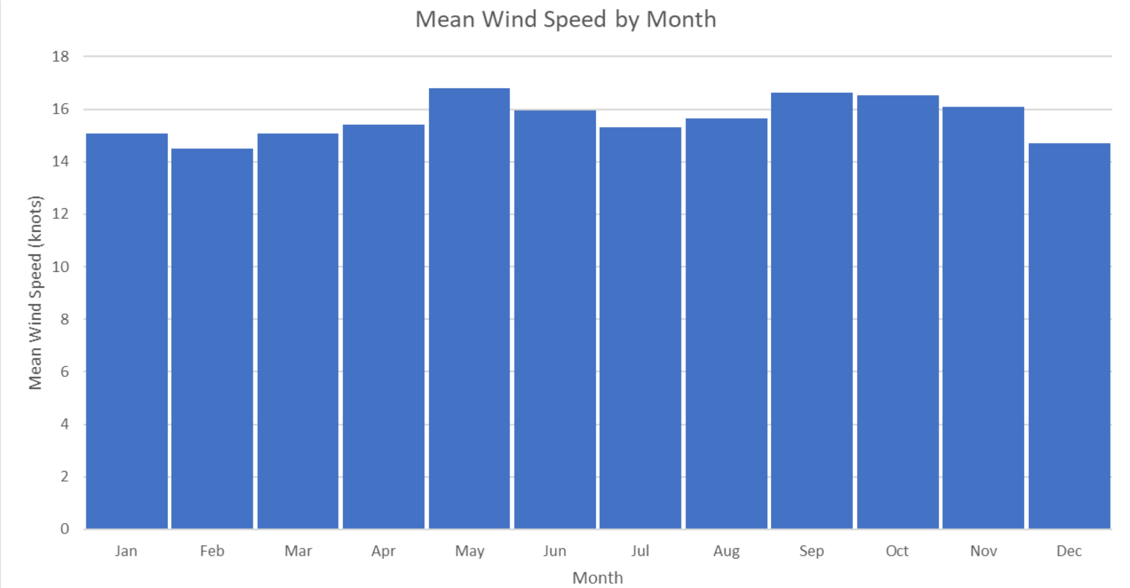


Figure 3.13: Mean wind speed by month (Source: Metocean portal 2019).

Waves

The wave heights presented in this subsection are all significant wave heights – H_s[16]. Maximum wave heights will be larger than significant wave heights.

It is understood that, ideally, H_s should be under 5 metres for offshore fin-fish farms to enable regular access to the farm for operational and maintenance purposes.

The maximum H_s derived from a 37-year regional wave hindcast model are shown in Figure 3.14. This modelling indicates that the maximum H_s at the proposed marine farming location, off the north-east coast of Stewart Island/Rakiura, is no greater than 3 metres. Greater maximum H_s are present to the north, south, and west of Stewart Island/Rakiura.

A wave rose for the region (Figure 3.15) shows the majority of waves at the proposed marine farming location travel to the north-west. When viewed alongside the wind rose information, it is evident that the proposed marine farming area, in the lee of Stewart Island/Rakiura, is shielded from what would otherwise be larger, predominant westerly winds and waves. The shallower depths in Foveaux Strait also act to attenuate large, long period waves.

Mean wave heights (Figure 3.16) at the proposed marine farming location range from approximately 0.7-0.9 metres.

[16] The mean of the highest third of waves.

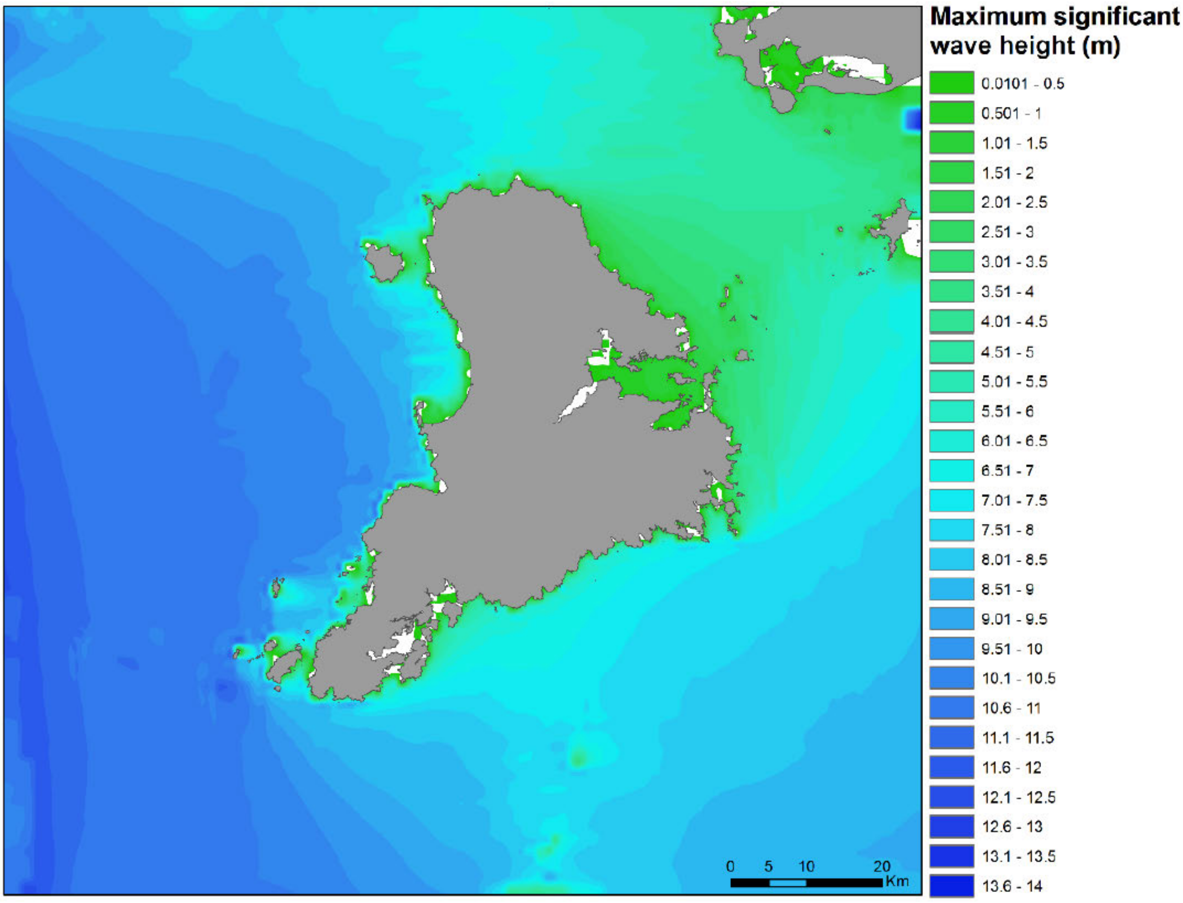


Figure 3.14: Maximum significant wave heights from Metocean 37-year hindcast model.

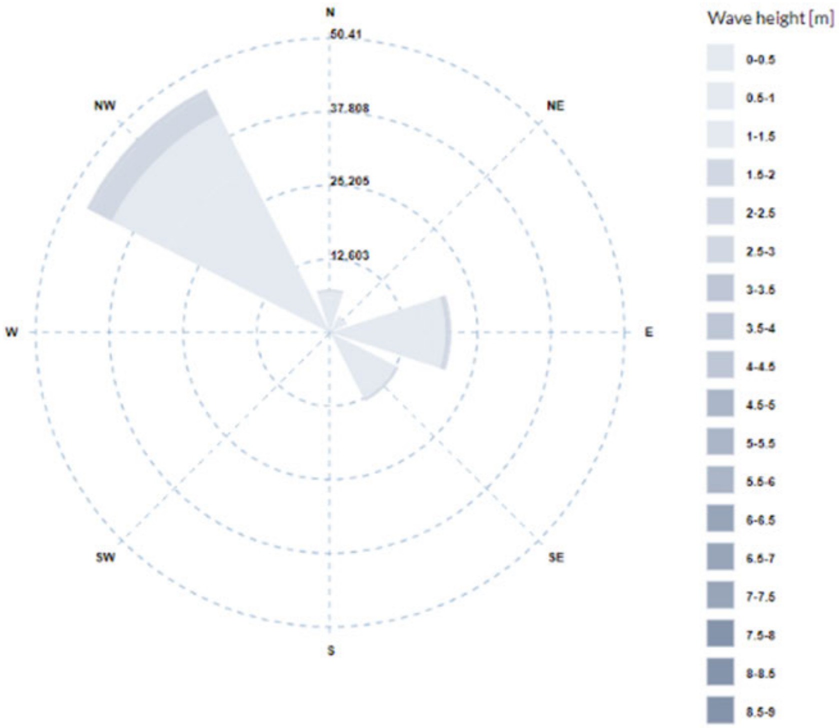


Figure 3.15: Wave rose for the proposed marine farming area (Metocean 2019)

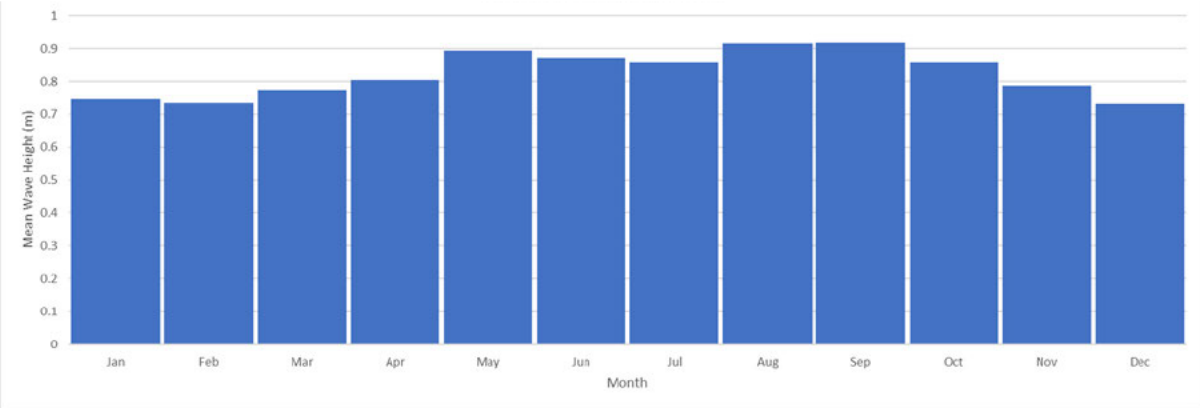


Figure 3.16: Mean wave heights by month (Metocean 2019).

Extreme Conditions

Data for extreme conditions which can be expected to occur in the northern part of the proposed Project area obtained from a 'whole of New Zealand model' is displayed in Table 3.1.

Table 3.1: Extreme wind and wave table for the northern extent of the proposed marine farming area.

	Return Period (years)		
	10	100	1000
H_s (m)	5.1	6.2	8.2
Wind speed (knots)	49	55	67

3.5.3 *Sea-bed Composition*

The nautical charts show the sea bed to be composed of a mixture of course sand, pebbles, and broken shells. This is ideal anchoring material as it allows anchors to dig in deep and hold well.

This assessment aligns to the detailed Canadian ocean engineering company Dynamic Systems Analysis Ltd (DSA Ltd) mooring analysis (refer Section 3.3.3) who assess the seabed in the area as being suitable to facilitate the mooring of fish farms.

3.5.4 *Water Depths*

The depth of water in the proposed location varies across the proposed site from approximately 20 metres to 30 metres. The presence of sand waves on the chart and varying depth is indicative of a higher current area.

3.5.5 *Tides*

While the closest primary port to the proposed marine farms is South Port in Bluff, the closest secondary port is 6505c Half Moon Bay – Oban. Table 3.2 compares tidal information from each port.

There is no significant difference in the tidal conditions across the two ports. At springs, the tidal range at Stewart Island/Rakiura is 2 metres whilst Bluff is 2.3 metres.

Table 3.2: Comparison of tidal information from closest primary and secondary ports to the proposed marine farming location.

Port	MHWS	MHWN	MLWN	MLWS	MSL	Ratio range
Bluff	2.8m	2.4m	0.9m	0.5m	1.74m	-
Oban	2.6m	2.2m	1.1m	0.6m	1.6m	0.87

There are two tidal diamonds on NZ Chart 69 in the general vicinity of the proposed marine farming location:

- Bravo (46˚ 33.9' S 167˚ 51.8' E).
- Delta (46˚ 43.1' S 168˚ 23.8' E).

The maximum rate reported is 2 knots in a westerly direction. The tidal diamonds are detailed in Table 3.3. Additionally, there are indications on NZ Chart 69 that there may be a tidal stream up to 2.5 knots on the northern coast of Stewart Island/Rakiura.

Table 3.3: Tidal diamond direction and flow.

	Tidal diamond Bravo – SN 650 C			Tidal diamond Delta – SN 650 E		
Hours	Direction	Spring	Neap	Direction	Spring	Neap
-6	261	0.9	0.6	267	0.9	0.6
-5	186	0.4	0.4	249	0.4	0.3
-4	127	0.9	0.9	175	0.9	0.6
-3	111	1.4	1.4	116	1.4	0.8
-2	102	1.6	1.6	098	1.6	1.1
-1	096	1.5	1.5	090	1.5	1.1
HW*	090	1.2	1.2	086	1.2	0.8
+1	080	0.7	0.7	083	0.7	0.5
+2	333	0.2	0.2	001	0.2	0.1
+3	290	1	1	270	1	0.7
+4	286	1.3	1.3	286	1.3	0.9
+5	285	1.3	1.3	282	1.3	0.9
+6	290	0.9	0.9	270	0.9	0.6

* Based on HW Bluff.

3.5.6 Currents

There are no significant ocean currents that will impact the proposed marine farm location shown on NZ Chart 69.

However, during 2018-2019 NTS deployed three Acoustic Doppler Current Profilers (ADCP) that showed a clear north-west / south-east current roughly following the coastline of Stewart Island at the site[17]. The maximum measured current was found to be about 2 knots.

[17] Steinke, D. (2025). *Hananui Aquaculture Site – Front-End Engineering Design Report Rev B.*

3.5.7 Tsunami

New Zealand is situated on an active plate boundary and so is vulnerable to tsunamis. Whilst these events are rare, a recent article published in the New Zealand Journal of Geology and Geophysics reviewed tsunami hazard for southern New Zealand and stated that tsunami heights of 4-12m could be expected at a 2500-year return period[18]. These figures were derived from a report released by GNS Science on an update to New Zealand's Tsunami Hazard Model which estimates the 2,500-year return period tsunami height for Stewart Island/Rakiura to be 4-8m[19].

GNS Science also produced a report detailing tsunami hazard curves for 20-kilometre coastal sections derived from the 2021 National Tsunami Hazard Model. The relevant section of coastline for the Project is shown in Figure 3.17 with the associated tsunami hazard curve[20]. It is indicated that a tsunami with a return period of 250-years could have a wave amplitude of approximately 2.5m. 250-years represents about a 10% chance over the expected life of the Project. As such, this can be considered a useful indication of the non-normal design requirement.

While not directly relevant to the area of Garden Point, Popovich et al[21] identified that the greatest tsunami threats to South Port were found to be a M_W 9.0 earthquake source on the Puysegur Subduction Zone and a M_W 9.5 earthquake on the Peru Subduction Zone. These events were associated with maximum water levels of 2.5 and 2m above sea level at the entrance to the port, and maximum current speeds in the entrance of 24 and 15 knots respectively.

While the current quoted for the South Port entrance will not be experienced in the area of Garden Point, a non-normal current will be felt. The design criteria that the farm structures will need to be designed for will need to account for a current expected for a sea surface tsunami surge similar to that which may be experienced at the entrance to the Bluff Harbour.

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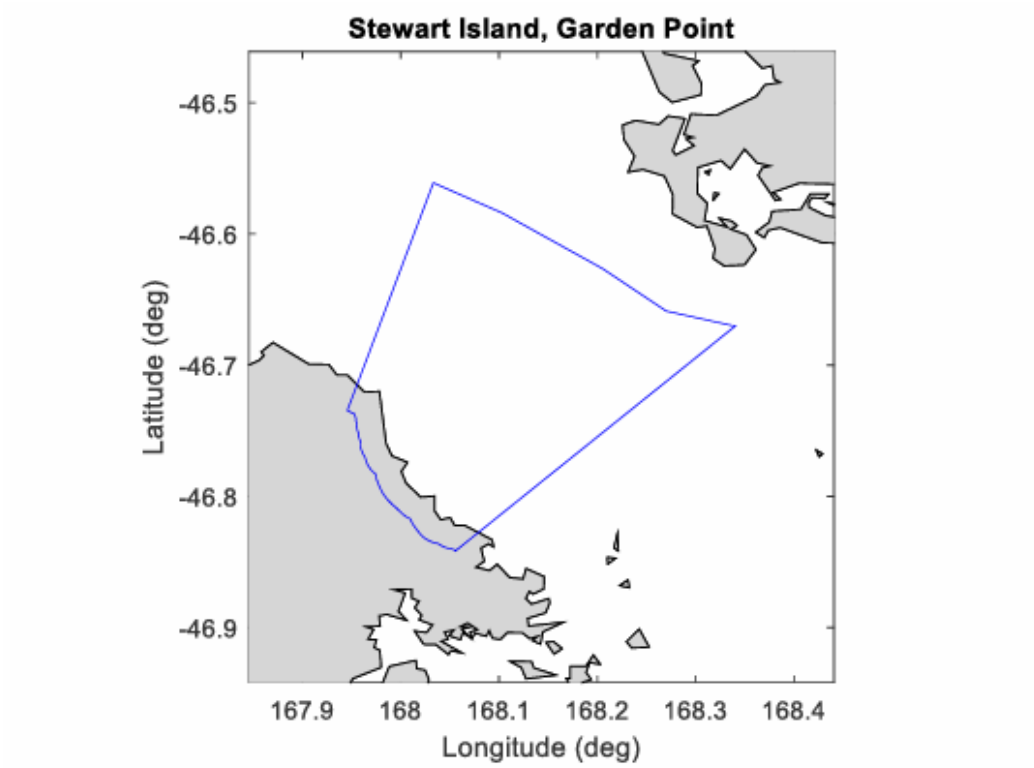
[18] C. Orchiston, U. Cochran, and A. Vause. (2024). A review of tsunami hazard for southern Aotearoa New Zealand with implications for future research. *New Zealand Journal of Geology and Geophysics*. https://doi.org/10.1080/00288306.2024.2419369

[19] WL Power, DR Burbidge, AR Gusman. (2023). The 2021 update to New Zealand's national tsunami hazard model. Lower Hutt: GNS Science. GNS Science Report 2022/06.

[20] WL Power, DR Burbidge, AR Gusman. (2023). Tsunami hazard curves and deaggregation plots for 20 km coastal sections, derived from the 2021 National Tsunami Hazard Model. Lower Hutt: GNS Science. GNS Science Report 2022/61.

[21] Popovich et al. in 2021 investigated the potential for tsunami damage at New Zealand ports.



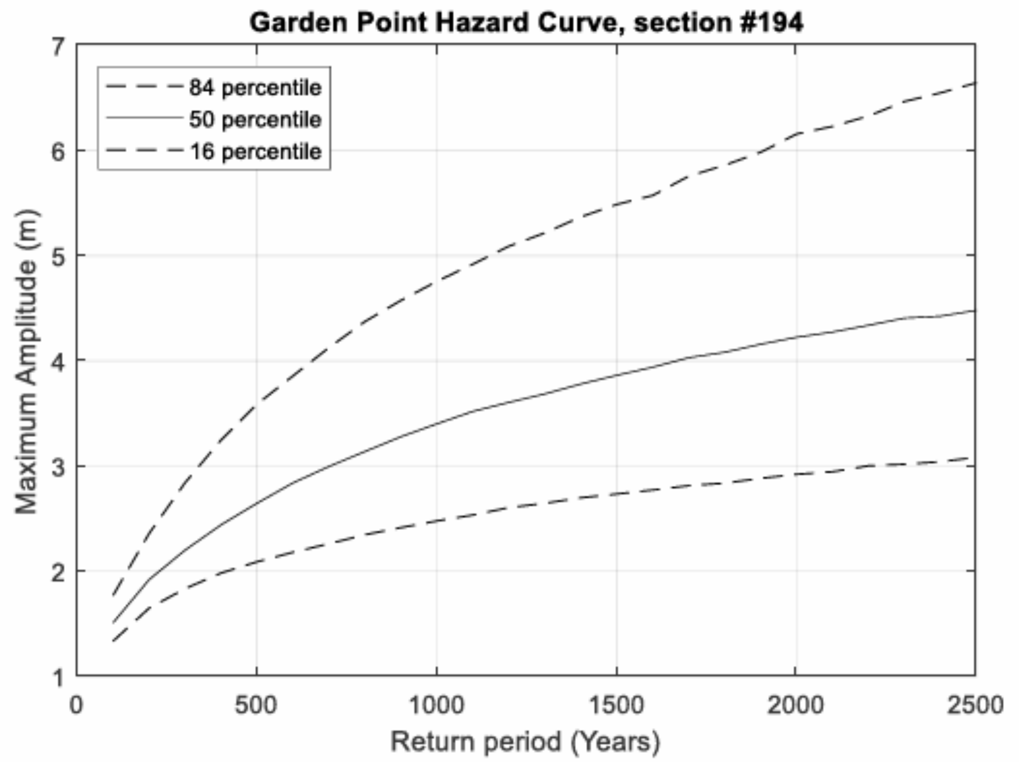


Figure 3.17: Tsunami hazard curve for the coastal section alongside the proposed Project area. Source: GNS Science Report 2022/61, page 396.

3.6 Farm

3.6.1 Construction

While the exact details of the intended construction phasing for the marine farms are not available at the time of writing this report, the design was reported to be fairly typical of current floating ring designs. Generally, marine farm pens are assembled on shore and towed to the proposed marine farming area where they are secured to pre-laid mooring grids. The nets can be installed once the pens are secured to the mooring grid or otherwise installed onshore and rolled up to reduce drag when the pens are towed. The feed barges are typically transported to the site once all structures are in place.

While the detail of the design will be developed from established international standards, the actual design requirements must reflect local metocean and current conditions – both normal and non-normal (i.e. credible extreme events and natural hazards).

3.6.2 Access for Small Craft

The preliminary pen and mooring design is displayed in Figure 3.18. The underwater profile of the anchor lines is expected to provide a static under keel clearance of 6 metres at the buoyed edge of the farm, 9.2 metres at 20 metres off the buoys, and not less than 22 metres at 100 metres off the buoys.

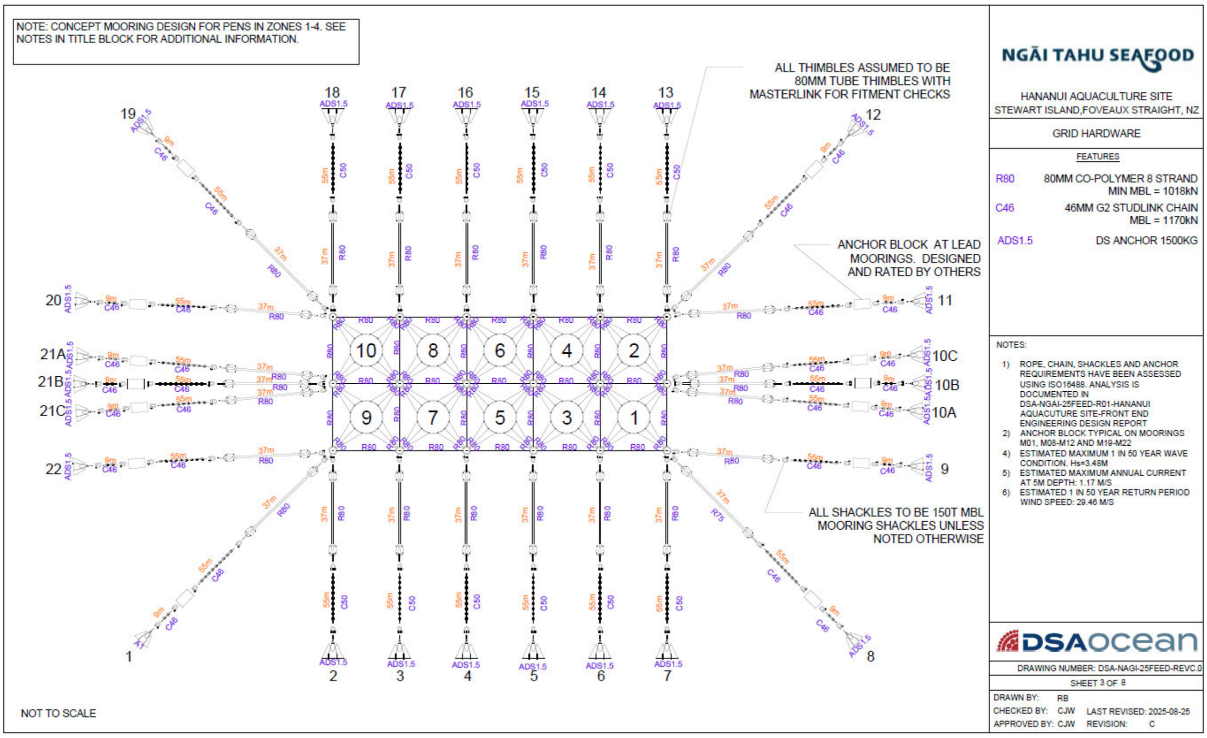


Figure 3.18: Copy of DSA Ocean drawing number DSA-NAGI-25FEED-REVC.0 Sheet 3 of mooring design.

3.6.3 Response to Emergencies

Timely responses to maritime emergencies in the general area of the Project can be difficult due to the isolation and frequent poor weather – and indeed that area is recognised as being at times challenging for mariners. However, once the farms are operational, there may be occasions where farm-servicing personnel are able to assist with unrelated emergencies in the vicinity of the farms. An example is the presence of a defibrillator on board most commercial vessels which may be used in the event of a medical emergency aboard a vessel passing near to the farms.

3.6.4 Aids to Navigation

Considerations for the Design of AtoN

Section 200(2) of the Maritime Transport Act stipulates that a person (including a local authority) who operates a port, cargo terminal, marina, jetty, marine farm, or other maritime facility must provide navigational aids for that facility and is responsible for them. The design and placement of these AtoN must be appropriate for the circumstances. For example, in this case, as large vessels operate in the area, lighting requirements will be different to that of farms located in bays or remote areas. It is also of note that the cumulative effects of lights can create unnecessary complexity and confuse navigators.

The following types of AtoN are relevant to the marking of marine farming areas and farm structures. The lighting of ships underway and at anchor is also discussed below.

Cardinal Marks

Cardinal marks are used to show the extent of a hazard to navigation. IALA Guideline G1162 states that for aquaculture, cardinal marks alone may be used to direct vessel traffic away from the farms.

The exact colouring, top-mark and colours, and flash-rate of any light indicates whether they are positioned to the north, east, south, or west of the hazard (Figure 3.19). When considering the use of cardinal marks, Maritime NZ should be consulted on the need and positioning.

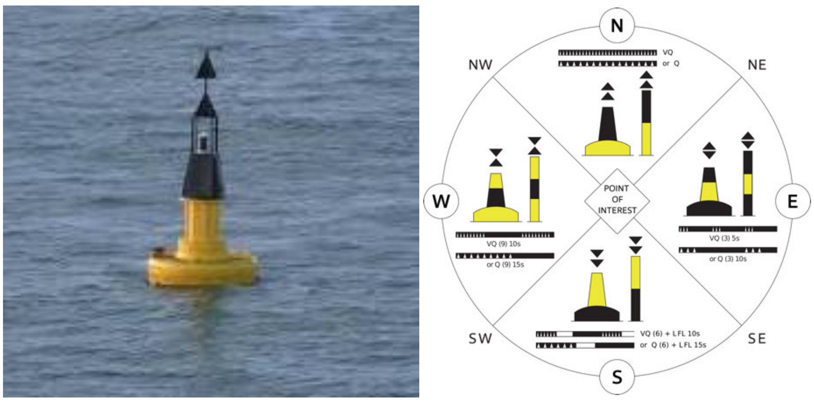


Figure 3.19: Example of a cardinal mark (left) and how each direction's cardinal mark differs (right).

Special Marks

Figure 3.20: Example of a special mark.

Special marks are the default option for marking the extremities of marine farms unless circumstances dictate a better option. They are typically yellow in colour, flash with a yellow light at night, and usually have an “X” placed atop of them (Figure 3.20).

Compensation Buoys

The proposed marine farm structures include compensation buoys above the node plates at the corner of each pen structure (refer Section 3.3.3). These buoys are yellow and are primarily designed to provide buoyancy and stability for the marine farm structure (Figure 3.21). Due to their size and colour, they are somewhat similar to a special mark – albeit without a top mark or light.

Figure 3.21: Example of compensation buoys around a marine farm pen.

3.6.5 Ship’s Lighting

Ships underway at night are required to show a white stern light, a navigational light on each side (red/green), and, dependent on the ship’s length, all-round mast white headlights (Figure 3.22 and Figure 3.23). The requirement will extend to farm workboats operating at night or under restricted visibility – that is they will, while underway, be expected to have a stern light, a navigation light on each side (red/green) and probably a mast headlight. Any support barge will show an all-round white anchor light.

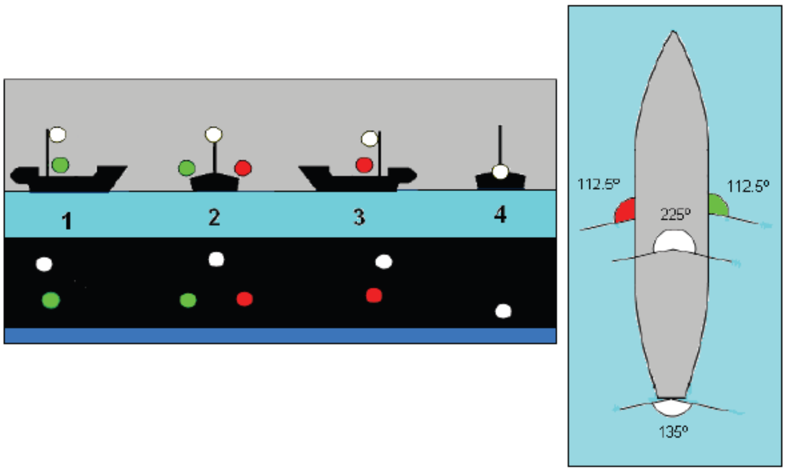


Figure 3.22: indicative navigational lighting of a workboat at night.

Ships at Anchor

Ships at anchor at night are required to show a set of lights and to switch on their deck lights for enhanced visibility (Figure 3.23 and Figure 3.24). Whilst AtoN such as cardinal marks and special marks are specifically designed to flash with light at night in specific patterns, ships at anchor remain lit with a visible superstructure. As a result, there is more light pollution and glow from an anchored vessel than there is for a mark.

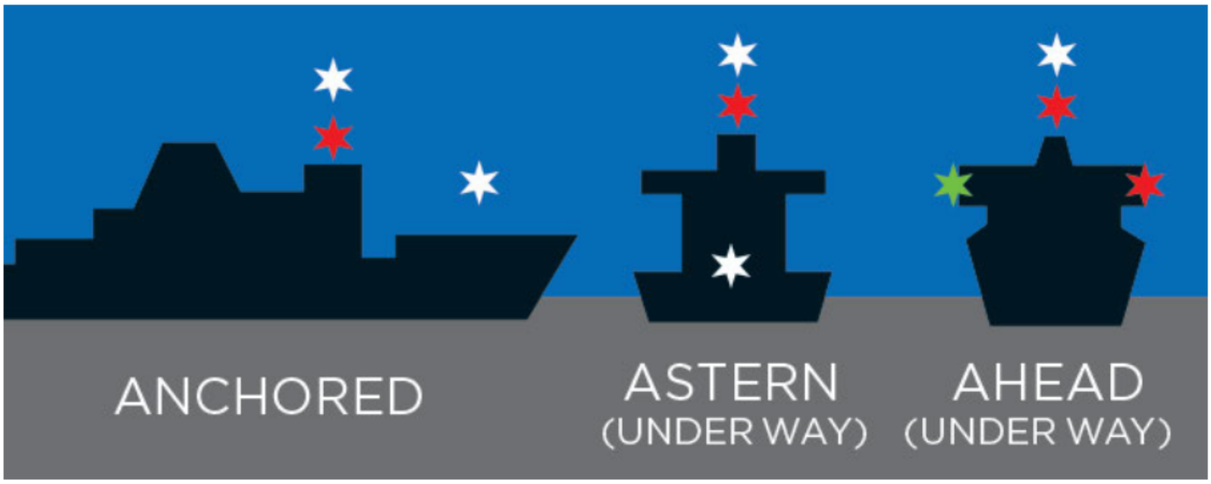


Figure 3.23: large vessel lighting when at anchor and underway.

Figure 3.24: Tanker at anchor with deck lights on (vessel typical of those operating off the New Zealand coast).

The lighting of the marine farms must be to the satisfaction of the Regional Harbourmaster and, ultimately, Maritime NZ who may require additional or different AtoN to that proposed by this report.

3.6.6 *AtoN Lighting Characteristics*

Lights associated with AtoN have characteristics defined by IALA. That is, the lights have been specifically designed to be identified by their colour and their flash sequence to enhance navigational safety in the hours of darkness (between sunset to sunrise) and during restricted visibility (during rain and fog). The main factors affecting the visible range of these lights are external to the installation and may be grouped as follows:

- Atmospheric light transmission (meteorological visibility).
- Human perception.
- Background lighting.
- Geographical range (height of observer and light).
- Dynamic effects (e.g. motion of the light installation, obscuration of light by wave crests).

The geographical range of a light is *"the greatest distance at which an object or a light source could be seen under conditions of perfect visibility, as limited only by the curvature of the earth, by the refraction of the atmosphere, and by the elevation of the observer and the object or light"*.

However, this is also affected by the vertical divergence of the light source. Vertical beam divergence is specified as the angle of the beam between points where the intensity has fallen to a fraction of the maximum intensity within the beam. When a light is used on a buoy, as is the case with marks for fin-fish farms, its angle is constantly changing due to wave action and so the beam is not always pointing directly towards the horizon. The vertical divergence of the beam is typically designed to account for this wave action.

These lighting characteristics do not necessarily apply to all lighting utilised by ships at anchor – as will be case for any ship at anchor near to the Project. Deck lighting on a large vessel is not specifically designed for identification by other mariners but rather to provide visibility for the crew working on board the ship. As such, these lights are not designed to have specific vertical divergences and so will light and reflect off the ship superstructure, glowing for observers at a wide range of viewing angles (Figure 3.24).

Note that lighting used for farming purposes must not interfere with the visibility of AtoN.

Virtual AtoN Beacons

Virtual AtoN beacons use electronic digital signals to create an electronic image of a beacon at a given location. Virtual beacons are intended to complement physical AtoN, not replace them, and in doing so provide an additional layer of information in various scenarios where this may be beneficial.

This subsidiary role is partly due to the reliance of virtual beacons on electronic communication and so are subject to potential disruptions or failures. They also may not be visible to all vessels depending on their receiver capabilities and display systems (principally chart plotters). These beacons use the same AIS technology as used to indicate the position of vessels.

As chart plotters devices are becoming relatively inexpensive, almost all commercial mariners now routinely fit and use them. Many recreational owners, but not all, also now choose to fit and use them.

Virtual AtoN can provide real-time information about hazards, temporary obstructions, or even specific locations that might not be easily marked with physical buoys or lights. They are particularly useful in dynamic situations where a hazard arises suddenly.

IALA recommend that aquaculture developers consider equipping marine farms with an AIS AtoN system[22].

The use of AIS as a virtual AtoN can provide benefits and services to installation owners, navigators, and local and national authorities. These benefits include:

- Subject to a passing / nearby vessel being AIS equipped:
  - Provides identification of the AtoN in all weather conditions.
  - Complements existing signals (light, sound, radar reflection) from AtoN.
  - Indicates if a floating AtoN is off position.
  - Marks or delineates tracks, routes, areas, and limits.
  - Enhances the marking of offshore structures.
  - Provides additional AtoN capability where the installation of physical AtoN is technically or economically difficult.

[22] IALA. (2013). *The Marking of Man-Made Offshore Structures*. https://vasab.org/wp-content/uploads/2018/06/2013_IALA_Marking-of-Man-Made-Offshore-Structures.pdf

4 Navigational Risk Assessment

A risk assessment is the overall process of establishing the scope, context, and criteria, identification, analysis, evaluation, and, finally, treatment of the risk. The following sub-section describes a process that includes each of these steps.

4.1 Risk Assessment Process

The scope and context of the Project and hence the navigational risk assessment are covered in the previous sections of this report. This section and those that follow complete the risk identification, analysis, evaluation, and treatment that form the ISO31000 process.

This risk assessment considers hazards under two criteria:

- Risk to others due to the farm's presence; and
- Risk in the event of the farm experiencing a structural or mooring failure.

To ensure coverage of the four key risk assessment steps, the following tasks were completed to the level indicated:

1. Understanding the context – the context was established and is described in Section 3.
2. Identification of risks – the key risks were identified through consultation with stakeholders, the professional experience of experts, inspection of engineering drawings, experience with other fin-fish farms (including another offshore development), and site visits.
3. Consultation with key stakeholders – consultation over an extended period with stakeholders, including discussions with the experienced South Port sea-pilots and Operations Manager, the Harbourmaster, and the fishing boat operator during a site visit associated with the prior application.
4. Analysis and assessment of risk – this report includes the analysis and assessment of risks based on information received from stakeholders, site visits, and independent investigations.

4.2 Navigational Risk Scenarios

For the purposes of this assessment, navigational risks have been separated into the following main scenarios which are discussed in the following sections of this report and assessed in Section 7.1. These are:

1. Interactions between third-party small vessels and the marine farm.
2. Interactions between workboats and marine farm structures.
3. Causes and effects of a large vessel passing close by or impacting a marine farm.
4. Causes and effects of a large vessel dragging anchor and impacting a marine farm.
5. Causes and effects of large vessels choosing to drift while awaiting access to South Port.
6. Causes and effects of a farm or parts thereof breaking free or being lost and creating risk for vessels and other water users.

5 Risk Identification

The purpose of risk identification is to find, recognise and describe risks associated with the Project. Risks have been identified based on the experience and expertise of the Navigatus team complemented by the views of key maritime stakeholders and guidelines and from the information set out in Section 3.

5.1 Risk from the Presence of the Farm

The presence of the marine farm at the proposed location introduces a navigational hazard for vessels operating in or along the north-east coast of Stewart Island/Rakiura. In the proposed location, the farm will have a funnelling effect whereby small and potentially medium-sized vessels (vessels less than 500 GT) may navigate between the coastline and the proposed farm area whilst larger vessels may utilise waters further out into Foveaux Strait than they currently need to. It is also noted that this maritime traffic presents a hazard to the farm itself – both in terms of personal and navigational safety and in terms of the potential loss of asset value.

5.2 Charted Anchorages

From inspection of the traffic density mapping (AIS derived data), it is evident that both charted anchorages (Figure 3.2) in the immediate vicinity of the proposed farm location are regularly used by large vessels, including the anchorage off Murray Beach which is inshore of the proposed farms. The other designated anchorage is to the north of the proposed location of the farm.

It is evident from the AIS data that vessel-masters typically choose to anchor between 1-2 nautical miles (2 – 4km) off the coast with the prevailing weather conditions at the time likely to dictate the final position.

South Port sea-pilots have previously indicated that routine operations could result in up to two vessels requiring to be at anchor before berth availability or tidal conditions are suitable. There have been examples, however, where up to four vessels have been anchored in the area at the same time.

5.3 Vessel Activity in the Vicinity of the Proposed Farm

The profile of vessel activity in the Foveaux Strait and north-east coast of Stewart Island/Rakiura is a critical factor when identifying the applicable navigational hazards. In general, the level of vessel activity in the area relative to other regions of New Zealand would be characterised as 'low'. The majority of traffic in the immediate vicinity is due to large vessels anchoring or drifting whilst awaiting berths in Bluff. Cruise vessels operating to and from the west to Paterson Inlet/Whaka a Te Wera also pass to the east of the proposed location (just outside the pilotage area).

It is understood that recreational activity fluctuates seasonally with an increase in recreational activity occurring during the summer months, on public holidays, weekends, and over the Christmas period when enjoying the water is part of the New Zealand outdoor culture.

There are a number of different stakeholders, different areas of operations, and times where activity is at its highest. Maritime stakeholders include Stewart Island/Rakiura ferry services, water taxi services for locals and tourists, tour operators, workboats servicing aquaculture at Stewart Island/Rakiura, commercial fishing vessels, commercial cargo vessels and recreational vessels used for fishing, diving, touring, or general transport.

5.4 Natural Vessel Routes

As previously mentioned, the position of a farm Project is a critical factor to the level of risk it may represent to vessels operating in the area. Therefore, when considering the proposed farm locations, it is important to determine the main routes of vessels while transiting through or moving about within the coastal marine area. The Maritime NZ Marine Farm Guidelines set out a key requirement that the proposed farms are positioned at least a minimum distance off recognised transit routes so that they do not interfere with navigation. The extent to which this is important will vary according to the level of marine traffic, the type of traffic, the density of the traffic, the farm's position relative to other marine hazards and other variables such as wind, sea state/conditions, and visibility (which are all factors of safe navigation).

Despite a lack of defined navigational routes, there are, as expected, commonalities in the way vessels transit in the area of Stewart Island/Rakiura or through the Foveaux Strait. Publicly available AIS data viewed on the Marine Traffic™ web portal and procured from Vessel Finder™, alongside several previous discussions with local mariners, South Port's sea-pilots, and the Harbourmaster helped to understand the natural transit routes taken by the vessels operating in the area.

5.5 Cruise Ships

Regular and expedition cruise ships navigate Foveaux Strait and the waters near Stewart Island/Rakiura each year. Many of these vessels visit Paterson Inlet/Whaka a Te Wera which can involve navigating to the north and east or through the proposed marine farming area (Figure 5.1). The shortest path for these ships when travelling to or from Paterson Inlet/Whaka a Te Wera between Stewart Island/Rakiura and Titi/Muttonbird Islands results in the ships passing close to or through the northern section of the proposed marine farming area. This indicates that there is risk for these vessels to interact with the northernmost of the proposed marine farms. This risk is analysed, and treatments are proposed in the following sections.

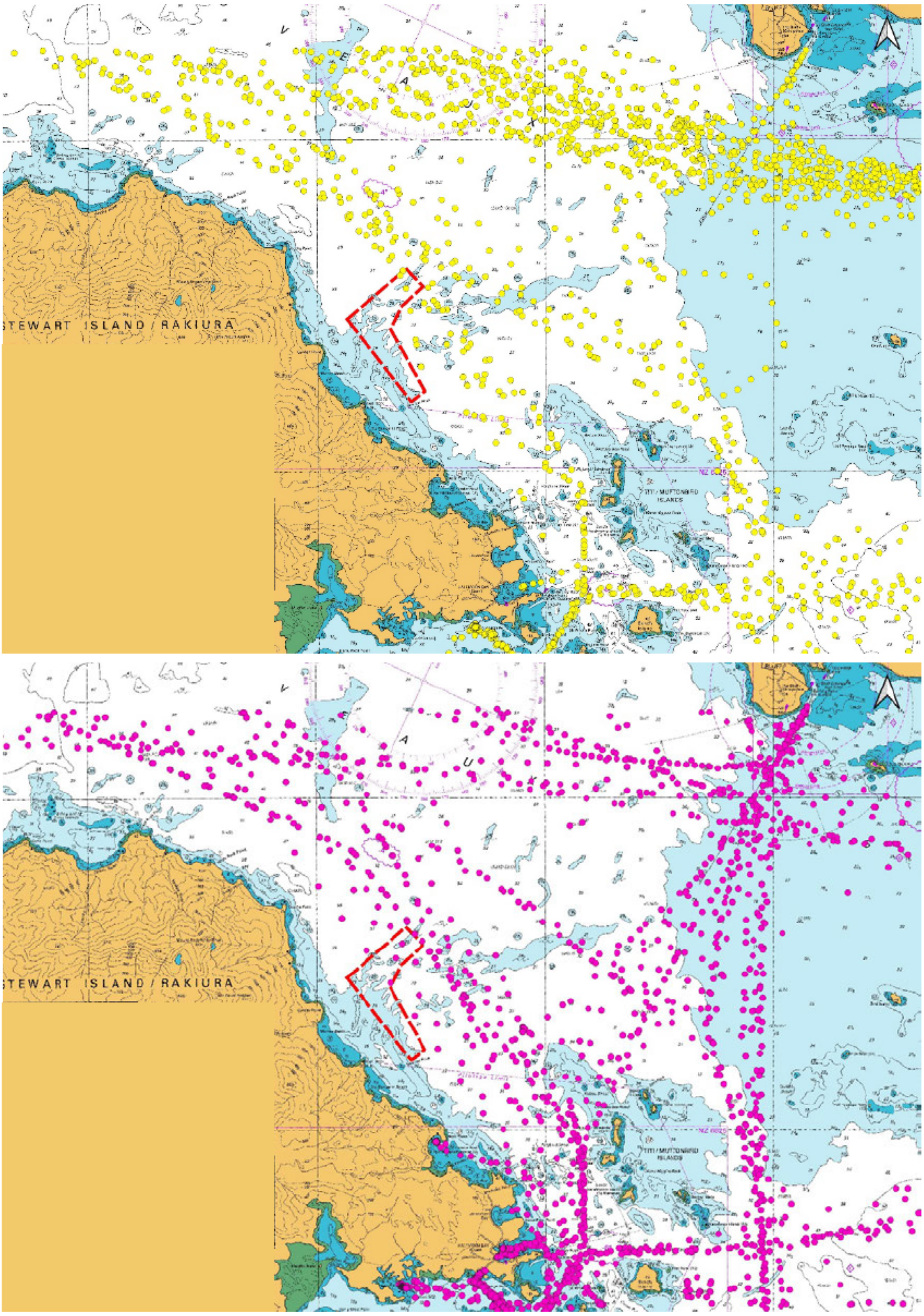


Figure 5.1: AIS datapoints for large-cruise (upper image) and expedition-ships (lower image) ships (2024).

5.6 Recreational Vessels

For small, powered craft, navigational paths taken are generally the shortest route between two points unless seeking relative shelter or due to the relative set of the waves (direction of the waves). The route taken by sail craft is less predictable as they will try to find clean wind conditions and if making to windward will tack (zigzag) as they progress.

Across New Zealand there is a wide range in level of local knowledge and seamanship skills in the recreational sector. However, due to the isolation and often difficult conditions, the recreational activity around Stewart Island/Rakiura will typically be being undertaken by skippers with a generally higher competency level than elsewhere, with the focus being on skill and knowledge of local weather conditions.

5.7 Workboats

Farm operator workboats will need to operate in proximity and adjacent to the farm pens. There is chance of these workboats contacting the pens, feed barge, and other farm structures – including the submerged lines. Whilst the operators of these vessels will be trained, qualified, and knowledgeable of the farms, there is always some chance of an event occurring.

In addition, work may require personnel to be moving to and from workboats and farms. During these interactions, a man-overboard (MOB) event could lead to drowning, crushing (between a workboat and farm structure), or hypothermia.

5.8 Identified Risks

A summary of the risks identified is set out in Table 5.1.

Table 5.1: Identified risks.

Vessel Type	Risk	Causal Factor
Recreational vessels	Collision with infrastructure	Out of date information Low visibility of pens Inquisitive nature Route not clear Obstruction between feed barge and pens Not expecting a marine farm Large area and distance between farms Farm configuration changes over time Farm not contiguous or consistent in layout Vessels attempting to cut between pens/farms/feed barges
	Collision with vessel	Concentration of traffic Less navigable water Funnelling of vessels towards shore Additional traffic
	Grounding	Funnel towards Newton Rock Route closer to the coastline

Vessel Type	Risk	Causal Factor
Commercial vessels	Collision with infrastructure	Out of date information Low visibility of pens Obstruction between feed barge and pens Large area and distance between farms Farm configuration changes over time Farm not contiguous or consistent in layout Vessels attempting to cut between pens/farms/feed barges
	Collision with vessel	Concentration of traffic Less navigable water Additional traffic
	Grounding	Funnel towards Newton Rock Route closer to the coastline
Ferries / tourist vessels	Collision with infrastructure	Out of date information Low visibility of pens Obstruction between feed barge and pens Large area and distance between farms Farm configuration changes over time Farm not contiguous or consistent in layout Vessels attempting to cut between pens/farms/feed barges

Vessel Type	Risk	Causal Factor
	Collision with vessel	Concentration of traffic Less navigable water Not on the ferry route Additional traffic
	Grounding	Funnel on to Newton Rock Route closer to the coastline
Cruise ships	Collision with infrastructure	Low visibility of pens
	Collision with vessel	Concentration of traffic Less navigable water Additional traffic
Large vessel navigation transit	Collision with infrastructure	Low visibility of pens
	Collision with vessel	Concentration of traffic Less navigable water Additional traffic
Vessels at anchor	Collision with vessel	Concentration of traffic Less navigable water Additional traffic Reduced anchorage area Drifting instead of anchoring Additional traffic
	Grounding	Anchoring closer to shore Drifting instead of anchoring Anchor dragging

Vessel Type	Risk	Causal Factor
Workboats	Collision with vessel	Concentration of traffic Less navigable water Funnelling of vessels towards shore Additional traffic
	Collision with infrastructure	Need to be in close proximity to farm structures Low visibility of pens
	Man overboard	Work requiring movement between vessels / structures

In addition to the risk for vessels, the following risks were identified.

Vessel Type	Risk	Causal Factor
Farms	Damage	Weather conditions Structural failure Collision with vessel
	Break free / loose item(s)	Weather conditions Mooring failure Structural failure Collision with vessel Procedure/operational error Poor maintenance

6 Risk Assessment

As a result of the risks identified above, further assessment was undertaken to comprehend the nature of the risk and the associated characteristics.

6.1 Assessment Areas

To aid understanding from a mariner's perspective, the overall area has been further considered by assessing four conceptual areas to allow the issues associated with each specific area to be assessed and described.

- Area 1 – overall area of Foveaux Strait.
- Area 2 – proposed farming location.
- Area 3 – the area to the north and east of the proposed location and showing the majority of the transiting traffic in the area.
- Area 4 – covers the direct navigation route between Oban and Bluff.

6.2 Area 1 Overall

The risk exposure can be expressed across a number of factors to understand the area of most significant risk. The proximity between vessels and the Project, the number of people onboard the vessel and the duration of the interaction.

There is some traffic that transits across the current proposed location of the Project. Smaller coastal vessels, such as any charter vessels transporting hunters and trampers to or from the coastline alongside the proposed Project area, would likely choose to transit closer to shore, passing inland of the farms.

Any deviation required to these vessels would be minimal – but will require that the farm area is properly charted and marked.

Larger vessels typically keep further off the coast when not under pilotage and, as a result, a direct transit line to the Stewart Island pilotage area would have them remain outside but passing close to the proposed area. It is important to note that some cruise ships pass through the proposed marine farming area (refer Section 5.5).

If deemed necessary, any additional distance from a small alteration of course will have minimal impact to transit times but will require that the farm area is properly charted and marked.

There are records of large commercial vessels routinely anchoring in and around the proposed Project area. This is assessed in Section 6.3.1.

The most-travelled route in the area is that between Bluff and Oban which includes the daily ferry services between the two towns. This route passes close to the Titi / Muttonbird Islands approximately 5.5 nautical miles (~10km) from the proposed marine farm location.

There are two navigation routes transiting Foveaux Strait east-west, one tracks north of Ruapuke Island whilst the other tracks south of it. The northern route passes approximately 6 nautical miles (~11km) from the northernmost edge of the proposed marine farm location. The southern track is closer to 2 nautical miles (~4km) from the northernmost edge of the proposed marine farm location.

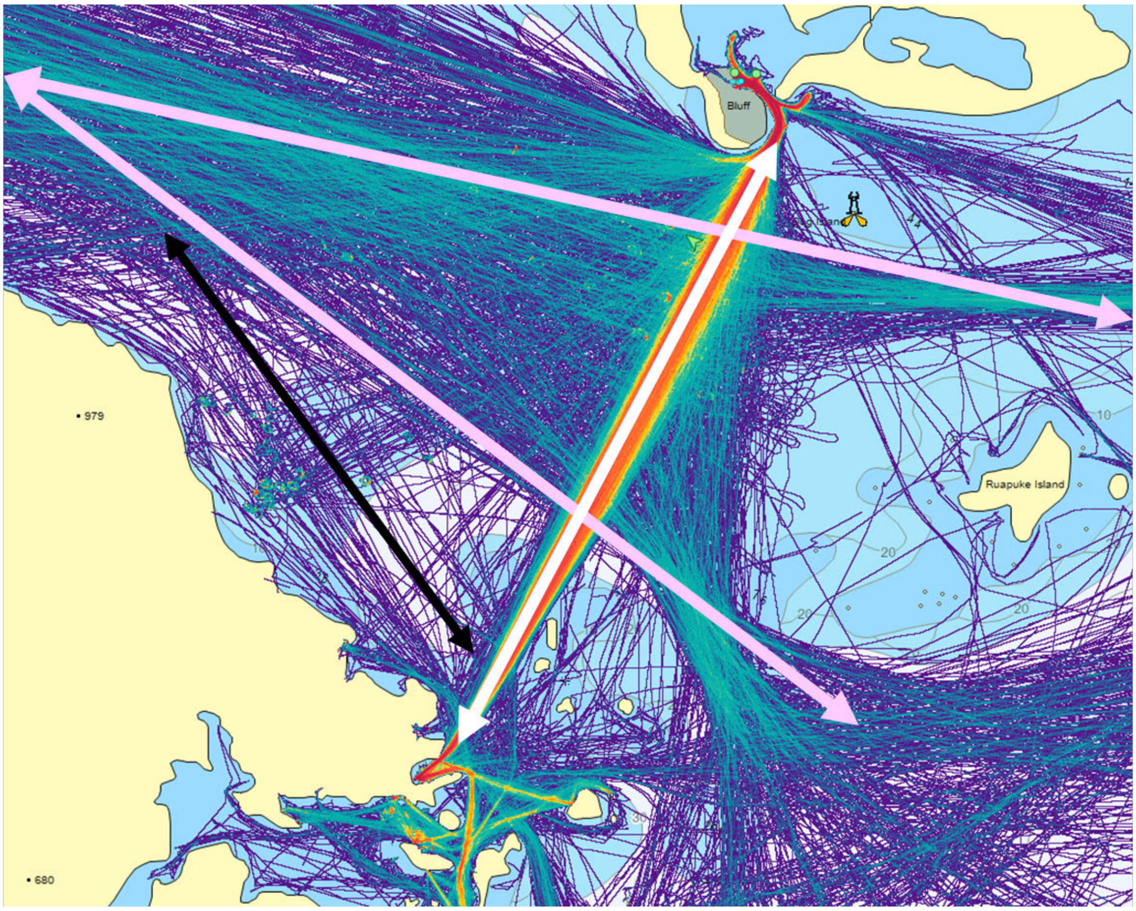


Figure 6.1: AIS density map for all vessels in 2023 with arrows overlaid indicating navigational routes (white between ports, pink transiting Foveaux Strait, and black the inshore cruise ship route between Paterson Inlet and the West Coast).

6.3 Area 2 Farm Project Location

6.3.1 Large Ship Anchorages

AIS data of position reports for all of 2024 across the proposed marine farming area and Foveaux Strait was analysed. Corresponding metadata is described in Appendix B. A separate AIS dataset containing position reports for vessels in the years 2017, 2018, and 2019 was also analysed. The 2023 heat map was sourced from online service supplied by MarineTrafiic™ – this being the latest available. Data for the 2020 – 2022 period was not used due to the non-normal impact of Covid 19 pandemic on maritime activity.

The 2024 AIS data was filtered for reports for which the NAVSTAT was “At anchor” and the reported speed was less than 2 knots. The resulting data shows that 18 different vessels (16 cargo ships and 2 tankers) anchored off the north-eastern coastline of Stewart Island/Rakiura in 2024, 6 of these vessels anchored within the proposed Project area. These vessels anchored in the area a combined 24 times with no more than two vessels ever anchoring in the area at the same time. The duration of these anchorages ranged from approximately 5 hours 30 minutes to 264 hours (11 days). The corresponding AIS position reports are shown in Figure 6.2.

Across 2017, 2018, and 2019, there were 90 instances of vessels anchoring near to the proposed Project area – 26 in 2017, 29 in 2018, and 35 in 2019. During this time, the anchorages ranged from approximately 1 hour 15 minutes to 538 hours (over 22 days) with a maximum of four vessels anchored in the area at any one time in 2017, two in 2018, and three in 2019.

Whilst some Masters choose to anchor by the charted anchorages by Saddle Point and Murray Beach, most choose to anchor further offshore either within the proposed Project area or further out towards Foveaux Strait.

Given the position of the proposed marine farming area, the anchorage off of Murray Beach anchorage will not be a viable anchorage for large vessels as it is positioned between the proposed Project area and the coastline of Stewart Island/Rakiura. However, vessels of less than 500GT and less than 50 metres in length overall (LOA) would still be able to use the Murray Beach bay as an anchorage if seeking close-in shelter.

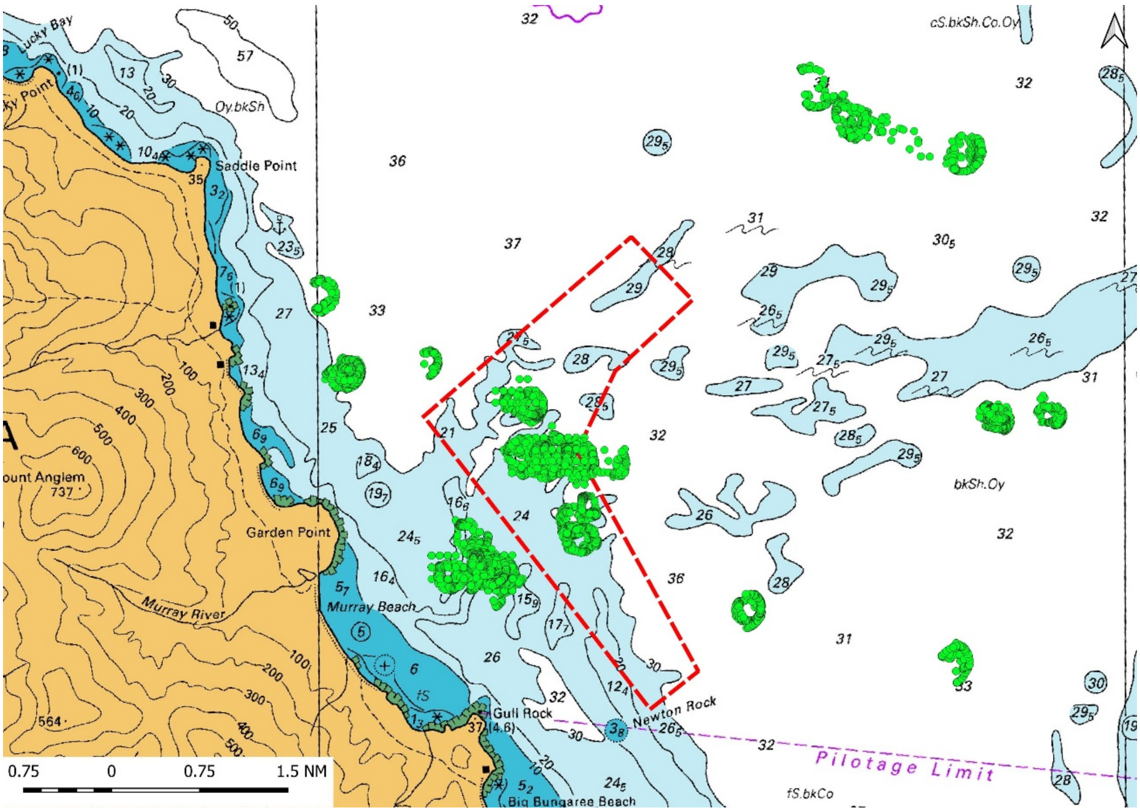


Figure 6.2: AIS datapoints for vessels "At anchor" in and near the proposed marine farming area (2024).

In addition, analysis of AIS positions recorded across 2017, 2018, and 2019 (Figure 6.3) indicates that ships have previously been seen favouring the water space towards Saddle Point, north of the proposed Project area.

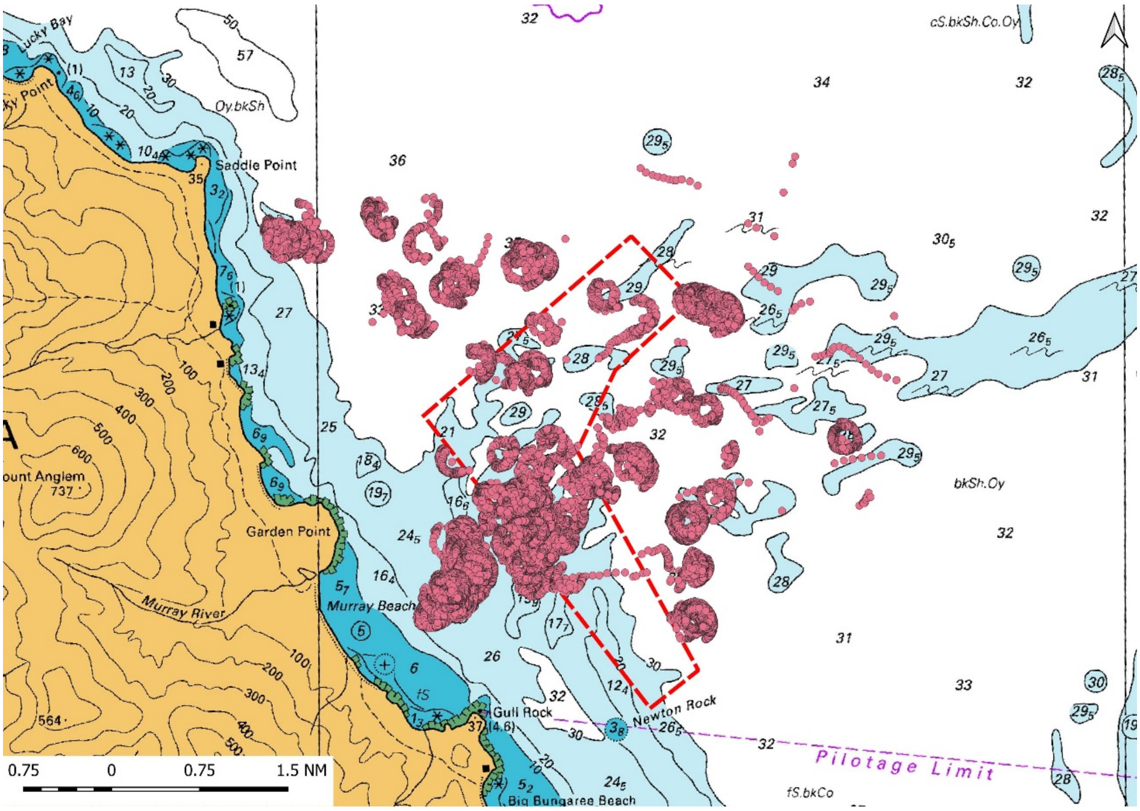


Figure 6.3: AIS datapoints for vessels captured at <1 knot in and near proposed marine farming area (2017-2019).

6.3.2 Collisions with Farms

Many variables would affect the consequences of collisions with any fin-fish farm. Such variables include vessel size, speed, angle of impact, vessel shape, farm design, weather conditions, position and number of persons on board the vessel and many more.

However, in general, the faster a vessel collides with a farm and the smaller the size of the vessel, the higher the resulting probability of injury or loss of life on board the vessel.

Given the circular plastic ring design, the structure would be quite forgiving during a collision impact from a vessel. However, self-evidently, all efforts should be made to avoid collisions with the pens of other farm structures.

As part of the mooring structure, the pens are secured into four 'node' plates. These plates have a buoy attached that rides on the sea-surface. While not their primary purpose, these buoys effectively mark the extent of the structure and the point at which the near-surface mooring lines extend to. Given the concept design, the static under keel clearance at the buoys' positions will be 6 metres and extend to about 10 metres at a range of 20 metres out from the buoys. This static depth is assessed as being safe for small and medium vessels operating in or near the farm's location and would not pose a significant risk of collision with the cables.

It is currently proposed that two sets of pens will be fed from one central feed barge or mobile feed vessel. The associated feeding tubes will be a hazard to navigation for any small vessel attempting to pass between the feed barge and the pens. The currently proposed distance between the feed barge and pens is approximately 180 metres. Sufficient communication, lighting and marking of this hazard will need to be put in place to ensure that vessels do not attempt to pass between the barges and the pens.

6.3.3 Farm Breakaway

The navigational risks discussed in the preceding sections assume that the farms and mooring systems operate as designed and the farm remains securely in place. If a mooring system or farm itself fails, a new significant navigational hazard would be created. If the farm became free floating after breaking away from its moorings, it would become a hazard for nearby marine traffic. For large vessels this would be expected to result in fouling of the ship's propeller and potentially a loss of propulsion and the associated control of the vessel. Clearly, it is the responsibility of the owner of any marine structure to ensure that the structure remains in the charted position to avoid it becoming a significant hazard to shipping.

As a farm structure is under the influence of tidal and wind patterns, passing mariners would have little warning that the farm has moved from the position marked on the chart unless actively advised of the situation. The main barrier to such an event occurring is the engineering quality of the mooring system and farm structure as well as the procedures to ensure it is operating and maintained as designed.

The probability of a farm breakaway event is dependent on mooring design, correct maintenance of the mooring system, and construction/installation. Specific considerations relevant to this are as follows.

Pen Design

The inherently low profile of the farm design will mean the farm would be of limited visibility to mariners. This contributes to collision risk relative to a more visible structure. This effect may be more significant for the crew of smaller vessels due to the lower viewing angle and the fact that they are less likely to be equipped with radar or an AIS receiver.

However, provided the farms are appropriately charted, marked, and lit, and that the feed barge should be relatively visible, it can be expected that mariners will be aware of the presence of the farms.

Forces on the Mooring System

The key and routine forces that the mooring system must hold a farm against are water flow, current, tidal sea-water level rise and swell/wave motion. The first forces on the farm's structure will be due to the speed of the water flow assessed against the drag of the farm's structure and pen nets, while the forces on the cables and anchors will be due to the drag of the farm structure and the mooring wires themselves. Wave and swell action will cause the farm to raise and lower as they pass. This movement will place an uneven and undulating load on to the mooring system. Tidal rise does not itself create a force but must be allowed for and the current forces must be considered for any state of the tide.

Ultimate limit state (ULS) analyses must be undertaken based on extreme wave and wind conditions, as well as other credible non-normal situations. The design assessment must look at how the cages and floating structures respond to the waves and the induced forces on the mooring system. The mooring system must be designed to have sufficient compliance to respond to the waves regardless of tidal state (level and current).

Design for the Environment

As the placement of aquaculture farms into the coastal region outside of sheltered bays and sounds is relatively new for New Zealand, the design process will need to take account of the current and expected conditions and suitability of the design to withstand the resulting forces. International experience suggests that the concepts are now becoming well understood and the technology available to facilitate safe operations in the proposed location.

Wind forces will have a lesser effect due to the low freeboard and limited above water structures. Similar forces act on the feed barge and its mooring system. Although in this case, wind forces will likely be stronger than experienced by the pens themselves and possibly stronger than current forces.

Given the far-field and near-field tsunami threat that New Zealand is exposed to, the design criteria must account for a tsunami event that could credibly occur during the life of the Project. Based upon prior work, it is Navigatus' view that a 10% chance of design exceedance is a reasonable criterion. Assuming a 25 or 30-year Project life, in practice this would equate to a design that can withstand (current and sea-level change) a 1-in-300-year tsunami event.

To manage the limited uncertainty this situation creates, the mooring system design will need to be professionally engineered and independently peer-reviewed prior to owner sign-off and construction commencing. This requirement for peer review is important and it is suggested that, to give the necessary assurance to all parties, Navigatus consider it should be included as a condition of consent. It is noted that, given differing planning regimes and hazard profiles, engineering standards originating from overseas may not in themselves specify such a requirement.

6.3.4 Mooring Design

A design for the proposed mooring system has been provided by DSA Ltd and an image is shown in Figure 3.18. We understand that this design criteria is that laid out in the relevant Norwegian Standard[23]. This standard requires consideration of 'accident' events but not tsunami events. does not consider and so consideration of the ability of the design to withstand credible tsunami induced current and sea-level rise (long-wave height) needs to be accounted for (see para above).

While special marks will indicate hazards near the pens themselves, due to the additional presence of the feeding pipes and other near-surface obstructions, vessels will not be able to safely pass between the feed barge and adjacent pens. Instead, vessels will have to transit around the outer edge of each individual farm. To prevent inadvertent transit between the farms from a small vessel approaching from the north-west, it is recommended that a floating barrier (a string of small buoys) is positioned to prevent vessels transiting between the feed barge and between each set of pens within each farm assembly.

[23] NZ9415

6.3.5 Debris from Farms

Items such as ropes, netting, floats or hoses may come loose from the marine farms and become marine farming debris. Vessels may become entangled or otherwise become fouled with the items causing potential damage to vessels. This is a recognised industry hazard that must be managed – preferably by prevention – by the farm owner. Loose items typically occur after periods of adverse weather conditions or due to operational/procedural errors.

The reduction in these events and actions required following, should be included as part of the operator's standard operating procedures (SOPs).

6.3.6 Commercial Fishing Vessels

The proposed location is outside of oyster fishing areas and the home port for these vessels being Bluff, there will be limited impact to current routes. There may be some deviation required if avoiding weather or proceeding from one fishing area to the next. There is some historical evidence that suggests that on a rare occasion an offshore commercial fishing vessel will pass through the area.

Fisheries New Zealand provided NTS with a heatmap of commercial fishing activity in and around the proposed farming area over the period January 2020 through to May 2023. The heatmap includes the boundary for a previously proposed marine farming area. This image has been georeferenced to also include the farming area proposed for this Project (Figure 6.4).

The areas of relatively high commercial fishing activity are located approximately 5 km north-east of the proposed marine farming area and outside of the CMA assessment boundary. Instances of relatively medium commercial fishing activity are seen east, south-east, west, and north-west of the proposed marine farming area. The volume of commercial fishing activity that occurred within the boundary of the proposed marine farming area can be described as relatively low.

Overall, it is assessed that there will be minimal impact to the navigation of commercial fishing vessels from the proposed farm.

Full details of the commercial fishing activity in the area are available in: Hananui aquaculture project: Characterisation and assessment of potential impacts on commercial fishing Prepared by Nici Gibbs, Fathom Consulting Ltd for Ngāi Tahu Seafood Resources Ltd DRAFT: 28 May 2025.

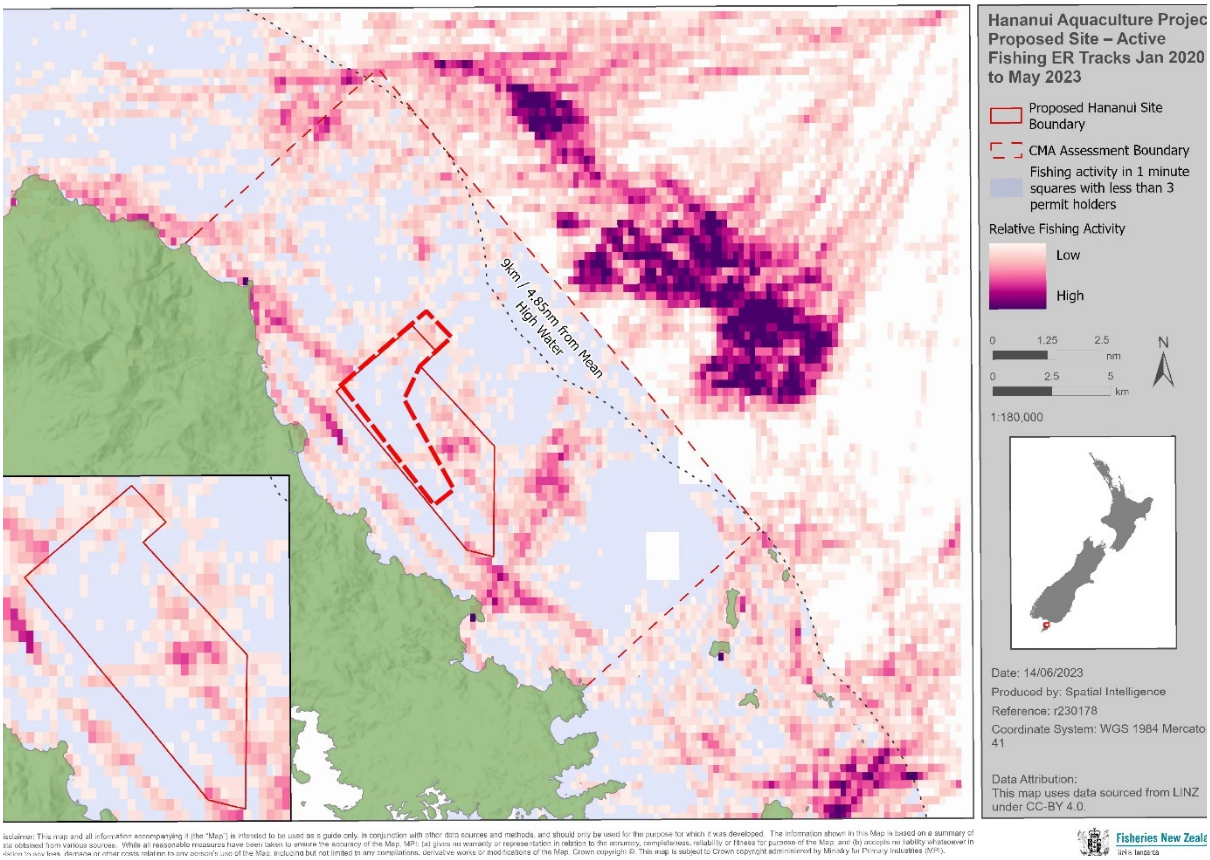


Figure 6.4: Fisheries New Zealand heatmap for Jan 2020 – May 2023 with proposed farming area outlined in thick, red, dashed line.

6.3.7 Charter Vessels

Chartered vessel activity for transportation along the coastline for excursions and fishing does occur around the proposed Project area.

In the case of transportation, charter vessels will typically take the shortest route between two points – in this case staying relatively close to the coastline of Stewart Island/Rakiura. As a result, these vessels are likely to pass between the proposed Project area and the nearby coast and so will not be materially impacted by the Project.

The data indicates that excursions rarely occur in the proposed Project area. The area is remote and away from the more popular excursion areas of the islands from Ulva Island to the south to the Titi Islands to the south-east.

Charter fishing may occur in the proposed Project area but to a significantly lessor degree than is experienced to the southeast of the Project area. Data supplied by Fisheries New Zealand (Figure 6.5) shows that between a period from 2018 to 2024, no amateur charter vessel events occurred within the proposed Project area (noting that areas with fewer than three fishers were omitted from the dataset).

Provided the farms remain properly marked and charted and loose-object events not allowed to occur, there should be no reason that charter fishing could not continue within and around the area.

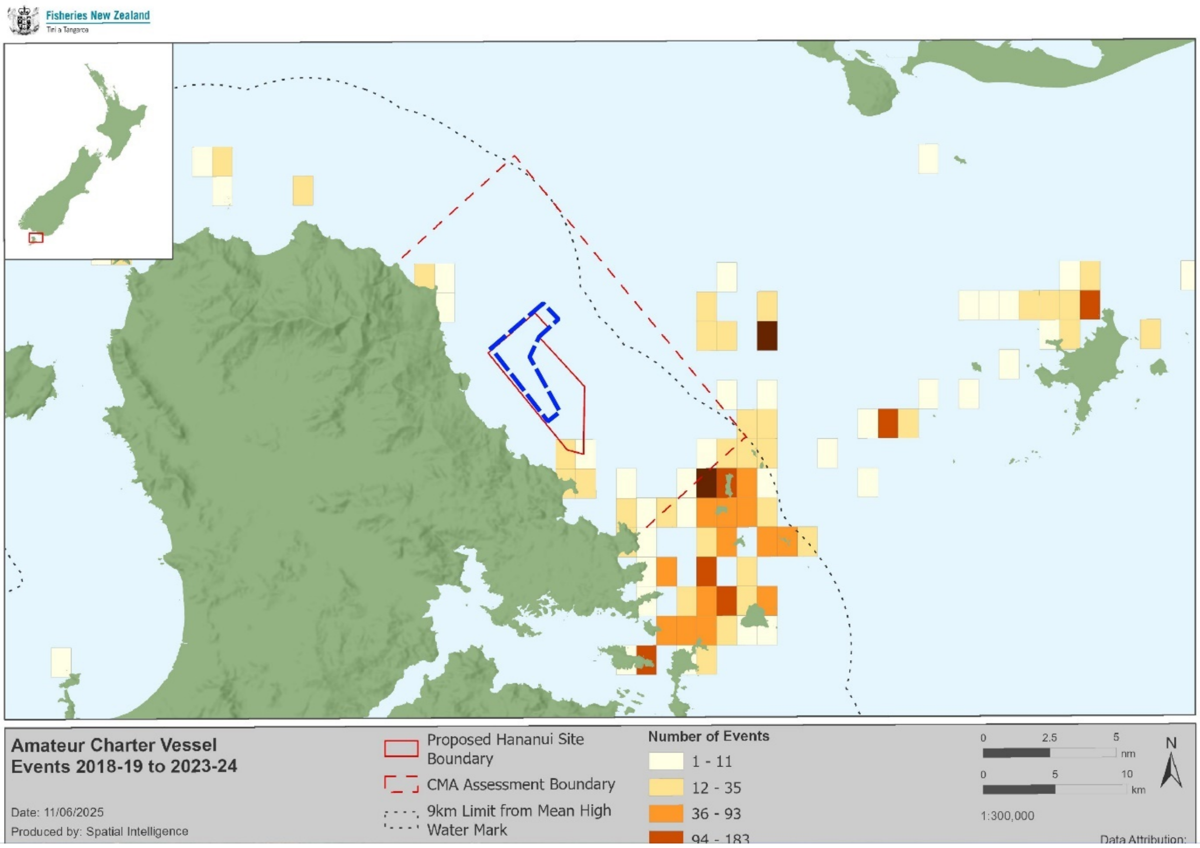


Figure 6.5: Fisheries New Zealand amateur charter vessel events analysis with Project area overlaid (blue-dashed boundary).

6.4 Area 3 Shipping Routes

This zone covers the area to the north and east of the proposed location and is the area where the majority of the transiting traffic passes. Figure 6.1 and the figures in Appendix A display shipping activity.

6.4.1 Large Ship Navigation

As a result of the distance between the farm area and the main shipping routes through Foveaux Strait, it is assessed that the proposed location of the farm will not have any impact on large vessels transiting the area.

6.4.2 Cruise Ship Navigation

As with the large ship navigation and the distance to the main shipping routes, it is assessed that the proposed location of the Project will not have any impact to the navigation of the majority of cruise vessels that transit through Foveaux Strait as they head from the east coast and west coast.

However, for those cruise vessels that are navigating between the west coast and Stewart Island/Rakiura via the north-eastern coastline, they will pass close to the area of the farms (see Figure 6.1). It is therefore critical that they have visibility of the farms and be able to remain clear to the east as they approach or depart the pilotage limit for Paterson Inlet/Whaka a Te Wera.

It is noted that as the cruise ships using this route will probably have been under pilotage and will be required to, a pilot will be embarked. However, the Pilot can only take over in pilotage waters and is not required to be on the bridge at other times. It therefore must not be assumed that the Pilot will have advised the Master of the presence of the Project.

The normal maritime procedures whereby nautical charts and ‘The New Zealand Pilot’ are updated must therefore be followed to unsure Masters do have that information to hand. Informing LINZ of the Project in sufficient time once construction is planned, of the Project and associated AtN, as well as the new indicated anchorages as approved by the harbour master are requirements routinely included as consent conditions.

6.5 Area 4 Direct Route

This area covers the direct route between Oban and Bluff. Relatively small passenger ferries service this route. AIS datapoints of regular passenger ferries are displayed in Figure 6.6. The distance between the regular route taken by ferries and the proposed location of the Project is significant. It is clear that the farm will not create any navigational issues for the local ferry operations.

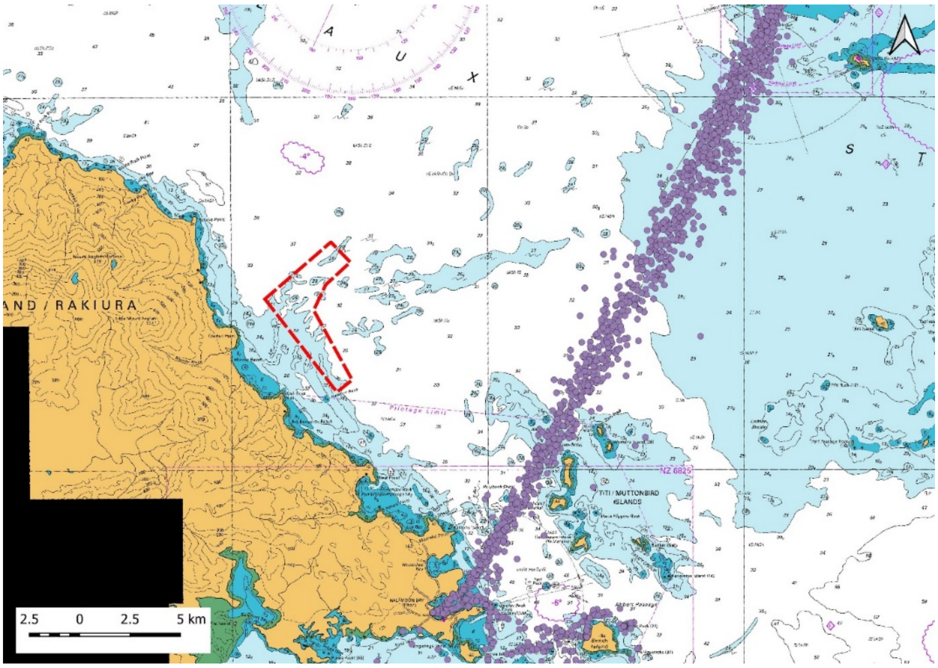


Figure 6.6: AIS datapoints for regular passenger services in 2024.

7 Risk Evaluation

This section discusses and evaluates the risks discussed throughout this report. When considering the risk for the Project, it is important to keep the consequences of an event in perspective. Formal risk assessment as per ISO31000 (risk management) and ISO31010 (Risk analysis) enables this.

The evaluation of risks has been undertaken using the likelihood and consequence descriptors presented in Table 7.1 and

Table 7.2. A risk rating is then assigned using Table 7.3. It is important to note that the qualitative risk-scales used are typical of those applied within the maritime sector and are designed to match the context and range of possible untoward outcomes. The consequence scale is an 'order of magnitude' scale covering the full range of potential impact. The purpose is to scale mitigation appropriately with the intent to reduce risk to as low as reasonably practical (ALARP). It is further noted that most planning and legislative legislation and guidance use the terms 'risk'' and 'hazard' more akin to 'lay' language. Given the need to understand navigational hazards and risks, Navigatus has intentionally used the terms as per ISO31000 and ISO31010 as per normal maritime industry practice.

With regard to environmental impact; it is understood that a Āpiti Hono Tātai Hono can be applied across all types of environmental assessment as it is premised on a holistic overview of Ira Atua Ira Tangata that makes no distinction between 'cultural' or 'natural' or any other dissociative landscape/water classifications. The terms used in the consequence descriptors should therefore by seen to apply to 'cultural' or/and 'natural' outcomes.

Table 7.1: Likelihood descriptors.

	Indicative frequency (during the life of the farm)
Frequent	Will occur and probably more than once
Likely	Almost bound to occur at some stage
Possible	May / may not occur
Low likelihood	Not expected to occur
Improbable	Highly unlikely to occur

Table 7.2: Consequence descriptors.

	Navigational impact	**Environmental impact**
Dire	Loss of large vessel. Fatalities.	Environmental incident causing very significant or long-term harm to the environment.
Severe	Damage to large vessel Loss of small vessel. Significant damage to a farm. Injuries.	Environmental incident causing significant harm to the environment that is difficult to mitigate. Major loss of stock to the ocean.

	Navigational impact	Environmental impact
Major	Seaworthiness of vessel brought into question. Disabled vessel. Emergency actions required.	Environmental incident causing harm to the environment – recoverable over time. Some stock loss.
Minor	Operational occurrence, minor harm or similar unintended event.	Environmental incident causing limited harm to the environment – Clean up required.
Negligible	Suboptimal process.	Minor incident – easily cleaned up.

Table 7.3: Risk matrix.

		Consequence				
		Negligible	**Minor**	**Major**	**Severe**	**Dire**
Likelihood	**Probable**	Low risk	Moderate risk	Very high risk	Extreme risk	Extreme risk
	Likely	Very low risk	Low risk	High risk	Very high risk	Extreme risk
	Possible	Very low risk	Low risk	Moderate risk	High risk	Very high risk
	Unlikely	Very low risk	Very low risk	Low risk	Moderate risk	High risk
	Improbable	Very low risk	Very low risk	Low risk	Moderate risk	High risk

7.1 Risk Scenarios

As introduced in Section 4.2, six overarching causal scenarios have been identified to aid the assessment and communication of risk associated with the Project. An initial qualitative likelihood and impact assessment was conducted to quantify the risk assuming the proposed Project was placed without any mitigations or controls.

The six causal scenarios are:

1. Interactions between third-party small vessels and the marine farm.
2. Interactions between workboats and marine farm structures.
3. Causes and effects of a large vessel passing close by or impacting a marine farm.
4. Causes and effects of a large vessel dragging anchor and impacting a marine farm.
5. Causes and effects of large vessels choosing to drift while awaiting access to South Port.
6. Causes and effects of a farm or parts thereof breaking free or being lost and creating risk for vessels and other water users.

7.2 Initial Risk Assessment

Table 7.4 shows the six outcome scenarios that could result from the six causal scenarios. The associated risk levels are pre-mitigation (raw risk).

Table 7.4: Initial risk assessment results (worst case outcome).

Scenario	Likelihood	Impact	Risk
Allision (large vessel)	Possible	Dire	Very high
Allision (small vessel)	Likely	Major	High
Collision (large vessels)	Unlikely	Severe	High
Collision (small vessels)	Probable	Major	Very high
Structural failure (break-way)	Possible	Severe	Moderate
Loose objects	Likely	Minor	Low

Table 7.5: Initial risk assessment results (most likely outcome).

Scenario	Likelihood	Impact	Risk
Allision (large vessel)	Possible	Severe	High
Allision (small vessel)	Likely	Minor	Low
Collision (large vessels)	Unlikely	Major	Low
Collision (small vessels)	Probable	Minor	Moderate
Structural failure (break-way)	Possible	Major	Moderate
Loose objects	Likely	Minor	Low

To reduce the risks across the scenarios to as low as reasonably practicable (ALARP), a series of controls and mitigations are required. These are discussed in Section 8.

8 Risk Mitigation

8.1 Scope

The purpose of this section is to establish how the risks identified and assessed in the previous sections of this report may be appropriately managed. While the purpose of mitigating navigational risk is to prevent unwanted events between vessels and farm structures and operations, it is also worth noting that while this risk assessment considers navigational and environmental risk, there is an associated asset-investment risk exposure that NTS will need to consider and assess against their own internal risk appetite.

8.2 Responsibilities and Liabilities

It is important to recognise where responsibility of approved or accepted mitigations lies. For example, while the Harbourmaster may approve a AtN plan, the responsibility for placing and maintaining those AtoN lies with the party that creates the hazard while responsibility for avoiding a properly marked and notified hazard lies with the master of any vessel operating in the area.

Farms are major investments and represent considerable value – both in terms of the structures and the fish stocks. As such, while not the focus of this navigational risk assessment report, it must be recognised that the proper monitoring and maintenance of risk mitigation also acts to protect the farm owner's investment. This incentive on the owner can be seen as supporting confidence across the regulatory bodies

8.3 Anchorages

The proposed location of the Project conflicts with some of the area currently charted for and used by large vessels anchoring whist awaiting berth availability in South Port. The area used is seaward of the designated anchorage in the Murray Beach bay as shown in Figure 6.2.

Whilst it is acknowledged the that the proposed marine farming area is situated in a location previously identified as being suitable for anchoring and allocated as such. However it is noted roughly half of the recorded anchorages in 2024 occurred outside of the proposed marine farming area or the Murray Beach bay (6.3.1). This indicates that other nearby areas are, while possibly not quite a sheltered, are actually suitable for the anchoring of large ships. Small vessels will still be able to chose to anchor in the bight of Murry Beach.

An assessment of the suitability of alternative anchorage positions based on a vessel size of 280 metres LOA (the maximum size of a container ship capable of entering South Port[24]) using up to 15 shackles[25] on deck was undertaken. This corresponds to a stern swing circle of 692.5 metres. These proposed alternative anchorages are shown in Figure 8.1.

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[24] South Port New Zealand Limited. (2023). *Pre-Arrival Information to Enter the Port of Bluff Version 9*. https://southport.co.nz/uploads/Pre-arrival-information-for-vessels.pdf

[25] A shackle is 27.5 metres of cable with the term "on deck" referring to that paid out.

It is assessed that there is sufficient navigable water in the area adjacent to the proposed farm area that can be utilised by vessels choosing to anchor whilst awaiting berth allocation at South Port. Figure 8.1 shows that there are five areas where large vessels could anchor while remaining in the lee of Stewart Island/Rakiura. The designated anchorage in the Murray Beach bay does not directly conflict with the proposed farm area. However, only relatively small vessels will be able to utilise tjis bay as an anchorage.

A review of the hindcast model was used to provide a comparison of the expected extreme wind and wave conditions between the general area that is currently used for anchoring and the proposed alternative locations (Table 8.1).

Table 8.1: Conditions at Proposed Marine Farming Area and Proposed Alternative Anchorages.

Location	Extreme Wind (knots) 10/100-year return periods	Extreme Significant Wave Height (metres) 10/100-year return periods
Proposed marine farming area	49/55	5.1/6.2
Northwest of proposed marine farming area	48/54	4.8/5.8
East of proposed marine farming area	49/55	5.3/6.4

These extremes are relatively similar across the areas compared with the water towards Saddle Point in the north expected to have slightly lower extremes in magnitude than the other areas assessed.

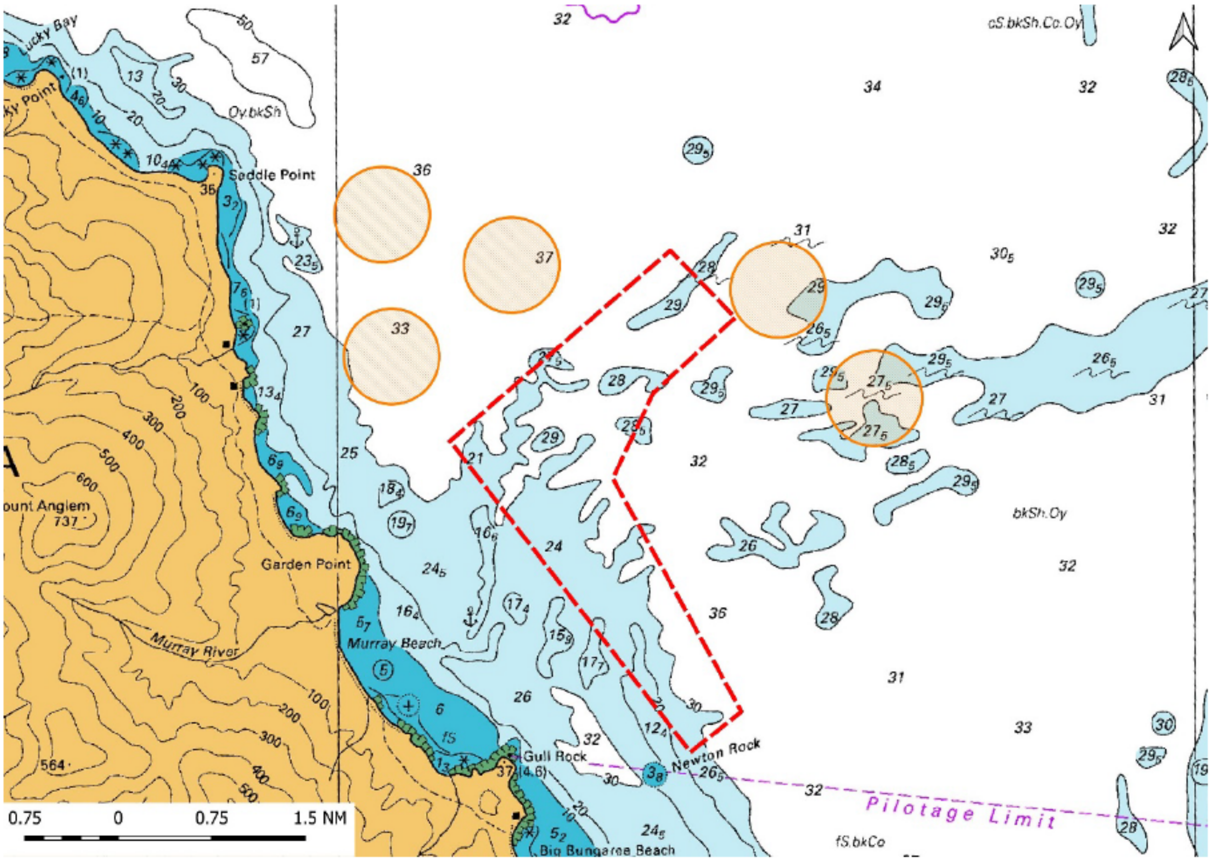

Figure 8.1: Proposed marine farming area with alternative anchorages marked in orange.

While the nearby areas are found suitable to be designated anchorages, they will still be relatively close to the farms and ships coming to anchor will be manoeuvring. It is therefore imperative that the masters of these vessels are aware of the existence and extent of the overall farm area.

8.4 Traffic

Due to the navigation routes into and out of Oban and Paterson Inlet/Whaka a Te Wera, the proposed location presents the lowest impact on local vessel navigational safety in the area. However, both large cruise ships and expedition ships do at times pass close to or through the area. As a result, it is imperative that the masters of these vessels are aware of the existence and extent of the overall farm area. As it is, a normal maritime procedures whereby nautical charts and 'The New Zealand Pilot' are updated is in place.

Provided this process is followed, Masters will have the information to hand. Informing LINZ of the Project in sufficient time once construction is planned, of the Project and associated AtN, as well as the new indicated anchorages as approved by the harbour master are requirements routinely included as consent conditions in maritime development projects.

Given the low volume of small vessel traffic currently experienced and that the proposed farm will not generate high levels of activity, traffic levels will still remain low overall. Given that any increase will involve professional workboat crews, it is not expected that their movements would threaten the safety of other vessels.

8.5 Visual Navigation

Mariners often navigate using a combination of sight, radar, AIS, and chart plotters. It is critical that the visual elements in terms of lighting at night and general appearance and correct marking during the day be considered from a navigational risk perspective.

8.5.1 Lights and Marks

For the lighting to be effective the farm will need to be appropriately lit and marked to the satisfaction of the Harbourmaster, if authority has been delegated, or the Director of Maritime NZ. It is recommended that the final design and configuration of the AtoN is detailed as a consent condition. The proposed design has limited above waterline structures that may be difficult to see from a distance.

In accordance with the Maritime NZ Marine Farm Guidelines, the following have been considered when designing AtoN for the Project:

- **Background lights:** there is a lack of background lights at the proposed location of the marine farms and so this will not be an issue. The only other lights in the vicinity will be from vessels at anchor or navigating near to the proposed marine farm location.
- **Relationship to surrounding features, natural or constructed:** the proposed marine farms are in an isolated area of the country with no nearby constructed features. The southernmost corner of the proposed marine farming area is close to Newton Rock.

- **Local traffic:** while the proposed farm Project area is located near the transit routes in Foveaux Strait and the Oban to Bluff route, there is little evidence of other vessels routinely following natural routes (the shortest direct, safe path) while transiting through or near the proposed Project area.
- **Placement of AtoN on landward or seaward side:** there will be vessels navigating both landward and seaward of the proposed marine farming area.
- **Existing AtoN:** there are no existing AtoN in the vicinity of the proposed marine farms.
- **Availability category:** IALA recommend that AtoN provided for an offshore aquaculture farm should have an availability Category 2 – 99.0% (Table 8.2). However, for areas of high risk – such as offshore marine farms – an availability Category 1 (99.8%) may be more appropriate. Given that the proposed marine farms will be close to large vessel anchorages, the cardinal mark lights should be considered Category 1. Modern off-the-shelf lighting technology is very robust and can be expected to meet these requirements. Availability Category 2 is adequate for the special marks on the marine farm pens. In both cases, automatic fault reporting should be included in the equipment selection.

Table 8.2: IALA availability categories.

Category	Type of AtoN	Availability target	Recommended response time	Example of use	Relevance to marine farms
1	Considered to be of primary navigational significance.	99.8%	Immediately	Used to mark primary routes, channels, waterways or dangers.	Likely category for offshore marine farms.
2	Considered to be of navigational significance.	99.0%	24 hours	Used to mark secondary routes and to supplement marking of primary routes.	Default for marine farm AtoN.
3	Considered to be of necessary navigational significance.	97.0%	Next working day	-	May be suitable in areas of low traffic / lower risk environments.

The nature of construction requires compensation buoys to be attached to the mooring nodes. The position of these buoys marks the extent of the mooring node plates and enables marking of the extremities of the pens. In addition, IALA Guideline 1162 The Marking of Offshore Man-made Structures recommends, at minimum, the use of special marks on the corners of rectangular marine farms.

The proposed lights and marks for each stage of the farm Project are shown in Figure 8.2. Note this arrangement assumes that each group of ten pens is positioned close to its twin group. It is recommended, however, that should the arrangement be changed so that the overall width of the group is greater than the length (5 pens), then all four corners of each group should have lights installed.

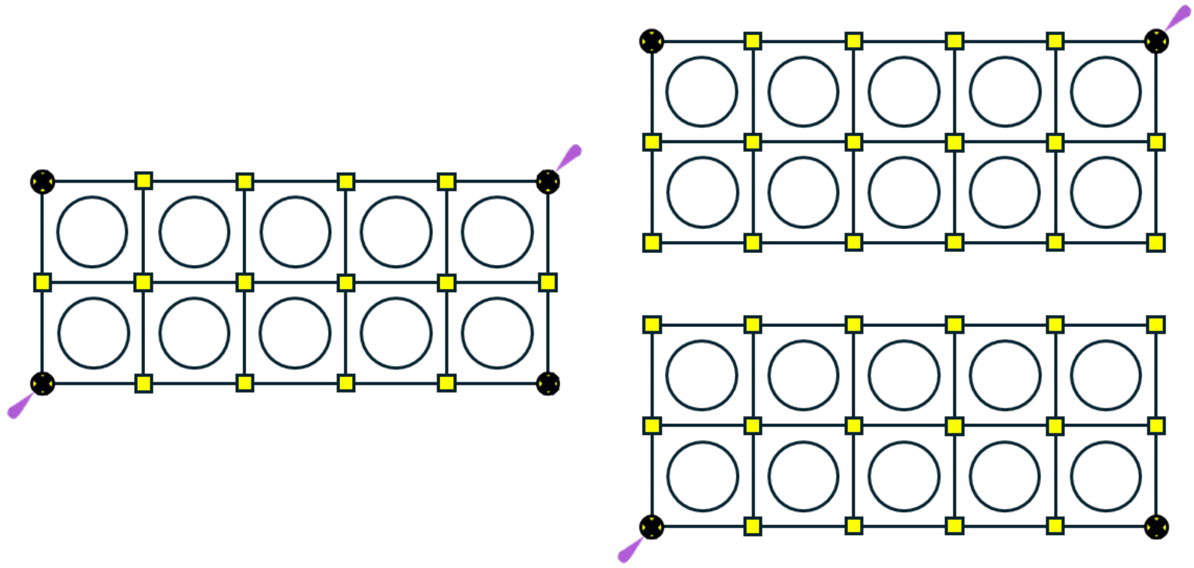

Figure 8.2: Proposed marine farm lighting (left: stage one, right: stage two) where a yellow square denotes a yellow compensation buoy, a yellow circle with an 'X' denotes a yellow special mark with a yellow cross shape on a short post, and a purple drop denotes a flashing yellow light.

In addition, the feed barge – positioned between each pair of farms but slightly offset from them (refer Figure 3.7) – will also need to be lit to show its presence and physical extent. There may also be a requirement to show the dangers to navigation that extend out from the barge such as feeding tubes.

To be effective and fit for purpose, all lights should be purpose built and suitable for the anticipated sea conditions. To avoid confusion, the lights should have synchronised flashing to enable comprehension of the full form of the structures. The navigation light flashing/oscillating sequence should meet a defined IALA pattern.

The recommended light characteristic for the special marks is to flash yellow every 5 seconds with the flash sequence GPS-synchronised across the entire farm. The light should have a minimum nominal range of 2 nautical miles (~4km). This will ensure that small to medium sized vessels choosing to navigate between the farms and the north-eastern coastline of Stewart Island/Rakiura are kept within range of the lights – the coastline along this stretch of water is no more than 1.8 nautical miles (~3km) from the Project area (Figure 8.3) – and so are kept aware of the farm's presence.

Having navigational lighting at night on fixed structures in known positions will create additional points of reference for mariners in an area with limited navigational lights. It is anticipated that having a well-marked and accurately charted farm in the proposed location could aid nighttime visual navigation and situational awareness in the area.

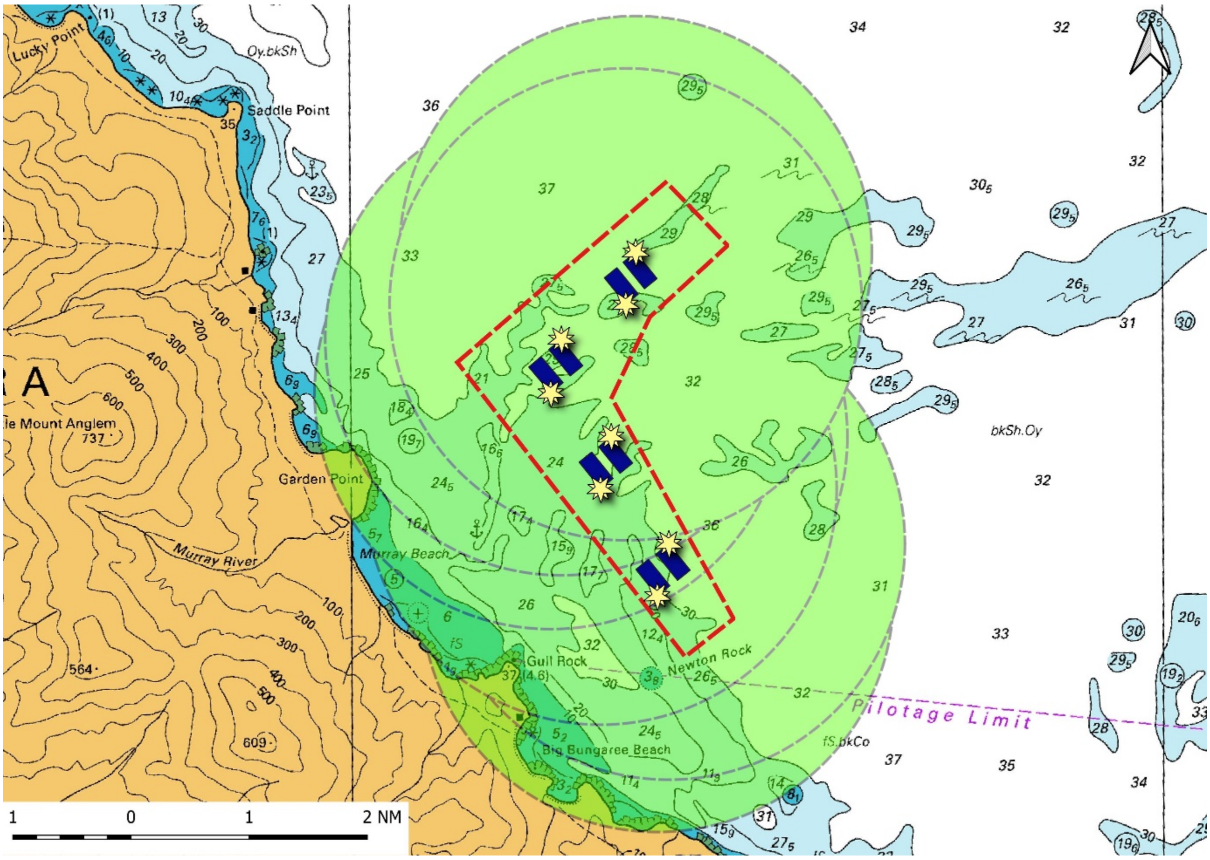

Figure 8.3: Nominal range of lighting from proposed special marks (stars indicate locations of lit special marks). Note this assume tightly group pairs of ten-pen sets. With widely spaced pairs, each ten-pen group would have two lights.

8.5.2 Northern Cardinal Mark

To delineate the northern extremity of the Project area and the associated navigational hazards, a northern cardinal mark is required. While it is assessed that few vessels transit close to or over this area, this mark will ensure that all vessel traffic understands the extent of the Project area and the associated safe water.

It is recommended that this cardinal mark be fitted with a white light with a nominal range of 6 nautical miles (~11km). This mark will be visible to all masters of large vessels and cruise ships approaching from the north-west or south-east, including from the pilotage limit for Paterson Inlet/Whaka a Te Wera, giving them sufficient time to ensure they steer clear of the marked hazards.

8.5.3 Eastern Cardinal Mark

To delineate the eastern extremity of the Project area and the associated navigational hazards, an eastern cardinal mark is required to be placed at the easternmost point, midway between the line connecting the north-eastern most and south-easternmost corners of the proposed Project area. This will highlight the hazard located to the west of the mark and ensure that the majority of vessels remain outside of the Project area and away from existing navigational dangers such as Newton Rock.

It is recommended that this cardinal mark be fitted with a white light with a nominal range of 3 nautical miles (~5.5km).

8.5.4 Southern Cardinal Mark

To delineate the southern extremity of the Project area and associated navigational hazards, a southern cardinal mark is required to be placed on Newton Rock. This will ensure that all vessel traffic understands the extent of the Project area and keep vessels away from the existing navigational hazard that is Newton Rock.

It is recommended that this cardinal mark be fitted with a white light with a nominal range of 3 nautical miles (~5.5km).

8.5.5 Western Cardinal Mark

To delineate the western extremity of the Project area and associated navigational hazards, a western cardinal mark is required to be placed on the western extremity of the proposed Project area. This will ensure that all vessel traffic understands the hazard to the east of the mark.

It is recommended that this cardinal mark be fitted with a white light with a nominal range of 3 nautical miles (~5.5km).

The proposed position of each of the special and cardinal marks described above is displayed in Figure 8.4 and Figure 8.5.

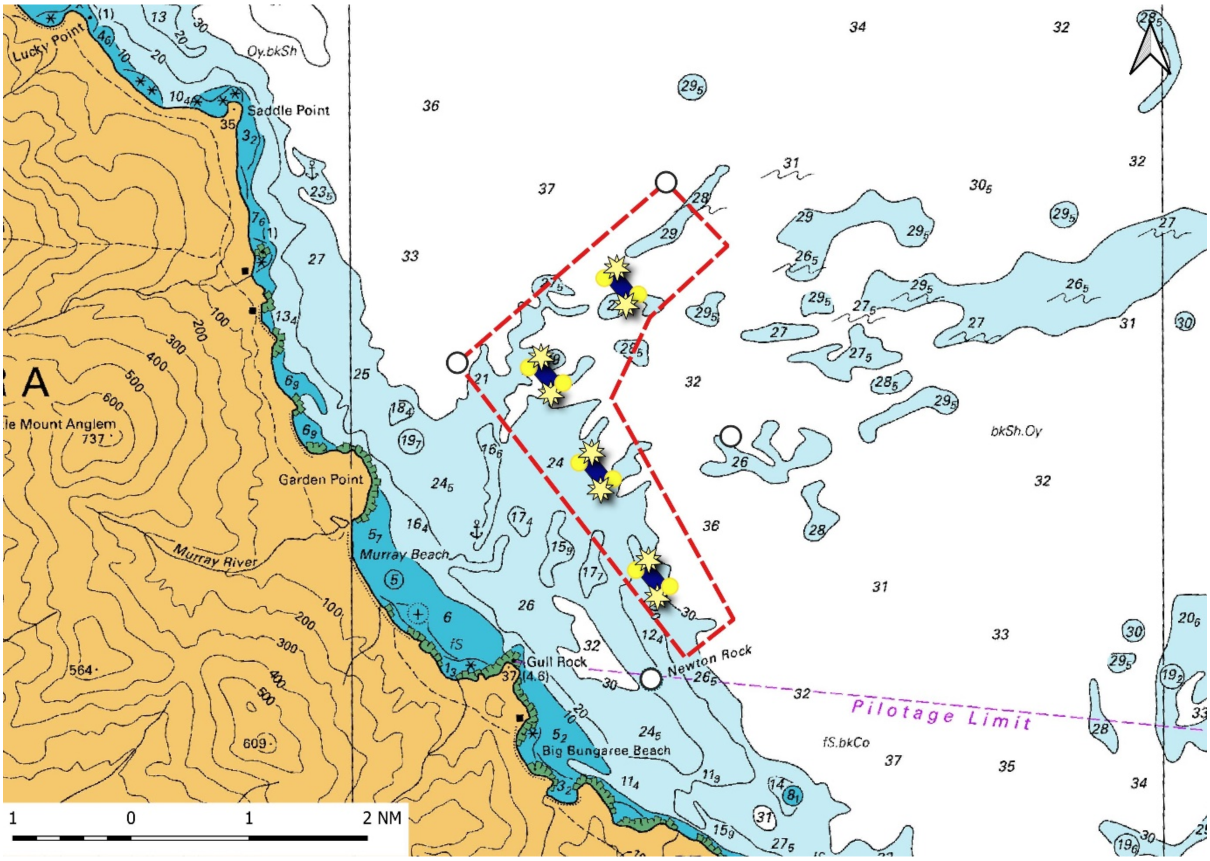

Figure 8.4: Proposed lighting for stage 1 farms (star denotes a lit special mark, white circles are cardinal marks, yellow circles are unlit special marks).

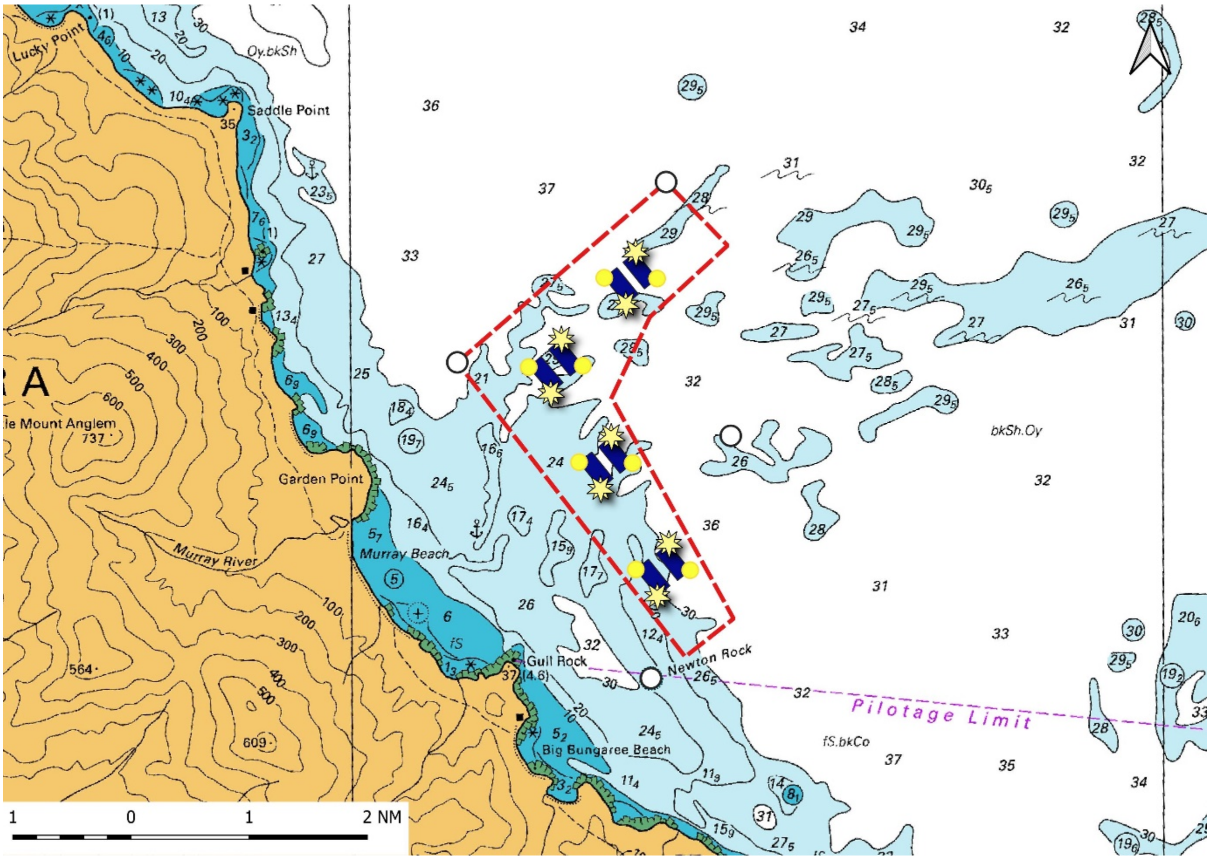

Figure 8.5: Proposed lighting for stage 2 farms (star denotes lit special marks, white circles are cardinal marks, yellow circles are unlit special marks).

8.5.6 Visual Appearance

The farm needs to be considered from a visual amenity perspective. This is covered in detail in the expert report to be completed by Isthmus but is also discussed here.

From a navigational safety perspective, it is essential that the farm location is made apparent to mariners by all practical means. While the farm itself will be more visually prominent due to the seal jump fencing and bird mesh above the floating collar, it is imperative that the farm structure and any buoys are clearly visible to mariners under as wide a range of conditions as reasonably possible. Given the understanding that the farm should aim not to be any more visually prominent than is required, maritime visibility can be enhanced by means of radar reflector, navigational lights, buoys, maritime day-shapes, and virtual means.

It is critical to note that IALA recommends that the nominal range of lighting is calculated for a meteorological visibility of 10 nautical miles (~18.5km) with differing illuminance at the eye of an observer based on whether it is day or nighttime[26]. In effect, this means that whilst the nominal range of lighting as recommended in Section 8.5.1 ranges from 2 to 6 nautical miles (~4km – 11km), the actual visibility of the lights will vary based on the meteorological visibility at the time of observation. It should also be noted that lights designed to meet IALA standards have deliberate vertical divergence (refer Section 3.6.4).

[26] IALA. (2017). *MARINE SIGNAL s - CALCULATION, DEFINITION AND NOTATION OF LUMINOUS RANGE*. https://www.iala.int/product/r0202/

Figure 8.6 illustrates the nominal ranges of the recommended AtoN in 10 nautical mile meteorological visibility. The northern cardinal mark, with a nominal range of 6 nautical miles (~11km), will be the most visible light associated with the Project. The other cardinal marks may, at times, be visible at night from the coast. Some of the special mark lights will be visible from coastal areas in clear visible conditions.

Table 8.3 sets out the risk treatments that may impact visual amenity and how these may be altered to reduce their impact.

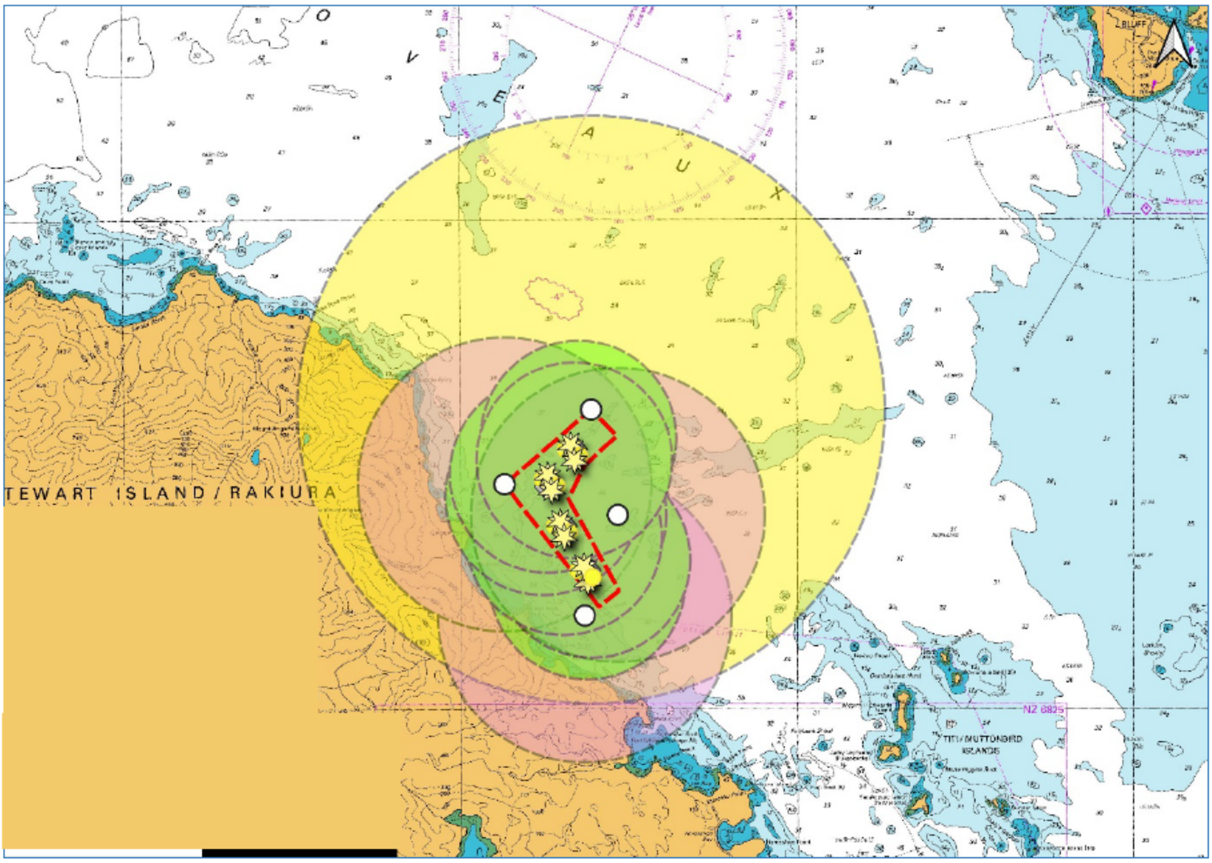

Figure 8.6: Nominal ranges of proposed lighting in 10 NM meteorological visibility conditions (green = nominal range of special marks, gold = nominal range of northern cardinal mark, purple = nominal range of other cardinal marks).

Table 8.3: Potential impacts on visual amenity and associated potential mitigations.

Risk Treatment	Potential impact on visual amenity	Potential mitigations
Alternative anchorages	Large ship less visible from Stewart Island/Rakiura.	The alternative anchorages may result in large vessels anchoring further from Murray Beach than is currently the case. This will reduce the visibility of large vessels at night from the coastline of Stewart Island/Rakiura. It must be noted that the charted anchorage to the north of the proposed site will remain available.

Risk Treatment	Potential impact on visual amenity	Potential mitigations
Traffic	Increased traffic due to workboats operating in and around the farms. Traffic flow changes due to the presence of the farm.	There is only a minor increase in traffic due to workboats operating in and around the farms. These are not large vessels. The placement of the Project area and farms is parallel to the general traffic flow in the area. Small to medium sized vessels may pass inland of the farms whilst large vessels will remain east in Foveaux Strait.
Lighting of location of Project and of farm structures	Cardinal marks with yellow lights are proposed to demarcate the Project area. Lights may be visible from Stewart Island/Rakiura under certain conditions. Farm structures, including the feed barges, will also be fitted with lighting.	The nominal range of lights may be adjusted to reduce their visibility from Stewart Island/Rakiura whilst remaining visible for an appropriate nominal range. IALA Guideline G1162 for the Marking of Offshore Man-Made Structures states that if the prevailing situation warrants, cardinal marking alone may be used to direct vessel traffic away from aquaculture farms. However, given the extent of the farm area, this would not be wise in this case. The 2NM nominal range of the special mark lights makes the light only visible from the coast of Stewart Island/Rakiura in near-perfect visual conditions. The marine farm lighting is sufficiently spaced out across the proposed area that visibility of the lights from a land-based observer will vary depending on their field of view. It is noted that the deck lighting of any nearby large vessel at anchor will be notable more visual than the light emitted from the AtN. However, the recognised coded flash sequence of the AtN will ensure that mariners will still be able to discern the AtN against the brighter lights of any anchored vessels.

8.6 Break-away Mitigation

The engineering and design of moorings and pens needs to assure that farm breakaway does not occur. Proper engineering design following best practice from overseas and peer review by a professional and formally recognised design engineer with suitable professional experience would help mitigate the risk.

Movement monitoring is critical to ensure rapid alert of farms that have broken free of their moorings. As the proposed farms are relatively remote and may be unmanned at times, it is critical to have early notification of a free-floating farm. It is considered reasonable that a movement monitoring regime should be employed. Movement monitoring can be achieved with a range of technology including AIS and GPS systems.

The fitting of an AIS transponder to each set of pens to mark the extent of each individual farm's location will aid in the case of a full breakaway of any group of pens.

8.7 Emergency Procedures

In the event of a breakaway event, emergency procedures covering a number of different scenarios are required to manage the event. It is assumed that suitable emergency procedures will be enforced.

8.8 Reasonable Mitigations

The following controls are considered essential to address the risks and have been assumed:

- Assurance of quality of engineering design;
- Assurance of the secure mooring of the farm (through design and engineering peer review processes);
- Policies and procedures to ensure monitoring of the mooring condition and performance (real-time and through life inspection);
- Systems and procedures to respond to mooring issues ahead of failures;
- Systems and procedures to respond to failures to all vessels in the general vicinity;
- Sound management of work activity associated with the farms (e.g. workboat crew training etc.) and ongoing assurance of this management; and
- Education and notices for local and visiting recreational users in the area on dealing with navigation around salmon farms and the hazards they create.[27]

8.9 Improvements in Navigational Safety

The presence of the farm would create a number of enhancements in navigational safety:

- Skilled mariners working on the farm, operating in an otherwise isolated area, can provide first response, a point of safety, or essential medical support for mariners in distress.
- Increase in navigational markers in an area with few existing markers for both day and night-time navigation and during periods of restricted visibility.
- If fitted with a radio reporting station, such a station could report local weather conditions and so contribute to navigational safety in the area.

[27] Salmon Farming in Tasmania http://www.mast.tas.gov.au/guides/salmon-farming-tasmania/

8.10 Engineering Design

As with other aspects of the design, the engineering of the mooring system and pen design is critical to the prevention of breakaway situations and risk. It is therefore essential that high quality engineering design is assured. Appropriate experience must be sought to ensure the design is workable and safe. To limit engineering-failure risk to an acceptable level, it is critical that the probability of an initiating event is very low. The following established controls within the engineering profession reflect this risk and would be expected:

- Design to be based on best international practice and standards and experience for similar sea conditions and type of farming operation.
- Design criteria to cover for both normal metocean conditions as well as extreme conditions and credible natural hazards that could occur during the life of the Project.
- Given that marine structures are subjected to forces and conditions that are difficult to quantify and so, together with one-off locations, different mooring systems, range of sea-bottom characteristics, and resulting conditions require experienced designers:
  - Employment of a suitably qualified professional design engineers (e.g. IntPE) for all stages of design that are novel or generally outside of established standards.
  - Following best practice engineering design and tried practices for salmon or fin-fish farms in similar conditions.
- Peer review by another independent engineer (with coastal/maritime structures training) also of IntPE or equivalent professional standing. This peer review should include confirmation of the research and calculations associated with the local environment (current and wave action), as well as the structural and load calculations.
- Oversight by a suitably qualified engineer with experience in the installation of the farm structures.
- Inclusion of the maintenance plan into the farm management systems.

In addition to ensuring that no breakaway event occurs, two additional “layers of control” are recommended and include the monitoring of the movement of a farm to give warning of a developing issue and establishing emergency procedures to warn vessels if an event occurs.

9 Existing Aquaculture Comparison

9.1 Comparison Against other Marine Farms

As part of this navigational risk assessment, the relative risk of the proposed farm Project is compared to existing farms in both New Zealand and Australia.

Key features for each of the comparison sites are:

- **Marlborough Sounds:** located within protected waters offered by the topography, the proximity to navigational routes varies with some adjacent to major shipping routes and others that are located in bays or inlets.
- **Big Glory Bay:** located within Big Glory Bay, this farm is off natural navigational routes and in close proximity to mussel farms.
- **Storm Bay (Tasmania):** located in Storm Bay, this farm is the closest comparison to the proposed farm. It has been placed off natural transit routes but in the vicinity of shipping lanes.

9.2 Summary of Comparisons

The risk evaluation for the identified factors with an indication of its relative contribution to navigational risks is in Table 9.1.

In summary, given the farm's position and the reasonable mitigations and controls discussed and assumed in this report, it is considered that the presence of the proposed Project will not make a meaningful/material difference to the navigational risk from the existing salmon farms in New Zealand that are near vessel transit routes. Storm Bay is assessed as higher risk due to proximity to shipping channels and being a more exposed location.

Table 9.1: Comparison of navigational risk elements between existing farms and the proposed farm.

	Navigational Risk Element					
Site	**Position relative to vessel routes**	**Activity in direct proximity**	**Breakaway**	**Onsite management**	**Collision exposure**	**Need for visual aids to navigation**
Marlborough Sounds	Comparable	Comparable	Comparable	Comparable	Comparable	Lower
Big Glory Bay	Lower	Lower	Lower	Comparable	Lower	Lower
Storm Bay, (Tasmania)	Comparable	Higher	Higher	Higher	Higher	Lower

10Additional Considerations

10.1 Navigational and Maritime Safety Benefits

Once in place and established and given the farm's position will be charted, visiting professional mariners will know of its presence. For these and local mariners transiting the area the farm will become a fixed, known object on which a master can determine their relative position and rate of passage. It will, in effect, serve as an AtoN. Given the general lack of highly visible defined objects in the area, there can be little doubt that the farm will prove to be a valuable navigational aid.

The navigational and maritime benefits of a farm and associated infrastructure can be summarised as:

- The proposed farm and cardinal marks will give an excellent visual reference in an area where otherwise there are only limited visual references in conditions of restricted visibility.
- As with many of the other farms, having professional and well-equipped crew on board offers both a place of refuge and probably a source of aid in the event of trouble.
- For large vessels, a defined and well-marked location that will aid navigation.
- The opportunity to position a weather station that will be able to broadcast actual conditions in the southern part of Foveaux Strait .

10.2 Construction and Installation of the Farm

10.2.1 Construction Activity

During surveying, laying of farm anchors, and installation of the farm, there will be associated vessel activity that will differ and exceed that of the normal operation of the farms. This may include pen-sets under tow at night or during the day, which mariners will need to recognise the symbol for to avoid collision with towlines that are often hard to see. The navigational safety impact of this short term and non-standard activity can be effectively managed through standard project management safety procedures, practices, and education – the maritime part of which would, in turn, need the Harbourmaster's review during its development.

Provided the construction activity is well communicated, vessels clearly marked, and curious small boat crews kept to a safe distance, there is little reason to consider that this activity should create a significant hazard to the local and visiting water users.

Construction can be expected to be adequately managed by means of a Maritime Construction Safety Management Plan (MCSMP) which will need to be reviewed and accepted by the Harbourmaster prior to construction activity beginning.

10.2.2 Maritime Construction Safety Management Plan

It is not appropriate to develop a MCSMP prior to the completion of the detailed design of the marine farms and associated construction methodology and is not recommended as being required as part of the application. However, a MCSMP will be required to ensure the risks associated with construction of the farm are properly mitigated and controlled so as not to create a hazard to other mariners, protect staff and contractors from harm and mitigate any associated liabilities. A MCSMP should cover the following:

- Introduction
  - Project overview
  - Purpose of the MCSMP
  - MCSMP development (expertise and parties involved etc)
  - Context (e.g. legislative)
- List and description of key stakeholders including:
  - South Port sea-pilots
  - Fisheries stakeholders
  - Ferry and local commercial operators
  - Community representatives (e.g. clubs)
  - Other marine activities
- Principles and priorities for maritime safety
  - Rules of the Sea
  - Engagement and oversight by the regional Harbourmaster
  - Meeting Maritime NZ rules and guidance
  - Maritime NZ approvals (if and as required)
- Construction methods and associated marine activities
- Controls
  - Shore-side establishment and assembly area
  - On water construction zone / exclusion zone
  - Lighting
  - Construction vessels and equipment management
  - Procedures:
    - Heavy lifting
    - Contractor vessel management
    - Construction diving activities
    - Construction incident / emergency response procedures

      - Visual obstruction
- Communication principles and arrangements
  - Processes for regular communication
  - Early formal notification
  - Notices to mariners
  - Contact details
- Commissioning (operational acceptance)

11 Residual Risk

As a result of the risk treatments and mitigations detailed in Sections 8 and 10, the residual navigational risk assessment for the proposed Project is as follows in Table 11.1.

Table 11.1: Risk profile associated with post-control application.

Scenario	Likelihood	Impact	Risk
Allision (large vessel)	Unlikely	Severe	Moderate
Allision (small vessel)	Possible	Minor	Low
Collision (large vessels)	Unlikely	Major	Low
Collision (small vessels)	Possible	Minor	Low
Structural failure (break-way)	Unlikely	Major	Low
Loose objects	Possible	Minor	Low

The residual risk shows a reduction across the six key scenarios. This is primarily from the controls recommended resulting in a reduction in the likelihood of an event being initiated.

While all other residual risks are rated 'low', the residual risk associated with large vessel allision remains a "moderate". This rating is driven both by the presence of large vessels in the area and by the consequence associated with such an allision. This is the combination of operational and environmental consequence. This risk, however, is assessed as comparative to the risk associated with routine business-as-usual operations that exist in the maritime environment. This residual risk is assessed as being at a level that is ALARP.

12Conclusions

The proposed Hananui Aquaculture Project is located in an area that has some navigational complexity but is overwise safe. While the sea conditions in the area can be poor and high wind conditions are expected, there are generally low levels of small and medium vessel traffic. It is also situated some distance from recognised large vessel navigation routes.

The location of established large vessel anchorages in close proximity to and overlapping the proposed site creates a notable development conflict. However, this conflict can be adequately mitigated by relocating the designated anchorages to other suitable locations in the surrounding area prior to construction commencing and issuing notices to mariners. These steps would be expected to be included in the MCSMP.

Having carried out the assessment of the hazards of the proposed Project, it is concluded that, provided the risks associated with the Project are properly mitigated, the risk will be ALARP and acceptable.

The key mitigations can be summarised as consisting of:

Navigational

- Area is suitably marked with a full set of cardinal buoys.
- Each farm is properly marked and lit with special marks.
- The position of the Project is properly charted.

Design

- Farms are engineered to established standards.
- Design criteria includes for normal metocean conditions and extreme events (including reasonably predictable natural hazards).
- Assurance of quality of engineering design.
- Assurance of the secure mooring of the farm (through design and engineering peer review processes).

Management

- Policies and procedures to ensure monitoring of the mooring condition and performance (real-time and through life inspection).
- Systems and procedures to respond to mooring issues ahead of failures.
- Systems and procedures to respond to failures to all vessels in the general vicinity.
- Sound management of work activity associated with the farms (e.g. workboat crew training etc.) and ongoing assurance of this management.

The navigational risk considered in this assessment was at a general level.

The navigational risk is assessed as comparative to the risk associated with routine operations that exist in the maritime environment.

Having carried out the assessment of the hazards of the proposed farm area and compared this to the situations of other existing farms in New Zealand and Tasmania, it is concluded that given the above-mentioned practical mitigations including relocating the designated anchorages, the risk associated with the proposed farm locations can be adequately managed.

Appendix A AIS Density Maps

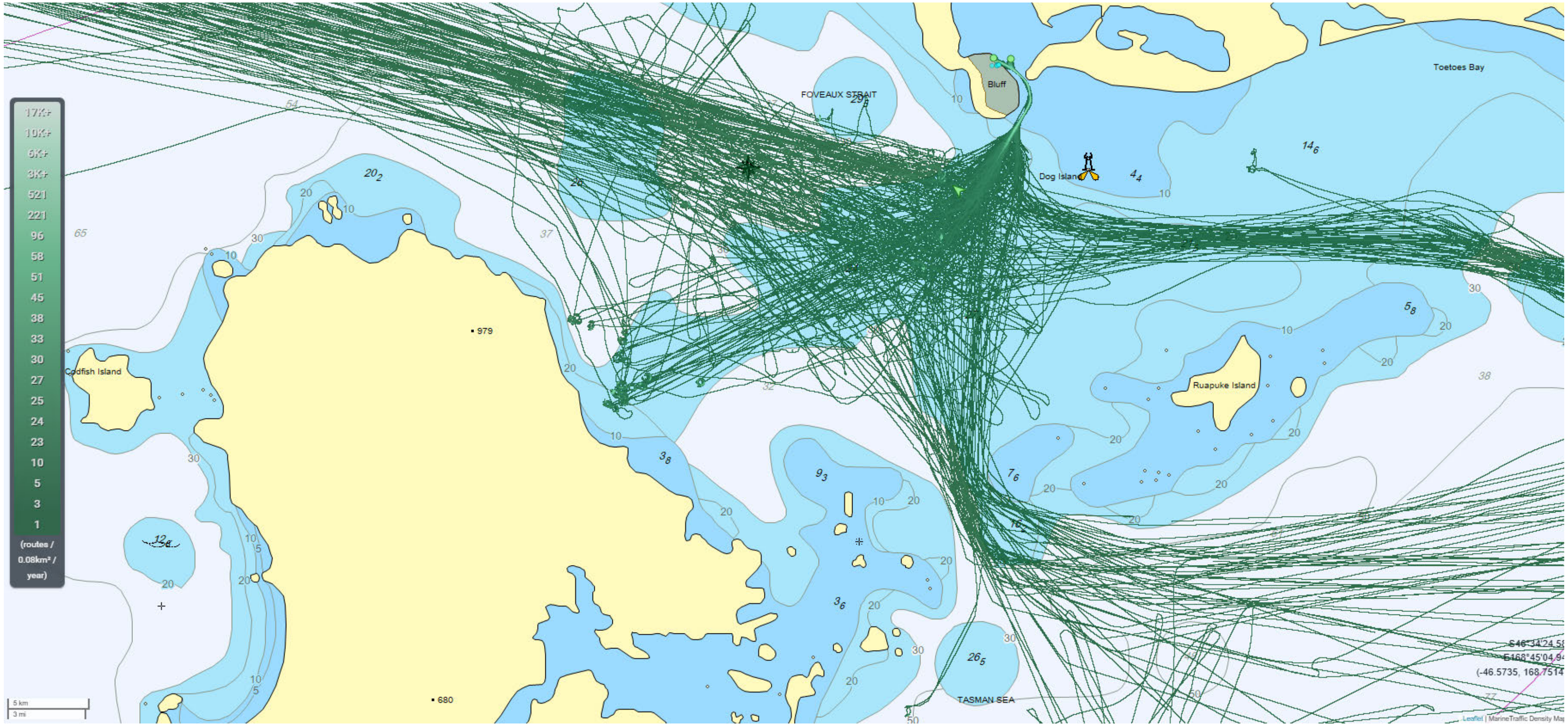

Figure A.1: Cargo vessel AIS density map for 2023.

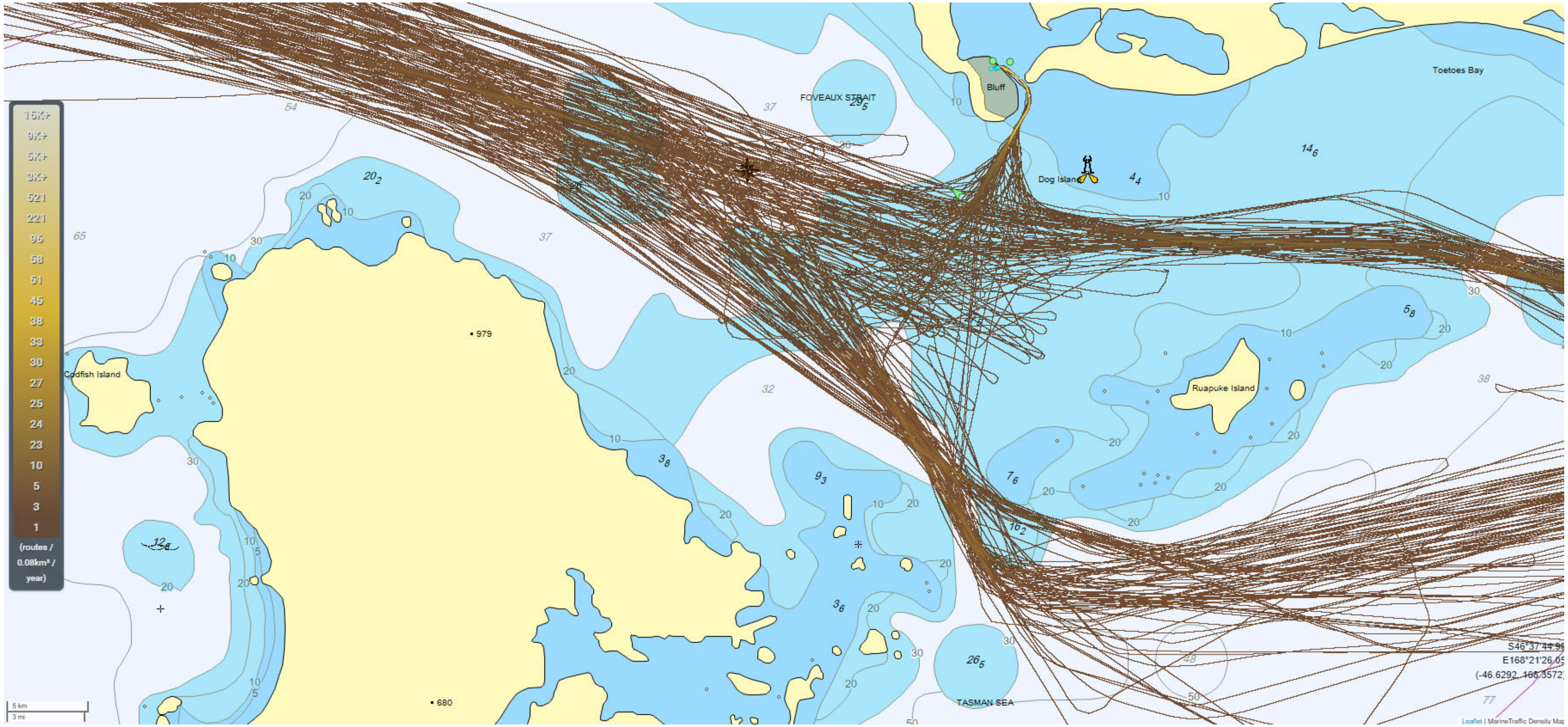

Figure A.2: Container AIS density map for 2023.

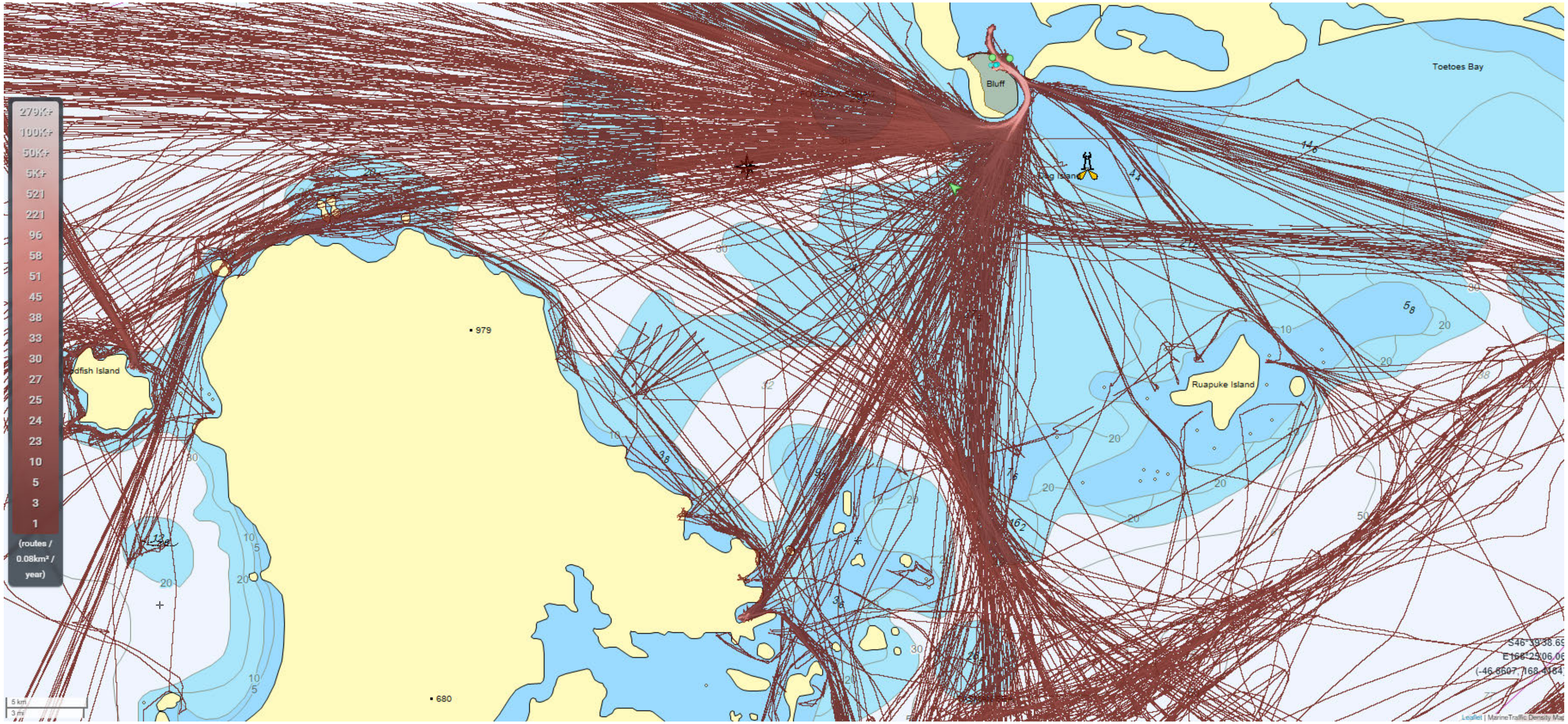

Figure A.3: Fishing vessel AIS density map for 2023.

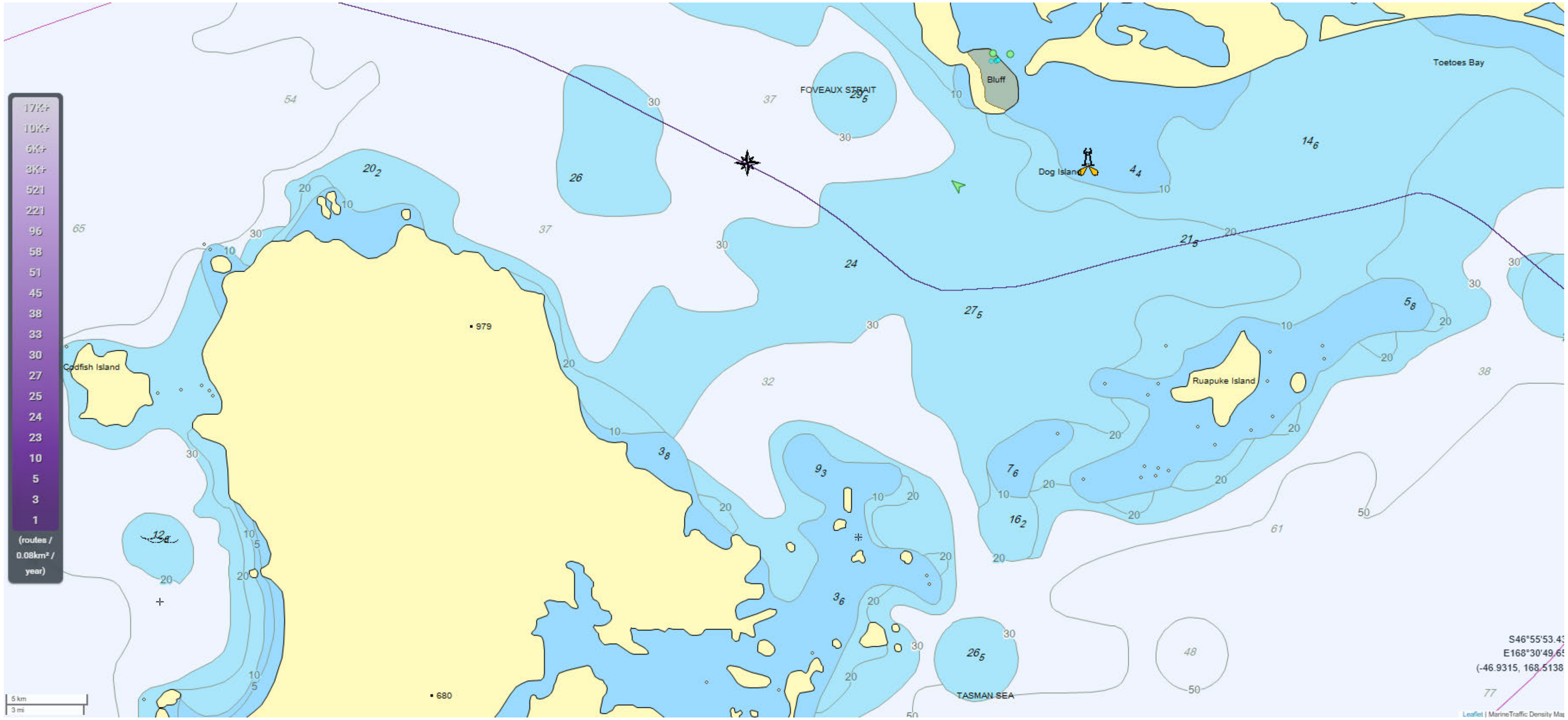

Figure A.4: LPG tanker AIS density map for 2023.

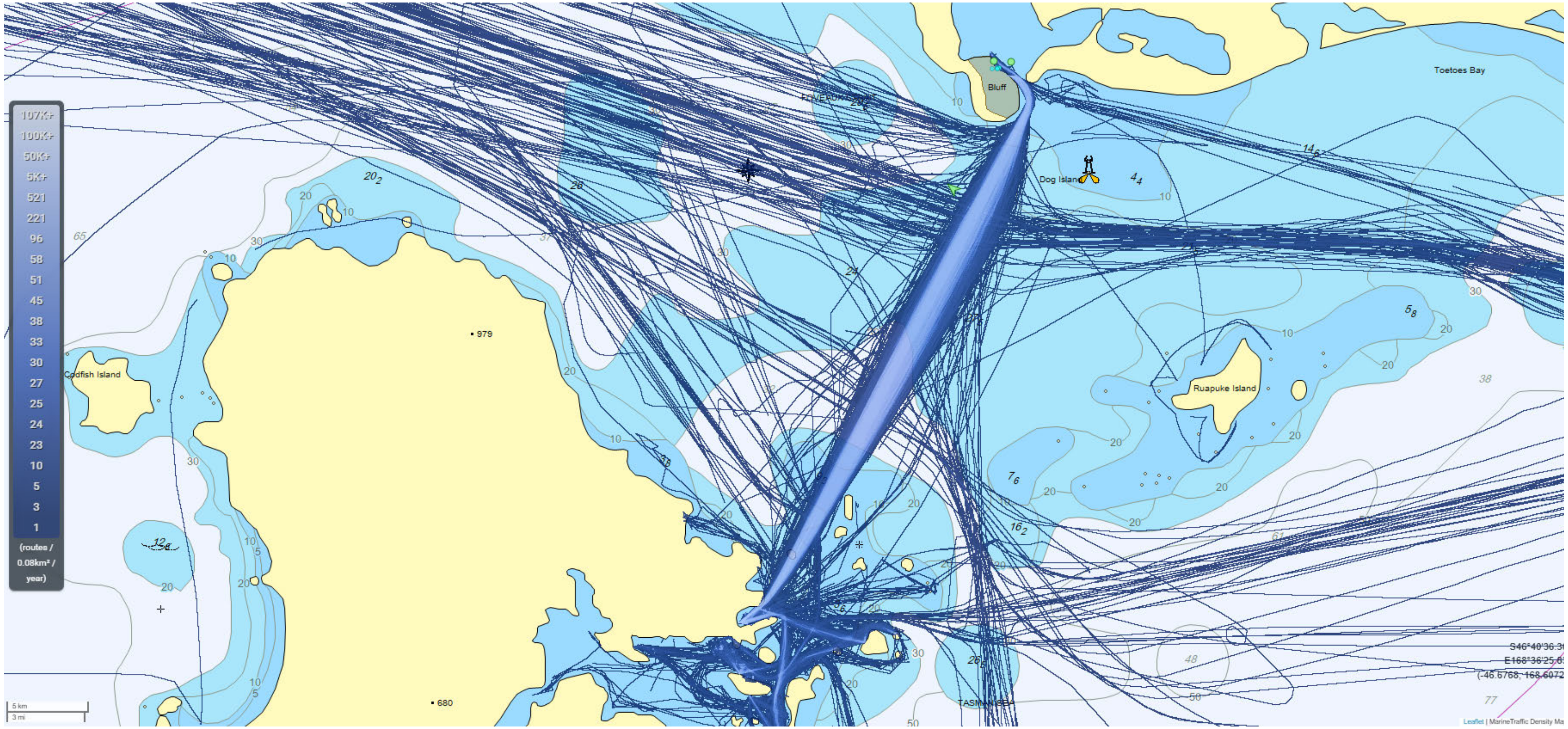

Figure A.5: Passenger vessel AIS density map for 2023.

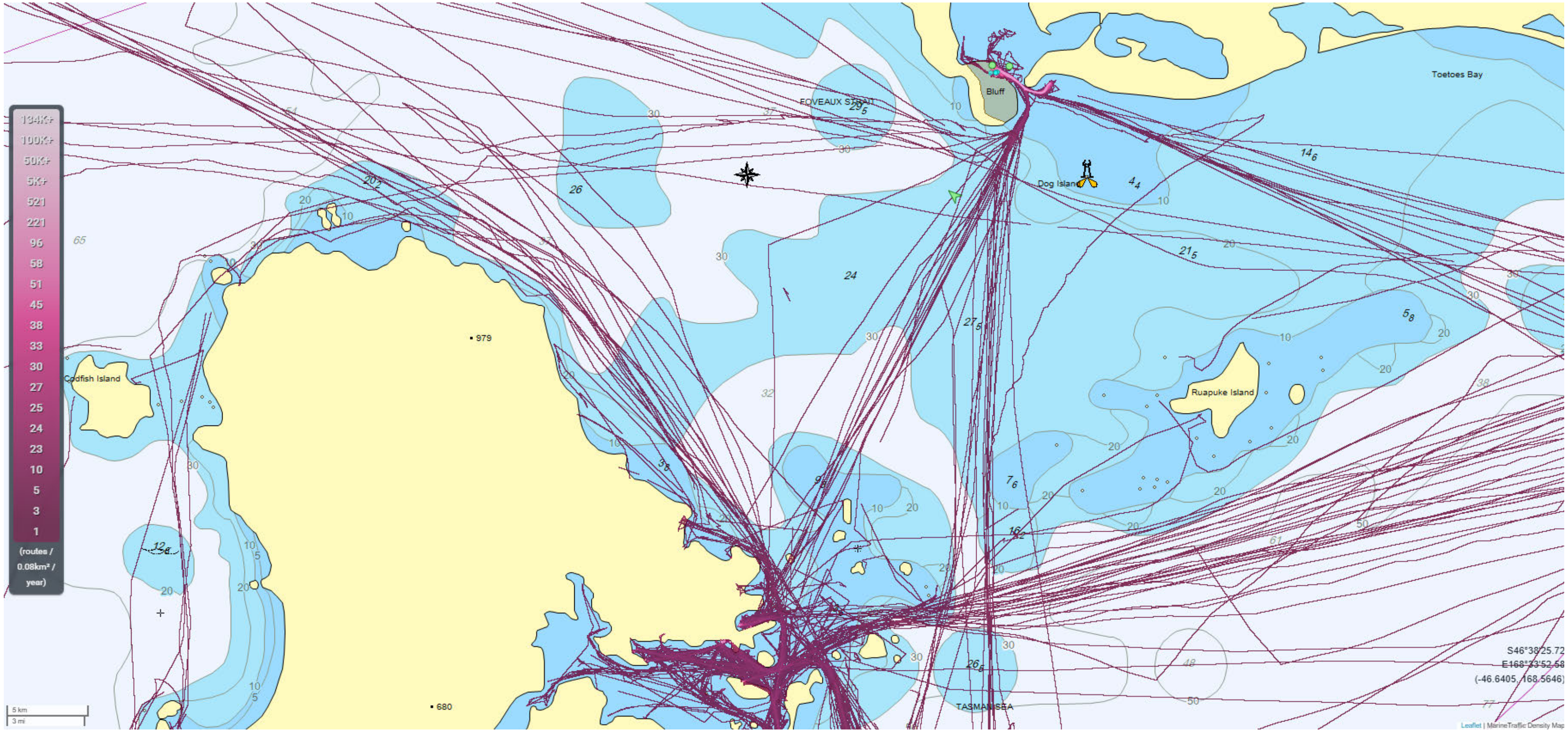

Figure A.6: Pleasure craft AIS density map for 2023.

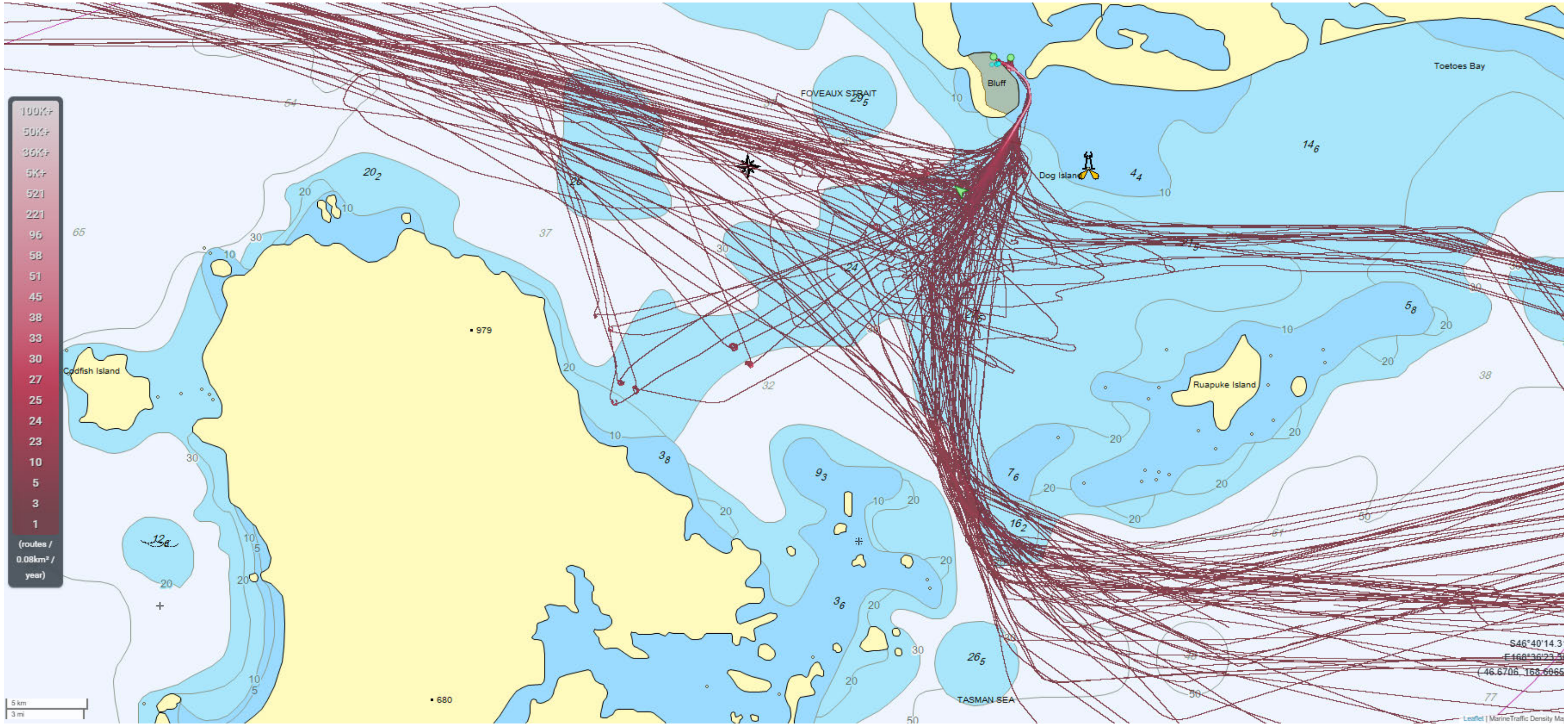

Figure A.7: Tanker AIS density map for 2023.

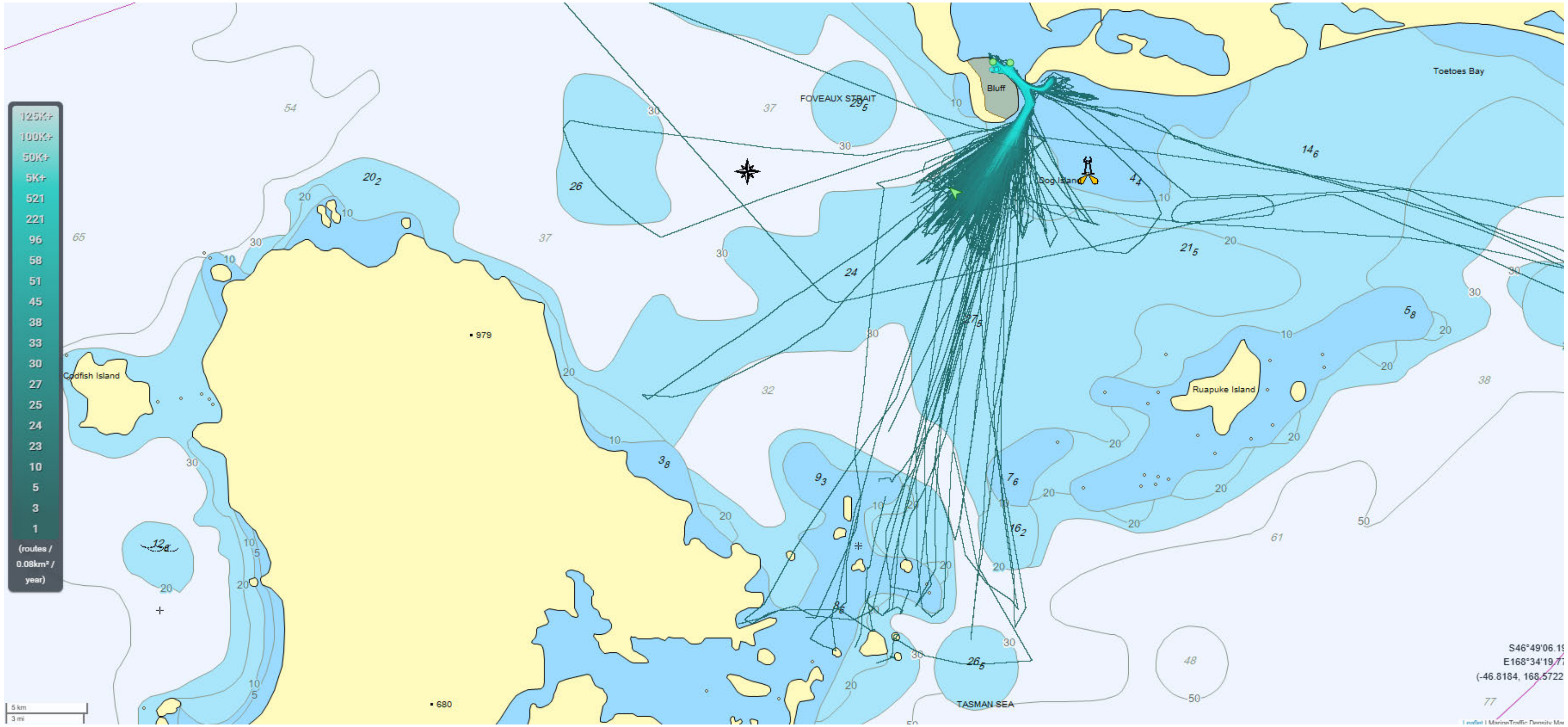

Figure A.8: Tug and special craft AIS density map for 2023.

Appendix B AIS Metadata

Metadata for the AIS data analysed as part of this risk assessment is listed in .

Data Field	Description
DATE TIME (UTC)	Date and time in UTC when the AIS recorded the vessel position.
MMSI	MMSI number of the vessel.
LATITUDE	Geographical latitude coordinate in WGS84.
LONGITUDE	Geographical longitude coordinate in WGS84.
COURSE	Course over ground (degrees).
SPEED	Speed over ground (knots).
HEADING	Heading (degrees) of the vessel's hull.
NAVSTAT	AIS Navigation Status as reported by the vessel.
IMO	IMO number of the vessel.
NAME	Name of the vessel.
CALLSIGN	Callsign of the vessel.
AISTYPE	Type of the vessel according to AIS Specification.
A	Dimension (metres) from the AIS GPS antenna to the bow of the vessel.
B	Dimension (metres) from the AIS GPS antenna to the stern of the vessel.
C	Dimension (metres) from the AIS GPS antenna to the port of the vessel.
D	Dimension (metres) from the AIS GPS antenna to the starboard of the vessel.
DRAUGHT	Draught of the vessel in metres.
DESTINATION	Port of destination (manually entered).
ETA	Estimated time of arrival at the port of destination (manually entered).

Appendix C Risk Register

			Initial Risk Assessment (most likely)			Residual Risk Assessment			
ID	Hazard	Causal Factor(s)	Likelihood	Impact	Risk Rating	Mitigations	Likelihood with Mitigations	Impact with Mitigations	Residual Risk Rating
1	Allision (large vessel)	Out of date information Low visibility of pens Not expecting a marine farm Large area and distance between farms Farm configuration changes over time Farm not contiguous or consistent in layout Vessels drifting / dragging Vessel not under command	Possible	Severe	High	1. Lighting and marking of farm extremity and farm structures creates a landmark for navigation. 2. Farm charted. 3. Notice to Mariners issued. 4. Farms parallel to coastline and general traffic flow. 2. 5. Pilot advice	Unlikely	Severe	Moderate
1	Allision (small vessel)	Out of date information Low visibility of pens Inquisitive nature Route not clear Obstruction between feed barge and pens Not expecting a marine farm Large area and distance between farms Farm configuration changes over time Farm not contiguous or consistent in layout Vessels attempting to cut between pens/farms/feed barges	Likely	Minor	Low	1. Lighting and marking of farm extremity and farm structures creates a landmark for navigation. 2. Farm charted. 3. Notice to Mariners issued. 4. Farms parallel to coastline and general traffic flow.	Possible	Minor	Low

3	Collision (large vessel)	Concentration of traffic Less navigable water Funnelling of vessels towards anchored vessels Reduced anchorage area Drifting instead of anchoring	Unlikely	Major	Low	1. Lighting and marking of farm creates a landmark for navigation. 2. Alternative anchorages to north and east of proposed Project area.	Unlikely	Major	Low
3	Collision (small vessel)	Concentration of traffic Less navigable water Funnelling of vessels towards shore Additional traffic Reduced anchorage area	Probable	Minor	Moderate	1. Lighting and marking of farm creates a landmark for navigation.	Possible	Minor	Low
4	Structural failure (breakaway)	Weather conditions Tsunami Poor maintenance Design not suitable Design error Mooring failure Structural failure Vessel collision with farm	Possible	Major	Moderate	1. Peer reviewed engineering design. 2. Farm structure and mooring system designed using international best practice and standards. 3. Farm designed to withstand extreme weather events and a 1 in 300-year tsunami event. 4. Lighting and marking of farm extremity and structures. 5. Real-time monitoring of structure position.	Unlikely	Major	Low
4	Loose objects / debris	Weather conditions Poor maintenance Equipment failure Poor practice Poor training Lack of structural management plan	Likely	Minor	Low	1. Asset management Plan or similar 2. High standards 3. Formal training systems 4. Ship's husbandry standards 5. Human monitoring of farm.	Possible	Minor	Low

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